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DESCRIPTION AND OPERATION

ENGINE CONTROL MODULE DESCRIPTION

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

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

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

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

ECM Function

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

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

EEPROM

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

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

Data Link Connector (DLC)

The data link connector (DLC) provides serial data communication for ECM diagnosis. This connector allows the technician to use a scan tool in order to monitor various serial data parameters, and display DTC information. The DLC is located inside the driver's compartment, underneath the instrument panel.

Malfunction Indicator Lamp (MIL)

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

ECM Service Precautions

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

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instructs you to do so. These circuits should only be tested with a DMM unless the diagnostic procedure instructs otherwise.

Emissions Diagnosis For State I/M Programs

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

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

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

Aftermarket (Add-On) Electrical And Vacuum Equipment

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

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

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

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

Electrostatic Discharge (ESD) Damage

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

The electronic components that are used in the control systems are often designed to carry very low voltage. These electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 V of static electricity can cause damage to some electronic components. By comparison, it takes as much as 4, 000 V for a person to even feel a static discharge.

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

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

Emissions Control Information Label

The underhood Vehicle Emissions Control Information Label contains important emission specifications. This identifies the year, the displacement of the engine in liters, and the class of the vehicle.

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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. The returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

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

Electronic Returnless Fuel System

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

Fuel Pump Driver Control Module

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

Fuel Pressure Sensor

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

Fuel Tank

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

Fuel Fill Pipe

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

Fuel Tank Fuel Pump Module

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

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

- The fuel level sensor
- The fuel pump and reservoir assembly

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

Fuel Level Sensor

The fuel level sensor consists of a float, a wire float arm, and a ceramic resistor card. The position of the float arm indicates the fuel level. The fuel level sensor contains a variable resistor which changes resistance in correspondence with the position of the float arm.

Fuel Pump

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

Pressure Relief Regulator Valve

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

Fuel Strainer

The fuel strainer attaches 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 fuel. The fuel strainer normally requires no maintenance. Fuel stoppage at this point indicates that the fuel tank contains an abnormal amount of sediment or contamination.

Fuel Filter

The fuel filter is located on the fuel feed pipe, between the low pressure fuel pump and the high pressure fuel pump. The paper filter element traps particles in the fuel that may damage the fuel injection system. The filter housing is made to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature.

Nylon Fuel Pipes

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

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

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

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

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

Quick-Connect Fittings

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

Fuel Feed Front Pipe Check Valve

The one way in-line check valve is a part of the fuel feed front pipe. The check valve is located just before the high pressure fuel pump. Fuel flows into the large end of the check valve and unseats a round check ball. Fuel then flows around the check ball and out the small end and the holes around the small end. The check ball is seated closed by a spring when the fuel pressure is very low. The spring seats the check ball and keeps the fuel from draining back when the engine is not operating in order to help prevent long cranking times. The check valve also acts as a pulse damper to help limit the high pressure fuel pump pressure pulsations from affecting the low side fuel pressure sensor located by the fuel tank.

High Pressure Fuel Pump

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The pump is mounted on the rear of the engine and is driven by a four-lobe cam on the camshaft. This pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2 to 20 MPa (290 to 2, 900 PSI), depending on engine speed and load. Output drivers in the ECM provide the pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by closing and opening the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail. When the control solenoid is NOT powered, the pump operates at minimum flow rate. In the event of pump control failure, the high pressure system is protected by a relief valve in the pump.

Fuel Rail Assembly

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

- The direct fuel injectors
- The fuel rail pressure sensor

Fuel Injectors

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

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

Fuel Injection Fuel Rail Fuel Pressure Sensor

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

Fuel Metering Modes of Operation

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

Starting Mode

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

Clear Flood Mode

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

Run Mode

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

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

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

Acceleration Mode

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

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Deceleration Mode

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

Battery Voltage Correction Mode

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

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

Fuel Cutoff Mode

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

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

Fuel Trim

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

CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

Circuit/System Description

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

- Engine power output
- Fuel economy

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- Lower exhaust emissions

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

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

Camshaft Position Actuator System Operation

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

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

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

The ECM can also command the camshaft position actuator solenoid valve - Intake and camshaft position actuator solenoid valve - exhaust to stop oil flow from both passages in order to hold the current camshaft position. The ECM is continuously comparing camshaft position sensor - intake and camshaft position sensor - exhaust input with camshaft position actuator solenoid valve - Intake and camshaft position actuator solenoid valve - exhaust input in order to monitor camshaft position and detect any system malfunctions. The following table provides camshaft phase commands for common driving conditions:

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

Intake Camshaft Mid Park Lock (if Equipped)

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

EVAPORATIVE EMISSION CONTROL SYSTEM DESCRIPTION

Typical Evaporative Emission (EVAP) System Hose Routing Diagram

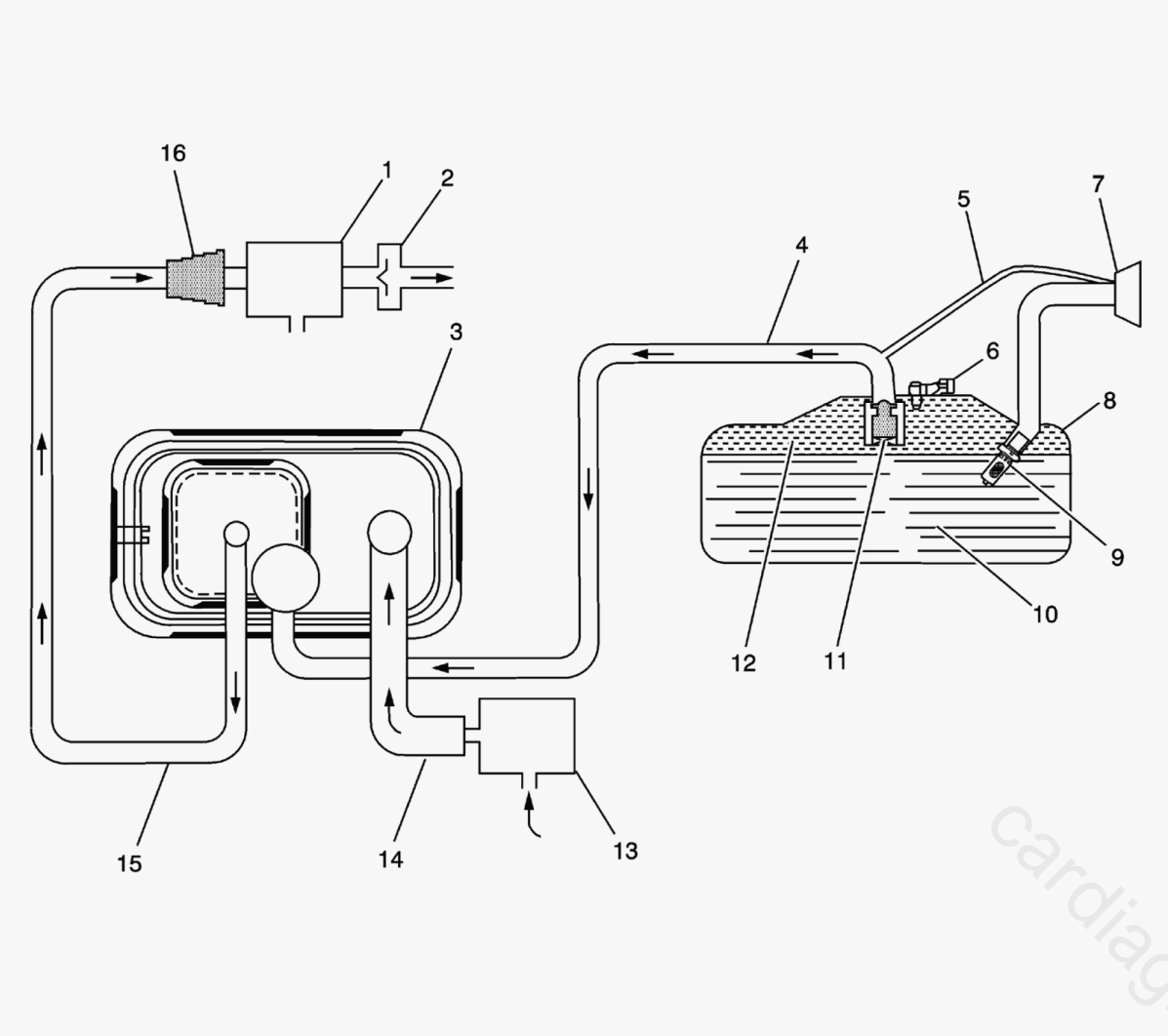

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Fig. 1: View Of Typical Evaporative Emission (EVAP) System Hose Routing Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Evaporative Emissions (EVAP) Purge Solenoid Valve
2	Purge Tube Check Valve, Turbo-Charged Applications Only
3	EVAP Canister
4	EVAP Vapor Tube
5	Vapor Recirculation Tube (ORVR)
6	Fuel Tank Pressure Sensor
7	Fuel Filler Cap (Some Vehicles May Have A Capless Design)
8	Fuel Tank
9	Fuel Fill Pipe Inlet Check Valve
10	Liquid Fuel
11	Fill Limit Vent Valve (FLVV)
12	Fuel Vapor
13	EVAP Canister Vent Solenoid Valve
14	Vent hose
15	EVAP Purge Tube
16	EVAP Canister Purge Tube Connector

EVAP System Operation

The EVAP control system limits fuel vapors from escaping into the atmosphere. Fuel tank vapors are allowed to move from the fuel tank, due to pressure in the tank, through the EVAP vapor tube, into the

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

Purge Solenoid Valve Leak Test

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

Large Leak Test

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

Canister Vent Restriction Test

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

Small Leak Test

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

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

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

EVAP System Components

The EVAP system consists of the following components:

EVAP Purge Solenoid Valve

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

Purge Tube Check Valve

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

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

EVAP Canister

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

Vapor Recirculation Tube

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

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

Fuel Tank Pressure Sensor

The fuel tank pressure sensor measures the difference between the pressure or vacuum in the fuel tank and outside air pressure. Depending on the vehicle, the sensor can be located in the vapor space on top of the fuel tank, in the vapor tube between the canister and the tank, or on the EVAP canister. A high fuel tank pressure sensor voltage indicates a low fuel tank pressure or vacuum. A low fuel tank pressure sensor voltage indicates a high fuel tank pressure.

Fuel Fill Pipe Check Valve

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

EVAP Vent Solenoid Valve

The EVAP vent solenoid valve controls fresh airflow into the EVAP canister. The valve is normally open. The canister vent solenoid valve is closed only during EVAP system tests performed by the ECM like large leak and engine off natural vacuum test.

Fuel Fill Cap

The fuel fill cap is equipped with a seal and a vacuum relief valve and is tethered. A torque-limiting device prevents the cap from being over tightened. To install the cap, turn the cap clockwise until you hear clicks. This indicates that the cap is correctly torqued and fully seated. A built-in device indicates that the fuel filler cap is fully seated. A fuel filler cap that is not fully seated may cause a malfunction in the emission system.

Capless Fuel Fill

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

Fill Limit Vent Valve

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

- The fuel limit vent valve is located on the inside top of the fuel tank
- This valve is not serviced separately

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- Controls the fuel tank fill level by closing the primary vent from the fuel tank and forcing the fuel fill nozzle to shut off.
- Prevents liquid fuel from exiting the fuel tank via the EVAP pipe to the canister.
- Provides fuel-spillage protection in the event of a vehicle rollover by closing the vapor path from the tank to the EVAP canister.

ELECTRONIC IGNITION SYSTEM DESCRIPTION

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

The electronic ignition system consists of the following components:

Crankshaft Position Sensor

The crankshaft position sensor works in conjunction with a reluctor wheel on the crankshaft (front mounted crankshaft position sensor) or a reluctor wheel that is part of the flywheel (rear mounted crankshaft position sensor). The ECM monitors the voltage frequency on the crankshaft position sensor signal circuit. As each reluctor wheel tooth rotates past the sensor, the sensor creates a digital ON/OFF pulse. This digital signal is processed by the ECM. This creates a signature pattern that enables the ECM to determine the crankshaft position. The ECM uses the signal to determine which pair of cylinders is approaching top dead center based on the crankshaft position signal alone. The camshaft position sensor signals are used in order to determine which of these 2 cylinders is on a firing stroke, and which is on the exhaust stroke. The ECM uses this to properly synchronize the ignition system, the fuel injectors, and the knock control. This sensor is also used in order to detect misfire.

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

Camshaft Position Sensor

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

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

Knock Sensor

The knock sensor system enables the ECM to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation, also known as spark knock. The knock sensor system uses 1 or 2 flat response 2-wire sensors. The sensor uses piezo-electric crystal technology that produces an AC voltage signal of varying amplitude and frequency based on the engine vibration or noise level. The amplitude and frequency depend upon the level of knock that the knock sensor detects. The ECM receives the knock sensor signal through the high and low signal circuits.

The ECM learns a minimum noise level, or background noise, at idle from the knock sensor and uses calibrated values for the rest of the RPM range. The ECM uses the minimum noise level to calculate a noise channel. A normal knock sensor signal will ride within the noise channel. As engine speed and load change, the noise channel upper and lower parameters will change to accommodate the normal

knock sensor signal, keeping the signal within the channel. In order to determine which cylinders are knocking, the ECM only uses knock sensor signal information when each cylinder is near top dead center (TDC) of the firing stroke. If knock is present, the signal will range outside of the noise channel.

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

Ignition Coils

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

Engine Control Module (ECM)

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

- Throttle position sensor
- Engine coolant temperature (ECT) sensor
- Mass air flow (MAF) sensors
- Intake air temperature (IAT) sensors
- Vehicle speed sensor (VSS)
- Transmission gear position or range information sensors
- Engine knock sensors
- Ambient pressure sensors (BARO)

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THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

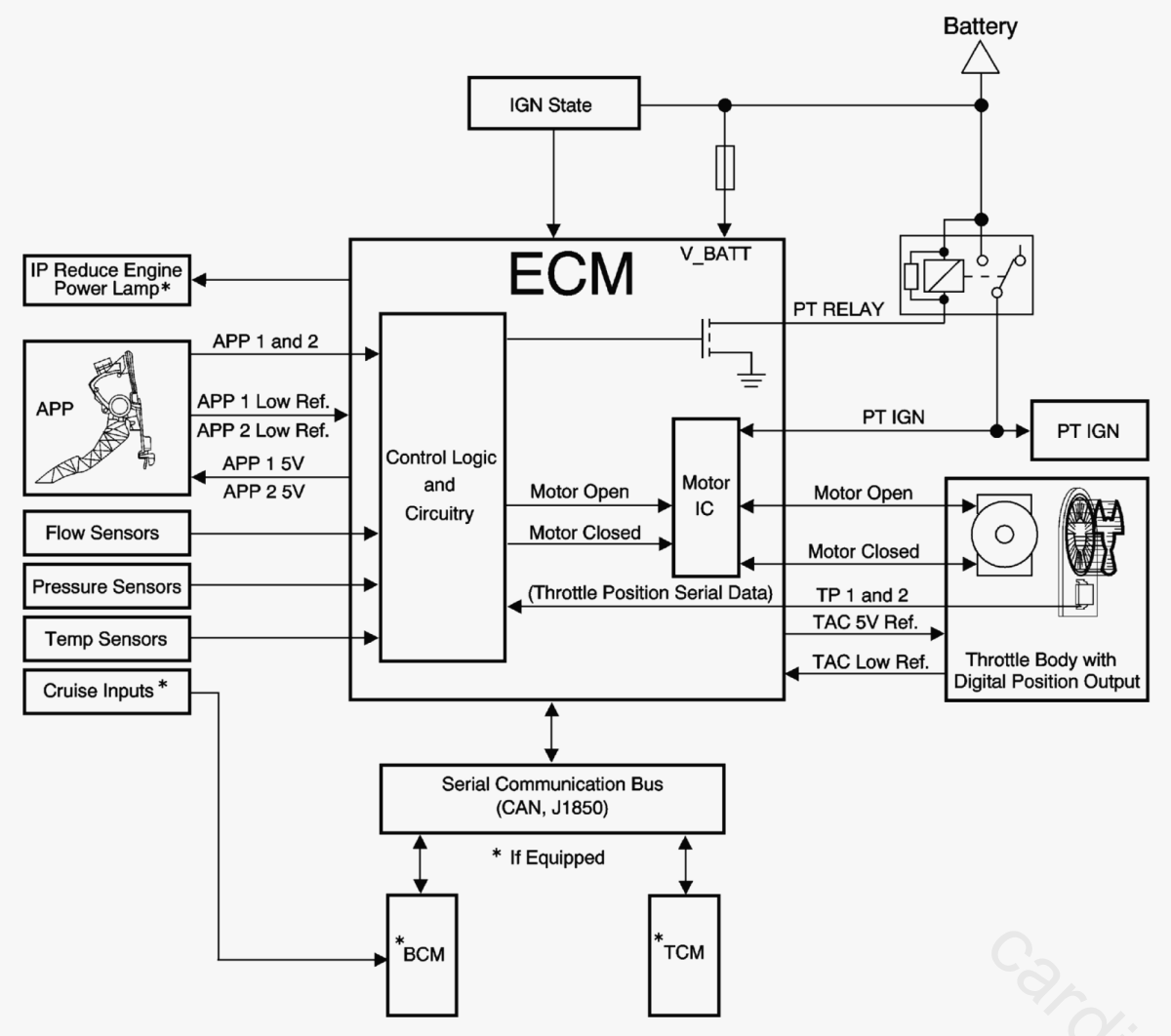

Fig. 2: Throttle Actuator Control (TAC) System Description
Courtesy of GENERAL MOTORS COMPANY

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

Modes Of Operation

Normal Mode

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

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

Reduced Engine Power Mode

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

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

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

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

The engine control module (ECM) learns the airflow through the throttle body to ensure the correct idle. The learned airflow values are stored within the ECM. These values are learned to adjust for production variation and will continuously learn during the life of the vehicle to compensate for reduced airflow due to throttle body coking. Anytime the throttle body airflow rate changes, for example due to cleaning or replacing, the values must be relearned.

An engine that had a heavily coked throttle body that has been cleaned or replaced may take several drive cycles to unlearn the coking. To accelerate the process, the scan tool has the ability to reset the learned value back to zero. A new ECM will also have values set to zero. Cleaning the throttle body when the ECM is replaced can reduce the time it take for the ECM to relearn the minimum idle speed.

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

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

TURBOCHARGER SYSTEM DESCRIPTION

Turbocharger Description and Operation

A turbocharger is a compressor that is used to increase the power output of an engine by increasing the mass of the oxygen and therefore the fuel entering the engine. The dual-scroll turbocharger is mounted either to the exhaust manifold or directly to the head. The turbine is driven by the energy generated by the flow of the exhaust gases. The turbine is connected by a shaft to the compressor which is mounted in the induction system of the engine. The centrifugal compressor blades compress the intake air above atmospheric pressure, thereby increasing the density of the air entering the engine.

The turbocharger incorporates a wastegate that is controlled by the ECM, by means of a pulse width modulated (PWM) solenoid, to control boost pressure. A turbocharger bypass valve (compressor recirculation valve), controlled by the ECM, is used to prevent compressor surging and damage by opening during abrupt closed throttle conditions. The bypass valve opens during closed throttle deceleration conditions, which allows the air to recirculate to the turbocharger compressor inlet. During a wide open throttle command, the bypass valve closes to optimize turbo response.

The turbocharger is connected to the engine oiling system by a supply and drain pipe. The oil is required for the bearing system function and also serves to carry some heat from the turbocharger. There is a cooling system circuit in the turbocharger that further reduces operating temperatures and passively dissipates bearing housing heat away from the turbocharger on shut down.

Wastegate Solenoid Valve

The wastegate valve opens and closes a bypass passage beside the turbine wheel. A spiral spring works in the closing direction while the pressure in the diaphragm works in the opening direction. The ECM supplies a PWM signal to the solenoid valve, which then allows pressure from the turbo to come through. When the pressure overcomes the spring force the actuator rod begins to move, opening the wastegate valve to a corresponding degree. The ECM changes wastegate valve opening by varying the PWM signal, which regulates the turbine speed.

At low loads, the wastegate valve is closed. All the exhaust gas then passes through the turbine. At high loads, the volume of exhaust gas is greater, which makes the turbine wheel rotate faster. This delivers a greater air displacement to the engine.

When the air displacement becomes so large that the current air mass per combustion cannot be controlled with the throttle alone, the turbo must be regulated. This is done by opening the wastegate valve so that some of the exhaust gas passes through the wastegate. Consequently, this gas does not contribute to driving the turbine and the turbine speed will be regulated so that the turbo air displacement will be correct.

When certain DTCs are set the ECM will limit the amount of available boost pressure. Limiting boost pressure is accomplished by the ECM controlling the wastegate actuator solenoid valve and maintaining the duty cycle at 0 %. This means that the ECM will not actively close the wastegate during greater engine loads. The system at this point is limited to mechanical boost. Mechanical boost means that the wastegate will still move, but the amount of motion is limited by the mechanical properties of the return spring within the diaphragm valve, the pneumatic properties of the actuator, and the physics of the exhaust gas flow in the exhaust system.

The following diagrams illustrate the turbocharger wastegate closed and open conditions:

Turbocharger Wastegate Closed

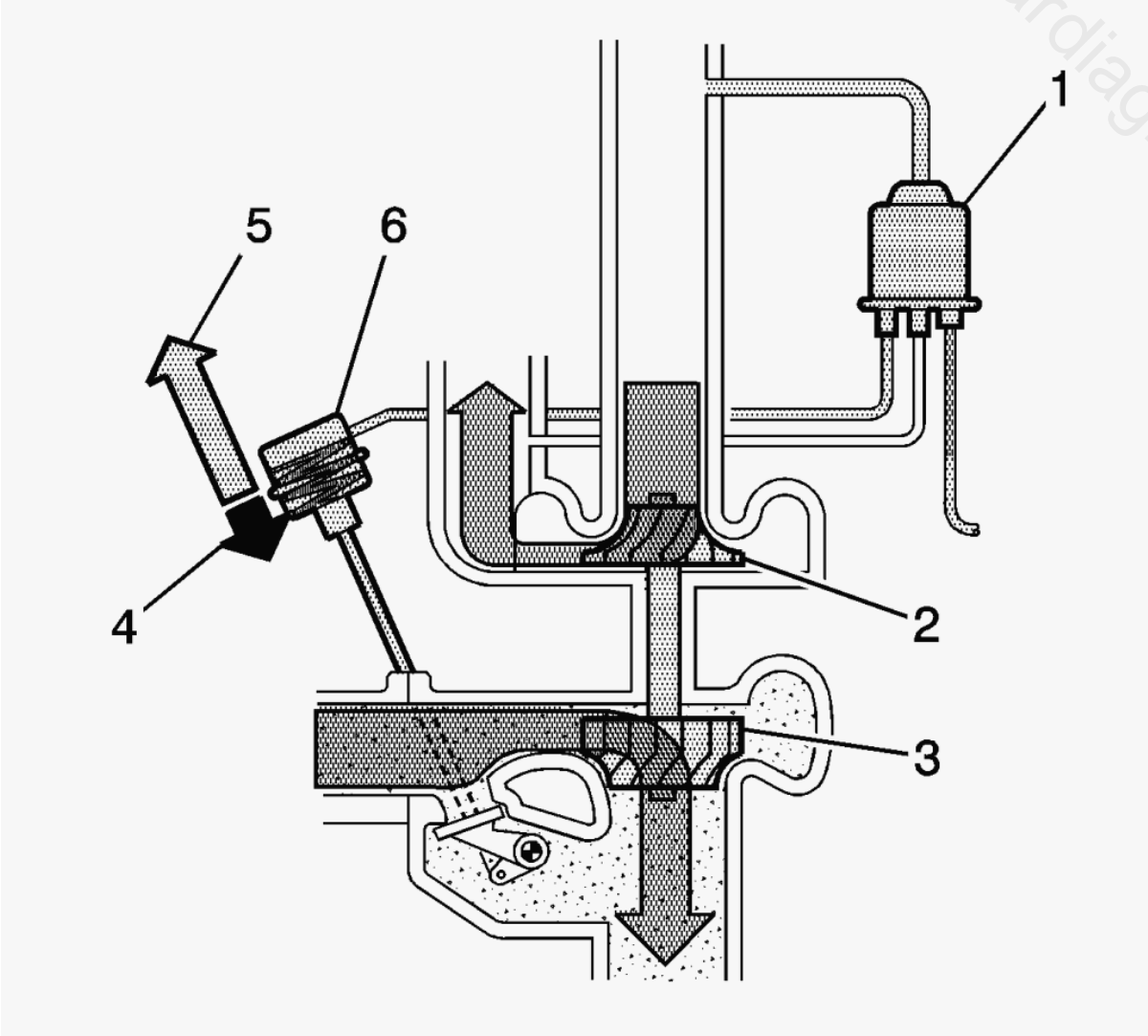

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Fig. 3: TC Wastegate Closed
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger Wastegate Actuator Solenoid Valve with Duty Cycle at 100 percent
2	Compressor
3	Turbine
4	Exhaust Gas Pressure
5	Spring Force
6	Turbocharger Wastegate Diaphragm Valve

Turbocharger Wastegate Open

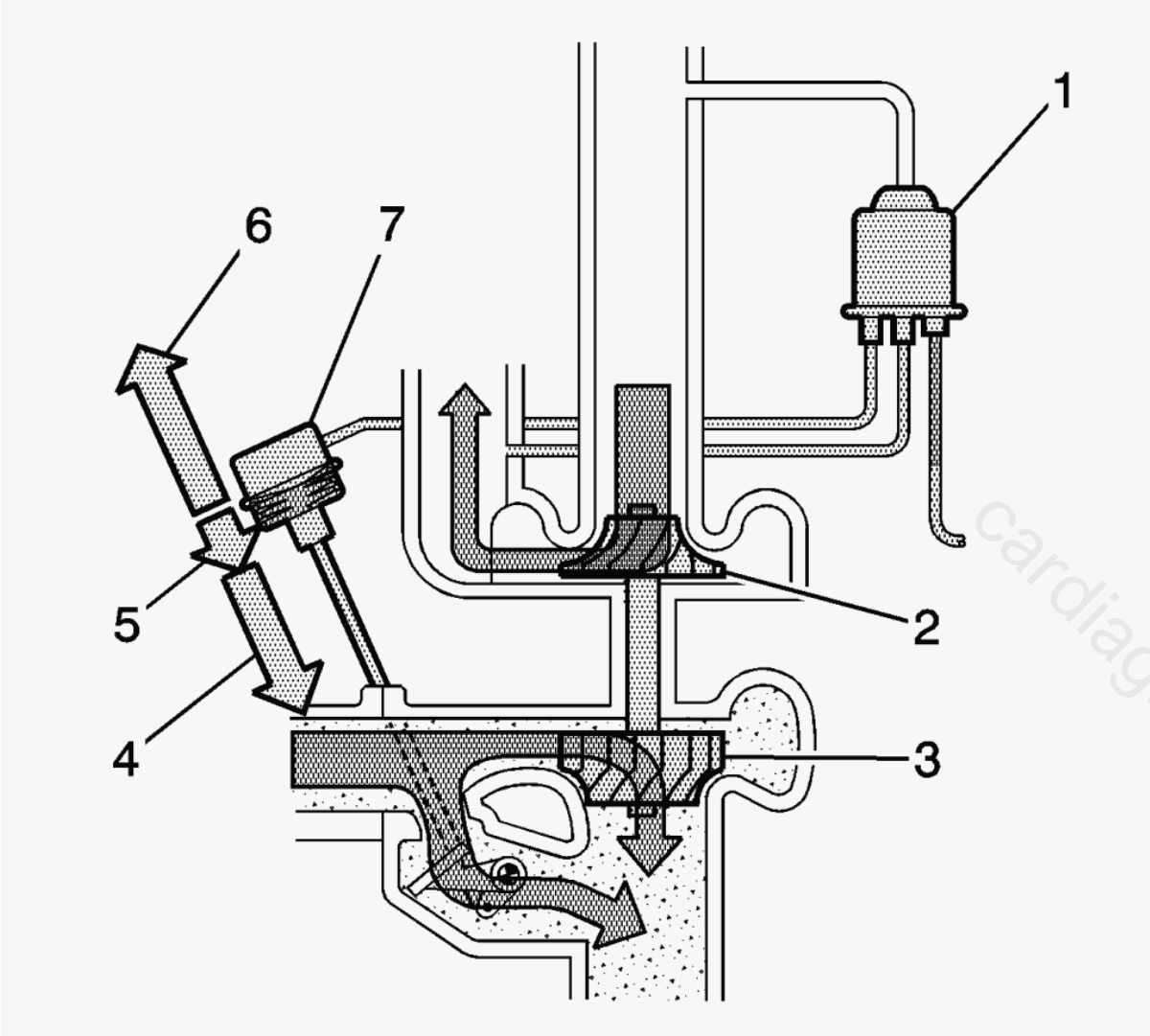

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Fig. 4: TC Wastegate Open
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger Wastegate Actuator Solenoid Valve with Duty Cycle at 0 percent
2	Compressor
3	Turbine
4	Regulating Pressure
5	Exhaust Gas Pressure
6	Spring Force
7	Turbocharger Wastegate Diaphragm Valve

The wastegate is completely closed at idle. All of the exhaust energy is passing through the turbine.

During normal operation, when wide open throttle is requested at lower engine speeds, the ECM commands the wastegate solenoid with a duty cycle of 100 % to minimize any turbo lag. During engine

loads in the middle and upper RPM ranges, the ECM commands the solenoid with a duty cycle of 65 - 80 %.

Bypass Solenoid Valve (Compressor Recirculation Valve)

The turbocharger bypass valve prevents the turbo from exceeding the surge limit of the compressor at low flow and high pressure. This occurs when the engine is running with a load and the throttle suddenly closes. In this case, flow is almost null and pressure is very high. This not only is damaging to the turbocharger, but also generates noise and decelerates turbine speed. The ECM supplies a voltage signal to the solenoid valve output driver, which regulates the open or closed valve position.

Accelerator Pedal Depressed

The bypass valve is closed. The force in the return spring integrated in the valve presses the valve cone against its seat in the turbo housing. The valve is turned OFF.

Accelerator Pedal Released

In order to avoid pressure spikes in the intake manifold and unloading or overrunning the turbo, the ECM sends a voltage signal to the bypass valve, which will then open. The compressed air on the pressure side of the turbo is led to the intake via the open valve. When the pressure drops, the turbine speed can be kept relatively high and the turbocharger is prevented from exceeding the surge limit of the compressor.

Charge Air Cooler

The turbocharger intake system is supported by an air-to-air charge air cooler system, which uses fresh air drawn through a heat exchanger to reduce the temperature of the hot compressed air exiting the turbo compressor, prior to delivery to the engine combustion system. Inlet air temperature can be reduced by up to 100Â°C (180Â°F), which enhances performance. This is due to the higher density of oxygen in the cooled air, which promotes optimal combustion. The charge air cooler is connected to the turbocharger and to the throttle body by flexible ductwork that requires the use of special high torque fastening clamps. In order to prevent any type of air leak when servicing the ductwork, the tightening specifications, cleanliness and proper positioning of the clamps is critical, and must be strictly adhered to.

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DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0010, P0011, P0013, P0014, P2088, P2089, P02090, OR P2091: INTAKE/ EXHAUST CAMSHAFT POSITION ACTUATOR

Diagnostic Instructions

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

DTC Descriptor

DTC P0010

Intake Camshaft Position Actuator Solenoid Valve Control Circuit

DTC P0011

Intake Camshaft Position System Performance

DTC P0013

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit

DTC P0014

Exhaust Camshaft Position System Performance

DTC P2088

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage

DTC P2089

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage

DTC P2090

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage

DTC P2091

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

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

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Additional DTCs may set.				

Circuit/System Description

For an overview of the component/system, refer to:**Camshaft Actuator System Description**

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

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

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

Conditions for Running the DTC

DTC P0010, P0013, P2088, P2089, P2090, P2091

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

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

DTC P0011, P0014

- DTC P0010, P0013, P2088, P2089, P2090, P2091 = Not set
- Camshaft Position Actuator Solenoid Valve = On
- Desired Camshaft Position = Does not vary greater than 3Â° - For greater than 4 s
- Engine = Running
- Ignition Voltage = Greater than 11V

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

Conditions for Setting the DTC

DTC P0010, P0013, P2088, P2089, P2090, P2091

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

DTC P0011, P0014

Desired Camshaft Position & Camshaft Position = Not within 8Â°of each other - For greater than 30s

Actions Taken When the DTC Sets

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

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

DTC P0011, P0014 = Type C DTC

Conditions for Clearing the DTC

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

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

DTC P0011, P0014 = Type C DTC

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

NOTE:

- **The engine oil level and the oil pressure are critical to the correct operation of the system.**
- **Engine oil condition has a major impact on the camshaft actuator system.**
- **If a crankshaft or camshaft position sensor DTC is set, the scan tool camshaft position actuator output control will be disabled.**

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0335, P0336, P0340, P0341, P0365, P0366 is not set.
   - **If any of the DTCs are set**

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Refer to:**Diagnostic TROUBLE Code (DTC) List - Vehicle**

- **Go to next step: If none of the DTCs are set**

3. Verify the following conditions do not exist:
   - Engine Oil - Contaminated/Dirty/Fill Level = Low
   - Engine Oil Pressure - Low - Refer to:**Oil Pressure Diagnosis and Testing**
   - **If a condition exists**

     Repair as necessary

   - **Go to next step: If no condition exists**
4. Engine idling.
5. Perform the appropriate scan tool control function:
   - Exhaust Camshaft Position Actuator - From 0 to 10Â° and back to 0Â°Â°.
   - Intake Camshaft Position Actuator - From 0 to 10Â° and back to 0Â°.
   - Verify the appropriate scan tool parameter:
   - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
   - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status = OK or Not Run
   - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
   - Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
   - Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status = OK or Not Run
   - Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
6. Perform the appropriate scan tool control function:
   - Exhaust Camshaft Position Actuator - From 0 to 10Â° and back to 0Â°.
   - Intake Camshaft Position Actuator -Â» From 0 to 10Â° and back to 0Â°..
   - Verify the appropriate scan tool parameter:
   - Exhaust Camshaft Position Variance = Less than 2Â° - During each of the commanded states
   - Intake Camshaft Position Variance = Less than 2Â° - During each of the commanded states
   - **If 2Â° or greater**

     Refer to: Circuit/System Testing

   - **Go to next step: If less than 2Â°**
7. Verify the scan tool parameter:
   - Intake Camshaft Position Variance = Less than 2Â°
   - Exhaust Camshaft Position Variance = Less than 2Â°
   - Perform the action while monitoring the parameter:
   - Wiggle the harness and connector:Q6 Camshaft Position Actuator Solenoid Valve
   - Wiggle the harness and connector:K20 Engine Control Module
   - **If 2Â°or greater**

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

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- **Go to next step: If less than 2Â°**

8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

   - **Go to next step: If the DTC is not set**

9. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the appropriate electrical connector:Q6 Camshaft Position Actuator Solenoid Valve
3. Test for less than 10 ohms between the test points:Low Reference circuit terminal 2/B & Ground
   - **If 10 ohms or greater**
   1. Disconnect the electrical connector:K20 Engine Control Module
   2. Test for less than 2 ohms between the test points:Low Reference circuit terminal 2/B @Component harness & The other end of the circuit@Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component:K20 Engine Control Module
   - **Go to next step: If less than 10 ohms**
4. Connect a test lamp between the test points:Control circuit terminal 1/A & Low Reference circuit terminal 2/B
5. Engine - Running
6. Perform the appropriate scan tool control function:
   - Exhaust Camshaft Position Actuator Solenoid Valve - On and Off
   - Intake Camshaft Position Actuator Solenoid Valve - On and Off

     Verify the test lamp turns On and Off.

   - **If the test lamp is always Off**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Disconnect the electrical connector:K20 Engine Control Module
   3. Test for infinite resistance between the test points:Control circuit terminal 1/A @Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 ohms between the test points:Control circuit terminal 1/A@Component harness & The other end of the circuit@Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component:K20 Engine Control Module
   - **If the test lamp is always On**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Disconnect the electrical connector:K20 Engine Control Module
   3. Ignition - On / Vehicle - In Service Mode
   4. Test for less than 1 V between the test points:Control circuit terminal 1/A@Component harness & Ground

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- If 1 V or greater - Repair the short to voltage on the circuit.
- If less than 1 V - Replace the component:K20 Engine Control Module

- **Go to next step: If the test lamp turns On and Off**

7. Verify DTC P0011, P0014 is not set.
   - **If the DTC is set**
   1. Ignition/Vehicle - Off
   2. Remove the component:Q6 Camshaft Position Actuator Solenoid Valve
   3. Verify a condition does not exist with the component:Q6 Camshaft Position Actuator Solenoid Valve
      - Engine Oil - Leaking@Harness Connector
      - Screen - Misaligned/Missing/Restricted/Torn
      - Valve - Scored/Visible Damage
      - If a condition exists - Replace the component:Q6 Camshaft Position Actuator Solenoid Valve
      - If no condition exists

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

   1. Swap the two components:
      - Q6E Camshaft Position Actuator Solenoid Valve - Exhaust
      - Q6F Camshaft Position Actuator Solenoid Valve - Intake
   2. Engine running.

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

   3. Perform the appropriate scan tool control function:
      - Exhaust Camshaft Position Actuator - From 0 to 10Â° and back to 0Â°.
      - Intake Camshaft Position Actuator - From 0 to 10Â° and back to 0Â°.
      - Verify the appropriate scan tool parameter:
      - Exhaust Camshaft Position Variance = Less than 2Â° - During each of the commanded states
      - Intake Camshaft Position Variance = Less than 2Â° - During each of the commanded states
      - If 2Â° or greater - Replace the component:Camshaft Position Actuator
      - If less than 2Â° - Replace the component:Q6 Camshaft Position Actuator Solenoid Valve - The original component that set the DTC
   - **Go to next step: If the DTC is not set**
8. Test or replace the component:Q6 Camshaft Position Actuator Solenoid Valve

Component Testing

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector:Q6 Camshaft Position Actuator Solenoid Valve
3. Test for 6 to 12 ohms between the test points:Control terminal 1/A & Low Reference terminal 2/B
   - **If not between 6 and 12 ohms**

     Replace the component:Q6 Camshaft Position Actuator Solenoid Valve

   - **Go to next step: If between 6 and 12 ohms**

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4. Test for infinite resistance between the test points:Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component:Q6 Camshaft Position Actuator Solenoid Valve

    - **Go to next step: If infinite resistance**
5. All OK.

Dynamic Test

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector:Q6 Camshaft Position Actuator Solenoid Valve
3. Connect a jumper wire between the test points:Low Reference terminal 2/B & Ground
4. Momentarily connect a 7.5A fused jumper wire between the test points:Control terminal 1/A & B+

   Verify the component turns On and Off when connecting and disconnecting the jumper wire:Q6 Camshaft Position Actuator Solenoid Valve

    - **If the component does not turn On and Off**

      Replace the component:Q6 Camshaft Position Actuator Solenoid Valve

    - **Go to next step: If the component turns On and Off**
5. All OK.

Repair Instructions

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

- **Camshaft Position Actuator Solenoid Valve Replacement - Exhaust**
- **Camshaft Position Actuator Solenoid Valve Replacement - Intake**
- **Camshaft Position Actuator Replacement**
- For control module replacement, programming, and setup refer to:**Control Module References**

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0016

Crankshaft Position - Intake Camshaft Position Not Plausible

DTC P0017

Crankshaft Position - Exhaust Camshaft Position Not Plausible

Circuit/System Description

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

Conditions for Running the DTC

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

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects a camshaft that is greater than 8 degrees advanced or 12 degrees retarded in relationship to the crankshaft.

Actions Taken When the DTC Sets

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

{WithoutTurbocharger}DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

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

{WithoutTurbocharger}DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

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

Reference Information

Description and Operation

Camshaft Actuator System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

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

    - **Go to next step: 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.

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- The correct installation of the Q6 Camshaft Position Actuator Solenoid Valves.
- The correct installation of the B23 Camshaft Position Sensors.
- The correct installation of the B26 Crankshaft Position Sensor.
- A timing chain tensioner condition.
- An incorrectly installed timing chain.
- Excessive play in the timing chain.
- A timing chain that jumped teeth.
- A crankshaft reluctor wheel that has moved in relationship to top dead center (TDC) on the crankshaft.
- **Go to next step: If the DTC is not set**

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

     A mechanical condition listed above still exists.

   - **Go to next step: 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 - Exhaust**
- **Camshaft Position Actuator Solenoid Valve Replacement - Intake**
- **Camshaft Position Sensor Replacement - Exhaust**
- **Camshaft Position Sensor Replacement - Intake**
- **Crankshaft Position Sensor Replacement (FWD)** **Crankshaft Position Sensor Replacement (AWD)**
- **Camshaft Timing Chain and Sprocket Cleaning and Inspection**

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DTC P0030, P0031, P0032, P0036, P0037, P0038, P0053, P0054, P0135, P0141, P103B, OR P103C: HO2S HEATER CONTROL

Diagnostic Instructions

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

DTC Descriptor

DTC 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 P103B

HO2S Heater Supply Voltage Sensing Circuit Performance

DTC P103C

HO2S Heater Supply Voltage Sensing Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P0030, P0036, P0037, P0132, P0135, P0138, P0141, P103B, P103C	P0030, P0036, P0132, P0135, P0138, P0141, P103B, P103C	P0690	P0135, P0141
Control	P0030, P0036, P0037, P0132, P0135, P0138, P0141	P0030, P0036, P0132, P0135, P0138, P0141	P0030, P0032, P0036, P0038, P0132, P0135, P0138, P0141, P0690	P0135, P0141

Circuit/System Description

Circuit	Description
Ignition	Supplied from a fuse.
Control	The output circuit is switched to ground to activate the component.

Component	Description
B52 Heated Oxygen Sensor	In addition to the hot exhaust gas, heated oxygen sensors have a resistor heating element to minimize the time required for the sensor to reach operating temperature. The ECM monitors the temperature and turns the heater on as necessary.

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Component	Description
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

P0030, P0031, P0032, P0036, P0037, P0038

- Engine Speed = Greater than 400 RPM
- Ignition Voltage = 11 to 32 V

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 5s

P0053, P0054

- DTCs related to the following system/component = Not Set
  - B34 Engine Coolant Temperature Sensor
  - B111B Turbocharger Boost/Intake Air Temperature Sensor
- ECT Sensor & IAT Sensor = Within 8Â°C (14Â°F) of each other
- ECT Sensor = 30 to 255Â°C 86 to 491Â°F)
- Engine = Running
- Ignition Voltage = Less than 32 V

Frequency the DTC runs = Once - Per cold start-up - After the running conditions are met

P0135, P0141

- DTC P0116, P0117, P0118, P0119, P0128, P111E = Not set
- HO2S Heater = Device controls are not active.
- HO2S 1, 2 Heater Command = Greater than 0% Duty Cycle
- Ignition Voltage = 10 to 32V

Frequency the DTC runs = 2 times - Per drive cycle - After the running conditions are met - For greater than 120 s

P103B, P103C

- Engine = CrankingorRunning
- Ignition Voltage = 10 to 32 V

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 3 s

Conditions for Setting the DTC

P0030, P0031, P0032, P0036, P0037, P0038

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

P0053, P0054

HO2S Heater Resistance = Resistance Out Of Range - During engine startup

P0135, P0141

HO2S 1, 2 Heater 0.3 to 2.5A - For greater than 10 s

P103B

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HO2S Heater Supply Voltage & Ignition Voltage = Not within 2V of each other - For greater than 3 s

P103C

HO2S Heater Supply Voltage = Less than 6 V - For greater than 3 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

High resistance in the circuits of the component may set DTC P103B, P103Cwithout setting the DTC for the component:B52 Heated Oxygen Sensor

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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

Circuit/System Verification

1. Engine - Idling - At normal operating temperature

   NOTE: **This step only applies to the following component DTCs:HO2S Heater**

2. Verify DTC P103B, P103C is not set and no other DTCs are set.
   - **If DTC P103B, P103C is set and other DTCs are set**

     Refer to: Circuit/System Testing - Test 1

   - **If DTC P103B, P103C is not set and other DTCs are set**

     Refer to: Circuit/System Testing - Test 1

   - **If DTC P103B, P103C is set and no other DTCs are set**

     Refer to: Circuit/System Testing - Test 2

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- **Go to next step: If no DTC is set**

3. Verify the scan tool parameter:
   - HO2S 1, 2 Heater Control Circuit High Voltage Test Status = OK or Not Run
   - HO2S 1, 2 Heater Control Circuit Low Voltage Test Status = OK or Not Run
   - HO2S 1, 2 Heater Control Circuit Open Test Status = OK or Not Run
   - **If not the specified state**

     Refer to: Circuit/System Testing - Test 1

   - **Go to next step: If the specified state**
4. Verify the scan tool parameter:

   HO2S 1, 2 Heater = 0.3 to 2.4A

   - **If not between 0.3 and 2.4A**

     Refer to: Circuit/System Testing - Test 1

   - **Go to next step: If between 0.3 and 2.4A**
5. Verify the scan tool parameter:HO2S 1, 2 Heater = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector:B52 Heated Oxygen Sensor
   - Wiggle the harness and connector:K20 Engine Control Module
   - **If the value spikes or drops out**

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

   - **Go to next step: If the value does not spike or drop out**
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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to step 2

   - **Go to next step: If the DTC is not set**
7. All OK.

Circuit/System Testing

Test1

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the appropriate electrical connector: B52 Heated Oxygen Sensor
3. Ignition - On / Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points:Ignition circuit terminal 2 & Ground
   - **If the test lamp does not turn On and the circuit fuse is OK**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Test for less than 2 ohms between the test points:Ignition circuit terminal 2 & Output terminal@Fuse
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.
   - **If the test lamp does not turn On and the circuit fuse is open**
   1. Ignition/Vehicle - Off & Remove - Test lamp

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2. Connect the electrical connector: B52 Heated Oxygen Sensor
3. Ignition - On / Vehicle - In Service Mode
4. Replace the component: Fuse
5. Verify the fuse does not open.
    - If the fuse opens and there are components connected to the circuit - Disconnect a component and repeat step 4.4
    - If the fuse opens with all components disconnected from the circuit - Repair the short to ground on the circuit.
    - If the fuse does not open after disconnecting a component from the circuit - Replace the component disconnected last.
    - If the fuse does not open with all components connected.

    NOTE: **It may be necessary to use a scan tool control function to operate a component.**

6. Operate the component: Each component on the circuit - One at a time

    Verify the fuse does not open when any of the components are activated.

    - If the fuse opens - Replace the component that caused the fuse to open when activated.
    - If the fuse does not open.
7. All OK.

- **Go to next step: If the test lamp turns On**

5. Verify a test lamp does not turn On between the test points:Ignition circuit terminal 2 & Control circuit terminal 1
    - **If the test lamp turns On**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Disconnect the appropriate electrical connector:K20 Engine Control Module
    3. Test for infinite resistance between the test points:Control circuit terminal 1 @Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component:K20 Engine Control Module
    - **Go to next step: If the test lamp does not turn On**
6. Remove - Test Lamp
7. Engine - Running
8. Verify the scan tool parameter:HO2S 1, 2 Heater Control Circuit Open Test Status = Malfunction
    - **If not the specified state**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector:K20 Engine Control Module
    3. Ignition - On / Vehicle - In Service Mode
    4. Test for less than 1 V between the test points:Control circuit terminal 1 @Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component:K20 Engine Control Module
    - **Go to next step: If the specified value**

    NOTE:
    - **As little as 10 ohms of resistance in a circuit may cause a DTC to set.**
    - **Performing this test may set additional DTCs.**

9. Connect a 3 A fused jumper wire between the test points:Control circuit terminal 1 & Ignition circuit terminal 2

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10. Engine - Running
11. Verify the scan tool parameter:HO2S 1, 2 Heater Control Circuit High Voltage Test Status = Malfunction
    - **If not the specified state**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the appropriate electrical connector:K20 Engine Control Module
    3. Test for less than 2 ohms between the test points:Control circuit terminal 1 @Component harness & The other end of the circuit@Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component:K20 Engine Control Module
    - **Go to next step: If the specified state**
12. Test or replace the component:B52 Heated Oxygen Sensor

Test 2

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector:K20 Engine Control Module
3. Test for less than 2 ohms between the test points:Output terminal@Fuse & The other end of the circuit@Control module harness
    - **If 2 ohms or greater**

      Repair the open/high resistance in the circuit:

    - **Go to next step: If less than 2 ohms**
4. Replace the component:K20 Engine Control Module

Repair Instructions

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

- **Heated Oxygen Sensor Replacement - Sensor 1**
- **Heated Oxygen Sensor Replacement - Sensor 2**
- For control module replacement, programming, and setup refer to: **Control Module References**

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DTC P0033, P0034, OR P0035: TURBOCHARGER SOLENOID VALVE

Diagnostic 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 P0033

Turbocharger Bypass Solenoid Valve Control Circuit

DTC P0034

Turbocharger Bypass Solenoid Valve Control Circuit Low Voltage

DTC P0035

Turbocharger Bypass Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

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

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage Circuit	P0033, P0034, P0243, P0245*	P0033	P0033	-	-
Turbocharger Bypass Valve Solenoid Control Circuit	P0033, P0034	P0033, P0034	P0033, P0034	P0035, P0690	P0033
* Ignition fuse opens.					

Circuit/System Description

The dual-scroll turbocharger incorporates a wastegate that is controlled by the engine control module (ECM) by means of a pulse width modulation (PWM) solenoid, to regulate the pressure ratio of the compressor. An ECM controlled compressor bypass valve is integrated into the unit to prevent compressor surging and damage from vibrations by opening during abrupt closed throttle conditions. The bypass valve is open during closed throttle deceleration conditions to allow air to recirculate in the turbocharger and maintain compressor speed.

As engine load and RPM increase, the turbocharger bypass valve is commanded closed by the ECM. As soon as the throttle closes, the valve is commanded open to allow the turbocharger air to recirculate to prevent compressor surging.

Conditions for Running the DTCs

- Ignition is On or the engine is running.
- Battery voltage is at least 11 V.
- Run/Crank voltage is greater than 5 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

The ECM detects an open, a short to ground, or a short to voltage on the turbocharger bypass solenoid valve control circuit for greater than 2 s.

Action Taken When the DTCs Set

- DTCs P0033, P0034, and P0035 are Type A DTCs.
- The Service Vehicle Soon Indicator may illuminate.

Conditions for Clearing the MIL/DTCs

DTCs P0033, P0034, and P0035 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Turbocharger 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 a click is heard or felt from the Q40 Turbocharger Bypass Solenoid Valve when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
   - **If a click is not heard or felt**

     Refer to Circuit/System Testing

   - **Go to next step: If a click is heard or felt**
3. Verify the circuit status parameters listed below do not display Malfunction when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool:
   - Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status
   - Turbocharger Bypass Solenoid Valve Control Circuit Open Test Status
   - Turbocharger Bypass Solenoid Valve Control Circuit Low Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing

   - **Go to next step: 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 a DTC does not set.
   - **If a DTC sets**

     Refer to Circuit/System Testing

   - **Go to next step: If a DTC does not set**
6. All OK

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the Q40 Turbocharger Bypass Solenoid Valve, 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.
   2. Test for less than 2 Ω in the ignition circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition Off, remove the test lamp.

      NOTE: **A short circuit 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 supplied by the fuse and replace as necessary.
- **Go to next step: 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.
    - **Go to next step: If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive 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.
    - **Go to next step: If OK is displayed**
6. Install a 3 A fused jumper wire between the control circuit terminal 2 and the ignition circuit terminal 1.
7. Verify the scan tool Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
    - **If Malfunction is not displayed**
    1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If Malfunction is displayed**
8. Test or replace the Q40 Turbocharger Bypass Solenoid Valve.

Component Testing

Static Test

1. Ignition Off, disconnect the harness connector at the Q40 Turbocharger Bypass Solenoid Valve.
2. Test for 10 - 14 Ω between the control terminal 2 and the Ignition terminal 1 of the Q40 Turbocharger Bypass Solenoid Valve.
    - **If not between 10 - 14 Ω**

      Replace the Q40 Turbocharger Bypass Solenoid Valve.

    - **Go to next step: If between 10 - 14 Ω**
3. All OK

Dynamic Test

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1. Install a 10 A fused jumper wire between the ignition terminal 2 of the Q40 Turbocharger Bypass Solenoid Valve and 12 V. Install a jumper wire between the control terminal 1 and ground.
2. Verify the Q40 Turbocharger Bypass Solenoid Valve plunger retracts.
    - **If the plunger does not retract.**

      Replace the Q40 Turbocharger Bypass Solenoid Valve.

    - **Go to next step: If the plunger retracts.**
3. All OK

Repair Instructions

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

- **Turbocharger Bypass Valve Solenoid Replacement**
- **Control Module References** for ECM replacement, programming, and setup

DTC P0068 OR P1101: AIRFLOW PERFORMANCE

Diagnostic Instructions

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

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Circuit/System Description

The engine control module (ECM) compares actual air flow 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

- Engine speed is at least 800 RPM.
- Ignition voltage is at least 6.4 V.

The DTC runs continuously when the above conditions are met.

DTC P1101

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0335, or P0336 is not set
- Engine speed is between 400 - 6, 100 RPM
- Engine coolant temperature (ECT) is between -7 to +125Â°C (+19 to +257Â°F).
- Intake air temperature (IAT) is between -20 to +125Â°C (-4 to +257Â°F).

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTCs

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

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, P06A3, or P06D2 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. If you were sent here from DTC P0106, P0121, or P0236; refer to Circuit/System Testing.
4. Ignition ON, verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90 %.
   - **90 % or greater**

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

   - **Go to next step: If less than 90 %**
5. Verify the scan tool Throttle Position Sensors 1 and 2 parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
   - **If Disagree**

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

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- **Go to next step: If Agree**

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

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

   - **Go to next step: If the MAP Sensor parameter is within range**
8. Verify the engine is equipped with a turbocharger.
   - **If not equipped with a turbocharger**

     Refer to Step 11.

   - **Go to next step: If equipped with a turbocharger**
9. Verify the scan tool Boost Pressure Sensor parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.
   - **If the Boost Pressure Sensor parameter is not in range**

     Refer to **DTC P0236** for further diagnosis.

   - **Go to next step: If the Boost Pressure Sensor parameter is within range**
10. Verify the scan tool Boost Pressure Sensor parameter decreases after starting the engine.
    - **If the Boost Pressure Sensor parameter does not decrease**

      Refer to **DTC P0236** for further diagnosis.

    - **Go to next step: If the Boost Pressure Sensor parameter does decrease**
11. 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.

    - **Go to next step: If between 26 - 52 kPa (3.8 - 7.5 PSI) and changes**
12. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
    1. Engine idling
    2. Perform the scan tool snapshot function.
    3. Increase the engine speed slowly to 3, 000 RPM and then back to idle.
    4. Exit from the scan tool snapshot and review the data.
    5. Observe the MAF Sensor parameter frame by frame with a scan tool.

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

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

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

      Refer to Circuit/System Testing.

    - **Go to next step: If the DTC does not set**
15. All OK

Circuit/System Testing

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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, improperly installed, collapsed, or restricted components
    - Improper operation of turbocharger wastegate actuator or bypass valve, where equipped
    - 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.

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

      Repair or replace component as appropriate.

    - **Go to next step: If no condition is found**
3. All OK

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Repair Instructions

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

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

DTC P0089, P00C6, P228C, P228D, P2C1E, P2C1F, OR P2C20: FUEL PRESSURE REGULATOR

Diagnostic Instructions

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

DTC Descriptors

DTC P0089

Fuel Pressure Regulator Performance

DTC P00C6

Fuel Rail Pressure Low During Engine Cranking

DTC P228C

Fuel Pressure Regulator Control Performance - Low Pressure

DTC P228D

Fuel Pressure Regulator Control Performance - High Pressure

DTC P2C1E

Cold Start Fuel Pressure Regulator Performance

DTC P2C1F

Cold Start Fuel Pressure Regulator Control Performance - Low Pressure

DTC P2C20

Cold Start Fuel Pressure Regulator Control Performance - High Pressure

Circuit/System Description

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a four-lobe cam on the camshaft. This high pressure fuel pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2 to 15 MPa (290 to 2, 176 PSI), depending on engine speed and load. Output drivers in the ECM provide the high pressure fuel pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by opening and closing the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail. The high pressure fuel pump is normally closed and will not deliver an increase in fuel pressure when the control solenoid is NOT powered. In the event of pump control failure, the high pressure system is protected by a relief valve in the pump that prevents the pressure from exceeding 24 MPa (3, 481 PSI).

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

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

Conditions for Running the DTC

P0089, P228C, or P228D

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0627, P0628, P0629, or P1682 are not present.
- Battery voltage is greater than 8 V.
- The engine has been running for greater than or equal to 10 s.
- Low side fuel pressure is greater than 300 kPa (44 PSI).
- Barometric (BARO) pressure is greater than or equal to 70 kPa.
- Intake air temperature (IAT) is warmer than or equal to -10Â°C (14Â°F).
- Fuel temperature is between -10Â°C and +132Â°C (14Â°F and 270Â°F).
- Vehicle is not in a low fuel condition
- The DTCs run continuously when the above conditions are met.

P00C6

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0627, P0628, P0629, or P1682 are not present.

- Ignition voltage is greater than 8 V.
- Engine coolant temperature is less than 65Â°C (149Â°F).
- Low side fuel pressure is greater than 300 kPa (44 PSI).
- Vehicle is not in a low fuel condition
- The diagnostic runs once for each engine start.

P2C1E, P2C1F or P2C20

- DTC P0016, P0017, P0090, P0091, P0092, P00C9, P00CA, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0192, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0627, P0628, P0629, P111E, P127C, P128A, P128B, P128F, P1682, P16E4, or P16E5 are not present
- Battery voltage is greater than 11 V.
- Low side fuel pressure is greater than 300 kPa (44 PSI).
- Barometric (BARO) pressure is greater than or equal to 70 kPa.
- Intake air temperature (IAT) is warmer than or equal to -10Â°C (14Â°F).
- Fuel temperature is between -10Â°C and +132Â°C (14Â°F and 270Â°F).
- Catalyst Warm up enabled

Conditions for Setting the DTC

P0089

- The high pressure fuel pump has exceeded the control limits. This condition exists when the Fuel Rail Pressure Regulator Command is 0Â° or greater than 92Â° for 12.5 s.

P00C6 Condition 1

- If the Fuel Rail Pressure Sensor is less than the target set point before the engine is cranked, the pressure rise diagnostic is used.
- The pressure rise diagnostic will fail if the Fuel Rail Pressure Sensor has not increased to the target set point within 9 s at -16Â°C (3.2Â°F) ECT or within 4 s if ECT is greater than 0Â°C (32Â°F).

P00C6 Condition 2

- If the Fuel Rail Pressure Sensor is greater than the target set point before the engine is cranked, the pressure fall diagnostic is used.
- The pressure fall diagnostic will fail if the Fuel Rail Pressure Sensor has dropped below 2 MPa (290 PSI) if the ECT is less than -16Â°C (3.2Â°F) or 0.6 MPa (87 PSI) if the ECT is greater than -16Â°C (3.2Â°F).

P228C, P2C1F

- The Fuel Rail Pressure Sensor is less than the Desired Fuel Rail Pressure by a predetermined value.
- The above condition exists for 10.00 s failures out of 12.50 s samples.

P228D, P2C20

- The Fuel Rail Pressure Sensor is greater than the Desired Fuel Rail Pressure by a predetermined value.
- The above condition exists for 10.00 s failures out of 12.50 s samples.

P2C1E

- This DTC determines when the high pressure pump control has reached to its max or min authority during Cataylst Warm up.
- The above condition exists for 10.00 seconds failures out of 12.50 Seconds samples.

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Action Taken When the DTC Sets

- DTCs P0089 and P00C6 are Type B DTCs.
- DTCs P228C, P228D, P2C1E, P2C1F and P2C20 are Type A DTCs.
- A message center or an indicator displays Reduced Engine Power.
- Scan tool control of the high pressure fuel pump is inhibited.

Conditions for Clearing the DTC

- DTCs P0089 and P00C6 are Type B DTCs.
- DTCs P228C, P228D, P2C1E, P2C1F and P2C20 are Type A DTCs.

Diagnostic Aids

- Any problem with the camshaft may set fuel pressure DTCs due to the location and design of the high pressure fuel pump. If camshaft position control DTCs are current or in history, a cam control issue may be the root cause.
- A faulty valve, plunger, or solenoid in the high pressure fuel pump may set a DTC. High pressure fuel pump damage will most likely be undetectable upon visual inspection.
- A restricted fuel feed pipe between the fuel feed pipe fuel pressure sensor and the high pressure fuel pump may set a DTC.
- A leaking or restricted fuel injector may set a DTC.
- A leak in the high pressure fuel system may set a DTC.
- Vapor lock may set DTC P0089
- For DTC P00C6, P2C1E, P2C1F, and P2C20, park the vehicle outdoors overnight and perform a start in the morning.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Attempt to start and idle the engine.
2. Observe the DTC information with a scan tool. DTCs P0089, P00C6, P228C, P2C1E, P2C1F, P228D and P2C20 should not set.

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

  Refer to Circuit/System Testing.

- **Go to next step: If none of the DTCs are set**

3. Engine idling.
4. Verify the scan tool Fuel Rail Pressure Sensor parameter is approximately 1.9 - 5.0 MPa (276 - 725 PSI).
   - **If not between 1.9 - 5.0 MPa (276 - 725 PSI)**

     Refer to Circuit/System Testing.

   - **Go to next step: If between 1.9 - 5.0 MPa (276 - 725 PSI)**

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

5. Road test the vehicle and perform a wide open acceleration from a stop until the transmission shifts into second gear. On manual transmission applications, shift to second gear or stop the test near 2, 500 RPM. Repeat the test at least three times.
6. Verify DTCs P0089, P00C6, P228C, P2C1F, P228D and P2C20 do not set.
   - **If any of the DTCs set**

     Refer to Circuit/System Testing.

   - **Go to next step: 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.

   - **Go to next step: If the DTC does not set**
9. All OK.

Circuit/System Testing

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

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

     Replace the Camshaft.

   - **Go to next step: If the lobes are OK**
3. Test or replace the G18 High Pressure Fuel Pump.

Component Testing

1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump.

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

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2. Test for 1.09 - 1.21 Ω at 20Â°C (68Â°F) between the high control circuit terminal 2 and the low control circuit terminal 1.
    - **If not between 1.09 - 1.21 Ω**

      Replace the G18 High Pressure Fuel Pump.

    - **Go to next step: If between 1.09 - 1.21 Ω**
3. Test for infinite resistance between each terminal and the G18 High Pressure Fuel Pump housing.
    - **If less than infinite resistance**

      Replace the G18 High Pressure Fuel Pump.

    - **Go to next step: If infinite resistance**
4. All OK

Repair Instructions

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

- **Fuel Pump Replacement** for the G18 High Pressure Fuel Pump replacement.
- **Intake and Exhaust Camshaft, Bearing Cap, and Lash Adjuster Removal**
- Perform the Fuel Rail Pressure Relief Valve Reset procedure, if supported on the scan tool.

DTC P0090, P0091, P0092, P00C8, P00C9, OR P00CA: FUEL PRESSURE CONTROL

Diagnostic 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 Descriptors

DTC P0090

Fuel Pressure Regulator Control Circuit

DTC P0091

Fuel Pressure Regulator Control Circuit Low Voltage

DTC P0092

Fuel Pressure Regulator Control Circuit High Voltage

DTC P00C8

Fuel Pressure Regulator High Control Circuit

DTC P00C9

Fuel Pressure Regulator High Control Circuit Low Voltage

DTC P00CA

Fuel Pressure Regulator High Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Control	P0090, P0091, P00C8, P00C9	P0090, P00C8	P0089, P228D	-

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

Circuit/System Description

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a three-lobe cam on the camshaft. This high pressure fuel pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2 to 20 MPa (290 - 2, 900 PSI), depending on engine speed and load. Output drivers in the ECM provide the pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by closing and opening the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail.

It is important to note that the high pressure fuel pump is a trailing-edge control system, meaning that if the control solenoid is NOT powered, the pump operates at minimum flow rate. In the event of pump control failure, the high pressure system is also protected by a relief valve in the pump that prevents the pressure from exceeding 24 MPa (3, 481 PSI).

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

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

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Conditions for Running the DTC

- Battery voltage is greater than or equal to 11 V.
- Engine speed is greater than or equal to 50 RPM.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTC

P0090

The ECM detects an open circuit in the high pressure fuel pump actuator low control circuit for 4 s.

P0091

The ECM detects a short to ground in the high pressure fuel pump actuator low control circuit for 4 s.

P0092

The ECM detects a short to voltage in the high pressure fuel pump actuator low control circuit for 4 s.

P00C8

The ECM detects an open circuit in the high pressure fuel pump actuator high control circuit for 4 s.

P00C9

The ECM detects a short to ground in the high pressure fuel pump actuator high control circuit for 4 s.

P00CA

The ECM detects a short to voltage in the high pressure fuel pump actuator high control circuit for 4 s.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0685 or P1682 is not set.
    - **If any of the DTCs are set**

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

    - **Go to next step: If none of the DTCs are set**
3. Verify the scan tool parameters listed below do not display Malfunction when commanding the Fuel Pressure Regulator ON andOFF.
    - Fuel Pressure Regulator Control Circuit High Voltage Test Status

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- Fuel Pressure Regulator Control Circuit Open Test Status
- Fuel Pressure Regulator Control Circuit Low Voltage Test Status
- Fuel Pressure Regulator High Control Circuit High Voltage Test Status
- Fuel Pressure Regulator High Control Circuit Open Test Status
- Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
- **If Malfunction is displayed**

  Refer to Circuit/System Testing.

- **Go to next step: 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.

   - **Go to next step: If the DTC does not set**
6. All OK

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump.
2. Ignition ON, verify that a test lamp does not illuminate between ground and the terminals listed below:
   - High control circuit terminal 2
   - Low control circuit terminal 1
   - **If the test lamp illuminates**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the appropriate control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
      - **Go to next step: If the test lamp does not illuminate**
3. Test for B+ between the high control circuit terminal 2 and ground.
   - **If less than B+**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the high control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the high control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If B+**
4. Ignition OFF, connect a test lamp between the high control circuit terminal 2 and the low control circuit terminal 1.
5. Ignition ON, command the Fuel Pressure Regulator ON and OFF with a scan tool.
6. Verify the test lamp turns ON and OFF.
   - **If the test lamp does not turn ON and OFF**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the low control circuit terminal 1 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance

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3. Test for less than 2 Ω in the low control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.
- **Go to next step: If the test lamp turns ON and OFF**

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

Component Testing

1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump.

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

2. Test for 1.09 - 1.21 Ω at 20Â°C (68Â°F) between the high control circuit terminal 2 and the low control circuit terminal 1.
    - **If not between 1.09 - 1.21 Ω**

      Replace the G18 High Pressure Fuel Pump.

    - **Go to next step: If between 1.09 - 1.21 Ω**
3. Test for infinite resistance between each terminal and the G18 High Pressure Fuel Pump housing.
    - **If less than infinite resistance**

      Replace the G18 High Pressure Fuel Pump.

    - **Go to next step: If infinite resistance**
4. All OK

Repair Instructions

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

- **Fuel Pump Replacement** for G18 High Pressure Fuel Pump replacement.
- **Control Module References** for control module replacement, programming and setup.
- Perform the Fuel Rail Pressure Relief Valve Reset procedure, if supported on the scan tool.

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DTC P0096 OR P0111: AIR INTAKE TEMPERATURE SENSOR 1

Diagnostic Instructions

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

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199**	P0111, P0113, P0114, P2199**	P0113*, P0114, P2199**	P0111, P2199**
Low Reference	-	P0111, P0113, P0114, P2199**	P0113*, P0114	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+. **If applicable.				

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0097, P00F4**, P06D2, P11C2**, P2199**, P2227, P2228	P0096, P00F4**, P0097, P11C2**, P2199**, P2227, P2228	P0097, P00F4**, P06D2, P11C2**, P2199**, P2227, P2228	-
Sensor	P0097, P00F5**, P11C3**, P2199**	P0097, P00F4**, P11C2**, P2199**	P0097*, P00F4**, P11C2**, P2199**	-
Low Reference	-	P0097, P00F4**, P0113, P11C2**, P2227, P2229	-*	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+. **If applicable.				

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Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz*
Ground	-	-40Â°C (-40Â°F) 10 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

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

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

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

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

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

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

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

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IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

IAT Sensor 2 - Temperature, Frequency Table

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

Conditions for Running the DTCs

P0096 and P0111

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

Conditions for Setting the DTCs

NOTE: P0096 Can fail under any of the following 3 sets of conditions.

P0096 - Condition 1

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

  AND

- The ECM determines the absolute difference between IAT sensor 2 start-up temperature and the IAT sensor 3 start-up temperature is greater than 25Â°C (45Â°F).

AND

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 3 start-up temperature is less than or equal to 25Â°C (45Â°F).
- This DTC runs once per ignition cycle when the enabling conditions are met.

P0096 - Condition 1

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

AND

- The ECM determines the absolute difference between IAT sensor 2 start-up temperature and the IAT sensor 3 start-up temperature is greater than 25Â°C (45Â°F).

AND

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 3 start-up temperature is greater than 25Â°C (45Â°F).
- This DTC runs once per ignition cycle when the enabling conditions are met.

P0096 - Condition 3

- The ECM determines the IAT sensor 3 start-up temperature is between the IAT sensor 1 and IAT sensor 2 start-up temperatures.

AND

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

AND

- The ECM determines the absolute difference between IAT sensor 3 and the IAT sensor 2 start-up temperatures is greater than absolute difference between IAT sensor 3 and the IAT sensor 1 start-up temperatures.

DTC P0096 runs once at the beginning of an ignition cycle when any one of the above 3 enabling sets of conditions is met.

NOTE: P0111 Can fail under any of the following 3 sets of conditions.

P0111 - Condition 1

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

AND

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 3 start-up temperature is greater than 25Â°C (45Â°F).

AND

- The ECM determines the absolute difference between IAT sensor 2 start-up temperature and the IAT sensor 3 start-up temperature is less than or equal to 25Â°C (45Â°F).

P0111 - Condition 2

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- The ECM determines the IAT sensor 2 start-up temperature is between the IAT sensor 1 and IAT sensor 3 start-up temperatures.

AND

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 3 start-up temperature is greater than 25Â°C (45Â°F).

AND

- The ECM determines the absolute difference between IAT sensor 2 and the IAT sensor 1 start-up temperatures is greater than absolute difference between IAT sensor 2 and the IAT sensor 3 start-up temperatures.

P0111 - Condition 3

- The ECM determines the IAT sensor 3 start-up temperature is between the IAT sensor 1 and IAT sensor 2 start-up temperatures.

AND

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

AND

- The ECM determines the absolute difference between IAT sensor 3 and the IAT sensor 1 start-up temperatures is greater than absolute difference between IAT sensor 3 and the IAT sensor 2 start-up temperatures.

DTC P0111 runs once at the beginning of an ignition cycle when any one of the above 3 enabling sets of conditions is met.

Action Taken When the DTCs Set

- DTC P0096 is a Type C DTC.
- DTC P0111 is a Type B DTC.

Conditions for Clearing the DTCs

- DTC P0096 is a Type C DTC.
- DTC P0111 is a Type B DTC.

Diagnostic Aids

- With the ignition On, when the engine is cold and not running, properly functioning IAT sensor 1 and IAT sensor 2 will gradually increase the scan tool IAT Sensor 1 and IAT Sensor 2 parameters. This is due to the heat that is generated by the multifunction intake air sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values: 10 Hz; -40Â°C (-40Â°F), and there are also Humidity Sensor DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

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

Powertrain Component Views

Powertrain Component Views

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 P00EA, P00EB, P00EC, P0097, P0098, P0099, P0112, P0113, P0114, P0641, P0651, P0697, P06A3, or P06D2 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: 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 scan tool parameters listed below are within 30Â°C (54Â°F).
   - Start-Up IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3
   - **If not within the specified range**

     Refer to Circuit/System Testing.

   - **Go to next step: If within the specified range**
5. Engine idling, verify the scan tool parameters listed below are between: -38 and +149Â°C (-36 and +300Â°F).
   - IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3
   - **If not within the specified range**

     Refer to Circuit System Testing.

   - **Go to next step: If within the specified range**
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.

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- **Go to next step: 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. Verify the conditions listed below do not exist with the air induction system:
   - 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
   - **If a condition exists**

     Repair or replace the component as necessary.

   - **Go to next step: If none of the conditions exist**
2. Determine if **EL-38522-A** or equivalent is available.
   - **If EL-38522-A or equivalent is not available**
   1. Test or replace the B75C Multifunction Intake Air sensor.
   2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
   3. Verify the DTC does not set.
      - **If the DTC sets**

        Replace the K20 Engine Control Module.

      - **Go to next step: If no DTCs set**
   4. All OK.
   - **Go to next step: If EL-38522-A or equivalent is available**
3. Ignition Off, connect the leads of the **EL-38522-A** as listed below:
   - Red lead to the signal circuit terminal 6 at the harness connector
   - Black leads to ground
   - Battery voltage supply lead to B+
4. Set the **EL-38522-A** to the specifications listed below:
   - Signal switch to 5 V
   - Frequency switch to 5 kHz
   - Duty Cycle switch to 50 % (Normal)
5. Engine idling, verify the scan tool MAF Sensor parameter is between 4, 950 - 5, 050 Hz.
   - **If not within the specified range**

     Replace the K20 Engine Control Module.

   - **Go to next step: If within the specified range**
6. Test or replace the B75C Multifunction Intake Air Sensor

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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. To test IAT Sensor 1, verify the resistance between terminals 1 - 3 of the sensor is within the range specified in the **Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)** **Temperature Versus Resistance - Intake Air Temperature Sensor (Delco Sensor)** , table for Hitachi sensors, while varying the sensor between known temperatures.
   - **If not within the specified range**

     Replace the B75C Multifunction Intake Air Sensor.

   - **Go to next step: If within the specified range**
3. All OK.

Multifunction Intake Air Sensor

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

     Replace the B75C Multifunction Intake Air Sensor.

   - **Go to next step: If within the specified range**
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 engine control module replacement, programming, and setup

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

Diagnostic Instructions

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

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

Typical Scan Tool Data

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F)* 10 Hz
Ground	-	-40Â°C (-40Â°F) 10 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Intake Air Humidity Sensor

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient humidity, temperature, and engine bay conditions			
Ignition 1	0 %	0 %	-
Signal	100 %	0 %	0 %*
Ground	-	0 %	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

The IAT sensor 2 produces a frequency signal, based on the inlet air temperature, which is equal to the humidity present within the sensor bore. The signal varies with inlet air temperature and is displayed by the scan tool as Â°C (Â°F) and Hertz (Hz) and the relative humidity is displayed in percent (%). The ECM supplies a regulated voltage to the signal circuit. The signal circuit is shared by the IAT sensor 2 and the humidity sensor. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for these sensors:

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor

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- MAF sensor
- BARO pressure sensor

IAT Sensor 2 - Temperature, Frequency Table

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

Conditions for Running the DTCs

P0097, P0098, and P0099

- DTCs P0685, P0686, P0687, P0689, P0690 or P1682 are not set.
- The ignition is ON, or the engine is running.
- The Ignition 1 voltage is at least 11 V.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P0097

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

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

P0098

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

P0099

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

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Action Taken When the DTC Sets

- P0097, P0098, and P0099 are Type B DTCs for North America.
- P0097, P0098, and P0099 are Type C DTCs for all except North America.
- The ECM commands the cooling fans ON.

Conditions for Clearing the MIL/DTC

- P0097, P0098, and P0099 are Type B DTCs for North America.
- P0097, P0098, and P0099 are Type C DTCs for all except North America.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

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- **Connector Repairs**
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Powertrain Component Views

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

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Circuit/System Verification

1. Ignition On.
2. Verify that DTC P00F4, P00F5, P00F6, P0102, P0103, P0641, P0651, P0697, P06A3, or P06D2 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: 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. Verify the following scan tool parameters are within 30Â°C (54Â°F) of each other.
   - Start-Up IAT Sensor 1
   - IAT Sensor 2
   - **If not within 30Â°C (54Â°F)**

     Refer to Circuit/System Testing.

   - **Go to next step: If within 30Â°C (54Â°F)**
4. Engine running.
5. Verify the following scan tool parameters are between -38 and +149Â°C (-36 and +300Â°F).
   - IAT Sensor 1
   - IAT Sensor 2
   - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

     Refer to Circuit System Testing.

- **Go to next step: If between: -38 and +149Â°C (-36 and +300Â°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 sets**

     Refer to Circuit/System Testing.

   - **Go to next step: 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 5 Ω between the low reference circuit terminal 3 and ground.
   - **If 5 Ω or greater**
   1. Disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Test for less than 5 Ω between the ground circuit terminal 7 and ground.
   - **If 5 Ω or greater**
   1. Ignition Off.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **Go to next step: If less than 5 Ω**
4. Ignition On.
5. Verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition Off, remove the test lamp and remove the fuse for the ignition voltage circuit.
   2. Test for less than 2 Ω in the ignition voltage circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**

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

   1. Ignition Off, remove the test lamp, the fuse for the ignition voltage circuit, and disconnect all components on the circuit.
   2. Test for infinite resistance between the ignition voltage circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
   - **Go to next step: If a test lamp illuminates**

NOTE: **The intake air temperature sensor 2 signal circuit is pulled up with**

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low current voltage within the controller. Normally, a voltage can be measured on the circuit with a DMM, but the current will not be high enough to illuminate a test lamp.

6. Verify the scan tool Intake Air Humidity Sensor parameter is less than 1%.
    - **If 1% or greater**
    1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the IAT 2 signal circuit terminal 8 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If less than 1%**
7. Ignition Off, install a 3 A fused jumper wire between the IAT 2 signal circuit terminal 8 and the low reference circuit terminal 3.
8. Ignition On.
9. Verify the scan tool Intake Air Humidity Sensor parameter is greater than 99%.
    - **If 99% or less**

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

    1. Ignition Off, remove the jumper wire and disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition On.
    3. Test for less than 1 V between the IAT 2 signal circuit terminal 8 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V.
    4. Ignition Off.
    5. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If greater than 99%**
10. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Vehicle OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.
    - **If not within the specified range**

        Replace the B75C Multifunction Intake Air Sensor.

    - **Go to next step: If within the specified range**
3. All OK.

Testing with EL-38522-A

NOTE: **In-correct diagnosis will result if Circuit/System Testing is not completed before performing the following test.**

1. Perform the following test using a **EL-38522-A** Variable Signal Generator or equivalent, if available.
2. Ignition Off, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:

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1. Red lead to the signal circuit terminal 8 at the harness connector
2. Black leads to ground
3. Battery voltage supply lead to B+

3. 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 250 Hz
4. Ignition On, verify the scan tool IAT Sensor 2 parameters listed below are within the ranges listed below:
   - IAT Sensor 2 is between 248 - 252 Hz

     NOTE: **Changing the frequency should cause a warmer or colder IAT 2 temperature.**

   - IAT Sensor 2 is between 70 - 76Â°C (160 - 166Â°F)

     NOTE: **Increasing or decreasing the duty cycle should have an inverse affect on humidity.**

   - Intake Air Humidity Sensor is between 48 - 52%
   - **If a parameter is not within the specified range**

     Replace the K20 Engine Control Module.

   - **Go to next step: If all the parameters are within the specified range**
5. 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 engine control module replacement, programming, and setup.

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DTC P00C7: INTAKE AIR PRESSURE MEASUREMENT SYSTEM - MULTIPLE SENSORS NOT PLAUSIBLE

Diagnostic Instructions

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

DTC Descriptor

DTC P00C7

Intake Air Pressure Measurement System - Multiple Sensors Not Plausible

Circuit/System Description

The Intake Air Pressure Measurement System consists of 3 sensors, the barometric pressure (BARO) sensor, the manifold absolute pressure (MAP) sensor, and the Turbocharger Boost sensor.

Conditions for Running the DTC

- DTCs P0106, P0107, P0108, P2122, P2123, P2127, P2128, P2138 or P2610 are not set.
- The engine is running.
- Time between current ignition cycle and the last time the engine was running is greater than 10 s.
- Manifold pressure between 50 - 115 kPa (7.25 - 16.68 PSI).

- BARO pressure between 50 - 115 kPa (7.25 - 16.68 PSI).
- Turbocharger boost pressure between 50 - 115 kPa (7.25 - 16.68 PSI).
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P00C7 is a Type B DTC.

Conditions for Clearing the DTC

DTC P00C7 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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/Vehicle in Service mode.
2. Verify that DTCs P0106, P0107, P0236, P0237, P0238, P2227, P2228, P2229 or P2230 are not set.
    - **If any of the DTCs are set**

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

    - **Go to next step: If none of the DTCs is set**
3. Verify none of the following conditions exist:
    - The air intake duct system for loose connecting clamps, cracks, or other damage
    - A damaged Q38 Throttle Body blade or shaft
    - Splits, kinks, or improper connections at the vacuum hoses
    - Faulty positive crankcase ventilation system operation

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- Carbon deposits on the throttle blade.
- Vacuum leaks at the intake manifold, Q38 Throttle Body, Q17 Fuel Injector O-rings, and B111B Turbocharger Boost and Intake Air Temperature Sensor.
- **If a condition exists**

  Repair as necessary.

- **Go to next step: If none of the conditions exist**

4. Verify the following scan tool parameters are within range of the Altitude vs. Barometric Pressure table. Refer to: **Altitude Versus Barometric Pressure** table.
   - BARO Sensor
   - MAP Sensor
   - Turbocharger Boost Sensor
   - **If a sensor parameter is not within range**

     Refer to the appropriate diagnostic below for further diagnosis.

   - Barometric Pressure (BARO) Sensor. Refer to: **DTC P2227-P2230**
   - Manifold Absolute Pressure (MAP) Sensor. Refer to: **DTC P0106**
   - Turbocharger Boost Pressure Sensor. Refer to: **DTC P0236**
   - **Go to next step: If all sensor parameters are within range**
5. All OK

Repair Instructions

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

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

DTC P00E9: INTAKE AIR TEMPERATURE (IAT) SENSOR 3 CIRCUIT PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P00E9

Intake Air Temperature (IAT) Sensor 3 Circuit Performance

Typical Scan Tool Data

IAT Sensor 3

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature; and engine bay conditions			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

The intake air temperature (IAT) sensor 3 is a variable resistor that changes an engine control module (ECM) supplied 5 V signal. The signal varies with intake manifold air temperature and is displayed by

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the scan tool as Â°C (Â°F). The IAT sensor 3 is integrated with the manifold absolute pressure sensor in the intake manifold. The ECM provides a ground for the IAT sensor 3 low reference circuit.

IAT Sensor 3 - Temperature, Resistance, Voltage Table

IAT Sensor 3	IAT Sensor 3 Resistance	IAT Sensor 3 Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTC

P00E9

- DTC P0097, P0098, P00EA, P00EB, P0112, P0113, P0117, P0118, or P0119 is not set.
- The vehicle has been Off at least 8 hours.
- Ignition voltage is at least 11 V.
- The DTC runs once per ignition cycle when the enabling conditions are met.

Conditions for Setting the DTC

P00E9 - Condition 1

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is less or equal to 25Â°C (45Â°F).

  AND

- The ECM determines the absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 1 start-up temperature is greater than 25Â°C (45Â°F).

  AND

- The ECM determines the absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 2 start-up temperature is greater than 25Â°C (45Â°F).

P00E9 - Condition 2

- The ECM determines the IAT sensor 1 start-up temperature is between the IAT sensor 3 start-up temperature and the IAT sensor 2 start-up temperature

  AND

- The ECM determines the absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 2 start-up temperature is greater than 25Â°C (45Â°F).

  AND

- The absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 1 start-up temperature is greater than the absolute difference between IAT sensor 2 start-up temperature and the IAT sensor 1 start-up temperature.

P00E9 - Condition 3

- The ECM determines the IAT sensor 2 start-up temperature is between the IAT sensor 3 start-up temperature and the IAT sensor 1 start-up temperature

  AND

- The ECM determines the absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 1 start-up temperature is greater than 25Â°C (45Â°F).

  AND

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- The absolute difference between IAT sensor 3 start-up temperature and the IAT sensor 2 start-up temperature is greater than the absolute difference between IAT sensor 2 start-up temperature and the IAT sensor 1 start-up temperature.

Action Taken When the DTC Sets

DTC P00E9 is a Type B DTC.

Conditions for Clearing the DTCs

DTC P00E9 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views

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 P00EA, P00EB, P00EC, P0097, P0098, P0099, P0112, P0113, P0114, P0641, P0651, P0697, P06A3, or P06D2 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: 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 scan tool parameters listed below are within 30Â°C (54Â°F).
   - Start-Up IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3
   - **If not within the specified range**

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Refer to Circuit/System Testing.

- **Go to next step: If within the specified range**

5. Engine idling, verify the scan tool parameters listed below are between: -38 and +149Â°C (-36 and +300Â°F).
   - IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3
   - **If not within the specified range**

     Refer to Circuit System Testing.

   - **Go to next step: If within the specified range**
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.

   - **Go to next step: 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. Verify the conditions listed below do not exist with the air induction system:
   - 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
   - **If a condition exists**

     Repair or replace the component as necessary.

   - **Go to next step: If none of the conditions exist**
2. Test or replace the B65 Intake Manifold Pressure and Air Temperature Sensor

Component Testing

Intake Manifold Pressure and Air Temperature Sensor

1. Ignition Off, disconnect the harness connector at the B65 Intake Manifold Pressure and Air Temperature Sensor.
2. Verify the resistance between terminals 1 - 3 of the sensor is within the range specified in the **Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)** **Temperature Versus Resistance - Intake Air Temperature Sensor (Delco Sensor)** table, for Delco sensors, while varying the sensor between known temperatures.

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- **If not within the specified range**

  Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

- **Go to next step: If within the specified range**

3. All OK.

Repair Instructions

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

- **Intake Air Pressure and Temperature Sensor Replacement** for intake manifold pressure and air temperature sensor replacement.
- **Control Module References** for engine control module replacement, programming, and setup

DTC P00EA, P00EB, P00EC: INTAKE AIR TEMPERATURE (IAT) SENSOR 3 CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P00EA

Intake Air Temperature (IAT) Sensor 3 Circuit Low Voltage

DTC P00EB

Intake Air Temperature (IAT) Sensor 3 Circuit High Voltage

DTC P00EC

Intake Air Temperature (IAT) Sensor 3 Circuit Erratic

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Diagnostic Fault Information

IAT Sensor 3

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P00EA, P00EB	P00E9, P00EB, P00EC	P00EB, P00EC*	P00E9
Low Reference	-	P00E9, P00EB, P00EC	P00EB, P00EC*	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT Sensor 3

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature; and engine bay conditions			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

The intake air temperature (IAT) sensor 3 is a variable resistor that changes an engine control module (ECM) supplied 5 V signal. The signal varies with intake manifold air temperature and is displayed by the scan tool as Â°C (Â°F). The IAT sensor 3 is integrated with the manifold absolute pressure sensor in the intake manifold. The ECM provides a ground for the IAT sensor 3 low reference circuit.

IAT Sensor 3 - Temperature, Resistance, Voltage Table

IAT Sensor 3	IAT Sensor 3 Resistance	IAT Sensor 3 Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTCs

P00EA, P00EB, and P00EC

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

Conditions for Setting the DTC

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

P00EA

The ECM detects that the IAT sensor 3 signal is warmer than 149Â°C (300Â°F) for at least 5 s.

P00EB

The ECM detects that the IAT sensor 3 signal is colder than -60Â°C (-76Â°F) for at least 5 s.

P00EC

The ECM detects that the IAT sensor 3 signal is intermittent or has abruptly changed for at least 5 s.

Action Taken When the DTCs Set

- DTCs P00EA, P00EB, and P00EC are Type B DTCs.
- The ECM commands the cooling fans On.

Conditions for Clearing the DTCs

DTCs P00EA, P00EB, and P00EC are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

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- **Connector Repairs**
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- **Wiring Repairs**

Powertrain Component Views

Powertrain Component Views

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

1. Ignition On.
2. Verify that DTC P0641, P0651, P0697, P06A3, or P06D2 is not set.
   - **If any of the DTCs are set**

     Refer to **DTC P0641, P0651, P0697, P06A3, or P06D2** .

   - **Go to next step: 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 scan tool parameters listed below are within 30Â°C (54Â°F).
   - Start-Up IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3
   - **If not within the specified range**

     Refer to Circuit/System Testing.

   - **Go to next step: If within the specified range**
5. Engine idling, verify the scan tool parameters listed below are between: -38 and +149Â°C (-36 and +300Â°F).
   - IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3
   - **If not within the specified range**

     Refer to Circuit System Testing.

   - **Go to next step: If within the specified range**
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.

   - **Go to next step: If the DTC does not set**
8. All OK

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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 B65 Intake Manifold Pressure and Air Temperature Sensor.
2. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
   - **If 2 Ω or greater**
   1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **Go to next step: If less than 2 Ω**
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 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**

     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.
   - **Go to next step: If between 4.8 - 5.2 V**
4. Ignition On, test for 4.8 - 5.2 V between the signal circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**

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

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

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- **Go to next step: If between 4.8 - 5.2 V**

5. Test or replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

Component Testing

Intake Manifold Pressure and Air Temperature Sensor

1. Ignition Off, disconnect the harness connector at the B65 Intake Manifold Pressure and Air Temperature Sensor.
2. Verify the resistance between terminals 1 - 3 of the sensor is within the range specified in the **Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)** **Temperature Versus Resistance - Intake Air Temperature Sensor (Delco Sensor)** table, for Delco sensors, while varying the sensor between known temperatures.
   - **If not within the specified range**

     Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

   - **Go to next step: If within the specified range**
3. All OK.

Repair Instructions

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

- **Intake Air Pressure and Temperature Sensor Replacement** for intake manifold air pressure and temperature sensor replacement.
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P00F4, P00F5, P00F6: INTAKE AIR HUMIDITY SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P00F4

Intake Air Humidity Sensor Circuit Low Voltage

DTC P00F5

Intake Air Humidity Sensor Circuit High Voltage

DTC P00F6

Intake Air Humidity Sensor Circuit Erratic

Diagnostic Fault Information

Intake Air Humidity

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

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

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 temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz*
Ground	-	-40Â°C (-40Â°F) 10 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

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

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

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

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

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

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

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

Conditions for Running the DTCs

P00F4, P00F5, and P00F6

- DTC P1682 is not active.
- The ignition is On.

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- 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

P00F4

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

P00F5

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

P00F6

The ECM 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 P00F4, P00F5, and P00F6 are Type C DTCs.

Conditions for Clearing the MIL/DTC

DTCs P00F4, P00F5, and P00F6 are Type C DTCs.

Diagnostic Aids

- The Intake Air Humidity Signal parameter displays the measured humidity within the air intake system and may differ from atmospheric humidity measured outside the air intake system.
- With the ignition On, the engine Off, if the engine is cold, a properly functioning humidity sensor will gradually increase the scan tool Intake Air Humidity Signal parameter. This is due to the heat that is generated by the multifunction intake air sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the 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 Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

Powertrain Component Views

Powertrain Component Views

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 (Diagnostic Tools) Special Tools (Mechanical Tools) .

Circuit/System Verification

1. Ignition On.
2. Verify that DTC P0641, P0651, P0697, P06A3, or P06D2 is not set.
   - **If any of the DTCs are set**

     Refer to DTC P0641, P0651, P0697, P06A3, or P06D2 for further diagnosis.

   - **Go to next step: 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. Verify the following scan tool parameters are within 30Â°C (54Â°F) of each other.
   - Start-Up IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3; where equipped
   - **If not within 30Â°C (54Â°F)**

     Refer to Circuit/System Testing.

   - **Go to next step: If within 30Â°C (54Â°F)**
4. Engine idling, verify the scan tool Intake Air Humidity parameter is between 5 and 90 %.

   NOTE: **On vehicles equipped with Auto Start/Stop, it may be necessary to OPEN the hood to enable the engine to idle.**

5.
   - **If not between 5 and 90 %**

     Refer to Circuit/System Testing.

   - **Go to next step: 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 sets**

     Refer to Circuit/System Testing.

   - **Go to next step: 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, disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 2 Ω between the ground circuit terminal 7 and ground.

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- **If 2 Ω or greater**

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

- **Go to next step: If less than 2 Ω**

3. Ignition On, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**

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

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

    1. Ignition Off, remove the test lamp.
    2. Test for infinite resistance between the ignition voltage circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.

    - **Go to next step: If a test lamp illuminates**

4. Test for greater than 10.5 V between the humidity signal circuit terminal 8 and ground.
    - **If 10.5 V or less**

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

    - **If greater than 10.5 V**

5. Determine if **EL-38522-A** or equivalent is available.
    - **If EL-38522-A, or equivalent is not available**

    1. Test or replace the B75C Multifunction Intake Air sensor.
    2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
    3. Verify the DTC does not set.
        - **If the DTC sets**

          Replace the K20 Engine Control Module.

        - **Go to next step: If no DTCs set**

    4. All OK.

    - **Go to next step: EL-38522-A, or equivalent is available**

6. Ignition Off, connect the leads of the **EL-38522-A** as listed below:
    - Red lead to the signal circuit terminal 8 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
7. Set the **EL-38522-A** to the specifications listed below:
    - Signal switch to 5 V
    - Frequency switch to 250 Hz
    - Duty Cycle switch to 50 % (Normal)

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8. Ignition On, verify the scan tool Intake Air Humidity parameter is between 45 - 55 %.
    - **If not within the specified range**

      Replace the K20 Engine Control Module.

    - **Go to next step: If within the specified range**
9. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Verify the scan tool Intake Air Humidity Sensor parameter is between 5 - 95%, and changes, when varying the air humidity in the intake duct near the sensor.
    - **If not within the specified range or does not change**

      Replace the B75C Multifunction Intake Air Sensor.

    - **Go to next step: If within the specified range and changes**
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 engine control module replacement, programming, and setup.

DTC P0101: MASS AIR FLOW (MAF) SENSOR PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0101

Mass Air Flow (MAF) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P2199**	P0096, P0097, P00F4, P0102, P2199**	P0102	P0096	P0101, P0103
Signal	P0102	P0102	P0102	P0102	P0101, P0103, P1101
Ground	-	P0096, P0097, P00F4, P0102, P2199**	P0102	-	P0102
**If applicable.					

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage

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

Circuit Description

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

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

Conditions for Running the DTCs

- DTC P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0335, or P0336 is not set
- The engine speed is between 400 - 6, 100 RPM.
- The engine coolant temperature (ECT) is between -7 to +125Â°C (+19 to +257Â°F).
- The intake air temperature (IAT) is between -20 and +125Â°C (-4 and +257Â°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0101 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0101 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Electrical Information Reference

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- **Connector Repairs**
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- **Wiring Repairs**

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

1. Ignition On.
2. Verify that DTC P0102, P0103, P0641, P0651, P0697, P06A3 or P06D2 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. If you were sent here from DTC P0068, P0106, P0121, P0236, or P1101; refer to Circuit/System Testing.
4. Ignition On, verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
   - **90 % or greater**

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

   - **Go to next step: If less than 90 %**
5. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
   - **If Disagree**

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

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

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

   - **Go to next step: If within the specified range**

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

      Refer to **DTC P0236**.

    - **Go to next step: If within the specified range**
9. Verify the scan tool Boost Pressure Sensor parameter decreases after starting the engine.
    - **If the parameter does not decrease**

      Refer to **DTC P0236** for further diagnosis.

    - **Go to next step: If the parameter does decrease**
10. 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 within the specified range or does not change**

      Refer to **DTC P0106**.

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

      Refer to Circuit/System Testing.

    - **Go to next step: If the 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.

    - **Go to next step: If the DTC does not set**
14. All OK

Circuit/System Testing

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

1. Verify the integrity of the entire air induction system by verifying that none of the conditions listed below exist:
    - Any damaged components
    - Improper operation of turbocharger wastegate actuator or bypass valve; where equipped
    - Improperly installed components
    - Collapsed, restricted, or damaged components
    - Loose clamps, cracks, or other damage
    - An air flow restriction
    - Restricted air filter

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

  Repair or replace component as necessary.

- **Go to next step: If no condition is found**

2. Determine if **EL-38522-A** or equivalent is available.
   - **If EL-38522-A or equivalent is not available**
   1. Test or replace the B75C Multifunction Intake Air sensor.
   2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
   3. Verify the DTC does not set.
      - **If the DTC sets**

        Replace the K20 Engine Control Module.

      - **Go to next step: If no DTCs set**
   4. All OK.
   - **Go to next step: If EL-38522-A or equivalent is available**
3. Ignition Off, connect the leads of the **EL-38522-A** as listed below:
   - Red lead to the signal circuit terminal 6 at the harness connector
   - Black leads to ground
   - Battery voltage supply lead to B+
4. Set the **EL-38522-A** to the specifications listed below:
   - Signal switch to 5 V
   - Frequency switch to 5 kHz
   - Duty Cycle switch to 50 % (Normal)
5. Engine idling, verify the scan tool MAF Sensor parameter is between 4, 950 - 5, 050 Hz.
   - **If not within the specified range**

     Replace the K20 Engine Control Module.

   - **Go to next step: If within the specified range**
6. Test or replace the B75C Multifunction Intake Air sensor.

Repair Instructions

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

- **Mass Airflow Sensor Replacement** for multifunction intake air sensor replacement
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0102 OR P0103: MASS AIR FLOW SENSOR FREQUENCY

Diagnostic Instructions

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

DTC Descriptors

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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, P121B**	P0102, P01101, P121A**	P0690	P0101
Signal	P0102, P1101	P0102, P1101	P0102*	P0101, P1101
Ground	-	P0102	-	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+. ** If applicable.				

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Parameter Normal Range:** 2, 000 - 10, 000 Hz			
Ignition Voltage	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz*
Ground	-	0 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit Description

The sensors listed below are integrated within the mass air flow/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

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- 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 10 V.
- The above conditions are met for at least 1 s.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0102

The ECM detects that the MAF Sensor signal parameter is less than 1, 825 Hz (about 0.37 g/s) for at least 250 cylinder firing events.

P0103

The ECM detects that the MAF Sensor signal parameter is at least 8, 712 Hz (about 280 g/s) for at least 250 cylinder firing events.

Action Taken When the DTCs Set

DTCs P0102 and P0103 are Type B DTCs.

Conditions for Clearing the MIL/DTCs

DTCs P0102 and P0103 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

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Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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EL-38522-A Variable Signal Generator

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

Circuit/System Verification

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

     Refer to Circuit/System Testing.

   - **Go to next step: If within the specified range**
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.
   - **If the parameter does not change smoothly and gradually**

     Refer to Circuit/System Testing.

   - **Go to next step: If the parameter changes smoothly and gradually**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: 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 Ω between the ground circuit terminal 7 and ground.
   - **If 2 Ω or greater**
   1. Ignition Off. Disconnect the sensor chassis ground.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the chassis ground connection.
   - **Go to next step: If less than 2 Ω**
3. Ignition On, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition Off, remove the test lamp.
   2. Test for less than 2 Ω in the ignition voltage circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition Off, remove the test lamp.

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2. Test for infinite resistance between the ignition voltage circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
- **Go to next step: If a test lamp illuminates**

4. Ignition On, test for 4.8 - 5.2 v between the signal circuit terminal 6 and ground.
    - **If less than 4.8 V**
    1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
    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.
    - **Go to next step: If between 4.8 - 5.2 V**
5. Determine if **EL-38522-A** or equivalent is available.
    - **If EL-38522-A or equivalent is not available**
    1. Test or replace the B75C Multifunction Intake Air sensor.
    2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
    3. Verify the DTC does not set.
        - **If the DTC sets**

          Replace the K20 Engine Control Module.

        - **Go to next step: If no DTCs set**
    4. All OK.
    - **Go to next step: If EL-38522-A or equivalent is available**
6. Ignition Off, connect the leads of the **EL-38522-A** as listed below:
    - Red lead to the signal circuit terminal 6 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
7. Set the **EL-38522-A** to the specifications listed below:
    - Signal switch to 5 V
    - Frequency switch to 5 kHz
    - Duty Cycle switch to 50 % (Normal)
8. Engine idling, verify the scan tool MAF Sensor parameter is between 4, 950 - 5, 050 Hz.
    - **If not within the specified range**

      Replace the K20 Engine Control Module.

    - **Go to next step: If within the specified range**
9. Test or replace the B75C Multifunction Intake Air sensor.

Repair Instructions

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

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- **Mass Airflow Sensor Replacement** for multifunction intake air sensor replacement
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0106: MANIFOLD ABSOLUTE PRESSURE SENSOR

Diagnostic Instructions

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

DTC Descriptor

DTC P0106

Manifold Absolute Pressure (MAP) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P018C, P0532, P0641	P0106, P0107	P0106, P018C, P0533, P0641	P0106
Signal	P0106, P0107	P0106, P0108	P0106, P0108*	P0106
Low Reference	-	P0106, P0108	-	P0106
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine idling at normal operating temperature **Parameter Normal Range:** 26 - 52 kPa (3.8 - 7.6 PSI)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	435 kPa (63.1 PSI)
Signal	0 kPa (0 PSI)	435 kPa (63.1 PSI)	435 kPa (63.1 PSI)
Low Reference	-	435 kPa (63.1 PSI)	-

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 turbocharger output. A silicone chip 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. Integrated within this sensor is also an intake air temperature (IAT) sensor.

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.

Integrated within the MAP sensor is a 4th circuit for the IAT. A signal voltage is supplied to the ECM relative to intake air temperature. The low reference is shared with the MAP sensor low reference. The IAT is diagnosed within it's own DTC.

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Under normal operation the greatest pressure that can exist in the intake manifold is at ignition ON, engine OFF, which is equal to the barometric pressure (BARO). The 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.

Conditions for Running the DTC

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

Conditions for Setting the DTC

The ECM detects that the MAP Sensor pressure is not within range of the calculated pressure that is derived from a system of models for more than 0.5 s.

Action Taken When the DTC Sets

DTC P0106 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0106 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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-23738-A Vacuum Pump

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

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, P06A3, P06D2 or P06D6 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTC are set**
3. If you were sent here from DTC P0068, P0101, P0121, P0236, or P1101; refer to Circuit/System Testing.
4. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90%.
   - **If 90% or greater**

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

   - **Go to next step: If less than 90%**
5. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
   - **If Disagree**

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

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

     Refer to Circuit/System Testing.

   - **Go to next step: If the MAP Sensor parameter is in range**
8. Verify the scan tool Boost Pressure Sensor parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.
   - **If the Boost Pressure Sensor parameter is not in range**

     Refer to **DTC P0236** for further diagnosis.

   - **Go to next step: If the Boost Pressure Sensor parameter is in range**
9. Verify the scan tool Boost Pressure Sensor parameter decreases after starting the engine.
   - **If the Boost Pressure Sensor parameter does not decrease**

     Refer to **DTC P0236** for further diagnosis.

   - **Go to next step: If the Boost Pressure Sensor parameter is within range**
10. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 24 - 52 kPa (3.4 - 7.5 PSI) and changes with accelerator pedal input.
    - **If not between 24 - 52 kPa (3.4 - 7.5 PSI) or does not change**

      Refer to Circuit/System Testing.

    - **Go to next step: If between 24 - 52 kPa (3.4 - 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

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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**.

- **Go to next step: If the MAF Sensor parameter does change 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 a DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **Go to next step: If the DTC does not set**
14. All OK.

Circuit/System Testing

1. Check 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
   - Loose or improper installation of the turbocharger and the charge air cooler, including the flexible ductwork
   - An air flow restriction
   - Any vacuum leak
   - Improperly routed vacuum hoses
   - A restriction in the MAP Sensor port or the BARO port
   - Proper operation of the positive crankcase ventilation system
   - Missing, restricted or leaking exhaust components. Refer to **Symptoms - Engine Exhaust** .
   - Engine mechanical condition; for example: low compression or incorrect timing chain installation. Refer to **Symptoms - Engine Mechanical** .
   - **If a condition is found**

     Repair or replace the component as appropriate.

   - **Go to next step: If no condition is found**
2. Ignition OFF, and all vehicle systems OFF, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B65 Intake Manifold Pressure and Air Temperature Sensor.
3. Test for less than 2 Ω between the low reference circuit terminal 3 or A and ground.
   - **If 2 Ω or greater**
   1. Ignition OFF, disconnect the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 2 Ω**
4. Ignition ON.
5. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 2 or C and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect 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 Ω in the 5 V reference circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

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

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the 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.

- **Go to next step: If between 4.8 - 5.2 V**

6. Ignition ON, verify the scan tool MAP 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. Ignition ON, test for infinite resistance between the signal circuit terminal 4 or D and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If greater than 4.7 V**
7. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 4 or D and the low reference circuit terminal 3 or A.
8. Ignition ON, verify the scan tool MAP Sensor voltage parameter is less than 0.2 V.
    - **If 0.2 V or greater**
    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 terminal 4 or D and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open or high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 0.2 V**
9. Test or replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

Component Testing

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

Skewed Sensor Test

1. Ignition OFF, remove the B65 Intake Manifold Pressure and Air Temperature 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 B65 Intake Manifold Pressure and Air Temperature Sensor, with the **GE-23738-A** . Verify the scan tool MAP Sensor pressure parameter decreases between 13 - 21 kPa (1.8 - 3.0 PSI).

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- **If the parameter does not decrease between 13 - 21 kPa (1.8 - 3.0 PSI).**

  Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

- **Go to next step: 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 B65 Intake Manifold Pressure and Air Temperature 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 B65 Intake Manifold Pressure and Air Temperature Sensor.

   - **Go to next step: 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 B65 Intake Manifold Pressure and Air Temperature Sensor. and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 2 or C of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 3 or A of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 4 or D 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 -15 kPa (4.4 in Hg) of vacuum to the sensor with the **GE-23738-A** . Verify the voltage changes, without any spikes or dropouts, between 1.3 - 0.9 V.
   - **If not between 1.3 - 0.9 V or has spikes or dropouts**

     Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

   - **Go to next step: If between 1.3 - 0.9 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.

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

DTC P0107 OR P0108: MANIFOLD ABSOLUTE PRESSURE SENSOR VOLTAGE

Diagnostic Instructions

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

DTC Descriptors

DTC P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P018C, P0532, P0641	P0106, P0107	P0106, P018C, P0533, P0641	P0106
Signal	P0106, P0107	P0106, P0108	P0106, P0108*	P0106
Low Reference	-	P0106, P0108	-	P0106
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

MAP Sensor

Circuits	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine idling at normal operating temperature **Parameter Normal Range:** 26 - 52 kPa (3.8 - 7.6 PSI)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)
Signal	0 kPa (0 PSI)	255 kPa (36.9 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 turbocharger output. A silicone chip 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. Integrated within this sensor is also an intake air temperature (IAT) sensor.

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.

Integrated within the MAP sensor is a 4th circuit for the IAT. A signal voltage is supplied to the ECM relative to intake air temperature. The low reference is shared with the MAP sensor low reference. The IAT is diagnosed within it's own DTC.

Under normal operation the greatest pressure that can exist in the intake manifold is at ignition ON, engine OFF, which is equal to the barometric pressure (BARO). The 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.

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 Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Turbocharger 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

GE-23738-A Vacuum Pump

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

Circuit/System Verification

1. Ignition ON, verify that DTC DTC P0641, P0651, P0697, P06A3, P06D2 or P06D6 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: 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.

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

  Refer to Circuit/System Testing for further diagnosis.

- **Go to next step: If the MAP Sensor parameter is within range**

4. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 24 - 52 kPa (3.4 - 7.5 PSI) and changes with accelerator pedal input.
   - **If not between 24 - 52 kPa (3.4 - 7.5 PSI) or does not change**

     Refer to Circuit/System Testing.

   - **Go to next step: If between 24 - 52 kPa (3.4 - 7.5 PSI) and changes**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
6. Verify a DTC does not set.
   - **If any DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If no DTC sets**
7. All OK.

Circuit/System Testing

1. Ignition OFF, and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down. Disconnect the harness connector at the B65 Intake Manifold Pressure and Air Temperature Sensor.
2. Test for less than 2 Ω between the low reference circuit terminal 3 or A and ground.
   - **If 2 Ω or greater**
   1. Ignition OFF, disconnect the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 2 Ω**
3. Ignition ON, test for 4.8 - 5.2 V between the 5 V reference circuit terminal 2 or C and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.

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

   -
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the 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.
   - **Go to next step: If between 4.8 - 5.2 V**
4. Ignition ON, verify the scan tool MAP Sensor parameter is greater than 4.7 V.

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- **If 4.7 V or less**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for infinite resistance between the signal circuit terminal 4 or D and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K20 Engine Control Module.

- **Go to next step: If greater than 4.7 V**

5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 4 or D and the low reference circuit terminal 3 or A.
6. Ignition ON, verify the scan tool MAP Sensor voltage parameter is less than 0.2 V.
    - **If 0.2 V or greater**

    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 terminal 4 or D and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open or high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

    - **Go to next step: If less than 0.2 V**

7. Test or replace the B65 Intake Manifold Pressure and Air Temperature 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 B65 Intake Manifold Pressure and Air Temperature 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 B65 Intake Manifold Pressure and Air Temperature 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 B65 Intake Manifold Pressure and Air Temperature Sensor.

    - **Go to next step: 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 B65 Intake Manifold Pressure and Air Temperature 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 B65 Intake Manifold Pressure and Air Temperature Sensor.

    - **Go to next step: 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 B65 Intake Manifold Pressure and Air Temperature Sensor and disconnect the harness.

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2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 2 or C of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 3 or A of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 4 or D 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 -15 kPa (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 1.3 - 0.9 V.
    - **If not between 1.3 - 0.9 V or has spikes or dropouts**

      Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

    - **Go to next step: If between 1.3 - 0.9 V and there are no spikes or dropouts**
7. All OK.

Repair Instructions

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

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

DTC P0112, P0113, OR P0114: INTAKE AIR TEMPERATURE SENSOR CIRCUIT VOLTAGE

Diagnostic Instructions

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

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DTC Descriptors

DTC P0112

Intake Air Temperature (IAT) Sensor 1 Circuit Low Voltage

DTC P0113

Intake Air Temperature (IAT) Sensor 1 Circuit High Voltage

DTC P0114

Intake Air Temperature (IAT) Sensor 1 Circuit Intermittent

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199**	P0111, P0113, P0114, P2199**	P0097*, P0113, P0114, P11C2, P2199**	P0111, P2199**
Low Reference	-	P0111, P0113, P0114, P2199**	P0113*, P0114	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+. **If applicable.				

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

The intake air temperature (IAT) sensor 1 is a variable resistor that measures the temperature of the air in the sensor bore. The engine control module (ECM) supplies 5 V to the IAT sensor 1 signal circuit and a ground for the IAT sensor 1 low reference circuit. The signal varies with inlet air temperature and is displayed by the scan tool as Â°C (Â°F).

The multifunction intake air sensor houses the following:

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

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

Conditions for Running the DTCs

P0112, P0113, and P0114

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

Conditions for Setting the DTC

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

P0112

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

P0113

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

P0114

Where this DTC is used, the ECM detects that the IAT sensor signal is intermittent or has abruptly changed for at least 5 s.

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 1 and 2 of this verification procedure only if the ignition has been Off for 8 hours or more.**

1. Ignition On.
2. Verify the scan tool parameters listed below are within 30Â°C (54Â°F):
   - Start-Up IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3; where equipped
   - **If not within the specified range**

     Refer to Circuit/System Testing.

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

     Refer to Circuit/System Testing.

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- **Go to next step: If within the specified range**

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.

   - **Go to next step: If the DTC does not set**
6. All OK

Circuit/System Testing

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

1. Ignition Off, and all vehicle systems Off, it may take up to 2 min. for all vehicle systems to power down.
2. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
3. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
   - **If 2 Ω or greater**
   1. Ignition Off.
   2. Disconnect the harness connector X2 at the K20 Engine Control Module.
   3. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **Go to next step: If less than 2 Ω**
4. Ignition On.
5. Test for 4.8 - 5.2 V between the intake air temperature sensor 1 signal circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition Off.
   2. Disconnect the harness connector X1 at the K20 Engine Control Module.
   3. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition Off.

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

   2. Disconnect the harness connector X1 at the K20 Engine Control Module.
   3. Ignition On.
   4. 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.
   - **Go to next step: If between 4.8 - 5.2 V**
6. Ignition On.
7. Verify the scan tool IAT Sensor 1 parameter is colder than -39Â°C (-38Â°F).

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- **If warmer than -39Â°C (-38Â°F).**

1. Ignition Off.
2. Disconnect the harness connector X1 at the K20 Engine Control Module.
3. 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
4. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **Go to next step: If colder than -39Â°C (-38Â°F).**

8. Ignition Off.
9. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3.
10. Verify the scan tool IAT Sensor 1 parameter is warmer than 148Â°C (298Â°F).
    - **If colder than 148Â°C (298Â°F).**

    1. Ignition Off,
    2. Remove the jumper wire, disconnect the harness connector X1 at the K20 Engine Control Module.
    3. Ignition On.
    4. 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
    5. Ignition Off.
    6. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

    - **Go to next step: If warmer than 148Â°C (298Â°F).**

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

Component Testing

Multifunction Intake Air Sensor

1. Ignition Off.
2. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.

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

3. Verify the resistance between terminals 1 - 3 of the sensor is within the range specified in the Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor) Temperature Versus Resistance - Intake Air Temperature Sensor (Delco Sensor) , table for Hitachi sensors, while varying the sensor between known temperatures.
    - **If not within the specified range**

      Replace the B75C Multifunction Intake Air Sensor.

    - **Go to next step: If within the specified range**
4. 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.

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DTC P0117, P0118, OR P0119: ENGINE COOLANT TEMPERATURE SENSOR

Diagnostic Instructions

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

DTC Descriptor

DTC 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, P0119	P0118, P0119	P0118*, P0119	P0119, P0128
Low Reference	-	P0118, P0119**	*	P0119, P0128
Internal control module or component damage may occur if the circuit shorts to B+. Additional DTCs may set.				

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine=Idling - At normal operating temperature. **Parameter Normal Range:** 88 to 105Â°C (190 to 221Â°F)			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-

Circuit/System Description

For an overview of the component/system, refer to:**Cooling System Description and Operation**

Circuit	Description
Signal	The control module input circuit has an internal resistance connected t o5V
Low Reference	Grounded through the control module.

Component	Description
B34 Engine Coolant Temperature Sensor	The sensor is a 2 wire negative temperature coefficient thermistor. As the temperature of the fluid increases, the resistance of the sensor decreases, varying the voltage on the signal circuit.

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Component	Description
K20 Engine Control Module	The control module contains a microprocessor used to process input data to control outputs. The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

P0117

Ignition = On

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

P0118

- Engine = Running - For greater than 10 s
- IAT Sensor = Warmer than -7Â°C (19Â°F)

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

P0119

DTC P0117, P0118 = Not set

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

Conditions for Setting the DTC

P0117

Engine Coolant Temperature = Warmer than 149Â°C (300Â°F) - For greater than 5 s

P0118

Engine Coolant Temperature = Colder than -39Â°C (-38Â°F)- For greater than <5 s

P0119

Engine Coolant Temperature = Intermittent - For greater than 3s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

- A/C Compressor = Off
- Cooling Fan = On
- Engine Coolant Temperature - Gauge = Inoperative

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

After starting the engine, the ECT sensor parameter value should rise steadily and then stabilize after the thermostat opens.

Reference Information

Schematic Reference

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Engine Controls Wiring Schematics 1.5L (LYX)

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

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter:ECT Sensor = -39 to 149Â°C (-38 to 300Â°F)
   - **If not between -39 and 149Â°C (-38 and 300Â°F)**

     Refer to: Circuit/System Testing

   - **Go to next step: If between -39 and 149Â°C (-38 and 300Â°F)**
3. Verify the scan tool parameter:ECT Sensor = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector:B34 Engine Coolant Temperature Sensor
   - Wiggle the harness and connector:X2 @K20 Engine Control Module
   - **If the value spikes or drops out**

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

   - **Go to next step: If the value does not spike or drop out**
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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

   - **Go to next step: If the DTC is not set**
5. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector:B34 Engine Coolant Temperature Sensor

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3. Test for less than 2 ohms between the test points:Low Reference circuit terminal 2/B & Ground
    - **If 10 ohms or greater**
    1. Disconnect the appropriate electrical connector:K20 Engine Control Module
    2. Test for less than 2 ohms between the test points:Low Reference circuit terminal 2/B @Component harness & The other end of the circuit@Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component:K20 Engine Control Module
    - **Go to next step: If less than 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Verify the scan tool parameter:ECT Sensor = Colder than -39Â°C (-38Â°F
    - **If -39Â°C (-38Â°F) or warmer**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector:K20 Engine Control Module
    3. Test for infinite resistance between the test points:Signal circuit terminal 1A @Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component:K20 Engine Control Module
    - **Go to next step: If colder than -39Â°C (-38Â°F)**
6. Connect a 3 A fused jumper wire between the test points:Signal circuit terminal 1A & Low Reference circuit terminal 2B
7. Verify the scan tool parameter:ECT Sensor = Warmer than 149Â°C (300Â°F)
    - **If 149Â°C (300Â°F) or colder**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the appropriate electrical connector:K20 Engine Control Module
    3. Ignition - On / Vehicle - In Service Mode
    4. Test for less than 1 V between the test points:Signal circuit terminal 1A @Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for less than 2 ohms between the test points:Signal circuit terminal 1A @Component harness & The other end of the circuit@Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component:K20 Engine Control Module
    - **Go to next step: If warmer than 149Â°C (300Â°F)**
8. Test or replace the component:B34 Engine Coolant Temperature Sensor

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector:B34 Engine Coolant Temperature Sensor
3. Test for 42 to 78, 834 ohms between the test points:Signal terminal 1A & Low Reference terminal 2B
    - **If not between 42 and 78, 834 ohms**

      Replace the component:B34 Engine Coolant Temperature Sensor
    - **Go to next step: If between 42 and 78, 834 ohms**
4. Verify the value is within the range listed in the table:**Temperature Versus Resistance - Engine Coolant Temperature Sensor**
    - **If not in the specified range**

      Replace the component:B34 Engine Coolant Temperature Sensor

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- **Go to next step: If in the specified range**

5. Test for infinite resistance between the test points:Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component:B34 Engine Coolant Temperature Sensor

    - **Go to next step: If infinite resistance**
6. All OK.

Repair Instructions

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

- **Engine Coolant Temperature Sensor Replacement - Water Outlet**
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P0121, P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, OR P2135: THROTTLE POSITION SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P0121

Throttle Position Sensor 1 Performance

DTC P0122

Throttle Position Sensor 1 Circuit Low Voltage

DTC P0123

Throttle Position Sensor 1 Circuit High Voltage

DTC P0222

Throttle Position Sensor 2 Circuit Low Voltage

DTC P0223

Throttle Position Sensor 2 Circuit High Voltage

DTC P16A0

Sensor Communication Circuit Low Voltage

DTC P16A1

Sensor Communication Circuit High Voltage

DTC P16A2

Sensor Communication Circuit Performance

DTC P2135

Throttle Position Sensors 1-2 Not Plausible

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P06A3	P0122*, P0222*, P16A0	P06A3	P0121, P16A2, P2135*
Signal	P0122*, P0222*, P16A0	P0122*, P0222*, P16A1	P0123*, P0223*, P16A0**, P16A1**, P16A2**	P0121, P16A2, P2135*
Low Reference	-	P0123*, P0223*, P16A1	-	P0121, P16A2, P2135*
* This DTC set indicates an internal throttle body condition. ** A short to voltage causes P16A1 to set. If DTC P16A0, P16A1, and P16A2 set at the same time, an intermittent circuit condition exists.				

Typical Scan Tool Data

Throttle Position Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. **Parameter Normal Range:** Throttle Position Sensor 1 3.75 - 4.75 V			
5 V Reference	5.0 V	5.0 V	5.0 V
Signal	5.0 V	0.0 V	0.0 V
Low Reference	-	0.0 V	-

Throttle Position Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. **Parameter Normal Range:** Throttle Position Sensor 2 0.45 - 0.90 V			
5 V Reference	0.0 V	0.0 V	0.0 V
Signal	0.0 V	5.0 V	5.0 V
Low Reference	-	5.0 V	-

Circuit/System Description

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

Conditions for Running the DTC

P0121

- Before the ECM can report that DTC P0121 failed, DTCs P0097, P0098, P0099, P0112, P0113, P0114, P0117, P0118, and P0119 must run and pass.
- DTCs P0097, P0098, P0099, P0102, P0103, P0107, P0108, P0112, P0113, P0114, P0117, P0118, P0119, P0237, P0238, P0335, P0336, P2228, P02229, or P2230 is not set.
- The engine speed is between 400 - 6, 100 RPM.

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- The engine coolant temperature (ECT) is -7 to +125Â°C (19 - 257Â°F).
- The intake air temperature (IAT) is -20 to +126Â°C (-4 to +259Â°F).
- The DTC runs continuously when the above conditions are met.

P0122, P0123, P0222, P0223

- DTC P06A3 is not set.
- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.41 V and reduced power is not active.
- The DTCs run continuously when the above condition are met.

P16A0, P16A1, or P16A2

- DTC P06A3 is not set.
- The ignition is ON or the engine is operating.
- The run/crank voltage is greater than 6.41 V.
- The DTCs run continuously once the above conditions are met for greater than 1 s.

P2135

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

Conditions for Setting the DTC

P0121

The ECM detects that the throttle position sensor input is stuck within normal operating range for greater than 178 ms.

P0122

The ECM detects the throttle position sensor 1 signal voltage is less than 0.33 V for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P0123

The ECM detects the throttle position sensor 1 signal voltage is greater than 4.75 V for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P0222

The ECM detects the throttle position sensor 2 signal voltage is less than 0.25 V for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P0223

The ECM detects the throttle position sensor 2 signal voltage is greater than 4.59 V for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P16A0

The ECM detects a low voltage circuit condition on the throttle position sensor signal circuit for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P16A1

The ECM detects a high voltage circuit condition on the throttle position sensor signal circuit for greater than 178 ms, or for 247 ms of a 497 ms time frame.

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P16A2

The ECM detects an incorrect message was received over the throttle position sensor signal circuit for greater than 178 ms, or for 247 ms of a 497 ms time frame.

P2135

- The ECM detects that throttle position sensors 1 and 2 disagree greater than 7 % at minimum throttle, with a linear threshold to 10 % at wide open throttle (WOT).

  OR

- The ECM detects that the TP sensor 1 and 2 learned minimum throttle position voltages is greater than 5 percent of the 5 volt reference voltage.
- Either condition exists for greater than 181 ms, or for 247 ms of a 497 ms time frame.

Action Taken When the DTC Sets

- P0121 is a Type B DTC.
- P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 are Type A DTCs.
- The ECM commands the throttle actuator control (TAC) system to operate in a Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions, the ECM commands the engine OFF.

Conditions for Clearing the DTC

- P0121 is a Type B DTC.
- P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 are Type A DTCs.

Diagnostic Aids

- 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 that provide estimates of MAF, MAP, and if equipped, barometric pressure (BARO) and throttle inlet air pressure (TIAP). The models are then compared to the actual measured values from the MAF, MAP, BARO, TIAP, the throttle position sensors, and to each other to determine if DTC P0121 is the appropriate DTC to fail.
- 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 Wiring Schematics 1.5L (LYX)

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

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

1. Ignition ON,
2. Verify that DTC P0601 - P0606, P06A3, and P16F3 is not set.
   - **If a DTC is set**

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

   - **Go to next step: If a DTC is not set**
3. Verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90 %.
   - **If 90 % or greater**

     Refer to Throttle Body Inspection and Cleaning .

   - **Go to next step: If less than 90 %**
4. Verify that DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, or P2135 are not set.
   - **If DTC P0122, P0123, P0222, P0223, or P2135 are the only DTCs set**

     Replace the Q38 Throttle Body.

   - **If DTC P16A0, P16A1, or P16A2 is set with any of the DTCs**

     Refer to Circuit/System Testing

   - **Go to next step: If none of the DTCs are set**
5. Verify the Throttle Position Sensors 1 and 2 parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
   - **If Agree is not displayed**

     Replace the Q38 Throttle Body.

   - **Go to next step: If Agree is displayed**
6. Verify DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If a DTC is not set**
7. Determine the current vehicle testing altitude.
8. Verify the scan tool MAP Sensor pressure parameter is within range specified in the Altitude Versus Barometric Pressure table.
   - **If the MAP Sensor pressure is not in range**

     Refer to DTC P0106.

   - **Go to next step: If the MAP Sensor pressure is within range**

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9. Engine idling.
10. Verify the scan tool MAP Sensor pressure parameter is between 22 - 52 kPa (3.2 - 7.5 psi) and changes with accelerator pedal input.
    - **If not within range or does not change**

      Refer to **DTC P0106**.

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

      Refer to **DTC P0101**.

    - **Go to next step: If the MAF Sensor parameter changes smoothly and gradually**
12. Verify the scan tool Boost Pressure Sensor pressure and BARO parameters are within 3 kPa (0.4 psi) with engine at idle.
    - **If the parameters are not within range**

      Refer to **DTC P0236**.

    - **Go to next step: If the parameters are within range**
13. Verify the scan tool MAP Sensor parameter and the Boost Pressure Sensor parameter are within 20 kPa (2.9 psi) during a WOT acceleration at the time of the 1 - 2 shift.
    - **If the parameters are not within range**

      Refer to **DTC P0236**

    - **Go to next step: If the parameters are within range**
14. 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.
15. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **Go to next step: If the DTC does not set**
16. All OK.

Circuit/System Testing

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

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at Q38 Throttle Body. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 4 and ground.
    - **If 5 Ω or greater**
    1. Disconnect the harness connector X2 at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

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- **Go to next step: If less than 5 Ω**

3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 5 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector X2 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.
    - **Go to next step: If between 4.8 - 5.2 V**
5. Test for 4.8 - 5.2 V between the signal circuit terminal 3 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector X2 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.
    - **Go to next step: If between 4.8 - 5.2 V**
6. 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 min for all vehicle systems to power down.
5. Ignition ON.
6. Verify the Throttle Position Sensors 1 and 2 parameter displays Agree while performing the Throttle Sweep Test with a scan tool.

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- **If Agree is not displayed**

  Test or replace the Q38 Throttle Body.

- **Go to next step: If Agree is displayed**

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

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

   - **Go to next step: If DTC does not set**
8. All OK.

DTC P0128: ENGINE COOLANT TEMPERATURE (ECT) BELOW THERMOSTAT REGULATING TEMPERATURE

Diagnostic Instructions

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

DTC Descriptor

DTC P0128

Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

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Diagnostic Fault Information

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

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running at various operating conditions **Parameter Normal Range:** Varies with coolant temperature			
ECT Sensor Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)

Circuit/System Description

The purpose of this diagnostic is to analyze the performance of the thermostat, by using the ECT sensor to determine if the engine coolant will increase at the correct rate, and also meet the calibrated target temperatures under various operating conditions. The ECM uses the start-up ECT and the start-up intake air temperature (IAT) to begin the diagnostic calculation. The air flow into the engine is accumulated, and vehicle speed, distance, and engine run time are also factored in to determine if the ECT does increase normally and reach the calibrated target temperatures.

Conditions for Running the DTC

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0502, P0503, P1104, P16F3, P2101, or P2135 is not set.
- The start-up ECT is colder than 60Â° C (140Â° F).

- The Engine Coolant Thermostat Heater Command is less than 20 %.
- The engine OFF time is greater than 30 min.
- The engine run time is between 1 and 30 minutes.
- The vehicle has traveled greater than 2.4 kilometers (1.5 miles).
- The Ethanol in the fuel is less than 87 %.
- This DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

- The ECM determines that the ECT has not met its calibrated target of 60Â° C (140 Â°F) when the start-up ambient temperature was between 10 and 52Â° C (50 and 126Â° F), for greater than 1 s.

  OR

- The ECM determines that the ECT has not met its calibrated target of 5Â° C (41 Â°F) when the start-up ambient temperature was between - 7 and 10Â° C (19 and 50Â° F), for greater than 1 s.

Action Taken When the DTC Sets

- DTC P0128 is a Type B DTC.
- The A/C is commanded OFF and inoperative.
- The Cooling Fans are commanded ON.

Conditions for Clearing the MIL/DTC

DTC P0128 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

     Repair as necessary

   - **Go to next step: If the coolant level is correct**

   NOTE: **A critical analysis of the operation of the thermostat is necessary to properly diagnose this DTC.**

2. Verify the proper heat range and the operation of the thermostat. Refer to **Thermostat Diagnosis** .
   - **If a condition is found**

     Replace the Thermostat.

   - **Go to next step: If a condition is not found**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Step 1.

   - **Go to next step: If the DTC does not set**
5. All OK.

Repair Instructions

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

Engine Coolant Thermostat Housing Replacement (LYX)

DTC P0131, P0132, P0137, OR P0138: HO2S CIRCUIT VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **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 P0137

HO2S Circuit Low Voltage Sensor 2

DTC P0138

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HO2S Circuit High Voltage Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137	P0132, P0138	P0132, P0138	P0133, P1133*, P015A*, P015B*
HO2S Low Signal	P0131, P0137	P0132, P0138	P0132, P0138	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:** 23 - 1 930 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 - 1 275 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, closed loop is entered. The control module uses the HO2S voltage to determine the air to fuel ratio. An HO2S voltage that increases toward 1 000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

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

Conditions for Running the DTC

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.
- DTCs run continuously when the above conditions are met for greater than 5s.

DTC P0132 or P0138

- DTCs P0106, P0108, P0201, P0202, P0203, P0204, P0442, P0443, P0449, P0452, P0453, P0455 and P0496 are not set.
- The Ignition voltage is between 10 - 32 V.
- The Ignition is OFF for greater than 8 h.
- 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 5 s.
- The engine is not decelerating.

DTCs run continuously when the above conditions are met for greater than 5 s.

Conditions for Setting the DTC

P0131 or P0137

The engine control module detects that the heated oxygen sensor voltage is less than 40 mV for greater than 40 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.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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

    - **Go to next step: 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.**

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Refer to Circuit/System Testing.

- **Go to next step: If between 50 - 1 050 mV.**

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

     Refer to Circuit/System Testing.

   - **Go to next step: 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 Ω in the high signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 3.0 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the high signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: 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.
   - **Go to next step: If between 1.7 - 2.1 V**
4. Connect a 3 A fused jumper wire between the high signal circuit terminal 4 and the low signal circuit terminal 3.

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

5. Verify the scan tool 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.
   2. Test for less than 2 Ω in the low signal circuit end to end.

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

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.
    - **Go to next step: 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 Diagnosis** .
    - Fuel that is contaminated. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
    - Fuel saturation of the evaporative emission (EVAP) canister
    - Exhaust leaks
    - Engine vacuum leaks
    - **If any of the conditions exist**

      Repair as necessary.

    - **Go to next step: 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: HO2S DELAYED RESPONSE

Diagnostic Instructions

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

DTC Descriptors

DTC P0133

HO2S Slow Response Sensor 1

DTC P013A

HO2S Slow Response Rich to Lean Sensor 2

DTC P013B

HO2S Slow Response Lean to Rich Sensor 2

DTC P013E

HO2S Delayed Response Rich to Lean Sensor 2

DTC P013F

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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

Diagnostic Fault Information

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

Typical Scan Tool Data

HO2S 1 or 2

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

Circuit/System Description

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

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

Conditions for Running the DTC

P0133

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0131, P0132, P0134, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300 - P0308, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P1104, P1248, P1249, P124A,

P124B, P124C, P124D, P124E, P124F, P1516, P16F3, P2100 - P2103, P2119, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2176, P2227 - P2230 are not set.
- The Ignition voltage is between 10 - 32 V.
- The engine is OFF for greater 8 hours.
- The engine coolant temperature (ECT) is warmer than 70Â°C (158Â°F).
- The intake air temperature (IAT) is warmer than -40Â°C (-40Â°F)
- The fuel level is greater than 10%.
- The engine run time is greater than 120 s.
- The engine speed is between 1, 000 - 3, 500 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 10 - 40 g/s.
- The fuel system is in Closed Loop.
- Device controls are not active.
- Ethanol content is less than 87%.
- Fuel control is not in power enrichment.
- Decel fuel cut-off is not active.
- The DTCs run once per drive cycle when the above conditions are met for 3 s.

P013A or P013E

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

P013B or P013F

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

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- The DTCs run once per ignition cycle when the above conditions are met.

P015A or P015B

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

P2270

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The system voltage is between 10 - 32 V.
- The fuel level is greater than 10%.
- The pedal position is less than 4%.
- The engine speed is between 1, 250 - 2, 300 RPM.
- The engine airflow is between 3 - 12 g/s.
- The vehicle speed is between 55 - 120 km/h (35 - 74 mph).
- The fuel state is in Closed Loop.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The HO2S heaters are ON for more than 180 s.
- The predicted catalytic converter temperature is between 600 - 850Â°C (1, 112 - 1, 562Â°F).
- This DTC runs once per trip when all of the above conditions have been met for 1 s.

P2271

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270 are not set.
- The system voltage is between 10 - 32 V.
- The fuel level is greater than 10%.
- The engine speed is between 1, 250 - 2, 300 RPM.

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- The engine airflow is between 3 - 12 g/s.
- The vehicle speed is between 55 - 120 km/h (34.2 - 74.6 mph).
- The fueling state is in Closed Loop.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- Power take-off is not active.
- The heated oxygen sensor heaters have been on more than 180 s.
- The predicted catalyst temperature is between 600 - 850Â°C (1, 112 - 1, 562Â°F).
- DTCs P013A, P013E, and P2270 have run and passed.

THEN

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

Conditions for Setting the DTC

P0133, P015A or P015B

- The engine control module detects that the heated oxygen sensor rich-to-lean or lean-to-rich average response time is greater than a calibrated value.
- The DTCs set within 60 s when the above condition is met.

P013A

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

P013B

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

P013E

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

P013F

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

P2270

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

P2271

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

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

- DTCs P0133, P013E, P013F, P2270, and P2271 are Type B DTCs.

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- DTCs P013A, P013B, P015A, and P015B are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
   - **Go to next step: If a DTC is not set**
3. Verify none of the conditions listed below exist:
   - Lean or rich fuel injectors - Refer to **Fuel Injector Diagnosis** .
   - Water intrusion in the HO2S harness connector
   - Low or high fuel system pressure - Refer to **Fuel System Diagnosis** .
   - Fuel that is contaminated - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
   - Fuel saturation of the evaporative emission (EVAP) canister
   - Exhaust leaks
   - Engine vacuum leaks
   - Engine oil consumption - Refer to **Oil Consumption Diagnosis** .
   - Engine coolant consumption - Refer to **Loss of Coolant** .
   - **If any of the above conditions exist**

     Repair as necessary.
   - **Go to next step: If none of the conditions exist**
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not reset.
   - **If the DTC sets**

     Test or replace the appropriate B52 HO2S.

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- **Go to next step: If the DTC does not set**

6. 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: FUEL TRIM SYSTEM

Diagnostic Instructions

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

DTC Descriptors

DTC P0171

Fuel Trim System Lean

DTC P0172

Fuel Trim System Rich

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Circuit/System Description

The engine control module (ECM) controls a Closed Loop air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. The ECM monitors the heated oxygen sensor (HO2S) signal voltage, and adjusts the fuel delivery based on the signal voltage while in Closed Loop. A change made to the fuel delivery changes the long and short term fuel trim values. The short term fuel trim values change rapidly in response to the HO2S signal voltages. These changes fine tune the engine fueling. The long term fuel trim values change in response to trends in the short term fuel trim The long term fuel trim makes coarse adjustments to fueling in order to re-center and restore control to short term fuel trim. The ideal fuel trim values are around 0 %. A positive fuel trim value indicates that the ECM is adding fuel in order to compensate for a lean condition. A negative fuel trim value indicates that the ECM is reducing the amount of fuel in order to compensate for a rich condition.

Conditions for Running the DTC

- DTCs P0030, P0053, P0101, P0102, P0103, P0106, P0107, P0108, P0131 - P0135, P0201 - P0204, P0236, P0237, P0238, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300 - P0304, P0458, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, or P2230 are not set.
- The engine is in Closed Loop status.
- The catalyst monitor diagnostic intrusive test, post 02 diagnostic intrusive test, device control, and evaporative emission leak test are not active.
- The engine coolant temperature (ECT) is between -20 and +150Â°C (-4 and +302Â°F).
- The intake air temperature (IAT) is between -20 and +150Â°C (-4 and +302Â°F).
- The manifold absolute pressure (MAP) is between 5 - 255 kPa (0.7 - 37 psi).
- The engine speed is between 400 - 6, 100 RPM.
- The mass air flow (MAF) is between 0.5 - 510 g/s.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 psi).
- The fuel level is greater than 10 % and no fuel level 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.
- Any un-metered air into the engine causes this DTC to set. Thoroughly inspect all areas of the engine for vacuum leaks.
- A MAF sensor condition can cause this DTC without setting a MAF DTC. If there is a MAF sensor condition, the MAF sensor parameters will appear to be within range.
- Verify that the air filter is the correct one for this application. Verify that the engine oil fill cap is in place and that it is tight. Verify that the engine oil dip stick is fully seated.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

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

- **Go to next step: 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.

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

     Refer to Circuit/System Testing.

   - **Go to next step: 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**

   - **Go to next step: If within the specified range**
3. Engine running at the operating temperature.
4. Verify the Long Term Fuel Trim parameter is between -10 % and +10 %.
   - **If greater than +10 %**
   1. Ignition OFF.
   2. Inspect for the conditions listed below:
      - Mass air flow (MAF) sensor signal skewed - If the Short Term Fuel Trim parameter changes greater than 20 % when the MAF sensor is disconnected, refer to **DTC P0101**.
      - Fuel contamination - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
      - Missing, restricted, or leaking exhaust components - Refer to **Symptoms - Engine Exhaust** .
      - Malfunctioning fuel injectors - Refer to **Fuel Injector Diagnosis** .
      - Vacuum hoses for splits, kinks, and improper connections
      - 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
      - Leaks in the components of the vacuum operated engine mount system
      - Missing air filter element
      - Cracked EVAP canister
      - Evaporative pipes obstructed or leaking
      - The crankcase ventilation system for leaks - Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
        - If a condition is found, repair as necessary.
        - If no condition is found, inspect the engine for a mechanical condition. Refer to **Symptoms - Engine Mechanical** .

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- **If less than -10 %**

1. Ignition OFF.
2. Inspect for the conditions listed below:
    - Mass air flow (MAF) sensor signal skewed - If the Short Term Fuel Trim parameters for both banks changes greater than 20 % when the MAF sensor is disconnected, refer to **DTC P0101**.
    - Fuel contamination - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
    - Missing, restricted, or leaking exhaust components - Refer to **Symptoms - Engine Exhaust** .
    - Malfunctioning fuel injectors - Refer to **Fuel Injector Diagnosis**
    - Collapsed or restricted air intake duct
    - Excessive fuel pressure - Refer to **Fuel System Diagnosis**
    - Dirty or restricted air filter
    - Objects blocking the throttle body
    - Improper operation of the evaporative emissions control system
    - Excessive fuel in the crankcase - Change the engine oil as necessary.
- If a condition is found, repair as necessary.
- If no condition is found, inspect the engine for a mechanical condition. Refer to **Symptoms - Engine Mechanical** .
- **Go to next step: If between -10 % and +10 %**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
6. Verify DTC P0171 or P0172 is not set.
    - **If any of the DTCs set**

      Refer to conditions listed above.

    - **Go to next step: If none of the DTCs set**
7. All OK.

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Repair Instructions

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

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

DTC P0182, P0183, P0187, P0188, P111F, P126E, OR P126F: FUEL TEMPERATURE SENSOR CIRCUIT VOLTAGE

Diagnostic Instructions

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

DTC Descriptors

DTC P0182

Fuel Temperature Sensor Circuit Low Voltage

DTC P0183

Fuel Temperature Sensor Circuit High Voltage

DTC P0187

Fuel Temperature Sensor 2 Circuit Low Voltage

DTC P0188

Fuel Temperature Sensor 2 Circuit High Voltage

DTC P111F

Fuel Temperature Sensor 1 - Fuel Temperature Sensor 2 Not Plausible

DTC P126E

Fuel Rail Temperature Sensor 1 Performance

DTC P126F

Fuel Rail Temperature Sensor 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0236, P0237, P0340, P0345, P0365, P0390, P0452, P0522, P0532, P0641, P16E5	P128C, P128D, P128F, P16E4, P16E5	P0121, P018D, P0236, P0641, P1400, P16E5, P2227, P222B	-
Signal	P16E4	P16E5	P16E5	-
Low Reference	-	P16E5	-	-

Typical Scan Tool Data

Fuel Rail Pressure Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. **Parameter Normal Range:** 2.9-3.2 MPa			
5 V Reference	655.4 MPa	655.4 MPa	655.4 MPa
Signal	655.4 MPa	655.4 MPa	655.4 MPa
Low Reference	-	655.4 MPa	-

Circuit/System Description

The fuel pressure/temperature sensor transmits fuel pressure and temperature information by serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT) protocol. The fuel pressure/temperature sensor internal microprocessor allows 4 separate sensor outputs from one 3 wire sensor. The engine control module (ECM) supplies the fuel pressure/temperature sensor with a 5 V reference circuit, a low reference circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the fuel pressure/temperature sensor to the ECM. The ECM decodes the serial data signal into separate voltages.

Conditions for Running the DTC

P0182 or P0183

- DTC P126E, P128C, P16E4, or P16E5 is not set.
- DTC P126E or P128C is not pending.
- Ignition is ON.
- The DTCs run continuously when the above conditions are met.

P0187 or P0188

- DTC P126F, P128D, P16E4, or P16E5 is not set.

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- DTC P126F or P128D is not pending.
- Ignition is ON.
- The DTCs run continuously when the above conditions are met.

P111F

- DTC P0182, P0183, P0187, P0188, P126E, P126F, P128C, P128D, P16E4, or P16E5 is not set.
- DTC P128C, P128D, P16E4, or P16E5 is not pending.
- Ignition is ON.
- The DTC runs continuously when the above conditions are met.

P126E

- DTC P128C, P16E4, or P16E5 is not set.
- DTC P128C is not pending.
- Ignition is ON.
- The DTC runs continuously when the above conditions are met.

P126F

- DTC P128D, P16E4, or P16E5 is not set.
- DTC P128D is not pending.
- Ignition is ON.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0182

The engine control module detects the fuel temperature sensor 1 SENT digital read value is less than 145 for greater than 6 s.

P0183

The engine control module detects the fuel temperature sensor 1 SENT digital read value is greater than 1, 865 for greater than 6 s.

P0187

The engine control module detects the fuel temperature sensor 2 SENT digital read value is less than 145 for greater than 6 s.

P0188

The engine control module detects the fuel temperature sensor 2 SENT digital read value is greater than 1, 865 for greater than 6 s.

P111F

The engine control module detects the difference between fuel temperature sensor 1 and fuel temperature sensor 2 is greater than 20Â°C (68Â°F) for greater than 12.5 s.

P126E

The engine control module detects the fuel temperature sensor 1 SENT digital read value is greater than or equal to 4, 089 for greater than 6 s.

P126F

The engine control module detects the fuel temperature sensor 2 SENT digital read value is greater than or equal to 4, 089 for greater than 6 s.

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Action Taken When the DTC Sets

DTC P0182, P0183, P0187, P0188, P111F, P126E, and P126F are Type B DTCs.

Conditions for Clearing the DTC

DTC P0182, P0183, P0187, P0188, P111F, P126E, and P126F are Type B DTCs.

Diagnostic Aids

- A high resistance condition on the fuel pressure/temperature sensor circuits could cause a DTC to set.
- Inspect for a contaminated fuel system.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

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Powertrain Component View

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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/Vehicle in Service Mode.
2. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
    - **If any of the DTCs are set**

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

    - **Go to next step: If none of the DTCs are set**
3. Verify that DTC P0182, P0183, P0187, P0188, P111F, P126E, P126F, P127C, P128A, P128B, P128C, P128D, P128F, P16E4, or P16E5 are not set.
    - **If DTC P0182, P0183, P0187, P0188, P111F, P126E, or P126F are the only DTCs set**

      Replace the B310 Fuel Pressure/Temperature Sensor.

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- **If DTC P127C, P128A, P128B, P128C, P128D, P128F, P16E4, or P16E5 is set with any of the DTCs**

  Refer to Circuit/System Testing.

- **Go to next step: If none of the DTCs are set**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify that no DTCs are set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing.

   - **Go to next step: If none of the DTCs are set**
6. All OK.

Circuit/System Testing

NOTE: **Disconnecting the fuel pressure/temperature sensor harness connector causes additional DTCs to set.**

1. Ignition/Vehicle OFF, and all vehicle systems OFF, disconnect the harness connector at B310 Fuel Pressure/Temperature Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.
   - **If 5 Ω or greater**
   1. Ignition/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Ignition/Vehicle ON.
4. 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/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition/vehicle 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.
   - **Go to next step: 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/Vehicle 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 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.
- **If greater than 5.2 V**

1. Ignition/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition/vehicle 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.
- **Go to next step: If between 4.8 - 5.2 V**

6. Replace the B310 Fuel Pressure/Temperature Sensor.

Repair Instructions

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

- **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement** for B310 Fuel Pressure/Temperature Sensor
- **Control Module References** for control module replacement, programming, and setup

DTC P018B, P018C, P018D: FUEL PRESSURE SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P018B

Fuel Pressure Sensor Performance

DTC P018C

Fuel Pressure Sensor Circuit Low Voltage

DTC P018D

Fuel Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0192, P0532, P0641, P2228	P018C	P018D, P0193, P0523, P0641, P2227	P018B
Signal	P018C	P018C	P018D	P018B
Low Reference	-	P018D	P018D	P018B

Circuit/System Description

The fuel pressure sensor is located on the chassis fuel pipe. The fuel pressure sensor monitors the fuel pressure in the fuel line. The engine control module (ECM) monitors the voltage signal from the fuel pressure sensor. The sensor provides a fuel pressure signal to the ECM, which is used to provide Closed Loop fuel pressure control.

Conditions for Running the DTC

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P018B

- DTC P018C, P018D, P0231, P0232, P023F, P0641, P1255, P129D, or P12A6 is not set.
- Engine is running for greater than or equal to 5 s.
- Fuel pump enable circuit is commanded ON.
- Fuel pressure is greater than 0 kPa (0 PSI)
- Low fuel level warning not present.
- The DTC runs continuously when the conditions above are met.

P018C or P018D

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

Conditions for Setting the DTC

P018B

The engine control module does not detect a normal fuel pressure change 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.

P018C

The engine control module detects that the fuel pressure sensor voltage is less than 0.2 V for 1 s.

P018D

The engine control module detects that the fuel pressure sensor voltage is greater than 4.8 V for 1 s.

Action Taken When the DTC Sets

DTC P018B, P018C and P018D are Type B DTCs.

Conditions for Clearing the DTC

DTC P018B, P018C and P018D are Type B 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 Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**

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- Connector Repairs
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC U0074 or U18A2 is not set or stored in history.
   - **If DTC U0074 or U18A2 is set or stored in history**

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

   - **Go to next step: If DTC U0074 or U18A2 is not set or stored in history**
3. Engine running.
4. Verify the scan tool Fuel Pressure Sensor parameter is between 0.2 - 4.8 V.
   - **If not between 0.2 - 4.8 V**

     Refer to Circuit/System Testing.

   - **Go to next step: If between 0.2 - 4.8 V**
5. Verify the scan tool Fuel Pressure Sensor increases or decreases when commanding an increase and decrease in Fuel Pressure with a scan tool.
   - **If the pressure does not change**

     Refer to Circuit/System Testing.

   - **Go to next step: If the pressure changes**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: 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 B47 Fuel Pressure Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.

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

- **If greater than 5.2 V**

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

- **Go to next step: If between 4.8 - 5.2 V**

5. Verify the scan tool Fuel Pressure Sensor parameter is less than 1 V.
    - **If 1 V or greater**

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

    - **Go to next step: If less than 1 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1, wait 15 s.
7. Verify the scan tool Fuel 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 3 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

    - **Go to next step: If greater than 4.8 V**
8. Replace the B47 Fuel Pressure Sensor.

Repair Instructions

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

- **Fuel Pressure Sensor Replacement - Fuel Feed Pipe (FWD)** **Fuel Pressure Sensor Replacement - Fuel Feed Pipe (AWD)**
- **Control Module References** for control module replacement, programming and setup.

DTC P0191 OR P0192: FUEL PRESSURE SENSOR

Diagnostic Instructions

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

DTC Descriptors

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DTC P0191

Fuel Rail Pressure Sensor Performance

DTC P0192

Fuel Rail Pressure Sensor Circuit Low Voltage

Diagnostic Fault Information

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

Circuit/System Description

The fuel pressure/temperature sensor transmits fuel pressure and temperature information by serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT) protocol. The fuel pressure/temperature sensor internal microprocessor allows 4 separate sensor outputs from one 3 wire sensor. The engine control module (ECM) supplies the fuel pressure/temperature sensor with a 5 V reference circuit, a low reference circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the fuel pressure/temperature sensor to the ECM. The ECM decodes the serial data signal into separate voltages.

Conditions for Running the DTC

P0191

- The engine is running for greater than 1 min.
- The commanded fuel pressure rate of change, increase or decrease, is less than 3 MPa (435 PSI) for greater than or equal to 1.25 s.
- The DTC runs continuously within the enabling conditions.

P0192

- The engine is cranking or running.
- The DTC runs continuously within the enabling condition.

Conditions for Setting the DTC

P0191

The difference between the commanded high pressure and the measured high pressure is greater than or less than a predefined threshold for greater than or equal to 1.5 s.

P0192

The ECM detects that the fuel pressure/temperature sensor signal voltage is low for greater than 30 s with the engine running or greater than 10 s with the engine cranking.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

DTCs P0191, P0192 are Type A DTCs.

Diagnostic Aids

- A high resistance condition on the fuel pressure/temperature sensor circuits could cause a DTC to set.
- Inspect for a contaminated fuel system.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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 / Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following system/component:5V Reference
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Verify there are no DTCs set related to the following system/component:B310 Fuel Pressure/Temperature Sensor
   - **If other DTCs are set - With DTC P0191 set.**

     Refer to Circuit/System Testing.

   - **Go to next step: If only DTC P0191 is set & No other DTCs related to the concerned component are set.**

     Replace the component:B310 Fuel Pressure/Temperature Sensor

   - **Go to next step: If none of the DTCs are set**

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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 that no DTCs are set.
    - **If any of the DTCs are set**

      Refer to Circuit/System Testing.

    - **Go to next step: If none of the DTCs are set**
6. All OK.

Circuit/System Testing

NOTE: **Disconnecting the fuel pressure/temperature sensor harness connector causes additional DTCs to set.**

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at B310 Fuel Pressure/Temperature Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 3 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If between 4.8 - 5.2 V**
5. Test for 4.8 - 5.2 V between the signal 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 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**

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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.
- **Go to next step: If between 4.8 - 5.2 V**

6. Replace the B310 Fuel Pressure/Temperature Sensor.

Repair Instructions

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

- **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement** for B310 Fuel Pressure/Temperature Sensor.
- **Control Module References** for control module replacement, programming and setup.

DTC P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, OR P2157: CYLINDER INJECTOR CONTROL CIRCUITS

Diagnostic Instructions

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

DTC Descriptor

DTC P0201

Cylinder 1 Injector Control Circuit

DTC P0202

Cylinder 2 Injector Control Circuit

DTC P0203

Cylinder 3 Injector Control Circuit

DTC P0204

Cylinder 4 Injector Control Circuit

DTC P0261

Cylinder 1 Injector Control Circuit Low Voltage

DTC P0262

Cylinder 1 Injector Control Circuit High Voltage

DTC P0264

Cylinder 2 Injector Control Circuit Low Voltage

DTC P0265

Cylinder 2 Injector Control Circuit High Voltage

DTC P0267

Cylinder 3 Injector Control Circuit Low Voltage

DTC P0268

Cylinder 3 Injector Control Circuit High Voltage

DTC P0270

Cylinder 4 Injector Control Circuit Low Voltage

DTC P0271

Cylinder 4 Injector Control Circuit High Voltage

DTC P1248

Cylinder 1 Injector High Control Circuit Shorted to Control Circuit

DTC P1249

Cylinder 2 Injector High Control Circuit Shorted to Control Circuit

DTC P124A

Cylinder 3 Injector High Control Circuit Shorted to Control Circuit

DTC P124B

Cylinder 4 Injector High Control Circuit Shorted to Control Circuit

DTC P2147

Cylinder 1 Injector High Control Circuit Low Voltage

DTC P2148

Cylinder 1 Injector High Control Circuit High Voltage

DTC P2150

Cylinder 2 Injector High Control Circuit Low Voltage

DTC P2151

Cylinder 2 Injector High Control Circuit High Voltage

DTC P2153

Cylinder 3 Injector High Control Circuit Low Voltage

DTC P2154

Cylinder 3 Injector High Control Circuit High Voltage

DTC P2156

Cylinder 4 Injector High Control Circuit Low Voltage

DTC P2157

Cylinder 4 Injector High Control Circuit High Voltage

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short Between Circuits
Control circuit terminal 2 @Q17A Fuel Injector 1	P2147	P0201	P2148	P1248
Control circuit terminal 1 @Q17A Fuel Injector 1	P0261	P0201	P0262	P1248
Control circuit terminal 2 @Q17B Fuel Injector 2	P2150	P0202	P2151	P1249
Control circuit terminal 1 @Q17B Fuel Injector 2	P0264	P0202	P0265	P1249
Control circuit terminal 2 @Q17C Fuel Injector 3	P02153	P0203	P2154	P124A
Control circuit terminal 1 @Q17C Fuel Injector 3	P0267	P0203	P0268	P124A
Control circuit terminal 2 @Q17D Fuel Injector 4	P2156	P0204	P2157	P124B
Control circuit terminal 1 @Q17D Fuel Injector 4	P0270	P0204	P0271	P124B

Typical Scan Tool Data

Fuel Injector Control Circuit Test Status

Circuit	Short to Ground	Open	Short to Voltage	Short between the circuits
Operating Conditions: Engine at Idle **Parameter Normal Range:** OK or Not Run				
Control circuit terminal 2	High Control Circuit Low Voltage	Open	High Control Circuit High Voltage	High Control Circuit Shorted to Control Circuit
Control circuit terminal 1	Control Circuit Low Voltage	Open	Control Circuit High Voltage	High Control Circuit Shorted to Control Circuit

Circuit/System Description

Circuit	Description
Control circuit terminal 2	Regulated voltage supplied by the control module.
Control circuit terminal 1	The output circuit is switched to ground to activate the component.

Component	Description
Q17 Fuel Injector	Fuel injectors are solenoid valves that inject fuel either into the intake system or directly into the cylinder. The amount of fuel injected depends on the length of the electrical pulse that is applied. The fuel injectors of this system have an operating voltage range of 12 to 65V.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

- DTC P062B = Not set
- Engine is Running
- Battery Voltage = Greater than 11 V

DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0201, P0202, P0203, P0204

Control circuit = Open - For greater than 1 s

P0261, P0264, P0267, P0270

Control circuit - Low = Short to Ground - For greater than 1 s

P0262, P0265, P0268, P0271

Control circuit - Low = Short to Voltage - For greater than 1 s

P1248, P1249, P124A, P124B

Control Circuit Shorted to Control Circuit - For greater than 1 s

P2147, P2150, P2153, P2156

Control circuit - High = Short to Ground - For greater than 1s

P2148, P2151, P2154, P2157

Control circuit - High = Short to Voltage - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

If the condition is intermittent, wiggle the related wiring harnesses and connectors, with the ignition/vehicle on or engine running, while monitoring the scan tool circuit status parameters for the component. The parameters will display if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

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

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter:
   - Cylinder 1 Injector Control Circuit Status = OK
   - Cylinder 2 Injector Control Circuit Status = OK
   - Cylinder 3 Injector Control Circuit Status = OK
   - Cylinder 4 Injector Control Circuit Status = OK
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
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

   - **Go to next step: If the DTC is not set**
5. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
3. Test for infinite resistance between the test points:
   - {Q17A Fuel Injector 1} Control circuit terminal 71 & Ground
   - {Q17B Fuel Injector 2} Control circuit terminal 68 & Ground
   - {Q17C Fuel Injector 3} Control circuit terminal 70 & Ground
   - {Q17D Fuel Injector 4} Control circuit terminal 69 & Ground
   - **If less than infinite resistance**
   1. Disconnect the appropriate electrical connector: Q17 Fuel Injector
   2. Test for infinite resistance between the test points:
      - {Q17A Fuel Injector 1} Control circuit terminal 71@ Control module harness & Ground
      - {Q17B Fuel Injector 2} Control circuit terminal 68 @ Control module harness & Ground
      - {Q17C Fuel Injector 3} Control circuit terminal 70 @ Control module harness & Ground
      - {Q17D Fuel Injector 4} Control circuit terminal 69 @ Control module harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for infinite resistance between the test points:

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- {Q17A Fuel Injector 1} Control circuit terminal 51 @ Control module harness & Ground
- {Q17B Fuel Injector 2} Control circuit terminal 48 @ Control module harness & Ground
- {Q17C Fuel Injector 3} Control circuit terminal 50 @ Control module harness & Ground
- {Q17D Fuel Injector 4} Control circuit terminal 49 @ Control module harness & Ground
- If less than infinite resistance - Repair the short to ground on the circuit.
- If infinite resistance - Replace the component: Q17 Fuel Injector

- **Go to next step: If infinite resistance**

4. Ignition - On / Vehicle - In Service Mode
5. Test for less than 1 V between the test points:
    - {Q17A Fuel Injector 1} Control circuit terminal 71 & Ground
    - {Q17B Fuel Injector 2} Control circuit terminal 68 & Ground
    - {Q17C Fuel Injector 3} Control circuit terminal 70 & Ground
    - {Q17D Fuel Injector 4} Control circuit terminal 69 & Ground
    - **If 1 V or greater**
    1. Disconnect the appropriate electrical connector: Q17 Fuel Injector
    2. Test for less than 1 V between the test points:
        - {Q17A Fuel Injector 1} Control circuit terminal 71 @ Control module harness & Ground
        - {Q17B Fuel Injector 2} Control circuit terminal 68 @ Control module harness & Ground
        - {Q17C Fuel Injector 3} Control circuit terminal 70 @ Control module harness & Ground
        - {Q17D Fuel Injector 4} Control circuit terminal 69 @ Control module harness & Ground
        - If 1V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Repair the short to voltage on the circuit:
        - {Q17A Fuel Injector 1} Control circuit terminal 51
        - {Q17B Fuel Injector 2} Control circuit terminal 48
        - {Q17C Fuel Injector 3} Control circuit terminal 50
        - {Q17D Fuel Injector 4} Control circuit terminal 49
    - **Go to next step: If less than 1 V**
6. Ignition/Vehicle - Off
7. Test for less than 2 ohms between the test points:
    - {Q17A Fuel Injector 1} Control circuit terminal 71 & Control circuit terminal 51
    - {Q17B Fuel Injector 2} Control circuit terminal 68 & Control circuit terminal 48
    - {Q17C Fuel Injector 3} Control circuit terminal 70 & Control circuit terminal 50
    - {Q17D Fuel Injector 4} Control circuit terminal 69 & Control circuit terminal 49
    - **If 3 ohms or greater**
    1. Disconnect the appropriate electrical connector: Q17 Fuel Injector
    2. Test for less than 2 ohms between the test points:
        - {Q17A Fuel Injector 1} Control circuit terminal 71 @ Control module harness & Control circuit terminal 2 @ Component harness
        - {Q17B Fuel Injector 2} Control circuit terminal 68 @ Control module harness & Control circuit terminal 2 @ Component harness
        - {Q17C Fuel Injector 3} Control circuit terminal 70 @ Control module harness & Control circuit terminal 2 @ Component harness

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- {Q17D Fuel Injector 4} Control circuit terminal 69 @ Control module harness & Control circuit terminal 2 @ Component harness
- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms

3. Test for less than 2 ohms between the test points:
    - {Q17A Fuel Injector 1} Control circuit terminal 51 @ Control module harness & Control circuit terminal 1 @ Component harness
    - {Q17B Fuel Injector 2} Control circuit terminal 48 @ Control module harness & Control circuit terminal 1 @ Component harness
    - {Q17C Fuel Injector 3} Control circuit terminal 50 @ Control module harness & Control circuit terminal 1 @ Component harness
    - {Q17D Fuel Injector 4} Control circuit terminal 49 @ Control module harness & Control circuit terminal 1 @ Component harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component: Q17 Fuel Injector
- **Go to next step: If less than 3 ohms**

8. Replace the component: K20 Engine Control Module

Component Testing

Fuel Injector Diagnosis

Repair Instructions

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

- **Fuel Injector Replacement**
- For control module replacement, programming, and setup refer to:**Control Module References**

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DTC P0234 OR P0299: ENGINE BOOST

Diagnostic 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 P0234

Engine Overboost

DTC P0299

Engine Underboost

Circuit Description

The boost pressure sensor measures the range of pressures between the turbocharger and the throttle body. The sensor used on this engine is a three atmosphere sensor. Pressure in this portion of the induction system is affected by engine speed, throttle opening, turbocharger boost pressure, Intake air temperature (IAT), barometric pressure (BARO), and the efficiency of the charge air cooler.

The sensor provides a signal voltage to the engine control module (ECM), relative to the pressure changes. Under normal operation the greatest pressure that can exist in this portion of the induction system at ignition On, engine Off is equal to the BARO. When the engine is operated at wide-open throttle (WOT) the turbocharger can increase the pressure to near 240 kPa (34.8 psi). The pressure is equal to the BARO when the engine is idling or decelerating.

Conditions for Running the DTCs

- DTC P00C0, P00C1, P00C2, P0033, P0034, P0035, P0045, P0047, P0048, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0236, P0237, P0238, P0243, P0245, P0246, P0247, P0249, P0250, P111E, P2227, P2228, P2229, or P2230 is not set.
- Engine speed is between 1, 500 - 6, 500 RPM.
- Desired boost pressure is between 140 - 240 kPa (20.3 - 35 psi)
- Barometric Pressure (BARO) is between 60 - 120 kPa (8.7 - 17.4 psi).
- Engine coolant temperature (ECT) is between -40 to +126Â°C (-40 to +259Â°F).
- Intake air temperature (IAT) is between -40 to +80Â°C (-40 to +176Â°F)
- Turbocharger bypass valve is not under output device control.
- Pressure control is in closed loop.

The DTCs run continuously when the above conditions have been met.

OR

- DTC P00C0, P00C1, P00C2, P0033, P0034, P0035, P0045, P0047, P0048, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0236, P0237, P0238, P0243, P0245, P0246, P0247, P0249, P0250, P111E, P2227, P2228, P2229, P2230 or P2261 is not set.
- Engine speed is between 2, 000 - 3, 500 RPM.
- Barometric Pressure (BARO) is between 60 - 120 kPa (8.7 - 17.4 psi).
- Engine coolant temperature (ECT) is between -40 to +126Â°C (-40 to +259Â°F).
- Intake air temperature (IAT) is between -40 to +80Â°C (-40 to +176Â°F)
- Turbocharger bypass valve is not under output device control.
- Pressure control is in open loop.

The DTCs run continuously when the above conditions have been met.

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Conditions for Setting the DTC

P0234

The ECM detects that the actual boost pressure is greater than the desired boost pressure by a calibrated amount for greater than 3 s.

P0299

The ECM detects that the actual boost pressure is less than the desired boost pressure by a calibrated amount for greater than 3 s.

Action Taken When the DTCs Set

- DTCs P0234 and P0299 are Type A DTCs.
- The Service Vehicle Soon Indicator may illuminate.

Conditions for Clearing the MIL/DTCs

DTCs P0234 and P0299 are Type A DTCs.

Diagnostic Aids

- The charge air cooler is connected to the turbocharger and to the throttle body by flexible duct work that requires the use of special high torque fastening clamps. These clamps cannot be substituted. In order to prevent any type of air leak when servicing the ductwork, the tightening specifications and proper positioning of the clamps is critical, and must be strictly adhered to.
- Use a smoke generating device or a solution of dish soap and water in a spray bottle to pinpoint any suspected air leaks in the induction system and in the charge air cooler assembly.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Turbocharger 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

GE-23738-A Vacuum Pump

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

Circuit/System Verification

1. Ignition On.
2. Verify DTC P0106, P0107, P0108, P0236, P0237, P0238, P0243, P0245, P0246, P2227, P2228, P2229, or P2230 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Verify the scan tool BARO Sensor parameter is within the range specified in the **Altitude Versus Barometric Pressure** table for the current testing altitude.
   - **If the parameter is not within the range specified in the table.**

     Refer to **DTC P2227-P2230** .

   - **Go to next step: If the parameter is within the range specified in the table.**
4. Verify the scan tool MAP Sensor and BARO Sensor parameters are within 3 kPa (0.4 psi).
   - **If the parameters are not within 3 kPa (0.4 psi).**

     Refer to **DTC P0106**.

   - **Go to next step: If the parameters are within 3 kPa (0.4 psi).**
5. Verify the scan tool Boost Pressure Sensor and BARO Sensor parameters are within 3 kPa (0.4 psi).
   - **If the parameters are not within 3 kPa (0.4 psi).**

     Refer to **DTC P0236**.

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- **Go to next step: If the parameters are within 3 kPa (0.4 psi).**

6. Verify a click is heard or felt from the Q40 turbocharger bypass valve solenoid when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
   - **If a click is not heard or felt**

     Refer to **DTC P0033-P0035**.

   - **Go to next step: If a click is heard or felt**
7. Verify the parameters listed below do not display Malfunction when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
   - Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status
   - Turbocharger Bypass Solenoid Valve Control Circuit Open Test Status
   - Turbocharger Bypass Solenoid Valve Control Circuit Low Voltage Test Status
   - **If Malfunction is displayed**

     Refer to **DTC P0033-P0035**.

   - **Go to next step: If Malfunction is not displayed**
8. Verify a series of clicks, which increase in frequency, are heard or felt from the Q42 turbocharger wastegate solenoid valve when commanding the Turbocharger Wastegate Solenoid Valve between 5 - 95% with a scan tool.
   - **If a series of clicks in increasing frequency are not heard or felt**

     Refer to **DTC P0243, P0245, or P0246**.

   - **Go to next step: If a series of clicks in increasing frequency is heard or felt**
9. Verify the parameters listed below do not display Malfunction when commanding the Turbocharger Wastegate Solenoid Valve between 5 - 95% with a scan tool.
   - Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status
   - Turbocharger Wastegate Solenoid Valve Control Circuit Open Test Status
   - Turbocharger Wastegate Solenoid Valve Control Circuit Low Voltage Test Status
   - **If Malfunction is displayed**

     Refer to **DTC P0243, P0245, or P0246**.

   - **Go to next step: If Malfunction is not displayed**
10. Engine running.
11. Verify the scan tool MAP Sensor parameter and the Boost Pressure Sensor parameter are within 20 kPa (2.9 psi) during a WOT acceleration at the time of the 1-2 shift.
    - **The parameters are not within 20 kPa (2.9 psi)**

      Refer to Circuit/System Testing.

    - **Go to next step: parameter are within 20 kPa (2.9 psi)**
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 a DTC does not set.
    - **If a DTC sets**

      Refer to Circuit/System Testing

    - **Go to next step: If a DTC does not set**
14. All OK

Circuit/System Testing

1. Verify the conditions listed below do not exist:

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- Loose clamps, cracks or other damage in the air intake duct system
- Collapsed or restricted intake duct system
- Restricted air filter
- Any air flow restriction
- Any air leak between the turbocharger and the throttle body, including the charge air cooler assembly
- Splits, kinks or improper connections at the vacuum hoses
- Any vacuum leak
- Restricted, leaking or incorrect routing of hoses going to the components listed below:
  - Q42 turbocharger wastegate solenoid valve
  - Turbocharger wastegate actuator
  - Turbocharger
- Missing, restricted or leaking exhaust components.
- Exhaust leak between the turbocharger and the exhaust manifold
- Restricted or leaking turbocharger oil supply line
- Loose or incorrect installation of any components
- **If a condition exists**

  Repair or replace the component as necessary.

- **Go to next step: If none of the conditions exist**

2. Ignition Off, disconnect the Compressor Inlet to Solenoid hose at the turbocharger and apply 51 kPa (15 inches Hg) of vacuum to the hose with the **GE 23738-A** , ignition On.
3. Verify the pressure decreases to 0 kPa (0 inches Hg) when commanding the Turbocharger Wastegate Solenoid Valve to at least 15% with a scan tool.
   - **The pressure does not decrease to 0 kPa (0 inches Hg)**

     Replace the Q42 turbocharger wastegate solenoid valve

   - **Go to next step: The pressure decreases to 0 kPa (0 inches Hg)**
4. Connect the Compressor Inlet to Solenoid hose to the turbocharger.
5. Disconnect the hose from the turbocharger wastegate actuator and connect the exhaust/pressure port of the **GE 23738-A** , or a suitable hand pressure pump, to the actuator.
6. Verify the wastegate actuator rod moves when applying pressure to the actuator.
   - **If the actuator does not move**
   1. Disconnect the wastegate actuator arm from the wastegate.
   2. Verify the wastegate actuator rod moves when applying pressure to the actuator.
      - If the actuator does not move, replace the turbocharger wastegate actuator
      - If the actuator moves, replace the turbocharger
   - **Go to next step: If the actuator moves**

NOTE: **Leave harness connector connected or re-connect it after removing valve.**

7. Ignition Off. Disconnect the Q40 turbocharger bypass solenoid valve ignition On.
8. Verify the turbocharger bypass valve plunger retracts and extends when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
   - **The valve plunger does not retract and extend**

     Replace the Q40 turbocharger bypass solenoid valve

   - **Go to next step: The valve plunger retracts and extends**
9. Verify the conditions listed below do not exist with the turbocharger assembly. Refer to **Turbocharger Cleaning and Inspection**

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- Cracked, damaged or worn turbine blades
- Restricted wastegate, turbine, ports or passages
- Foreign material
- **A condition exists**

  Repair or replace the turbocharger as necessary

- **Go to next step: None of the conditions exist**

10. Replace the turbocharger.

Repair Instructions

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

- **Turbocharger Replacement**
- **Turbocharger Bypass Valve Solenoid Replacement**
- **Turbocharger Wastegate Actuator Replacement**
- **Turbocharger Wastegate Regulator Solenoid Valve Replacement**
- **Control Module References** for ECM replacement, programming, and setup

DTC P0236: TURBOCHARGER BOOST SENSOR PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0236

Turbocharger Boost Sensor Performance

Circuit Description

The boost pressure sensor measures the range of pressures between the turbocharger and the throttle body. The sensor used on this engine is a three atmosphere sensor. Pressure in this portion of the induction system is affected by engine speed, throttle opening, turbocharger boost pressure, Intake air temperature (IAT), barometric pressure (BARO), and the efficiency of the charge air cooler.

The sensor provides a signal voltage to the engine control module (ECM), relative to the pressure changes. Under normal operation the greatest pressure that can exist in this portion of the induction system at ignition On, engine Off is equal to the BARO. When the engine is operated at wide-open throttle (WOT) the turbocharger can increase the pressure to near 240 kPa (34.8 psi). The pressure is equal to the BARO when the engine is idling or decelerating.

Conditions for Running the DTC

- DTC P0106, P0107, P0108, P0237, P0238, P2227, P2228, P2229, or P2230 is not set.
- DTC P0106, P0107, P0108, P0237, or P0238 is not pending.
- Ignition is On.
- Engine is Off.
- The time between current ignition cycle and the last time the engine was running is greater than 10 s.

The DTC runs continuously when the above conditions have been met.

OR

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- DTC P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0237, P0238, P0335, P0336, P2227, P2228, P2229 or P2230 is not set.
- DTC P0112, P0113, P0117, or P0118 is not pending.
- Engine speed is between 400 - 6, 100 RPM.
- Engine Coolant Temperature (ECT) is between -7 to +125Â°C (19.4 - 257Â°F).
- Intake Air Temperature (IAT) is between -20 to +125Â°C (-4 to +257Â°F).

The DTC runs continuously when the above conditions have been met.

Conditions for Setting the DTC

- The ECM detects that the boost pressure sensor signal is not within range of a model derived from engine speed, the BARO sensor, the MAF sensor, the MAP sensor, the throttle position sensor and the turbocharger boost pressure sensor when the engine is running.

  OR

- The ECM detects that the boost pressure sensor signal is less than 44 kPa (6 psi) or greater than 115 kPa (16.7 psi) when the ignition is On and the engine is NOT rotating.

  OR

- The ECM detects that the difference between MAP and BARO is less than or equal to 10 kPa and the difference between turbocharger boost pressure and MAP is greater than 10 kPa and the difference between turbocharger boost pressure and BARO is greater than 10 kPa when the ignition is On and the engine is NOT rotating.

Action Taken When the DTCs Set

- DTC P0236 is a Type C DTC.
- The Service Vehicle Soon Indicator may illuminate.

Conditions for Clearing the MIL/DTCs

DTC P0236 is a Type C DTC.

Diagnostic Aids

- The charge air cooler is connected to the turbocharger and to the throttle body by flexible duct work that requires the use of special high torque fastening clamps. These clamps cannot be substituted. In order to prevent any type of air leak when servicing the duct work, the tightening specifications and proper positioning of the clamps is critical, and must be strictly adhered to.
- Use a smoke generating device or a solution of dish soap and water in a spray bottle to pinpoint any suspected air leaks in the induction system and in the charge air cooler assembly.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Turbocharger 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. Verify that DTC P0237, P0238, P0641, P0651, P0697, P06A3, or P06D2 is not set.
   - **If the DTC is set**

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

   - **Go to next step: If the DTC is not set**
2. If you were sent here from DTC P0068, P0101, P0106, P0121, or P1101 refer to Circuit/System Testing.
3. Ignition On.
4. 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 .

   - **Go to next step: If less than 90%**
5. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
   - **If Disagree**

     Refer to DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135.

   - **Go to next step: If Agree**
6. Verify the scan tool BARO parameter is within the range specified in the Altitude Versus Barometric Pressure table, for the current vehicle testing altitude.
   - **If not within the specified range**

     Refer to DTC P2227-P2230 .

   - **Go to next step: If within the specified range**
7. Verify the scan tool MAP Sensor pressure and BARO parameters are within 3 kPa (0.4 psi).
   - **If not within 3 kPa (0.4 psi).**

     Refer to DTC P0106.

   - **Go to next step: If within 3 kPa (0.4 psi).**
8. Engine idling.
9. Verify the scan tool MAP Sensor pressure parameter is between 26 - 52 kPa (3.8 - 7.5 psi) and changes with accelerator pedal input.
   - **If not between 24 - 52 kPa (3.4 - 7.5 psi) or does not change**

     Refer to DTC P0106.

   - **Go to next step: If between 24 - 52 kPa (3.4 - 7.5 psi) and changes**
10. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
    1. Engine idling

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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 it does not change smoothly and gradually**

  Refer to **DTC P0101**.

- **Go to next step: If it changes smoothly and gradually**

11. Verify the scan tool Boost Pressure Sensor pressure and BARO parameters are within 3 kPa (0.4 psi).
    - **If not within 3 kPa (0.4 psi).**

      Refer to Circuit/System Testing

    - **Go to next step: If within 3 kPa (0.4 psi).**
12. Verify the scan tool MAP Sensor parameter and the Boost Pressure Sensor parameter are within 20 kPa (2.9 psi) during a WOT acceleration at the time of the 1-2 shift.
    - **If not within 20 kPa (2.9 psi)**

      Refer to Circuit/System Testing.

    - **Go to next step: If within 20 kPa (2.9 psi)**
13. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
14. Verify a DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **Go to next step: If the DTC does not set**
15. All OK.

Circuit/System Testing

1. Verify the conditions listed below do not exist:
   - Loose clamps, cracks, or other damage in the air intake duct system.
   - Loose clamps, cracks, or other damage in the charge air cooler system.
   - Collapsed or restricted air intake duct system.
   - Restricted air filter.
   - Splits, kinks or improper connections at the vacuum hoses.
   - Missing, restricted or leaking exhaust components - Refer to **Symptoms - Engine Exhaust** .
   - Vacuum leaks at the intake manifold and throttle body.
   - **If a condition exists**

     Repair as necessary.

   - **Go to next step: If none of the conditions exist**
2. Replace the B111 Turbocharger Boost Sensor.

Repair Instructions

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

- **Turbocharger Air Pressure Sensor Replacement** for turbocharger boost sensor replacement.
- **Control Module References** for engine control module replacement, programming, and setup

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DTC P0237 OR P0238: TURBOCHARGER BOOST CIRCUIT VOLTAGE

Diagnostic Instructions

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

DTC Descriptors

DTC P0237

Turbocharger Boost Sensor Circuit Low Voltage

DTC P0238

Turbocharger Boost Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0236, P0237, P0340, P0365, P0452, P0532, P0641, P2227	P0236, P0237, P2227	P0236, P0238, P0453, P0641, P2227	P0236
Intake Air Pressure Signal	P0236, P0237, P2227	P0236, P0237, P2227	P0236, P0238, P2227	P0236
Low Reference	-	P0098, P0236, P0238, P2227	-	-

Typical Scan Tool Data

Boost Pressure Sensor

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: BARO to 240 kPa (34.8 psi) **Operating Conditions:** Engine running			
5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	269 kPa (39 psi)
Boost Pressure Signal	0 kPa (0 psi)	0 kPa (0 psi)	269 kPa (39 psi)
Low Reference	-	267 kPa (38.7 psi)	-

Circuit Description

The boost pressure sensor measures the range of pressures between the turbocharger and the throttle body. The sensor used on this engine is a three atmosphere sensor. Pressure in this portion of the induction system is affected by engine speed, throttle opening, turbocharger boost pressure, Intake air temperature (IAT), barometric pressure (BARO), and the efficiency of the charge air cooler.

The sensor provides a signal voltage to the engine control module (ECM), relative to the pressure changes. Under normal operation the greatest pressure that can exist in this portion of the induction system at ignition On, engine Off is equal to the BARO. When the engine is operated at wide-open throttle (WOT) the turbocharger can increase the pressure to near 240 kPa (34.8 psi). The pressure is equal to the BARO when the engine is idling or decelerating.

Conditions for Running the DTC

- Ignition is On or the engine is running.
- The DTCs run continuously when the above conditions have been met.

Conditions for Setting the DTC

P0237

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The ECM detects that the boost pressure sensor voltage is less than 0.66 V for greater than 5 s.

P0238

The ECM detects that the boost pressure sensor voltage is greater than 4.3 V for greater than 5 s.

Action Taken When the DTC Sets

- DTCs P0237 and P0238 are Type C DTCs.
- The Service Vehicle Soon Indicator may illuminate.
- The ECM will disable boost control and limit the system to mechanical boost only, resulting in a substantial decrease in engine power.

Conditions for Clearing the MIL/DTC

DTCs P0237 and P0238 are Type C DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Turbocharger 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** .

   - **Go to next step: If the DTC is not set**
3. Verify the scan tool BARO parameter is within the range specified in the **Altitude Versus Barometric Pressure** table, for the current vehicle testing altitude.
   - **BARO is not in range**

     Refer to **DTC P2227-P2230** .

   - **Go to next step: BARO is within range**

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4. Verify the scan tool Boost Pressure Sensor pressure and BARO parameters are within 3 kPa (0.4 psi).
    - **The parameters are not within 3 kPa (0.4 psi).**

      Refer to Circuit/System Testing.

    - **Go to next step: The parameters are within 3 kPa (0.4 psi).**
5. Verify the scan tool MAP Sensor parameter and the Boost Pressure Sensor parameter are within 20 kPa (2.9 psi) during a WOT acceleration at the time of the 1-2 shift.
    - **The parameters are not within 20 kPa (2.9 psi)**

      Refer to Circuit/System Testing.

    - **Go to next step: The parameters are within 20 kPa (2.9 psi)**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
7. Verify a DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **Go to next step: 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 B111 Turbocharger Boost Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
    - **If 5 Ω or greater**
    1. Ignition Off, disconnect the X3 harness connector at the K20 engine control module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 engine control module.
    - **Go to next step: If less than 5 Ω**
3. Ignition On.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.
    - **If less than 4.8 V**
    1. Ignition Off, disconnect the X3 harness connector at the K20 engine control module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 engine control module.

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

    - **If greater than 5.2 V**
    1. Ignition Off, disconnect the X3 harness connector at the K20 engine control module, ignition On.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.

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- If less than 1 V, replace the K20 engine control module.
- **Go to next step: If between 4.8 - 5.2 V**

5. Verify the scan tool Boost Pressure Sensor voltage parameter is greater than 4.5 V.
   - **If 4.5 V or less**
   1. Ignition Off, disconnect the X3 harness connector at the K20 engine control module, ignition On.
   2. Test for infinite resistance between the signal circuit terminal 3 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **Go to next step: If greater than 4.5 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the low reference circuit terminal 2.
7. Verify the scan tool Boost Pressure Sensor voltage parameter is less than 0.2 V.
   - **If 0.2 V or greater**
   1. Ignition Off, remove the jumper wire, disconnect the X3 harness connector at the K20 engine control module, Ignition On.
   2. Test for less than 1 V between the signal circuit terminal 3 and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V
   3. Ignition OFF.
   4. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω, replace the K20 engine control module.
   - **Go to next step: If less than 0.2 V**
8. Test or replace the B111 Turbocharger Boost Sensor.

Repair Instructions

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

- **Turbocharger Air Pressure Sensor Replacement** for turbocharger boost sensor replacement.
- **Control Module References** for ECM replacement, programming, and setup.

DTC P0243, P0245, OR P0246: TURBOCHARGER WASTEGATE SOLENOID VALVE

Diagnostic 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 P0243

Turbocharger Wastegate Solenoid Valve Control Circuit

DTC P0245

Turbocharger Wastegate Solenoid Valve Control Circuit Low Voltage

DTC P0246

Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

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Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	P0033, P0034, P0243, P0245, P0443, P06DA, P06DB*	P0243	P0243	-	-
Turbocharger Wastegate Solenoid Control	P0243, P0245	P0243, P0245	P0243, P0245	P0246	P0243
* Ignition fuse opens. A message center or an indicator may display ENGINE POWER IS REDUCED. Engine may experience NO Crank - NO Start condition.					

Circuit/System Description

The dual-scroll turbocharger incorporates a wastegate that is controlled by the engine control module (ECM) by means of a pulse width modulation (PWM) solenoid, to regulate the pressure ratio of the compressor. An ECM controlled compressor bypass valve is integrated into the unit to prevent compressor surging and damage from vibrations by opening during abrupt closed throttle conditions. The bypass valve is open during closed throttle deceleration conditions to allow air to recirculate in the turbocharger and maintain compressor speed.

As engine load and RPM increase, the turbocharger bypass valve is commanded closed by the ECM. As soon as the throttle closes, the valve is commanded open to allow the turbocharger air to recirculate to prevent compressor surging.

Conditions for Running the DTCs

- Ignition is On or the engine is running.
- Battery voltage is at least 11 V.

The DTCs run continuously when the above conditions are met.

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Conditions for Setting the DTCs

P0243

The ECM detects an open circuit on the turbocharger wastegate solenoid control circuit for greater than 2 s.

P0245

The ECM detects a short to ground on the turbocharger wastegate solenoid control circuit for greater than 2 s.

P0246

The ECM detects a short to voltage on the turbocharger wastegate solenoid control circuit for greater than 2 s.

Action Taken When the DTCs Set

- DTCs P0243, P0245, and P0246 are Type A DTCs.
- The Service Vehicle Soon Indicator may illuminate.
- The ECM will disable boost control and limit the system to mechanical boost only, resulting in a substantial decrease in engine power.

Conditions for Clearing the MIL/DTCs

DTCs P0243, P0245, and P0246 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Turbocharger 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 a series of clicks, which increase in frequency, are heard or felt from the Q42 turbocharger wastegate solenoid valve when commanding the Turbocharger Wastegate Solenoid Valve between 5 - 95 % with a scan tool.
   - **If a series of clicks in increasing frequency are not heard or felt**

     Refer to Circuit/System Testing.

   - **Go to next step: If a series of clicks in increasing frequency is heard or felt**
3. Verify the parameters listed below do not display Malfunction when commanding the Turbocharger Wastegate Solenoid Valve between 5 - 95 % with a scan tool.
   - Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status
   - Turbocharger Wastegate Solenoid Valve Control Circuit Open Test Status
   - Turbocharger Wastegate Solenoid Valve Control Circuit Low Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **Go to next step: 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 a DTC does not set.
   - **If a DTC sets**

     Refer to Circuit/System Testing

   - **Go to next step: If a DTC does not set**
6. All OK

Circuit/System Testing

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1. Ignition Off, disconnect the harness connector at the Q42 Turbocharger Wastegate Solenoid Valve, 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.
    2. Test for less than 2 Ω in the ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition Off, remove the test lamp.

        NOTE: **A short circuit in any component supplied by the fuse may cause the fuse to open and set a DTC when the component is activated.**

    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 supplied by the fuse and replace as necessary.
    - **Go to next step: 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.
    - **Go to next step: If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the Turbocharger Wastegate Solenoid Valve between 5 - 95 % 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.
    - **Go to next step: If OK is displayed**
6. Install a 3 A fused jumper wire between the control circuit terminal 2 and the ignition circuit terminal 1.
7. Verify the scan tool Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the Turbocharger Wastegate Solenoid Valve between 5 - 95 % with a scan tool.
    - **If Malfunction is not displayed**
    1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If Malfunction is displayed**
8. Test or replace the Q42 Turbocharger Wastegate Solenoid valve.

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Repair Instructions

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

- **Turbocharger Wastegate Regulator Solenoid Valve Replacement**
- **Control Module References** for ECM replacement, programming and setup.

DTC P0231, P0232, OR P023F: FUEL PUMP CONTROL CIRCUIT VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **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	-	P0232, P023F	U18A7	P023F, P2635
Low Reference	-	P0232, P023F, P0506	-	P023F, P2635

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Circuit/System Description

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

Conditions for Running the DTC

P0231

- The ignition voltage is between 9 - 32 V.
- The fuel pump enable circuit is commanded ON.
- The fuel pump driver control module output current is less than 100 A.

P0232

- The ignition voltage is between 9 - 32 V.
- The fuel pump enable circuit is commanded OFF.
- The above conditions are met for 4 s.

P023F

- The ignition voltage is between 9 - 32 V.

- The fuel pump enable circuit is commanded ON.
- Fuel pump driver over-temperature indicated.

Conditions for Setting the DTC

P0231

The fuel pump driver control module detects that the fuel pump control circuit is shorted to ground for 1 s.

P0232

The fuel pump driver control module detects that the fuel pump output circuit voltage is greater than 3.86 V for 0.5 s when the voltage should be 0 V.

P023F

The fuel pump driver control module detects that the fuel pump control circuit is open for 1 s.

Action Taken When the DTC Sets

- DTCs P0231 and P023F are Type A DTCs.
- DTC P0232 is a Type B DTC.

Conditions for Clearing the DTC

- DTCs P0231 and P023F are Type A DTCs.
- DTC P0232 is a Type B DTC.

Diagnostic Aids

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

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the fuel pump turns ON and OFF when commanding the Fuel Pump Enable On and Off with a scan tool.
   - **If the fuel pump does not turn ON and OFF**

     Refer to Circuit/System Testing.

   - **Go to next step: If the fuel pump turns ON and OFF**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

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

     Refer to Circuit/System Testing.

   - **Go to next step: 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 K111 Fuel Pump Driver Control Module and the X350 inline harness connector.
2. Test for less than 2 Ω in the low reference circuit end to end between the appropriate terminal at the body side of connector X350 and at the K111 Fuel Pump Driver Control Module.
   - **If 2 Ω or greater**

     Repair the open/high resistance in the circuit.

   - **Go to next step: If less than 2 Ω**
3. Connect the harness connector at the K111 Fuel Pump Driver Control Module.
4. Ignition ON, connect a test lamp between the fuel pump control circuit terminal and the low reference circuit terminal at the body side of connector X350.
5. Verify the test lamp turns ON and OFF when commanding the Fuel Pump Enable On and Off with a scan tool.
   - **If the test lamp is always OFF**
   1. Ignition OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
   2. Test for infinite resistance between the fuel pump control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the fuel pump control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, test or replace the K111 Fuel Pump Driver Control Module.
   - **If the test lamp is always ON**
   1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K111 Fuel Pump Driver Control Module, ignition ON.
   2. Test for less than 1 V between the fuel pump control 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, test or replace the K111 Fuel Pump Driver Control Module.
- **Go to next step: If the test lamp turns ON and OFF**

6. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module and at the G12 Fuel Pump. It may take up to 2 minutes for all vehicle systems to power down.
7. Test for infinite resistance between the low reference circuit and ground.
    - **If less than infinite resistance**

      Repair the short to ground on the circuit.

    - **Go to next step: If infinite resistance**
8. Test for less than 2 Ω in the low reference circuit end to end.
    - **If 2 Ω or greater**

      Repair the open/high resistance in the circuit.

    - **Go to next step: If less than 2 Ω**
9. Test for infinite resistance between the fuel pump control circuit and ground.
    - **If less than infinite resistance**

      Repair the short to ground on the circuit.

    - **Go to next step: If infinite resistance**
10. Test for less than 2 Ω in the fuel pump control circuit end to end.
    - **If 2 Ω or greater**

      Repair the open/high resistance in the circuit.

    - **Go to next step: If less than 2 Ω**
11. Replace the G12 Fuel Pump.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
2. Connect a DMM, set on the diode setting, with the positive lead at terminal 16 and the negative lead at terminal 9 of the K111 Fuel Pump Driver Control Module
3. Test for 0.4 - 0.8 V between terminal 16 and terminal 9.
    - **If not between 0.4 - 0.8 V**

      Replace the K111 Fuel Pump Driver Control Module.

    - **Go to next step: If between 0.4 - 0.8 V**
4. Connect a DMM, set on the diode setting, with the positive lead at terminal 9 and the negative lead at terminal 16 of the K111 Fuel Pump Driver Control Module
5. Test for OL between terminal 9 and terminal 16.
    - **If not OL**

      Replace the K111 Fuel Pump Driver Control Module.

    - **Go to next step: If OL**
6. All OK

Repair Instructions

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

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- Fuel Pump Power Control Module Replacement (FWD) Fuel Pump Power Control Module Replacement (AWD) for K111 Fuel Pump Driver Control Module replacement
- Fuel Tank Fuel Pump Module Replacement (FWD) Fuel Tank Fuel Pump Module Replacement (AWD) for G12 Fuel Pump replacement

DTC P0300, P0301, P0302, P0303, P0304: ENGINE/CYLINDER 1-4 MISFIRE DETECTED

Diagnostic Instructions

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

DTC Descriptors

DTC P0300

Engine Misfire Detected

DTC P0301

Cylinder 1 Misfire Detected

DTC P0302

Cylinder 2 Misfire Detected

DTC P0303

Cylinder 3 Misfire Detected

DTC P0304

Cylinder 4 Misfire Detected

Circuit/System Description

The engine control module (ECM) uses information from the crankshaft position sensor and the camshaft position sensor to determine when a engine cylinder misfire is occurring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM can detect individual cylinder misfire events.

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

Conditions for Running the DTC

- DTC P0010, P0011, P0013, P0014, P0016, P0017, P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0122, P0123, P0191, P0192, P0193, P0222, P0223, P0335, P0336, P0340, P0341, P0365, P0366, P0601, P0604, P0606, P0651, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2227, P2228, P2229, or P2230 is not set.
- The engine speed is less than 1, 000 RPM and DTC P0315 is set.
- The engine speed is greater than 1, 400 RPM.
- The crankshaft position and camshaft position sensors are synchronized.
- The engine coolant temperature (ECT) is between -7 and 127Â°C (19 - 261Â°F).

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- If the ECT is colder than -7Â°C (19Â°F) at start-up, this diagnostic will not run until the ECT is between 21 - 127Â°C (70 - 261Â°F).
- The battery voltage is between 9 - 32 V.
- The vehicle is not in a acceleration or deceleration condition.
- The ECM is not detecting a rough road signal.
- The fuel level is at least 11%.
- The ECM is not in fuel cut-off or deceleration fuel cut-off mode.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0300

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

P0301, P0302, P0303, or P0304

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

Action Taken When the DTC Sets

- DTCs P0300 - P0304 are Type B DTCs.
- The ECM will flash the malfunction indicator lamp (MIL) when a catalyst damaging level of misfire is present.

Conditions for Clearing the DTC

DTCs P0300 - P0304 are Type B DTCs.

Diagnostic Aids

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

Reference Information

Description and Operation

- **Electronic Ignition System Description**
- **Fuel System Description**

DTC Type Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL26792 HEI Spark Tester

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

Circuit/System Verification

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

1. Engine Running at normal operating temperature.
2. Verify there is no abnormal engine noise.
   - **If abnormal engine noise is present**

     Refer to Symptoms - Engine Mechanical .

   - **Go to next step: If abnormal engine noise is not present**
3. Perform the scan tool Crankshaft Position Variation Learn procedure.
4. Verify no DTCs are set.
   - **If any DTCs other than P0300 - P0304 are set**

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

   - **If DTC P0300 - P0304 is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If no DTCs are set**
5. Verify the scan tool Cylinder 1 - 4 Current Misfire Counter parameters do not increment.
   - **If increments**

     Refer to Circuit/System Testing.

   - **Go to next step: If does not increment**
6. Engine Running, perform the Cylinder Power Balance Test with a scan tool.
7. Verify the engine speed changes when each injector is disabled and then enabled.
   - **If engine speed does not change**

     Refer to Circuit/System Testing.

   - **Go to next step: If engine speed does change**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**

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10. All OK.

Circuit/System Testing

1. Verify none of the following conditions listed below exist:
    - Damage, carbon tracking, or fluid intrusion of the spark plug boots and/or spark plugs
    - Vacuum hose splits, kinks, and incorrect connections
    - Engine vacuum leaks
    - Crankcase ventilation system for vacuum leaks
    - Fuel pressure that is too low or too high. Refer to **Fuel System Diagnosis** .
    - Contaminated fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
    - Exhaust system restrictions
        - **If a condition exists**

          Repair or replace as necessary.

        - **Go to next step: If no conditions exist**

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

2. Ignition OFF, remove the appropriate T 8 Ignition Coil from the spark plug and connect the **EL 26792** HEI Spark Tester to the spark plug boot, engine Cranking.
3. Verify the spark output.
    - **If no output or the output is weak**

      Refer to **Electronic Ignition System Diagnosis** .

    - **Go to next step: If the output is good**
4. Ignition OFF.
5. Verify the conditions listed below. Refer to **Ignition System Specifications** .
    - The correct spark plug type
    - The correct spark plug gap
    - The correct spark plug torque
    - **If a condition exists**

      Repair or replace as necessary.

    - **Go to next step: If no conditions exist**
6. Exchange the suspect spark plug with another cylinder that is operating correctly.
7. Engine Running.
8. Verify the scan tool Cylinder 1 - 4 Current Misfire Counter does not increment for the cylinder where the suspect spark plug was installed.
    - **If increments**

      Replace the spark plug.

    - **Go to next step: If does not increment**
9. Test or inspect for the conditions listed below:
    - A lean or rich Q17 Fuel Injector - Refer to **Fuel Injector Diagnosis** .
    - An engine mechanical condition - Refer to **Symptoms - Engine Mechanical** .

Repair Instructions

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

Repair Verification

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1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 s.
5. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to the **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.
6. Engine Running, verify the scan tool Cylinder 1 - 4 Current Misfire Counter parameters do not increment.
    - If the misfire counter parameters increment, a misfire condition still exists.
7. To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420. Refer to **DTC P0420** .

DTC P0315: CRANKSHAFT POSITION SYSTEM VARIATION NOT LEARNED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **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 variation learn feature is used to calculate reference period errors caused by slight tolerance variations in the crankshaft, and the crankshaft position sensor. The calculated error allows the engine control module (ECM) to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wider range of engine speed and load conditions.

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

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

Conditions for Running the DTC

Engine is Running.

The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0315 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P0315 is a Type A DTC.

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Diagnostic Aids

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

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Perform the scan tool **Crankshaft Position Variation Learn** procedure.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
3. Verify the DTC is not set.
    - **If the DTC sets**

      Replace the K20 Engine Control Module.

    - **Go to next step: If the DTC does not set**
4. All OK

Repair Instructions

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

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

DTC P0324, P0325, P0326, P0327, P0328, P0329, P0330, P0331, P0332, P0333, P06B6, OR P06B7: KNOCK SENSOR CIRCUIT PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0324

Knock Sensor System Performance

DTC P0325

Knock Sensor 1 Circuit

DTC P0326

Knock Sensor 1 Performance

DTC P0327

Knock Sensor 1 Circuit Low Voltage

DTC P0328

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Knock Sensor 1 Circuit High Voltage

DTC P0330

Knock Sensor 2 Circuit

DTC P0331

Knock Sensor 2 Performance

DTC P0332

Knock Sensor 2 Circuit Low Voltage

DTC P0333

Knock Sensor 2 Circuit High Voltage

DTC P06B6

Control Module Knock Sensor Processor 1 Performance

DTC P06B7

Control Module Knock Sensor Processor 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal 1/A	P0327, P0332, P06B6, P06B7	P0325, P0330	P0328, P0333	P0324*, P0326**, P0331**
Signal - Terminal 2/B	P0327, P0332	P0325, P0330	P0328, P0333	P0324*, P0326**, P0331**
*Signal Performance=High **Signal Performance=Low				

Circuit/System Description

For an overview of the component/system, refer to:**Electronic Ignition System Description**

Circuit	Description
Signal-Terminal l /A	The control module input circuit has an internal resistance connected to 5V.
Signal-Terminal 2/B	The control module input circuit has an internal resistance connected to 1.33V.

Component	Description
B68 Knock Sensor	The sensor uses piezo-electric crystal technology that produces an AC voltage signal of varying amplitude and frequency based on the engine vibration or noise level. The amplitude and frequency depend upon the level of knock that the knock sensor detects.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

The knock sensor measures vibrations of the engine block. To some extent it is comparable to a microphone. The sensor produces an AC voltage that is proportional in frequency and amplitude to the vibrations. The ECM can deduce from the signal if and which cylinder is knocking. This enables the

ECM to adjust the spark timing so that the best fuel efficiency is gained. The ECM learns a minimum knock sensor noise level at idle and uses calibrated values for the rest of the engine speed range.

Conditions for Running the DTC

P0324, P0326, P0331 Condition 1

- Engine = Running - For greater than 2 s
- Engine Coolant Temperature = Greater than -40Â°C (-40Â°F)
- Intake Air Temperature = Greater than -40Â°C (-40Â°F)
- Engine Speed = Less than 8, 500 RPM
- Mass Air Flow Per Cylinder = Less than 2, 000 mg

Condition 2

- Engine = Running - For greater than 2 s
- Engine Coolant Temperature = Greater than -40Â°C (-40Â°F)
- Intake Air Temperature = Greater than -40Â°C (-40Â°F)
- Engine Speed = Greater than 8, 500 RPM - Cumulative = Greater than 200 engine revolutions
- Mass Air Flow Per Cylinder = Less than 2, 000 mg

Condition 3

- Engine = Running - For greater than 2 s
- Engine Coolant Temperature = Greater than -40Â°C (-40Â°F)
- Intake Air Temperature = Greater than -40Â°C (-40Â°F)
- Engine Speed = Greater than 2, 250 RPM - Greater than 75 engine revolutions
- Mass Air Flow Per Cylinder = Greater than 30 mg

Condition 4

- Engine = Running - For greater than 2 s
- Engine Coolant Temperature = Greater than -40Â°C (-40Â°F
- Intake Air Temperature = Greater than -40Â°C (-40Â°F)
- Engine Speed = Greater than 8, 500 RPM - Greater than 100 engine revolutions
- Mass Air Flow Per Cylinder = Greater than 2, 000 mg

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

P0325, P0330

- Engine = Running - Greater than 200 engine revolutions For greater than 2 s
- Engine Speed = 400 to 5, 500 RPM-Greater than 75 engine revolutions
- Mass Air Flow Per Cylinder = 20 to 2, 000 mg
- Engine Coolant Temperature = Greater than -40Â°C (-40Â°F
- Intake Air Temperature = Greater than -40Â°C (-40Â°F)

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

P0327, P0328, P0332, P0333

Engine Speed = Less than 8, 500 RPM

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

P06B6, P06B7

- Engine = Running - For greater than 2 s

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- Engine Speed = 400 to 5, 500 RPM-Greater than 75 engine revolutions
- Mass Air Flow Per Cylinder = 20 to 2, 000mg

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

Conditions for Setting the DTC

P0324

Knock Sensor Signal = Excessive engine knocking

P0325, P0330

Signal circuit = Open - For greater than 5s

P0326, P0331

Signal Performance = Low Frequency

P0327, P0332

Signal circuit = Short to Ground - For greater than 5 s

P0328. P0333

Signal circuit = Short to Voltage - For greater than 5 s

P06B6, P06B7

A fault of the processor that evaluates the knock sensor signal was detected.

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Actions Taken When the DTC Sets

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

DTC P0325, P0327, P0328, P0330, P0332, P0333 = Type B DTC

The ignition timing is retarded to reduce potentially engine-damaging knocking.

Conditions for Clearing the DTC

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

DTC P0325, P0327, P0328, P0330, P0332, P0333 = Type B DTC

Diagnostic Aids

- Inspect the knock sensor for physical damage. A damaged sensor may cause a DTC to set.
- The knock sensor mounting surface should be free of burrs, casting flash, and foreign material.
- Tightening the retaining bolt too much or simply dropping the knock sensor on the ground can damage it.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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

Circuit/System Verification

1. Engine - Running
2. Verify DTC P0325, P0327, P0328, P0330, P0332, P0333, P06B6, P06B7 is not set.
    - **If only DTC P0325, P0327, P0328, P0330, P0332, P0333 is set**

      Refer to: Circuit/System Testing

    - **If only DTC P06B6, P06B7 is set**

      Replace the component:K20 Engine Control Module

    - **Go to next step: If none of the DTCs are set**
3. Verify the scan tool parameter:Cylinder 1-4 Knock Detected = No

   Perform the action while monitoring the parameter:

    - Wiggle the harness and connector:B68 Knock Sensor
    - Wiggle the harness and connector:K20 Engine Control Module
    - **If not the specified state**

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

    - **Go to next step: If the specified state**
4. Verify DTC P0324, P0326, P0331 is not set.
    - **If the DTC is set**
    1. Verify a condition does not exist with the component:B68 Knock Sensor
        - Incorrect installation - Refer to:**Fastener Specifications**
        - Interference with other components - Bracket/Engine Wiring Harness/Hoses / Lines
        - Visible Damage
        - If a condition exists - Repair or replace as necessary
        - If no condition exists
    2. Verify the condition did not cause the DTC to set:
        - Accessory drive bracket - Loose/Visible Damage
        - Drive Belt & Belt Driven Device - Loose/Visible Damage
        - Engine - Mechanical Condition - Refer to: **Symptoms - Engine Mechanical**
        - Fuel - Contaminated/Poor Quality
        - If a condition exists - Repair or replace as necessary
        - If all conditions test normal - Test or replace the component:B68 Knock Sensor
    - **Go to next step: If none of the DTCs are set**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

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- **If the DTC sets**

  Refer to: Circuit/System Testing

- **Go to next step: If the DTC is not set**

6. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector:B68 Knock Sensor
3. Ignition - On / Vehicle - In Service Mode
4. Test for 1 to 2 V between the test points:Signal circuit terminal 2/B & Ground
   - **If less than 1 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the appropriate electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points: Signal circuit terminal 2/B @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 ohms between the test points: Signal circuit terminal 2/B @ Component harness & The other end of the circuit@Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K20 Engine Control Module
   - **If greater than 2 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the appropriate electrical connector: K20 Engine Control Module
   3. Ignition - On / Vehicle - In Service Mode
   4. Test for less than 1V between the test points: Signal circuit terminal 2/B @Component harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - If less than 1 V - Replace the component: K20 Engine Control Module
   - **Go to next step: If between 1 and 2 V**
5. Test for 2 to 4 V between the test points:Signal circuit terminal 2/B & Ground
   - **If less than 2 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the appropriate electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points: Signal circuit terminal 1/A @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 ohms between the test points: Signal circuit terminal 1/A @ Component harness & The other end of the circuit@Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K20 Engine Control Module
   - **If greater than 4 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the appropriate electrical connector:K20 Engine Control Module
   3. Ignition - On / Vehicle - In Service Mode
   4. Test for less than 1 V between the test points: Signal circuit terminal 1/A @Component harness & 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 component: K20 Engine Control Module
- **Go to next step: If between 2 and 4 V**

6. Test or replace the component:B68 Knock Sensor

Repair Instructions

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

- **Knock Sensor Replacement (Sensor 1)** **Knock Sensor Replacement (Sensor 2)**
- For control module replacement, programming, and setup refer to:**Control Module References**

DTC P0335 OR P0336: CRANKSHAFT POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **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	P0335, P0557, P057C, P0651, P118C	P0335	P0558, P0651, P118C	P0336
Signal	P0335, P0506	P0335, P0506	P0335	P0336
Low Reference	-	P0335, P0506	-	P0336

Circuit/System Description

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The crankshaft position sensor is a magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of invisible magnetic segments on the edge of the crankshaft position reluctor ring mounted on the crankshaft. Each magnetic segment on the ring is spaced at a 60 segment spacing with 2 missing spaces for a 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 position reluctor ring to the ECM as each segment on the ring rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed and decodes the crankshaft position reluctor ring 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

- DTCs P0101, P0102 and P0103 are not set.

OR

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

  AND

- The airflow into the engine is greater than 1.5 g/s.

Condition 2

- The engine is running.
- The starter is not engaged.

Condition 3

- DTCs P0365 or P0366 are not set.
- The engine is running or the starter is engaged.

P0336 Condition 1

- DTCs P0335 is not set.
- The airflow into the engine is greater than 1.5 g/s.
- Engine speed is greater than 450 RPM.

Condition 2

- The engine is running.
- The starter is not engaged.

Condition 3

- DTCs P0101, P0102, and P0103 are not set.
- The airflow into the engine is greater than 1.5 g/s.

  OR

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

Condition 4

- DTCs P0365 or P0366 are not set.
- The engine is running or the starter is engaged.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0335 Condition 1

The ECM does not detect a crankshaft position sensor pulse for greater than 4 s.

Condition 2

The ECM does not detect a crankshaft position sensor pulse for greater than 0.3 s.

Condition 3

The ECM does not detect a crankshaft position sensor pulse for 2 out of 10 engine revolutions.

P0336 Condition 1

The ECM detects that 10 or more crankshaft resynchronizations have occurred within 10 s.

Condition 2

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The ECM does not detect the synchronization gap on the reluctor ring for greater than 0.4 s.

Condition 3

The ECM does not detect the synchronization gap on the reluctor ring for 1.5 s after the starter was engaged.

Condition 4

The ECM detects less than 51 or greater than 65 crankshaft position sensor pulses during 1 engine revolution for 8 out of 10 engine revolutions.

Action Taken When the DTC Sets

- DTCs P0335 and P0336 are Type B DTCs.
- The camshaft position sensor is used to determine engine position.
- The camshaft actuators are commanded to the parked position, if applicable.

Conditions for Clearing the DTC

DTCs P0335 and P0336 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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 P0651 is not set.
   - **If the DTC is set**

     Refer to **DTC P0641, P0651, P0697, P06A3, or P06D2** .

   - **Go to next step: If the DTC is not set**
3. Engine Running.
4. Verify the scan tool Crankshaft Position Active Counter parameter increments.

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- **If the counter does not increment**

  Refer to Circuit/System Testing.

- **Go to next step: 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.

   - **Go to next step: 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.

   - **Go to next step: If the DTC does not set**
8. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B26 Crankshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If 2 Ω or less, replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the 5 V reference 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.
   - **Go to next step: If between 4.8 - 5.2 V**
5. Test for 4.8 - 5.2 V between the signal circuit terminal 3 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

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

- **If greater than 5.2 V**

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

- **Go to next step: If between 4.8 - 5.2 V**

6. Ignition OFF, connect a 3 A fused jumper wire to the signal circuit terminal 3, ignition ON.

NOTE: **Additional DTCs may set when performing this test.**

7. Verify the scan tool Crankshaft Position 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.

    - **Go to next step: If the counter increments**
8. Verify DTC P0336 is not set.
    - **If the DTC is set**

      NOTE: **The crankshaft position reluctor ring is magnetic and may be functionally damaged if any magnetic object comes in contact with it. This type of damage is not visually detectable but will set the DTC.**

      1. Inspect for the conditions listed below:
          - Excessive play or looseness of the B26 Crankshaft Position Sensor or the crankshaft position reluctor ring
          - Improper installation of the B26 Crankshaft Position Sensor
          - Foreign material passing between the B26 Crankshaft Position Sensor and the crankshaft position reluctor ring
          - Damaged crankshaft position reluctor ring
          - Excessive air gap between the B26 Crankshaft Position Sensor and the crankshaft position reluctor ring
          - Timing chain or belt, tensioner, and sprockets for wear or damage
          - If a condition is found

            Repair or replace as necessary.

          - If a condition is not found
      2. Replace the B26 Crankshaft Position Sensor.
      3. Clear the DTC and test drive the vehicle.
      4. Verify the DTC is not set.
          - If the DTC is set, replace the crankshaft position reluctor ring.
          - If the DTC is not set, all OK.
    - **Go to next step: If the DTC is not set**
9. Test or replace the B26 Crankshaft Position Sensor.

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Repair Instructions

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

- **Crankshaft Position Sensor Replacement (FWD)** **Crankshaft Position Sensor Replacement (AWD)**
- **Control Module References** for engine control module replacement, programming, and setup

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

Diagnostic Instructions

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

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0192, P0452, P0522, P0532, P0641, P2227, P2228	P0340, P0365	P018D, P0193, P0453, P0523, P0641, P2227	-
Signal	P0340, P0365	P0340, P0365	P0340, P0365	P0341, P0366
Low Reference	-	P0340, P0365	P0340, P0365	-

Circuit/System Description

The camshaft position sensors each have 3 circuits consisting of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The camshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the camshaft position sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency with 4 varying width output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the camshaft position sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM uses the cylinder 1 exhaust camshaft position sensor to determine injector and ignition system synchronization. The intake and exhaust camshaft position sensors are also used to determine camshaft to crankshaft relationship. The ECM also uses camshaft position sensor output information to determine the camshaft relative position to the crankshaft to control camshaft phasing and limp-home operation.

Conditions for Running the DTC

P0340 or P0365 Condition 1

- DTCs P0101, P0102, and P0103 are not set.
- The airflow into the engine is greater than 1.5 g/s.

  OR

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

Condition 2

- The engine is running.
- The starter is not engaged.

Condition 3

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

Condition 4

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

P0341 or P0366 Condition 1

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

Condition 2

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

The DTCs run continuously once the above conditions are met.

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Conditions for Setting the DTC

P0340 or P0365 Condition 1

- The ECM does not detect a camshaft position sensor pulse for greater than 5.5 s.

  OR

- The ECM does not detect a camshaft position sensor pulse for greater than 4 s since the time the starter has been engaged.

Condition 2

The ECM detects less than 4 camshaft position sensor pulse for greater than 3 s.

Condition 3

The ECM does not detect a camshaft position sensor pulse during the first 2 engine revolutions.

Condition 4

The ECM does not detect a camshaft position sensor pulse during 200 engine revolutions.

P0341 or P0366 Condition 1

- The ECM detects less than 4 camshaft position sensor pulses during 2 engine revolutions.

  OR

- The ECM detects greater than 6 camshaft position sensor pulses during 2 engine revolutions.

Condition 2

The ECM detects less than 398 or greater than 402 camshaft position sensor pulses during 200 engine revolutions.

Action Taken When the DTC Sets

- DTCs P0340, P0341, P0365, and P0366 are Type B DTCs.
- The camshaft position actuator is commanded to the Home or Parked position.
- The ignition system defaults to a failed camshaft position sensor limp home mode.

Conditions for Clearing the MIL/DTC

DTCs P0340, P0341, P0365, and P0366 are Type B DTCs.

Diagnostic Aids

- With a DTC set, the engine may crank for an extended period of time at start-up
- The exhaust camshaft position sensor is used for injector and ignition system synchronization. A stalling condition will occur if the camshaft position sensor signal is intermittent and a DTC may not set. Inspect all camshaft position sensor circuits for poor connections.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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.

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

  Refer to **DTC P0641, P0651, P0697, P06A3, or P06D2** .

- **Go to next step: 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.

   - **Go to next step: 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.

   - **Go to next step: 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 Ω between the low reference circuit terminal 2 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If 2 Ω or less, replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance.
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If between 4.8 - 5.2 V**
5. 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 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

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

- **Go to next step: 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 or belt, 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.
    - **Go to next step: If none of the DTCs are set**
7. Test or replace the B23 Camshaft Position Sensor.

Repair Instructions

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

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

DTC P034A OR P034B: CRANKSHAFT POSITION SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P034A

Crankshaft Position Sensor - Engine Start Position Incorrect

DTC P034B

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Crankshaft Position Sensor - Crankshaft Direction Incorrect

Circuit/System Description

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

Conditions for Running the DTC

P034A

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

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

P034B

- DTC P0335, P0336, or P0651 is not set.
- Engine speed is between 400 - 2000 RPM.
- The airflow into the engine is greater than 1.5 g/s.
- The engine control module (ECM) detects crankshaft position sensor pulses.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P034A

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

P034B

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

Action Taken When the DTC Sets

DTC P034A and P034B are Type B DTCs.

Conditions for Clearing the DTC

DTC P034A and P034B are Type B DTCs.

Diagnostic Aids

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

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0335, P0336, or P0651 is not set.

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

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

- **Go to next step: If none of the DTCs are set**

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

     Replace the B26 Crankshaft Position Sensor.

   - **Go to next step: If the DTC does not set**
5. All OK.

Repair Instructions

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

Crankshaft Position Sensor Replacement (FWD) **Crankshaft Position Sensor Replacement (AWD)**

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DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0351, P0352, P0353, P0354, P2300, P2301, P2303, P2304, P2306, P2307, P2309, OR P2310: IGNITION COIL 1-4 CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P0351

Ignition Coil 1 Control Circuit

DTC P0352

Ignition Coil 2 Control Circuit

DTC P0353

Ignition Coil 3 Control Circuit

DTC P0354

Ignition Coil 4 Control Circuit

DTC P2300

Ignition Coil 1 Control Circuit Low Voltage

DTC P2301

Ignition Coil 1 Control Circuit High Voltage

DTC P2303

Ignition Coil 2 Control Circuit Low Voltage

DTC P2304

Ignition Coil 2 Control Circuit High Voltage

DTC P2306

Ignition Coil 3 Control Circuit Low Voltage

DTC P2307

Ignition Coil 3 Control Circuit High Voltage

DTC P2309

Ignition Coil 4 Control Circuit Low Voltage

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DTC P2310

Ignition Coil 4 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Coil 1 Control	P0300, P2300	P0300, P0351	P0300, P2301	P0300, P0351
Ignition Coil 2 Control	P0300, P2303	P0300, P0352	P0300, P2304	P0300, P0352
Ignition Coil 3 Control	P0300, P2306	P0300, P0353	P0300, P2307	P0300, P0353
Ignition Coil 4 Control	P0300, P2309	P0300, P0354	P0300, P2310	P0300, P0354
Ground - Terminal 1/A@T8A Ignition Coil 1	-	P0300, P0351	-	P0300
Ground - Terminal 1/A@T8B Ignition Coil 2	-	P0300, P0352	-	P0300
Ground - Terminal 1/A@T8C Ignition Coil 3	-	P0300, P0353	-	P0300
Ground - Terminal 1/A@T8D Ignition Coil 4	-	P0300, P0354	-	P0300

Circuit/System Description

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

Conditions for Running the DTC

- The engine is cranking or running.
- Ignition voltage greater than 11 V.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match.

Action Taken When the DTC Sets

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

Conditions for Clearing the MIL/DTC

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 26792 HEI Spark Tester

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

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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.

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

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
5. All OK.

Circuit/System Testing

NOTE: **It may take up to2 min for all vehicle systems to power down before an accurate ground or low reference circuit continuity test can be performed.**

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the appropriate electrical connector:T8 Ignition Coil
3. Test for less than 10 ohms between the test points: Ground circuit terminal 1/A & Ground
   - **If 10 ohms or greater**

1. Disconnect the ground connection:Ground terminal
2. Test for less than 2 ohms between the test points: Ground circuit terminal 1/A@Component harness & The other end of the circuit
    - 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.

- **Go to next step: If less than 10 ohms**

4. Engine - Running
5. Verify the appropriate scan tool Ignition Coil Control Circuit Low Voltage Test Status does not display Malfunction.
    - **If Malfunction is displayed**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the control circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If Malfunction is not displayed**
6. Verify the appropriate scan tool Ignition Coil Control Circuit High Voltage Test Status does not display Malfunction.
    - **If Malfunction is displayed**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage in the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If Malfunction is not displayed**
7. Ignition OFF, install a 10 A fused jumper wire between the control circuit terminal 3 or C and ground, engine Running.
8. Verify the appropriate scan tool Ignition Coil Control Circuit Low Voltage Test Status displays Malfunction.
    - **If Malfunction is not displayed**
    1. Ignition OFF, remove the fused jumper, and disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If Malfunction is displayed**
9. Test or replace the T8 Ignition Coil.

Component Test

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

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

      Replace the T8 Ignition Coil.

    - **Go to next step: If the output is normal**
4. All OK.

Repair Instructions

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

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

DTC P0420: CATALYST SYSTEM LOW EFFICIENCY

Diagnostic Instructions

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

DTC Descriptor

DTC P0420

Catalyst System Low Efficiency

Circuit/System Description

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

Conditions for Running the DTC

- DTC P0030, P0031, P0032, P0036, P0037, P0038, P0053, P0054, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0135, P0137, P0138, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P16F3, P2101, P2135, P2270, or P2271 is not set.
- Ignition voltage is between 10 - 32 V.
- HO2S heater resistance is learned.
- Accelerator pedal position is no more than 3%.
- Mass air flow (MAF) is between 2 - 20 g/s.
- Fuel level is greater than 10%.
- Fuel system is in closed loop.
- Evaporative emissions (EVAP) diagnostics are not in control of purge.
- Predicted catalyst temperature is between 550 - 910Â°C (1, 022 - 1, 670Â°F).
- HO2S heater is commanded On for greater than 60 s.
- Engine speed is between 1, 900 - 3, 500 RPM to initially enable the test.
- Engine speed is between 1, 850 - 3, 650 RPM to keep the test enabled.
- Vehicle speed is between 66 - 125 km/h (41 - 78 mph) to initially enable the test.
- Vehicle speed is between 58 - 128 km/h (36 - 80 mph) to keep the test enabled.
- Engine is operating in decel fuel cut off (DFCO).

This diagnostic attempts one test during each valid decel fuel cut off period once the above conditions have been met. This diagnostic attempts up to 3 tests during each drive cycle.

Conditions for Setting the DTC

The ECM has detected that the catalyst efficiency has degraded below a calibrated threshold.

Action Taken When The DTC Sets

DTC P0420 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P0420 is a Type A DTC.

Diagnostic Aids

Inspect for the conditions listed below, which may cause a catalyst to degrade:

- Engine misfire
- High engine oil or high coolant consumption
- Retarded spark timing
- Weak or poor spark
- Lean fuel mixture
- Rich fuel mixture
- Damaged oxygen sensor or wiring harness

Reference Information

Electrical Information Reference

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

DTC Types Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify there are no other DTCs set.
    - **If other DTCs are set**

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

    - **Go to next step: If no other DTCs are set**
3. Operate the vehicle within the Conditions for Running the DTC.
4. Verify the scan tool Catalyst Monitor Not At Idle Test Conditions Met parameter changes to Yes.
    - **If Yes is not displayed**

      Refer to step 3.

    - **Go to next step: 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 Passed when performing the steps listed below:

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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 No Result is displayed**

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

- **If Failed is displayed**

  Refer to Circuit /System Testing

- **Go to next step: If Passed is displayed**

7. All OK.

Circuit/System Testing

1. Verify the conditions listed below do not exist with the catalytic converter:
   - Dents
   - Severe discoloration caused by excessive temperatures
   - Road damage
   - Internal rattles caused by damaged catalyst substrate
   - Restrictions
     - **If a condition is found**

       Replace the catalytic converter.

     - **Go to next step: 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.

     - **Go to next step: 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.

     - **Go to next step: If no condition is found**
4. Replace the catalytic converter.

Repair Instructions

- Warm Up Three-Way Catalytic Converter Replacement (LYX) Warm Up Three-Way Catalytic Converter Replacement (LTG)

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- Exhaust Leakage
- Heated Oxygen Sensor Replacement - Sensor 2
- Restricted Exhaust

Repair Verification

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

      Refer to step 5.

    - **Go to next step: 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 Passed 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 No Result is displayed**

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

    - **If Failed is displayed**

      Refer to Circuit /System Testing

    - **Go to next step: If Passed is displayed**
9. All OK.

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

Diagnostic Instructions

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

DTC Descriptor

DTC P0442

Evaporative Emission (EVAP) System Small Leak Detected

Circuit/System Description

The engine off natural vacuum (EONV) test is the small leak detection diagnostic for the evaporative emission (EVAP) system. This diagnostic tests the EVAP system for a small leak when the key is turned OFF and the correct conditions are met. Heat from the exhaust system is transferred into the fuel tank while the vehicle is operating. When the vehicle is turned OFF and the EVAP system is sealed a change in the fuel tank vapor temperature occurs which results in a corresponding pressure change in the fuel tank vapor space. This change is monitored by the engine control module (ECM) using the fuel tank pressure sensor input. With a leak in the system, the amount of pressure change will be less than that of a sealed system.

Conditions for Running the DTC

- DTCs P010B, P012B, P012C, P012D, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P012B, P012C, P012D, P0222, P0223, P0236, P0237, P0238, P0443, P0446, P0449, P0452, P0453, P0455, P0458, P0459, P0461, P0462, P0463, P0496, P0498, P0499, P0502, P0503, P0722, P0723, P111E, P117D, P017C, P017D, P017B, P117B, P117F, P117E, P117C, P2066, P2067, P2068, P1221, P222B, P222C, P222D, P222E, P262B. are not set.
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant sensor (ECT) is greater than 63Â°C (145Â°F)
- The fuel level is between 10 - 90%.
- The start-up engine coolant temperature (ECT) and the start-up intake air temperature (IAT) are within 8Â°C (14Â°F).
- The engine run time before shut-off was greater than 10 min.
- The drive distance before engine shut-off was greater than 5 km (3 mi).
- The ambient air temperature at the end of the drive cycle is between 0 - 34Â°C (32 - 93Â°F).
- DTC P0442 runs once per drive cycle during the hot soak period after the ignition is turned OFF and may require up to 40 min to complete. The control module will not make more than 2 test attempts per day. The time since the last completed engine off natural vacuum test must be at least 17 h if passed or 10 h if failed.

Conditions for Setting the DTC

- The ECM detects a leak in the EVAP system that is greater than a calibrated amount.
- The ECM must complete several engine off natural vacuum tests before the diagnostic can turn the MIL ON or OFF.

Action Taken When the DTC Sets

DTC P0442 is a Type A DTC.

Conditions for Clearing the DTC

DTC P0442 is a Type A DTC.

Diagnostic Aids

- The EVAP system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. When injecting smoke at the service port tool temporarily leave the EVAP Vent Solenoid Valve open until smoke is observed then close the system and continue testing.
- To help locate intermittent leaks using the **GE-41413-A** , move all EVAP components while observing smoke with the **GE-41413-SPT** .
- Individual components can be isolated and tested using adapters in the **GE-41413-300** .
- When servicing the EVAP system, test pressure must not exceed 13 in H20 (0.5 PSI) as pressure in excess of this could cause system components to perform inaccurately.
- A condition may exist where a leak in the EVAP system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the EVAP system and then observe the Fuel Tank Pressure Sensor parameter for vacuum decay.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

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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

Special Tools

- **CH-48096** EVAP Service Port Access Tool
- **GE-41413 - A** Evaporative Emissions System Tester
- **GE-41413 - SPT** High Intensity White Light
- **GE-41413 - 300** EVAP Cap and Plug Kit

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

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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 Not Venting or System Seal with a scan tool to seal the EVAP system.
4. Use the flow meter on the **GE-41413-A** calibrated to 0.51 mm (0.020 in) to determine if there is a leak.
    - **If a leak is detected**

1. Use the **GE-41413-A** to apply smoke to the EVAP system at the purge tube service port until the leak is located using the **GE-41413-SPT** .
    - If leak is detected, repair or replace the affected component as necessary.
- **Go to next step: If no leak is detected**

5. All OK.

Repair Instructions

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

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0443

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit

DTC P0458

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

DTC P0459

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

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

P0443

The ECM detects the EVAP Purge Solenoid Valve control circuit is open within 0.25 s.

P0458

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

P0459

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

Action Taken When the DTC Sets

DTC P0443, P0458 and P0459 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0443, P0458 and P0459 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

1. Ignition ON, verify DTC P0690 is not set.
   - **If the DTC is set**

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

   - **Go to next step: If the DTC is not set**
2. Verify the EVAP Purge Solenoid Valve control circuit status parameters do not display Malfunction while commanding the solenoid from 0% to 50% and back to 0% with a scan tool:
   - EVAP Purge Solenoid Valve Control Circuit Open Test Status
   - EVAP Purge Solenoid Valve Control Circuit Low Voltage Test Status

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

  Refer to Circuit/System Testing

- **Go to next step: If Malfunction is not displayed**

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

     Refer to Circuit/System Testing

   - **Go to next step: 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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing

   - **Go to next step: If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q12 Evaporative Emission Purge Solenoid Valve, ignition ON,
2. Verify that a test lamp illuminates between the ignition voltage circuit terminal 1/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 Ω in the ignition circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp.
   2. Test for infinite resistance between the ignition circuit and ground
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test all components connected to the ignition voltage circuit for a short and replace as necessary.
   - **Go to next step: If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the ignition circuit terminal 1/A and the control circuit terminal 2/B.
   - **If the test lamp illuminates**
   1. Ignition OFF, remove the test lamp, disconnect the appropriate 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.
   - **Go to next step: If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the EVAP Purge Solenoid Valve to 50% with a scan tool.
   - **If OK is not displayed**

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1. Ignition OFF, disconnect the appropriate 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.

- **Go to next step: If OK is displayed**

6. Install a 3 A fused jumper wire between the control circuit terminal 2/B and the ignition circuit terminal 1/A.
7. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the EVAP Purge Solenoid Valve to 50% with a scan tool.
    - **If Malfunction is not displayed**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω replace the K20 Engine Control Module.
    - **Go to next step: If Malfunction is displayed**
8. Test or replace the Q12 Evaporative Emission Purge Solenoid Valve.

Component Testing

Static Test

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

      Replace the Q12 Evaporative Emission Purge Solenoid Valve.

    - **Go to next step: If between 10-30 Ω**
3. All OK.

Dynamic Test

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

      Replace the Q12 Evaporative Emission Purge Solenoid Valve.

    - **Go to next step: If it does turn on & off/clicks and flows vacuum**
4. 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, programming and setup

DTC P0446: EVAPORATIVE EMISSION (EVAP) VENT SYSTEM PERFORMANCE

Diagnostic Instructions

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- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **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 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 P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0121, P0122, P0123, P0128, P0191, P0192, P0193, P0222, P0223, P0443, P0601, P0604, P0606, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2176, are not set.
- The ignition voltage is between 11 - 32 V.
- The barometric pressure (BARO) is more than 70 kPa.
- The fuel level is between 10 - 90%.
- The startup engine coolant temperature (ECT) is less than 35Â°C (95Â°F).
- The startup intake air temperature (IAT) is between 4 - 30Â°C (39 - 86Â°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 L (0.5 gal) of fuel must be consumed before setting the DTC for the second time.

Action Taken When the DTC Sets

DTC P0446 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0446 is a Type B DTC.

Diagnostic Aids

- An intermittent condition could be caused by a damaged EVAP vent housing, a temporary blockage at the EVAP vent solenoid valve inlet, or a pinched vent hose. A blockage in the vent system may also cause a poor fuel fill condition.
- An EVAP canister filter that is restricted can cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

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Powertrain Component Views

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH-41415-30** Fuel Tank Cap Adapter
- **GE-41413-A** Evaporative Emissions System Tester

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

    - **Go to next step: If the DTC is not set**

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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**.

    - **Go to next step: 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.

    - **Go to next step: 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.

    - **Go to next step: 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 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.

    - **Go to next step: If 0 in H2O**

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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.

    - **Go to next step: If the DTC does not set**
9. All OK.

Repair Instructions

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

- **Evaporative Emission Canister Replacement (FWD)** **Evaporative Emission Canister Replacement (AWD)**
- **Evaporative Emission Canister Vent Solenoid Valve Replacement**
- **Fuel Tank Pressure Sensor Replacement (FWD)** **Fuel Tank Pressure Sensor Replacement (AWD)**

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0449

Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit

DTC P0498

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

DTC P0499

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

Diagnostic Fault Information

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

Circuit/System Description

The evaporative emission (EVAP) vent solenoid valve is a normally open valve. Battery voltage is supplied to the EVAP vent solenoid valve through a fuse. The engine control module (ECM) grounds the EVAP vent solenoid valve control circuit through an internal switch called a driver. The evaporative emission (EVAP) vent solenoid valve is a normally open valve. Battery voltage is supplied to the EVAP vent solenoid valve through a fuse. A scan tool will display the commanded state of the EVAP vent solenoid valve as ON (Not Venting) or OFF (Venting).

Conditions for Running the DTC

The DTCs run continuously.

Conditions for Setting the DTC

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P0449

The ECM detects the EVAP Vent Solenoid Valve control circuit is open within 0.25 s.

P0498

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

P0499

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

Action Taken When the DTC Sets

DTC P0449, P0498 and P0499 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0449, P0498 and P0499 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

1. Ignition ON.
2. Verify the EVAP Vent Solenoid Valve control circuit status parameters do not display Malfunction while commanding the solenoid to ON (Not Venting) and OFF (Venting) with a scan tool:
   - EVAP Vent Solenoid Valve Control Circuit Open Test Status
   - EVAP Vent Solenoid Valve Control Circuit Low Voltage Test Status
   - EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status

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- **If Malfunction is displayed**

  Refer to Circuit/System Testing

- **Go to next step: If Malfunction is not displayed**

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

     Refer to Circuit/System Testing

   - **Go to next step: 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

   - **Go to next step: If the DTC does not set**
6. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q13 Evaporative Emission Vent Solenoid Valve, ignition ON.
2. Verify that a test lamp illuminates between the B+ circuit terminal A or 2 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test all components connected to the B+ circuit for a short and replace as necessary.
   - **Go to next step: If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the B+ circuit terminal A or 2 and the control circuit terminal B or 1.
   - **If the test lamp illuminates**
   1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **Go to next step: If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the EVAP Vent Solenoid Valve to ON (Not Venting) with a scan tool.
   - **If OK is not displayed**

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1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
- **Go to next step: If OK is displayed**

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

Component Testing

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

      Replace the Q13 Evaporative Emission Vent Solenoid Valve.

    - **Go to next step: If between 10-30 Ω**
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, programming and setup

DTC P0451, P0452, P0453, OR P0454: FUEL TANK PRESSURE SENSOR PERFORMANCE

Diagnostic Instructions

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

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Fuel Tank Pressure Sensor Circuit High Voltage

DTC P0454

Fuel Tank Pressure Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0452, *	P0451	P0452, *	P0453, *	-
Signal	P0452	P0451	P0452	P0453	P0451, P0454
Low Reference	-	P0446, P0451	P0453, *	-	P0451
* Additional DTCs may set					

Typical Scan Tool Data

Fuel Tank Pressure Sensor Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF **Parameter Normal Range:** 1.3 - 1.7 V			
5 V Reference	0 V	0 V	4.2 - 5 V
Signal	0 V	0 V	5 V
Low Reference	-	4.5 V	-

Circuit/System Description

The fuel tank pressure sensor measures vapor pressure or vacuum in the evaporative emission (EVAP) system. The engine control module (ECM) supplies a 5 V reference and a low reference circuit to the fuel tank pressure sensor. The fuel tank pressure sensor signal voltage varies depending on EVAP system pressure or vacuum. The controller also uses this fuel tank pressure signal to determine atmospheric pressure for use in the engine-off small leak test, DTC P0442. Before using this signal as an atmospheric reference it must first be re-zeroed.

Conditions for Running the DTC

P0451

- DTC P0451 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- The number of times this test runs can range from 0 - 2 per engine-off period. The length of the test can be up to 10 min.

P0452 and P0453

DTC P0452 and P0453 run continuously when the ignition is ON.

P0454

- DTC P0454 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- This test can run once per engine-off period. The length of the test can be up to 10 min.
- A refueling event is not detected. A refueling event is confirmed if the fuel level has a persistent change of 10% for 30 s during a 10 min refueling rationality test.

Conditions for Setting the DTC

P0451

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

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P0452

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

P0453

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

P0454

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

Action Taken When the DTC Sets

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

Diagnostic Aids

P0451 and P0454

- A restriction in the EVAP canister or vent lines could prevent fuel vapor pressure from bleeding off fast enough. If the vent system cannot bleed off pressure fast enough, the re-zero procedure may not complete successfully, which could cause this DTC to set.
- Ensure that the reference port on the fuel tank pressure sensor is unobstructed.
- A fuel tank pressure sensor that is skewed or does not have a linear transition from low to high may cause this DTC to set. Scan tool control functions, snapshot, and plot functions can help detect erratic sensor response. To test the sensor signal under vacuum conditions, use the Quick Snapshot and the Purge/Seal functions to capture data while commanding purge to 20%, then plot the data to look for erratic sensor operation. A similar test can be done for the pressure side of the sensor operation by applying pressure with the **GE-41413-A** while taking a snapshot.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **GE-41413-A** Evaporative Emission System Tester
- **GE-41415-60** Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter

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

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0641, P0651, P0697, P06A3, or P06D2 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Remove the fuel cap or install **GE-41415-60** for capless fuel fill, if equipped.
4. Ignition ON, engine OFF.
5. Verify the scan tool Fuel Tank Pressure sensor parameter is between 1.3 and 1.7 V.
   - **If not between 1.3 - 1.7 V**

     Refer to Circuit/System Testing.

   - **Go to next step: If between 1.3 - 1.7 V**
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.

   - **Go to next step: If the DTC does not set**
8. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, this may take up to 2 min, for all vehicle systems to power down. Disconnect the harness connector at the B150 Fuel Tank Pressure Sensor.
2. Test for less than 5 Ω of resistance between the low reference circuit terminal 2 and ground.
   - **If 5 Ω or greater**
     1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
     2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 3 and ground.

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

- **If greater than 5.2 V**

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

5. Verify the scan tool Fuel Tank Pressure parameter is less than 0.2 V.
    - **If 0.2 V or greater**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit terminal 1 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
        - **Go to next step: If less than 0.2 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3.
7. Verify the scan tool Fuel Tank Pressure sensor parameter is greater than 4.7 V.
    - **If 4.7 V or less**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
        - **Go to next step: 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 (FWD)** **Fuel Tank Pressure Sensor Replacement (AWD)**
- **Control Module References** for control module replacement, programming and setup

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

Diagnostic Instructions

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

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DTC Descriptor

DTC P0455

Evaporative Emission (EVAP) System Large Leak Detected

Circuit/System Description

The engine control module (ECM) tests the evaporative emission (EVAP) system for a large leak or restrictions to the purge path in the EVAP system. When the enabling criteria has been met, the ECM commands the EVAP vent solenoid valve and purge solenoid valve ON, allowing vacuum into the EVAP system. The ECM monitors the fuel tank pressure sensor voltage to verify that the system is able to reach a predetermined level of vacuum within a set amount of time.

Conditions for Running the DTC

- DTCs P00C8, P00C9, P010C, P010D, P16A0, P16A1, P16A2, P160E, P160D, P16F3, P0068, P0101, P0102, P0103, P0111, P0112, P0113, P0114 P0116, P0117, P0118, P0122, P0123, P0125, P0128, P0191, P0192, P0193, P0222, P0223, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0601, P0604, P0606, P0722, P0723, P1104, P1682, P2100, P2101, P2102, P2103, P2135, P2176, P2227, P2228, P2229, P2230 are not set.
- The ignition voltage is between 11 - 32 V.
- The barometric pressure (BARO) is greater than 70 kPa.
- The fuel level is between 10 - 90%.
- The cold startup engine coolant temperature (ECT) and the startup intake air temperature (IAT) are within 8Â°C (14Â°F).
- The startup engine coolant temperature (ECT) is less than 35Â°C (95Â°F).
- The startup intake air temperature (IAT) is between 4 - 34Â°C (39 - 93Â°F).
- DTC P0455 runs once per cold start, shortly after purge is enabled followed by vent system performance test P0446.

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Conditions for Setting the DTC

- The EVAP system is not able to achieve or maintain a calibrated level of vacuum before a calibrated amount of purge volume has passed through the system.
- After setting the DTC for the first time, 2 L (0.5 gal) of fuel must be consumed before setting the DTC for the second time.
- With a DTC P0455 detected a weak vacuum follow-up test (fuel cap replacement test) will run and pass if tank vacuum is greater than 2.74 kPa (11 in H2O). This test will run for a maximum of 21 min. This test runs until it passes.

Action Taken When the DTC Sets

DTC P0455 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0455 is a Type B DTC.

Diagnostic Aids

- Inspect for a loose, missing, damaged, or incorrect fuel fill cap.
- Inspect for a damaged fuel filler neck seal surface.
- A blockage or restriction in the EVAP purge solenoid valve, purge pipe, EVAP canister, or vapor pipe, can cause this DTC to set.
- The EVAP system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. For example, when injecting smoke at the service port remove the fuel fill cap, or temporarily leave the vent open, until smoke is observed, then close the system and continue testing. If using a fuel cap adapter at the filler neck, use the **J-41413-VLV** at the service port to allow the system to fill faster.

- To help locate intermittent leaks using the **GE-41413-A** move all EVAP components while observing smoke with the **GE-41413-SPT** .
- Individual components can be isolated and tested using adapters in the **J-41413-300** .
- When servicing the EVAP system, test pressure must not exceed 13 in H20 (0.5 PSI) as pressure in excess of this could cause system components to perform inaccurately.
- A condition may exist where a leak in the EVAP system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the EVAP system and then observe the fuel tank pressure sensor parameter for vacuum decay.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

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Evaporative Emission Control System Description

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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

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

Circuit/System Testing

NOTE:

- **Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize or**

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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. Ignition ON, command the EVAP Purge/Seal function to Not Venting or System Seal with a scan tool to seal the EVAP system.
4. Verify that there is no leak in the EVAP system using the flow meter on the **GE-41413-A** , calibrated to 0.51 mm (0.020 in).
   - **If a leak is detected**
   1. Apply smoke to the EVAP system at the service access port adapter with the **GE-41413-A** .
   2. Locate the leak using the **GE-41413-SPT** .
      - When the leak is located, repair or replace the affected component as necessary.
   - **Go to next step: If no leak detected**

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

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

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

9. Command the EVAP Purge Solenoid Valve to 10-30% with a scan tool.
10. Verify the vacuum/pressure gauge on the **GE-41413-A** and the scan tool Fuel Tank Pressure Sensor parameter both show vacuum.
    - **If the vacuum/pressure gauge shows vacuum but the Fuel Tank Pressure Sensor parameter does not show vacuum**

      Replace the B150 Fuel Tank Pressure Sensor.

    - **If both do not show vacuum**

      Repair the restriction in the purge path.

    - **Go to next step: If both show vacuum**
11. Verify that the Fuel Tank Pressure Sensor parameter increases to greater than 3.2 V, and the pressure values are similar between the scan tool Fuel Tank Pressure Sensor and the vacuum/pressure gauge on the **GE-41413-A** .
    - **If not within the specified range**

      Replace the B150 Fuel Tank Pressure Sensor.

    - **Go to next step: If within the specified range**
12. All OK

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

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- Fuel Tank Pressure Sensor Replacement (FWD) Fuel Tank Pressure Sensor Replacement (AWD)
- Control Module References for control module replacement, programming and setup.

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

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- 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 sensor to determine if a vacuum is being drawn on the EVAP system. If vacuum in the EVAP system is more than a predetermined value within a predetermined time, this DTC sets.

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

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

Conditions for Running the DTC

- DTCs P00C8, P00C9, P010C, P010D, P16A0, P16A1, P16A2, P160E, P160D, P16F3, P0068, P0101, P0102, P0103, P0111, P0112, P0113, P0114 P0116, P0117, P0118, P0122, P0123, P0125, P0128, P0191, P0192, P0193, P0222, P0223, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0601, P0604, P0606, P0722, P0723, P1104, P1682, P2100, P2101, P2102, P2103, P2135, P2176, P2227, P2228, P2229, P2230 are not set.
- The ignition voltage is between 11 - 32 V.
- The engine OFF time is greater than 8 h,
- The barometric pressure (BARO) is greater than 70 kPa.
- The fuel level is between 10 - 90%.
- The startup engine coolant temperature (ECT) is less than 35Â°C (95Â°F).
- The startup intake air temperature (IAT) is between 4 - 30Â°C (39 - 86Â°F).
- DTC P0496 runs once per cold start, for up to 17 min, when the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0496 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0496 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. 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

   - **Go to next step: If the DTC does not set**
3. All OK

Circuit/System Testing

1. Ignition ON, engine OFF.
2. Seal the EVAP system using the Purge/Seal function with a scan tool.
3. Start the engine.
4. Observe the 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

   - **Go to next step: If within Specifications**
5. All OK

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Repair Instructions

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

Evaporative Emission Canister Purge Solenoid Valve Replacement

DTC P0506 OR P0507: IDLE SPEED LOW OR HIGH

Diagnostic Instructions

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

DTC Descriptors

DTC P0506

Idle Speed Low

DTC P0507

Idle Speed High

Circuit/System Description

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

Conditions for Running the DTC

- DTCs P0068, P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0171, P0172, P0174, P0175, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268. P0270, P0271, P0273, P0274, P0276, P0277, P0300 - P0306, P0351 - P0356, P0461 - P0464, P0496, P0627, P0628, P0629, P0722, P1516, P2066 - P2068, are not set.
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant temperature (ECT) is warmer than 60Â°C (140Â°F).
- The engine run time is greater than 60 s.
- The ignition voltage is between 11 - 32 V.
- The transmission is not changing gears.
- The torque converter clutch (TCC) is not changing states.
- The intake air temperature (IAT) is warmer than -20Â°C (-4Â°F).
- The vehicle speed is less than 3 km/h (2 mph).
- The commanded engine speed is steady within 25 RPM.
- The engine is idling for greater than 5 s.
- The DTCs run when the above conditions are met.

Conditions for Setting the DTC

P0506

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

P0507

The actual engine speed is 188 RPM greater than the desired idle speed for 10 s.

Action Taken When the DTC Sets

DTCs P0506 and P0507 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0506 and P0507 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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Throttle Actuator Control (TAC) System Description

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- **Connector Repairs**
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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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.

   - **Go to next step: If no other DTCs are set**
3. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
   - **If 90 % or greater**

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

   - **Go to next step: If less than 90 %**
4. Engine Idling at the normal operating temperature.
5. Verify the actual Engine Speed is not 100 RPM less than the Desired Idle Speed.
   - **If 100 RPM less than the Desired Idle Speed**

     Refer to Circuit/System Testing.

   - **Go to next step: 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.

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- **Go to next step: If 200 RPM less than the Desired Idle Speed**

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

     Refer to Circuit/System Testing.

   - **Go to next step: 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.

   - **Go to next step: 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.

   - **Go to next step: If a condition is not found**
2. All OK.

Repair Instructions

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

Throttle Body Assembly Replacement

DTC P050D: COLD START ROUGH IDLE

Diagnostic Instructions

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

DTC Descriptor

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DTC P050D

Cold Start Rough Idle

Circuit/System Description

During a cold start, the engine control module (ECM) commands dual-pulse mode during Open Loop operation to improve cold start emissions. In dual-pulse mode, the injectors are energized twice during each injection event. As with misfire diagnosis, in dual-pulse mode the ECM monitors the crankshaft position sensor and the camshaft position sensors to calculate crankshaft rotation speed. In normal operation, optimum fuel delivery during dual-pulse mode produces a steady crankshaft rotation speed. If the variations exceed a calibrated value, the code will be set.

Conditions for Running the DTC

- DTCs P0010, P0011, P0013, P0014, P0020, P0021, P0023, P0024, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101 - P0103, P0106 - P0108, P010B, P010C, P010D, P0112, P0113, P0117, P0118, P0119, P0122, P0123, P0128, P0192, P0193, P0201 - P0204, P0205, P0206, P0207, P0208, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0335, P0336, P0351 - P0354, P0355, P0356, P0357, P0358, P0502, P0503, P0506, P0507, P05CC, P05CD, P05CE, P05CF, P0627, P0628, P0629, P0697, P06A3, P0722, P0723, P0806, P0807, P0808, P111E, P1248, P1249, P124A, P127C, P127D, P124B, P128A, P128B, P128F, P16A0, P16A1, P16A2, P16E4, P16E5, P16F3, P182E, P1824, P182A, P182B, P182C, P182D, P182F, P1838, P1839, P1840, P1841, P18B5, P18B6, P18B7, P18B8, P18B9, P18BA, P18BB, P18BC, P18BD, P18BE, P18BF, P18C0, P18C1, P18C2, P18C3, P1915, P2088, P2089, P2090, P2091, P2092, P2093, P2094, P2095, P2122, P2123, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, P2322 are not set.
- The catalyst temperature is less than 350Â°C (662Â°F).
- The engine coolant temperature is between -15 - 56Â°C (5 - 132.8Â°F).
- The barometric pressure is greater than 76 kPa.
- The engine speed is between 450 - 2200 RPM.
- The accelerator pedal position is less than 110%.
- The engine is running for less than 30 s and a cold start has been detected.
- DTC P050D runs once per cold start.

Conditions for Setting the DTC

This DTC will set if the ECM detects variations in crankshaft rotation speed caused by the lack of adequate fuel delivery during dual-pulse mode.

Action Taken When the DTC Sets

- DTC P050D is a Type B DTC.
- The ECM disables dual pulse mode and energizes the fuel injector as it would for a warm engine.

Conditions for Clearing the DTC

DTC P050D is a Type B DTC.

Diagnostic Aids

- This DTC may be set with a misfire DTC, however the existence of this DTC is a higher priority and indicates the condition to diagnose is related to fuel and/or injectors, not the ignition/spark system.
- A restricted fuel injector may cause this DTC to set.
- High resistance in the circuits of the injectors could set this DTC without setting an injector DTC. Test the injector circuits of the affected cylinders for a high resistance if you suspect a condition.
- A drop in system voltage during cold start may set this DTC.

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Reference Information

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Engine Controls Wiring Schematics 1.5L (LYX)

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Circuit/System Verification requires cold start. Do not start vehicle prior to connecting scan tool and preparing to evaluate the condition during engine crank.**

1. Engine Cranking, start the engine and verify that the scan tool Cylinder 1-4 Current Misfire Counters are not incrementing during first 500 engine cycles.
   - **If Cylinder 1-4 Current Misfire Counters are incrementing**

     Refer to Circuit/System Testing.

   - **Go to next step: If Cylinder 1-4 Current Misfire Counters are not incrementing**
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
3. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
4. All OK.

Circuit/System Testing

1. Verify that the fuel pressure is not too low or too high - Refer to **Fuel System Diagnosis**.
   - **If a condition is found**

     Repair or replace components as necessary

   - **Go to next step: If the fuel pressure is OK**
2. Verify that the fuel is not contaminated - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.

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- **If the fuel is contaminated**

  Clean the fuel system - Refer to **Fuel System Cleaning** .

- **Go to next step: If the fuel is not contaminated**

3. Replace fuel injectors as indicated by high misfire counts.

Repair Instructions

Fuel Injector Replacement

Repair Verification

NOTE: **Repair Verification requires cold start.**

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 s.
5. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to the **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.

DTC P057B, P057C, P057D, OR P057E: BRAKE PEDAL POSITION SENSOR PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P057B

Brake Pedal Position Sensor Performance

DTC P057C

Brake Pedal Position Sensor Circuit Low Voltage

DTC P057D

Brake Pedal Position Sensor Circuit High Voltage

DTC P057E

Brake Pedal Position Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P057C, P0651*	P057C	P0651*	-
Signal	P057C	P057C	P057D	P057B
Low Reference	-	P057D	-	-
* Additional DTCs may set.				

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Typical Scan Tool Data

Brake Pedal Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition=On **Parameter Normal Range:** 0.25 to 4.75 V			
5 V Reference	0 V	0 V	2.2 V
Signal	0 V	0 V	5 V
Low Reference	-	5 V	-

Circuit/System Description

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to ground.
Low Reference	Grounded through the control module.

Component	Description
B22 Brake Pedal Position Sensor	The input voltage varies depending on the position of the sensor.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

The pedal assembly contains 2 potentiometer-type brake pedal position sensors. When the pedal is pressed, the voltage of one sensor goes up and the voltage of the other sensor goes down.

Conditions for Running the DTC

P057B

- DTC P057C, P057D = Not set
- Ignition Voltage = Greater than 10 V
- Shift Lever = Park - At least 1 time(s) during the ignition cycle
- Shift Lever = Not in Park
- Vehicle Speed = Greater than 8 km/h (5 MPH)
- Accelerator Pedal Position = Less than 5%

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

P057C, P057D, P057E

Ignition Voltage = Greater than 10 V

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

Conditions for Setting the DTC

P057B

Brake Pedal Position Sensor = Stuck in range - For greater than 1 s

P057C

Brake Pedal Position Sensor = Less than 0.25 V- For greater than 1 s

P057D

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Brake Pedal Position Sensor = Greater than 4.75 V - For greater than 1 s

P057E

Brake Pedal Position Sensor = Signal noisy or erratic

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify the scan tool parameter:Brake Pedal Position Sensor = 0.26 to 4.74 V
   - **If not between 0.26 and 4.74 V**

     Refer to: Circuit/System Testing

   - **Go to next step: If between 0.26 and 4.74 V**
3. Verify the scan tool parameter:Brake Pedal Position Sensor = The value should change while moving the sensor through the entire range.
   - **If the value does not change**

     Refer to: Circuit/System Testing

   - **Go to next step: If the value changes**
4. Verify the scan tool parameter:Brake Pedal Position Sensor = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector:B22 Brake Pedal Position Sensor
   - Wiggle the harness and connector: K20 Engine Control Module

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- **If the value spikes or drops out**

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

- **Go to next step: If the value does not spike or drop out**

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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

   - **Go to next step: If the DTC is not set**

6. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B22 Brake Pedal Position Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 6 & Ground
   - **If 10 ohms or greater**
   1. Disconnect the appropriate electrical connector: K20 Engine Control Module
   2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 6 @Component harness & The other end of the circuit@ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component:K20 Engine Control Module
   - **Go to next step: If less than 10 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 5 & Low Reference circuit terminal 6
   - **If less than 4.8 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the appropriate electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 5 @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 ohms between the test points: 5 V Reference circuit terminal 5 @ Component harness & The other end of the circuit@ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component:K20 Engine Control Module
   - **If greater than 5.2 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the appropriate electrical connector: K20 Engine Control Module
   3. Ignition - On / Vehicle - In Service Mode
   4. Test for less than 1 V between the test points:5 V Reference circuit terminal 5 @Component harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - If less than 1 V - Replace the component:K20 Engine Control Module

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- **Go to next step: If between 4.8 and 5.2 V**

6. Verify the scan tool parameter:Brake Pedal Position Sensor = Less than 0.25 V
    - **If 0.25 or greater**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Ignition - On / Vehicle - In Service Mode
    4. Test for less than 1 V between the test points:Signal circuit terminal 4 @Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component:K20 Engine Control Module
    - **Go to next step: If less than 0.25 V**
7. Connect a 3 A fused jumper wire between the test points:Signal circuit terminal 4 & 5 V Reference circuit terminal 5
8. Verify the scan tool parameter:Brake Pedal Position Sensor = Greater than 4.8 V
    - **If 4.8 V or less**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the appropriate electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points:Signal circuit terminal 4 @Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance
    4. Test for less than 2 ohms between the test points:Signal circuit terminal 4 @Component harness & The other end of the circuit@Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component:K20 Engine Control Module
    - **Go to next step: If greater than 4.8 V**
9. Test or replace the component:B22 Brake Pedal Position Sensor

Repair Instructions

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

- **Brake Pedal Position Sensor Replacement**
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P0601, P0602, P0603, P0604, P0606, P062B, P062F, P0630, P16F3, OR P262B: CONTROL MODULE PERFORMANCE

Diagnostic Instructions

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

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DTC P0604

Control Module Random Access Memory Performance

DTC P0606

Control Module Processor Performance

DTC P062B

Control Module Fuel Injector Control Performance

DTC P062F

Control Module Long Term Memory Performance

DTC P0630

VIN Not Programmed or Mismatched - Engine Control Module (ECM)

DTC P16F3

Control Module Redundant Memory Performance

DTC P262B

Control Module Power Off Timer Performance

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the ECM. This diagnostic also addresses if the ECM is not programmed.

Conditions for Running the DTCs

P0601, P0602, P0630

These DTCs run continuously when the ignition is in ON.

P0603, P062F

These DTCs run once per ignition cycle.

P0604

DTC P0604 runs continuously when the ignition is ON for greater than 30 s.

P0606, P062B

These DTCs run continuously when Ignition 1 Signal voltage is greater than 11 V.

P16F3

- The engine speed is greater than 680 RPM.
- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P2227, P2228, P2229, or P2230 are not set.
- DTC P16F3 runs continuously when the above conditions are met.

P262B

DTC P262B runs during ECM power down.

Conditions for Setting the DTCs

The ECM detects an internal failure or incomplete programming for more than 10 s.

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Actions Taken When the DTC Sets

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P0630, and P16F3 are Type A DTCs.
- DTC P262B is a Type B DTC.
- DTC P062F is a Type C DTC.

Conditions for Clearing the MIL/DTC

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P0630, and P16F3 are Type A DTCs.
- DTC P262B is a Type B DTC.
- DTC P062F is a Type C DTC.

Diagnostic Aids

- A disconnected Camshaft Position Sensor could set DTC P0606 and may cause a no crank condition.
- 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

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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 P0602 or P0630 is not set.
   - **If any of the DTCs are set**

   1. Program the K20 Engine Control Module. Refer to **Control Module References** .
   2. Verify DTC P0602 or P0630 is not set.
      - If any of the DTCs are set, replace the K20 Engine Control Module.

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- If none of the DTCs are set

3. All OK.
- **Go to next step: If none of the DTCs are set**

3. Verify DTC P0601, P0603, P0604, P0606, P062B, P062F, P16F3, or P262B is not set.
- **If any of the DTCs are set**

  Replace the K20 Engine Control Module.

- **Go to next step: 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 engine control module replacement, programming and setup.

DTC P0627, P0628, OR P0629: FUEL PUMP ENABLE CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P0627

Fuel Pump Enable Circuit

DTC P0628

Fuel Pump Enable Circuit Low Voltage

DTC P0629

Fuel Pump Enable Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0628, P12A6	P0506, P0627, P0629, P12A6	P0627, P0629, P12A6	P12A6

Circuit/System Description

The engine control module (ECM) provides ignition voltage to the fuel pump driver control module whenever the engine is cranking or running. The ECM enables the fuel pump driver control module as long as the engine is cranking or running, and ignition system reference pulses are received. While this enable voltage is being received, the fuel pump driver control module supplies a varying voltage to the in-tank fuel pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC

- The engine speed is greater than 0 RPM.
- The ignition voltage is greater than or equal to 11 V.
- The fuel pump enable circuit is commanded ON.

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 2.5 s.

Action Taken When the DTC Sets

DTCs P0627, P0628, and P0629 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0627, P0628, and P0629 are Type B DTCs.

Diagnostic Aids

An open in the fuel pump driver control module ground circuit may set DTCs P0627 and P0629.

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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 that DTC P0627, P0628, or P0629 is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If a DTC is not set**
3. Verify the parameters listed below do not display Malfunction when commanding the Fuel Pump Enable On and Off with a scan tool.
   - Fuel Pump Enable Circuit Low Voltage Test Status
   - Fuel Pump Enable Circuit Open Test Status
   - Fuel Pump Enable Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

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- **Go to next step: 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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the K111 Fuel Pump Driver Control Module harness connector.
2. Ignition ON for 10 s.
3. Verify that a test lamp does not illuminate between the control circuit terminal 2 and ground.
   - **If the test lamp illuminates**
   1. Ignition OFF, remove the test lamp, disconnect the 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.
   - **Go to next step: 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.
   - **Go to next step: If OK is displayed**
6. Install a 3 A fused jumper wire between the control circuit terminal 2 and ground.
7. Verify the scan tool Fuel Pump Enable Circuit Low Voltage Test Status parameter is Malfunction when commanding the Fuel Pump Enable On with a scan tool.
   - **If Malfunction is not displayed**
   1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If Malfunction is displayed**
8. Test or replace the K111 Fuel Pump Driver Control Module.

Repair Instructions

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

- **Fuel Pump Power Control Module Replacement (FWD)** **Fuel Pump Power Control Module Replacement (AWD)**
- **Control Module References** for control module replacement, programming and setup.

DTC P0641, P0651, P0697, P06A3, OR P06D2: 5V REFERENCE CIRCUIT

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Diagnostic Instructions

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

DTC Descriptors

DTC P0641

5V Reference 1 Circuit

DTC P0651

5V Reference 2 Circuit

DTC P0697

5V Reference 3 Circuit

DTC P06A3

5V Reference 4 Circuit

DTC P06D2

5V Reference 5 Circuit

Circuit/System Description

The engine control module (ECM) has 5 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.

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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, P06A3, and P06D2 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0641, P0651, P0697, P06A3, and P06D2 are Type A DTCs.

Diagnostic Aids

The 5V reference 1 circuit provides 5 V to the sensors listed below:

- Air conditioning (A/C) refrigerant pressure sensor
- Exhaust and intake camshaft position sensors
- Manifold absolute pressure/air temperature sensor
- Fuel pressure sensor

The 5V reference 2 circuit provides 5 V to the sensors listed below:

- Engine oil pressure sensor
- Crankshaft position sensor

- Brake pedal position sensor
- Brake booster vacuum sensor
- Turbocharger boost sensor

The 5V reference 3 circuit provides 5 V to the accelerator pedal position sensor 2.

The 5V reference 4 circuit provides 5 V to the sensors listed below:

- Accelerator pedal position sensor 1
- Throttle position sensor

The 5V reference 5 circuit provides 5 V to the sensors listed below:

- Fuel rail pressure sensor
- Multifunction intake air sensor
- Fuel tank pressure sensor

Disconnecting one component at a time from the affected 5V reference circuit while observing the scan tool 5V Reference Circuit Status parameter may help locate the fault. The scan tool parameter will change from Malfunction to OK when the source of the fault is disconnected. If all 5V reference components have been disconnected and a fault is still indicated, the fault may exist in the wiring harness.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify scan tool 5V Reference 1-5 Circuit Status parameters do not display Malfunction.
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing.

    - **Go to next step: If Malfunction is not displayed**

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

      Refer to Circuit/System Testing.

    - **Go to next step: If the DTC does not set**
5. All OK.

Circuit/System Testing

NOTE: **Additional DTCs will set when disconnecting the components.**

1. Ignition OFF, disconnect the harness connector at all appropriate sensors for the applicable DTC. Refer to Diagnostic Aids.
2. Ignition ON.
3. Test for 4.8 - 5.2 V between one of the 5V reference circuits and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5V reference circuit for each applicable component and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
    2. Test for less than 1 V between the 5V reference circuit for each applicable component and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: 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, 4, or 5 Circuit Status parameter displays OK while connecting each component associated with the 5V reference circuit one at a time.
    - **If OK is not displayed when a component is connected**

      Test the signal circuit of the component for a short to ground or voltage. If the circuit tests normal, replace the component.

    - **Go to next step: If OK is displayed after all components have been connected**
5. All OK.

Repair Instructions

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

- **Air Conditioning Cycling and Fan Control Refrigerant Pressure Sensor Replacement**
- **Camshaft Position Sensor Replacement - Exhaust**
- **Camshaft Position Sensor Replacement - Intake**
- **Intake Air Pressure and Temperature Sensor Replacement**
- **Engine Oil Pressure Sensor Replacement**
- **Crankshaft Position Sensor Replacement (FWD)** **Crankshaft Position Sensor Replacement (AWD)**

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- Brake Pedal Position Sensor Replacement
- Power Brake Booster Vacuum Pipe Replacement (LYX)
- Accelerator Pedal Assembly Replacement
- Throttle Body Assembly Replacement
- Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement
- Intake Air Pressure and Temperature Sensor Replacement for turbocharger boost/intake air temperature sensor replacement.
- Control Module References for engine control module replacement, programming, and setup.

DTC P0650, P263A, OR P263B: MALFUNCTION INDICATOR LAMP (MIL) CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P0650

Malfunction Indicator Lamp (MIL) Control Circuit

DTC P263A

Malfunction Indicator Lamp (MIL) Control Circuit Low Voltage

DTC P263B

Malfunction Indicator Lamp (MIL) Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0650	P0650	-	-
Control	P0650, P263A*	P0650, P263A	P263B	-
* The MIL remains ON				

Circuit/System Description

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

Conditions for Running the DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 11 - 32 V.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P0650 or DTC P263A

The ECM detects low voltage during the MIL control circuit driver OFF state. This indicates either a shorted to ground or an open MIL control circuit.

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DTC P263B

The ECM detects high voltage on the MIL control circuit during the driver ON state. This indicates a shorted to voltage MIL control circuit.

Action Taken When the DTC Sets

DTC P0650, P263A, and P263B are Type B DTCs.

Conditions for Clearing the DTC

DTC P0650, P263A, and P263B are Type B DTCs.

Diagnostic Aids

- If the condition is intermittent, move the related harnesses and connectors while monitoring the scan tool MIL control circuit status parameters. Perform this test with the ignition ON and the engine OFF, and with the engine running. The MIL control circuit status parameters change from OK or Not Run to Malfunction if there is a condition with a circuit or a connection.
- If the ECM detects low voltage on the MIL control circuit during the control circuit driver OFF state, DTCs P0650 and DTC P263A may set simultaneously.

Reference Information

Schematic Reference

- **Engine Controls Wiring Schematics**
- **Instrument Cluster Wiring Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - The MIL Control Circuit Low Voltage Test Status
    - The MIL Control Circuit Open Test Status
    - The MIL Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing.

    - **Go to next step: If Malfunction is not displayed**
3. Engine running.

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4. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - The MIL Control Circuit Low Voltage Test Status
    - The MIL Control Circuit Open Test Status
    - The MIL Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing.

    - **Go to next step: If Malfunction is not displayed**
5. Verify the malfunction indicator lamp turns ON and OFF when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - **If the malfunction indicator lamp does not turn ON and OFF**

      Refer to Circuit/System Testing.

    - **Go to next step: If the malfunction indicator lamp turns ON and OFF**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
    - **If the DTC sets**

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

    - **Go to next step: If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Ignition OFF.
2. Disconnect the X1 harness connector at the K20 Engine Control Module.
3. Ignition ON, verify the malfunction indicator lamp does not illuminate.
    - **If the malfunction indicator lamp illuminates**
    1. Test for infinite resistance between the control circuit terminal X1 71 and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance, replace the P16 Instrument Cluster.
    - **Go to next step: If the malfunction indicator lamp does not illuminate**
4. Connect a 3 A fused jumper wire between the control circuit terminal X1 71 and ground.
5. Verify the malfunction indicator lamp illuminates.
    - **If the malfunction indicator lamp illuminates**

      Replace the K20 Engine Control Module.

    - **If the malfunction indicator lamp does not illuminate**
    1. Test for less than 1 V between the control circuit terminal X1 71 and ground.
        - If 1 V or greater, repair the short to voltage in the circuit.
        - If less than 1 V
    2. Ignition OFF.
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω.
6. Ignition OFF, disconnect the harness connector at the instrument cluster.
7. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal 8 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.

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2. Test for infinite resistance between the ignition voltage circuit and ground.
    - If less than infinite resistance, repair the short to ground in the circuit.
- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.
2. Test for less than 2 Ω in the ignition voltage circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
- **Go to next step: If the test lamp illuminates**

8. Replace the P16 Instrument Cluster.

Repair Instructions

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

- **Instrument Cluster Replacement (Equinox)** **Instrument Cluster Replacement (Terrain)**
- **Control Module References** for control module replacement, programming, and setup

DTC P0685, P0686, P0687, P0689, P0690, OR P1682: ENGINE CONTROLS IGNITION RELAY CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC 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

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ - Relay Coil	P0689, P1682	P0685, P0689, P1682, P16A7, P16AF	-	-

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ - Relay Switch	P0689, P1682	P0685, P0689, P1682, P16A7, P16AF	-	-
Control - Component	P0689, P1682	P0689, P1682, P16A7, P16AF	P0690, P16B3	-
Control - Relay Coil	P0686, P0690	P0685, P0689, P1682, P16A7, P16AF	P0685, P0687, P0689, P1682*	-
* Internal control module or component damage may occur if the circuit shorts to B+.				

Circuit/System Description

Circuit	Description
B+ - Relay Coil	Supplied directly from the battery.
B+ - Relay Switch	Supplied directly from the battery.
Control - Component	The output circuit is switched to 12 V to activate the component.
Control - Relay Coil	The output circuit is switched to ground to activate the component.

Components

Component	Description
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
KR75 Engine Controls Ignition Relay	Relays are used to control a high power circuit with a low power signal.

4 ignition voltage circuits supply the ECM. The 4 circuits are supplied by 2 relay(s):

- KR73 Ignition Main Relay
- KR75 Engine Controls Ignition Relay

The ECM monitors and compares the voltages supplied by the relay(s).

Conditions for Running the DTC

P0685, P0686, P0687

Ignition Voltage = Greater than 11 V

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

P0689

- Ignition Voltage = Greater than 9 V
- Engine Controls Ignition Relay Command = On

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

P0690

- DTC P0685 = Not set
- Engine Controls Ignition Relay Command = Off - For greater than 2 s

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

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P1682

- Engine Controls Ignition Relay Command = On
- Ignition Voltage = Greater than 5.5 V

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

Conditions for Setting the DTC

P0685, P0686, P0687

Commanded state does not match the actual state - For greater than 2 s

P0689

Engine Controls Ignition Relay Feedback Circuit = Less than 5 V - For greater than 5 s

P0690

Engine Controls Ignition Relay Feedback Circuit = Greater than 4 V - For greater than 5 s

P1682

The following parameters are not within 3 V of each other:

- Ignition 1 Signal
- Engine Controls Ignition Relay Feedback Signal
- Engine Controls Ignition Relay Feedback 2 Signal

Actions Taken When the DTC Sets

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

DTC P1682 = Type A DTC

Conditions for Clearing the DTC

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

DTC P1682 = Type A DTC

Diagnostic Aids

If the condition is intermittent, wiggle the related wiring harnesses and connectors, with the ignition/vehicle on or engine running, while monitoring the scan tool circuit status parameters for the component. The parameters will display if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

- **Engine Controls Wiring Schematics 1.5L (LYX)**
- Power Distribution Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Electrical Center Identification Views**

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- Relay Replacement (Attached to Wire Harness) Relay Replacement (Within an Electrical Center)
- 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 / Vehicle - In Service Mode
2. Verify DTC P0685, P0686, P0687, P0689, P0690, P1682 is not set.
   - **If DTC P0685, P0686, P0687, P0689, P0690, P1682 is set**

     Refer to: Circuit/System Testing

   - **Go to next step: If none of the DTCs are set**
3. Ignition/Vehicle - Cycle On and Off

   Verify the component produces a clicking sound:KR75 Engine Controls Ignition Relay

   - **If the component does not produce a sound**

     Refer to: Circuit/System Testing

   - **Go to next step: If the component produces a sound**
4. Verify the following parameters are within 3 V of each other:
   - Ignition 1 Signal
   - Engine Controls Ignition Relay Feedback Signal
   - **If not within 3 V of each other**

     Refer to: Circuit/System Testing

   - **Go to next step: If within 3 V of each other**
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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

   - **Go to next step: If the DTC is not set**
6. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Remove the component:KR75 Engine Controls Ignition Relay
3. Verify a test lamp turns On between the test points:
   - B+ circuit terminal 3 & Ground
   - B+ circuit terminal 1 & Ground
   - **If the test lamp does not turn On**

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Replace the component:X50A Fuse Block - Underhood

- **Go to next step: If the test lamp turns On**

4. Ignition - On / Vehicle - In Service Mode
5. Connect a test lamp between the test points:Control circuit terminal 2 & B+ circuit
6. Perform the scan tool control function:Engine Controls Ignition Relay - On and Off

   Verify the test lamp turns On and Off.

   - **If the test lamp is always Off**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Disconnect the electrical connector:X1 @ K20 Engine Control Module
   3. Ignition - On / Vehicle - In Service Mode
   4. Test for less than 1 V between the test points: Control circuit terminal 2 @ Relay Socket & Terminal 67 @ Control module harness
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - If less than 1 V
   5. Ignition/Vehicle - Off
   6. Test for less than 2 ohms between the test points:Control circuit terminal 2 @Relay Socket & Terminal 67 @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component:K20 Engine Control Module
   - **If the test lamp is always On**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Disconnect the electrical connector:X1 @ K20 Engine Control Module
   3. Test for infinite resistance between the test points:Control circuit terminal 2 @ Relay Socket & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance - Replace the component:K20 Engine Control Module
   - **Go to next step: If the test lamp turns On and Off**
7. Verify the fuse is not open:
   - F14UA Fuse
   - F20UA Fuse
   - **If the fuse is open**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X1 @ K20 Engine Control Module
   3. Test for infinite resistance between the test points:Output terminal @ F20UA Fuse & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance - Replace the component: K20 Engine Control Module
8. Disconnect the electrical connector: X3 @ K20 Engine Control Module
9. Test for infinite resistance between the test points:Output terminal @ F14UAFuse & Ground
   - If less than infinite resistance - Repair the short to ground on the circuit.
   - If infinite resistance - Replace the component: K20 Engine Control Module
   - **Go to next step: If the fuse is not open**
10. Ignition - On / Vehicle - In Service Mode
11. Verify a test lamp does not turn On between the test points:Control circuit terminal 2 & Ground
    - **Go to next step: If the test lamp turns On**
12. Disconnect the electrical connector: X1 & X3 @ K20 Engine Control Module
13. Test for less than 1 V between the test points:
    - Control circuit terminal 73 @ Control module harness & Ground

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- Control circuit terminal 16 @ Control module harness & Ground
- **If 1 V or greater**

  Repair the short to voltage on the circuit.

- **Go to next step: If less than 1 V**
- **Go to next step: If the test lamp does not turn On**

14. Ignition/Vehicle - Off
15. Connect a 30 A fused jumper wire between the test points:Control circuit terminal 5 & B+ circuit terminal 3
16. Ignition - On / Vehicle - In Service Mode
17. Verify the scan tool parameter:Engine Controls Ignition Relay Feedback Signal = Within 1 V of the battery voltage
    - **If not within 1 V of the battery voltage**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the electrical connector: X1 & X3 @ K20 Engine Control Module
    3. Test for less than 2 ohms between the test points:
        - Control circuit terminal 5 @Relay Socket & Control circuit terminal 73 @ Control module harness
        - Control circuit terminal 5 @Relay Socket & Control circuit terminal 16 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K20 Engine Control Module
    - **Go to next step: If within 1 V of the battery voltage**
18. Test or replace the component:KR75 Engine Controls Ignition Relay

Component Testing

Relay Test

1. Ignition/Vehicle - Off
2. Remove the component:KR75 Engine Controls Ignition Relay
3. Test for 70 to 110 ohms between the test points:B+ circuit terminal 1 & Control circuit terminal 2
    - **If not between 70 and 110 ohms**

      Replace the component:KR75 Engine Controls Ignition Relay

    - **Go to next step: If between 70 and 110 ohms**
4. Test for infinite resistance between the test points:
    - Component terminal 3 & 1
    - Component terminal 3 & 2
    - Component terminal 3 & 5
    - Component terminal 1 & 5
    - **If less than infinite resistance**

      Replace the component:KR75 Engine Controls Ignition Relay

    - **Go to next step: If infinite resistance**
5. Connect a 3 A fused jumper wire between the test points:B+ circuit terminal 1 & B+

   Connect a jumper wire between the test points:Control circuit terminal 2 & Ground

6. Test for less than 2 ohms between the test points:Control circuit terminal 5 & B+ circuit terminal 3
    - **If 2 ohms or greater**

      Replace the component:KR75 Engine Controls Ignition Relay

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- **Go to next step: If less than 2 ohms**

7. All OK.

Repair Instructions

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

- **Engine Wiring Harness Junction Block Replacement**
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P0700: TRANSMISSION CONTROL MODULE REQUESTED MIL ILLUMINATION

Diagnostic Instructions

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

The Transmission Control Module (TCM) constantly monitors the transmission system for any condition which may adversely affect vehicle emissions. If a condition is detected, the TCM sets a DTC and sends a serial data message to the ECM. The ECM sets DTC P0700 to inform the technician that the TCM has set the emission related DTC. The serial data message sent by the TCM also contains a request for the ECM to illuminate the Malfunction Indicator Lamp (MIL)

The technician can observe the DTC that was set by the TCM by reviewing the ECM Freeze Frame records on the scan tool. The ECM Freeze Frame records also contain the engine operating conditions present when the transmission DTC set.

Conditions for Running the DTC

- The ignition is ON or the engine is running.
- DTC P0700 runs continuously.

Conditions for Setting the DTC

The ECM receives a serial data message from the TCM indicating that an emission related DTC has set in the TCM.

Action Taken When the DTC Sets

DTC P0700 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P0700 is a Type A DTC.

Diagnostic Aids

Communication codes, U-codes, as well as powertrain codes, P-codes, set in the TCM can cause the TCM to request DTC P0700 to be set in the ECM.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

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

1. Verify there are no engine control or communication DTCs set.
   - **If a DTC is set**

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

   - **Go to next step: 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** .

   - **Go to next step: 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** .

   - **Go to next step: If the DTC does not set**
5. All OK.

Repair Instructions

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

DTC C1201, P1000, P1001, P1003, P1008, P1009, P100A, P100E, P103D, P103E, P10B6-P10B9, P10BF, P10C6-P10C8, P10F5, P1100, P1103, P117A, P11FF, P1200, P128C-P128F, P129E, P12A8, P130F, P135C-P135F, P1436, P143A, P143B, P1472, P14A0, P14B6, P14BD, P14CD, P14CE, P14D4-P14D6, P150C, P151A, P151D, P153C, P153D, P155D, P1591, P15E2, P15F2, P15F9, P15FA, P15FB, P165C, P167F, P16E8, P16FF, P175F, P1761, P1762, P1775, P179B, P189C, P2544, P308D, P30B4, P30B5, P30BC, P30BD, P30D5, P30DE, P3168, P3169, OR P316B: SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

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

DTC Descriptor

DTC C1201

Transmission Range Redundant Command Message Counter Incorrect

DTC P1000

Fuel Pump Driver Control Module Reset Count Message Counter Incorrect

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DTC P1001

Evaporative Emission (EVAP) System Signals Message Counter Incorrect

DTC P1003

Fuel Composition Signals Message Counter Incorrect

DTC P1008

Engine Coolant Bypass Valve Command Signal Message Counter Incorrect

DTC P1009

Fuel Pump Driver Control Module Temperature High Signal Message Counter Incorrect

DTC P100A

Turbocharger Boost Control Signal Message Counter Incorrect

DTC P100E

Accelerator Pedal Position Signal Message Counter Incorrect

DTC P103D

Engine Coolant Pump Control Signal Message Counter Incorrect

DTC P103E

Auxiliary Coolant Pump Control Signal Message Counter Incorrect

DTC P10B6

Mass Air Flow Sensor Intake Air Signals Message Counter Incorrect Bank 1

DTC P10B7

Mass Air Flow Sensor Intake Air Signals Message Counter Incorrect Bank 2

DTC P10B8

Mass Air Flow Sensor Barometric Pressure Sensor Signal Message Counter Incorrect Bank 2

DTC P10B9

Mass Air Flow Sensor Barometric Pressure Sensor Signal Message Counter Incorrect Bank 1

DTC P10BF

Engine Coolant Bypass Valve Secondary Command Signal Message Counter Incorrect

DTC P10C6

Engine Diagnostic Status Signal Message Counter Incorrect

DTC P10C7

Reductant Control System Signal Message Counter Incorrect

DTC P10C8

Reductant Temperature Signal Message Counter Incorrect

DTC P10F5

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EVAP Purge Pump Status Message Counter Incorrect

DTC P1100

Fuel Level Sensor 2 Signal Message Counter Incorrect

DTC P1103

Water in Fuel Signal Message Counter Incorrect

DTC P117A

Engine Block Coolant Valve Signal Message Counter Incorrect

DTC P11FF

Fuel Pump Command Signal Message Counter Incorrect

DTC P1200

Fuel Level Sensor 1 Signal Message Counter Incorrect

DTC P128C

Fuel Rail Temperature Sensor 1 Signal Message Counter Incorrect

DTC P128D

Fuel Rail Temperature Sensor 2 Signal Message Counter Incorrect

DTC P128F

Fuel Rail Pressure Sensors 1 and 2 Signals Message Counter Incorrect

DTC P129E

Fuel Pump Driver Control Module Signal Message Counter Incorrect

DTC P12A8

Fuel Pump Control Status Signal Message Counter Incorrect

DTC P130F

Ignition On/Start Voltage Signal Message Counter Incorrect

DTC P135C

Cooling Fan 1 Status Signals Message Counter Incorrect

DTC P135D

Cooling Fan 2 Status Signals Message Counter Incorrect

DTC P135E

Cooling Fan 3 Status Signals Message Counter Incorrect

DTC P135F

Cooling Fan 4 Status Signals Message Counter Incorrect

DTC P1436

Particulate Matter Sensor Control Module Temperature Signal Message Counter Incorrect

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DTC P143A

Reductant Control System Diagnostic Signal Message Counter Incorrect

DTC P143B

Reductant Control System Information Signal Message Counter Incorrect

DTC P1472

Particulate Matter Sensor Signal Message Counter Incorrect

DTC P14A0

Charge Air Cooler Coolant Pump Status Signal Message Counter Incorrect

DTC P14B6

Mass Air Flow Sensor Signal Message Counter Incorrect

DTC P14BD

Mass Air Flow Sensor Signal Message Counter Incorrect Bank 2

DTC P14CD

Fuel Pump Driver Control Module Configuration Command Signal 1 Message Counter Incorrect

DTC P14CE

Fuel Pump Driver Control Module Configuration Status Signal Message Counter Incorrect

DTC P14D4

Fuel Pump Driver Control Module Configuration Command Signal 2 Message Counter Incorrect

DTC P14D5

Fuel Pump Driver Control Module Configuration Command Signal 3 Message Counter Incorrect

DTC P14D6

Fuel Pump Driver Control Module Configuration Command Signal 5 Message Counter Incorrect

DTC P150C

Transmission Control Module Engine Speed Request Signal Message Counter Incorrect

DTC P151A

Throttle Actuator Control (TAC) Signal Message Counter Incorrect

DTC P151D

Transmission Control Module Engine Shutdown Request Signal Message Counter Incorrect

DTC P153C

Engine Speed Signal Message Counter Incorrect

DTC P153D

Driver Torque Request Signal Message Counter Incorrect

DTC P155D

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Hill Descent Control Message Counter Incorrect

DTC P1591

Body Control Module Engine Speed Request Signal Message Counter Incorrect

DTC P15E2

Alternative Fuel System Request Signal Message Counter Incorrect

DTC P15F2

Engine Torque Command Signal Message Counter Incorrect

DTC P15F9

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

DTC P15FA

Wheel Slip Status Signal Message Counter Incorrect

DTC P15FB

Brake Pedal Position Sensor Signal Message Counter Incorrect

DTC P165C

Sensor Reference Voltage Status Message Counter Incorrect

DTC P167F

Battery Voltage Signal Message Counter Incorrect

DTC P16E8

Engine Controls Ignition Relay Signal Message Counter Incorrect

DTC P16FF

Engine Controls Ignition Relay Request Signal Message Counter Incorrect

DTC P175F

Acceleration Sensor Signal Message Counter Incorrect

DTC P1761

Up and Down Shift Switch Signal Message Counter Incorrect

DTC P1762

Transmission Mode Switch Signal Message Counter Incorrect

DTC P1775

Transmission Range Request Signal Message Counter Incorrect

DTC P179B

Transmission Range State Command Signal Message Counter Incorrect

DTC P189C

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Transmission Range Command Message Performance

DTC P2544

Transmission Torque Request Signal Message Counter Incorrect

DTC P30B4

NOx Sensor 1 Signal Message Counter Incorrect

DTC P30B5

NOx Sensor 2 Signal Message Counter Incorrect

DTC P30BC

Particulate Matter Sensor Control Module Status Signal Message Counter Incorrect

DTC P30BD

Engine Stall Prevention Active Signal Message Counter Incorrect

DTC P30D5

NOx Sensor 3 Signal Message Counter Incorrect

DTC P30DE

Fuel Rail Pressure Sensor 2 Signal Message Counter Incorrect

DTC P3168

Fuel Injector Set 2 Commands Signal Message Counter Incorrect

DTC P3169

Fuel Injector Control Module Commands Signal Message Counter Incorrect

DTC P316B

Secondary Fuel System Requests Signal Message Counter Incorrect

Circuit/System Description

Control modules connected to the serial data circuits monitor the communication during normal vehicle operation. Operating information and commands are exchanged among the control modules. Each module on the serial data circuit maintains a transmit error counter and a receive error counter. The counter values increase with detected errors and decrease with error-free messages.

Conditions for Running the DTC

- Ignition = On - For greater than 3 s
- Serial Data = Enabled

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

Conditions for Setting the DTC

Serial Data = Message Counter Incorrect - Control module that has set the DTC

The above condition(s) must occur 5 times.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type C DTC

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Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type C DTC

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following system/component:Serial Data
   - **If a related DTC is set**

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

   - **Go to next step: If a related DTC is not set**
3. Clear the DTCs.
4. Operate the vehicle within the Conditions for Running the DTC.

   Verify the DTC does not set.

   - **If the DTC sets**
   1. Ignition/Vehicle - Off
   2. Replace the component:The control module that is sending the error message.
   3. Operate the vehicle within the Conditions for Running the DTC.

      Verify the DTC does not set.

      - If the DTC sets

        Replace the component: Control module that has set the DTC

      - If the DTC does not set
   4. All OK.
   - **Go to next step: If the DTC does not set**
5. All OK.

Repair Instructions

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

For control module replacement, programming, and setup refer to: **Control Module References**

DTC P111E: ENGINE COOLANT TEMPERATURE SENSOR NOT PLAUSIBLE

Diagnostic Instructions

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

DTC Descriptor

DTC P111E

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Engine Coolant Temperature Sensor Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Signal	P0117	P0118	P0118	P0118	P0128, P111E
Low Reference	-	P0118	P0118	-	P0128

Typical Scan Tool Data

ECT Sensor Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** -39 to +120Â°C (-38 to +248Â°F)			
ECT Sensor	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)

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 5V to the ECT sensor signal circuit and a ground for the low reference circuit.

The purpose of this diagnostic is to determine if the input from the ECT sensor is skewed warmer than normal. The internal clock of the ECM will record the amount of time the engine is OFF. If the required engine OFF time is met at start-up, the ECM will compare the temperature difference between the actual measured ECT and a calibrated ECT model. The information for this model is derived from the previous drive cycle and includes the accumulated mass air flow (MAF), the engine run time, the ambient air temperature and the ECT at the end of the drive cycle.

If the ECM detects that the temperature difference between the measured and modeled ECT is not within an acceptable operating range of each other, then the ECM will continue to run this diagnostic to determine if a block heater was active during the engine OFF time.

Conditions for Running the DTC

- DTCs P0111, P0112, P0113, P0114, P0117, P0118, P0128, P0502, P0503, P0601, P1621, or P2610 are not set.
- The vehicle has had a minimum ignition OFF time of 8 hours.
- The engine is running.
- The start-up modeled ECT is colder than 50Â°C (+122Â°F).
- The previous accumulated MAF is greater than 6, 000 grams.
- The previous engine run time is greater than 600 seconds.

OR

- The vehicle has had a minimum ignition OFF time of 8 hours.
- The engine is running.
- The previous ECT at engine shutdown is warmer than 75Â°C (+167Â°F).
- The previous accumulated MAF is greater than 6, 000 grams.
- The previous engine run time is greater than 600 seconds.
- This DTC runs once per ignition cycle within the enabling conditions.

Conditions for Setting the DTC

P111E

The ECM detects a temperature difference at initial power-up that indicates that the actual measured ECT is 10Â°C (18Â°F) greater than the modeled ECT, and an active block heater has not been detected.

Action Taken When the DTC Sets

DTC P111E is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P111E is a Type B DTC.

Diagnostic Aids

- Engine coolant that is leaking through the sensor will create a high resistance short to ground. This condition results in less voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a warmer ECT.
- The ECM memory which includes the ignition OFF timer is maintained by battery power. If the ECM or the battery are disconnected for less than 15 seconds the proper operation of the ECM memory and the timer can be disrupted. Always disconnect these components for greater than 30 seconds.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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. Turn OFF the ignition.
2. Inspect the cooling system surge tank for the proper engine coolant level. Refer to **Cooling System Leak Testing** , and **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)** .
3. If the ignition has been OFF for 8 hours or greater, the intake air temperature (IAT) sensor, the IAT sensor 2, and the ECT sensor should be within 9Â°C (16Â°F) of each other and also the ambient temperature. Ignition ON, observe the scan tool IAT Sensor, IAT Sensor 2 and the ECT Sensor parameters. Compare those sensor parameters to each other and also to the ambient temperature to determine if the ECT sensor is skewed warmer.
4. Engine running, observe the ECT Sensor parameter. The reading should be between -39 to +120Â°C (-38 to +248Â°F) depending on the current ambient temperature and the vehicle operating conditions.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

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1. Ignition OFF and all vehicle systems OFF, disconnect the B34 Engine Coolant Temperature Sensor harness connector at the sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 5 Ω**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -39Â°C (-38Â°F).
    - **If warmer than -39Â°C (-38Â°F)**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance.
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module
    - **Go to next step: If colder than -39Â°C (-38Â°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 149Â°C (300Â°F).
    - **If warmer than 149Â°C (300Â°F)**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, Ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
7. Test or replace the B34 engine coolant temperature sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table. The resistance values should be in range of the table values.
    - **If not within the specified range**

      Replace the B34 Engine Coolant Temperature Sensor.

    - **Go to next step: 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.

    - **Go to next step: If infinite resistance**
4. All OK.

Repair Instructions

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

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- Engine Coolant Temperature Sensor Replacement - Water Outlet
- Control Module References for ECM replacement, programming, and setup

DTC P1255: FUEL PUMP CONTROL MODULE DRIVER HIGH TEMPERATURE

Diagnostic Instructions

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

DTC Descriptors

DTC P1255

Fuel Pump Control Module Driver High Temperature

Circuit/System Description

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

Conditions for Running the DTC

- The ignition voltage is between 9 - 32 V.
- The engine is cranking or running.
- The fuel pump enable circuit is commanded ON.
- The DTC runs continuously when the conditions above are met.

Conditions for Setting the DTC

The fuel pump driver control module detects a driver temperature greater than or equal to 320Â°F (160Â°C) for less than 0.2 s.

Action Taken When the DTC Sets

DTC P1255 is a Type B DTC.

Conditions for Clearing the DTC

DTC P1255 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

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

    - **Go to next step: If none of the DTCs are set**
3. Verify that the area where the K111 Fuel Pump Driver Control Module is located is free of debris, clutter, or any insulating material that would cause the fuel pump driver control module to overheat.
    - **If any debris, clutter, or other material is found**
    1. Clear the area where the K111 Fuel Pump Driver Control Module is located.
    2. Clear the DTC and test drive the vehicle.
    3. Verify the DTC does not set.
        - If the DTC sets, replace the K111 Fuel Pump Driver Control Module.
        - If the DTC is not set
    4. All OK.
    - **Go to next step: If no debris, clutter, or other material is found**
4. Clear the DTC and test drive the vehicle.
5. Verify the DTC does not set.
    - **If the DTC sets**

      Replace the K111 Fuel Pump Driver Control Module.

    - **Go to next step: If the DTC does not set.**
6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Fuel Pump Power Control Module Replacement (FWD) Fuel Pump Power Control Module Replacement (AWD)

DTC P127C, P128A, P128B, P128C, P128D, P128F, P16E4, OR P16E5: FUEL RAIL PRESSURE SENSOR 1 AND 2 OR FUEL RAIL PRESSURE-TEMPERATURE SENSOR 1 AND 2

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 P127C

Fuel Rail Pressure Sensor 2 Circuit Low Voltage

DTC P128A

Fuel Rail Pressure Sensor 1 Internal Performance

DTC P128B

Fuel Rail Pressure Sensor 2 Internal Performance

DTC P128C

Fuel Rail Pressure-Temperature Sensor Temperature 1 Message Incorrect

DTC P128D

Fuel Rail Pressure-Temperature Sensor Temperature 2 Message Incorrect

DTC P128F

Fuel Rail Pressure-Temperature Sensor Pressure Message Incorrect

DTC P16E4

Sensor Communication Circuit 3 Low Voltage

DTC P16E5

Sensor Communication Circuit 3 High Voltage

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0452, P06D2, P16E5	P16E4	P06D2, P128A, P128B	P0191
Signal	P16E4	P128C, P128D, P16E5	P16E5	P0191
Low Reference	-	P128C, P128D, P16E5	-	P0191

Typical Scan Tool Data

Fuel Rail Pressure Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. **Parameter Normal Range:** 2.9-3.2 MPa			
5 V Reference	655.4 MPa	655.4 MPa	655.4 MPa
Signal	655.4 MPa	655.4 MPa	655.4 MPa
Low Reference	-	655.4 MPa	-

Circuit/System Description

The fuel pressure/temperature sensor transmits fuel pressure and temperature information by serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT)

protocol. The fuel pressure/temperature sensor internal microprocessor allows 4 separate sensor outputs from one 3 wire sensor. The engine control module (ECM) supplies the fuel pressure/temperature sensor with a 5 V reference circuit, a low reference circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the fuel pressure/temperature sensor to the ECM. The ECM decodes the serial data signal into separate voltages.

Conditions for Running the DTC

P127C, P16E4 or P16E5

- Ignition is ON.
- No DTC clear code.
- The DTCs run continuously when the above conditions are met.

P128A or P128B

- DTC P128F, P16E4 or P16E5 is not set.
- Ignition is ON.
- The DTCs run continuously when the above conditions are met.

P128C, P128D, or P128F

- DTC P16E4 or P16E5 is not set.
- Ignition is ON.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P127C

The engine control module detects the uel pressure sensor 2 SENT digital read value is less than or equal to 76 for greater than 30 s with the engine running or greater than 10 s with the engine cranking.

P128A

The engine control module detects the fuel pressure sensor 1 SENT digital read value is greater than or equal to 4, 089 for greater than 3 s.

P128B

The engine control module detects the fuel pressure sensor 2 SENT digital read value is greater than or equal to 4, 089 for greater than 3 s.

P128C

The engine control module detects communication errors on the fuel pressure sensor temperature 1 SENT signal circuit for greater than 1 s.

P128D

The engine control module detects communication errors on the fuel pressure sensor temperature 2 SENT signal circuit for greater than 1 s.

P128F

The engine control module detects fuel pressure sensor SENT signal discrepancies for greater than 3 s.

P16E4

The engine control module detects the fuel pressure sensor SENT signal shorted low for greater than 3 s.

P16E5

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The engine control module detects the fuel pressure sensor SENT signal shorted high for greater than 3 s.

Action Taken When the DTC Sets

- DTCs P127C, P128A, P128B, P128F, P16E4, and P16E5 are Type A DTCs.
- DTCs P128C and P128D are Type B DTCs.
- A message center or an indicator displays Propulsion Power is Reduced and Service Stabilitrak.

Conditions for Clearing the DTC

- DTCs P127C, P128A, P128B, P128F, P16E4, and P16E5 are Type A DTCs.
- DTCs P128C and P128D are Type B DTCs.

Diagnostic Aids

- A high resistance condition on the fuel pressure/temperature sensor circuits could cause a DTC to set.
- Inspect for a contaminated fuel system.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

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

    - **Go to next step: If none of the DTCs are set**

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3. Verify that DTC P0182, P0183, P0187, P0188, P111F, P126E, P126F, P127C, P128A, P128B, P128C, P128D, P128F, P16E4, or P16E5 are not set.
    - **If DTC P128A, P128B, P128C, P128D, or P128F are the only DTCs set**

      Replace the B310 Fuel Pressure/Temperature Sensor.

    - **If DTC P0183, P0184, P0187, P0188, P111F, P126E, P126F, P127C, P16E4, or P16E5 is set with any of the DTCs**

      Refer to Circuit/System Testing.

    - **Go to next step: If none of the DTCs are set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **Go to next step: If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: **Disconnecting the fuel pressure/temperature sensor harness connector causes additional DTCs to set.**

1. Ignition/Vehicle OFF, and all vehicle systems OFF, disconnect the harness connector at B310 Fuel Pressure/Temperature Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.
    - **If 5 Ω or greater**
    1. Ignition/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 5 Ω**
3. Ignition/Vehicle ON.
4. 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/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition/vehicle 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.
    - **Go to next step: If between 4.8 - 5.2 V**
5. 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/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition/Vehicle OFF, disconnect the harness connector at the K20 Engine Control Module, ignition/vehicle 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.

- **Go to next step: If between 4.8 - 5.2 V**

6. Replace the B310 Fuel Pressure/Temperature Sensor.

Repair Instructions

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

- **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement** for B310 Fuel Pressure/Temperature Sensor
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P129E OR P12A8: FUEL PUMP DRIVER CONTROL STATUS SIGNAL MESSAGE COUNTER INCORRECT OR FUEL PUMP CONTROL SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

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

DTC Descriptors

DTC P129E

Fuel Pump Driver Control Status Signal Message Counter Incorrect

DTC P12A8

Fuel Pump Control Signal Message Counter Incorrect

Circuit/System Description

The fuel pump power control module is in constant communication with the ECM regarding the operating state of the fuel pump power control system. Serial data messages are sent in a continuously repeating series of rolling counts with associated password protect samples. Each count/sample is assigned a value. When the ECM determines that too many of the counts/samples contain an error value, the ECM sets DTC P129E or P12A8.

Conditions for Running the DTC

- The ignition voltage is greater than 7 V.
- The DTC runs continuously when the above condition is met.

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Conditions for Setting the DTC

The ECM detects an error value for over 1 s.

Action Taken When the DTC Sets

DTC P129E and P12A8 are Type A DTCs.

Conditions for Clearing the DTC

DTC P129E and P12A8 are Type A DTCs.

Diagnostic Aids

An intermittent fault in the CAN circuits will cause the ECM to set DTC P129E or P12A8.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **DTC P129E and P12A8 are informational DTCs.**
- **Diagnose all other engine control module DTCs prior to DTC P129E or P12A8.**

1. Verify that no other DTCs are set except for DTC P129E or P12A8.
   - **If any other DTCs are set**

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

   - **Go to next step: If only DTC P129E or P12A8 is set**
2. Replace the K111 Fuel Pump Power Control Module.
3. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
   - **If DTC sets**

     Replace the K20 Engine Control Module.

   - **Go to next step: If DTC does not set**
4. All OK.

Repair Instructions

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

- **Fuel Pump Power Control Module Replacement (FWD)** **Fuel Pump Power Control Module Replacement (AWD)** for K111 Fuel Pump Power Control Module Replacement
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P129D: FUEL PUMP DRIVER CONTROL MODULE IGNITION ON/START SWITCH CIRCUIT LOW VOLTAGE

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 Descriptor

DTC P129D

Fuel Pump Driver Control Module Ignition On/Start Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P129D	P129D	-	-

Circuit/System Description

The fuel pump driver control module monitors the ignition voltage circuit in order to determine if the voltage is within the normal operating range.

Conditions for Running the DTC

The DTC runs continuously when the modules are awake.

Conditions for Setting the DTC

The fuel pump driver control module Power Mode does not agree with the engine control module (ECM) Power Mode for 1 s.

Action Taken When the DTC Sets

DTC P129D is a Type B DTC.

Conditions for Clearing the DTC

DTC P129D is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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 Verification

1. Verify the engine cranks.
   - **If the engine does not crank**

     Refer to Starter Solenoid Does Not Click (Without KL9) Starter Solenoid Does Not Click (KL9) .

   - **Go to next step: If the engine cranks**
2. Ignition ON.
3. Verify DTC P0562 is not set.
   - **If the DTC sets**

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

   - **Go to next step: If the DTC does not set**
4. Verify DTC P129D is not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify DTC P129D is not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
7. All OK.

Circuit/System Testing

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

1. Ignition OFF, all vehicle systems OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Ignition ON.
3. Verify a test lamp illuminates between the ignition circuit terminal 6 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp.
   2. Test for less than 2 Ω in the ignition circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp, 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.

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- If the fuse is good, all OK.
- **Go to next step: If the test lamp illuminates**

4. Replace the K111 Fuel Pump Driver Control Module.

Repair Instructions

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

Fuel Pump Power Control Module Replacement (FWD) **Fuel Pump Power Control Module Replacement (AWD)**

DTC P12A6: FUEL PUMP DRIVER CONTROL MODULE ENABLE CIRCUIT PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P12A6

Fuel Pump Driver Control Module Enable Circuit Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0171, P0506, P0628, P12A6	P0171, P0506, P12A6	-	P12A6

Circuit/System Description

The engine control module (ECM) provides ignition voltage to the fuel pump driver control module whenever the engine is cranking or running. The control module enables the fuel pump driver control module as long as the engine is cranking or running, and ignition system reference pulses are received. While this enable voltage is being received, the fuel pump driver control module supplies a varying voltage to the in-tank fuel pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC

- The ignition voltage is greater than or equal to 9 V.
- The DTC runs continuously when the condition above is met.

Conditions for Setting the DTC

The ECM state of the fuel pump enable circuit does not match the state of the fuel pump enable circuit sensed by the fuel pump driver control module for 1 s.

Action Taken When the DTC Sets

DTC P12A6 is a Type A DTC.

Conditions for Clearing the DTC

DTC P12A6 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P12A6 is not set.
   - **If the DTC is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC is not set**
3. Verify the parameters listed below do not display Malfunction when commanding the Fuel Pump Enable On and Off with a scan tool.
   - Fuel Pump Enable Circuit Low Voltage Test Status
   - Fuel Pump Enable Circuit Open Test Status
   - Fuel Pump Enable Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **Go to next step: 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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Ignition ON for 10 s.
3. Verify that a test lamp does not illuminate between the control circuit terminal 2 and ground.

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- **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.

- **Go to next step: 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.

    - **Go to next step: If OK is displayed**
6. Install a 3 A fused jumper wire between the control circuit terminal 2 and ground.
7. Verify the scan tool Fuel Pump Enable Circuit Low Voltage Test Status parameter is Malfunction when commanding the Fuel Pump Enable On with a scan tool.
    - **If Malfunction is not displayed**

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

    - **Go to next step: If Malfunction is displayed**
8. Replace the K111 Fuel Pump Driver Control Module.

Repair Instructions

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

- **Fuel Pump Power Control Module Replacement (FWD)** **Fuel Pump Power Control Module Replacement (AWD)**
- **Control Module References** for control module replacement, programming and setup.

DTC P135A: IGNITION COIL SUPPLY VOLTAGE CIRCUIT BANK 1

Diagnostic Instructions

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

DTC Descriptor

DTC P135A

Ignition Coil Supply Voltage Circuit Bank 1

Diagnostic Fault Information

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

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

Circuit/System Description

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

Conditions for Running the DTC

- Delay starting at ignition On for 5 engine revolutions.
- Ignition Run/Crank relay voltage is greater than 5 V
- PT relay voltage is greater than 11 V

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects less than 2.5 V on the ignition coil supply voltage circuit.

Action Taken When the DTC Sets

DTC P135A is a Type B DTC.

Conditions for Clearing the DTC

DTC P135A is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

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

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Ignition 1 Signal parameter displays On.
    - **If On is not displayed**

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Refer to Circuit/System Testing.

- **Go to next step: If On is displayed**

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

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
2. Connect a 3 A fused jumper wire between the control circuit terminal 67 and ground, ignition ON.
3. Verify a test lamp illuminates between the ignition circuit terminal 51 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp.
   2. Test for less than 2 Ω in the ignition circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**

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

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

Repair Instructions

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

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

DTC P1400: COLD START EMISSION REDUCTION CONTROL SYSTEM

Diagnostic Instructions

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

DTC Descriptor

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DTC P1400

Cold Start Emission Reduction Control System

Circuit/System Description

The catalyst must be warmed to efficiently reduce the emissions. The cold start strategy is to reduce the amount of time it takes to warm the catalyst. During a cold start, the engine spark timing is altered to allow the catalyst to warm quickly. This diagnostic monitors the following to build an exhaust energy model:

- Spark advance
- Engine airflow
- Engine coolant temperature
- Engine run time

The actual model is then compared to the expected exhaust energy model.

Conditions for Running the DTC

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0114, P0116, P0117, P0118, P0121, P0122, P0123, P0201, P0202, P0203, P0204, P0222, P0223, P0300, P0301, P0302, P0303, P0304, P0335, P0336, P0351, P0352, P0353, P0354, P0641, P0651, P0697, P06A3, P2122, P2123, P2127, P2128, P2135, and P2138 are not set.
- The engine coolant temperature (ECT) is between -12 to +56Â°C (10 - 132Â°F).
- The calculated 3-way catalyst temperature is colder than 500Â°C (932Â°F).
- The barometric (BARO) pressure is greater than 75 kPa.
- The engine control module (ECM) will exit the diagnostic if the calculated 3-way catalyst temperature is greater than 1, 000Â°C (1832Â°F) when the engine run time is greater than 17 s.
- Vehicle speed is less than 1.6 km/h (1 mph).
- The accelerator pedal is not depressed.
- The ECM will exit the diagnostic if the engine run time is greater than a calibrated value.
- This DTC runs within the first 15 s of start-up. This diagnostic runs once per trip when a cold start has been determined.

Conditions for Setting the DTC

The actual exhaust energy model does not match the expected exhaust energy model.

Action Taken When the DTC Sets

DTC P1400 is a Type A DTC.

Conditions for Clearing the DTC

DTC P1400 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. Verify that none of the conditions listed below exists with the air intake system:
   - Damage, restriction, or modification
   - Dirty or deteriorating air filter element
   - Crankcase ventilation system for correct operation
   - Water intrusion
   - Vacuum leak and other unmetered air downstream of the mass air flow (MAF) sensor
   - Intake manifold leak
   - **If any of the above conditions exist**

     Repair as necessary.

   - **Go to next step: If none of the conditions exist**
2. Verify that none of the conditions listed below exists with the exhaust system:
   - Exhaust leak
   - Damaged, restricted, or modified exhaust system - Refer to Symptoms - Engine Exhaust .
   - **If any of the above conditions exist**

     Repair as necessary.

   - **Go to next step: If none of the conditions exist**
3. If all of the above conditions test normal, inspect for an engine mechanical condition that could alter the air flow into the combustion chamber. Refer to Symptoms - Engine Mechanical .
   - **If a condition exists - Repair or replace as necessary**
   - **Go to next step: If none of the conditions exists**
4. Vehicle OFF, allow the engine to cool to be within the temperatures listed in the Conditions for Running the DTC.
5. Engine running.
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 step 1

   - **Go to next step: If the DTC is not set**
8. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

DTC P150C: TRANSMISSION CONTROL MODULE ENGINE SPEED REQUEST SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

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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 Descriptor

DTC P150C

Transmission Control Module Engine Speed Request Signal Message Counter Incorrect

Circuit/System Description

To improve vehicle shift feel, the transmission control module (TCM) is constantly sending the ECM serial data messages with requests to modify engine speed or torque. These serial data messages are sent through two circuits which are part of a communication network called the controller area network (CAN). The ECM sets DTC P150C when it detects a discrepancy in the structure of this message causing its integrity to be questioned.

An intermittent fault in the controller area network (CAN) circuits will cause DTC P150C to set.

Conditions for Running the DTC

- DTCs P0506, P0507, or U0101 are not set.
- The engine is running for greater than 0.5 s.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the TCM engine speed request does not match the expected engine speed request.

Action Taken When the DTC Sets

DTC P150C is a Type B DTC.

Conditions for Clearing the DTC

DTC P150C is a Type B DTC.

Reference Information

Description and Operation

Data Link Communications Description and Operation

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **DTC P150C is an informational DTC.**
- **Diagnose all other engine control module DTCs prior to DTC P150C.**

1. Verify that no other DTCs are set except for DTC P150C.
   - **If any other DTCs are set**

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

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- **Go to next step: If only DTC P150C is set**

2. Replace the K71 Transmission Control Module.
3. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Replace the K20 Engine Control Module.

    - **Go to next step: If the DTC does not set**
5. All OK.

Repair Instructions

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

Control Module References for ECM or TCM replacement, programming, and setup

DTC P1516, P2101, P2119, OR P2176: THROTTLE ACTUATOR CONTROL (TAC)

Diagnostic Instructions

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

DTC Descriptor

DTC 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
Control - Close	P1516, P2101	P1516, P2101	P1516, P2101	P1516, P2101, P2176
Control - Open	P1516, P2101, P2119	P1516, P2101	P1516, P2101	P1516, P2101, P2176

Circuit/System Description

Circuit	Description
Control - Close	The output circuit is switched from ground to 12 V to activate the component.
Control - Open	The output circuit is switched from ground to 12 V to activate the component.

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Component	Description
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
Q38 Throttle Body	The throttle valve is actuated by a bidirectional DC motor. A spring pulls the valve to a rest or default position, in which the valve is almost closed. The throttle actuator motor can push against the force of the spring to open or close the valve. The more current flow through the motor, the more the valve moves.

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.

Conditions for Running the DTC

P1516

- DTC P0606, P1682 = Not set
- Ignition Voltage = Greater than 6.4 V
- Reduced Engine Power = Not Activated
- Desired Throttle Position = Steady State - For greater than 4 s

DTC runs continuously when the above conditions are met.

P2101 Condition 1

- DTC P0606, P1682 = Not set
- Ignition Voltage = Greater than 6.4 V
- Reduced Engine Power = Not Activated
- Engine = Running

Condition 2

- Engine = Not Running
- Ignition Voltage = Greater than 8.4 V
- Throttle Position = Learned
- Throttle Actuator Control System = Active
- Battery Saver Mode = Not Activated

DTC runs continuously when the above conditions are met.

P2119

- DTC P0122, P0123, P0222, P0223, P06A3 = Not set
- Battery Saver Mode = Not Activated
- Reduced Engine Power = Not Activated
- Ignition Voltage = Greater than 5.5 V
- Throttle Actuator Control System = Not Activated

DTC runs continuously when the above conditions are met.

P2176

- Ignition Voltage = Greater than 6.4 V
- Reduced Engine Power = Not Activated
- Throttle Position Learn = Active

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DTC runs continuously when the above conditions are met for greater than 2 s.

Conditions for Setting the DTC

P1516

- The following parameters are not within 2% of each other:
  - Desired Throttle Position
  - Throttle Position

DTC P2101 Condition 1

- The following parameters are not within 10% of each other:
  - Desired Throttle Position
  - Throttle Position

Condition 2

- Throttle Position Learn = Active
- Throttle Position = Greater than 36%

Condition 3

- Reduced Engine Power = Active
- Throttle Position = Greater than 35%

P2119

The throttle blade has not reached the closed position after the engine has been turned off.

P2176

Minimum Throttle Position Not Learned = Exceeded Number of Attempts

Actions Taken When the DTC Sets

- DTC P1516 is a Type B DTC.
- DTCs P2101, P2176 are Type A DTCs.
- DTC P2119 is a Type C DTC.
- Reduced Engine Power = Active
- P16 Instrument Cluster = Reduced Engine Power
- Under certain conditions, the control module commands the engine Off.

Conditions for Clearing the DTC

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

Diagnostic Aids

- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- A weak battery may cause this DTC to set.
- If the throttle blade becomes stuck, a DTC will set. Depending on the position of the throttle blade, the ECM may enter Engine Shutdown Mode. The ECM will disable fuel and de-energize the throttle actuator. If the condition remains present during the next ignition cycle, the ECM may disable engine cranking. Inspect the throttle body assembly for a stuck throttle blade if a throttle actuator DTC is current and the engine won't crank.

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- Inspect for a condition in which the throttle blade may have been held open. For example, ice may have formed in the throttle bore causing the throttle blade not to close.
- Under cold start conditions, it might happen briefly that the desired and the actual throttle blade position do not match.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0121, P0122, P0123, P0222, P0223, P0562, P0621, P0622, P16A0-P16A2, P2135 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Verify the scan tool parameter:Throttle Body Idle Air Flow Compensation = Less than 90%
   - **If 90% or greater**

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

   - **Go to next step: If less than 90%**
4. Clear the DTCs.
5. Ignition/Vehicle - Off
6. Ignition - On / Vehicle - In Service Mode
7. Perform the scan tool control function:Throttle Sweep

   Verify the scan tool parameter:TAC Motor = Enabled

   - **If not the specified state**

     Refer to: Circuit/System Testing

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- **Go to next step: If the specified state**

8. Verify the scan tool parameter:TAC Motor = Enabled

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector:Q38 Throttle Body
   - Wiggle the harness and connector:K20 Engine Control Module
   - **If not the specified state**

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

   - **Go to next step: If the specified state**

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

    - **Go to next step: If the DTC does not set**
11. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Verify the following conditions do not exist:

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

   - The throttle blade has not reached the closed position after the engine has been turned off.
   - The throttle blade is not closed by the spring.
   - The throttle blade is binding in open or closed position.
   - **If a condition exists**

     Replace the component:Q38 Throttle Body

   - **Go to next step: If no condition exists**

   NOTE: **Disconnecting the component electrical connector causes additional DTCs to set.**

3. Disconnect the electrical connector:Q38 Throttle Body
4. Ignition - On / Vehicle - In Service Mode
5. Test for 6 to 9 V between the test points:
   - Control circuit terminal 1 & Ground
   - Control circuit terminal 2 & Ground
   - **If less than 6 V**

   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
   3. Test for infinite resistance between the test points:
      - Control circuit terminal 1 @Component harness & Ground
      - Control circuit terminal 2 @Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance

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4. Test for less than 2 ohms between the test points:
    - Control circuit terminal 1 @Component harness & The other end of the circuit@Control module harness
    - Control circuit terminal 2 @Component harness & The other end of the circuit@Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component:K20 Engine Control Module
- **If greater than 9 V**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: X2 @K20 Engine Control Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 1 V between the test points:
    - Control circuit terminal 1 @Component harness & Ground
    - Control circuit terminal 2 @Component harness & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - If less than 1 V - Replace the component:K20 Engine Control Module
- **Go to next step: If between 6 and 9 V**

6. Ignition/Vehicle - Off
7. Disconnect the electrical connector: X2 @K20 Engine Control Module
8. Test for less than 2 ohms between the test points:
    - Control circuit terminal 1 @Component harness & The other end of the circuit@Control module harness
    - Control circuit terminal 2 @Component harness & The other end of the circuit@Control module harness
    - **If 2 ohms or greater - Repair the open/high resistance in the circuit.**
    - **Go to next step: If less than 2 ohms**
9. Test or replace the component:Q38 Throttle Body

Repair Instructions

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

- **Throttle Body Assembly Replacement**
- For control module replacement, programming, and setup refer to:**Control Module References**

DTC P163A: CONTROL MODULE FUEL PRESSURE REGULATOR 1 CONTROL SYSTEM CIRCUITRY PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P163A

Control Module Fuel Pressure Regulator 1 Control System Circuitry Performance

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). The ECM monitors the current required to control fuel pressure regulator and compares the current value to calibrated low and high thresholds.

Conditions for Running the DTC

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- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0627, P0628, P0629, or P1682 are not present.
- The engine is running.
- Battery voltage is greater than or equal to 11 V.
- Low side fuel pressure is greater than 300 kPa (43.5 PSI).
- Intake air temperature (IAT) is warmer than or equal to -10Â°C (14Â°F).
- Barometric pressure is greater than 70 kPa.
- Fuel temperature is between -10Â°C and +132Â°C (14Â°F and 270Â°F).
- DTC P163A runs continuously when the conditions are met for greater than 500 ms.

Conditions for Setting the DTC

The ECM detects a condition with the integrated circuits of the high pressure fuel pump actuator driver module or the ECM detects that the current used to drive the high pressure fuel pump actuator is out of range for greater than 4 s.

Action Taken When the DTC Sets

DTC P163A is a Type B DTC.

Conditions for Clearing the DTC

DTC P163A is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON/Vehicle in Service Mode.
2. Verify that no other DTCs are set.

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- **If any other DTCs are set**

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

- **Go to next step: If no other DTCs are set**

3. Verify that DTC P163A is not set.
   - **If the DTC is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC is not set**
4. Operate the vehicle within the Conditions for Running the DTC. It may be helpful to operate the vehicle within the conditions identified from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
6. All OK.

Circuit/System Testing

1. Ignition/Vehicle OFF and all vehicle systems OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump. It may take up to 2 min for all vehicle systems to power down.

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

2. Test for 1.09 - 1.21 Ω at 20Â°C (68Â°F) between the high control circuit terminal 2 and the low control circuit terminal 1 on the G18 High Pressure Fuel Pump.
   - **If not between 1.09 - 1.21 Ω**

     Replace the G18 High Pressure Fuel Pump.

   - **Go to next step: If between 1.09 - 1.21 Ω**
3. Ignition ON, verify that a test lamp does not illuminate between ground and the terminals listed below:
   - High control circuit terminal 2
   - Low control circuit terminal 1
   - **If the test lamp illuminates**
   1. Ignition OFF, disconnect the appropriate harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the appropriate control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
      - **Go to next step: If the test lamp does not illuminate**
4. Test for B+ between the high control circuit terminal 2 and ground.
   - **If less than B+**
   1. Ignition OFF, disconnect the appropriate harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the high control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the high control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.

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- If less than 2 Ω, replace the K20 Engine Control Module.
- **Go to next step: If B+**

5. Ignition OFF, connect a test lamp between the high control circuit terminal 2 and the low control circuit terminal 1.
6. Ignition ON, command the Fuel Pressure Regulator On and Off with a scan tool.
7. Verify the test lamp turns ON and OFF.
   - **If the test lamp does not turn ON and OFF**
   1. Ignition OFF, disconnect the appropriate harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the low control circuit terminal 1 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the low control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If the test lamp turns ON and OFF**
8. Test or replace the G18 High Pressure Fuel Pump.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump.

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

2. Test for 1.09 - 1.21 Ω at 20Â°C (68Â°F) between the high control circuit terminal 2 and the low control circuit terminal 1.
   - **If not between 1.09 - 1.21 Ω**

     Replace the G18 High Pressure Fuel Pump.

   - **Go to next step: If between 1.09 - 1.21 Ω**
3. Test for infinite resistance between each terminal and the G18 High Pressure Fuel Pump housing.
   - **If less than infinite resistance**

     Replace the G18 High Pressure Fuel Pump.

   - **Go to next step: If infinite resistance**
4. All OK

Repair Instructions

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

- **Fuel Pump Replacement** for G18 High Pressure Fuel Pump replacement
- **Control Module References** for control module replacement, programming and setup
- Perform the Fuel Rail Pressure Relief Valve Reset procedure, if supported on the scan tool.

DTC P16A7, P16AF, OR P16B3: ENGINE CONTROLS IGNITION RELAY

Diagnostic 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 Descriptors

DTC P16A7

Engine Controls Ignition Relay Feedback Circuit 2

DTC P16AF

Engine Controls Ignition Relay Feedback Circuit 2 Low Voltage

DTC P16B3

Engine Controls Ignition Relay Feedback Circuit 2 High Voltage

Diagnostic Fault Information

Engine Controls Ignition Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Relay Coil Supply Voltage	P0689, P1682, P16A7, P16AF	P0685, P0689, P1682, P16A7, P16AF	-
Relay Control Circuit	P0686, P0690, P16B3	P0685, P0689, P1682, P16A7, P16AF	P0685, P0687, P0689, P1682, P16A7, P16AF
Relay Feedback Circuit	P0689, P1682, P16A7, P16AF	P0689, P1682, P16A7, P16AF	P0690, P16B3

Typical Scan Tool Data

Engine Controls Ignition Relay Control Circuit Low Voltage, Open, and High Voltage Test Status - Component Commanded OFF

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded OFF **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage Test Status and Not Run for High Voltage Test Status • Component ON - Not Run for Open/Low Voltage Test Status and OK for High Voltage Test Status			
B+	Malfunction	Malfunction	-
Control	Malfunction	Malfunction	Not Run

Engine Controls Ignition Relay Control Circuit Low Voltage, Open, and High Voltage Test Status - Component Commanded ON

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded ON **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage Test Status and Not Run for High Voltage Test Status • Component ON - Not Run for Open/Low Voltage Test Status and OK for High Voltage Test Status			
B+	Not Run	Not Run	-
Control	Not Run	Not Run	Malfunction

Circuit/System Description

There are 3 ignition voltage circuits supplied to the engine control module (ECM). Two are supplied by the engine controls ignition relay, and the other is supplied by the ignition main relay. The ECM monitors and compares the ignition voltage supplied by the 2 relays.

Conditions for Running the DTC

P16A7

- The engine controls ignition relay is commanded ON.
- Ignition voltage is greater than 5.5 V.
- The DTC runs continuously when the above conditions are met.

P16AF

- The engine controls ignition relay is commanded ON.
- Ignition 1 signal voltage is greater than 11 V.
- The DTC runs continuously when the above conditions are met.

P16B3

The DTC runs when the engine controls ignition relay is commanded OFF.

Conditions for Setting the DTC

P16A7

The ECM detects that the voltage level difference is greater than 3 V between the 2 ignition voltage circuits for greater than 1 s.

P16AF

The ECM detects the engine controls ignition relay feedback circuit 2 is less than 5 V.

P16B3

The ECM detects the engine controls ignition relay feedback circuit 2 is greater than 4 V for greater than 5 s.

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Action Taken When the DTC Sets

- DTC P16A7 is a Type A DTC.
- DTCs P16AF and P16B3 are Type C DTCs.

Conditions for Clearing the DTC

- DTC P16A7 is a Type A DTC.
- DTCs P16AF and P16B3 are Type C DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

- **Engine Controls Wiring Schematics 1.5L (LYX)**
- Power Distribution Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Electrical Center Identification Views**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **A short to voltage on other components may cause DTC P16B3 to set. If any other DTC is set, diagnose that DTC first.**
- **If you were sent here from Engine Cranks But Does Not Run, proceed to Circuit/System Testing.**

1. Ignition ON, observe the scan tool DTC information. Verify DTC P16A7, P16AF, or P16B3 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing.

   - **Go to next step: If none of the DTCs are set**
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
3. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing unless sent here from Engine Cranks But Does Not Run.**

1. Ignition OFF, disconnect the KR75 Engine Controls Ignition Relay.
2. Verify a test lamp illuminates between ground and the B+ terminals listed below:
   - Terminal 85
   - Terminal 30
   - **If the test lamp does not illuminate**

     Replace the front compartment fuse block.

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- **Go to next step: If the test lamp illuminates**

NOTE:

- **High resistance in the circuit/underhood fuse block for either the KR75 Engine Controls Ignition Relay or the KR73 Ignition Main Relay can cause DTC P16A7 to set.**
- **A short to voltage on any of the circuits supplied by the engine controls ignition relay can cause DTC P16B3 to set.**

3. Ignition ON.
4. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal 87 and ground.
    - **If the test lamp illuminates**
    1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
    2. Ignition ON.
    3. Test for less than 1 V between ground and connector terminal 73.
        - If 1 V or greater, repair the short to voltage in the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp does not illuminate**
5. Ignition OFF, connect a 20 A fused jumper wire between the B+ circuit terminal 30 and the ignition voltage circuit terminal 87.
6. Ignition ON.
7. Verify the scan tool Engine Controls Ignition Relay Feedback Signal parameter displays B+.
    - **If B+ is not displayed**
    1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module
    2. Test for less than 2 Ω in the relay switch ignition voltage circuit 87 end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω
    3. Test for infinite resistance between the relay switch ignition voltage circuit 87 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If B+ is displayed**
8. Ignition OFF, connect a DMM, set to the diode setting, between control circuit terminal 86 and ground.
9. Verify the DMM displays OL.
    - **If OL is not displayed**
    1. Disconnect the X1 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between ground and the relay control circuit.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If OL is displayed**
10. Ignition ON.
11. Verify the DMM displays less than 1 V.
    - **If 1 V or greater**
    1. Ignition OFF, disconnect the X1 connector at the K20 Engine Control Module.
    2. Ignition ON.
    3. Test for less than 1 V on the relay control circuit.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    4. Test for less than 2 Ω in the control circuit end to end.

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

- **Go to next step: If less than 1 V**

12. Test or replace the KR75 Engine Controls Ignition Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR75 Engine Controls Ignition Relay.
2. Test for 70 - 110 Ω between terminals 85 and 86:
   - **If less than 70 Ω or greater than 110 Ω**

     Replace the KR75 Engine Controls Ignition Relay.

   - **Go to next step: If between 70 - 110 Ω**
3. Test for infinite resistance between the terminals listed below:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87
   - **If less than infinite resistance**

     Replace the KR75 Engine Controls Ignition Relay.

   - **Go to next step: If infinite resistance**
4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 Ω between terminals 30 and 87.
   - **If 2 Ω or greater**

     Replace the KR75 Engine Controls Ignition Relay.

   - **Go to next step: If less than 2 Ω**
6. All OK.

Repair Instructions

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

- **Battery Distribution Engine Compartment Fuse Block Replacement** .
- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P16FF: ENGINE CONTROLS IGNITION RELAY REQUEST SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

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

DTC Descriptor

NOTE: **This procedure may also diagnose malfunctions that are not detected by a DTC.**

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DTC P16FF

Engine Controls Ignition Relay Request Signal Message Counter Incorrect

Circuit/System Description

Control modules connected to the serial data circuits monitor the communication during normal vehicle operation. Operating information and commands are exchanged among the control modules. Each module on the serial data circuit maintains a transmit error counter and a receive error counter. The counter values increase with detected errors and decrease with error-free messages.

Conditions for Running the DTC

- Ignition On/Vehicle in Service Mode.
- Ignition Voltage = Greater than 11 V

Conditions for Setting the DTC

Serial Data = Message Counter Incorrect - Between the following control modules:

- K20 Engine Control Module
- K38 Chassis Control Module

Actions Taken When the DTC Sets

DTC 16FF is a Type B DTC.

Conditions for Clearing the DTC

DTC 16FF is a Type B DTC.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Verify there are no DTCs set related to the following system/component:Serial Data
    - **If other DTCs are set**

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

    - **If no other DTCs are set**
    1. Replace the component:K20 Engine Control Module
    2. Operate the vehicle within the Conditions for Running the DTC.
    3. Verify the DTC does not set.
        - If the DTC sets - Replace the component:K38 Chassis Control Module
        - If the DTC is not set
    4. All OK.
    - **Go to next step: If no DTC is set**
2. All OK.

Repair Instructions

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

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For control module replacement, programming, and setup refer to: **Control Module References**

DTC P2096 OR P2097: POST CATALYST FUEL TRIM SYSTEM LOW LIMIT OR HIGH LIMIT

Diagnostic Instructions

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

DTC Descriptor

DTC P2096

Post Catalyst Fuel Trim System Low Limit

DTC P2097

Post Catalyst Fuel Trim System High Limit

Circuit Description

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

Conditions for Running the DTC

- DTC P0016, P0017, P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P015A, P015B, P0178, P0179, P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0340, P0341, P0365, P0366, P0411, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0458, P0459, P0496, P0498, P0499, P111E, P1133, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P219A, P2227, P2228, P2229, P2230, P2269, P2270, P2271, P2440, P2444, or P2A00 is not set.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 PSI).
- The manifold absolute pressure (MAP) is between 0 - 200 kPa (0 - 29 PSI).
- The intake air temperature (IAT) is between - 20Â°C and +200Â°C (-4 and +392Â°F).
- The start up engine coolant temperature is warmer than - 20Â°C (- 4Â°F).
- The fuel control intrusive diagnostics are not active.
- The engine is operating under light acceleration, heavy acceleration, or cruise conditions.
- DTCs P2096 and P2097 run continuously when the conditions above have been met.

Conditions for Setting the DTC

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

Action Taken when the DTC Sets

DTCs P2096 and P2097 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2096 and P2097 are Type B DTCs.

Diagnostic Aids

- The post catalyst fuel trim diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may cause a DTC to set.

- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no other HO2S or fuel trim DTC is set.
   - **If any other HO2S or fuel trim DTC is set**

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

   - **Go to next step: If no other HO2S or fuel trim DTC is set**
3. Verify DTC P2096 or P2097 is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If no DTC is set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
5. Verify DTC P2096 or P2097 is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If no DTC is set**
6. All OK.

Circuit/System Testing

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Inspect for the conditions listed below:

P2096

- Air intake duct collapsed or restricted.
- Air filter dirty or restricted.
- Objects blocking the throttle body.
- Excessive fuel in the crankcase. Change engine oil as necessary.
- Rich fuel injectors. Refer to **Fuel Injector Diagnosis**.
- Excessive fuel system pressure. Refer to **Fuel System Diagnosis**.
- Fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Fuel saturation of the evaporative emissions (EVAP) canister
- Stuck open or leaking EVAP purge valve
- Restricted exhaust. Refer to **Symptoms - Engine Exhaust** .
- Improperly operating crankcase ventilation system. Refer to **Crankcase Ventilation System Inspection/Diagnosis** .

P2097

- Exhaust system leaks. Refer to **Symptoms - Engine Exhaust** .
- Split, kinked, or improperly connected vacuum hoses
- Insufficient fuel in the tank
- Leaks in the air induction system and air intake ducts
- Missing air filter element
- Cracked evaporative canister
- Evaporative pipes plugged, obstructed, or leaking
- Crankcase ventilation system leaking. Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
- Engine vacuum leaks
- Low fuel system pressure. Refer to **Fuel System Diagnosis**.
- Contaminated fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Lean fuel injectors. Refer to **Fuel Injector Diagnosis**.

- If a condition is found

  Repair as necessary.

Repair Instructions

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

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

DTC P2122, P2123, P2127, P2128, OR P2138: ACCELERATOR PEDAL POSITION (APP) SENSOR 1 OR ACCELERATOR PEDAL POSITION (APP) SENSOR 2

Diagnostic Instructions

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

DTC Descriptor

DTC P2122

Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

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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
5 V Reference - APP Sensor 1	P06A3	P2122, P2138	P06A3	P2138
Signal - APP Sensor 1	P2122	P2122, P2138	P2123	P2138
Low Reference - APP Sensor 1	-	P2123, P2138	-	P2138
5V Reference - APP Sensor 2	P0108, P0697	P2127, P2138	P0107, P0522, P0532, P0697	P2138
Signal - APP Sensor 2	P2127	P2127, P2138	P2128	P2138
Low Reference - APP Sensor 2	-	P2128, P2138	-	P2138

Typical Scan Tool Data

APP Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine idling. **Parameter Normal Range:** 0.88 to 1.08 V			
5 V Reference	0 V	0 V	2 to 4 V
Signal	0 V	0 V	4 to 5 V
Low Reference	-	4 to 5 V	-

APP Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine idling. **Parameter Normal Range:** 0.39 to 0.59 V			
5 V Reference	0 V	0 V	1 to 3 V
Signal	0 V	0 V	4 to 5 V
Low Reference	-	4 to 5 V	-

Circuit/System Description

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to ground.
Low Reference	Grounded through the control module.

Component	Description
B107 Accelerator Pedal Position Sensor	The sensor is an input to the control module.The input voltage varies depending on the position of the sensor.

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Component	Description
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

The pedal assembly contains 2 potentiometer-type accelerator pedal position sensors, which are not serviceable. When the accelerator pedal is pressed, the voltages of both sensors goes up. This redundant design enables the ECM to detect if the 2 signals indicate the same accelerator pedal position.

Conditions for Running the DTC

DTC P2122, P2123, P2127, P2128

- DTC P0697, P06A3 = Not set
- Ignition = OnorEngine Running
- Ignition Voltage = Greater than 6.4 V

DTC runs continuously when the above conditions are met.

P2138

- DTC P0697, P06A3, P2122, P2123, P2127, P2128 = Not set
- Ignition Voltage = Greater than 6.4 V
- Reduced Engine Power = Inactive

DTCs run continuously when the above conditions are met.

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Conditions for Setting the DTC

P2122

APP Sensor 1 = Less than 0.46 V - For greater than 175 ms

P2123

APP Sensor 1 = Greater than 4.75 V - For greater than 175 ms

P2127

APP Sensor 2 = Less than 0.33 V - For greater than 175 ms

P2128

APP Sensor 2 = Greater than 2.6 V - For greater than 175 ms

P2138

APP Sensor 1 and 2 = Not within a calibrated range - For greater than 188 ms

Action Taken When the DTC Sets

- DTCs P2122, P2123, P2127, P2128, 2138 are Type A DTCs.
- ECM commands the throttle actuator control (TAC) system to operate in a Reduced Engine Power mode.
- A message and/or warning indicator may be displayed to the driver.
- Under certain conditions, the control module commands the engine Off.

Conditions for Clearing the DTC

DTCs P2122, P2123, P2127, P2128, 2138 are Type A DTCs.

Diagnostic Aids

- A high resistance condition on the component circuits may cause a DTC to set.
- Ensure that the inline harness connector seals are installed correctly.Incorrect installation could result in water intrusion into the connector and may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0697, P06A3 is not set.
   - **If any of the DTCs are set**

     Refer to:**DTC P0641, P0651, P0697, P06A3, or P06D2**

   - **Go to next step: If none of the DTCs are set**
3. Verify the scan tool parameter:
   - APP Sensor 1 Circuit Status = OK
   - APP Sensor 2 Circuit Status = OK
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
4. Verify the scan tool parameter:
   - APP Sensor 1 = 0.8 to 4.0 V - The value should not spike or drop out while moving the sensor through the entire range.
   - APP Sensor 2 = 0.4 to 2.0 V - The value should not spike or drop out while moving the sensor through the entire range.
   - **If not in the specified range or does not change**

     Refer to: Circuit/System Testing

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- **Go to next step: If in the specified range and changes**

5. Verify the scan tool parameter:APP Sensor 1 and 2 = Agree
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
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

   - **Go to next step: If the DTC does not set**
8. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B107 Accelerator Pedal Position Sensor
3. Test for less than 5 ohms between the test points:
   - {APP Sensor 1}Low Reference circuit terminal 4 & Ground
   - {APP Sensor 2}Low Reference circuit terminal 5 & Ground
   - **If 5 ohms or greater**
   1. Disconnect the electrical connector: K20 Engine Control Module
   2. Test for less than 2 ohms between the test points:
      - {APP Sensor 1}Low Reference circuit terminal 4 @Component harness & The other end of the circuit@ Control module harness
      - {APP Sensor 2}Low Reference circuit terminal 5 @Component harness & The other end of the circuit@ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component:K20 Engine Control Module
   - **Go to next step: If less than 5 ohms**
4. Ignition - On / Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points:
   - {APP Sensor 1}5 V Reference circuit terminal 2 & Low Reference circuit terminal 4
   - {APP Sensor 2}5 V Reference circuit terminal 1 & Low Reference circuit terminal 5
   - **If less than 4.8 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector:K20 Engine Control Module
   3. Test for infinite resistance between the test points:
      - 5 V Reference circuit terminal 2 @ Component harness & Ground
      - 5 V Reference circuit terminal 1 @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 ohms between the test points:
      - 5 V Reference circuit terminal 2 @ Component harness & The other end of the circuit@ Control module harness

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- 5 V Reference circuit terminal 1 @ Component harness & The other end of the circuit@ Control module harness
- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms - Replace the component:K20 Engine Control Module

- **If greater than 5.2 V**

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

- **Go to next step: If between 4.8 and 5.2 V**

6. Verify the scan tool parameter:
    - APP Sensor 1 = Less than 0.2 V
    - APP Sensor 2 = Less than 0.2 V
    - **If 0.2 V or greater**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector:K20 Engine Control Module
    3. Ignition - On / Vehicle - In Service Mode
    4. Test for less than 1 V between the test points:
        - {APP Sensor 1}Signal circuit terminal 3 @Component harness & Ground
        - {APP Sensor 2}Signal circuit terminal 6 @Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component:K20 Engine Control Module

    - **Go to next step: If less than 0.2 V**

7. Connect a 3 A fused jumper wire between the test points:
    - {APP Sensor 1}Signal circuit terminal 3 & 5 V Reference circuit terminal 2
    - {APP Sensor 2}Signal circuit terminal 6 & 5 V Reference circuit terminal 1
8. Verify the scan tool parameter: = Greater than 4.8 V
    - **If 4.8 V or less**

    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the electrical connector:K20 Engine Control Module
    3. Test for infinite resistance between the test points:
        - {APP Sensor 1}Signal circuit terminal 3 @Component harness & Ground
        - {APP Sensor 2}Signal circuit terminal 6 @Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance
    4. Test for less than 2 ohms between the test points:
        - {APP Sensor 1}Signal circuit terminal 3 @Component harness & The other end of the circuit@ Control module harness
        - {APP Sensor 2}Signal circuit terminal 6 @Component harness & The other end of the circuit@ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component:K20 Engine Control Module

    - **Go to next step: If greater than 4.8 V**

9. Test or replace the component:B107 Accelerator Pedal Position Sensor

Repair Instructions

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

- **Accelerator Pedal Assembly Replacement**
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P2199: INTAKE AIR TEMPERATURE (IAT) SENSOR 1-2 NOT PLAUSIBLE

Diagnostic Instructions

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

DTC Descriptor

DTC P2199

Intake Air Temperature (IAT) Sensor 1-2 Not Plausible

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114**, P2199	P0111, P0113, P0114**, P2199	P0113*, P0114**, P2199	P0111, P2199
Low Reference	-	P0111, P0113, P0114**, P2199	P0113*, P0114**	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+. **Where used.				

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P2199	P0096, P0097, P00F4, P0102, P2199	-	P0096
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P0102, P2199	P0096*, P0097, P00F4, P0102, P2199	P0096
Ground	-	P0096, P0097, P00F4, P0102, P2199	-	P0096
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

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IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz*
Ground	-	-40Â°C (-40Â°F) 10 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

The intake air temperature (IAT) sensor 1 is a variable resistor that measures the temperature of the air in the sensor bore. The engine control module (ECM) supplies 5 V to the IAT sensor 1 signal circuit and a ground for the IAT sensor 1 low reference circuit. The signal varies with inlet air temperature and is displayed by the scan tool as Â°C (Â°F).

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

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

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

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

IAT Sensor 2 - Temperature, Frequency Table

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

Conditions for Running the DTC

- The ignition is ON.
- Ignition 1 voltage is at least 11 V.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

The ECM detects that the absolute difference between the IAT sensor 1 and the IAT sensor 2 temperatures is greater than 55Â°C (99Â°F) for longer than 5 s.

Action Taken When the DTC Sets

DTC P2199 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2199 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical 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 **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

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- **Go to next step: 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 30Â°C (54Â°F) of each other.
   - Start-Up IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3; where equipped
   - **If not within 30Â°C (54Â°F)**

     Refer to Circuit/System Testing.

   - **Go to next step: If within 30Â°C (54Â°F)**
5. Engine idling, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
   - IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3; where equipped
   - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

     Refer to Circuit/System Testing.

   - **Go to next step: If between: -38 and +149Â°C (-36 and +300Â°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 sets**

     Refer to Circuit/System Testing.

   - **Go to next step: 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 Ω between the low reference circuit terminal 3 and ground.
   - **If 2 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **Go to next step: If less than 2 Ω**
3. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.
   - **If 2 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the ground circuit end to end.

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

- **Go to next step: If less than 2 Ω**

4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
   2. Test for less than 2 Ω in the ignition voltage circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
   2. Test for infinite resistance between the ignition voltage circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
   - **Go to next step: If a test lamp illuminates**
5. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature sensor 1 signal circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**

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

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

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

- **Go to next step: If warmer than 148Â°C (298Â°F).**

9. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature sensor 2 signal circuit terminal 8 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**

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

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: 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. Test or replace the B75C Multifunction Intake Air sensor.
    2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
    3. Verify the DTC does not set.
        - **If the DTC sets**

          Replace the K20 Engine Control Module.

        - **Go to next step: If no DTCs set**
    4. All OK.
    - **Go to next step: 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 8 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

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13. 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.

    - **Go to next step: If between 28 - 32 Hz**
14. 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 B111B Turbocharger Boost/Intake Air Temperature sensor.
15. Test for less than 2 Ω between the intake air temperature sensor 3 low reference circuit terminal 1 and ground.
    - **If 2 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open or high resistance in the circuit.
        - If less than 2 Ω replace the K20 Engine Control Module.
    - **Go to next step: If less than 2 Ω**
16. Ignition ON, test for 4.8 - 5.2 V between the signal 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 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**

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

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If between 4.8 - 5.2 V**
17. Test or replace the B75C Multifunction Intake Air Sensor.

Component Testing

Multifunction Intake Air Sensor

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

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

2. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)** **Temperature Versus Resistance - Intake Air Temperature Sensor (Delco Sensor)** table for Hitachi Sensors. The resistance values should be in range of the table values.
    - **If not within the specified range**

      Replace the B75C Multifunction Intake Air Sensor.

    - **Go to next step: If within the specified range**

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3. All OK.

Multifunction Intake Air Sensor

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

      Replace the B75C Multifunction Intake Air Sensor.

    - **Go to next step: If within the specified range**
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 engine control module replacement, programming, and setup.

DTC P219A: FUEL TRIM CYLINDER BALANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P219A

Fuel Trim Cylinder Balance

Circuit/System Description

The Fuel Trim Cylinder Balance diagnostic detects a rich or lean cylinder to cylinder air/fuel ratio imbalance. The diagnostic monitors the pre-catalyst heated oxygen sensor (HO2S) signal's frequency and amplitude characteristics by calculating an accumulated voltage over a predetermined sample period. An imbalance is indicated when multiple samples of the accumulated voltage are consistently higher than the desired value.

Conditions for Running the DTC

- DTCs P0016, P0017, P0030, P0036, P0053, P0054, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0019, P0122, P0123, P0128, P0131 - P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201 - P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301 - P0304, P0340, P0341, P0365, P0366, P0411, P0442, P0455, P0458, P0496, P111E, P1133, P1248, P1249, P124A, P124B, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2147, P2148, P2150. P2151, P2153, P2154, P2156, P2157, P2270, P2271, P2440, P2444 or P2A00 are not set.
- The evaporative emission system device control and intrusive diagnostics are not active.
- The engine overspeed protection is not active.
- The engine is in closed loop status.
- The system voltage is greater than 11 V.
- The engine coolant temperature (ECT) is warmer than -20Â°C (-4Â°F).
- The engine speed is between 1, 200 - 4, 000 RPM.
- The mass air flow is between 0 - 100 g/s.
- The secondary air injection pump (if equipped) is not ON.
- The Exhaust Camshaft Position and Intake Camshaft Position are between 0 - 35 degrees.

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- Engine run time is greater than 30 s.
- Fuel level is greater than 10% and no fuel level sensor fault is present.
- The DTC runs continuously when the above conditions have been met.

Conditions for Setting the DTC

Multiple samples of the pre-catalyst HO2S accumulated voltage are consistently greater than the desired value.

Action Taken When the DTC Sets

DTC P219A is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P219A is a Type A DTC.

Diagnostic Aids

- The fuel trim cylinder balance diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may cause a DTC to set.
- Monitoring the misfire current counters, or misfire graph, may help to isolate the cylinder that is causing the condition.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

- **Circuit Testing**
- **Troubleshooting with a Test Lamp**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

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- **If any other DTCs are set**

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

- **Go to next step: If no other DTCs are set**

3. Verify DTC P219A is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing.

   - **Go to next step: 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.

   - **Go to next step: If no DTC is set**
6. All OK.

Circuit/System Testing

1. Engine idling, transmission in Park or Neutral, verify the manifold absolute pressure (MAP) sensor parameter is between 20 - 48 kPa.
   - **If not within the specified range** .

     Refer to **DTC P0106** .

   - **Go to next step: If within the specified range, inspect for the conditions listed below:**
   - Modified, damaged, leaking, or restricted air induction system components.
   - Improperly operating crankcase ventilation system. Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
   - Split, kinked, or improperly connected vacuum hoses.
   - Restricted, damaged, leaking, or modified exhaust system from the catalytic converter forward. Refer to **Symptoms - Engine Exhaust** .
   - Improperly operating fuel injectors. Refer to **Fuel System Diagnosis**.
   - Fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
   - Excessive fuel in the crankcase due to leaking injectors. Change engine oil as necessary.
   - Improperly operating ignition system. Refer to **Electronic Ignition System Diagnosis**.
   - **If a condition is found**

     Repair as necessary.

   - **Go to next step: If no condition is found**
2. Test the engine for any mechanical conditions such as sticking valves, lifters, etc., which could alter the flow into the combustion chamber. Refer to **Symptoms - Engine Mechanical** .

Repair Instructions

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

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

DTC P2227, P2228, P2229, OR P2230: BAROMETRIC PRESSURE (BARO) SENSOR PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

NOTE: **This procedure may also diagnose malfunctions that are not detected by a DTC.**

DTC P2227

Barometric Pressure (BARO) Sensor Performance

DTC P2228

Barometric Pressure (BARO) Sensor Circuit Low Voltage

DTC P2229

Barometric Pressure (BARO) Sensor Circuit High Voltage

DTC P2230

Barometric Pressure (BARO) Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P06D2, P2228	P2227, P2228	P06D2, P2227, P2229	P2227
Signal	P2227, P2228	P2227, P2229	P2227, P2229	P2227
Low Reference	-	P0113, P2199, P2227, P2229	-	P2227

Typical Scan Tool Data

BARO

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition - On / Vehicle - In Service Mode & Engine - Off **Parameter Normal Range:** 56 to 105 kPa (8.1 to 15.2 PSI)			
5 V Reference	0 kPa (0.0 PSI)	0 kPa (0.0 PSI)	127 kPa (18.4 PSI)
Signal	0 kPa (0.0 PSI)	127 kPa (18.4 PSI)	127 kPa (18.4 PSI)
Low Reference	-	127 kPa (18.4 PSI)	-

Circuit/System Description

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to 5 V.
Low Reference	Grounded through the control module.

Component	Description

Component	Description

B75C Multifunction Intake Air Sensor	The assembly has several functions:
	• The mass air flow sensor is a hot film type sensor that measures the mass of air (not the volume) entering the engine. The signal varies with engine load and is displayed by the scan tool in Hertz (Hz) and grams per second (g/s).
	• The intake air humidity sensor uses the same signal circuit as the intake air temperature sensor 2. The intake air humidity sensor modulates the pulse width of the signal. The intake air temperature sensor 2 modulates the frequency of the signal. That means the signal is both, PWM and FM modulated.
	• The barometric pressure sensor generates an analog voltage that is proportional to the ambient air pressure.
	• The intake air temperature sensor 1 varies its resistance depending on the temperature.
	  • Low temperature produces a high resistance:5.6 k ohms @ 0Â°C (32Â°F)
	  • High temperature produces a low resistance:187 ohms @ 100Â°C (212Â°F)

K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Component	Description
B75C Multifunction Intake Air Sensor	The barometric pressure sensor generates an analog voltage that is proportional to the ambient air pressure.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

The barometric pressure sensor is integrated into the multifunction intake air sensor.

Conditions for Running the DTC

P2227 Condition 1

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0121, P0122, P0123, P0222, P0223, P0236, P0237, P0238, P1516, P2101, P2135, P2228, P2229 = Not set
- Engine Running = For greater than 30 s

Condition 2

- DTC P0106, P0107, P0108, P0237, P0238, P2228, P2229, P2230, P2610 = Not set
- Ignition = On
- Engine Off = For greater than 6 min

DTC runs continuously when the above conditions are met.

P2228, P2229

Engine Running = For greater than 30 s

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DTC runs 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, P0236, P0237, P0238, P1516, P2101, P2135, P2228, P2229 = Not set
- Ignition = On

DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2227 Condition 1

BARO & Calculated BARO = The actual value is not within a predetermined range of the calculated value.

Condition 2

BARO = Less than 50 kPa (7.3 PSI) or Greater than 115 kPa (16.7 PSI)

P2228

BARO = Less than 2 V - For greater than 5 s

P2229

BARO = Greater than 4.5 V - For greater than 5 s

P2230

BARO = Signal noisy or erratic - For greater than 5 s

Actions Taken When the DTC Sets

DTCs P2227, P2228, P2229, P2230 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P2227, P2228, P2229, P2230 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Disassembled 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

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0106, P0107, P0108, P0641, P0651, P0697, P06A3, P06D2 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. Determine the current vehicle testing altitude.
4. Verify the scan tool parameter:
   - MAP Sensor = **Altitude Versus Barometric Pressure** - The value should be within the range listed in the table.
   - Boost Pressure = **Altitude Versus Barometric Pressure** - The value should be within the range listed in the table.
   - BARO = **Altitude Versus Barometric Pressure** - The value should be within the range listed in the table.
   - **If not in the specified range**
   - {MAP Sensor}Refer to:**DTC P0106** .
   - {Boost Pressure}Refer to:**DTC P0236** .
   - {BARO}Refer to: Circuit/System Testing.
   - **Go to next step: If in the specified range**
5. Verify the scan tool parameter:BARO = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector:B75C Multifunction Intake Air Sensor
   - Wiggle the harness and connector:X3 @K20 Engine Control Module
   - If the value spikes or drops out

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

   - If the value does not spike or drop out
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

   - **Go to next step: If the DTC is not set**
8. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector:B75C Multifunction Intake Air Sensor
3. Test for less than 2 ohms between the test points:Low Reference circuit terminal 3 & Ground

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- **If 10 ohms or greater**

1. Disconnect the electrical connector:X2 @K20 Engine Control Module
2. Test for less than 2 ohms between the test points:Low Reference circuit terminal 3 @Component harness & The other end of the circuit@Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component:K20 Engine Control Module

- **Go to next step: If less than 10 ohms**

4. Ignition - On / Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points:5 V Reference circuit terminal 2 & Low Reference circuit terminal 3
    - **If less than 4.8 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector:X1 @K20 Engine Control Module
    3. Test for infinite resistance between the test points:5 V Reference circuit terminal 2 @Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance
    4. Test for less than 2 ohms between the test points:5 V Reference circuit terminal 2 @Component harness & The other end of the circuit@Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component:K20 Engine Control Module

    - **If greater than 5.2 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector:X1 @K20 Engine Control Module
    3. Ignition - On / Vehicle - In Service Mode
    4. Test for less than 1 V between the test points:5 V Reference circuit terminal 2 @Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component:K20 Engine Control Module

    - **Go to next step: If between 4.8 and 5.2 V**

6. Verify the scan tool parameter:BARO = Greater than 4.7 V
    - **If 4.7 V or less**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector:X3 @K20 Engine Control Module
    3. Test for infinite resistance between the test points:Signal circuit terminal 4 @Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component:K20 Engine Control Module

    - **Go to next step: If greater than 4.7 V**

7. Connect a 3 A fused jumper wire between the test points:Signal circuit terminal 4 & Low Reference circuit terminal 3
8. Verify the scan tool parameter:BARO = Less than 0.2 V
    - **If 0.2 V or greater**

    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the electrical connector:X3 @K20 Engine Control Module
    3. Ignition - On / Vehicle - In Service Mode
    4. Test for less than 1 V between the test points:Signal circuit terminal 4 @Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 0.2 V

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5. Ignition/Vehicle - Off
6. Test for less than 2 ohms between the test points:Signal circuit terminal 4 @Component harness & The other end of the circuit@Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component:K20 Engine Control Module
- **Go to next step: If less than 0.2 V**

9. Test or replace the component:B75C Multifunction Intake Air Sensor

Repair Instructions

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

- **Mass Airflow Sensor Replacement** - B75C Multifunction Intake Air Sensor
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P2261: TURBOCHARGER BYPASS VALVE STUCK

Diagnostic Instructions

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

DTC Descriptor

DTC P2261

Turbocharger Bypass Valve Stuck

Circuit/System Description

The dual-scroll turbocharger incorporates a wastegate that is controlled by the engine control module (ECM) by means of a pulse width modulation (PWM) solenoid, to regulate the pressure ratio of the compressor. An ECM controlled compressor bypass valve is integrated into the unit to prevent compressor surging and damage from vibrations by opening during abrupt closed throttle conditions. The bypass valve is open during closed throttle deceleration conditions to allow air to recirculate in the turbocharger and maintain compressor speed.

As engine load and speed increase, the turbocharger bypass valve is commanded closed by the ECM. As soon as the throttle closes, the valve is commanded open to allow the turbocharger air to recirculate to prevent compressor surging.

Conditions for Running the DTC

- DTC P0033, P0034, P0035, P0101, P0102, P0103, P0236, P0237, or P0238 is not set.
- Engine speed is at least 1, 500 RPM
- Boost pressure versus the BARO pressure ratio is between 1.0 - 3.2.
- Turbocharger bypass valve has been commanded Open greater than 6% for greater than 1.5 s immediately after an abrupt closed throttle has occurred and the resulting pressure ratio across the compressor exceeds the calibrated pressure ratio limit.

The DTC runs continuously when the above conditions have been met.

Conditions for Setting the DTC

The ECM has detected a series of pulsations in the induction system that exceed a calibrated threshold.

Action Taken When the DTC Sets

- DTC P2261 is a Type C DTC.
- The Service Vehicle Soon Indicator may illuminate.

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Conditions for Clearing the MIL/DTC

DTC P2261 is a Type C DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Turbocharger 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 P0033, P0034, or P0035 is not set
   - **If any of the DTCs are set**

     Refer to **DTC P0033-P0035** .

   - **Go to next step: If none of the DTCs are set**
3. Verify the scan tool BARO Sensor parameter is within the range specified in the **Altitude Versus Barometric Pressure** table for the current testing altitude.
   - **If the parameter is not within the range specified in the table.**

     Refer to **DTC P2227-P2230**.

   - **Go to next step: If the parameter is within the range specified in the table.**
4. Verify the scan tool Boost Pressure Sensor and BARO Sensor parameters are within 3 kPa (0.4 psi).
   - **If the parameters are not within 3 kPa (0.4 psi).**

     Refer to **DTC P0236** .

   - **Go to next step: If the parameters are within 3 kPa (0.4 psi).**
5. Verify a click is heard or felt from the Q40 turbocharger bypass solenoid valve when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
   - **If a click is not heard or felt**

     Refer to Circuit/System Testing

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- **Go to next step: If a click is heard or felt**

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 a DTC does not set.
   - **If a DTC sets**

     Refer to Circuit/System Testing

   - **Go to next step: If a DTC does not set**
8. All OK

Circuit/System Testing

NOTE: **Leave harness connector connected or re-connect it after removing valve.**

1. Ignition Off. Disconnect the Q40 turbocharger bypass solenoid valve, ignition On.
2. Verify the turbocharger bypass valve plunger retracts and extends when commanding the Turbocharger Bypass Solenoid Valve between Active and Inactive with a scan tool.
   - **The valve plunger does not retract and extend**

     Replace the Q40 turbocharger bypass solenoid valve

   - **Go to next step: The valve plunger retracts and extends**
3. Verify the conditions listed below do not exist with the turbocharger assembly. Refer to **Turbocharger Cleaning and Inspection**
   - Cracked, damaged or worn turbine blades
   - Restricted wastegate, turbine, ports or passages
   - Foreign material
   - **If a condition exists**

     Repair or replace the turbocharger as necessary

   - **Go to next step: If none of the conditions exist**
4. Replace the Q40 turbocharger bypass solenoid valve

Component Testing

Static Test

1. Ignition Off, disconnect the harness connector at the Q40 turbocharger bypass solenoid valve.
2. Test for 10 - 14 Ω between the control terminal 2 and the Ignition terminal 1 of the Q40 turbocharger bypass solenoid valve.
   - **If not between 10 - 14 Ω**

     Replace the Q40 turbocharger bypass solenoid valve.

   - **Go to next step: If between 10 - 14 Ω**
3. All OK

Dynamic Test

1. Install a 15 A fused jumper wire between the ignition terminal 2 of the Q40 turbocharger bypass solenoid valve and 12 V. Install a jumper wire between the control terminal 1 and ground.
2. Verify the Q40 turbocharger bypass solenoid valve plunger retracts.
   - **If the plunger does not retract.**

     Replace the Q40 turbocharger bypass solenoid valve.

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- **Go to next step: If the plunger retracts.**

3. All OK

Repair Instructions

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

- **Turbocharger Bypass Valve Solenoid Replacement**
- **Turbocharger Replacement**

DTC P2544: TRANSMISSION TORQUE REQUEST CIRCUIT MESSAGE COUNTER INCORRECT

Diagnostic Instructions

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

DTC Descriptors

DTC P2544

Transmission Torque Request Circuit Message Counter Incorrect

Circuit/System Description

To improve shift feel, the transmission control module (TCM) is constantly sending the engine control module (ECM) serial data messages with requests to modify engine speed or torque. These serial data messages are sent through two circuits which are part of a communication network called the controller area network (CAN). The ECM sets DTC P2544 when it detects a discrepancy in the structure of the message causing the integrity of the message to be questioned.

Conditions for Running the DTC

- The engine run time is greater than 0.5 s.
- No other CAN errors are present.

Conditions for Setting the DTC

The ECM detects that the engine speed and torque modification messages from the TCM are either corrupted or intermittently missing for greater than 4 s.

Action Taken When the DTC Sets

- DTC P2544 is a Type B DTC.
- The TCM commands maximum line pressure during shifts, which results in harsh shifts.
- The TCM freezes adaptive functions.

Conditions for Clearing the DTC

DTC P2544 is a Type B DTC.

Diagnostic Aids

An intermittent fault in the CAN circuits will cause the ECM to set DTC P2544.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

NOTE:

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

1. Verify that no other DTCs are set except for DTC P2544.
   - **If any other DTCs are set**

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

   - **Go to next step: If only DTC P2544 is set**
2. Replace the K71 Transmission Control Module.
3. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
4. Verify the DTC does not set.
   - **If DTC sets**

     Replace the K20 Engine Control Module.

   - **Go to next step: If DTC does not set**
5. All OK.

Repair Instructions

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

Control Module References for ECM or TCM replacement, programming, and setup

DTC P25CA, P25CB, OR P25CC: INTAKE CAMSHAFT POSITION ACTUATOR PARK LOCK SOLENOID VALVE CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P25CA

Intake Camshaft Position Actuator Park Lock Solenoid Valve Control Circuit

DTC P25CB

Intake Camshaft Position Actuator Park Lock Solenoid Valve Control Circuit Low Voltage

DTC P25CC

Intake Camshaft Position Actuator Park Lock Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P25CB*	P25CB*	P0690*	-
Control	P0016, P25CB	P25CA	P25CC	-
* Additional DTCs may set.				

Circuit/System Description

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For an overview of the component/system, refer to:**Camshaft Actuator System Description**

Circuit	Description
Ignition	Supplied from a fuse.
Control	The output circuit is switched to ground to activate the component.

Component	Description
Q84 Camshaft Position Actuator Park Lock Solenoid Valve	A solenoid valve is an electro-mechanically operated valve. The valve is controlled by an electric current through the solenoid.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

- Ignition Voltage = Greater than 11 V
- Ignition = OnorEngine = Running
- Intake Camshaft Position Actuator Park Lock Solenoid Valve Command = On

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

Conditions for Setting the DTC

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

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Master Electrical Component List

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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Control Module References

Circuit/System Verification

NOTE: **Verify the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic.**

1. Engine - Running@ 1, 000 to 1, 500 RPM
2. Verify the scan tool parameter:
   - Intake Camshaft Position Actuator Park Lock Solenoid Valve Control Circuit High Voltage Test Status = OKorNot Run
   - Intake Camshaft Position Actuator Park Lock Solenoid Valve Control Circuit Low Voltage Test Status = OKorNot Run
   - Intake Camshaft Position Actuator Park Lock Solenoid Valve Control Circuit Open Test Status = OKorNot Run
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
3. Verify the scan tool parameter:
   - Intake Camshaft Position Actuator Park Lock Solenoid Valve Control Circuit High Voltage Test Status = OKorNot Run
   - Intake Camshaft Position Actuator Park Lock Solenoid Valve Control Circuit Low Voltage Test Status = OKorNot Run
   - Intake Camshaft Position Actuator Park Lock Solenoid Valve Control Circuit Open Test Status = OKorNot Run
   - Perform the action while monitoring the parameter:
   - Wiggle the harness and connector:Q84 Camshaft Position Actuator Park Lock Solenoid Valve
   - Wiggle the harness and connector:K20 Engine Control Module
   - **If not the specified state**

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

   - **Go to next step: If the specified state**
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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

   - **Go to next step: If the DTC is not set**
5. All OK.

Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector:Q84 Camshaft Position Actuator Park Lock Solenoid Valve
3. Ignition - On / Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points:Ignition circuit terminal 1 & Ground
   - **If the test lamp does not turn On and the circuit fuse is OK**
   1. Ignition/Vehicle - Off & Remove - Test lamp

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2. Test for less than 2 ohms between the test points:Ignition circuit terminal 1 & Output terminal@Fuse
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.
- **If the test lamp does not turn On and the circuit fuse is open**

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Connect the electrical connector:Q84 Camshaft Position Actuator Park Lock Solenoid Valve
3. Ignition - On / Vehicle - In Service Mode
4. Replace the component:Fuse
5. Verify the fuse does not open.
    - If the fuse opens and there are components connected to the circuit - Disconnect a component and repeat step 4
    - If the fuse opens with all components disconnected from the circuit - Repair the short to ground on the circuit.
    - If the fuse does not open after disconnecting a component from the circuit - Replace the component disconnected last.
    - If the fuse does not open with all components connected.
6. Operate each component on the circuit, one at a time.It might be necessary to use scan tool control functions to operate the components.

    Verify the fuse does not open when any of the components are activated.

    - If the fuse opens - Replace the component that caused the fuse to open when activated.
    - If the fuse does not open.
7. All OK.

- **Go to next step: If the test lamp turns On**

5. Verify a test lamp does not turn On between the test points:Control circuit terminal 2 & B+
    - **If the test lamp turns On**

    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Disconnect the electrical connector: X3 @K20 Engine Control Module
    3. Test for infinite resistance between the test points:Control circuit terminal 2 @Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component: K20 Engine Control Module
    - **Go to next step: If the test lamp does not turn On**
6. Remove - Test Lamp
7. Engine - Running@1, 000 to 1, 500 RPM
8. Verify the scan tool parameter: Intake Camshaft Position Actuator Park Lock Solenoid Valve Control Circuit High Voltage Test Status = OK
    - **If not the specified state**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X3 @K20 Engine Control Module
    3. Test for less than 1 V between the test points:Control circuit terminal 2 @Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component: K20 Engine Control Module
    - **Go to next step: If the specified state**
9. Ignition/Vehicle - Off
10. Connect a 3 A fused jumper wire between the test points:Control circuit terminal 2 & Ignition circuit terminal 1
11. Engine - Running@1, 000 to 1, 500 RPM

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12. Verify the scan tool parameter: Intake Camshaft Position Actuator Park Lock Solenoid Valve Control Circuit High Voltage Test Status = Malfunction
    - **If not the specified state**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the electrical connector: X3 @K20 Engine Control Module
    3. Test for less than 2 ohms between the test points:Control circuit terminal 2 @Component harness & The other end of the circuit@Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K20 Engine Control Module
    - **Go to next step: If the specified state**
13. Test or replace the component:Q84 Camshaft Position Actuator Park Lock Solenoid Valve

Component Testing

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector:Q84 Camshaft Position Actuator Park Lock Solenoid Valve
3. Test for 11 to 30 ohms between the test points:Control terminal 2 & Ignition terminal 1
    - **If not between 11 and 30 ohms**

      Replace the component:Q84 Camshaft Position Actuator Park Lock Solenoid Valve

    - **Go to next step: If between 11 and 30 ohms**
4. Test for infinite resistance between the test points:Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component:Q84 Camshaft Position Actuator Park Lock Solenoid Valve

    - **Go to next step: If infinite resistance**
5. All OK.

Dynamic Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector:Q84 Camshaft Position Actuator Park Lock Solenoid Valve
3. Connect a 3 A fused jumper wire between the test points:Ignition terminal 1 & 12 V

   CAUTION: **Complete the testing as quickly as possible in order to prevent overheating and damaging the component.**

4.
5. Momentarily connect a jumper wire between the test points:Control terminal 2 & Ground

   Verify the component turns On and Off when connecting and disconnecting the jumper wire:Q84 Camshaft Position Actuator Park Lock Solenoid Valve

    - **If the component does not turn On and Off**

      Replace the component:Q84 Camshaft Position Actuator Park Lock Solenoid Valve

    - **Go to next step: If the component turns On and Off**
6. All OK.

Repair Instructions

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

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- Camshaft Position Actuator Locating Pin Control Valve Replacement - Q84 Camshaft Position Actuator Park Lock Solenoid Valve
- For control module replacement, programming, and setup refer to: Control Module References

DTC P2618: CRANKSHAFT POSITION SIGNAL OUTPUT CIRCUIT LOW VOLTAGE OR HIGH VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P2618

Crankshaft Position Signal Output Circuit Low Voltage

DTC P2619

Crankshaft Position Signal Output Circuit High Voltage

Conditions for Running the DTC

- Ignition Voltage = Greater than 11 V
- Ignition = On
- Crankshaft Position Sensor Circuit = Active

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

Conditions for Setting the DTC

P2618

Crankshaft Position Signal Output Circuit = Short to GroundorOpen - For greater than 5 s

P2619

Crankshaft Position Signal Output Circuit = Short to Voltage - For greater than 5 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type C DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type C DTC

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Engine - Running
2. Verify there are no DTCs/symptoms related to the following system/component, if equipped:
    - K71 Transmission Control Module
    - K103 Fuel Injector Control Module
    - T3 Audio Amplifier

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- T6 Power Inverter Module
- **If a DTC or symptom exists**

  Refer to:

- **Diagnostic Trouble Code (DTC) List - Vehicle**
- **Symptoms - Vehicle**
- **Go to next step: If no DTC or symptom exists**

3. All OK.

DTC P2635: FUEL PUMP FLOW PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P2635

Fuel Pump Flow Performance

Circuit/System Description

The engine control module (ECM) supplies voltage to the fuel pump driver control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump driver control module remains active for 2 s, unless the engine is in crank or run. While this voltage is being received, the fuel pump driver control module closes the ground switch of the fuel pump. The fuel pump driver control module maintains correct fuel pressure based on the information from the fuel pressure sensor and varying the pulse width modulated controlled current to the fuel pump.

Conditions for Running the DTC

- DTC P018B, P018C, P018D, P0231, P0232, P023F, P0641, or P1255 are not active.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The ignition voltage is between 11 - 32 V.
- The engine has been running for greater than or equal to 30 s.
- The engine fuel flow is not 0.
- Low fuel level warning not present.
- The DTC runs continuously when the conditions above are met.

Conditions for Setting the DTC

The fuel pump driver control module detects a difference of Â± 60 kPa (8.7 PSI) at 400 kPa (58 PSI) request or Â±45 kPa (6.5 PSI) at 300 kPa (43.5 PSI) request between the desired fuel pressure and the actual fuel pressure for approximately 10 s.

Action Taken When the DTC Sets

DTC P2635 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2635 is a Type B DTC.

Diagnostic Aids

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The

Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

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

A restricted or dislocated fuel feed front pipe check valve may cause fuel pump flow performance issues.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC U0074 or U18A2 is not set or stored in history.
   - **If DTC U0074 or U18A2 is set or stored in history**

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

   - **Go to next step: If DTC U0074 or U18A2 is not set or stored in history**
3. Verify that DTC P018B, P018C, P018D, P0231, P0232, or P023F is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
4. Command the Fuel Pressure to 300 kPa (43.5 PSI) using the scan tool Control Function: Fuel Pressure Increase/Decrease.
5. Verify the scan tool parameter: Fuel Pressure Sensor & Desired Fuel Pressure are within 45 kPa (6.5 PSI) of each other at 300 kPa (43.5 PSI) request.
   - **If greater than 45 kPa (6.5 PSI)**

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Refer to Circuit/System Testing.

- **Go to next step: If less than 45 kPa (6.5 PSI)**

6. Command the Fuel Pressure to 400 kPa (58 PSI) using the scan tool Control Function: Fuel Pressure Increase/Decrease.
7. Verify the scan tool parameter: Fuel Pressure Sensor & Desired Fuel Pressure are within 60 kPa (8.7 PSI) of each other at 400 kPa (58 PSI) request.
   - **If greater than 60 kPa (8.7 PSI)**

     Refer to Circuit/System Testing.

   - **Go to next step: If less than 60 kPa (8.7 PSI)**
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.

   - **Go to next step: If the DTC does not set**
10. All OK.

Circuit/System Testing

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

1. Verify the proper fuel system pressure. Refer to **Fuel System Diagnosis**.
   - **If the fuel pressure is not normal**

     Repair the fuel system as necessary.

   - **Go to next step: If the fuel pressure is normal**
2. All OK.

Repair Instructions

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

- **Fuel Feed Front Pipe Replacement**
- **Fuel Feed Intermediate Pipe Replacement**
- **Fuel Feed Pipe Replacement (FWD)** **Fuel Feed Pipe Replacement (AWD)**
- **Fuel Injector Replacement**
- **Fuel Tank Fuel Pump Module Replacement (FWD)** **Fuel Tank Fuel Pump Module Replacement (AWD)**

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Turn OFF the ignition for 60 s.
5. Operate the vehicle within the Conditions for Running the DTC.
6. Command the Fuel Pressure to 300 kPa (43.5 PSI) using the scan tool Control Function: Fuel Pressure Increase/Decrease.

7. Verify the scan tool parameter: Fuel Pressure Sensor & Desired Fuel Pressure are within 45 kPa (6.5 PSI) of each other at 300 kPa (43.5 PSI) request.
    - **If greater than 45 kPa (6.5 PSI)**

      Refer to Circuit/System Testing.

    - **Go to next step: If less than 45 kPa (6.5 PSI)**
8. Command the Fuel Pressure to 400 kPa (58 PSI) using the scan tool Control Function: Fuel Pressure Increase/Decrease.
9. Verify the scan tool parameter: Fuel Pressure Sensor & Desired Fuel Pressure are within 60 kPa (8.7 PSI) of each other at 400 kPa (58 PSI) request.
    - **If greater than 60 kPa (8.7 PSI)**

      Refer to Circuit/System Testing.

    - **Go to next step: If less than 60 kPa (8.7 PSI)**
10. All OK.

DTC P26C8: CHASSIS CONTROL MODULE REQUESTED MIL ILLUMINATION

Diagnostic Instructions

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

DTC Descriptor

DTC P26C8

Chassis Control Module Requested MIL Illumination

Circuit/System Description

The chassis control module constantly monitors the chassis control system for any condition which may adversely affect vehicle emissions. If a condition is detected, the chassis control module sets a DTC and sends a serial data message to the engine control module (ECM). The ECM sets DTC P26C8 to inform the technician that the chassis control module has set the emission related DTC. The serial data message sent by the chassis control module also contains a request for the ECM to illuminate the malfunction indicator lamp (MIL).

The technician can observe the DTC that was set by the chassis control module by reviewing the ECM Freeze Frame records on the scan tool. The ECM Freeze Frame records also contain the engine operating conditions present when the chassis control module DTC set.

Conditions for Running the DTC

The ignition is ON, or the engine is running for greater than 3 s.

Conditions for Setting the DTC

The ECM receives a serial data message from the chassis control module indicating that an emission related DTC has set in the chassis control module.

Action Taken When the DTC Sets

- DTC P26C8 is a Type A DTC.
- DTC P26C8 will continue to be current or active as long as the chassis control module is requesting MIL illumination.

Conditions for Clearing the DTC

DTC P26C8 is a Type A DTC.

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Diagnostic Aids

Communication codes, U-codes, as well as powertrain codes, P-codes, set in the chassis control module will cause the chassis control module to request DTC P26C8 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 P26C8 is an informational DTC.**
- **Correct any engine control and communication DTCs before diagnosing chassis control module DTCs.**

1. Verify there are no engine control or communication DTCs set.
   - **If a DTC is set**

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

   - **Go to next step: If a DTC is not set**
2. Verify there are no chassis control module DTCs set.
   - **If a DTC is set**

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

   - **Go to next step: 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** .

   - **Go to next step: If the DTC does not set**
5. All OK.

Repair Instructions

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

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

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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.

Dieseling, Run-On

Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Engine Control Module (ECM) Commanded Reduced Engine Power

The ECM illuminates the Reduced Engine Power lamp and will limit engine power under potential engine damaging or emissions related conditions. A DTC may not set.

Hard Start

Engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stalls.

Hesitation, Sag, Stumble

Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

Lack of Power, Sluggishness, or Sponginess

The engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way.

Poor Fuel Economy

Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

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.

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Symptoms Verification

Before using the Symptom tables, perform the following inspections:

- Verify that the 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 that the vehicle tires are correctly inflated and meet original equipment specifications.
- Verify that the Flex Fuel reservoir has a sufficient amount of fuel in it.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.

Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

- Moisture and water intrusion in connectors, terminals, and components
- Incomplete connector mating
- Poor terminal contact
- High circuit or component resistance - High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness that is too short or tight
- Wire insulation that is chaffed or cut
- High or low ambient temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surfaces
- Electromagnetic 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 conditions listed below:
  - Collapsed
  - Damaged areas
  - Looseness
  - Incorrect installation
  - Leaking

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If any condition listed above has allowed non-metered air to enter the air induction system, the **Throttle Body Idle Air Flow Compensation Reset** procedure must be performed after the repair is complete.

- Inspect for air leaks at the throttle body mounting area, the Mass Air Flow (MAF) sensor and intake manifold sealing surfaces.
- Inspect the wiring harness for the following conditions:
  - Poor connections
  - Pinches
  - Cuts
- Inspect for loose, damaged, unseated, or missing sensors/components.
- Inspect the terminals for corrosion and correct contact.

Symptoms Testing

Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Engine Control Module (ECM) Commanded Reduced Engine Power, 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:
   - Incorrectly operating fuel system. Test/inspect for the following:
     - Incorrect system operation or fuel pressure. Refer to **Fuel System Diagnosis**.
     - Leaking or incorrectly operating fuel injectors. Refer to **Fuel Injector Diagnosis**.
     - Contaminated or poor quality fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
   - Incorrectly operating ignition system. Test/Inspect for the following:
     - Spark plugs with incorrect heat range or an abnormal condition. Refer to **Spark Plug Inspection** , and **Ignition System Specifications** .
     - Coolant or oil fouled spark plugs. For diagnosis, refer to **Oil Consumption Diagnosis** , and **Coolant in Combustion Chamber** .
     - Secondary ignition system susceptible to moisture. Wet down the secondary ignition system with water from a spray bottle to help locate damaged or deteriorated components. Look/listen for arcing or misfiring as the water is applied.
     - Weak spark using the **EL 26792** HEI Spark Tester. For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)** . Refer to **Electronic Ignition System Diagnosis**.
   - Non-metered air flow into the air induction system. If a leak is found, repair as necessary. The **Throttle Body Idle Air Flow Compensation Reset** procedure must be performed when the repair is complete.
   - An incorrectly installed MAF/Intake Air Temperature (IAT) Sensor. Refer to **Mass Airflow Sensor Replacement** .
   - An incorrectly operating transmission Ttorque Converter Clutch (TCC). The scan tool should indicate an engine speed drop when the TCC is commanded ON.
   - An incorrectly operating A/C compressor
   - Items that can cause an engine to run lean or rich. Refer to **DTC P0171 or P0172** .
   - 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 **DTC P0324-P0333, P06B6, or P06B7** , **DTC P0324-P0333, P06B6, or P06B7** , and **Knock Sensor Replacement (Sensor 1)** **Knock Sensor Replacement (Sensor 2)** .
   - An incorrectly operating turbocharger system, if equipped.
   - Leaking turbocharger charge air cooler system, if equipped.
   - Electromagnetic interference on the reference circuit, which can cause a misfire condition. You can usually detect electromagnetic interference with a scan tool by monitoring the

engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that electromagnetic interference is present. Inspect the high voltage components near the ignition control circuit if a condition exists.

- An incorrectly operating positive crankcase ventilation system. Inspect all connections for leaks or restrictions. Refer to **Crankcase Ventilation System Inspection/Diagnosis**
- A stuck open Evaporative Emission (EVAP) Canister Purge Solenoid Valve.
- An incorrectly operating variable camshaft actuator system. Engine warm and idling, command the intake and exhaust camshaft actuators from 0 degrees to 20 degrees and back to zero while observing the scan tool Intake Camshaft Position Variance and Exhaust Camshaft Position Variance parameters. Each parameter should be less than 2 degrees in each of the commanded states.
    - If any of the parameters is greater than 2 degrees, inspect the suspect camshaft actuator and camshaft actuator solenoid valve and valve bore for contamination, obstruction, and damage. Refer to **Camshaft Actuator System Description** , **Camshaft Position Actuator Solenoid Valve Replacement - Exhaust** , and **Camshaft Position Actuator Solenoid Valve Replacement - Intake** .
- An incorrectly operating engine cooling system. Test/Inspect for the following:
    - A thermostat with incorrect heat range. Refer to **Thermostat Diagnosis** .
    - Incorrectly operating engine coolant thermostat heater, if equipped. Refer to DTC P0597 - P0599.

      Incorrect engine coolant level. Refer to **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)** .
- An incorrectly operating exhaust system. Test/Inspect the components for the following:
    - Physical damage or possible internal malfunction.
    - Restricted 3-way catalytic converters.

      For more information, refer to **Symptoms - Engine Exhaust** .
- An engine mechanical condition. Test/Inspect for the following:
    - Too much 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
    - Too much carbon buildup in the combustion chambers. Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.
    - Incorrect engine parts

      For additional information, refer to **Symptoms - Engine Mechanical** .

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.
- If there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicle minimum octane requirements.

ECM Commanded Reduced Engine Power

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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 cluster. If equipped with the driver information center feature, a reduced engine power message may be displayed as well. A DTC may not be set.

A repair may not be necessary. Observe the scan tool Reduced Engine Power History parameter or refer to **K20 Engine Control Module: Scan Tool Information** to determine the reason for the reduced engine power event.

Verify or inspect for the following:

- Vehicle being operated at sustained high engine speeds, or, towing heavy loads up an incline for an extended period of time, which may cause the engine oil or coolant to overheat. Inspect the airflow passageways in front of the engine for obstructions and clear away any debris or foreign material that is found. If no obstructions are found, review approved driving habits with the customer. The customer may need to operate the vehicle at a higher engine speed to improve cooling system performance, or, at a slower engine speed to reduce engine load.
- A cooling fan condition which may cause the ECM to reduce engine power. Refer to **Cooling Fan Description and Operation** , and **Cooling System Description and Operation** to verify correct operation of the cooling fan.
- Fuel temperature out of range too high.
- High pressure fuel system condition. Refer to **Fuel System Diagnosis**, and **Fuel System Description** to verify high pressure fuel system operation.
- Reduced engine power due to OnStarÂ® remote command. Verify the vehicle is not in the OnStarÂ® initiated Stolen Vehicle Slowdown mode.
- Turbocharger boost pressure out of range, if equipped. Refer to **DTC P0234 or P0299** .
- Intake air temperature out of range too high. Engine running, observe the scan tool IAT sensor parameter. The readings should be between -40Â° C and +149Â° C (-40Â° F and +300Â° F. Refer to **DTC P0112, P0113, or P0114** for additional information.
- If equipped with manual transmission, excessively hot manual transmission fluid. Under severe operating conditions the fluid may become overheated, which may result in ECM commanded reduced engine power. Allow the transmission and fluid to cool down. Review the maintenance recommendation in the owners manual to determine if the transmission fluid is due to be serviced.
- If equipped with automatic transmission, an incorrect learned brake pedal position (BPP) sensor. Verify the following actions have not occurred:
  - An engine control module has been replaced
  - A BPP sensor that has been replaced
  - A BPP sensor is misaligned or incorrectly installed

    If any of the above actions have occurred, the **Brake Pedal Position Sensor Calibration** procedure must be performed.

Fuel Odor

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

Hard Start

- Observe the 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** .
- 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 3Â°C (5Â°F). If the ECT sensor is out of range with the IAT sensor, test the

resistance of the ECT sensor. Refer to **Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)** **Temperature Versus Resistance - Intake Air Temperature Sensor (Delco Sensor)** 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.

- Verify that the fuel system operates correctly and provides adequate pressure for engine start-up The fuel pump should turn ON for 2 s when the ignition is turned ON. Refer to **Fuel System Diagnosis**, and **Fuel System Description** for fuel pressure specifications and additional information.

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.

Lack of Power, Sluggishness, or Sponginess

- Inspect the engine electrical system for incorrect operation. Refer to **Symptoms - Engine Electrical** .
- Verify that each injector harness is connected to the correct injector.
- Inspect the MAF sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor Replacement** .
- If equipped with a Supplemental Transmission Auto Shift, verify that the brake sensor is not stuck in the applied position. The Enhanced Electronic Pedal Override functionality in the ECM reduces the driver torque request if the accelerator pedal and the brake pedal are applied simultaneously
- Verify the correct operation of the turbocharger system. Perform the following:
  - Inspect the turbocharger moving components for looseness, binding, wear and damage.
  - Verify that the turbocharger air inlet ducts and outlet ducts are tightly sealed and that the air passages are not obstructed. Engine running, use a smoke generating device or a solution of dish soap and water in a spray bottle to pinpoint any air leaks.
  - Inspect the turbocharger system for external fluid leaks. Inspect the gaskets and sealing surfaces and look for cracks in the turbocharger components.
  - Inspect for excessive turbocharger system noise. Operate the vehicle at various acceleration modes and compare the turbocharger noise to the noise made by a known good system.
  - For additional information, refer to **Turbocharger Cleaning and Inspection** .

Poor Fuel Economy

- 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 for heavy loads being carried or towed
- Inspect for acceleration rate too much or too often
- Inspect for incorrect operation of the speedometer.
- Inspect the brake system for brake drag.

Rough, Unstable, or Incorrect Idle and Stalling

- An excessively high idle may be due to the floor mat interfering with the accelerator pedal. With this condition present, it may not be possible to shift the transmission into gear. Inspect the accelerator pedal for binding and verify that the floor mat is not interfering with the accelerator pedal movement.
- Engine idle speed be unstable or the engine may stall if the ECM has learned an incorrect idle/airflow compensation value. A DTC may also set. Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90 % may indicate an excessive

accumulation of deposits in the throttle bore. If the throttle body needs cleaning, refer to **Throttle Body Inspection and Cleaning** .

The actions listed below may also cause the ECM to learn an incorrect idle value:

- The ECM has been replaced
- The throttle body has been replaced
- The throttle body has been cleaned but the idle learn procedure was not performed after completing the cleaning
- The air induction system was leaking, allowing non-metered air to enter the combustion chamber. The leak was repaired, but the idle learn procedure was not performed after repairing the leak.

  If any of the actions listed above have occurred, the **Throttle Body Idle Air Flow Compensation Reset** procedure must be performed.

- Inspect the engine mounts for looseness, damage, and wear.
- Inspect the intake and exhaust manifolds for casting flash.
- Inspect engine for a slushy or frozen condition. Refer to **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**

Surges/Chuggles

- Verify that each injector harness is connected to the correct injector.
- Inspect for slow responding Heated Oxygen Sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of room temperature vulcanizing sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The ECM reduces the amount of fuel delivered to the engine, causing a driveability condition.

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.

Diagnostic Aids

Inspect for any of the conditions listed below:

- If equipped with a key type ignition system, a partially retracted or folded over ignition key. When attempting to start the engine, the mechanical portion of the vehicle key must be locked in the fully extended position with the fob parallel to the key. Leaving the key partially retracted or folded over when starting may interrupt transponder authentication and result in an intermittent no-start condition. In such instances, DTC B3055 may also be set. If an intermittent no-start complaint is received, it may be necessary to discuss with the customer their starting habits and verify they are locking the key in the fully extended position, fob parallel to the key, before starting.
- A crankshaft position sensor condition. Check the crankshaft position sensor engine reference signal with a scan tool. Observe the Engine Speed parameter while cranking the engine. The scan tool should indicate a steady 200 - 300 RPM while cranking. If erratic values, such as sudden spikes in the engine speed, are displayed, the engine reference signal is not stable enough for the engine to start and run properly.

- Insufficient fuel. 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. Refer to **Fuel Injector Diagnosis** for diagnosis.
- Fuel injector ON time inadequate. When this condition is present, 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 engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Check all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle.
- Loose unsecured engine electrical grounds. Inspect the engine for good secure electrical grounds.
- Water or foreign material in the fuel, which can cause either a no start or a 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.
- An ignition system that is susceptible to moisture. If the engine starts and runs after being brought into a warm, dry repair shop, the ignition system may be susceptible to moisture. Spray water on the ignition system components and wiring while cranking the engine in order to check for an engine starting or will not stay running concern.
- 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.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

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

- **EL 26792** HEI Spark Tester

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

Circuit/System Verification

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

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

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1. Crank the engine for up to 15 s.
2. Verify that DTC P0117, P0118, P0122, P0123, P0222, P0223, P0335, P0336, P0513, P0562, P0563, P0601, P0602, P0603, P0604, P0606, P062F, P0633, P0641, P0651, P0685, P0689, P0690, P0697, P06A3, P06D2, P1516, P1631, P1682, P16F3, P2101, P2119, or P2610 is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
   - **Go to next step: If none of the DTCs are set**
3. Ignition ON.
4. Verify the security indicator on the instrument cluster illuminates momentarily.
   - **If the 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** .
   - **Go to next step: If the 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** .
   - **Go to next step: If greater than 0 RPM**
6. Connect the **EL 26792** HEI Spark Tester between the boot of a spark plug wire and ground.

   NOTE: **An erratic or weak spark is considered a no spark condition.**
7. Verify the spark tester sparks while cranking the engine.
   - **If the spark tester does not spark**

     Refer to **Electronic Ignition System Diagnosis**.
   - **Go to next step: If the spark tester sparks**
8. Ignition ON.

   NOTE:
   - **If the engine is too hot, high fuel pressure readings may result due to hot soak fuel boiling. Allow the engine coolant temperature to cool to less than 60Â° C (150Â° F) before attempting to verify fuel pressure.**
   - **The Fuel Pump Enable may need to be commanded On a few times in order to obtain the highest possible fuel pressure.**
   - **Additional DTCs may set when using the fuel pump output control.**
9. Command the Fuel Pump Enable On several times with a scan tool.
10. Verify the scan tool Fuel Pressure Sensor parameter is between 345 - 650 kPa (50 - 94 PSI) with the fuel pump running.
    - **If not within the specified range**

      Refer to **Fuel System Diagnosis**.
    - **Go to next step: If within the specified range**
11. Verify the scan tool Fuel Pressure Sensor parameter, after the fuel pump has turned OFF, decreases to less than 600 kPa (87 PSI) and does not decrease greater than 34 kPa (5 PSI) in 1 minute.

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- **If not within the specified range**

  Refer to **Fuel System Diagnosis**.

- **Go to next step: If within the specified range**

12. Verify the conditions listed below do not exist:
    - Collapsed air intake duct to the throttle body
    - Air filter and air intake system for restrictions and obstructions
    - Spark plugs for being gas or coolant fouled
    - A skewed manifold absolute pressure (MAP) sensor
    - A skewed engine coolant temperature (ECT) sensor
    - Test the exhaust system for restrictions. Refer to **Restricted Exhaust** .
    - Test the fuel for contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
    - Engine mechanical condition, for example, worn timing belt or low compression. Refer to **Symptoms - Engine Mechanical** .
      - **If a condition exists**

        Repair as necessary.

      - **Go to next step: If no conditions exist**

13. All OK.

Repair Verification

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

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 engine control module (ECM) and the transmission control module (TCM) monitor powertrain conditions for any condition which may adversely affect vehicle emissions. The ECM and the TCM communicate these conditions through the serial data network. When the ECM or TCM detects the adverse condition, a request is sent to the instrument panel cluster to illuminate the malfunction indicator lamp (MIL). Ignition 1 voltage is supplied internally through the instrument panel cluster to the MIL. The instrument panel cluster turns the MIL ON by internally grounding the MIL. The MIL should be on steady with the ignition ON and the engine OFF. The MIL should turn OFF when the engine is started.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Instrument Cluster Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. Command the Malfunction Indicator Lamp On and Off with a scan tool.
    - **If the MIL does not turn ON and OFF**

      Refer to Circuit/System Testing.

    - **Go to next step: If the MIL turns ON and OFF**
3. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
2. Ignition ON.
3. Verify a test lamp illuminates between the Ignition voltage circuit terminal 8 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ignition voltage circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the ignition voltage circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, test all components connected to the ignition voltage circuit and replace as necessary.
    - **Go to next step: If the test lamp illuminates**
4. Replace the P16 Instrument Cluster.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Instrument Cluster Replacement (Equinox) Instrument Cluster Replacement (Terrain)
- Control Module References for control module replacement, programming and setup

FUEL SYSTEM DIAGNOSIS

Diagnostic Instructions

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

Circuit/System Description

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

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

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 and the fuel feed front pipe check valve to the high pressure fuel pump. The fuel pump also supplies fuel to a venturi pump located on the bottom of the fuel tank fuel pump module. The function of the venturi pump is to fill the fuel tank fuel pump module reservoir. The fuel tank fuel pump module contains a reverse flow check valve. Both check valves maintain fuel pressure in the fuel feed pipe in order to prevent long cranking times.

Diagnostic Aids

- A faulty fuel feed front pipe check valve may cause a rattle, tick, knock, or buzz noise. The noise may be more pronounced at idle, approximately 600-800 RPM.
- An erratic low side fuel pressure reading may be caused by a faulty fuel feed front pipe check valve.
- Observe the Misfire Counters or perform the Fuel Injector Diagnosis to help identify a leaking fuel injector.

Reference Information

Description and Operation

Fuel System Description

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH-41769** Fuel Line Quick Disconnect Tool
- **EN-37287** Fuel Line Shut-off Adapter

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

Circuit/System Verification

NOTE:

- **Repair all fuel system related DTCs, except P2635, before performing this diagnostic.**
- **Inspect the fuel system for damage or external leaks before proceeding.**
- **Verify that adequate fuel is in the fuel tank before proceeding.**

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- **The Fuel Pump Enable may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.**
- **DO NOT perform the Fuel System Diagnosis if the engine coolant temperature is above 60Â°C (150Â°F). High fuel pressure readings may result due to hot soak fuel boiling. With the engine OFF, the fuel pressure may increase beyond the pressure relief regulator valve's setting point of 690 kPa (100 PSI) Â± 5%.**

1. Ignition ON, engine OFF, command the Fuel Pump Enable On several times with a scan tool.
2. Verify that the scan tool Fuel Pressure Sensor parameter is between 345 - 650 kPa (50 - 94 PSI).
    - **If less than 345 kPa (50 PSI)**

      Refer to Circuit/System Testing - Fuel Pressure Low.

    - **If greater than 650 kPa (94 PSI)**

      Replace the G12 Fuel Pump.

    - **Go to next step: If between 345 - 650 kPa (50 - 94 PSI)**
3. Verify that the scan tool Fuel Pressure Sensor parameter, after the fuel pump is turned off, decreases to less than 600 kPa (87 PSI).
    - **If greater than 600 kPa (87 PSI)**

      Replace the G12 Fuel Pump

    - **Go to next step: If less than 600 kPa (87 PSI)**
4. Verify that the scan tool Fuel Pressure Sensor parameter does not decrease greater than 34 kPa (5 PSI) in 1 min.
    - **If greater than 34 kPa (5 PSI)**

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

    - **Go to next step: If less than 34 kPa (5 PSI)**
5. Engine idling.
6. Verify that the scan tool Fuel Pressure Sensor parameter is between 300 - 400 kPa (43 - 58 PSI).
    - **If less than 300 kPa (43 PSI)**

      Refer to Circuit/System Testing - Fuel Pressure Low.

    - **If greater than 400 kPa (58 PSI)**

      Replace the G12 Fuel Pump.

    - **Go to next step: If between 300 - 400 kPa (43 - 58 PSI)**
7. Verify that the scan tool Fuel Pressure Sensor and the Desired Fuel Pressure are within 45 kPa (6.5 PSI) at 300 kPa (43.5 PSI) request or 60 kPa (8.7 PSI) at 400 kPa (58 PSI) request of each other while operating the vehicle through varying loads.
    - **If greater than 45 kPa (6.5 PSI) / 60 kPa (8.7 PSI)**

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

    - **Go to next step: If less than 45 kPa (6.5 PSI) / 60 kPa (8.7 PSI)**
8. 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 or dislocated fuel feed front pipe check valve
    - Restricted fuel feed pipe
    - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections
    - **If a condition exists**

      Repair as necessary.

    - **Go to next step: If no conditions exist**

      Replace the G12 Fuel Pump.

Fuel Pressure Leaks Down

1. Ignition OFF, relieve the fuel pressure. Refer to **Fuel Pressure Relief** .
2. Install the **EN-37287** between the chassis fuel feed hose and the engine compartment fuel feed pipe.
3. Open the valve on the **EN-37287** .
4. Ignition ON, command the Fuel Pump Enable On and then Off with a scan tool.
5. Close the valve on the **EN-37287** .
6. Verify that the scan tool Fuel Pressure Sensor parameter does not decrease more than 34 kPa (5 PSI) in 1 min.
    - **If greater than 34 kPa (5 PSI)**

      Replace the G12 Fuel Pump.

    - **Go to next step: If less than 34 kPa (5 PSI)**
7. Test for a faulty fuel feed front pipe check valve.
    - **If a condition exists**

      Replace the fuel feed front pipe.

    - **Go to next step: If no condition exists**
8. Test for a leaking G18 High Pressure Fuel Pump.
    - **If a condition exists**

      Replace the G18 High Pressure Fuel Pump.

    - **Go to next step: If no condition exists**

      Locate and replace the leaking Q17 Fuel Injector.

Fuel Pressure Drops Off

1. Verify none of the conditions listed below exist:
    - Restricted or dislocated fuel feed front pipe check valve
    - Restricted fuel feed pipe
    - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections
    - **If a condition exists**

      Repair as necessary.

    - **Go to next step: If no conditions exist**

      Replace the G12 Fuel Pump.

Repair Instructions

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

- **Fuel Feed Front Pipe Replacement**
- **Fuel Feed Pipe Replacement (FWD)** **Fuel Feed Pipe Replacement (AWD)**
- **Fuel Feed Intermediate Pipe Replacement**
- **Fuel Injector Replacement**
- **Fuel Pump Replacement** for G18 High Pressure Fuel Pump replacement
- **Fuel Tank Fuel Pump Module Replacement (FWD)** **Fuel Tank Fuel Pump Module Replacement (AWD)**

FUEL LEAK DIAGNOSIS

Reference Information

Special Tools

- **J-28428-E** High Intensity Black Light Kit
- **J-42220** Leak Detection Lamp

CAUTION: **When performing a Fuel Leak Diagnosis, it is VERY IMPORANT to use only GM approved Oil Dye, Part Number 88861206. If any other oil dye is used, it will cause damage to the fuel injection system components, as well as the emission control components. This will result in necessary replacement of the damaged components.**

1. Clean all of the fuel lines in the suspected area using brake cleaning solvent, and let dry.
2. Add 8 ounces of oil dye 88861206 to the fuel tank.
3. Start and idle the engine for 3 - 5 minutes.
4. Using a scan tool, increase the Fuel Rail Pressure, if applicable.
5. Verify there are no fuel leaks with **J-28428-E** or **J-42220** around the:
    - Fuel pump
    - Fuel rails
    - Fuel injector supply lines
    - Fuel supply lines
    - Fuel return lines, if equipped,
    - **High pressure or supply side fuel leak is found**

      Repair or replace the leaking component

    - **If equipped, return side fuel leak is found.**
    1. Verify that the fuel return line is not restricted
        - If the fuel return line is restricted, repair or replace as necessary
        - If the fuel return line is not restricted, repair or replace the leaking component
    - **Go to next step: No fuel leak is found**
6. All OK.

FUEL INJECTOR DIAGNOSIS

Diagnostic Instructions

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

Circuit/System Description

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Two methods of testing fuel injector balance are available, the Active Fuel Injector Tester or a scan tool. The Active Fuel Injector Tester and SIDI adaptor connects to the engine control module harness connectors to test the high pressure fuel pump performance, fuel injector wiring, and fuel injector operation. The Active Fuel Injector Tester displays step by step instructions to precisely determine pressure drop of each fuel injector. The scan tool fuel injector balance test is performed while the engine is running at idle. The scan tool pressurizes the fuel rail to a predetermined pressure before each fuel injector is pulsed for a precise amount of time allowing a measured amount of the fuel to be injected. This causes a drop in the system fuel pressure that is recorded and used to compare each fuel injector.

Diagnostic Aids

- Monitoring the scan tool Cylinder 1-4 Current Misfire Counters may help to isolate the fuel injector that is causing the condition.
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Electrical Information Reference

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

Special Tools

- **CH-47976** Active Fuel Injector Tester
- **CH-47976-500** Active Fuel Injection Tester SIDI Adapter Kit
- **CH-47976 - 503** Active Fuel Injection Tester cable G3
- **CH-47976 - 512** Active Fuel Injection Tester cable G3b Adapter

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

Fuel Injector Coil Test

NOTE:

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

1. Disconnect the appropriate Q17 Fuel Injector.
2. Test for 1.3 - 1.44 Ω at 20Â°C (68Â°F) between the control + circuit terminal 2 and the control - circuit terminal 1 at the Q17 Fuel Injector.
   - **If not between 1.3 - 1.44 Ω**

     Replace the Q17 Fuel Injector.

   - **Go to next step: If between 1.3 - 1.44 Ω**
3. Test for infinite resistance between each terminal at the Q17 Fuel Injector and the Q17 Fuel Injector housing/case.
   - **If less than infinite resistance**

     Replace the Q17 Fuel Injector.

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- **Go to next step: If infinite resistance**

4. All OK. Perform the Fuel Injector Balance Test.

Fuel Injector Balance Test

NOTE:

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

Fuel Injector Balance Test with Active Fuel Injector Tester - Preferred Method

1. Verify the battery is fully charged and all accessories are OFF.
2. Ignition OFF, all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down. Install **CH-47976** and **CH-47976-500** . Connect **CH-47976 - 503** and **CH-47976 - 512** to **CH-47976-500** .

NOTE:

- **Important that voltage is jumped to the correct fuse terminal.**
- **Not all (KL9) vehicle are affected. Only vehicles listed below require this jumper step.**

3. For applications with Start/Stop (KL9), battery voltage must be jumped to the low/negative side of the fuse for the KR27 Starter Relay using a 3 amp fused jumper wire. Reference below to determine the appropriate fuse to remove for your application.
   - Cruze (LE2) - Fuse F16UA, Fuse 16, "Fuel Injection"
   - Envision (LCV / LTG) - Fuse F3UA, Fuse F03, "NON/WALK"
   - Equinox/Terrain (LYX / LTG) - Fuse F3UA, Fuse 3, "Lambda 1"
   - Malibu (LFV / LKN / LTG) - Fuse F76UA, Fuse 76, "PWR/TRN OFF Engine"
   - Regal (LGX / LTG) - Fuse F46UA, Fuse 46, "ECM IGN"
4. Turn ON the Active Fuel Injector Tester and select the vehicle.
5. Ignition ON, perform the Injector Test with the Active Fuel Injector Tester.
   - **If the Active Fuel Injector Tester aborts testing due to incorrect fuel pressure or fuel leak down**

     Refer to **Fuel System Diagnosis**.

   - **Go to next step: If the Active Fuel Injector Tester does not abort testing**
6. Compare the test results with the appropriate recommended tolerance.
   - **If any fuel injector exceeds the recommended tolerance**

     Replace the appropriate Q17 Fuel Injector(s).

   - **Go to next step: If all fuel injectors are within the recommended tolerance**
7. All OK.

Fuel Injector Balance Test with Scan Tool

1. Verify the correct low side fuel pressure. Refer to **Fuel System Diagnosis**.
2. Engine idling, verify the scan tool Fuel Rail Pressure Sensor parameter is approximately 3 MPa (435 PSI).

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

3. Select the Fuel Injector Balance function within the Control Functions menu of a scan tool.

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4. Select and test an injector. Repeat for each injector.
5. Obtain and record a pressure drop value for each injector.
6. Add all of the individual pressure drop values except for the injector suspected of being faulty. This is the total pressure drop.
7. Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop.
8. Multiply the average pressure drop by 0.20. This is the acceptable variance from the average pressure drop, 20 percent.
9. Verify the difference between any individual pressure drop and the average pressure drop is not greater than the acceptable variance.
    - **If greater than the acceptable variance**

      Replace the Q17 Fuel Injector.

    - **Go to next step: If within the acceptable variance**
10. All OK.

Repair Instructions

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

Fuel Injector Replacement

FUEL INJECTOR CIRCUIT DIAGNOSIS

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Injector 1 Control +	P2147	P0201	P2148	P1248
Fuel Injector 1 Control -	P0261	P0201	P0262, P2148	P1248
Fuel Injector 2 Control +	P2150	P0202	P2151	P1249
Fuel Injector 2 Control -	P0264	P0202	P0265, P2151	P1249
Fuel Injector 3 Control +	P2153	P0203	P2154	P124A
Fuel Injector 3 Control -	P0267	P0203	P0268, P2154	P124A
Fuel Injector 4 Control +	P2156	P0204	P2157	P124B
Fuel Injector 4 Control -	P0270	P0204	P0271, P2157	P124B

Circuit/System Description

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

Diagnostic Aids

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

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Do Not perform this procedure unless directed here from the Fuel Injector Balance Test.**

1. Engine idling.
2. Verify the scan tool Cylinder 1 - 4 Current Misfire Counter parameters do not increment.
   - **If the Cylinder 1 - 4 Current Misfire Counters increment**

     Refer to Circuit/System Testing.
   - **Go to next step: If the Cylinder 1 - 4 Current Misfire Counters do not increment**
3. Verify the scan tool Cylinder 1 - 4 Injector Control Circuit Status parameters display OK.
   - **If the Cylinder 1 - 4 Injector Control Circuit Status parameters do not display OK**

     Refer to Circuit/System Testing.
   - **Go to next step: If the Cylinder 1 - 4 Injector Control Circuit Status parameters display OK**
4. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the X2 harness connector at the K20 Engine Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for infinite resistance between the appropriate Q17 Fuel Injector control + circuit and ground.
   - **If less than infinite resistance**
   1. Disconnect the harness connector of the Q17 Fuel Injector.
   2. Test for infinite resistance between the Q17 Fuel Injector control + circuit and ground.
      - If infinite resistance
   3. Test for infinite resistance between the Q17 Fuel Injector control - circuit and ground.
      - If less than infinite, repair the short to ground in the circuit.
      - If infinite, replace the Q17 Fuel Injector.
   - **Go to next step: If infinite resistance**

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3. Ignition ON.
4. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
    - **If 1 V or greater**
    1. Disconnect the harness connector of the Q17 Fuel Injector, ignition ON.
    2. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, repair the short to voltage on the control - circuit.
    - **Go to next step: If less than 1 V**
5. Ignition OFF.
6. Test for less than 3 Ω between the Q17 Fuel Injector control + circuit and control - circuit.
    - **If 3 Ω or greater**
    1. Disconnect the harness connector of the Q17 Fuel Injector.
    2. Test for less than 2 Ω on the control + circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω
    3. Test for less than 2 Ω on the control - circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the Q17 Fuel Injector.
    - **Go to next step: If less than 3 Ω**
7. Replace the K20 Engine Control Module.

Repair Instructions

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

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

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.

Circuit/System Description

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10% in non-blended gasoline or greater than 85% with E85 blended gasoline for flexible fuel applications can cause driveability conditions such as hesitation, lack of power, stalling, or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

Reference Information

Special Tool

CH 44175-A Alcohol Tester Kit, if available

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

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Circuit/System Verification

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

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

    - **If alcohol contamination is suspected**

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

    - **Go to next step: If the sample remains clear and bright**
4. All OK.

Circuit/System Testing

Alcohol in Fuel Testing with Special Tool, if Available

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

      Clean the fuel system.

    - **Go to next step: If no water appears in the fuel sample**
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.
4. Verify the non-blended gasoline fuel sample does not measure greater than 15% or an E85 blended gasoline fuel sample measures greater than 91% ethanol.
    - **If greater than the specified value**
    1. Add fresh regular gasoline to the vehicle's fuel tank.
    2. Remove a new sample of fuel from the tank.
    3. Test the fuel composition using **CH 44175 - A** Alcohol Tester Kit and Instruction Manual.
    4. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.
    5. Verify the non-blended gasoline fuel sample does not measure greater than 15% or an E85 blended gasoline fuel sample measures greater than 91% ethanol.
        - If additional testing indicates that the ethanol percentage is still above 15% for a non-blended gasoline sample, drain and replace the vehicle's fuel. Refer to **Fuel Tank Draining** .
        - If additional testing indicates that the E85 blended gasoline sample still measures above 91%, continue adding fresh, regular gasoline until the ethanol content is 85% or less.
    - **Go to next step: If the specified value or less**
5. All OK.

Alcohol in Fuel Testing without Special Tool

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

1. Using a 100 ml (3.38 oz) specified cylinder with 1 ml (0.034 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.

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2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.38 oz) and install a stopper.
3. Shake the cylinder vigorously for 10 - 15 s.
4. Carefully loosen the stopper in order to release the pressure.
5. Re-install the stopper and shake the cylinder vigorously again for 10 - 15 s.
6. Put the cylinder on a level surface for approximately 5 min in order to allow adequate liquid separation. If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be more than 10 ml (0.34 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5% alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.
7. Verify the non-blended gasoline fuel sample does not measure greater than 15%.
    - **If greater than the specified value**
    1. Add fresh regular gasoline to the vehicle's fuel tank.
    2. Remove a new sample of fuel from the tank.
    3. Test the fuel composition of the new sample.
    4. Verify the non-blended gasoline fuel sample does not measure greater than 15%.
        - If greater than the specified value, drain and replace the vehicle's fuel. Refer to **Fuel Tank Draining** .
        - If the specified value or less, all OK.
    - **Go to next step: If the specified value or less**
8. All OK.

Particulate Contaminants in Fuel

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel from the bottom of the fuel tank.
2. Place the container on a level surface for approximately 5 min in order to allow settling of the particulate contamination. Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles.
3. Verify there are no physical contaminants or water present in the fuel sample.
    - **If any physical contaminants or water are present**

      Clean the fuel system.

    - **Go to next step: If no physical contaminants or water are present**
4. All OK.

Repair Instructions

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

- **Fuel System Cleaning**
- **Fuel Tank Draining**

EVAPORATIVE EMISSION CONTROL SYSTEM DIAGNOSIS

Special Tools

- **CH-44284-2** Fuel Flapper Door Holder
- **EN-41413-VLV** EVAP Service Port Vent Fitting
- **GE-41415-60** Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter

Operating Instructions for the Evaporative Emission System Tester

Vehicle Setup

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WARNING: **Refer to Fuel and Evaporative Emission Pipe Warning .**

CAUTION: **Refer to Clean, Dry, Low Pressure Gas Source Caution .**

NOTE: **When servicing the evaporative emission (EVAP) system, test pressure must not exceed 13 in H20 (0.5 PSI) as pressure in excess of this could cause system components to perform inaccurately.**

NOTE: **A large difference between the vehicle temperature and shop temperature will seriously affect the accuracy of the tests. Always allow at least 15 min for the vehicle temperature to adjust to the shop temperature. Refer to Temperature Variation Instructions for more information about vehicle versus shop temperatures.**

1. Engine OFF, open the hood. Position a large fan to blow air under the vehicle onto the fuel tank area.
2. Connect the red battery clip from the tester to the positive battery terminal.

NOTE: **The vehicle battery must be fully charged for optimum tester performance.**

3. Connect the black battery clip from the tester to chassis ground.

Flow Meter Test - Leak Detection

CAUTION: **Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .**

1. Open the Nitrogen tank valve and turn the NITROGEN / SMOKE valve on the front control panel to NITROGEN.
2. Connect the hose to the correct test orifice on the bottom front of the tester. For orifice size, refer to the vehicle specific information found in service procedures for DTCs that relate to EVAP system leaks.
3. Press and release the remote switch to activate the tester.

NOTE: **The tester will time out after about 15 min. You may press the remote switch to reactivate the tester as desired.**

4. Position the sliding red flag on the flow meter to align with the floating indicator. When the red flag is set, press and release the remote switch to deactivate the tester.
5. Remove the hose from the test orifice and install the hose onto the vehicle. For proper connection location, and the special tool numbers for any adapters that may be required, refer to the service procedures for DTCs that relate to EVAP system leaks.
6. Ignition ON, seal the EVAP system per instructions in the service procedures for DTCs that relate to EVAP system leaks. Most systems can be sealed using a scan tool output control for the EVAP Vent Solenoid Valve, other systems require that the vent system be plugged.

NOTE:

- **Larger volume fuel tanks, and/or those with lower fuel levels, may require several minutes to fill with nitrogen.**
- **Static buildup may cause the float indicator to stick. It may be necessary to tap on the flow meter to free up the float.**
- **If fuel level is 90% or greater it will take longer to fill the system with smoke because the fuel fill tube check valve will be closed and force any smoke to pass through the on-board refueling vapor recovery pipe and orifice.**

7. Press and release the remote switch to activate the nitrogen flow and fill the system.
8. Verify the stable floating indicator position to the red flag.

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- **Above the red flag, result is unacceptable - fail**

  Go to the Smoke Procedure

- **Go to next step: Below the red flag - pass. Test complete**

9. Press and release the remote switch to deactivate the tester.

Smoke Procedure - Locate the Leak

NOTE: **It is not recommended to use the tester in an outside repair bay area because wind and sunlight may affect temperature and your ability to see the smoke.**

1. Turn OFF any fans that may cause air movement around or near the vehicle.

NOTE: **Completely unwind the nitrogen/smoke hose from the bracket to optimize the tester's performance.**

2. Connect the nitrogen/smoke hose to the vehicle as directed in the service procedures. Some vehicles require that the nitrogen/smoke hose be connected at the front of the EVAP system at the EVAP service port. An adapter may be necessary. Other vehicles require the connection be made at the rear of the system using an adapter at the fuel fill cap or capless fuel fill. Consult the service procedures for DTCs that relate to EVAP system leaks for vehicle specific instructions regarding connection location and adapters.
3. Open the Nitrogen tank valve and turn the nitrogen/smoke valve on the control panel to smoke.

NOTE: **The remote switch operates on a push ON, push OFF fashion.**

4. Press and release the remote switch to activate the tester and inject smoke into the EVAP system.
5. Verify smoke has filled the EVAP system by opening the system opposite the end where smoke is injected.

NOTE:

- **When injecting smoke at the service port:**
  - **Vehicles with gas cap - remove fill cap**
  - **Vehicles with capless fuel fill - open flappers with CH-44284-2 or GE-41415-60**

    Until smoke is observed, then close the system and continue testing.
- **If using a special tool fuel fill cap / capless fuel fill adapter at the filler neck, vent the system at the service port, with special tool EN-41413-VLV until smoke is observed then remove the vent fitting tool and close the system to continue with the test.**
- **Inject smoke in less than 2 min cycles for optimum tester performance.**

6. Press and release the remote switch to deactivate the tester.

NOTE: **For optimum visual smoke performance, deactivate the smoke flow and allow the system pressure to drop. Allowing the smoke to exit small holes at a low flow rate greatly enhances visibility.**

7. Introduce smoke into the system for an additional 60 s. Continue introducing smoke at 15 s intervals, as necessary until leak source is identified.
8. Using a high-intensity white light, inspect the entire EVAP system path, and look for the source of the leak indicated by the exiting smoke.
   - **Smoke seen leaking**

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Repair or replace the affected component.

- **Go to next step: No smoke seen leaking**

9. All OK

Temperature Variation Instructions

The Concern

Ideal circumstances for conducting the EVAP flow meter test require equal temperatures between the Nitrogen gas and the vehicle EVAP system. Significant differences in temperature between them can result in a flow or pressure change during testing, causing misleading results. Typically, the evaporative emission system tester is stored indoors, approximately 21Â°C (70Â°F). Vehicles brought in for diagnosis may have an EVAP system at significantly different temperatures.

For Example

NOTE: **With no temperature difference between the Nitrogen gas and EVAP system, the resulting vehicle EVAP system pressure will remain stable at 13 in. H2O (0.5 PSI) once pressurized, providing no leaks are present.**

When the EVAP flow meter tests are performed with significant differences in temperature between the Nitrogen gas and the vehicle EVAP system, the following results can occur:

- An increase in flow during the flow meter test can be caused by a vehicle's warm EVAP system cooling down.
- A decrease in flow during the flow meter test can be caused by a vehicle's cool EVAP system warming up.

The Solution

When working on a vehicle with significant temperature differences between the vehicle EVAP system and the Nitrogen gas, allow the vehicle EVAP system temperature to stabilize as close as possible to the temperature of the Nitrogen gas before conducting the flow meter test.

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 for a vehicle to pass on-board diagnostic (OBD) system tests and inspection/maintenance (I/M) emission inspections in order to renew license plates. This is accomplished by viewing the Inspection/Maintenance System Status or Data display on a scan tool. Using a scan tool, the technician can observe the I/M status in order to verify that the vehicle meets the criteria that complies with the local area requirements.

Condition for Updating the Inspection/Maintenance Emission System Status

NOTE: **New vehicles may not report an Inspection/Maintenance System Check pass or fail status for certain post catalyst oxygen sensor or heated oxygen sensor 2 diagnostics prior to 700 miles. After replacing a catalytic converter on a vehicle with greater than 700 miles, it may require up to an additional 700 miles to prevent a false failure status.**

Each system monitor requires at least one, and sometimes several, diagnostic tests. The result of each test is reported by a 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

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monitor has illuminated the malfunction indicator lamp (MIL). Once the system monitor is complete, the Inspection/Maintenance System Status or Data will indicate YES in the completed or Value column.

For example, when the HO2S heater status indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has 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 or Data will indicate NO under the Completed or Value column when any of the required tests for that system have not run. The following is a list of conditions that may set the Inspection/Maintenance System Status or Data indicator to NO:

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

Monitored Emission Control Systems

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

- The air conditioning system
- The 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)

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For the specific DTCs required for each system, refer to **Inspection/Maintenance (I/M) System DTC Table**. Systems such as fuel delivery, misfire, and comprehensive components may not be listed in a system status list. These tests run continuously and do not require an inspection/maintenance system status indicator.

Circuit/System Verification

1. Verify that all Inspection/Maintenance System Status or Data indicators report YES, and that no I/M Test DTCs are present.
   - **If any I/M Test DTCs are set**

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

   - **Go to next step: If no I/M Test DTCs are set**
2. All OK.

Circuit/System Testing

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

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

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

- **Go to next step: If no I/M DTCs are set**

2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.
   - **If a control module re-program or other repair is required,**

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

   - **Go to next step: If no repair is required**
3. Observe the Inspection/Maintenance System Status or Data indicators.
   - **If any Inspection/Maintenance System Status or Data indicators report NO**

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

   - **Go to next step: If no Inspection/Maintenance System Status or Data indicators report NO**
4. All OK.

INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **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 -5Â°C (23Â°F).
- The intake air temperature (IAT) at start-up is less than 40Â°C (104Â°F).
- The difference between the start-up IAT and ECT are within 3Â°C (5Â°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 12Â°C (22Â°F).
  - The start-up ECT minus start-up IAT are within 50Â°C (90Â°F).
- Fuel level is between 25 - 75%.

Circuit/System Verification

1. Verify that all I/M System Status indicators report YES, and that no I/M Test DTCs are present.
   - **If any I/M Test DTCs are set**

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

   - **Go to next step: If no I/M Test DTCs are set**
2. All OK.

Inspection/Maintenance System Set Procedure

NOTE: **Whenever the ignition is turned ON, ignition positive voltage is supplied**

to the heated oxygen sensor (HO2S) heaters. After verifying the enable criteria, turn OFF the ignition for approximately 5 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 min.
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 min:
   - 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.
    - 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** 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** 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.

POOR FUEL FILL QUALITY

Problem	Causes
DEFINITION: During the fueling process a continual, occasional, or no-fuel nozzle shut-off condition has occurred.	

Problem	Causes
Difficult to fill	• Fuel fill limiter vent valve stuck closed • Evaporative emission (EVAP) canister restricted • EVAP vent valve stuck closed • Hose between canister and canister vent solenoid twisted or kinked if applicable • High fuel temperature • Fuel filler hose is kinked • Faulty dispensing nozzle • Ignition switch ON, vent valve closed
Over fill	• Fill limiter vent valve stuck open or leaking • Fuel inlet check valve stuck open
Pre-mature shut-off of the fuel dispensing nozzle occurs immediately after engaging dispensing nozzle, tank empty	• Restricted vapor lines or fuel fill pipe • High fuel temperature • Inlet check valve at tank stuck closed, fill pipe full of fuel • Fuel tank full, gauge not accurate
Pre-mature shut-off of the fuel dispensing nozzle, more than 1/8 of tank capacity dispensed	• Kinked, pinched or plugged lines in fuel tank vent system • EVAP vent valve stuck closed or restricted • EVAP canister restricted • Fuel limiting vent valve stuck closed or obstruction at top of fuel tank
Fuel Spitback	• Restricted EVAP canister • High fuel temperature • Ignition switch ON, EVAP vent valve closed

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INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE

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.	
Boost System	**DTC P0234 or P0299**
Catalyst Monitor	**DTC P0420**
EGR/CMP	**DTC P0010-P0014 or P2088-P2091**
EVAP	**DTC P0442** **DTC P0446** **DTC P0455**
Fuel	**DTC P0089, P00C6, P228C, P228D, or P2C1E-P2C20** **DTC P219A**
Oxygen Sensor	**DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, or P2271**

System	DTCs Required to Set System Status to YES
Oxygen Sensor Heater	DTC P0030-P0032, P0036-P0038, P0053, P0054, P0135, P0141, P103B, or P103C

SERVICE BAY TEST

Diagnostic Instructions

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

Description

The purpose of the evaporative emission (EVAP) Service Bay Test is to aid in resetting the EVAP Inspection/Maintenance (I/M) System Status. For this vehicle, that is equipped with the engine off natural vacuum diagnostic, the Service Bay Test uses the scan tool to initiate the engine control module (ECM) regular sequence of EVAP system DTC tests, but with different enable criteria. By using the Service Bay Test the I/M indicator can be set without the need for multiple cold soaks.

The scan tool displays for the Service Bay Test are based on the events that occur within the following three categories:

EVAP Service Bay Test Status - Running

The vehicle must remain at rest, in Park, or in Neutral, during this portion of the test. This test inspects for large leaks and vent system restrictions. The purge valve leak diagnostic may run, but is not required. The scan tool will display test progress or the reason for an abort or failure.

EVAP Service Bay Test Status - Vehicle Ready for Drive Cycle

The scan tool will display time and distance needed to warm the fuel. The drive distance remaining rounds down to zero when there is anything less than 1 mile or kilometer remaining. The vehicle must be driven until the "return to service bay" message is displayed.

EVAP Service Bay Test Status - Engine Off Conditions Met

During this portion of the test, the ECM will remain active for up to 45 min when the ignition is turned OFF to allow control of the EVAP vent solenoid valve and run the engine off natural vacuum test. The ECM inspects for small leaks during this period by monitoring fuel tank pressure or vacuum. If the system is sealed, there will be a pressure or vacuum change. Pressure or vacuum changes that are not within the calibrated values indicate a leak.

NOTE:

- **Do not reorder the scan tool screen display. The EVAP Service Bay Test Status parameter is the main status message to observe. It will indicate when each category is active with the Test Results status parameter right beneath it.**
- **There are many possible screen messages. It is very important that you watch these messages and record any failure or abort message as this will aid the diagnosis.**
- **If any of these issues occur during or after the engine running portion of the test, the vehicle will need to soak for at least 8 h before retrying.**
- **An incorrect "drive distance not met" message is an indication that the service bay test aborted earlier and the vehicle was keyed off followed by retrying without waiting for at least 10 min before retrying.**

When the EVAP diagnostics are initiated by the Service Bay Test, the scan tool will indicate if the enable conditions listed below are not met, or will display a specific reason if the test aborts. When

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complete, the display will indicate that the tests completed or failed.

If

- The Service Bay Test aborts
- The scan tool resets
- The scan tool locks up
- The scan tool sets an error
- The diagnostic connector becomes disconnected

  Before starting the engine, the vehicle should be left keyed off for at least 10 min before retrying.

After the ignition off portion of the test has completed, the Service Bay Test will delay ECM shut down for 10 min to allow for analysis of scan tool data. A complete Test Results status message along with EVAP Monitor Complete value of YES is the goal.

Conditions for Running the Test

The following conditions must be met in order to enable the Service Bay Test:

- The battery voltage is between 11 - 32 V.
- The engine coolant temperature (ECT) is less than 35Â°C (95Â°F) at start-up.
- The intake air temperature (IAT) is less than 34Â°C (93Â°F) at start-up.
- The ambient air temperature is between 0 - 40Â°C (32 - 104Â°F) at start-up.
- The fuel level is within 10 - 90% capacity and cannot be refueled during the tests.
- The vehicle must have sat for 8 h since the last run time.
- The EVAP I/M System Status indicator is set to NO.

NOTE: **The use of the scan tool Clear DTCs function will reset all I/M statuses.**

- There are no DTCs displayed.
- The vehicle must be driven for the time and distance specified on the scan tool.
- The ignition must remain OFF during the engine OFF portion of the test, and the vehicle must remain at rest.

Test Procedure

NOTE:

- **If the Service Bay Test aborts or fails, a DTC will NOT be set.**
- **You must not rush the scan tool selections or erroneous results or error messages could occur.**

1. Select the Service Bay Test with the scan tool.

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

2. Follow the instructions on the scan tool. The EVAP Service Bay Test should complete and should not abort or fail.
   - **If the test aborts**

     Correct the condition for running the test, then retest.

     or

   - **If the test fails**

     Repair the vehicle for the condition indicated by the failure message, then retest.

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- **Go to next step: If the test passes**

NOTE: **There are several test parameters displayed and can vary by engine RPO.**

3. Verify that the EVAP Monitor Complete parameter, is set to YES.

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

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.5L (LYX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

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

Scan Tool Reference

Control Module References

Special Tools

EL 26792 HEI Spark Tester

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

Circuit/System Testing

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

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1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate T8 Ignition Coil. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the ground circuit terminal 1 or A and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **Go to next step: If less than 5 Ω**
3. Test for less than 5 Ω between the low reference circuit terminal 2 or B and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 5 Ω**
4. Ignition ON.
5. Verify a test lamp illuminates between the ignition circuit terminal 4 or D and ground.
    - **If the test lamp does not illuminate**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **Go to next step: If the test lamp illuminates**
6. Ignition OFF, exchange the suspect T8 Ignition Coil with the T8 Ignition Coil of a known functioning cylinder.
7. Engine Running.
8. Verify the scan tool Cylinder 1 - 4 Current Misfire Counter does not increment for the same cylinder that the suspect T8 Ignition Coil was removed from.
    - **If increments**

      Replace the K20 Engine Control Module.

    - **Go to next step: If does not increment**
9. Test or replace the T8 Ignition Coil.

Component Testing

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

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

      Replace the T8 Ignition Coil

    - **Go to next step: If the output is good**
4. All OK.

Repair Instructions

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

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

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2018 ENGINE PERFORMANCE

Engine Controls And Fuel - 1.5L (LYX) - Repair Instructions - Equinox & Terrain

REPAIR INSTRUCTIONS

CRANKSHAFT POSITION VARIATION LEARN

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis:**Strategy Based Diagnosis**

Description

The crankshaft position sensor variation or reluctor ring learn is used to calculate reference period errors caused by slight tolerance variations in the crankshaft and the crankshaft position sensor. The calculated error allows the ECM to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wider range of engine speed and load. The compensation values are stored in ECM memory after a learn procedure has been performed.

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced:

- B26 Crankshaft Position Sensor
- Any repair which disturbs the alignment between the components:B26 Crankshaft Position Sensor & Crankshaft
- Crankshaft
- Crankshaft Balancer
- Engine Assembly

Conditions for Running the Procedure

- DTC P0117, P0118, P0335, P0336 = Not set
- ECT = Greater than 60Â°C (140Â°F)
- Ignition Voltage = Greater than 11 V

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On / Vehicle - In Service Mode
2. Verify there are no other DTCs set, except for DTC P0300-P0308, P0315.
   - **If any other DTCs are set**

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

   - **Go to next step: If no other DTCs are set**
3. Select:Module Diagnostics

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4. Select:Engine Control Module
5. Select:Configuration/Reset Functions
6. Select:Learn Functions
7. Select:Crankshaft Position Variation Learn
8. Follow the instructions on the scan tool.

   Verify the scan tool procedure was successful.

   - **If the procedure was not successful and first time here**

   1. Ignition/Vehicle - Off
   2. Verify the following conditions do not exist:

   - B26 Crankshaft Position Sensor & Reluctor Ring - Foreign material passing between the components/Incorrect air gap
   - Battery Voltage - Low
   - Crankshaft Bearing - Worn
   - Crankshaft - Excessive runout/Visible Damage
   - Reluctor Ring - Misaligned/Visible Damage
   - Signal circuit@B26 Crankshaft Position Sensor - Electromagnetic Interference
     - If a condition exists - Repair or replace as necessary
     - If no condition exists - Repeat step 1
   - **If the procedure was not successful and performed 4 times or less**

     Repeat step 6

   - **If the procedure was not successful and performed 5 times**

     Replace the component:K20 Engine Control Module

   - **Go to next step: If the procedure was successful**
9. All OK.

Repair Instructions

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

For control module replacement, programming, and setup refer to:**Control Module References**

FUEL RAIL PRESSURE RELIEF VALVE LEARNED VALUES RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis:**Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system:G18 High Pressure Fuel Pump

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced: G18 High Pressure Fuel Pump - Replaced

Conditions for Running the Procedure

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Ignition = On

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On / Vehicle - In Service Mode
2. Select:Module Diagnostics
3. Select:Engine Control Module
4. Select:Configuration/Reset Functions
5. Select:Reset Functions
6. Select:Fuel Rail Pressure Relief Valve Learned Values Reset
7. Follow the instructions on the scan tool.

Repair Instructions

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

HO2S HEATER RESISTANCE LEARNED VALUES RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis:**Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system:B52 Heated Oxygen Sensor - Resistance

When to Perform the Procedure

NOTE:

- **This procedure is only required when the component is replaced for a mechanical issue with no DTC set.**
- **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced:B52 Heated Oxygen Sensor - Replaced

Conditions for Running the Procedure

Ignition Switch = Run/Crank

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On / Vehicle - In Service Mode
2. Select:Module Diagnostics
3. Select:Engine Control Module

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4. Select:Configuration/Reset Functions
5. Select:Reset Functions
6. Select:HO2S Heater Resistance Learned Values Reset

NOTE: **The scan tool does not display the learn/reset status.**

7. Follow the instructions on the scan tool. - The procedure will complete within 10 s
8. All OK.

Repair Instructions

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

INTAKE SYSTEM LEARNED VALUES RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis:**Strategy Based Diagnosis**

Description

For an overview of the component/system, refer to:**Turbocharger System Description**

This procedure resets the control module learned values of the component/system:Induction System - Airflow Adaptive Values

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

This procedure is required when the following component has been repaired, replaced, removed, or serviced:

- B65 Intake Manifold Pressure and Air Temperature Sensor
- B74 Manifold Absolute Pressure Sensor
- B75B Mass Air Flow/Intake Air Temperature Sensor
- B75C Multifunction Intake Air Sensor
- B111B Turbocharger Boost/Intake Air Temperature Sensor
- Q38 Throttle Body
- Q40 Turbocharger Bypass Solenoid Valve
- Q42 Turbocharger Wastegate Solenoid Valve
- Intake Air Duct - Collapsed/Leaking/Loose/Restricted
- Turbocharger

Conditions for Running the Procedure

- DTC P0033, P0034, P0035, P0068, P00C7, P0101, P0102, P0103, P0106, P0107, P0108, P0234, P0236, P0237, P0238, P0243, P0245, P0246, P0299, P1101, P2227-P2230, P2261 = Not set
- Engine = Off
- Ignition = On

Reference Information

Scan Tool Reference

Control Module References

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With Scan Tool

1. Ignition - On / Vehicle - In Service Mode
2. Select:Module Diagnostics
3. Select:Engine Control Module
4. Select:Configuration/Reset Functions
5. Select:Reset Functions
6. Select:Intake System Learned Values Reset
7. Follow the instructions on the scan tool.

Repair Instructions

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

THROTTLE BODY IDLE AIR FLOW COMPENSATION RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis:**Strategy Based Diagnosis**

Description

For an overview of the component/system, refer to:**Throttle Actuator Control (TAC) System Description**

This procedure triggers the control module to learn the values of the component:Q38 Throttle Body - Airflow Adaptive Values

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced:

- Q38 Throttle Body - Cleaned/Replaced
- K20 Engine Control Module - Replaced

Conditions for Running the Procedure

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P0697, P06A3, P06D2, P1248, P1249, P124A, P124B, P1516, P16A0-P16A2, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2176, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, P2322 = Not set
- Ignition = On
- Vehicle Speed Sensor = 0km/h (0MPH)

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

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1. Ignition - On / Vehicle - In Service Mode
2. Select:Module Diagnostics
3. Select:Engine Control Module
4. Select:Configuration/Reset Functions
5. Select:Reset Functions
6. Select:Throttle Body Idle Air Flow Compensation Reset
7. Follow the instructions on the scan tool.
8. Verify the scan tool parameter:Throttle Body Idle Air Flow Compensation = 0%
    - **If greater than 0**

      Repeat step 1

    - **Go to next step: If 0**
9. Engine - Idling - At normal operating temperature
10. Verify the scan tool parameter:Engine Speed = -100 to +200 RPM of the Desired Idle Speed
    - **{Test failed 1 time(s)}If not in the specified range**
    1. Engine idling. - For greater than 3 min
    2. Ignition/Vehicle - Off - For greater than 1 min
    3. Engine idling. - For greater than 3 min
    4. Repeat step 9
    - **{Test failed 2 time(s)}If not in the specified range**
    1. Perform the following action:Road test the vehicle.
    2. Vehicle Speed - Greater than 70 km (44 mi)
    3. Decelerate - For 2 s
    4. Repeat step 10.2 - 3 times
    5. Engine idling. - For greater than 3 min
    6. Repeat step 9
    - **{Test failed 3 time(s)}If not in the specified range**

      Refer to:**Diagnostic System Check - Vehicle**

    - **Go to next step: If in the specified range**
11. All OK.

Repair Instructions

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

WIRE TO WIRE REPAIR - ENGINE CONTROLS AND FUEL

Special Tools

- **EL-38125-10** Splice Sleeve Crimping Tool (non GMNA)
- **J-38125-5A** Ultra Torch Special Tool
- **J-38125-8** Splice Sleeve Crimping Tool (GMNA)

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

WARNING: **In order to reduce the risk of personal injury, loss of high voltage isolation to ground and higher system impedance, do not attempt to repair any HV wiring, connector, or terminal that is damaged. High voltage coaxial type cables are not repairable. Never attempt to repair a coaxial type cable. The entire cable/harness or component must be replaced. In order to maintain system integrity and personal safety, never attempt to repair any high voltage wiring, cables, or terminals. Performing**

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this procedure on high voltage circuits may result in serious injury or death.

NOTE: **If the wiring harness internal to the transmission is damaged, the wiring harness must be replaced. The use of splice sleeves in an attempt to repair the internal transmission wires, connectors, or terminals could result in performance issues.**

NOTE: **Do not splice wires in Door Harness Grommets.**

NOTE: **The DuraSeal splice sleeves have the following 2 critical features:**

- **A special heat shrink sleeve environmentally seals the splice. The heat shrink sleeve contains a sealing adhesive inside.**
- **A cross hatched (knurled) core crimp provides the necessary low resistance contact integrity for these sensitive, low energy circuits.**

Use only DuraSeal splice sleeves to form a one-to-one splice on all types of insulation except high voltage and specialty cables. Use DuraSeal splice sleeves where there are special requirements such as moisture sealing. Follow the instructions below in order to splice copper wire using DuraSeal splice sleeves.

Splice Sleeve Selection

Splice Sleeve Color	Crimp Tool Nest Color		Wire Gauge mm^2 / (AWG)
	3 Crimp Nests	4 Crimp Nests	
Salmon (Yellow-Pink) 19300089	Red (1) or Red/Green (1)	Red (2)	0.22 - 0.8/(18 - 26)
Blue 19168447	Blue (2)	Blue (3)	1.0 - 2.0/(14 - 16)
Yellow 19168448	Yellow (3)	Yellow (4)	3.0 - 5.0/(10 - 12)

NOTE: **You must perform the following procedures in the listed order. Repeat the procedure if any wire strands are damaged. You must obtain a clean strip with all of the wire strands intact.**

1. Open the harness by removing any tape:
   - Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in order to avoid wire insulation damage.
   - Use the DuraSeal splice sleeves on all types of insulation except Tefzel and coaxial.
   - Do not use the crimp and DuraSeal splice sleeve to form a splice with more than 2 wires coming together.
2. Cut as little wire off the harness as possible. You may need the extra length of wire in order to change the location of a splice.

   Adjust splice locations so that each splice is at least 40 mm (1.5 in) away from the other splices, harness branches, or connectors.

3. Strip the insulation:
   - When adding a length of wire to the existing harness, use the same size wire as the original wire.
   - Perform one of the following items in order to find the correct wire size:
     - Find the wire on the schematic and convert to regional wiring gauge size.
     - If you are unsure of the wire size, begin with the largest opening in the wire stripper and work down until achieving a clean strip of the insulation.
   - Strip approximately 5.0 mm (0.20 in) of insulation from each wire to be spliced.

- Do not nick or cut any of the strands. Inspect the stripped wire for nicks or cut strands.
- If the wire is damaged, repeat this procedure after removing the damaged section.

4. For high temperature wiring, slide a section of high temperature SCT1 shrink tubing down the length of wire to be spliced. Ensure that the shrink tubing will not interfere with the splice procedure.
5. Select the proper DuraSeal splice sleeve according to the wire size. Refer to the above table at the beginning of the repair procedure for the color coding of the DuraSeal splice sleeves and the crimp tool nests.

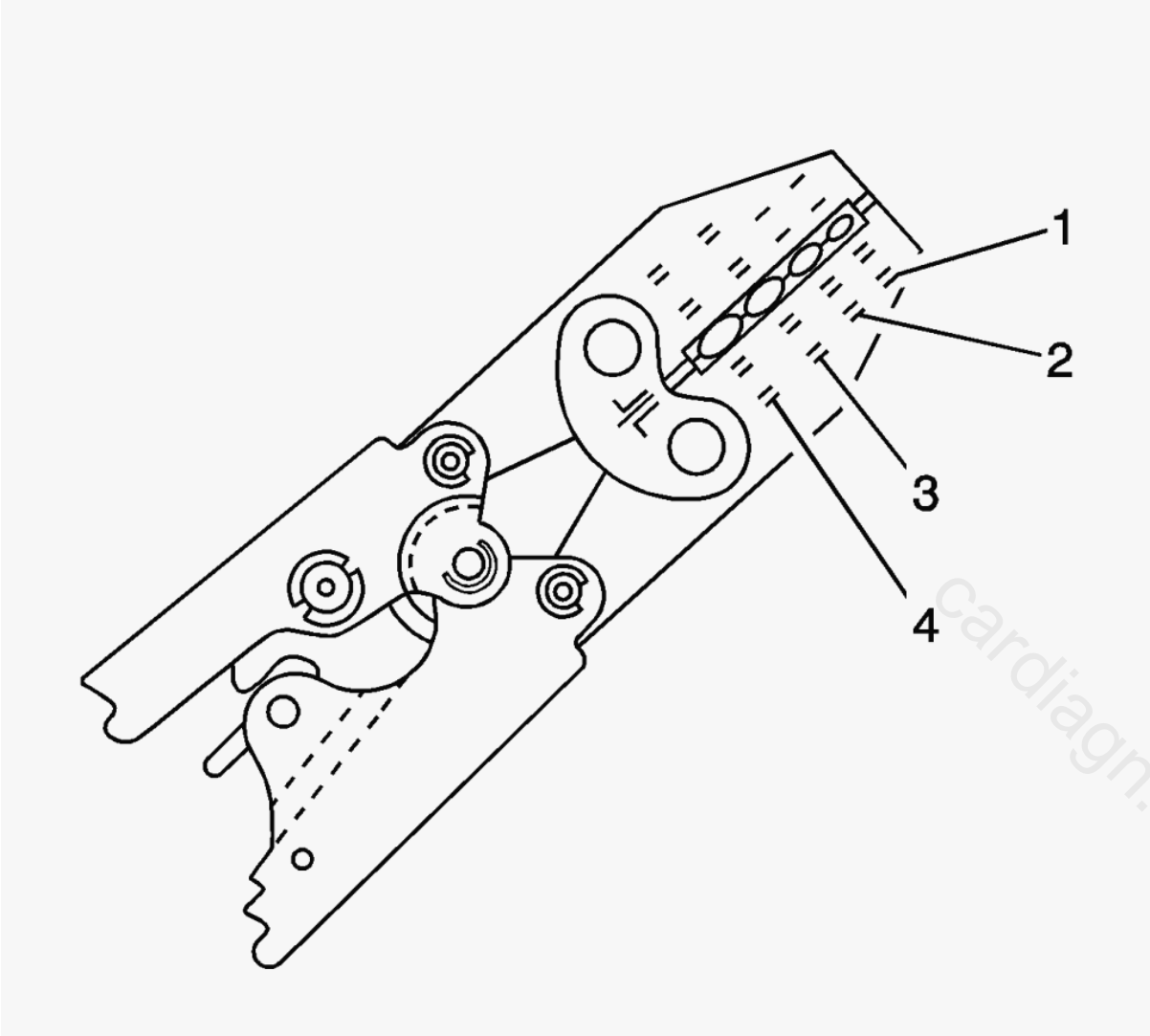

Fig. 1: Splice Sleeve Crimping Tool With 4 Crimp Nests
Courtesy of GENERAL MOTORS COMPANY

6. The **EL-38125-10** splice sleeve crimping tool has four crimp nests. The largest crimp nest (4) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (3) is used for crimping 14 and 16 gauge wires. The third largest crimp nest (2) is used for crimping 18 and 20 gauge wires. The smallest crimp nest (1) is used for crimping 22 to 26 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.

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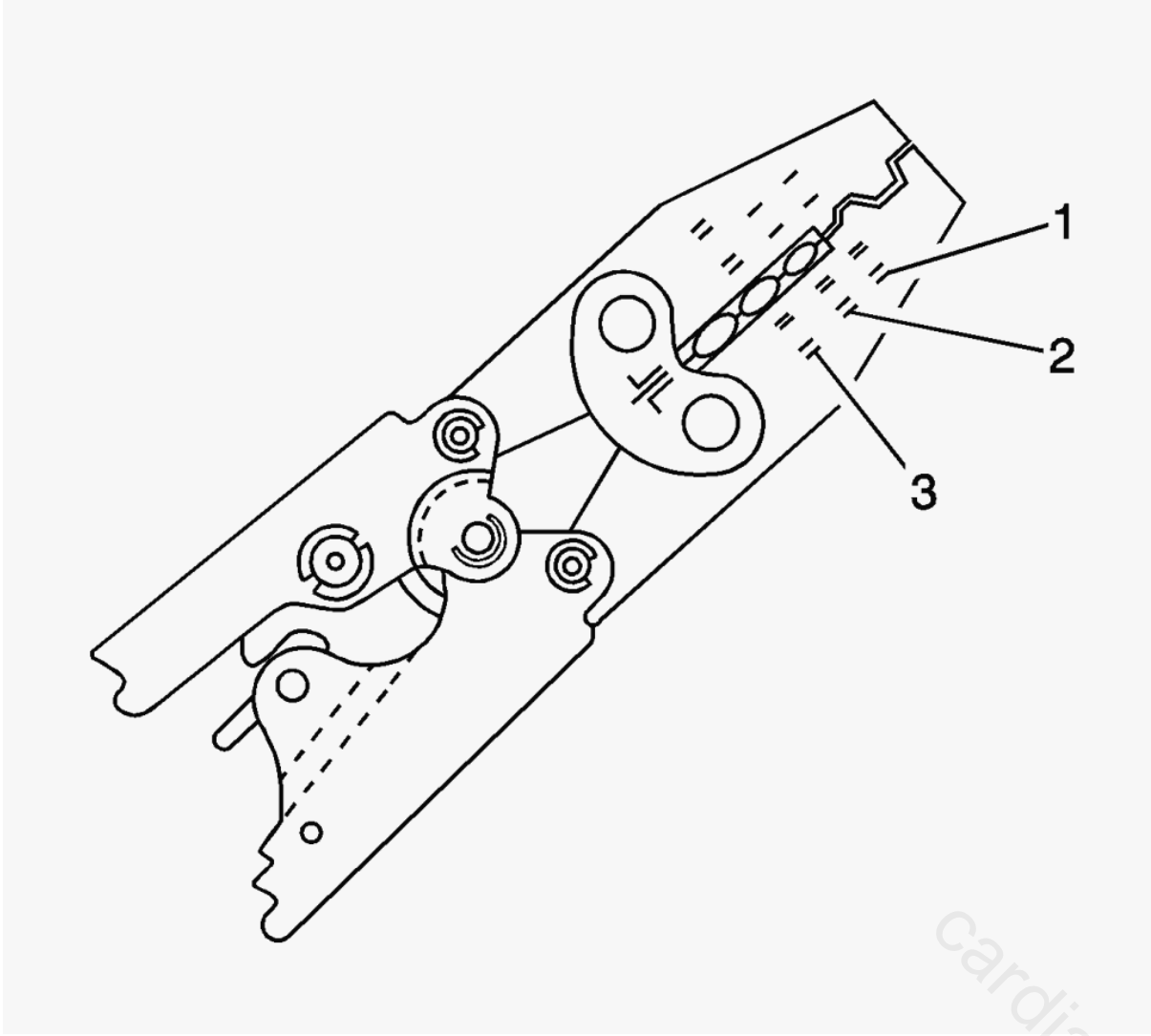

Fig. 2: Splice Sleeve Crimping Tool With 3 Crimp Nests
Courtesy of GENERAL MOTORS COMPANY

7. The **J-38125-8** splice sleeve crimping tool has three crimp nests. The largest crimp nest (3) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (2) is used for crimping 14 and 16 gauge wires. The smallest crimp nest (1) is used for crimping 18 to 20 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.
8. Use the splice sleeve crimp tool in order to position the DuraSeal splice sleeve in the proper color nest of the splice sleeve crimp tool. For the four crimp nest tool, use the three largest crimp nests to crimp the splice sleeves. For the three crimp nest tool, use all three crimp nests to crimp the splice sleeves. Use the four and three crimp tool diagrams (above) and the table (farther above) to match the splice sleeve with the correct crimp nest. The crimp tool diagram callout numbers match the numbers in the table (under crimp tool nest color).

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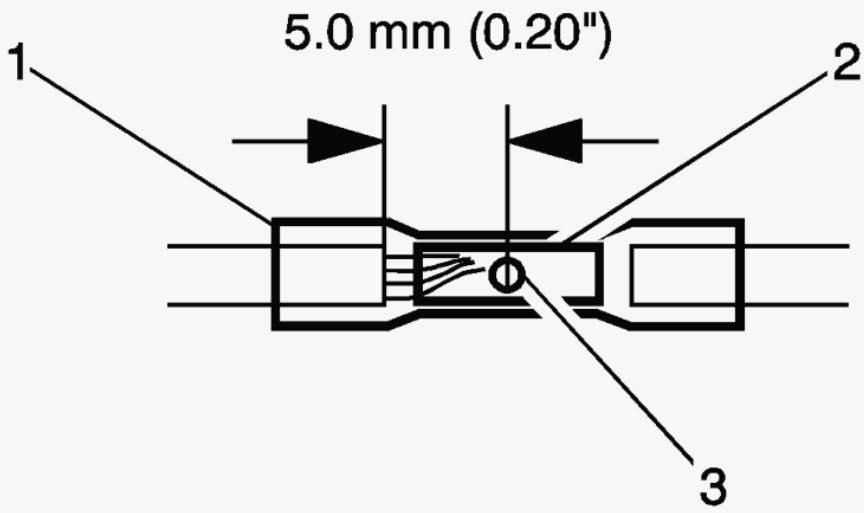

Fig. 3: Identifying DuraSeal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

9. Place the DuraSeal splice sleeve in the nest. Ensure that the crimp falls midway between the end of the barrel and the stop. The sleeve has a stop (3) in the middle of the barrel (2) in order to prevent the wire (1) from going further. Close the hand crimper handles slightly in order to firmly hold the DuraSeal splice sleeve in the proper nest.

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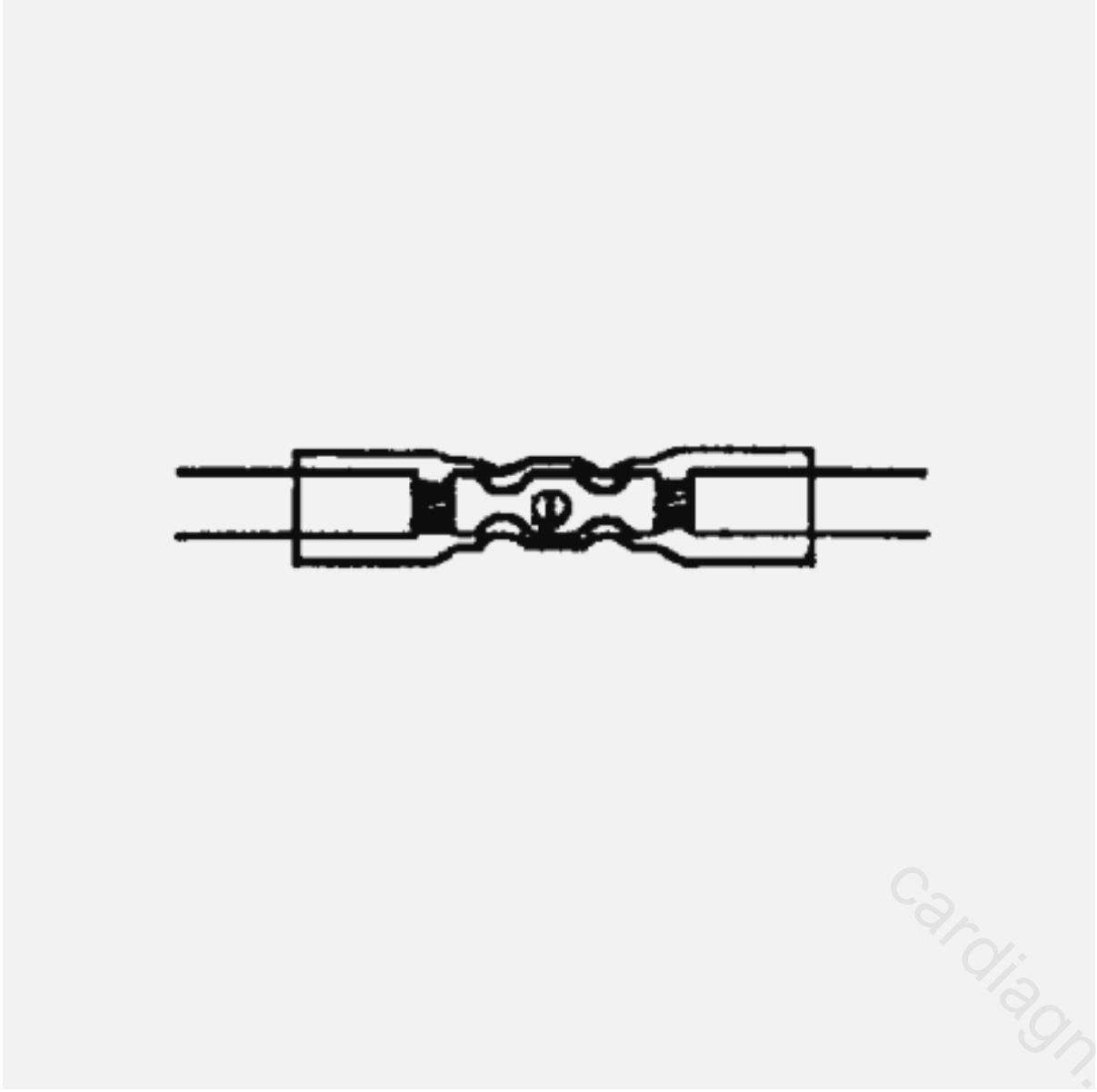

Fig. 4: Crimped DuraSeal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

10. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different gauges.
11. Tightly close the handles of the crimp tool until the crimper handles open when released.

    The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Repeat steps 4 and 6 for the opposite end of the splice.

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Fig. 5: Heated Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

12. Using the heat torch, apply heat to the crimped area of the barrel.
13. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
    - The tubing will shrink completely as the heat is moved along the insulation.
    - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

Weatherpack™ Wiring Repair

NOTE: **Some replacement pigtail connectors may be delivered without the terminated leads installed into the connector. For Weatherpack™ connectors, all terminated leads included in the package should to be installed into the connector. If the connector end view shows that a terminal is not occupied, the extra terminated lead(s) need to be installed and the end(s) sealed using a DuraSeal splice sleeve and taped back into the harness.**

1. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different gauges.

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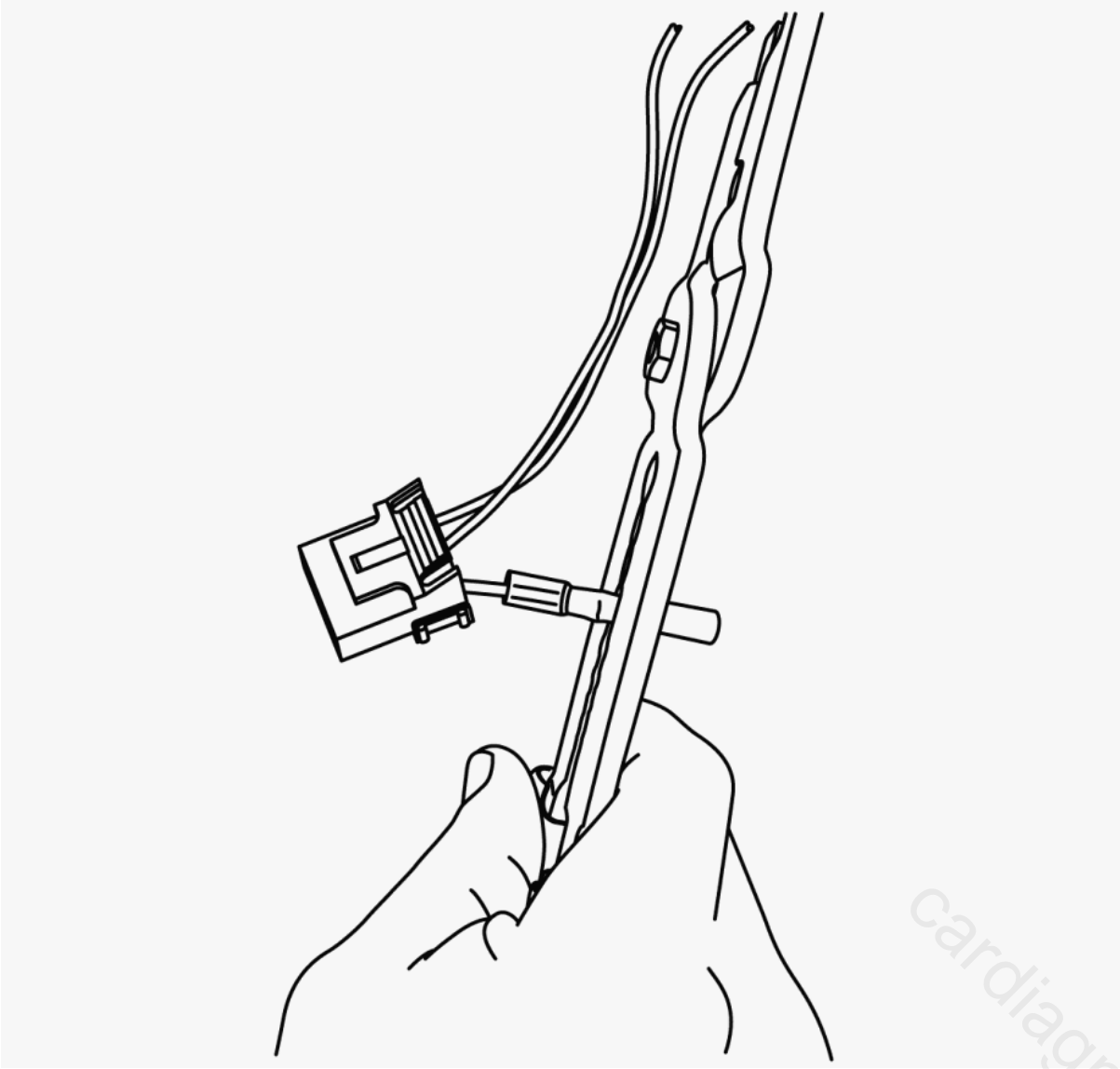

Fig. 6: Tightly Close Handles Of Crimp Tool
Courtesy of GENERAL MOTORS COMPANY

2. Tightly close the handles of the crimp tool until the crimper handles open when released.

   The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Holding the DuraSEAL with one hand gently tug on the wire to ensure it is crimped in the DuraSeal.

3. Using the heat torch, apply heat to the crimped area of the barrel.

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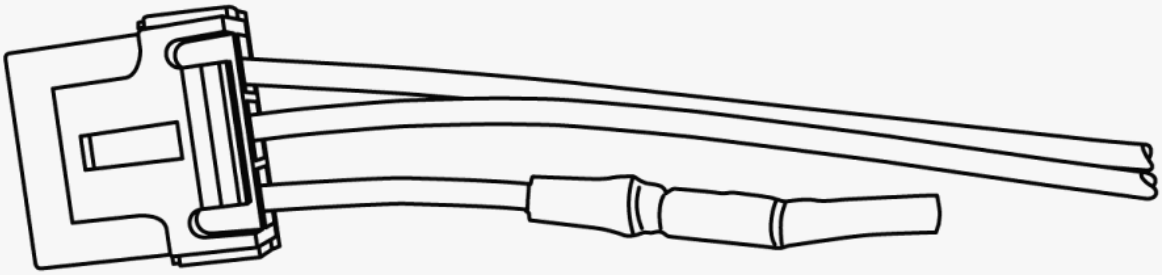

Fig. 7: Heat To Crimped Area Of Barrel
Courtesy of GENERAL MOTORS COMPANY

4. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
    - The tubing will shrink completely as the heat is moved along the insulation.
    - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

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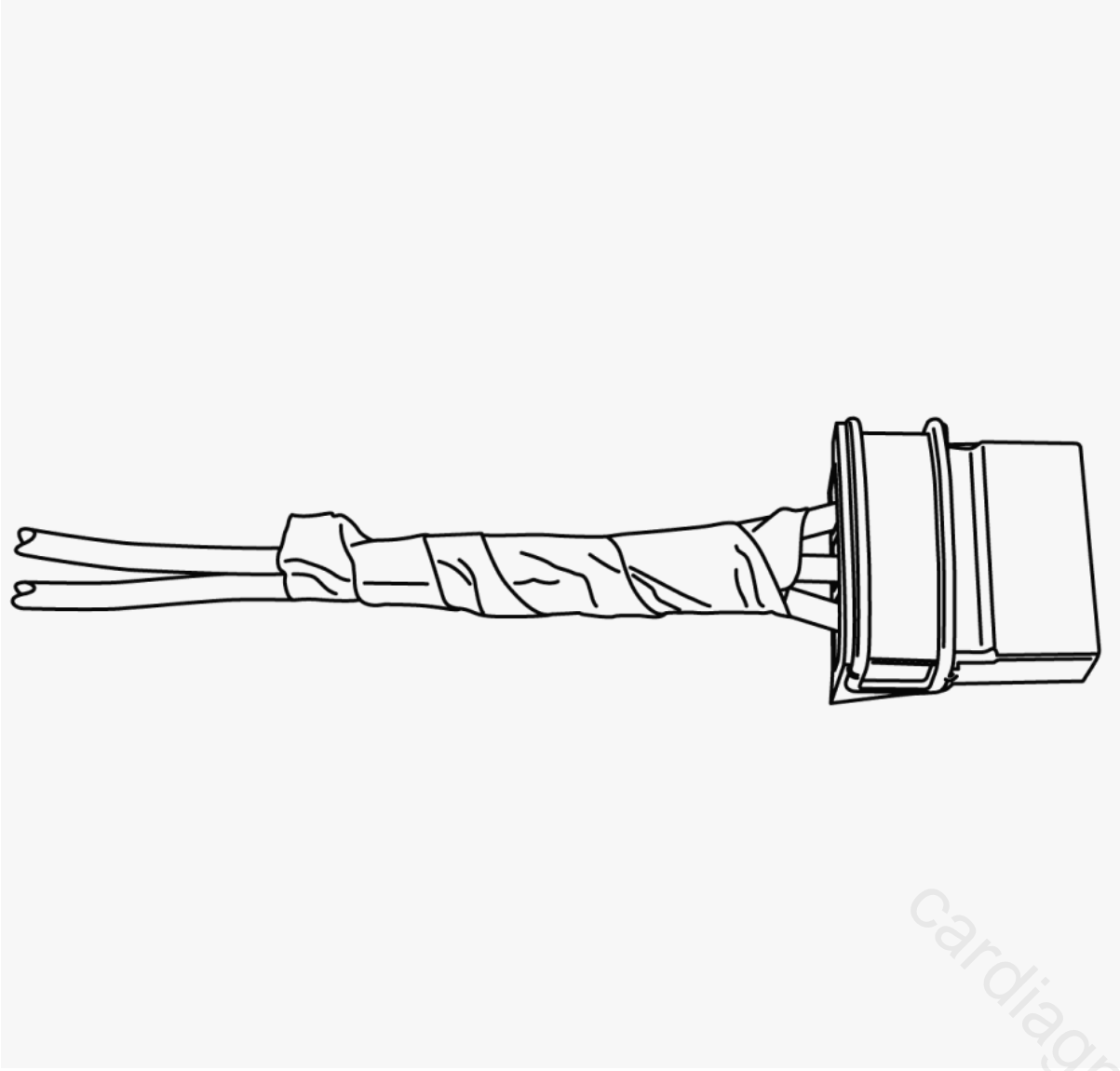

Fig. 8: Taping Extra Terminated Leads Back Into Harness
Courtesy of GENERAL MOTORS COMPANY

5. Tape the extra terminated lead(s) back into the harness.

High Temperature Wiring Repairs

Use the following procedures to perform high temperature wiring repairs:

1. Center the high temperature SCT1 shrink tube over the DuraSeal splice sleeve.
2. Using the heat torch, apply heat to the high temperature heat shrink tubing.
3. Gradually move the heat from the center to the open end of the tubing:
   - The tubing will shrink completely as the heat is moved along the insulation.
   - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.
4. Replace any reflective tape and clips that may have been removed during the repair.

CONNECTOR RECONNECTION - ENGINE CONTROLS AND FUEL

Special Tools

EL-35616 Terminal Test Probe Kit

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

When the condition is not currently present, but is indicated in DTC history, the cause may be intermittent. An intermittent may also be the cause when there is a customer complaint, but the symptom cannot be duplicated. Refer to the Symptom Table of the system that is suspect of causing the condition before trying to locate an intermittent condition.

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Most intermittent conditions are caused by faulty electrical connections or wiring. Inspect for the following items:

- Loose, corroded, or painted terminal stud/fastener
- Wiring broken inside the insulation
- Poor connection between the male and female terminal at a connector
- A terminal not seated all the way into the connector body
- Poor terminal to wire connection - Some conditions which fall under this description are poor crimps, poor solder joints, crimping over the wire insulation rather than the wire itself, and corrosion in the wire to terminal contact area, etc.
- Pierced or damaged insulation can allow moisture to enter the wiring causing corrosion. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.
- Wiring which has been pinched, cut, or its insulation rubbed through may cause an intermittent open or short as the bare area touches other wiring or parts of the vehicle.
- Wiring that comes in contact with hot or exhaust components
- Refer to **Inducing Intermittent Fault Conditions** in order to duplicate the conditions required, in order to verify the customer concern.
- Refer to **Testing for Electrical Intermittents** for test procedures to detect intermittent open, high resistance, short to ground, and short to voltage conditions.
- Refer to **Scan Tool Snapshot Procedure** for advanced intermittent diagnosis and Vehicle Data Recorder operation.

Testing for Terminal Fretting

Some intermittent conditions can be caused by wire terminal fretting corrosion. Fretting corrosion is a build-up of insulating, oxidized wear debris that can form when there is a small motion between electrical contacts. The oxidized wear debris can pile up enough at the electrical contact spots that the electrical resistance across the connection increases. Movement between the contacting surfaces as small as 10 to 100 microns can cause fretting. To put this in perspective, a sheet of paper is about 100 microns thick, so fretting motion is small and hard to see. Vibration and thermal expansion/contraction are the main sources that create fretting motion. Since vehicles vibrate and can experience large temperature swings, they are a good source for fretting motion. Tin, copper, nickel, and iron surfaces are all susceptible to fretting corrosion. Fretting corrosion can be difficult to see but it looks like small, dark smudges on the terminals contact surface.

To correct a fretting condition disconnect the suspect connector and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to both sides of the connector terminals. Then reconnect the connector and wipe away any excess lubricant. This will correct the additional terminal contact resistance due to the terminal fretting corrosion.

Testing for Proper Terminal Contact

It is important to test terminal contact at the component and any inline connectors before replacing a suspect component. Mating terminals must be inspected to ensure good terminal contact. A poor connection between the male and female terminal at a connector may be the result of contamination or deformation.

Contamination may be caused by the connector halves being improperly connected. A missing or damaged connector seal, damage to the connector itself, or exposing the terminals to moisture and dirt can also cause contamination. Contamination, usually in the underhood or underbody connectors, leads to terminal corrosion, causing an open circuit or intermittently open circuit.

Deformation is caused by probing the mating side of a connector terminal without the proper adapter. Always use the **EL-35616** kit when probing connectors. Other causes of terminal deformation are improperly joining the connector halves, or repeatedly separating and joining the connector halves. Deformation, usually to the female terminal contact tang, can result in poor terminal contact causing an open or intermittently open circuit.

Testing for Proper Terminal Contact in Bussed Electrical Centers

It is very important to use the correct test adapter when testing for proper terminal contact of fuses and relays in a bussed electrical center. Use the **EL-35616** kit to test for proper terminal contact. Failure to use the **EL-35616** kit can result in improper diagnosis of the bussed electrical center.

Follow the procedure below in order to test terminal contact:

1. Separate the connector halves.
2. Visually inspect the connector halves for contamination. Contamination may result in a white or green build-up within the connector body or between terminals. This causes high terminal resistance, intermittent contact, or an open circuit. An underhood or underbody connector that shows signs of contamination should be replaced in its entirety: terminals, seals, and connector body.
3. Using an equivalent male terminal/terminated lead, verify that the retention force is significantly different between a known good terminal and the suspect terminal. Replace the female terminal in question.

Flat Wire Connectors

There are no serviceable parts for flat wire connectors on the harness side or the component side.

Follow the procedure below in order to test terminal contact:

1. Remove the component in question.
2. Visually inspect each side of the connector for signs of contamination. Avoid touching either side of the connector as oil from your skin may be a source of contamination as well.
3. Visually inspect the terminal bearing surfaces of the flat wire circuits for splits, cracks, or other imperfections that could cause poor terminal contact. Visually inspect the component side connector to ensure that all of the terminals are uniform and free of damage or deformation.
4. Insert the appropriate adapter into the flat wire harness connector in order to test the circuit in question.

Control Module/Component Voltage and Grounds

Poor voltage or ground connections can cause widely varying symptoms.

- Test all control module voltage supply circuits. Many vehicles have multiple circuits supplying voltage to a control module. Other components in the system may have separate voltage supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the voltage source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Operate the component to test the ability of the circuit to carry sufficient current. Refer to **Circuit Testing** , and Power Distribution Wiring Schematics .
- Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point (screw or stud). Inspect the connections at the component and in splice packs, where applicable. Operate the component to test the ability of the circuit to carry sufficient current. Refer to **Circuit Testing** , and Ground Distribution Wiring Schematics .

Temperature Sensitivity

- An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/connection is cold, or only when the component/connection is hot.
- Freeze Frame, Failure Records, Snapshot, or Vehicle Data Recorder data may help with this type of intermittent condition, where applicable.
- If the intermittent is related to heat, review the data for a relationship with the following:
  - High ambient temperatures
  - Underhood/engine generated heat
  - Circuit generated heat due to a poor connection, or high electrical load

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    - Higher than normal load conditions, towing, etc.
- If the intermittent is related to cold, review the data for the following:
    - Low ambient temperatures - In extremely low temperatures, ice may form in a connection or component. Inspect for water intrusion.
    - The condition only occurs on a cold start.
    - The condition goes away when the vehicle warms up.
- Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
- If temperature is suspected of causing an intermittent fault condition, attempt to duplicate the condition. Refer to **Inducing Intermittent Fault Conditions** in order to duplicate the conditions required.

Electromagnetic Interference and Electrical Noise

Some electrical components/circuits are sensitive to electromagnetic interference or other types of electrical noise. Inspect for the following conditions:

- A mis-routed harness that is too close to high voltage/high current devices such as secondary ignition components, motors, generator etc. - These components may induce electrical noise on a circuit that could interfere with normal circuit operation.
- Electrical system interference caused by a malfunctioning relay, or a control module driven solenoid or switch - These conditions can cause a sharp electrical surge. Normally, the condition will occur when the malfunctioning component is operating.
- Installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. - These accessories may create interference in other circuits while operating and the interference would disappear when the accessory is not operating. Refer to **Checking Aftermarket Accessories** .
- Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode.
- The generator may be allowing AC noise into the electrical system.

Incorrect Control Module

- There are only a few situations where reprogramming a control module is appropriate:
    - A new service control module is installed.
    - A control module from another vehicle is installed.
    - Revised software/calibration files have been released for this vehicle.

NOTE: **DO NOT re-program the control module with the SAME software/calibration files that are already present in the control module. This is not an effective repair for any type of concern.**

- Verify that the control module contains the correct software/calibration. If incorrect programming is found, reprogram the control module with the most current software/calibration. Refer to **Control Module References** for replacement, setup, and programming.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

- **CH-41769** Fuel Line Disconnect Tool Set
- **CH-44581** Fuel Line Disconnect Tool

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

Removal Procedure

WARNING: **Refer to Diesel/Gasoline Vapors Warning .**

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1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

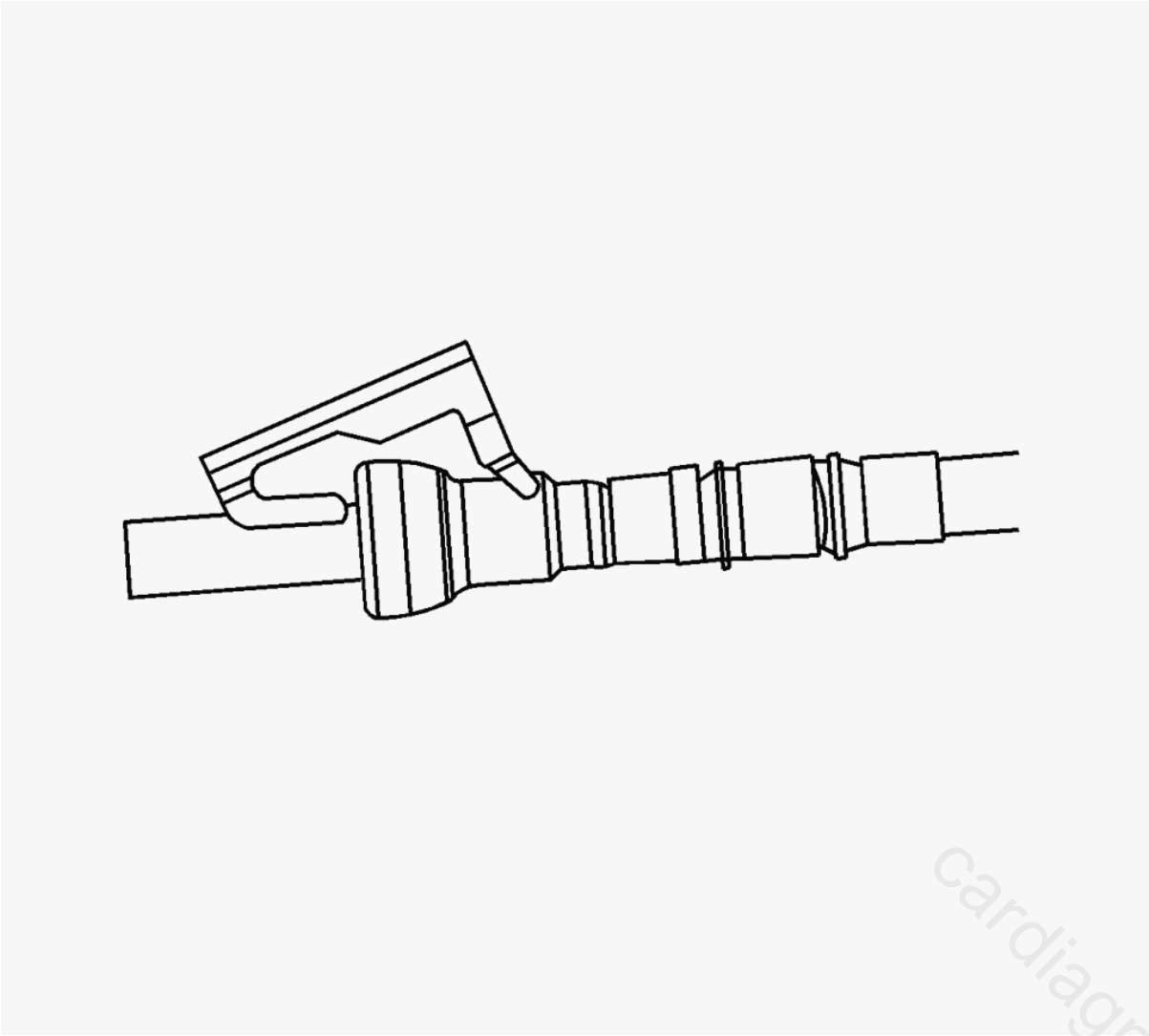

Fig. 9: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Remove the retainer from the quick-connect fitting.

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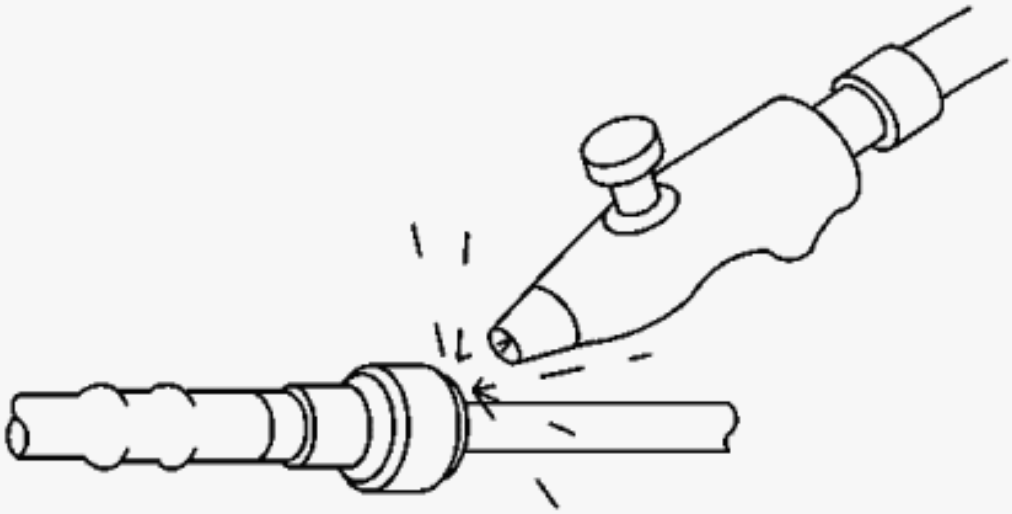

Fig. 10: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.**

3. Blow dirt out of the fitting using compressed air.

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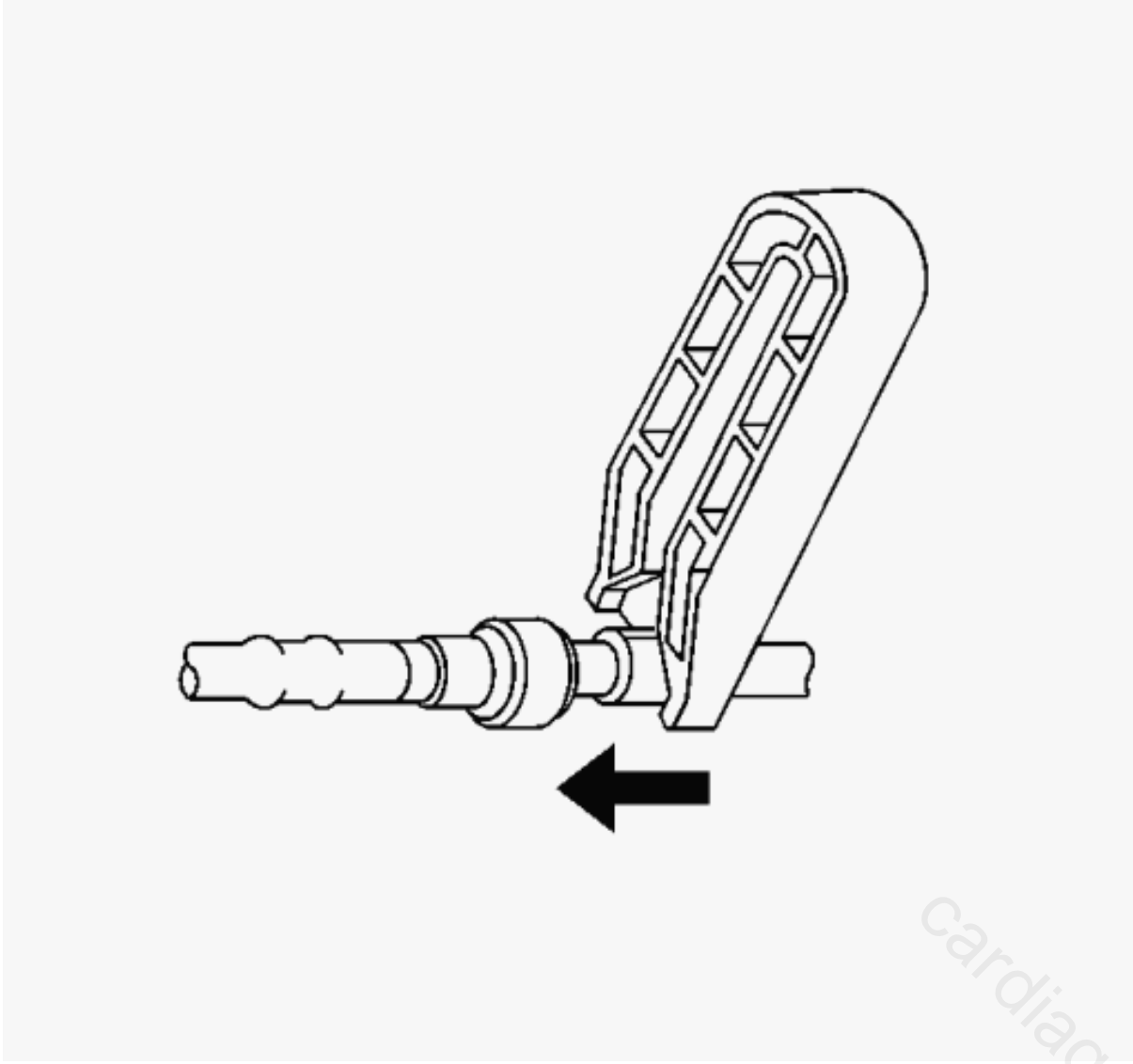

Fig. 11: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

4. Depending on the fuel line size and ability to access the fitting, choose the appropriate tool: **CH-41769** fuel line disconnect tool set or **CH-44581** fuel line disconnect tool. Insert the **CH-41769** fuel line disconnect tool set or **CH-44581** fuel line disconnect tool into the female connector, then push inward to release the locking tabs.

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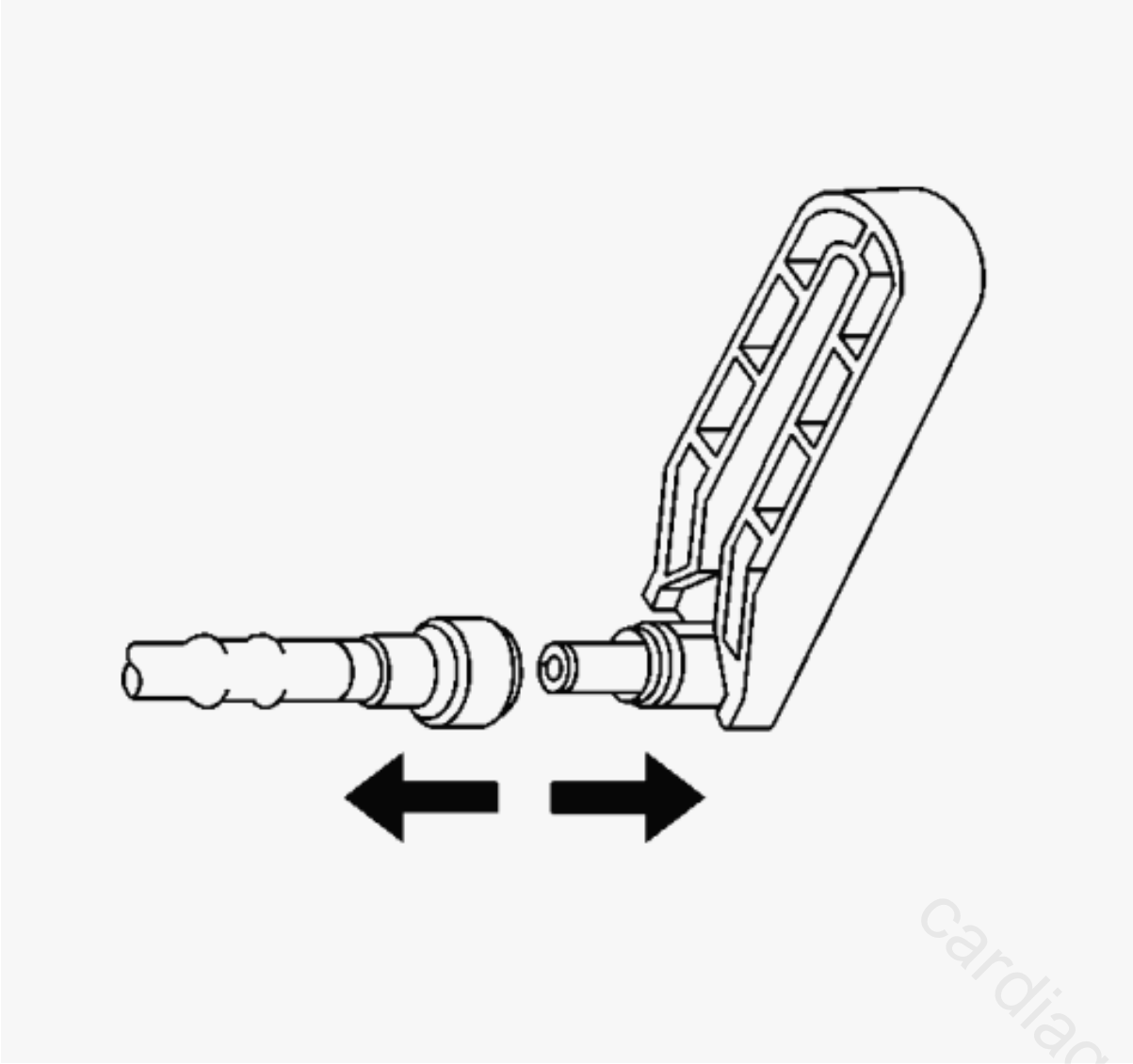

Fig. 12: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

5. Pull the connection apart.

CAUTION: **If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.**

6. Using a clean shop towel, wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs.
8. Clean or replace the components as required.

Installation Procedure

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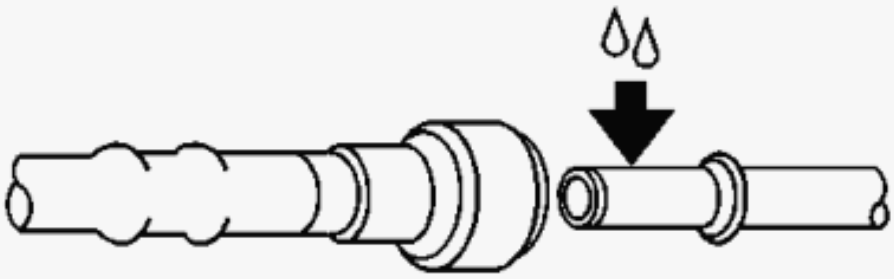

Fig. 13: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: **In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends.**

This will ensure proper reconnection and prevent a possible fuel leak.

During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

1. Apply a few drops of clean engine oil to the male pipe end.

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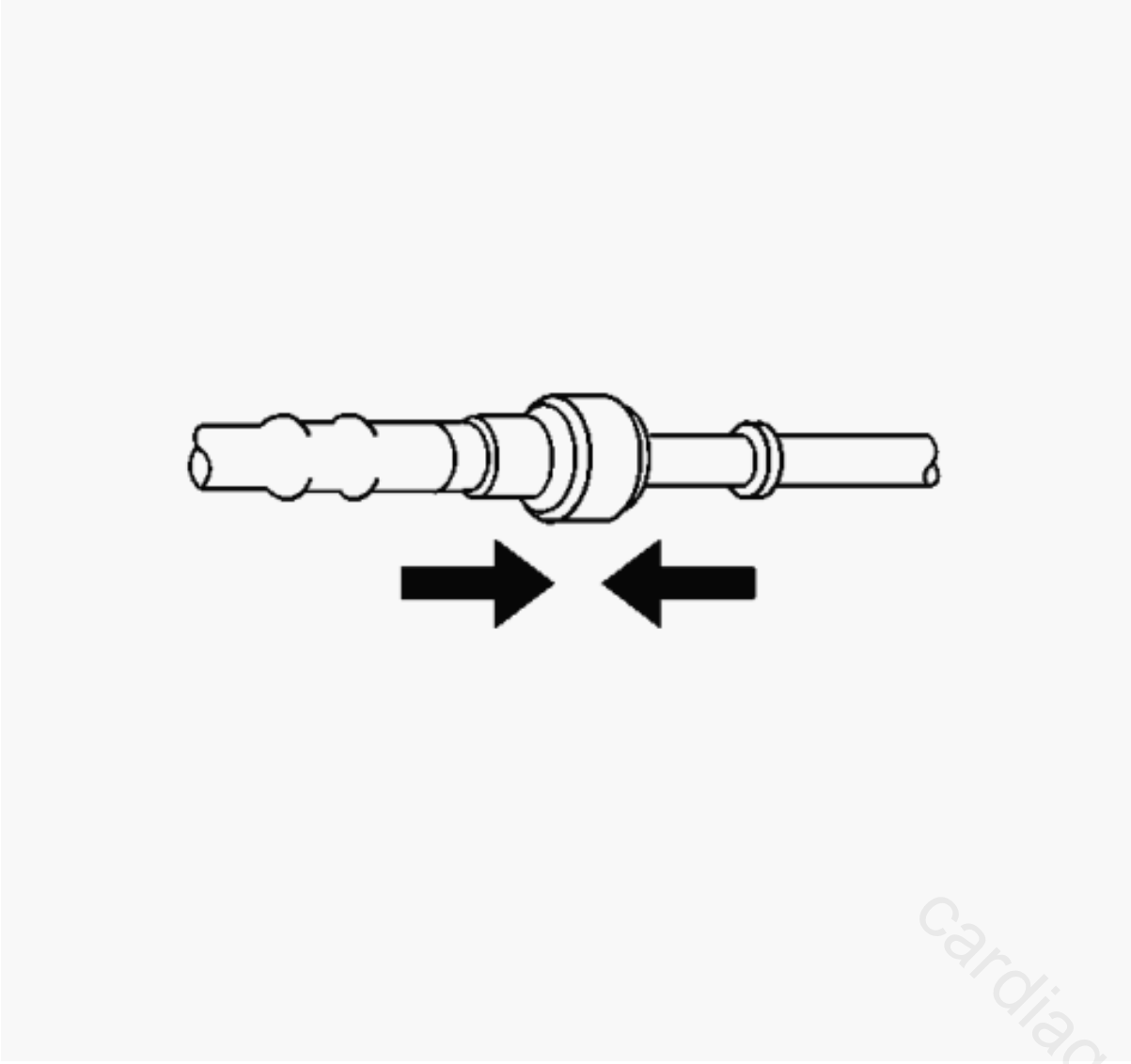

Fig. 14: View Of Connectors (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the quick-connect fitting together to cause the retaining tabs to snap into place.

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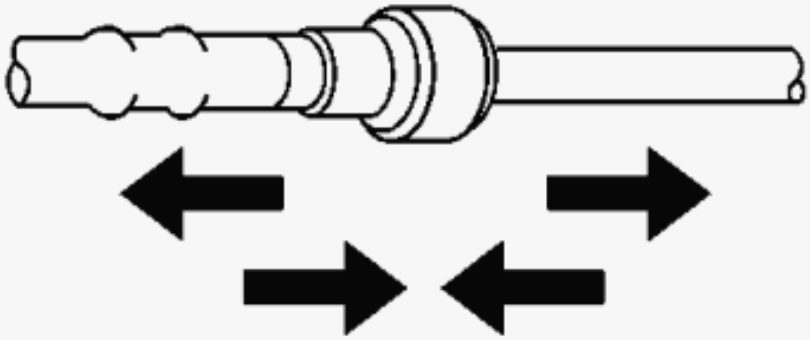

Fig. 15: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

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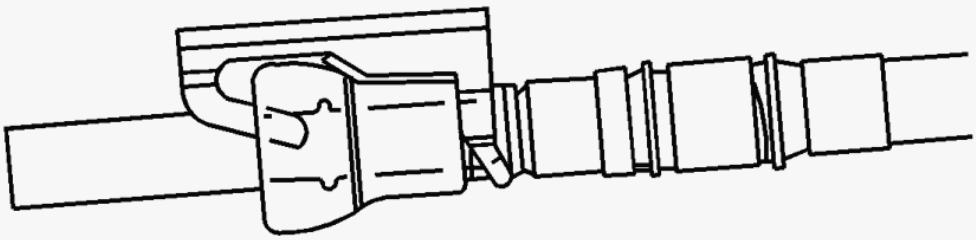

Fig. 16: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install the retainer to the quick-connect fitting.
5. Inspect for leaks using the following procedure:
    1. Turn the ignition ON, with the engine OFF for 2 seconds.
    2. Turn the ignition OFF, for 10 seconds.
    3. Turn the ignition ON, with the engine OFF for 2 seconds.
    4. Turn the ignition OFF.
    5. Inspect for leaks.

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Removal Procedure

WARNING: **Refer to Diesel/Gasoline Vapors Warning .**

NOTE: **If servicing a fuel system, insure the fuel pressure has been relieved.**

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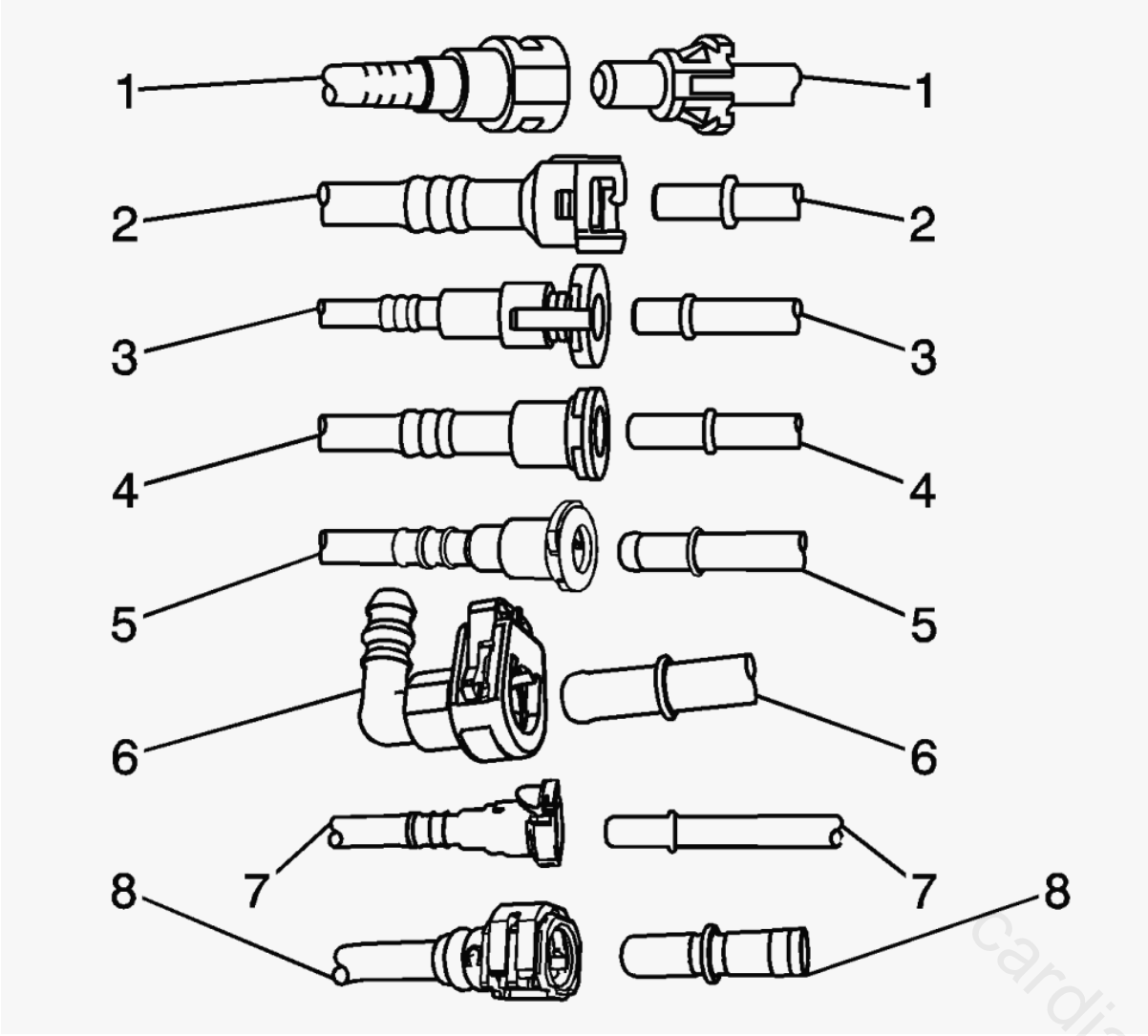

Fig. 17: Plastic Collar Quick Connect Fitting Service
Courtesy of GENERAL MOTORS COMPANY

NOTE: **There are several types of plastic collar fuel and evaporative emission quick connect fittings used on this vehicle.**

- **Bartholomew (1)**
- **Q Release (2)**
- **Squeeze to Release (3)**
- **Sliding Retainer (4)**
- **Global Connect (5)**
- **TI Loc (6)**
- **Safe Lock (7)**
- **Plastic Connector (8)**

The following instructions apply to all of these types of plastic collar quick connect fittings except where indicated.

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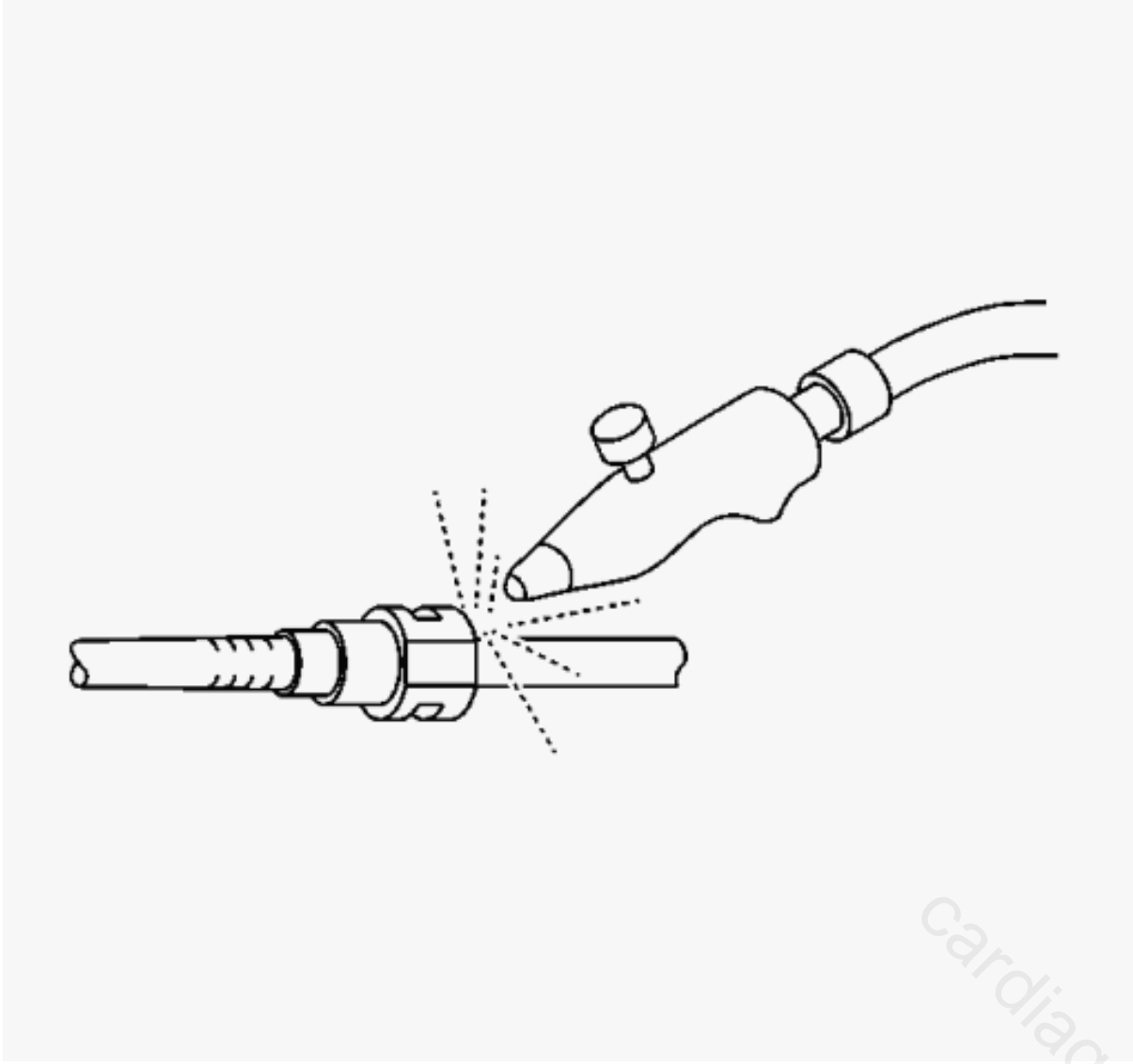

Fig. 18: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.**

1. Using compressed air, blow any dirt out of the quick-connect fitting.

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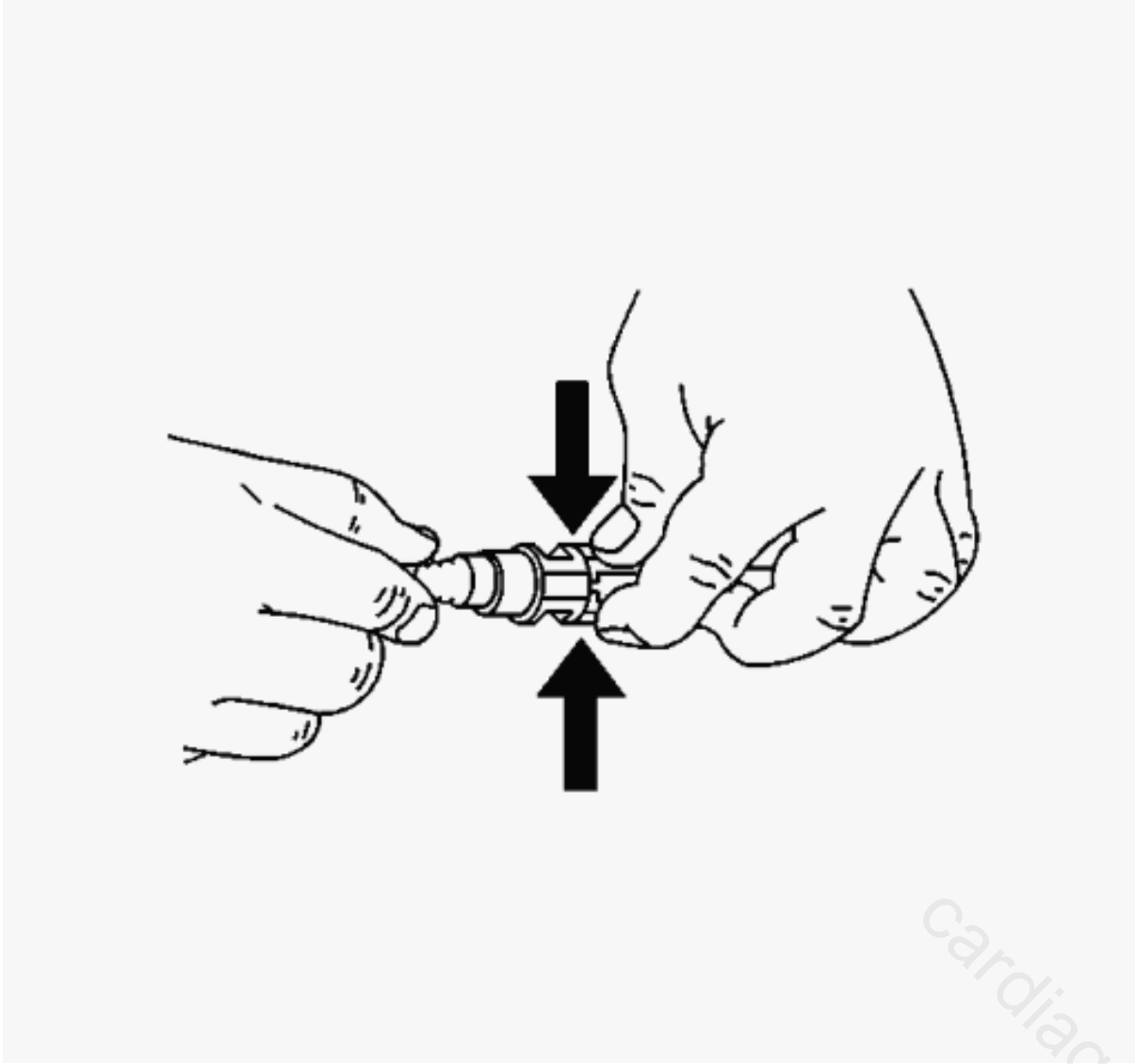

Fig. 19: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

2. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick-connect fitting release tabs.

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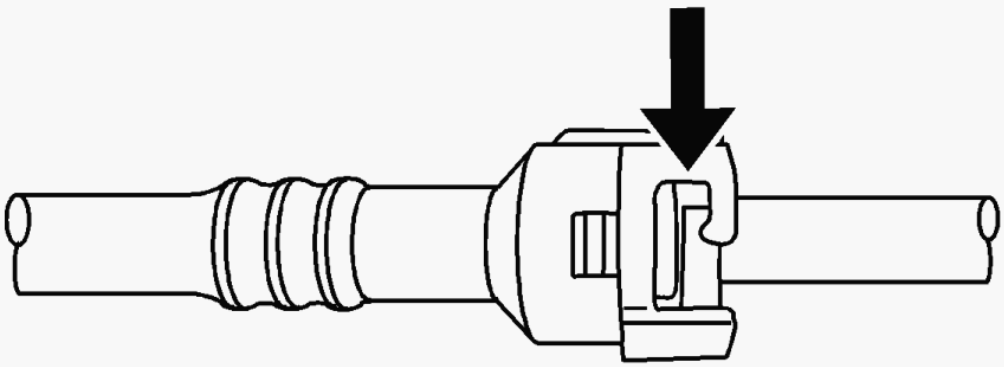

Fig. 20: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

3. This step applies to Q Release style connectors ONLY. Release the fitting by Pushing the tab toward the other side of the slot in the fitting.

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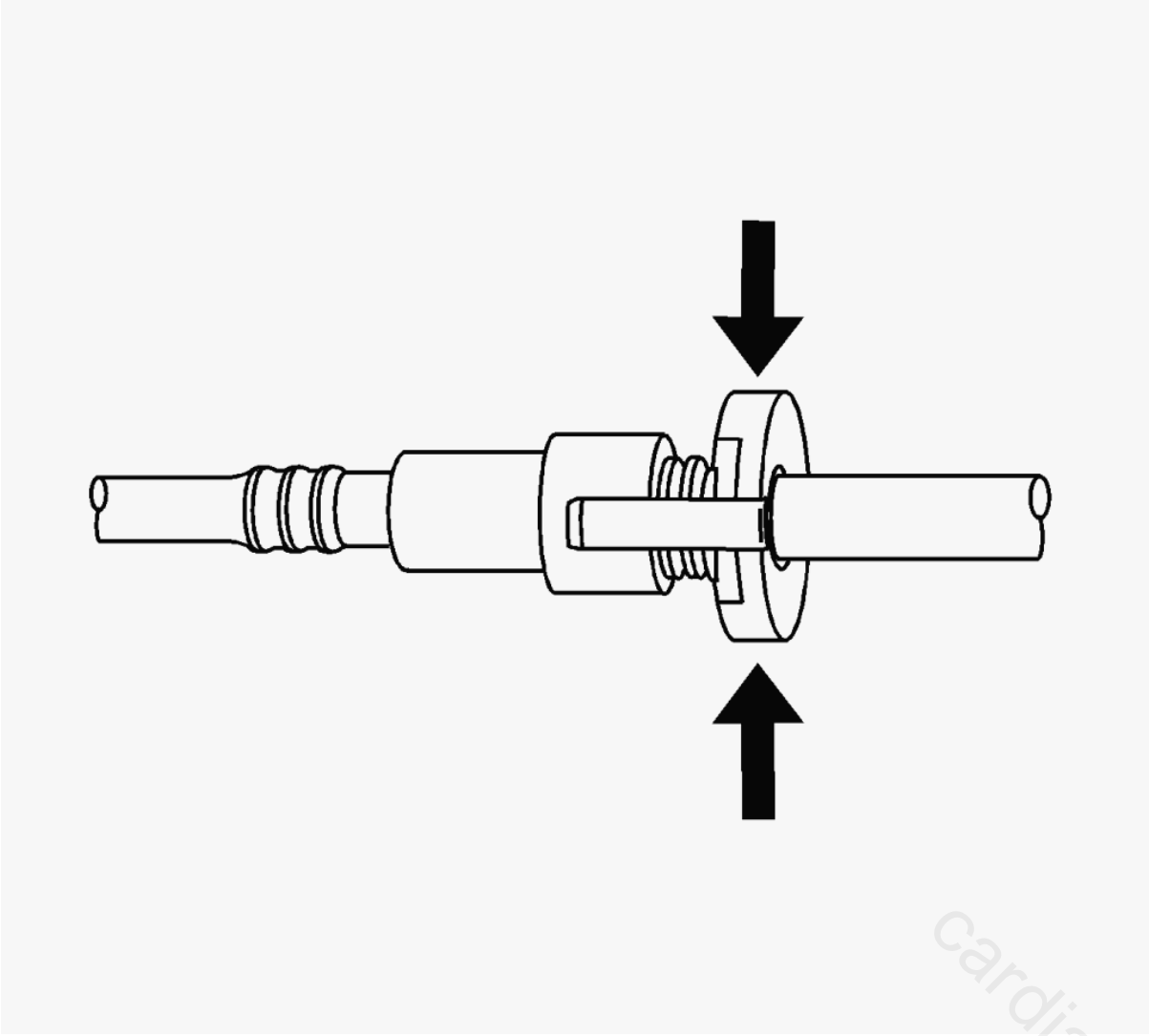

Fig. 21: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

4. This step applies to Squeeze to Release style connectors ONLY. Squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick-connect fitting.

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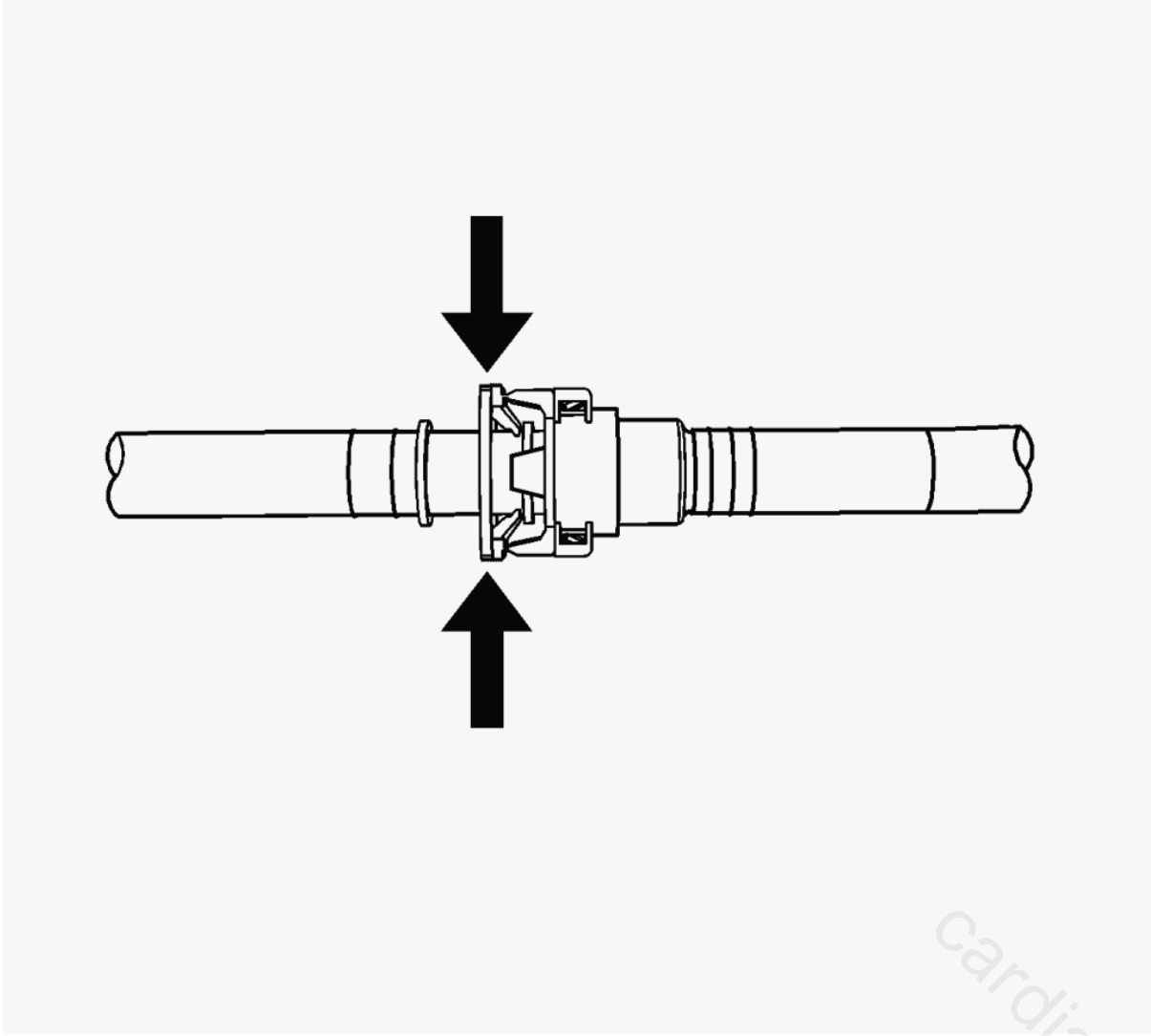

Fig. 22: Pushing In Male Side Of Connector
Courtesy of GENERAL MOTORS COMPANY

5. This step applies to Squeeze to Release style connectors ONLY. Push in the male side slightly in order to slide the retainer away from the retainers, squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick-connect fitting.

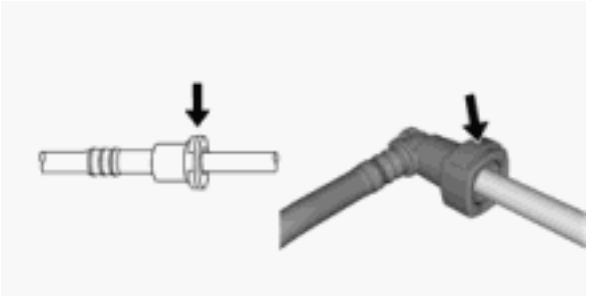

Fig. 23: Variants Of Sliding Retainer Style Connectors
Courtesy of GENERAL MOTORS COMPANY

NOTE: **There are two variants of sliding retainer style connectors shown above, both have the same release and installation procedure.**

6. This step applies to Sliding Retainer style connectors ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab doesn't move try pressing the tab in from the opposite side. The tab will only move in one direction.

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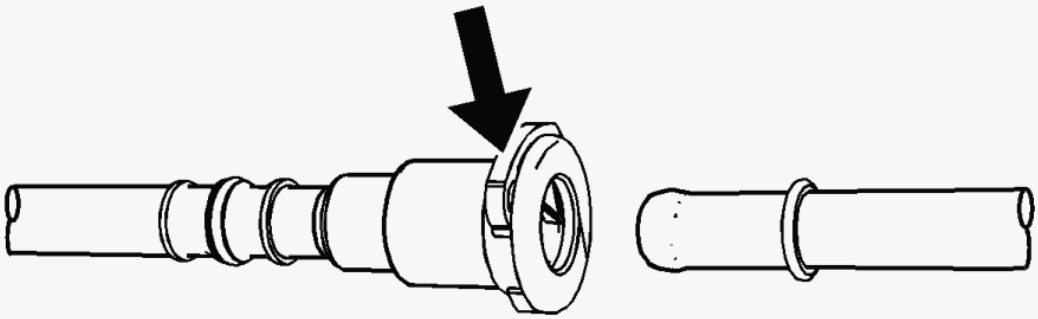

Fig. 24: Global Connector Style
Courtesy of GENERAL MOTORS COMPANY

7. This step applies to the Global Connector style only. Push the connector toward the tube in order to release the pressure. Press and hold down the release mechanism, and pull the connector straight out.

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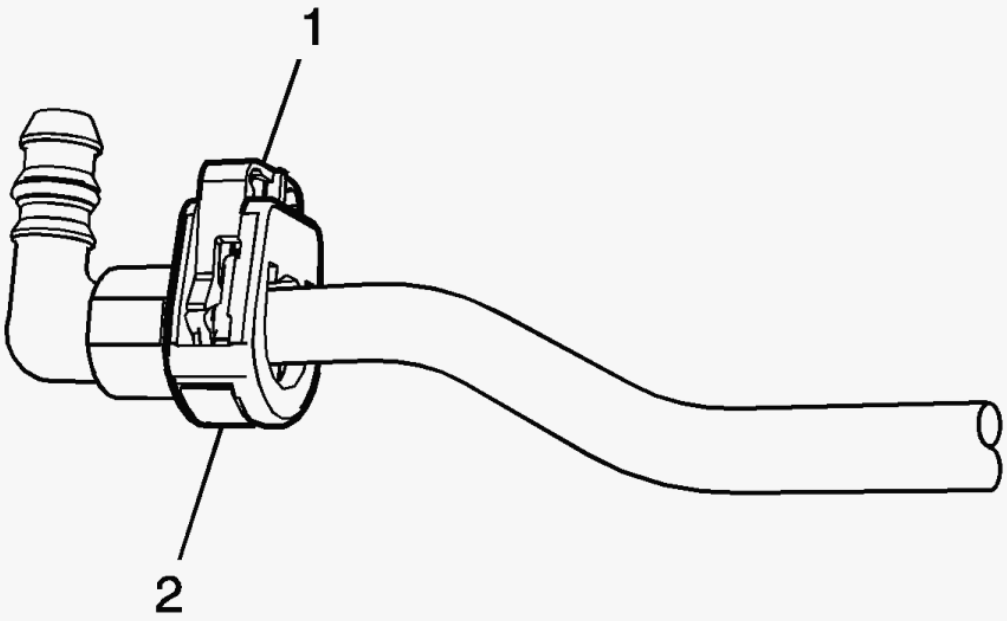

Fig. 25: TI Loc style
Courtesy of GENERAL MOTORS COMPANY

8. This step applies to the TI Loc style only. Push the connector toward the tube in order to release the pressure. Release the redundant latch (1) with two fingers or a flat bladed tool. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.

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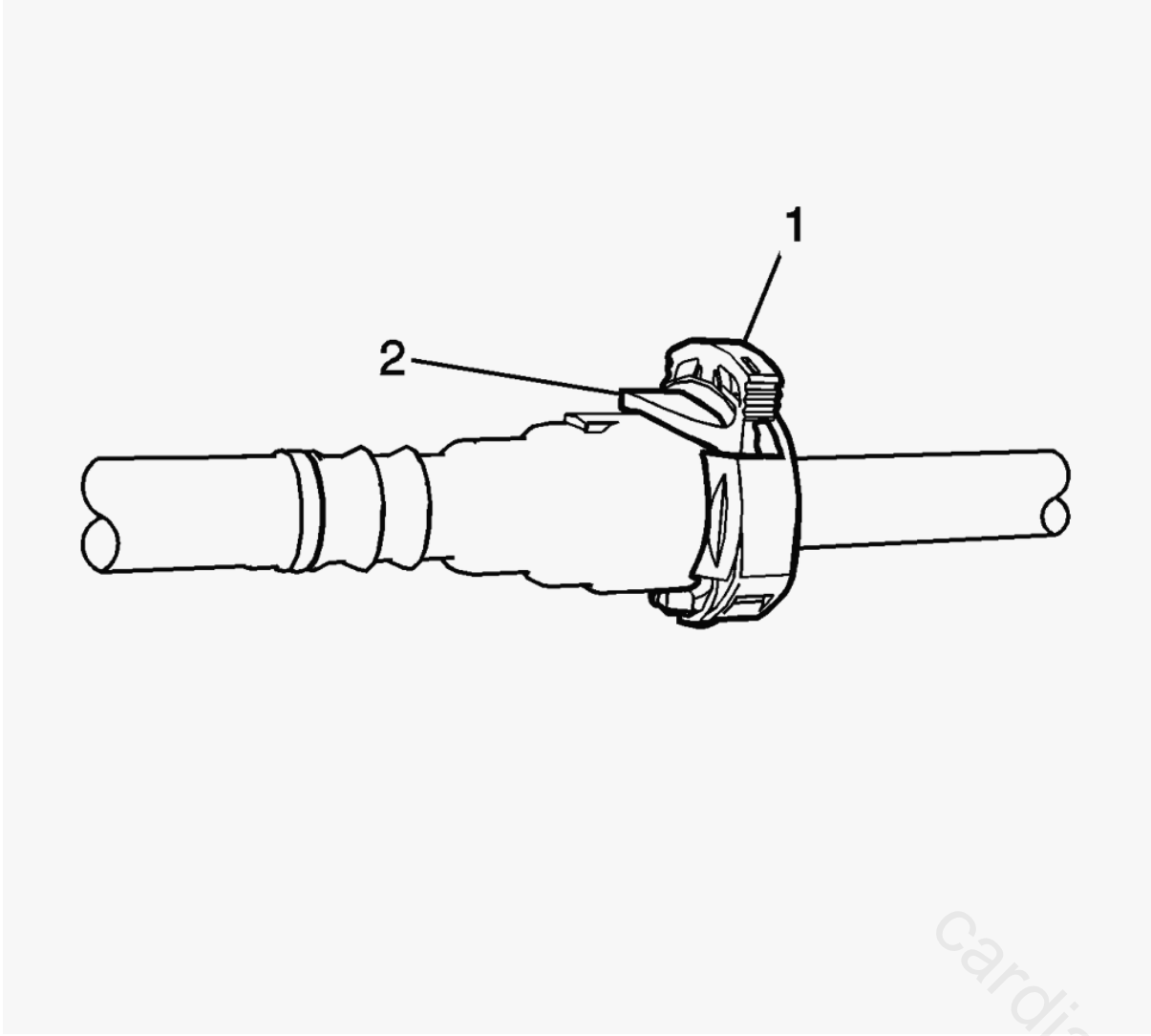

Fig. 26: Safe Lock Style
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Relieving Fuel Pressure Warning .**

9. This step applies to the Safe Lock style only. Push the connector toward the tube in order to release the pressure. Release the second latch (1) with two fingers. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.

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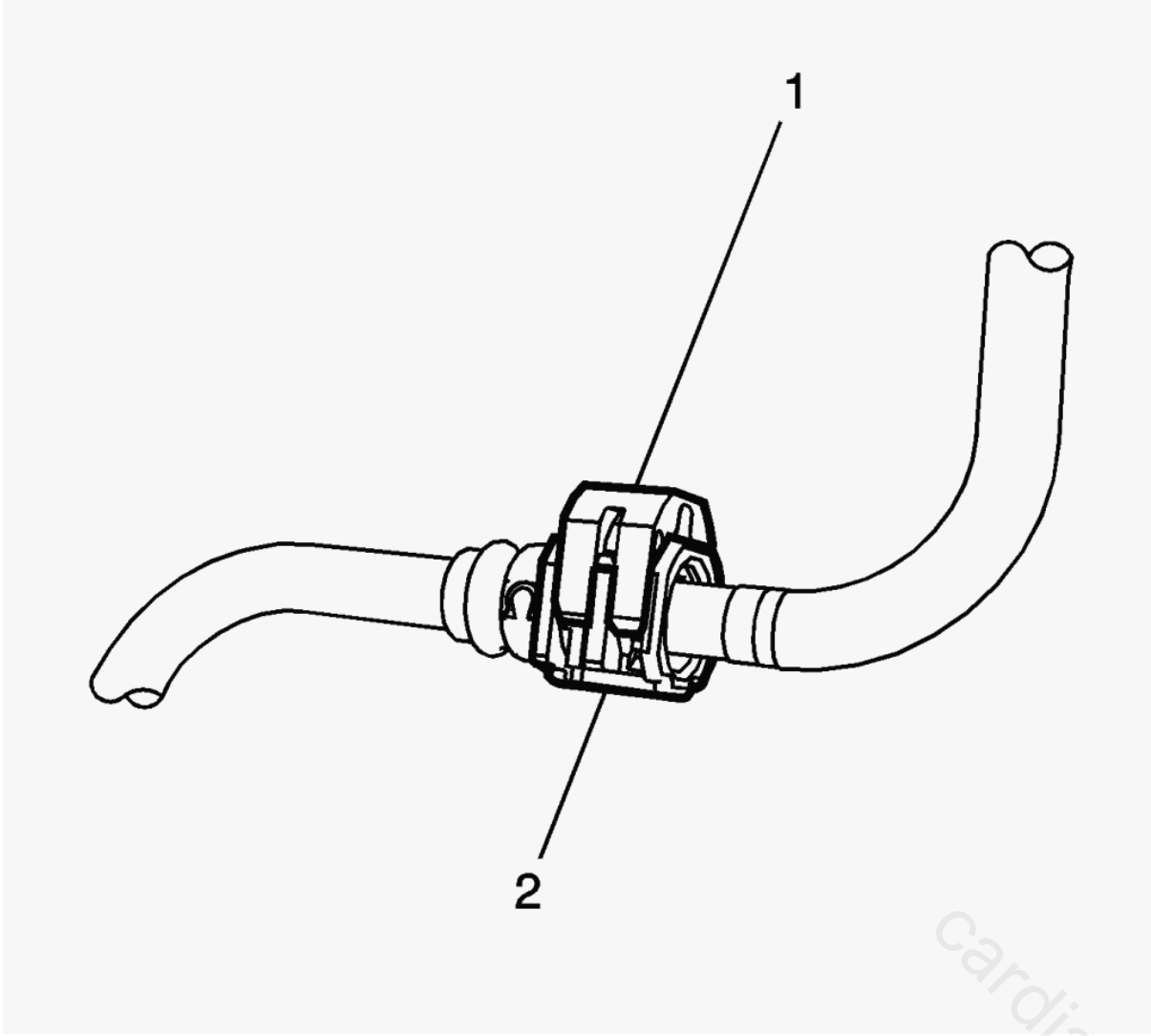

Fig. 27: Latch And Connector Straight Out
Courtesy of GENERAL MOTORS COMPANY

10. This step applies to the Plastic Connector style 8, push the connector toward the tube in order to release the pressure. Press the latch (1) inward in order to release the pipe, while pulling the connector (2) straight out.
11. Using a clean shop towel, wipe off the male pipe end.
12. Inspect both ends of the fitting for dirt and burrs.
13. Clean or replace components as necessary.

Installation Procedure

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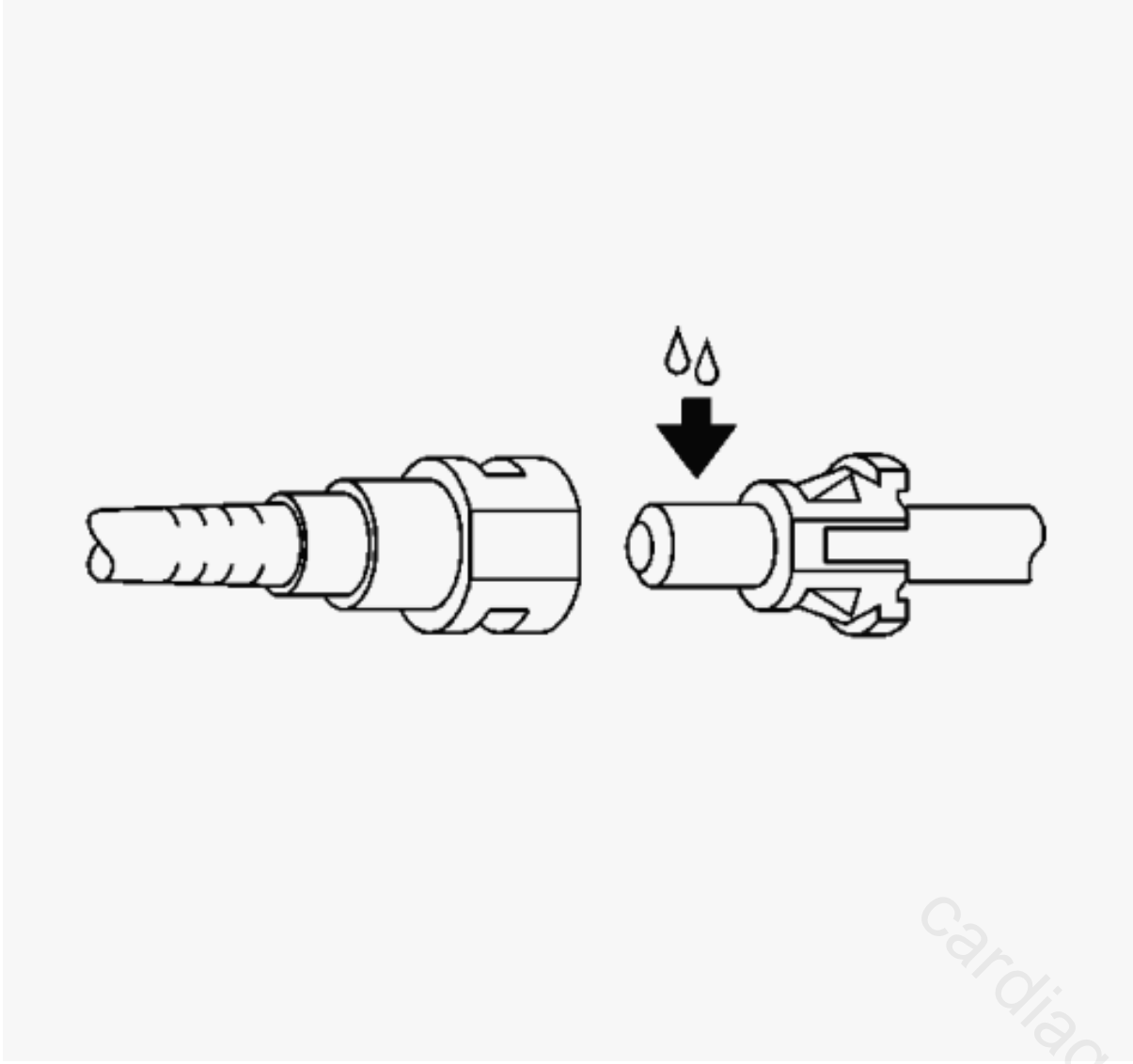

Fig. 28: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.**

1. Apply a few drops of clean engine oil to the male pipe end.

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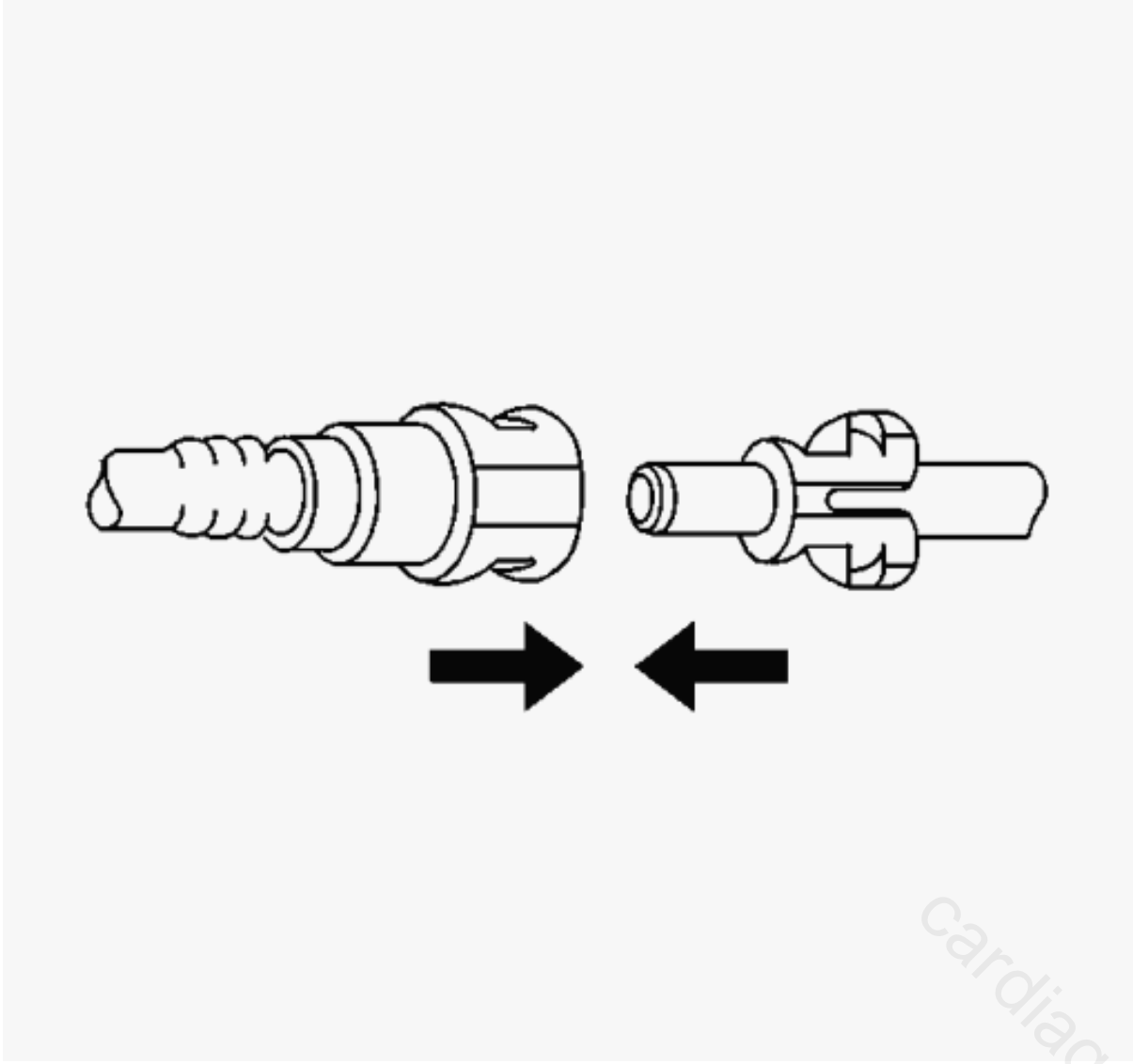

Fig. 29: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the quick-connect fitting together in order to cause the retaining feature to snap into place.

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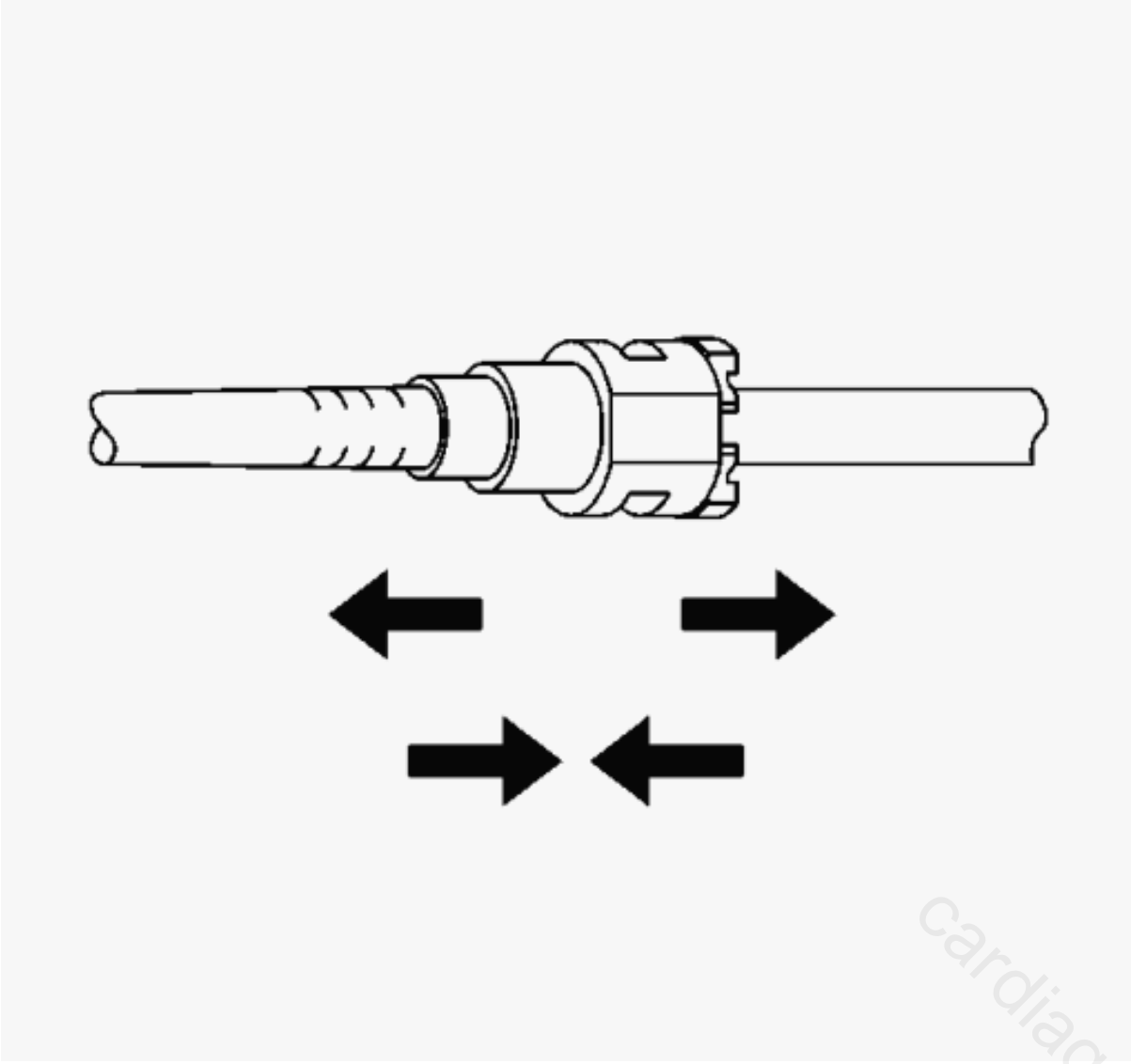

Fig. 30: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

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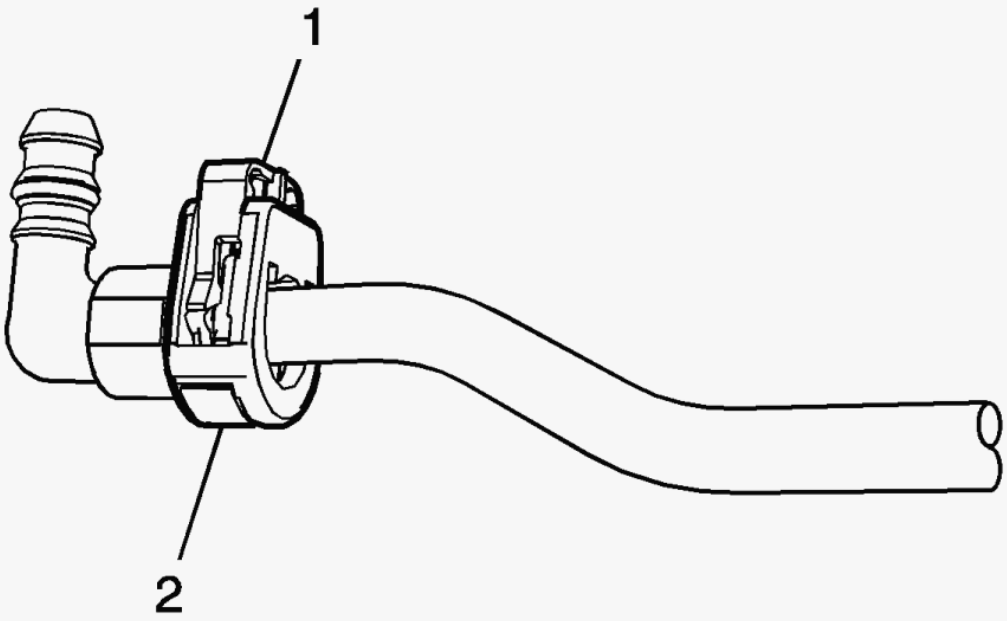

Fig. 31: TI Loc style
Courtesy of GENERAL MOTORS COMPANY

4. Insert the tube in the connector until the retainer snaps in place.
5. Push down on the redundant latch (1) until it is fully engaged and snapped into position.

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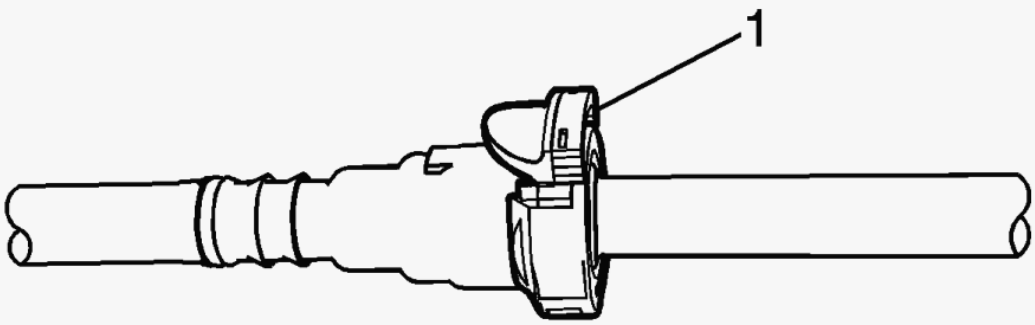

Fig. 32: Redundant Latch
Courtesy of GENERAL MOTORS COMPANY

6. Insert the tube in the connector until the retainer snaps in place.
7. Push down on the second latch (1) in order to secure the connection.

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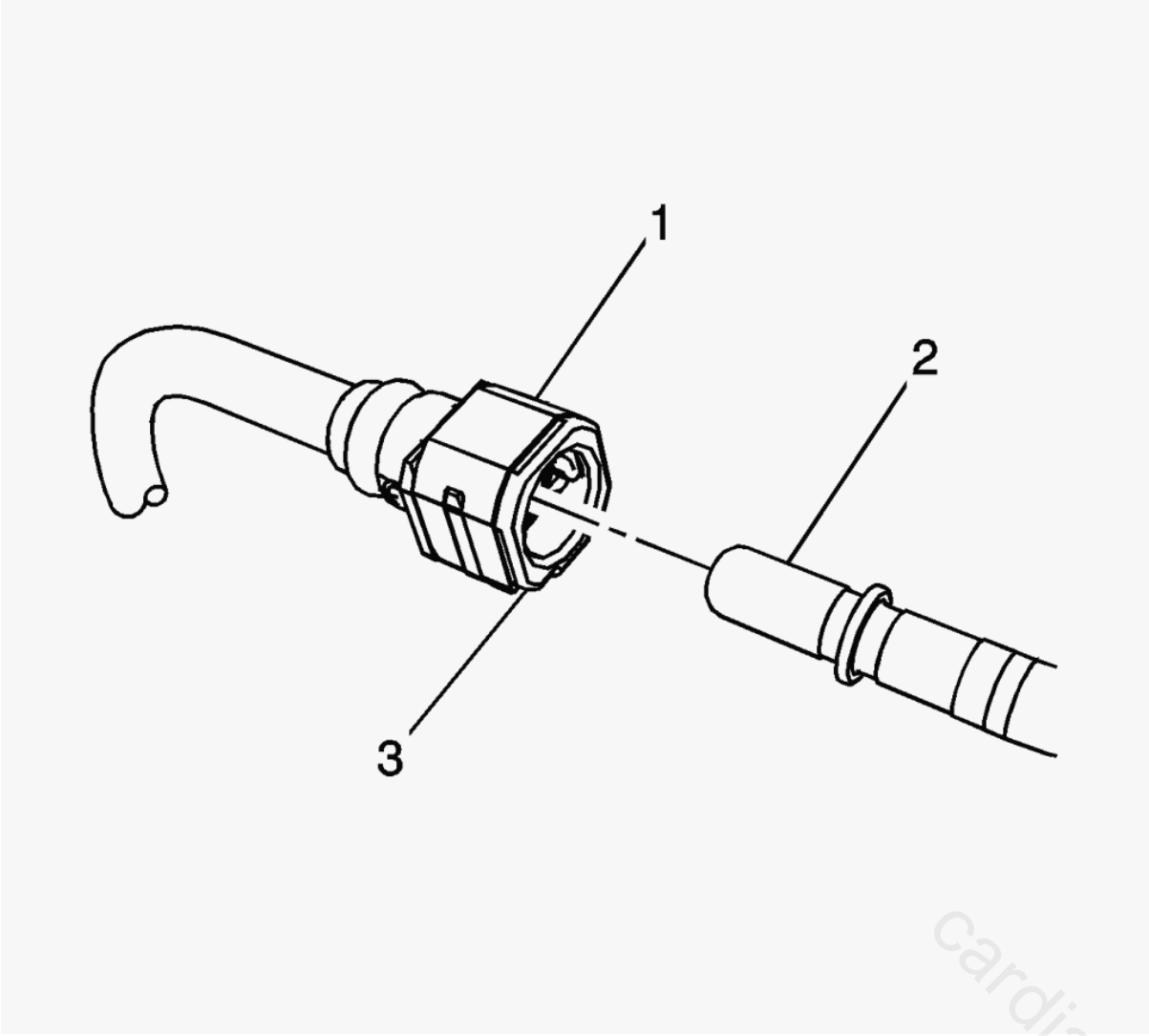

Fig. 33: Latch And Connector
Courtesy of GENERAL MOTORS COMPANY

8. For the plastic connector type 8, depress the latch (1) while inserting the connector (3) on to the pipe (2).
9. Move the latch (1) upward in order to secure the connection.
10. Inspect for leaks using the following procedure:
    1. Turn the ignition ON, with the engine OFF for 2 seconds.
    2. Turn the ignition OFF, for 10 seconds.
    3. Turn the ignition ON, with the engine OFF for 2 seconds.
    4. Turn the ignition OFF.
    5. Inspect for leaks.

EVAPORATIVE EMISSION SYSTEM CLEANING

Special Tools

GE 41413 - 200 Evaporative Pressure and Purge Station

Equivalent regional tools: Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools)

Inspection Procedure

CAUTION: **Use the Evaporative Emission (EVAP) System Tester GE 41413-A in order to provide a clean, dry, low pressure nitrogen gas source. Do not substitute any other pressurized source, gas or otherwise. Damage may result to the EVAP system, test equipment or cause a safety risk.**

NOTE: **Proceed with the following procedure only if referenced by an evaporative emission (EVAP) diagnostic or repair procedure.**

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1. Turn OFF the ignition.
2. Remove the EVAP canister purge valve. **Evaporative Emission Canister Purge Solenoid Valve Replacement**
3. Lightly tap the EVAP canister purge valve on a hard surface.
4. Inspect for carbon particles exiting either of the vacuum ports.
    - If no carbon particles were detected, but a blockage was detected during a diagnostic procedure, install the original EVAP canister purge valve. Continue with the cleaning procedure.
    - If carbon particles are found during the inspection procedure, continue with the cleaning procedure.
    - If a diagnostic procedure directed you to replace the EVAP canister purge valve and no carbon particles were detected, replace the EVAP canister purge valve. Return to the published service procedure.

Cleaning Procedure

1. Raise and support the vehicle. **Lifting and Jacking the Vehicle**
2. Remove the EVAP canister. **Evaporative Emission Canister Replacement (FWD)Evaporative Emission Canister Replacement (AWD)**
3. Turn OFF the main valve on the **GE 41413 - 200** station.
4. Disconnect the hose from the diagnostic station pressure regulator.
5. Using a section of vacuum hose, connect one end onto the EVAP pressure/purge diagnostic station pressure regulator.
6. Connect the other end of the vacuum hose to the canister side of the purge pipe.
7. Turn ON the main nitrogen cylinder valve and continue to discharge nitrogen for 15 seconds.
8. If the nitrogen does not clear the blockage, replace the purge pipe.
9. Return the EVAP pressure/purge diagnostic station to the stations original condition.
10. Install a new EVAP canister. **Evaporative Emission Canister Replacement (FWD)Evaporative Emission Canister Replacement (AWD)**
11. Lower the vehicle.
12. Install a new EVAP canister purge valve. **Evaporative Emission Canister Purge Solenoid Valve Replacement**
13. Return to the diagnostic table that sent you here.

ENGINE CONTROL MODULE REPLACEMENT

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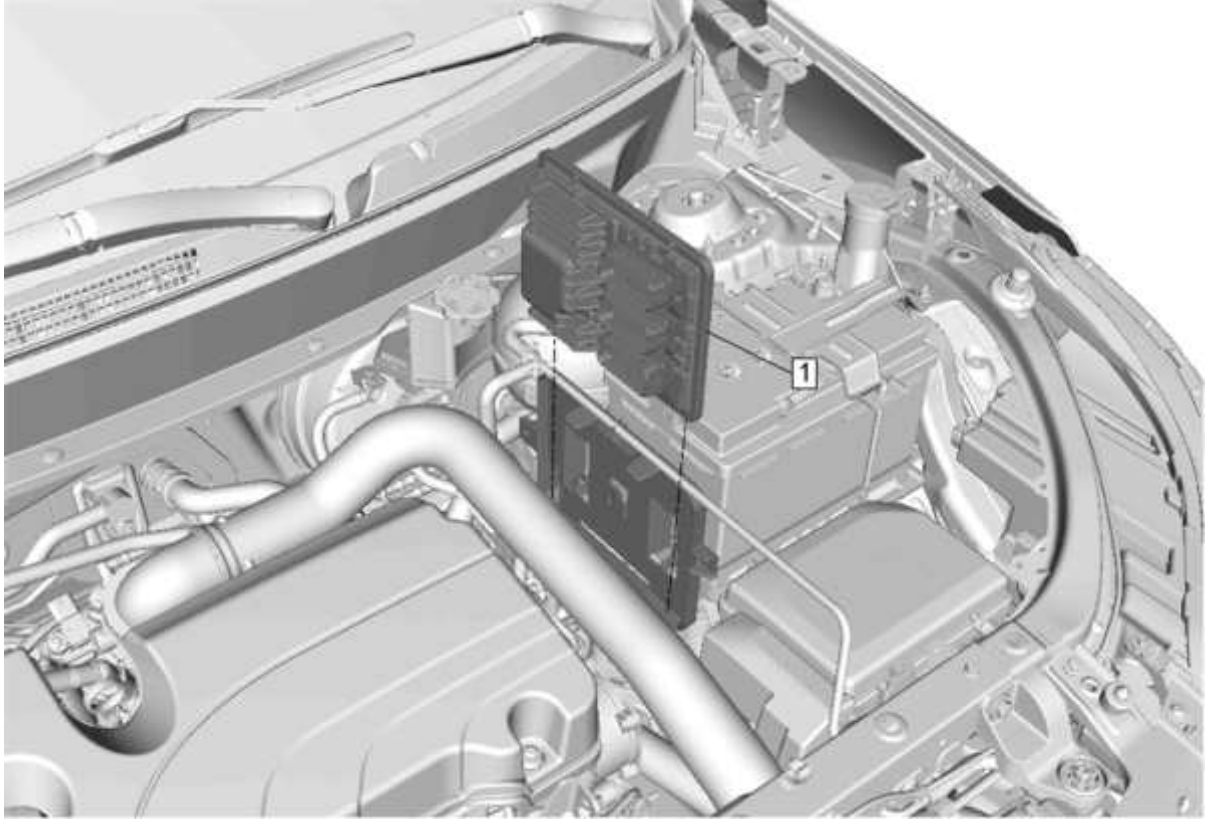

Fig. 34: Engine Control Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect the negative battery cable. **Battery Negative Cable Disconnection and Connection (KL9)**	

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Callout	Component Name
1	Engine Control Module **WARNING:** **Refer to Safety Glasses Warning .** **CAUTION:** **Always turn the ignition off when installing or removing the ECM connectors in order to prevent damage to the components.** **CAUTION:** • **Turn the ignition OFF when installing or removing the control module connectors and disconnecting or reconnecting the power to the control module (battery cable, powertrain control module (PCM)/engine control module (ECM)/transaxle control module (TCM) pigtail, control module fuse, jumper cables, etc.) in order to prevent internal control module damage.** • **Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control module, using battery booster cables, or when charging the vehicle battery.** • **In order to prevent any possible electrostatic discharge damage to the control module, do 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.** **Procedure** 1. Disconnect the electrical connectors from the engine control module. 2. Use a suitable tool to pry back the locking tabs and remove the engine control module from the bracket. 3. Perform the throttle body idle air flow compensation reset. **Throttle Body Idle Air Flow Compensation Reset** 4. If replacing the engine control module, it is necessary to reprogram the replacement module. **Control Module References** **NOTE:** **Before removing the engine control module (ECM), record the oil life percentage remaining. Use the scan tool to reset the Engine Oil Life remaining back to the original percentage recorded.**

ENGINE CONTROL MODULE BRACKET REPLACEMENT

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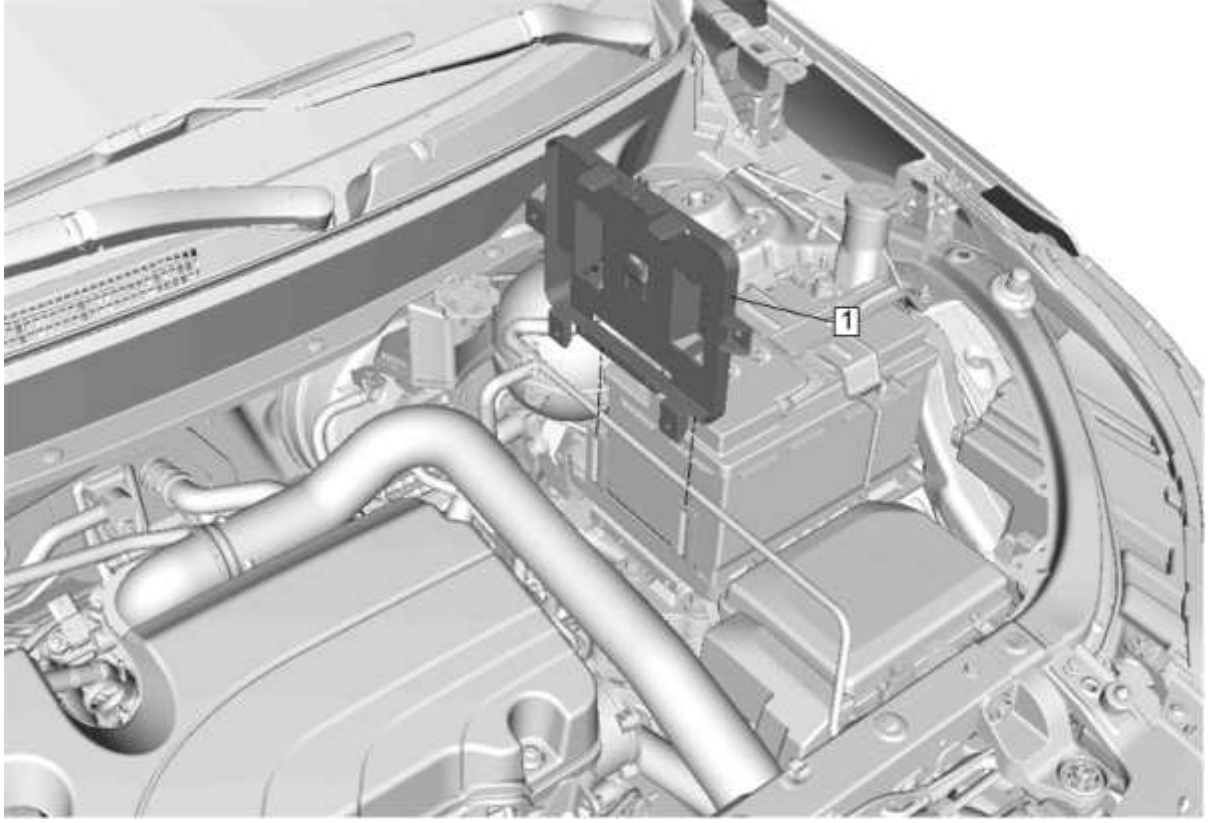

Fig. 35: Engine Control Module Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. **Engine Control Module Replacement** 2. Reposition away Engine Coolant Air Bleed Hose@Engine Control Module Bracket - **Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)** **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)** 3. Remove wiring harness from engine control module bracket.	
1	Engine Control Module Bracket **Procedure** Release retaining tab to remove bracket from battery tray.

ACCELERATOR PEDAL ASSEMBLY REPLACEMENT

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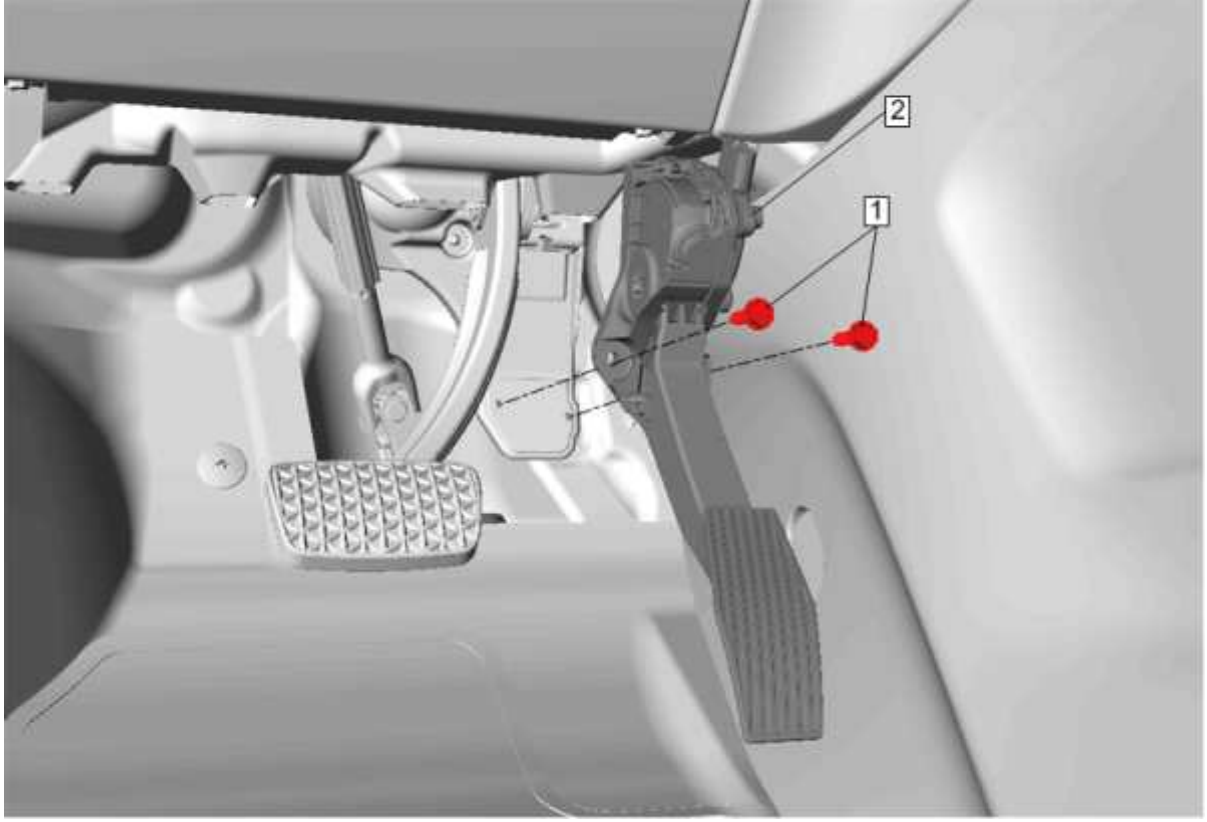

Fig. 36: Accelerator Pedal Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Accelerator Pedal Position Sensor Bolt[2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Accelerator Pedal Position Sensor **Procedure** Disconnect the electrical connector.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT - WATER OUTLET

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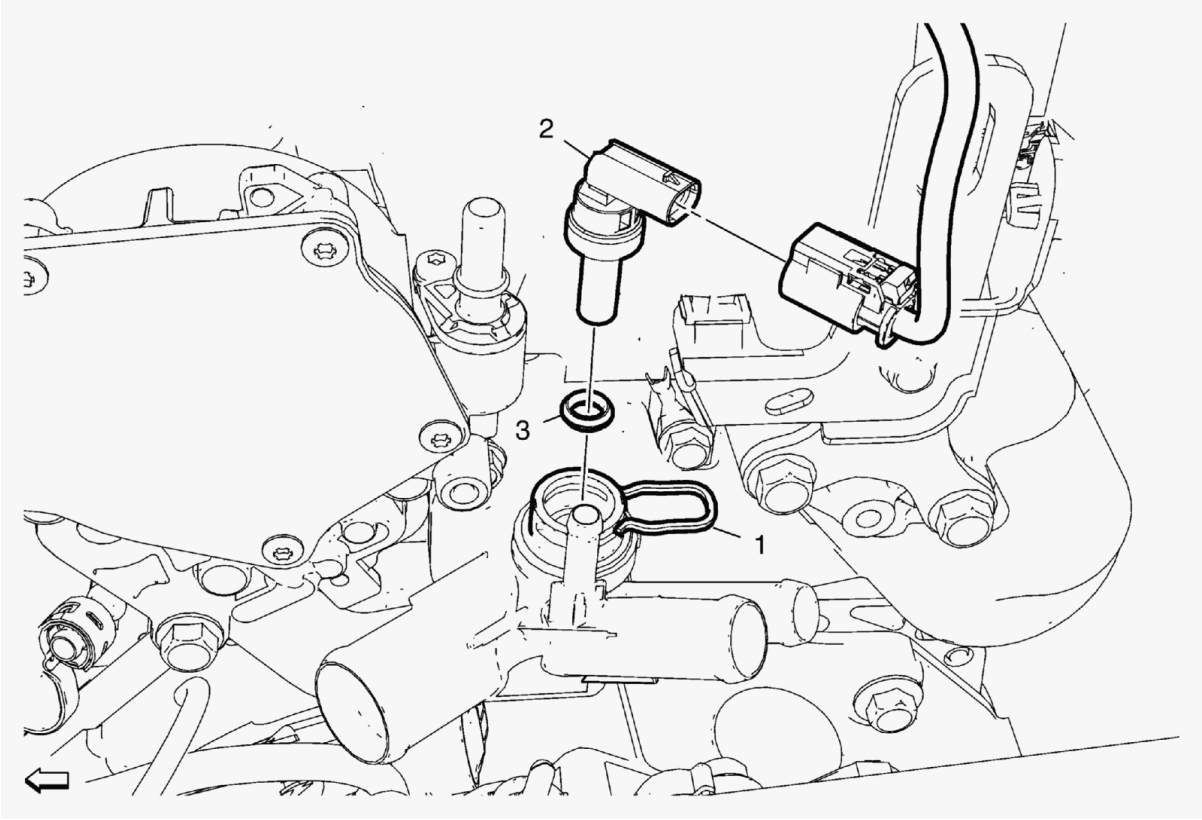

Fig. 37: Engine Coolant Temperature Sensor - Water Outlet
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure **Engine Lift Rear Bracket Replacement**	
1	Retaining Clamp
2	Engine Coolant Temperature Sensor **Procedure** Disconnect the electrical connector.
3	Engine Coolant Temperature Sensor Seal **Procedure** Install a NEW O-ring seal.

KNOCK SENSOR REPLACEMENT (SENSOR 1)

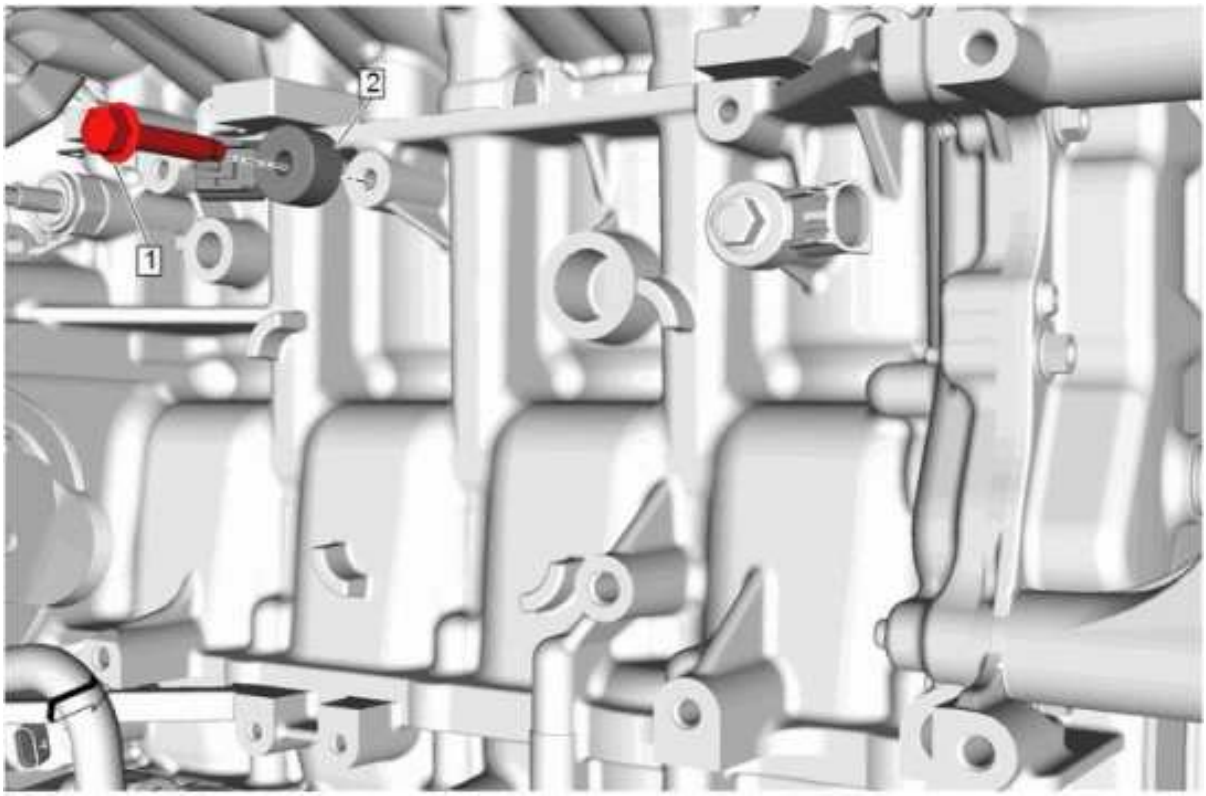

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Fig. 38: Knock Sensor (Sensor 1)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Starter Replacement (LYX - All Wheel Drive) Starter Replacement (LYX - Front Wheel Drive)	
1	Knock Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
2	Knock Sensor **Procedure** Disconnect the electrical connector.

KNOCK SENSOR REPLACEMENT (SENSOR 2)

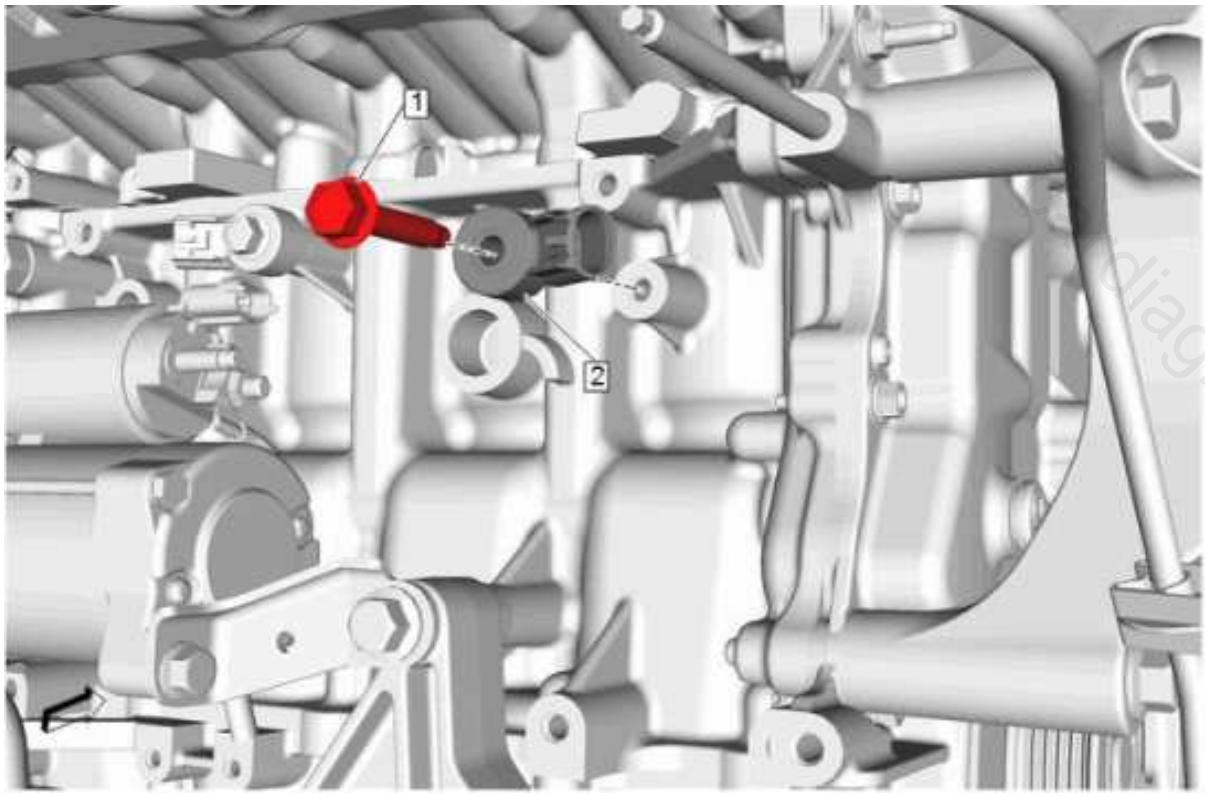

Fig. 39: Knock Sensor (Sensor 2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Generator Replacement (LYX) Generator Replacement (LTG)	
1	Knock Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)

Callout	Component Name
2	Knock Sensor **Procedure** Disconnect the electrical connector.

THROTTLE BODY ASSEMBLY REPLACEMENT

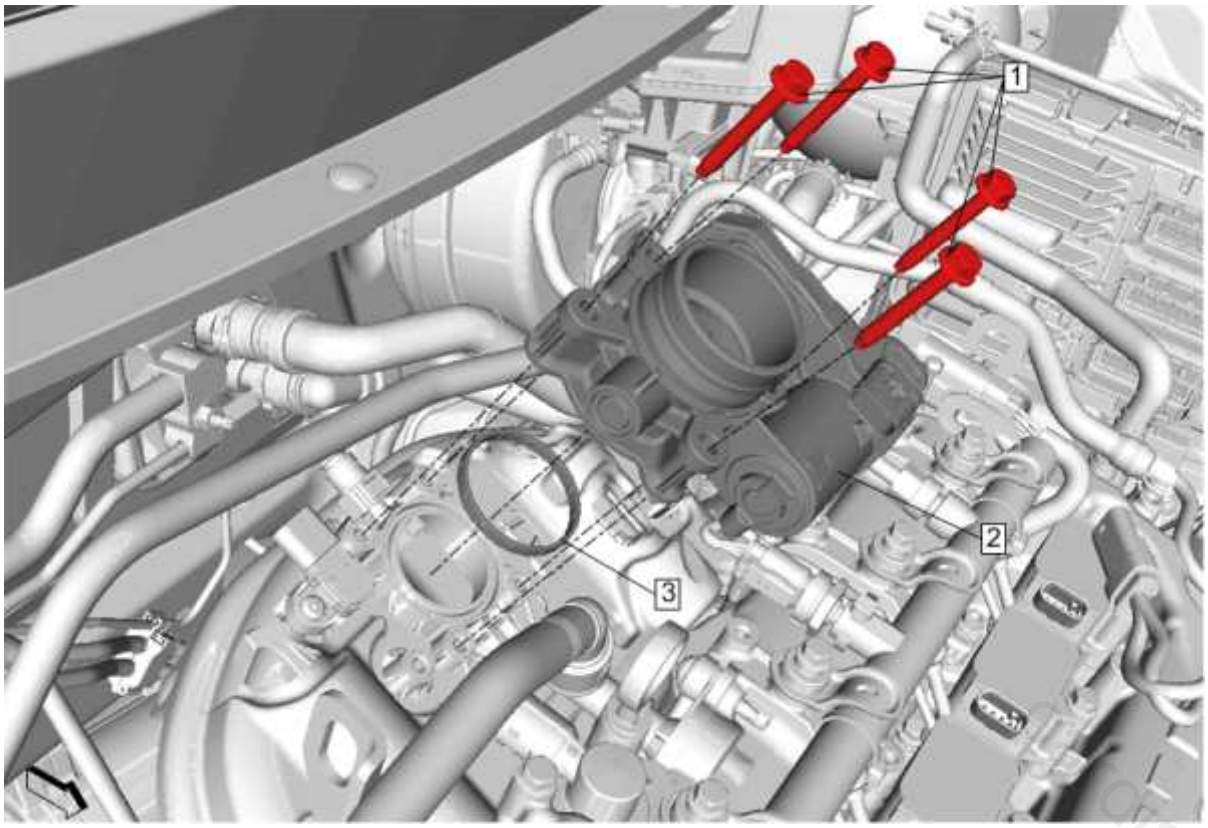

Fig. 40: Throttle Body Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Charge Air Cooler Outlet Air Tube Replacement 2. Disconnect the electrical connector.	
1	Throttle Body Bolt [4x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Throttle Body **Procedure** 1. Perform the intake system learned values reset. Intake System Learned Values Reset 2. Perform throttle body idle air flow compensation reset. Throttle Body Idle Air Flow Compensation Reset
3	Throttle Body Seal **Procedure** Install a NEW throttle body seal.

THROTTLE BODY INSPECTION AND CLEANING

1. Remove **Throttle Body Assembly Replacement**

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

CAUTION: **Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.**

NOTE: **Open the throttle valve in order to inspect all surfaces.**

2. Inspect the throttle body bore and the throttle valve plate for deposits.

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 **Throttle Body Assembly Replacement**.
5. **Throttle Body Idle Air Flow Compensation Reset**

FUEL PRESSURE RELIEF

WARNING: **Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.**

WARNING: **Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.**

Scan Tool Method - Preferred

1. Install a scan tool and turn the ignition ON.
2. Using the scan tool, command the fuel pump OFF allowing the low pressure fuel pump to shut off.
3. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 5-20 seconds.
4. Repeat step 3. Using the scan tool, verify pressure has dropped to a minimal level.
5. Turn the ignition OFF.

Alternate Method - If a scan tool is not available

1. Disable the fuel pump by removing the B+ fuel pump control module fuse. Refer to **Electrical Center Identification Views** .
2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 5-20 seconds.
3. Attempt to restart the vehicle to ensure pressure has dropped to a minimal level.
4. Turn the ignition OFF.

FUEL TANK DRAINING

WARNING: **Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.**

WARNING: **Place a dry chemical (Class B) fire extinguisher nearby before performing any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.**

CAUTION: **When performing a fuel tank draining procedure on a capless fuel system, only use the capless adapter funnel or equivalent. Using something other than the capless adapter funnel or equivalent may cause damage to the capless fuel system.**

1. Insert the capless adapter funnel or equivalent into the capless fill pipe.

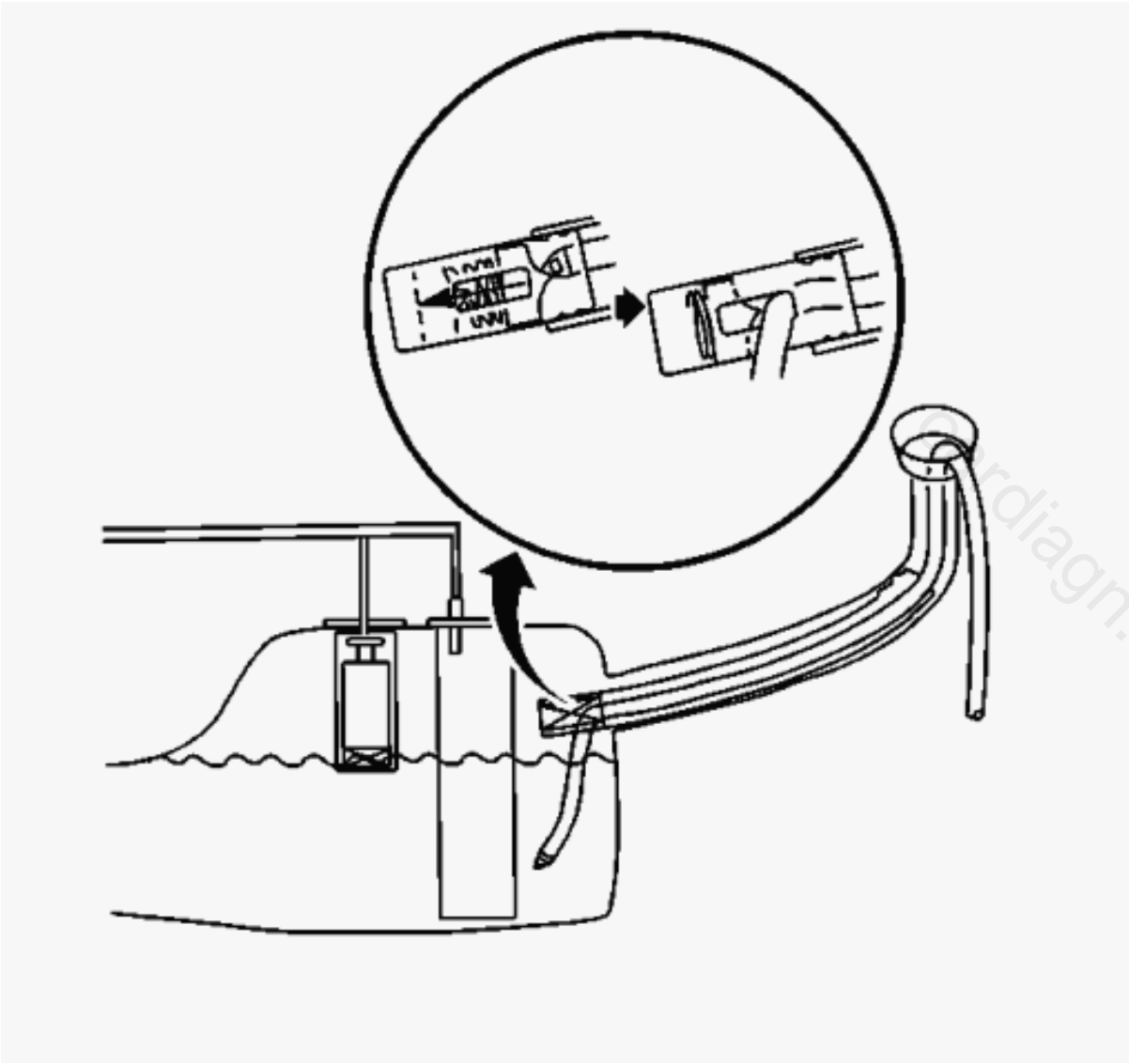

Fig. 41: Draining Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Lubricate the fuel drain hose with Transjel Lubricant or equivalent to aid in hose insertion.**

2. Insert the a suitable suction hose into the fuel tank until the bottom is reached.
3. Attach a suitable suction hose to the hose used with the hand or air operated pump device.
4. Use a hand or air operated pump device in order to drain as much fuel through the fuel fill pipe as possible.

FUEL TANK FILLER PIPE REPLACEMENT

Removal Procedure

WARNING: Refer to Diesel/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Drain fuel tank below filler pipe. Fuel Tank Draining
2. Remove Fuel Tank Filler Pipe Housing - Fuel Tank Filler Pipe Housing Replacement (Equinox) Fuel Tank Filler Pipe Housing Replacement (Terrain)
3. Remove Rear Wheelhouse Liner-Left Side - Rear Wheelhouse Liner Replacement- Left Side (Equinox) Rear Wheelhouse Liner Replacement- Left Side (Terrain)

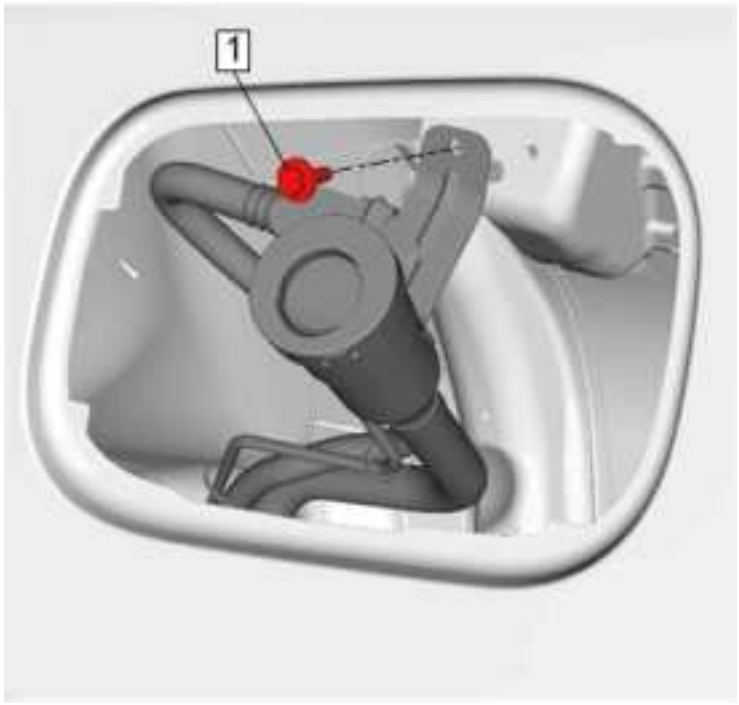

Fig. 42: Tank Filler Pipe Ground Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove Fuel Tank Filler Pipe Ground Bolt (1)

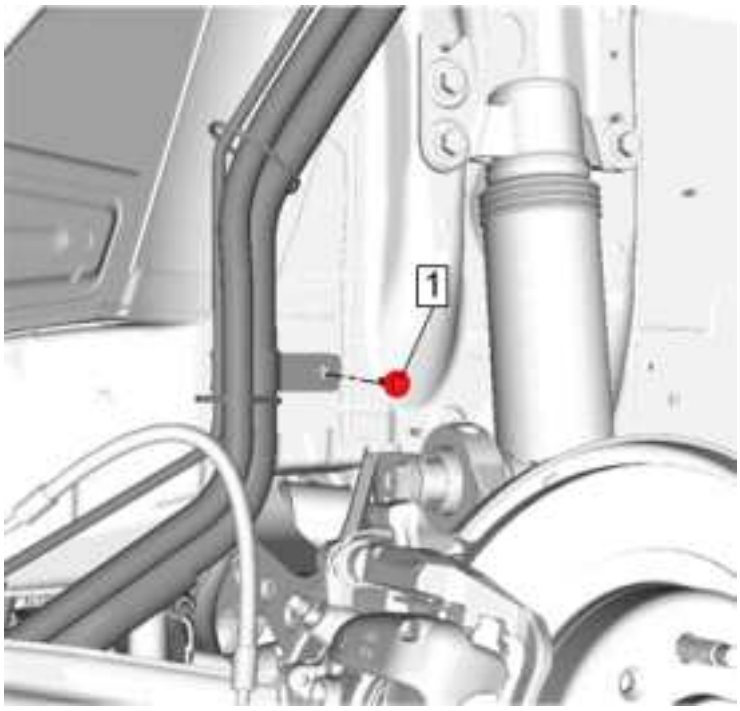

Fig. 43: Fuel Tank Filler Pipe Ground Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove Remove Fuel Tank Filler Pipe Ground Bolt (1)

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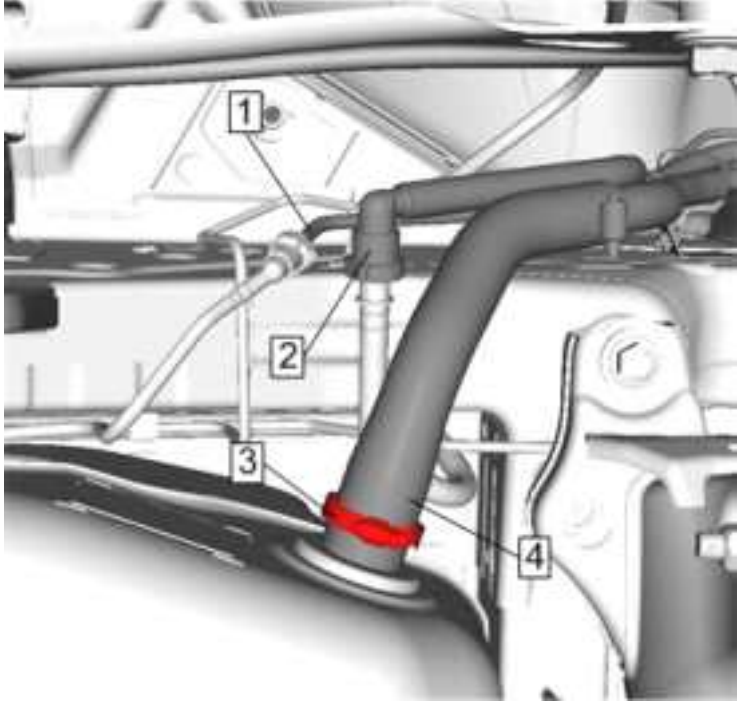

Fig. 44: Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect Fuel Tank Filler Pipe (1)**Plastic Collar Quick Connect Fitting Service**
7. Disconnect Evaporative Emission Canister Vent Hose (2)**Plastic Collar Quick Connect Fitting Service**
8. Remove Fuel Tank Filler Hose Clamp (3)
9. Remove Fuel Tank Filler Hose (4)

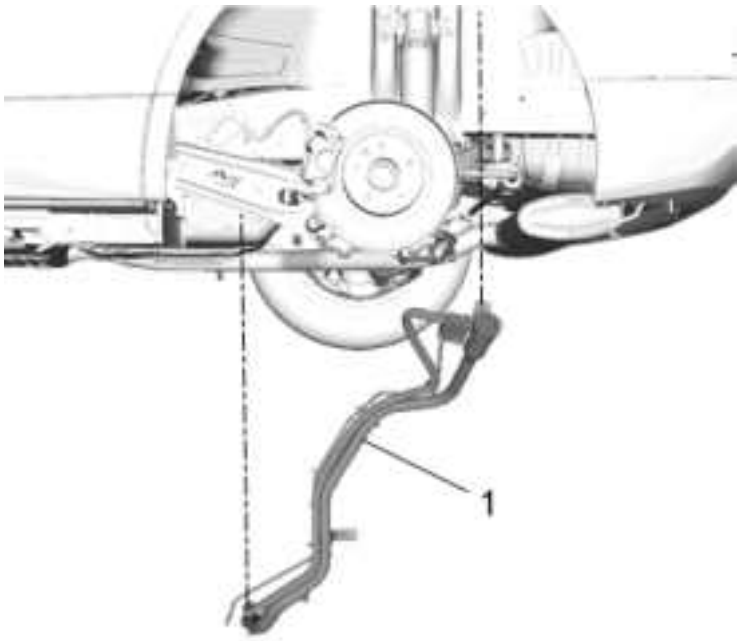

Fig. 45: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

10. Remove Fuel Tank Filler Pipe (1)

Installation Procedure

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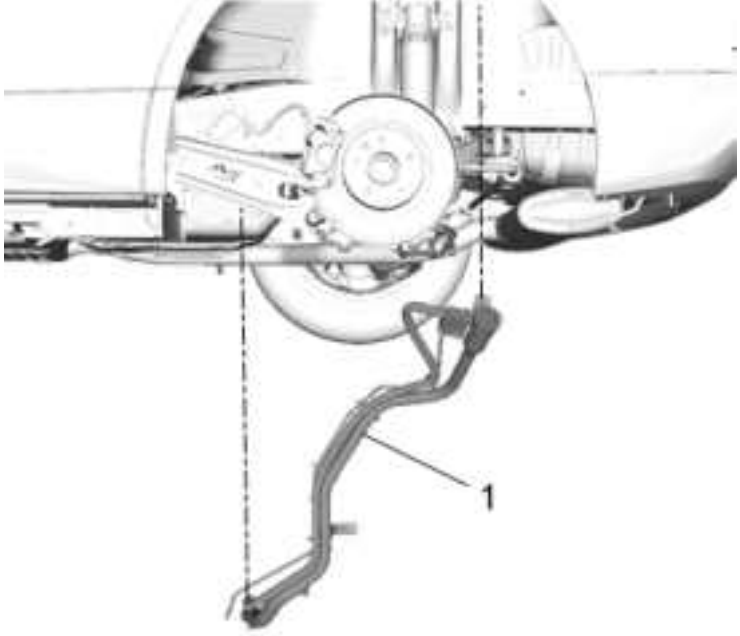

Fig. 46: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Install Fuel Tank Filler Pipe (1)

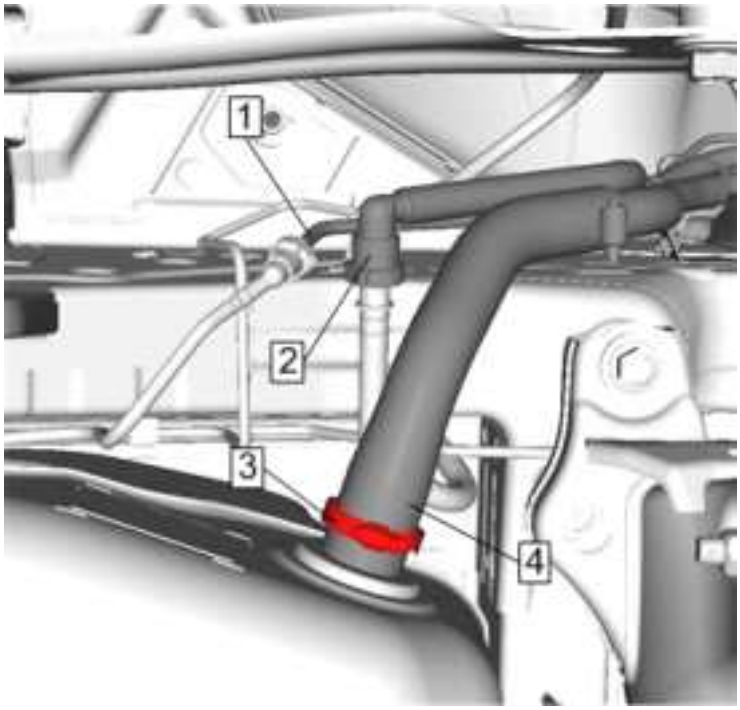

Fig. 47: Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Install Fuel Tank Filler Hose (4)

CAUTION: **Refer to Fastener Caution .**

3. Install Fuel Tank Filler Hose Clamp (3) and tighten 4 N.m (35 lb in)
4. Connect Evaporative Emission Canister Vent Hose (2)-**Plastic Collar Quick Connect Fitting Service**
5. Connect Fuel Tank Filler Pipe (1) - **Plastic Collar Quick Connect Fitting Service**

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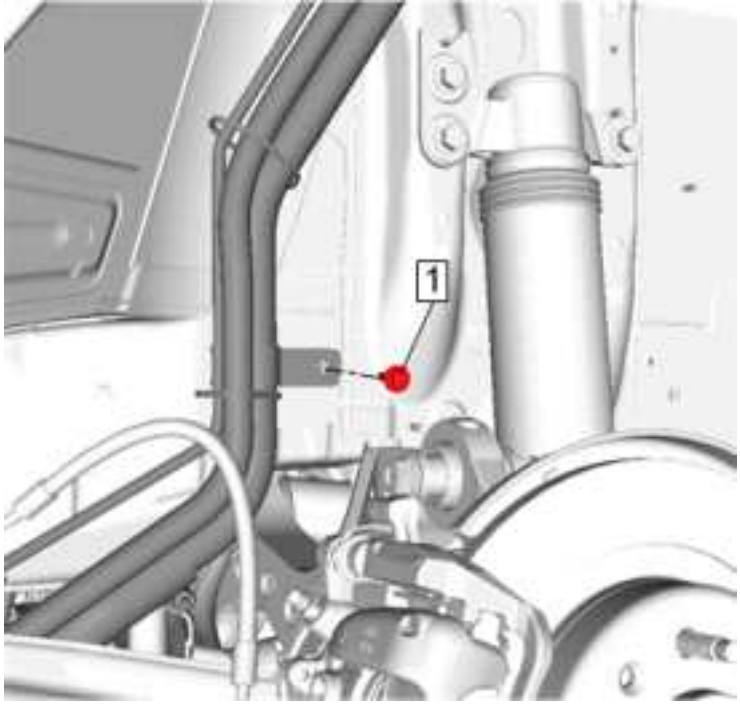

Fig. 48: Fuel Tank Filler Pipe Ground Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Install Fuel Tank Filler Pipe Ground Bolt(1) and tighten 9 N.m (80 lb in)

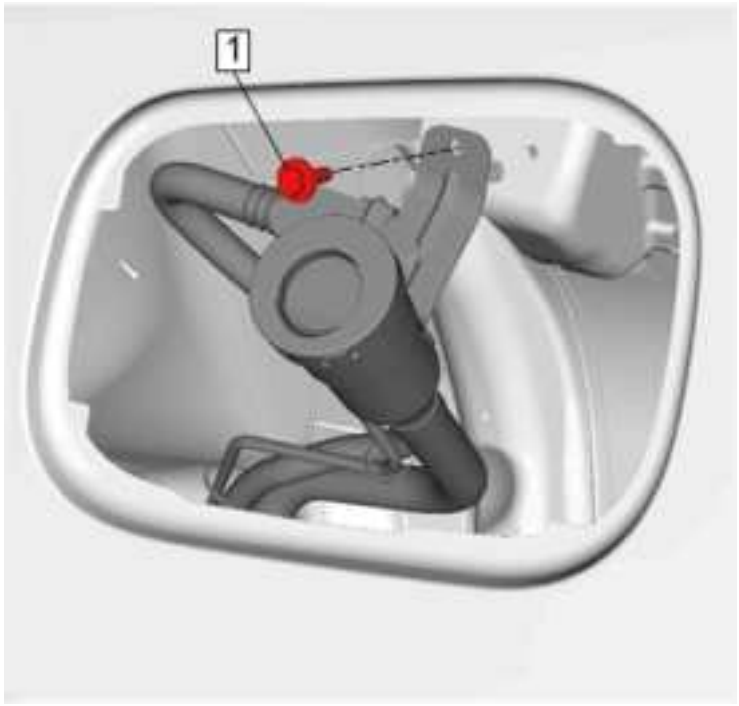

Fig. 49: Tank Filler Pipe Ground Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install Fuel Tank Filler Pipe Ground Bolt(1) and tighten 9 N.m (80 lb in)
8. Install Rear Wheelhouse Liner-Left Side - **Rear Wheelhouse Liner Replacement- Left Side (Equinox)** **Rear Wheelhouse Liner Replacement- Left Side (Terrain)**
9. Install Fuel Tank Filler Pipe Housing - **Fuel Tank Filler Pipe Housing Replacement (Equinox)** **Fuel Tank Filler Pipe Housing Replacement (Terrain)**
10. Refill fuel tank.

FUEL FEED PIPE REPLACEMENT (FWD)

Removal Procedure

WARNING: Refer to **Diesel/Gasoline Vapors Warning** .

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WARNING: **Refer to Safety Glasses Warning .**

1. Relieve the fuel system pressure. **Fuel Pressure Relief**
2. Disconnect Fuel Feed Front Pipe - **Fuel Feed Front Pipe Replacement**
3. Remove Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LYX)**

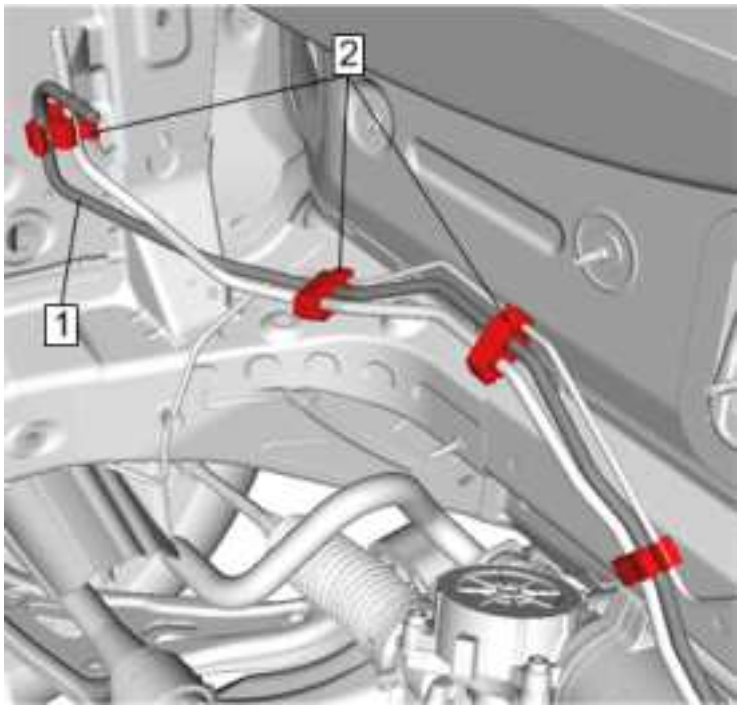

Fig. 50: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Remove Fuel Feed Pipe (1) @Retainer (2) - [4x]
5. Raise and support the vehicle. **Lifting and Jacking the Vehicle** .

Fig. 51: Shield
Courtesy of GENERAL MOTORS COMPANY

6. Remove Shield (1).

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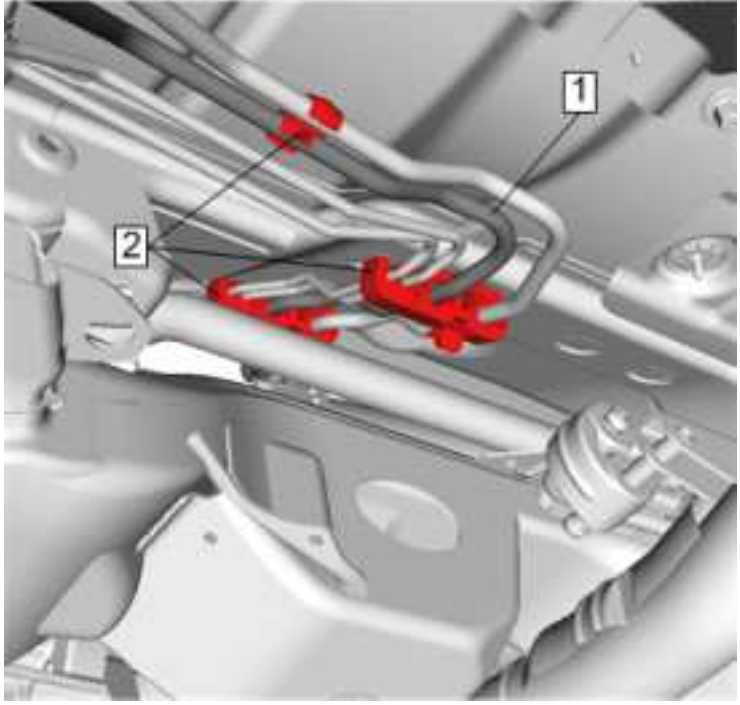

Fig. 52: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Remove Fuel Feed Pipe (1) @Retainer (2) - [3x]
8. Remove Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (Front Wheel Drive)**

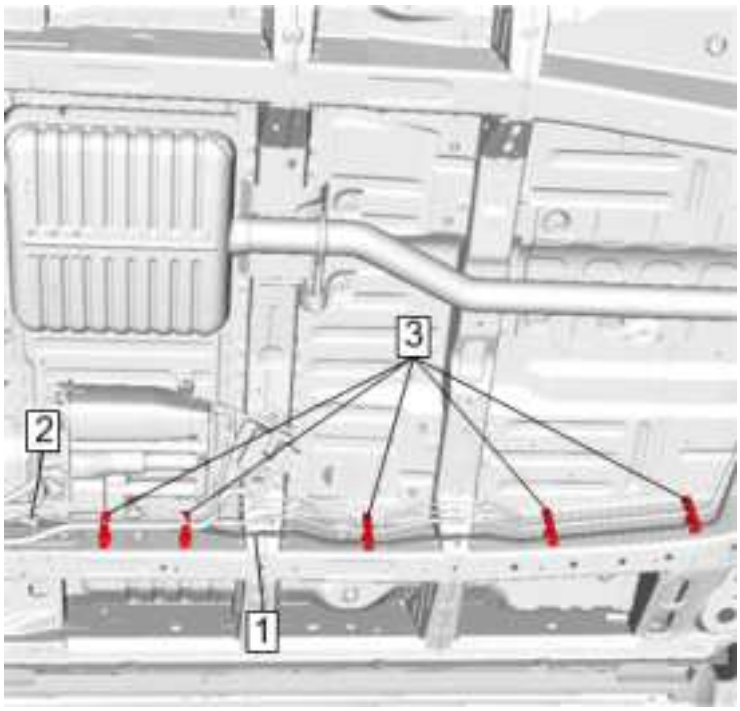

Fig. 53: Fuel Feed Pipe And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect Fuel Feed Pipe(1)@Fuel Pump Fuel Feed Hose(2) - **Plastic Collar Quick Connect Fitting Service**
10. Remove Fuel Feed Pipe (1) @Retainer (3) - [5x]

Installation Procedure

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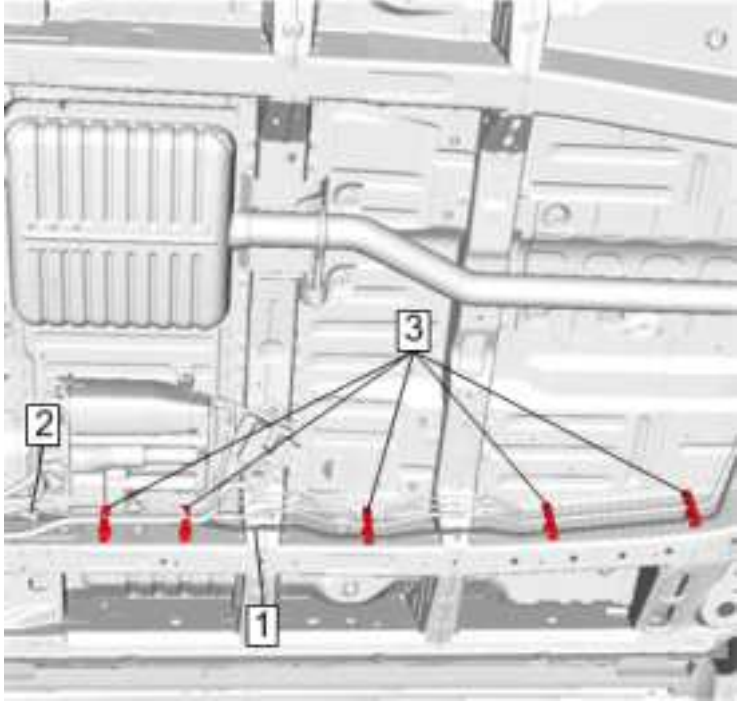

Fig. 54: Fuel Feed Pipe And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install Fuel Feed Pipe(1)@Retainer(3) - [5x]
2. Connect Fuel Feed Pipe(1)@Fuel Pump Fuel Feed Hose(2) -**Plastic Collar Quick Connect Fitting Service**
3. Install Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (Front Wheel Drive)**

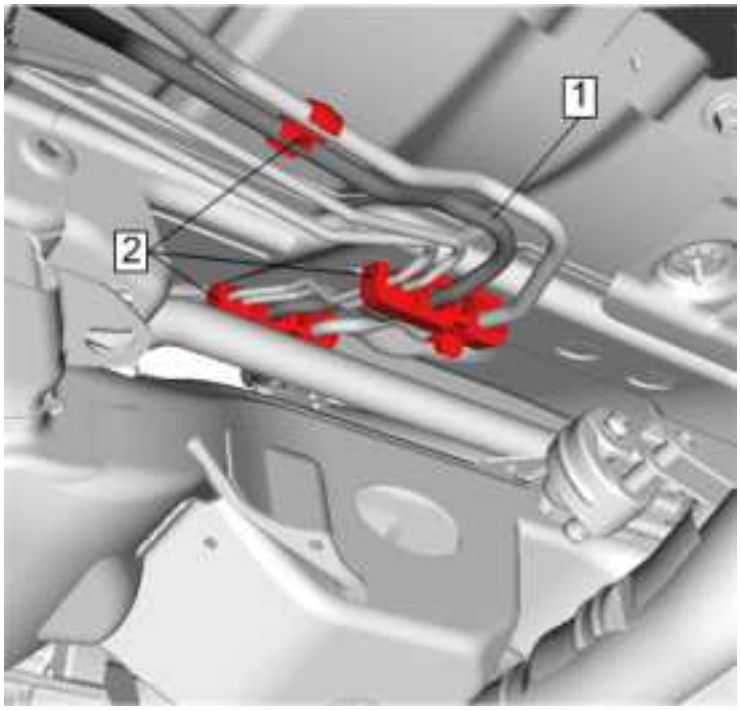

Fig. 55: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Fuel Feed Pipe(1)@Retainer(2) - [3x]

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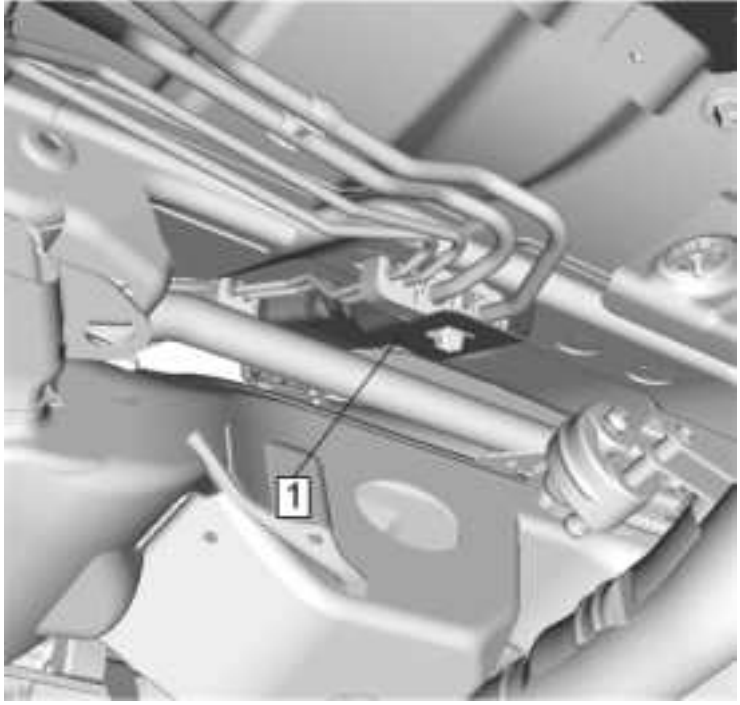

Fig. 56: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Install Shield (1)
6. Lower the vehicle.

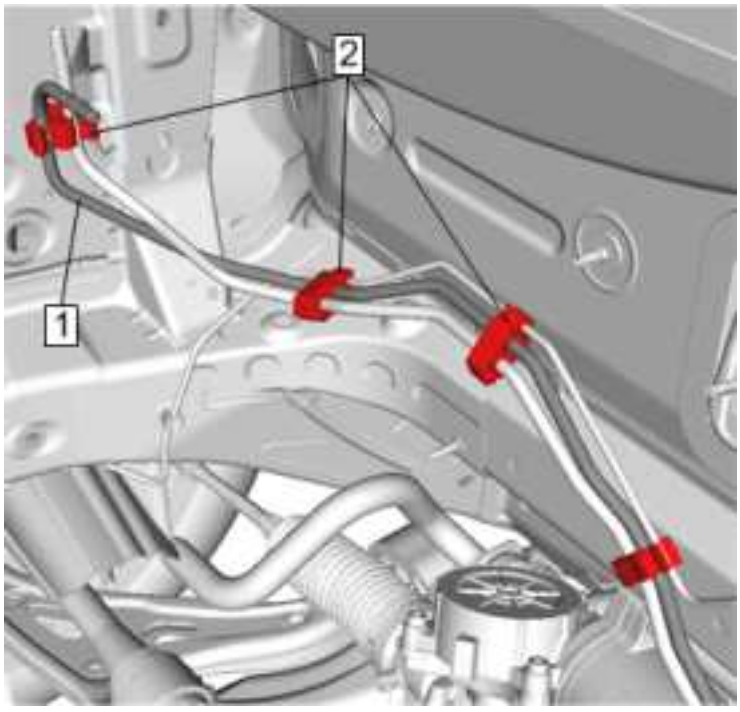

Fig. 57: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Install Fuel Feed Pipe(1)@Retainer(2) -[4x]
8. Install Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LYX)**
9. Connect Fuel Feed Front Pipe -**Fuel Feed Front Pipe Replacement**
10. Pressurize fuel system and check for fuel leaks.

FUEL FEED PIPE REPLACEMENT (AWD)

Removal Procedure

WARNING: Refer to **Diesel/Gasoline Vapors Warning** .

WARNING: Refer to **Safety Glasses Warning** .

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1. Relieve the fuel system pressure. **Fuel Pressure Relief**
2. Disconnect Fuel Feed Front Pipe - **Fuel Feed Front Pipe Replacement**

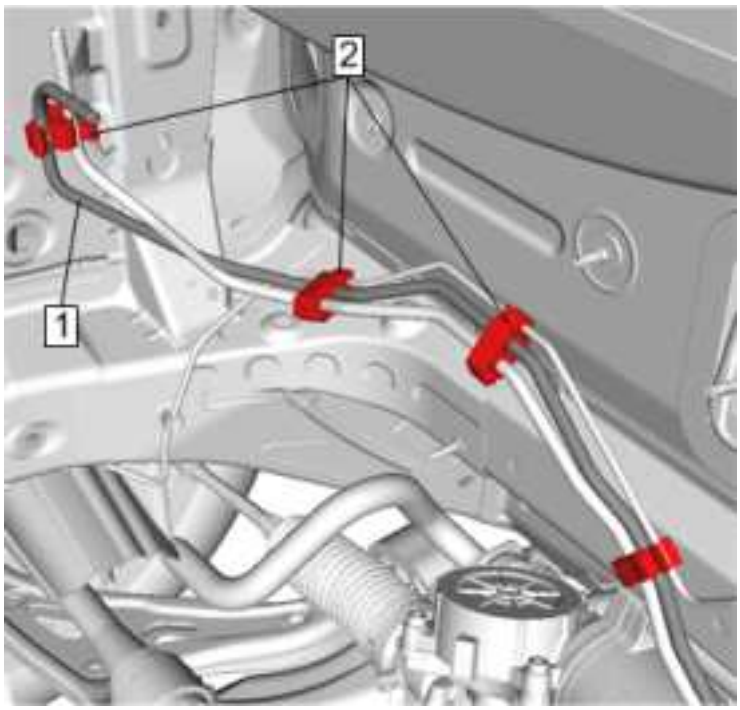

Fig. 58: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Remove Fuel Feed Pipe(1)@Retainer(2) - [4x]
4. Raise and support the vehicle. **Lifting and Jacking the Vehicle** .

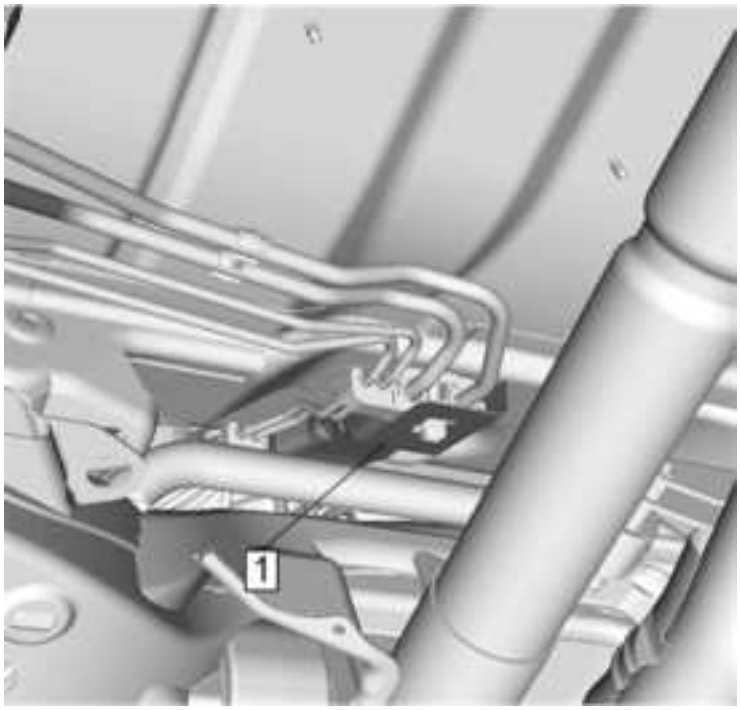

Fig. 59: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Remove Shield (1)

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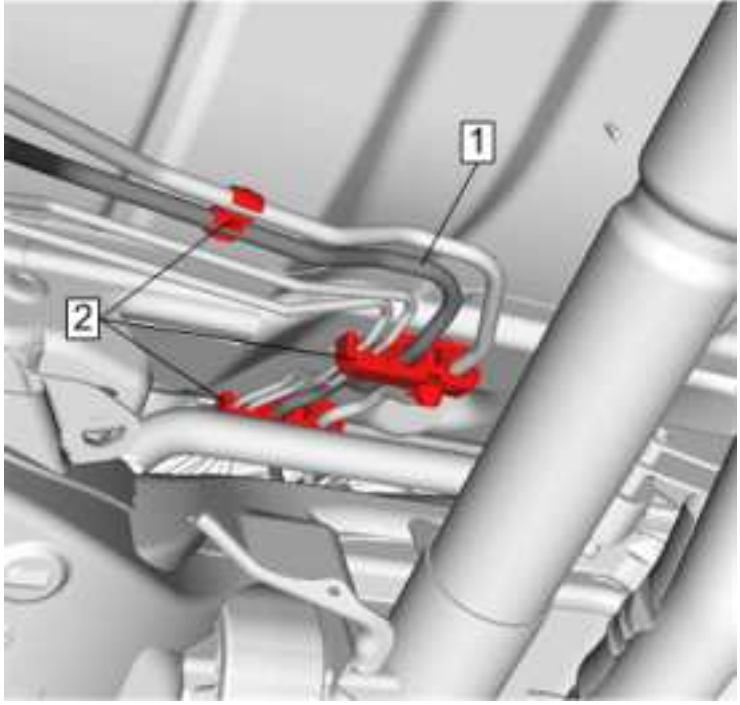

Fig. 60: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Remove Fuel Feed Pipe(1)@Retainer(2) - [3x]
7. Remove Underbody Rear Air Deflector -**Underbody Rear Air Deflector Replacement (All Wheel Drive)**

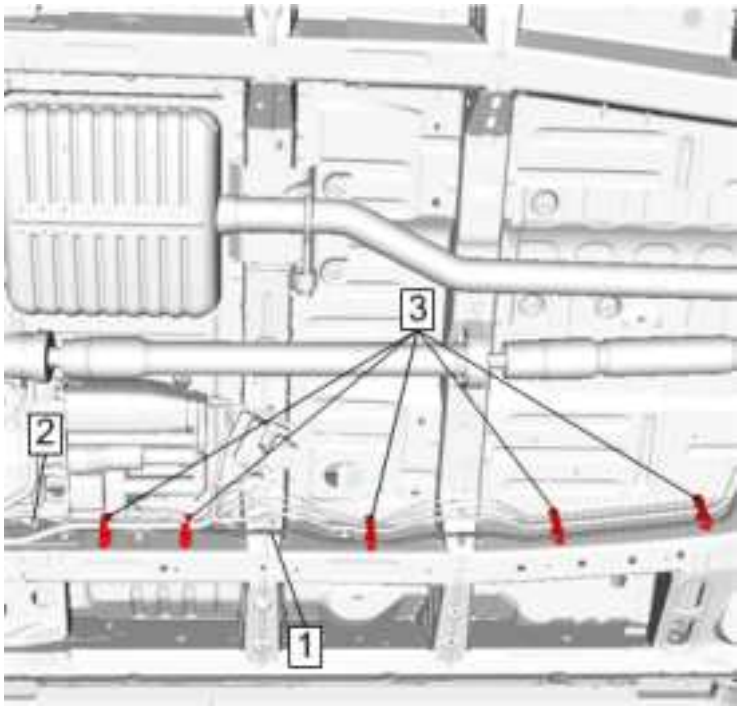

Fig. 61: Fuel Feed Pipe And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect Fuel Feed Pipe(1)@Fuel Pump Fuel Feed Hose(2) -**Plastic Collar Quick Connect Fitting Service**
9. Remove Fuel Feed Pipe(1)@Retainer(3) - [5x]

Installation Procedure

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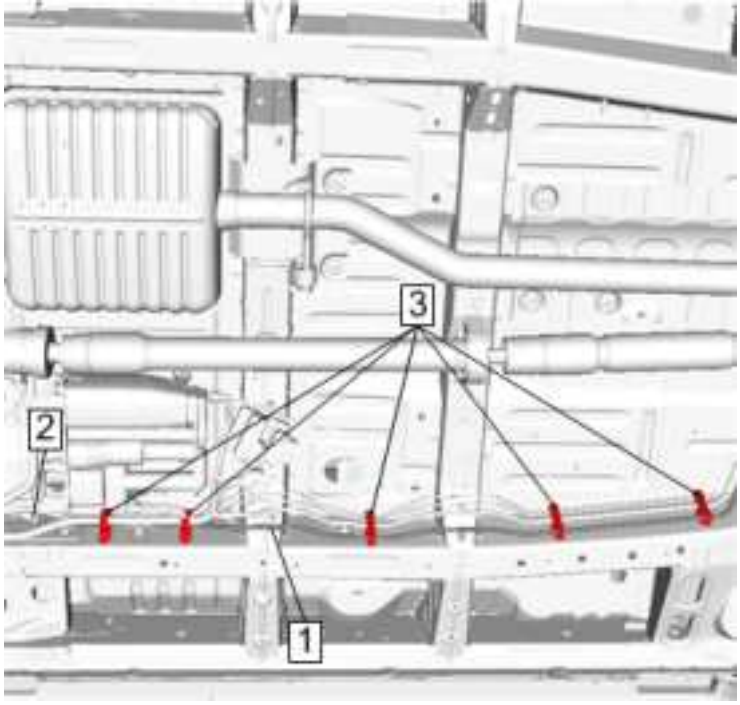

Fig. 62: Fuel Feed Pipe And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install Fuel Feed Pipe(1)@Retainer(3) - [5x]
2. Connect Fuel Feed Pipe(1)@Fuel Pump Fuel Feed Hose(2) - **Plastic Collar Quick Connect Fitting Service**
3. Install Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (All Wheel Drive)**

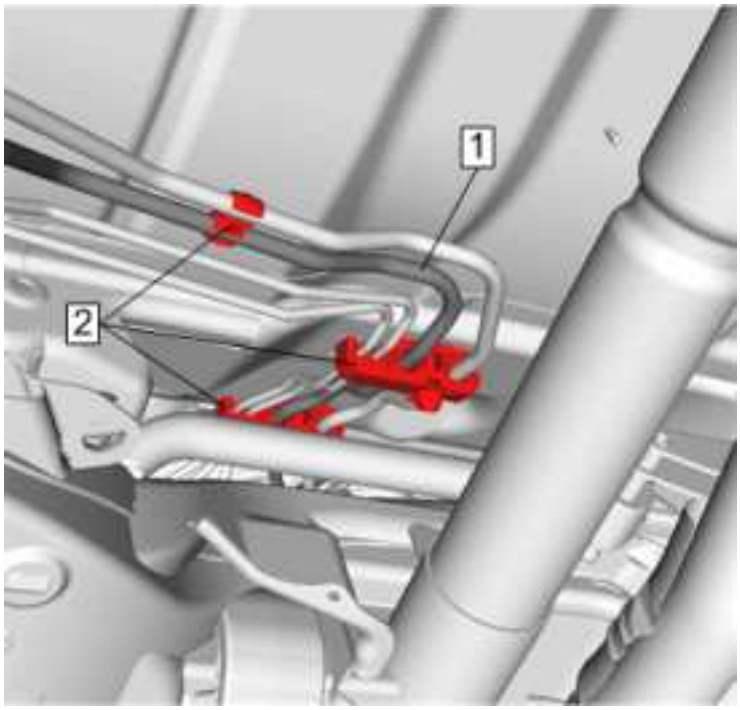

Fig. 63: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Fuel Feed Pipe(1)@Retainer(2) - [3x]

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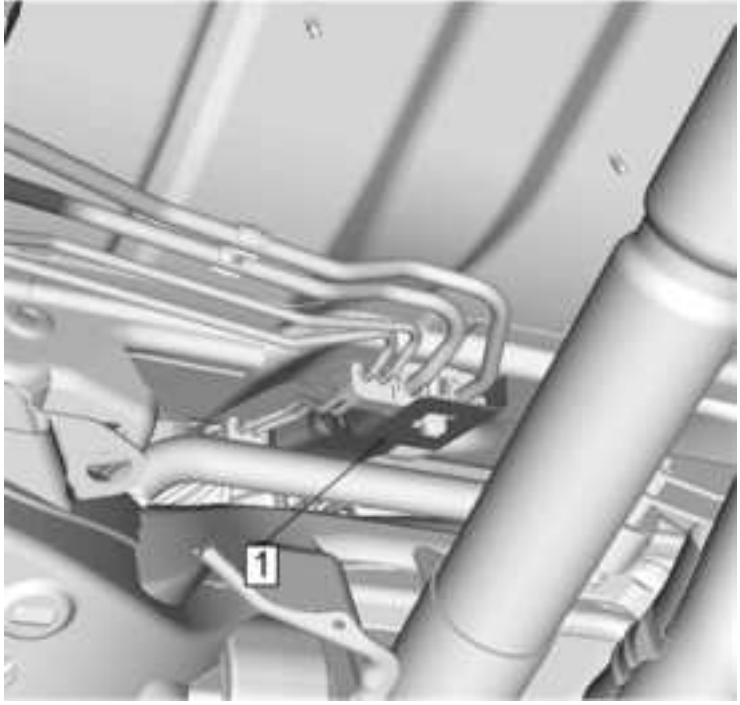

Fig. 64: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Install Shield (1)
6. Lower the vehicle.

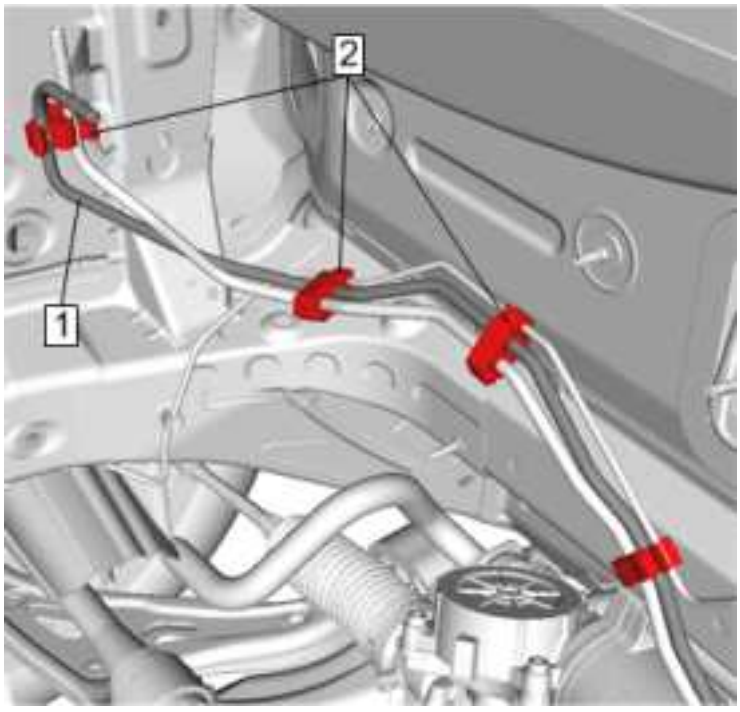

Fig. 65: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Install Fuel Feed Pipe(1)@Retainer(2) - [4x]
8. Connect Fuel Feed Front Pipe -**Fuel Feed Front Pipe Replacement**
9. Pressurize fuel system and check for fuel leaks.

FUEL TANK VENT HOSE REPLACEMENT (FWD)

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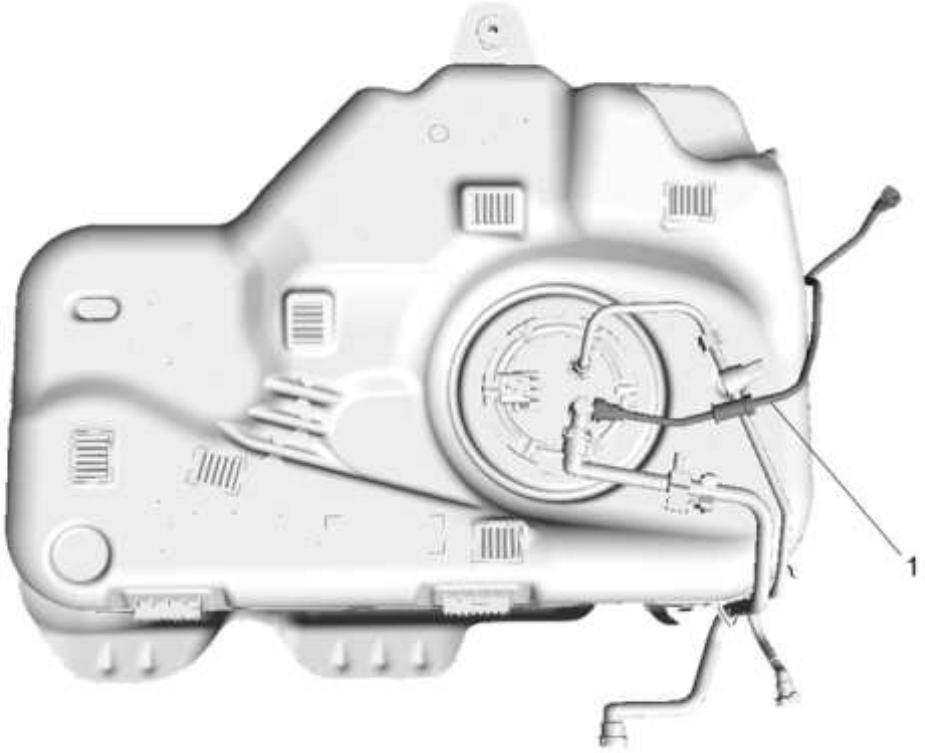

Fig. 66: Fuel Tank Vent Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Fuel Tank Replacement (FWD)	
1	Fuel Tank Vent Hose **Procedure** Disconnect the fuel tank vent hose. Plastic Collar Quick Connect Fitting Service

FUEL TANK VENT HOSE REPLACEMENT (AWD)

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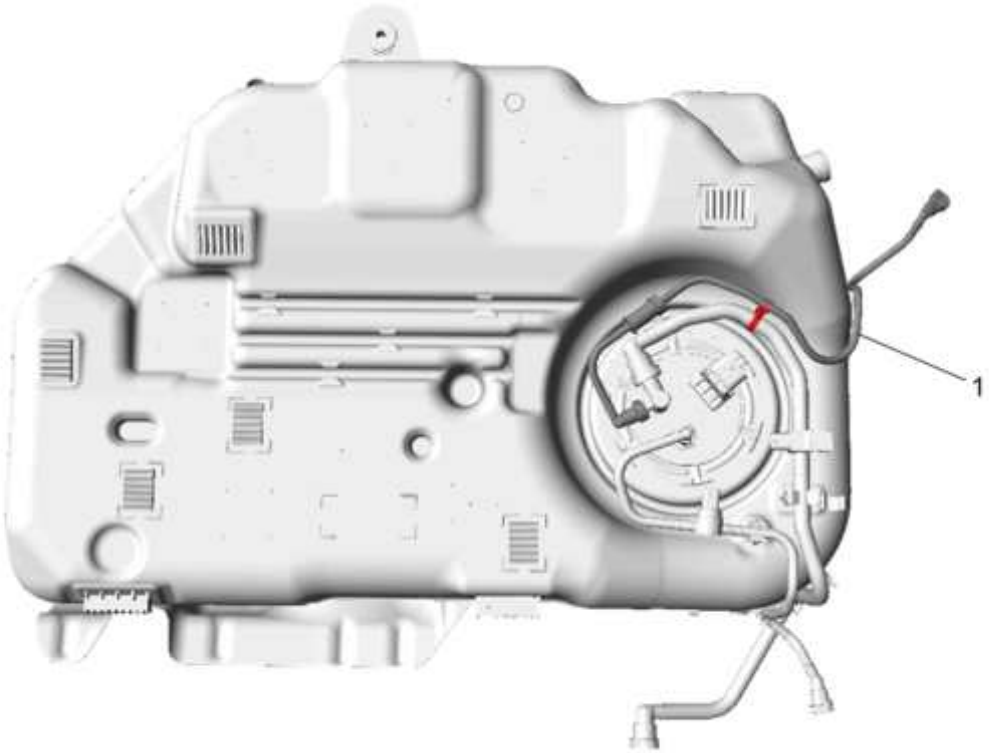

Fig. 67: Fuel Tank Vent Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Fuel Tank Replacement (AWD)	
1	Fuel Tank Vent Hose **Procedure** Disconnect the fuel tank vent hose and remove from retainer. Plastic Collar Quick Connect Fitting Service

FUEL TANK FUEL PUMP MODULE REPLACEMENT (FWD)

Special Tools

CH 52075 Fuel Sender Lock Ring Wrench

Equivalent regional tools:Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools)

Removal Procedure

WARNING: Refer to Diesel/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Remove Fuel Tank - Fuel Tank Replacement (FWD)

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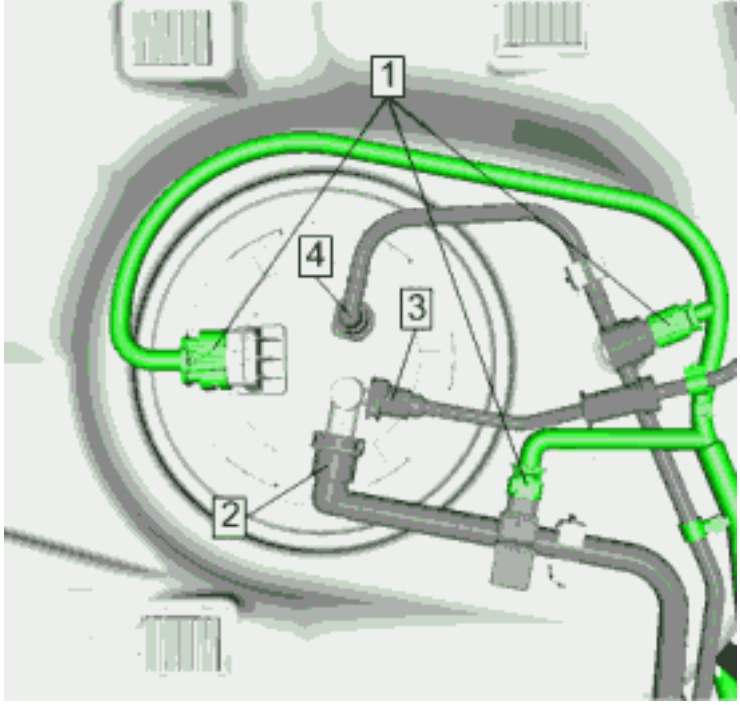

Fig. 68: Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Electrical Connector (1)
3. Disconnect Evaporative Emission Canister Vent Hose (2) - **Plastic Collar Quick Connect Fitting Service**
4. Disconnect Fuel Tank Vent Hose (3) - **Plastic Collar Quick Connect Fitting Service**
5. Disconnect Fuel Pump Fuel Feed Hose (4) - **Plastic Collar Quick Connect Fitting Service**

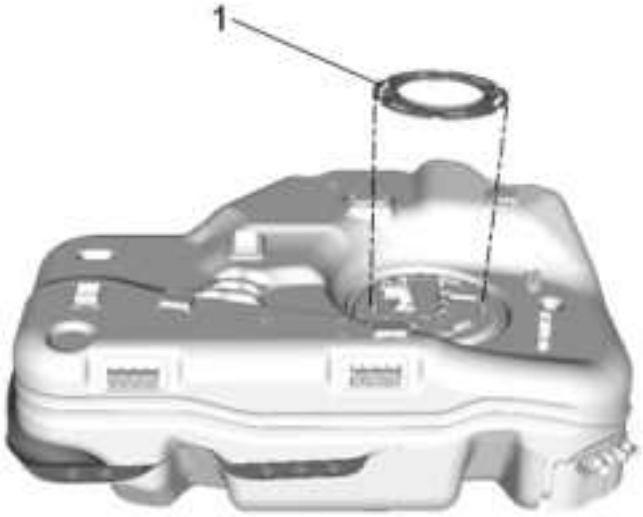

Fig. 69: Fuel Pump Lock Ring
Courtesy of GENERAL MOTORS COMPANY

6. Remove Fuel Pump Lock Ring (1) - **CH 52075** Fuel Sender Lock Ring Wrench

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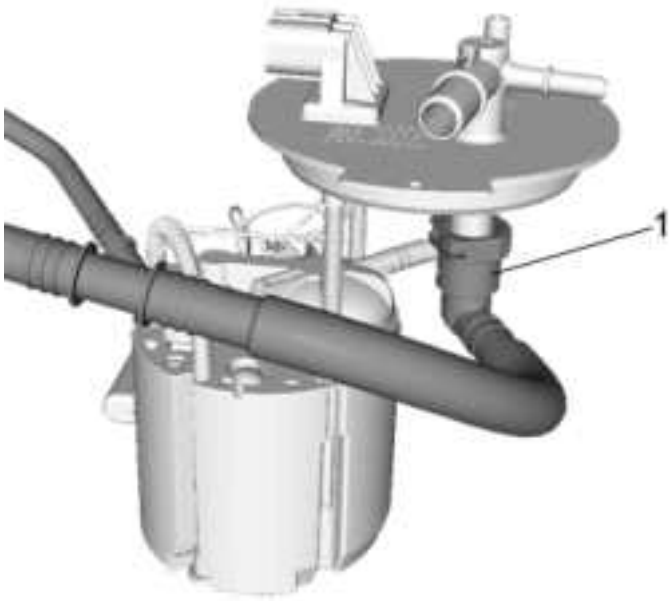

Fig. 70: Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Fuel Tank Vent Hose (1) - **Plastic Collar Quick Connect Fitting Service**

Fig. 71: Fuel Tank Fuel Pump Module
Courtesy of GENERAL MOTORS COMPANY

8. Remove Fuel Tank Fuel Pump Module (1)
9. Remove O-Ring (2) and DISCARD

Installation Procedure

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Fig. 72: Fuel Tank Fuel Pump Module
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW O-Ring (2)
2. Install Fuel Tank Fuel Pump Module (1)

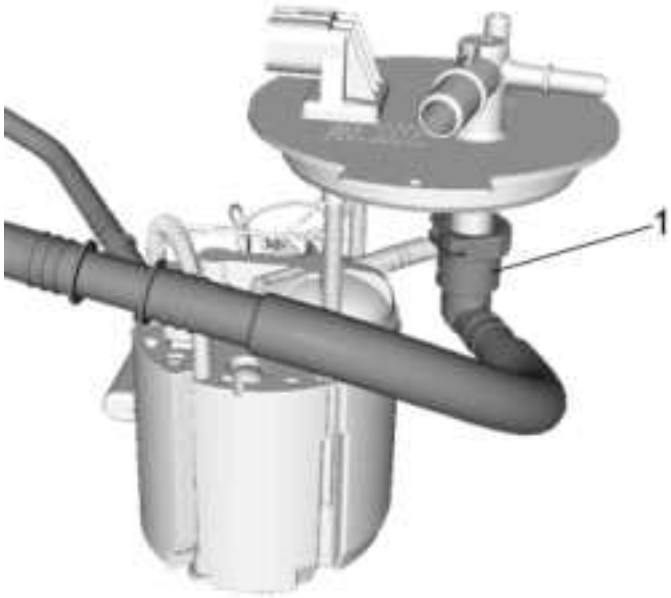

Fig. 73: Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

3. Connect Fuel Tank Vent Hose (1) - **Plastic Collar Quick Connect Fitting Service**

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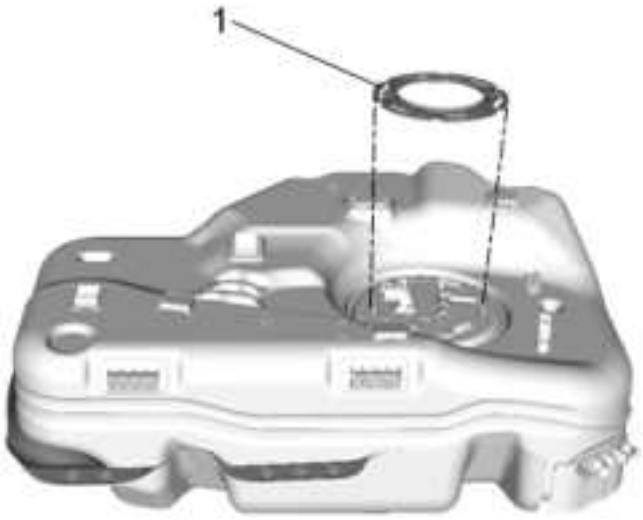

Fig. 74: Fuel Pump Lock Ring
Courtesy of GENERAL MOTORS COMPANY

4. Install Fuel Pump Lock Ring (1) - **CH 52075** Fuel Sender Lock Ring Wrench

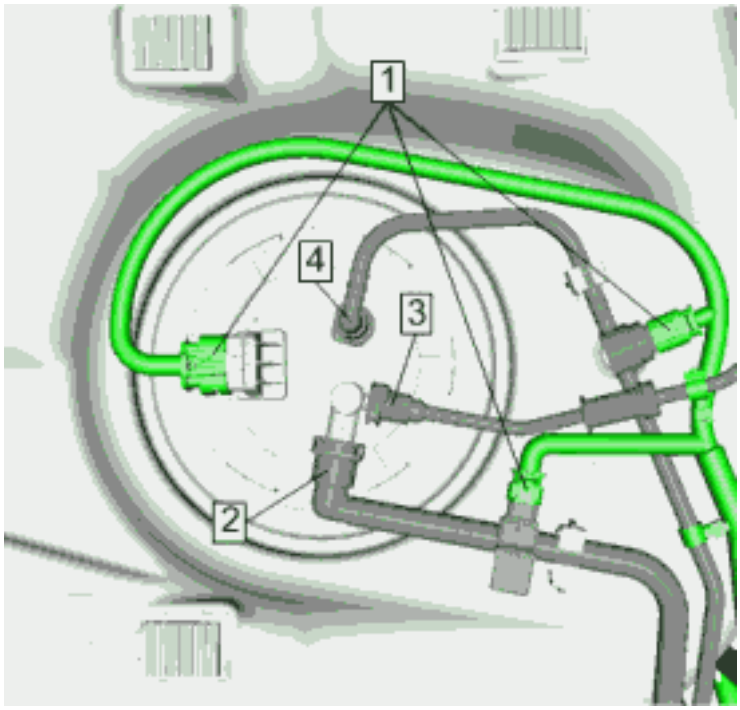

Fig. 75: Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

5. Connect Fuel Pump Fuel Feed Hose (4) - **Plastic Collar Quick Connect Fitting Service**
6. Connect Fuel Tank Vent Hose (3) - **Plastic Collar Quick Connect Fitting Service**
7. Connect Evaporative Emission Canister Vent Hose (2)**Plastic Collar Quick Connect Fitting Service**
8. Connect Electrical Connector (1)
9. Install Fuel Tank - **Fuel Tank Replacement (FWD)**

FUEL TANK FUEL PUMP MODULE REPLACEMENT (AWD)

Special Tools

CH 52075 Fuel Sender Lock Ring Wrench

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Equivalent regional tools:Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools)

Removal Procedure

WARNING: Refer to Diesel/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Remove Fuel Tank - Fuel Tank Replacement (AWD)

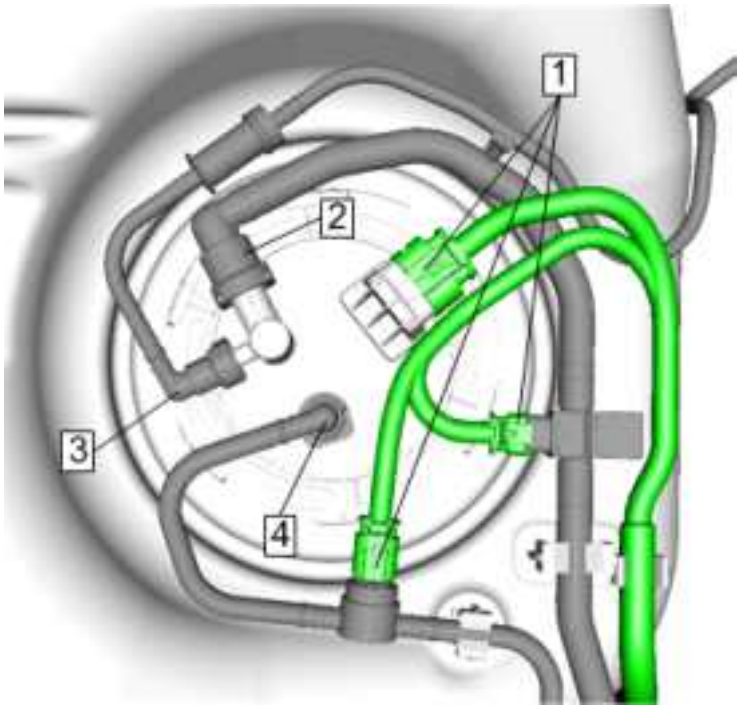

Fig. 76: Electrical Connector And Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Electrical Connector (1) -
3. Disconnect Evaporative Emission Canister Vent Hose (2) - Plastic Collar Quick Connect Fitting Service
4. Disconnect Fuel Tank Vent Hose (3) - Plastic Collar Quick Connect Fitting Service
5. Disconnect Fuel Pump Fuel Feed Hose (4) - Plastic Collar Quick Connect Fitting Service

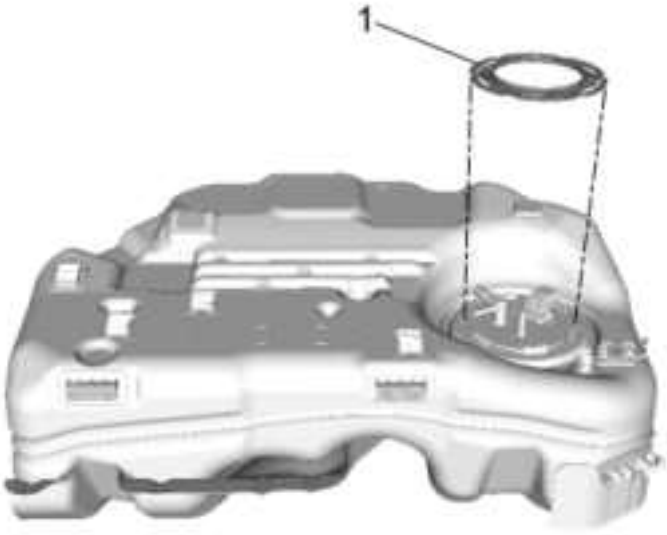

Fig. 77: Fuel Pump Lock Ring
Courtesy of GENERAL MOTORS COMPANY

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6. Remove Fuel Pump Lock Ring (1) - **CH 52075** Fuel Sender Lock Ring Wrench

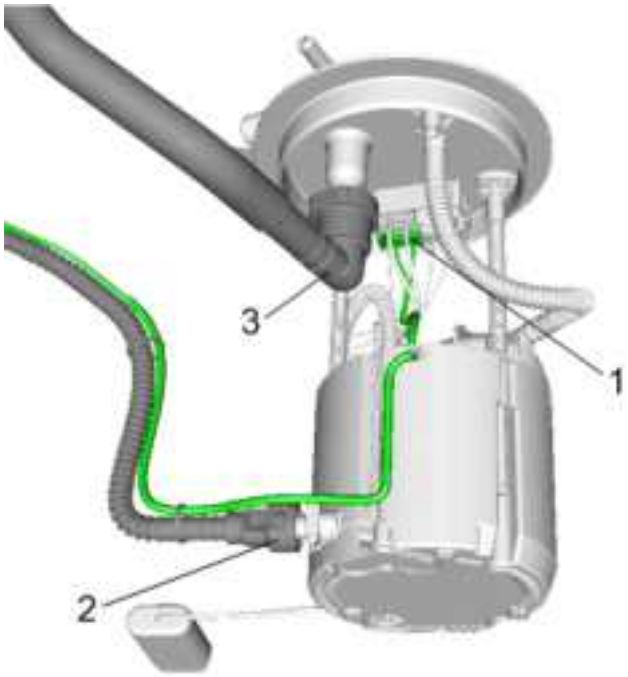

Fig. 78: Electrical Connector, Electrical Connector And Transfer Hose
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Electrical Connector (1) -
8. Disconnect Transfer Hose (2) - **Plastic Collar Quick Connect Fitting Service**
9. Disconnect Fuel Tank Vent Hose (3) - **Plastic Collar Quick Connect Fitting Service**

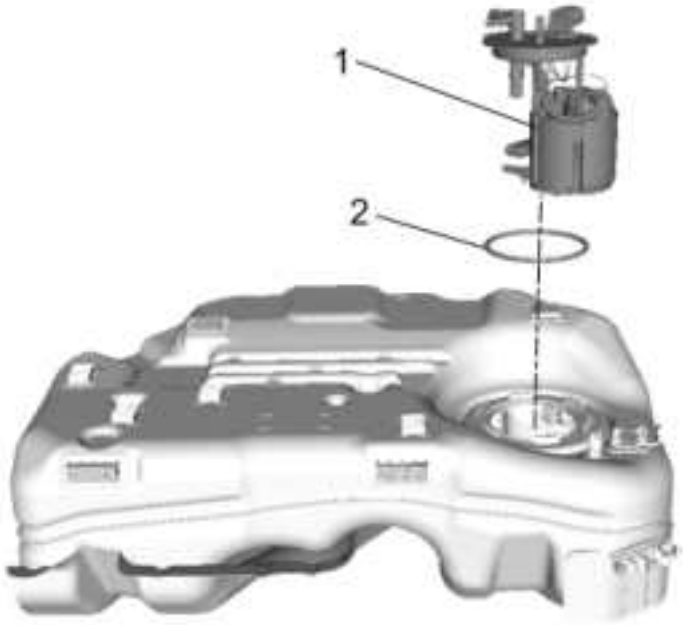

Fig. 79: Fuel Tank Fuel Pump Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

10. Remove Fuel Tank Fuel Pump Module (1).
11. Remove O-Ring (2) and DISCARD

Installation Procedure

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Fig. 80: Inspect Bottom Of Fuel Pump Module For Green Rubber Pads
Courtesy of GENERAL MOTORS COMPANY

1. Inspect bottom of fuel pump module for 3 green rubber pads (1). If rubber pads are present, remove and discard them from fuel pump module prior to installing the fuel pump module in the tank.

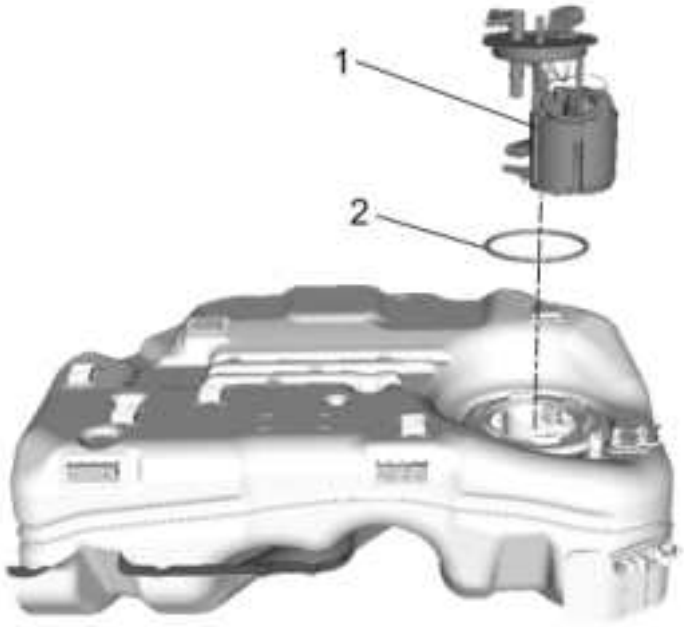

Fig. 81: Fuel Tank Fuel Pump Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

2. Install New O-Ring (2)
3. Install Fuel Tank Fuel Pump Module (1)

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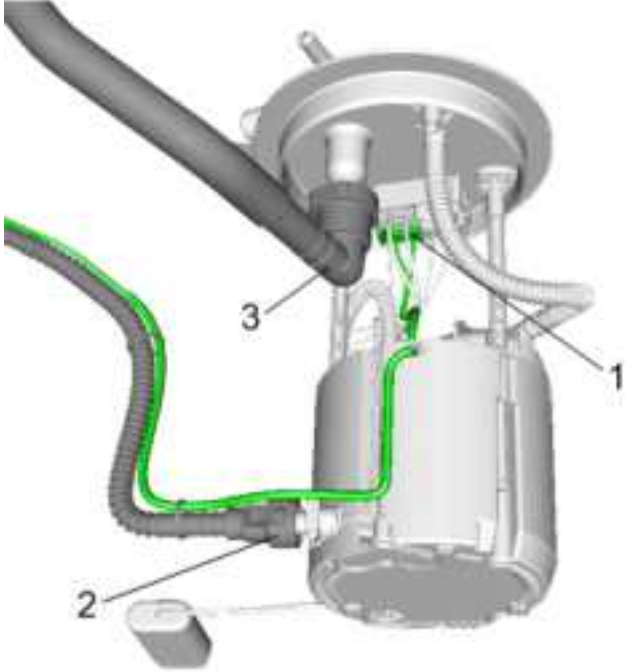

Fig. 82: Electrical Connector, Electrical Connector And Transfer Hose
Courtesy of GENERAL MOTORS COMPANY

4. Connect Fuel Tank Vent Hose (3) - **Plastic Collar Quick Connect Fitting Service**
5. Connect Transfer Hose (2) - **Plastic Collar Quick Connect Fitting Service**
6. Connect Electrical Connector (1)

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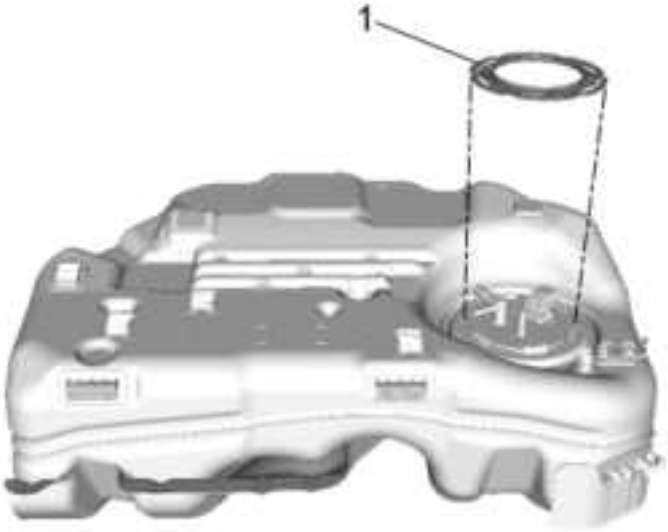

Fig. 83: Fuel Pump Lock Ring
Courtesy of GENERAL MOTORS COMPANY

7. Install Fuel Pump Lock Ring (1) **CH 52075** Fuel Sender Lock Ring Wrench

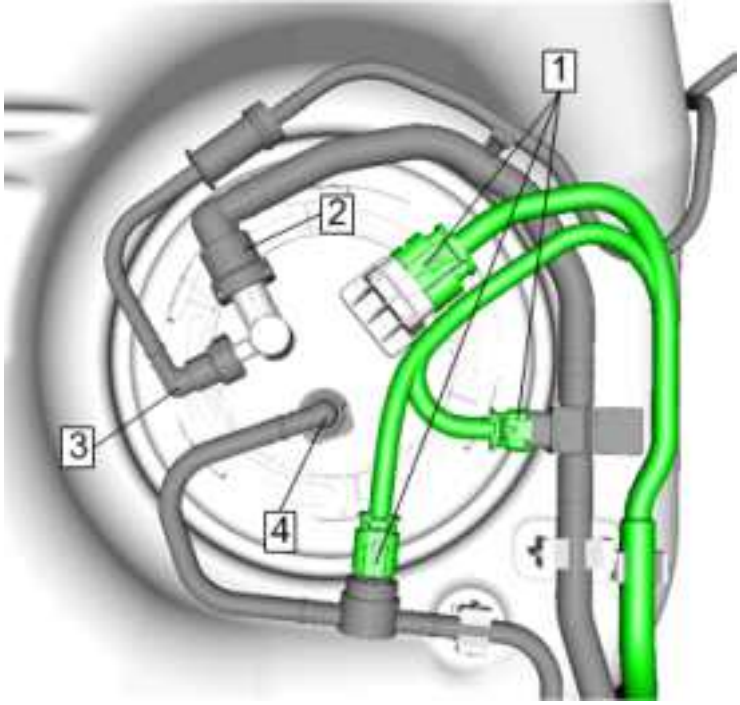

Fig. 84: Electrical Connector And Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

8. Connect Fuel Pump Fuel Feed Hose (4) - Plastic Collar Quick Connect Fitting Service
9. Connect Fuel Tank Vent Hose (3) - Plastic Collar Quick Connect Fitting Service
10. Connect Evaporative Emission Canister Vent Hose (2) - Plastic Collar Quick Connect Fitting Service
11. Connect Electrical Connector (1)
12. Install Fuel Tank - Fuel Tank Replacement (AWD)

FUEL TANK SHIELD REPLACEMENT (FWD)

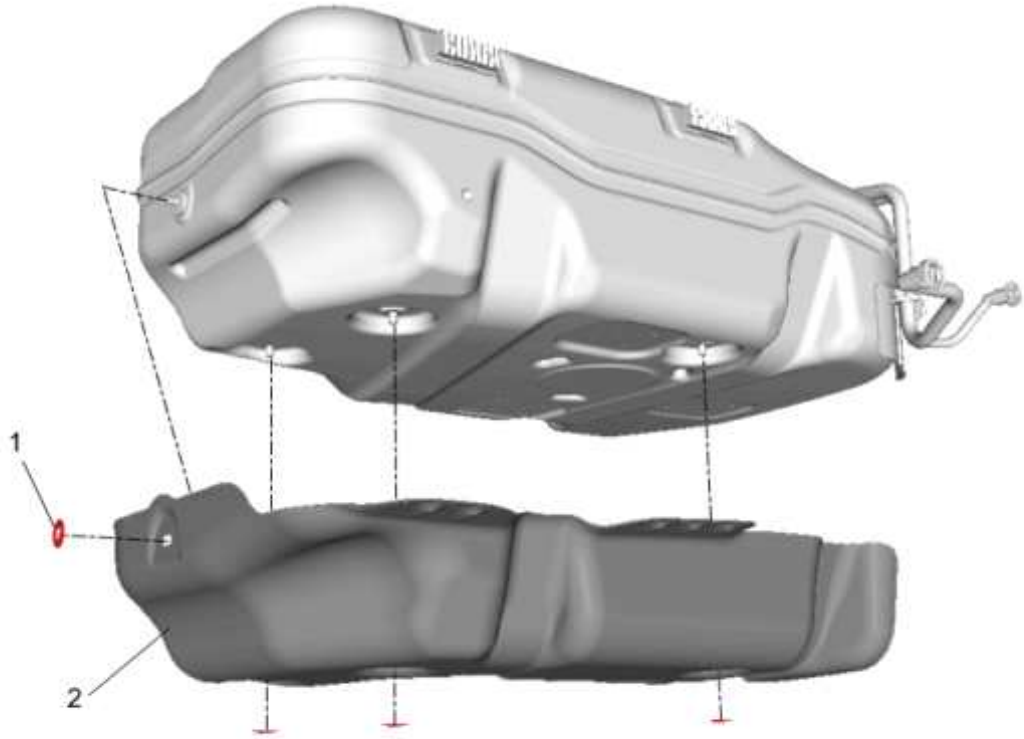

Fig. 85: Fuel Tank Shield (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

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Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . Preliminary Procedure Fuel Tank Replacement (FWD)	
1	Fuel Tank Shield Retainer[4x]
2	Fuel Tank Shield

FUEL TANK SHIELD REPLACEMENT (AWD)

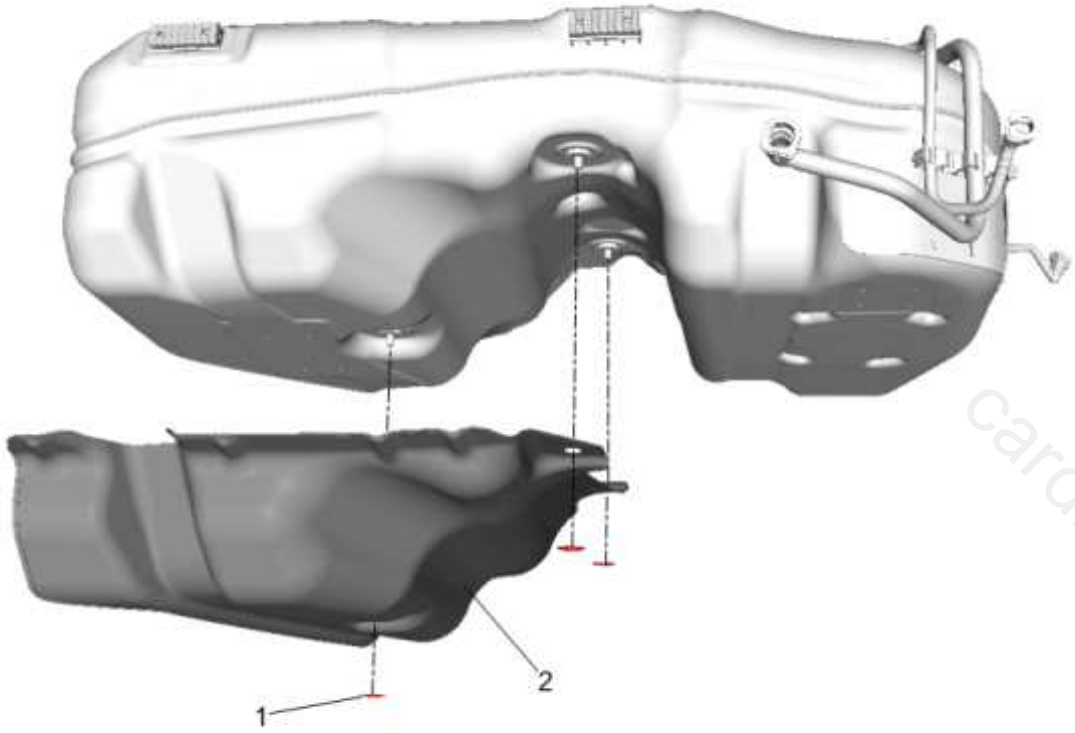

Fig. 86: Fuel Tank Shield (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . Preliminary Procedure Fuel Tank Replacement (AWD)	
1	Fuel Tank Shield Retainer[3x]
2	Fuel Tank Shield

FUEL TANK REPLACEMENT (FWD)

Removal Procedure

WARNING: Refer to Diesel/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

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1. Relieve the fuel system pressure. **Fuel Pressure Relief**
2. Drain the fuel tank. **Fuel Tank Draining**
3. Raise and support the vehicle. **Lifting and Jacking the Vehicle** .
4. Remove Exhaust Muffler Assembly - **Exhaust Muffler Replacement (LTG, LYX)**
5. Remove Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (Front Wheel Drive)**

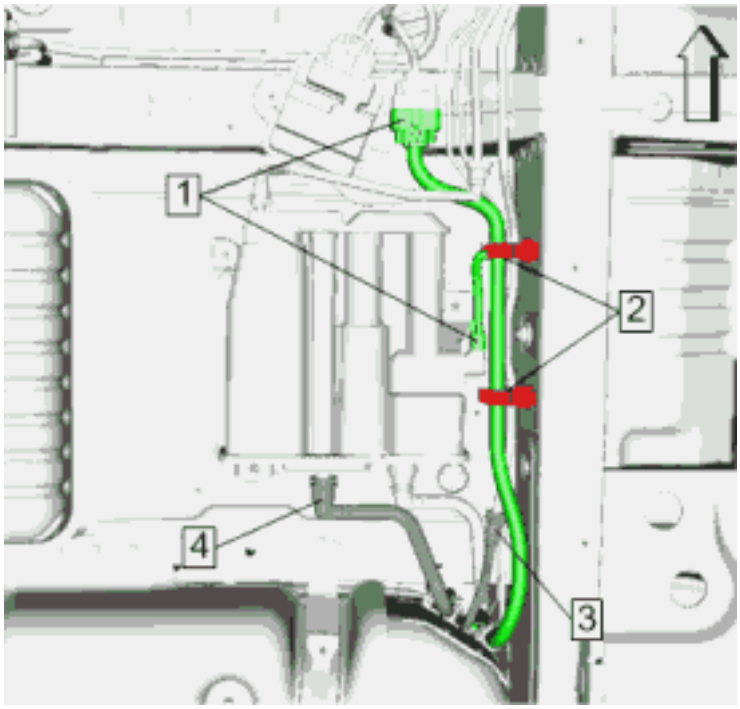

Fig. 87: Fuel Tank Fuel Pump Module Wiring Harness And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect Fuel Tank Fuel Pump Module Wiring Harness (1) - [2x]
7. Remove Fuel Tank Fuel Pump Module Wiring Harness (1) @Retainer - [2x]
8. Disconnect Fuel Pump Fuel Feed Hose (3) - **Plastic Collar Quick Connect Fitting Service**
9. Disconnect Evaporative Emission Canister Vent Hose (4) - **Plastic Collar Quick Connect Fitting Service**

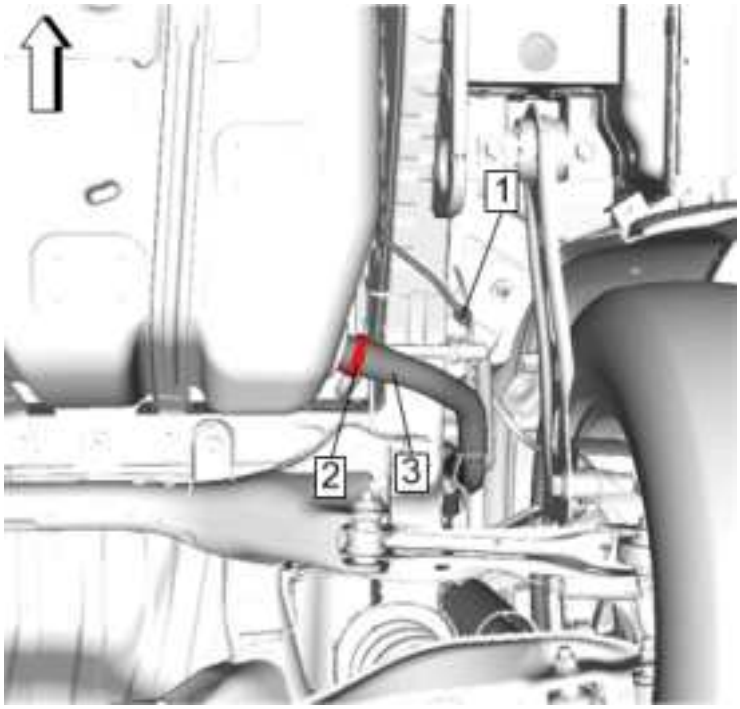

Fig. 88: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect Fuel Tank Vent Hose (4) - **Plastic Collar Quick Connect Fitting Service**

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11. Remove Fuel Tank Filler Hose Clamp (2)
12. Remove Fuel Tank Filler Hose (3)

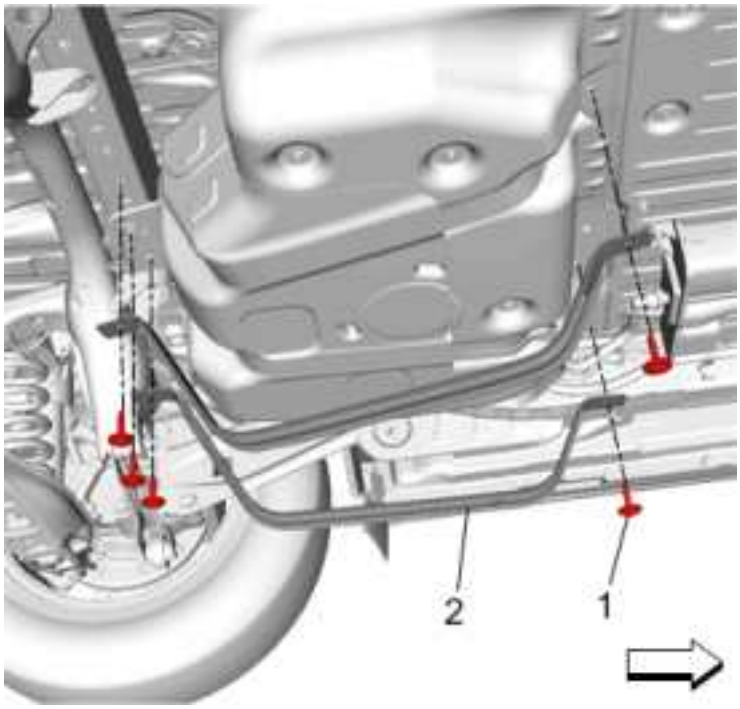

Fig. 89: Fuel Tank Strap And Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Place a suitable adjustable jack under the fuel tank.
14. Remove Fuel Tank Strap Bolt (1)
15. Remove Fuel Tank Strap (2)

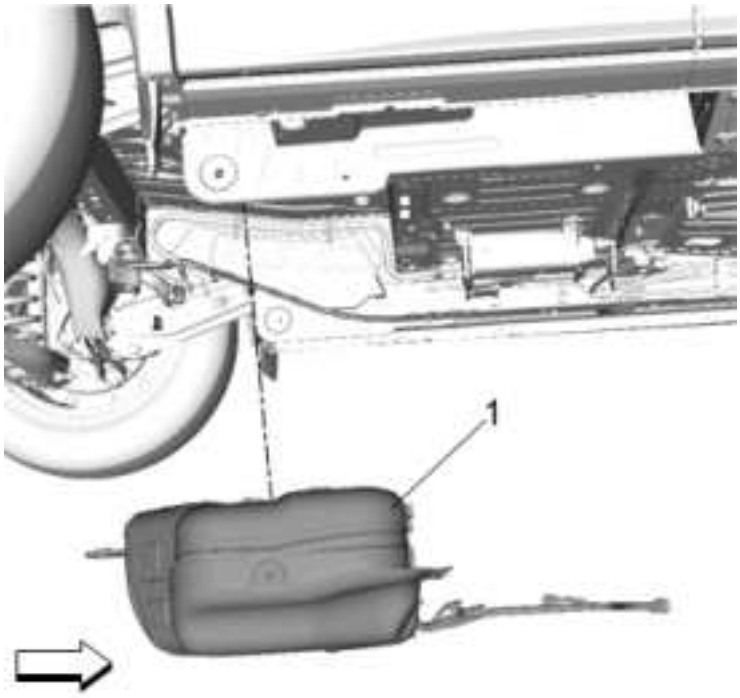

Fig. 90: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

16. Remove Fuel Tank (1) -
17. If replacing fuel tank transfer parts as necessary.

Installation Procedure

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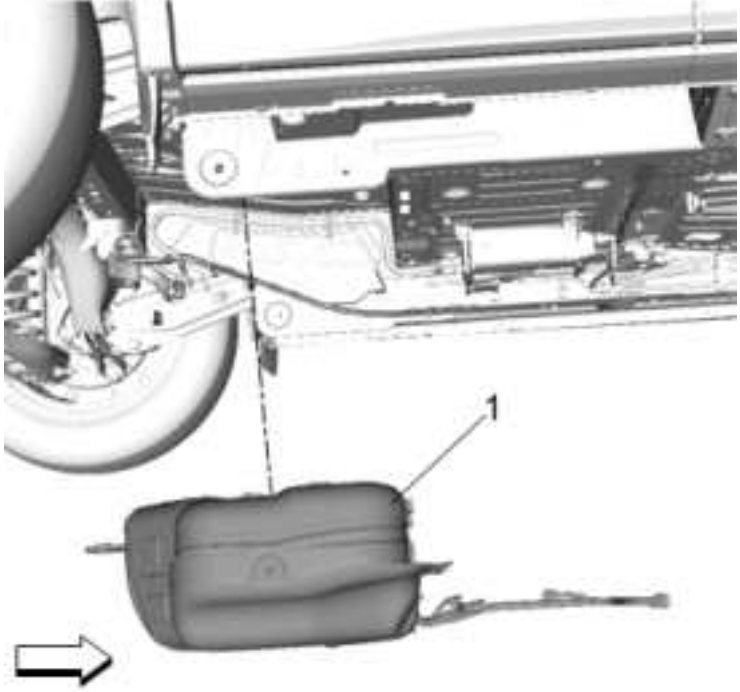

Fig. 91: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

1. Place a suitable adjustable jack under the fuel tank.
2. Install Fuel Tank (1).

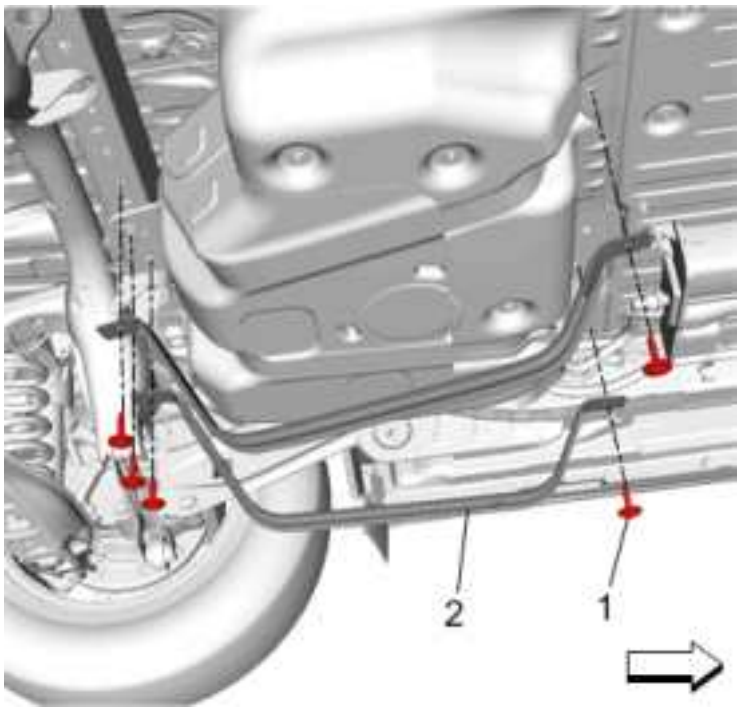

Fig. 92: Fuel Tank Strap And Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install Fuel Tank Strap (2)

CAUTION: **Refer to Fastener Caution .**

4. Install Fuel Tank Strap Bolt (1) and tighten [5x] 22 N.m (16 lb ft)

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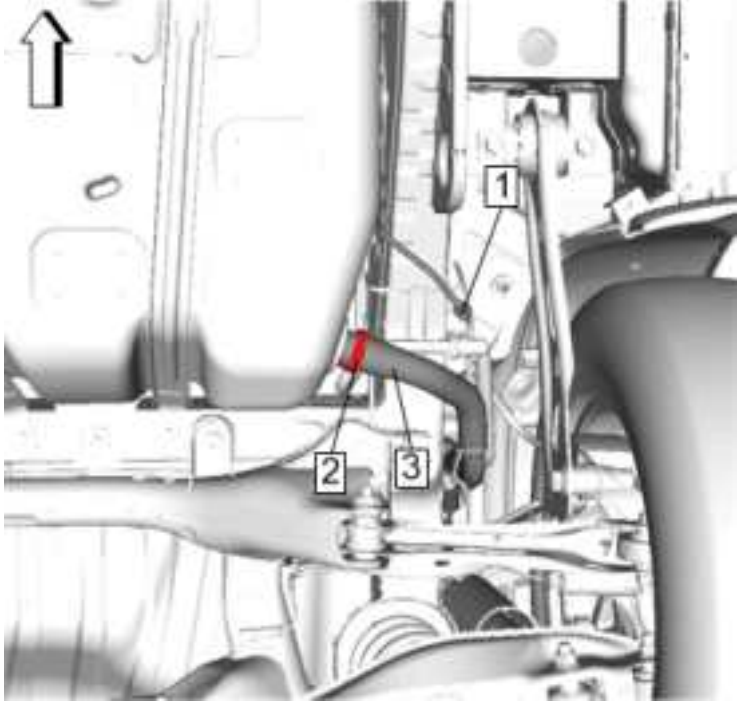

Fig. 93: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Install Fuel Tank Filler Hose (3)
6. Install Fuel Tank Filler Hose Clamp (2) and tighten 4 N.m (35 lb in)
7. Connect Fuel Tank Vent Hose -**Plastic Collar Quick Connect Fitting Service**

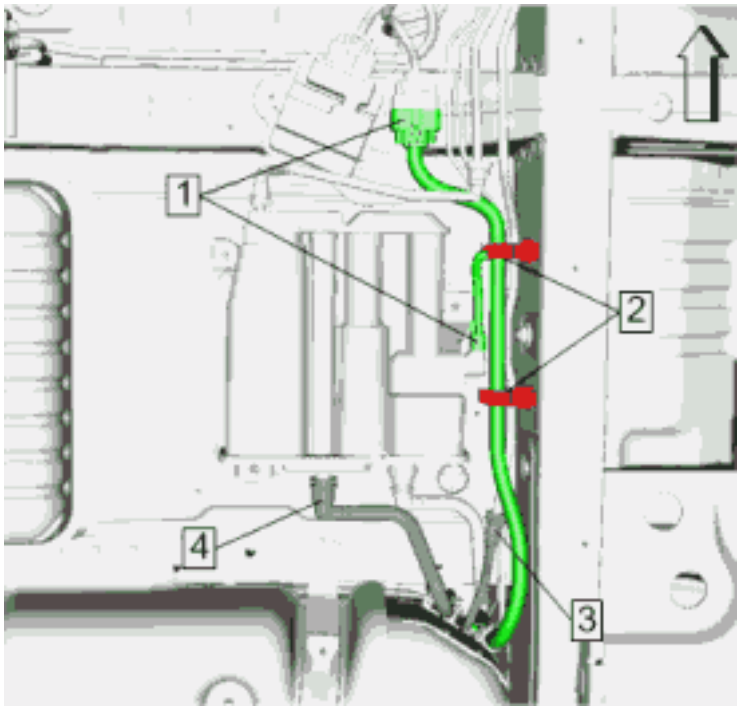

Fig. 94: Fuel Tank Fuel Pump Module Wiring Harness And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

8. Connect Evaporative Emission Canister Vent Hose (4) **Plastic Collar Quick Connect Fitting Service**
9. Connect Fuel Pump Fuel Feed Hose (3) - **Plastic Collar Quick Connect Fitting Service**
10. Install Fuel Tank Fuel Pump Module Wiring Harness (1) @Retainer - [2x]
11. Connect Fuel Tank Fuel Pump Module Wiring Harness (1) - [2x]
12. Install Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (Front Wheel Drive)**
13. Install Exhaust Muffler Assembly - **Exhaust Muffler Replacement (LTG, LYX)**
14. Lower the vehicle.

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15. Refill the fuel tank.
16. Inspect for fuel leaks.

FUEL TANK REPLACEMENT (AWD)

Removal Procedure

WARNING: Refer to Diesel/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Relieve the fuel system pressure. Fuel Pressure Relief
2. Drain the fuel tank. Fuel Tank Draining
3. Raise and support the vehicle. Lifting and Jacking the Vehicle .
4. Remove Exhaust Muffler Assembly - Exhaust Muffler Replacement (LTG, LYX)
5. Remove Driveline Torque Tube -Driveline Torque Tube Replacement
6. Remove Underbody Rear Air Deflector - Underbody Rear Air Deflector Replacement (All Wheel Drive)

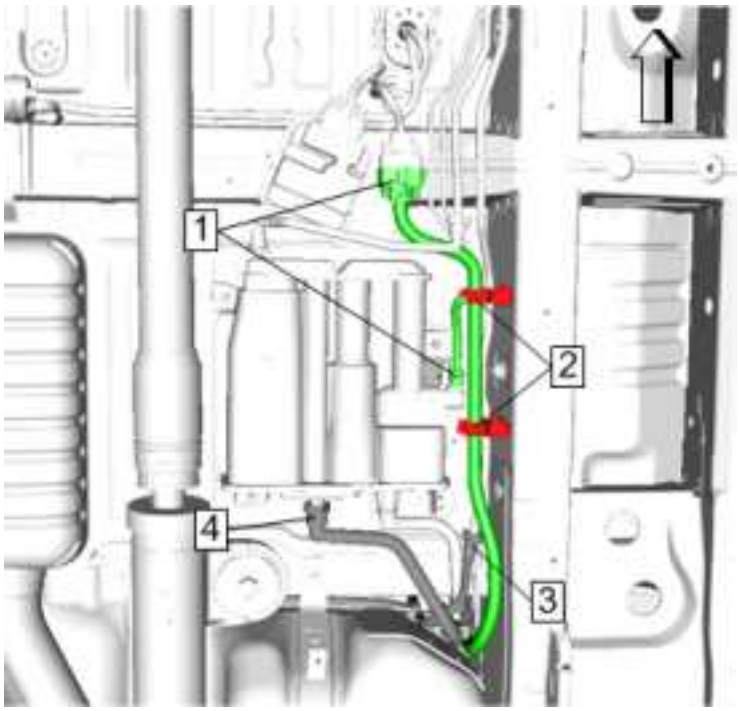

Fig. 95: Fuel Tank Fuel Pump Module Wiring Harness, Fuel Pump Fuel Feed Hose And Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Fuel Tank Fuel Pump Module Wiring Harness (1) - [2x]
8. Remove Fuel Tank Fuel Pump Module Wiring Harness (1) @Retainer - [2x]
9. Disconnect Fuel Pump Fuel Feed Hose (3) - Plastic Collar Quick Connect Fitting Service
10. Disconnect Evaporative Emission Canister Vent Hose (4) - Plastic Collar Quick Connect Fitting Service

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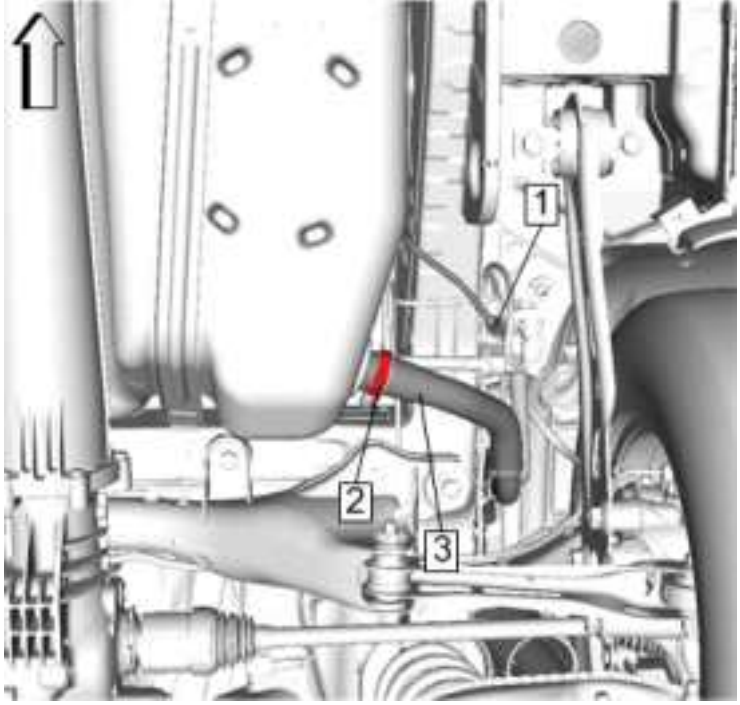

Fig. 96: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect Fuel Tank Vent Hose (1) -**Plastic Collar Quick Connect Fitting Service**
12. Remove Fuel Tank Filler Hose Clamp (2)
13. Remove Fuel Tank Filler Hose (3)

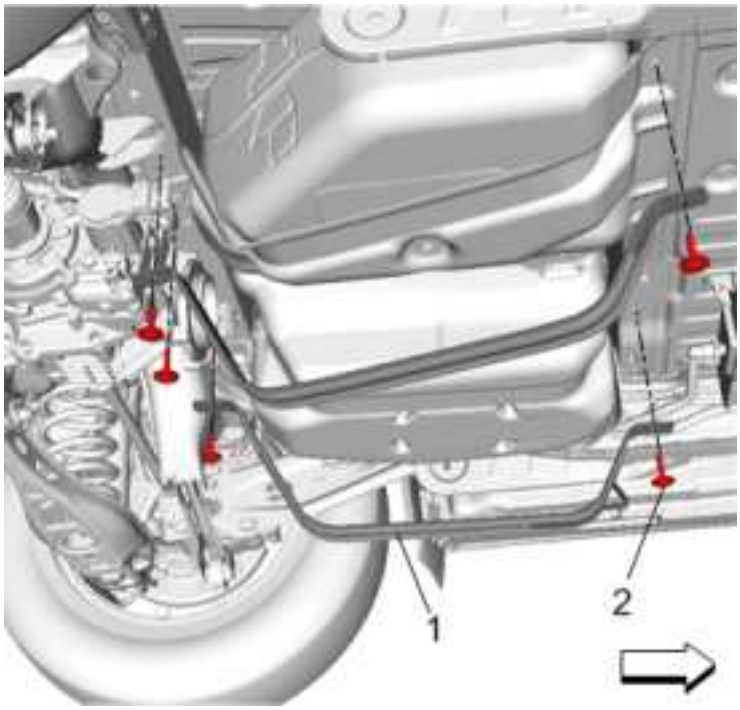

Fig. 97: Fuel Tank Strap And Bolt
Courtesy of GENERAL MOTORS COMPANY

14. Place a suitable adjustable jack under the fuel tank.
15. Remove Fuel Tank Strap Bolt (2)
16. Remove Fuel Tank Strap (1)

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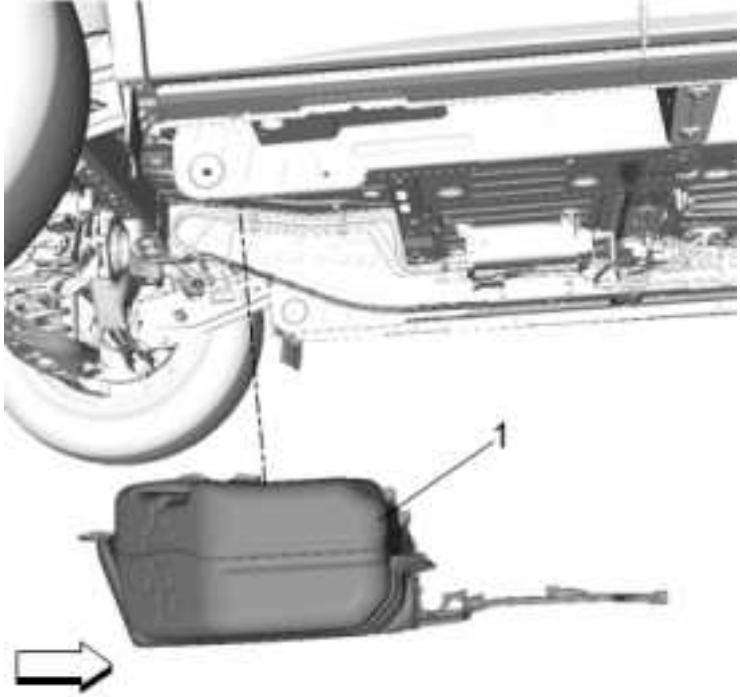

Fig. 98: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

17. Remove Fuel Tank (1)
18. If replacing fuel tank transfer parts as necessary.

Installation Procedure

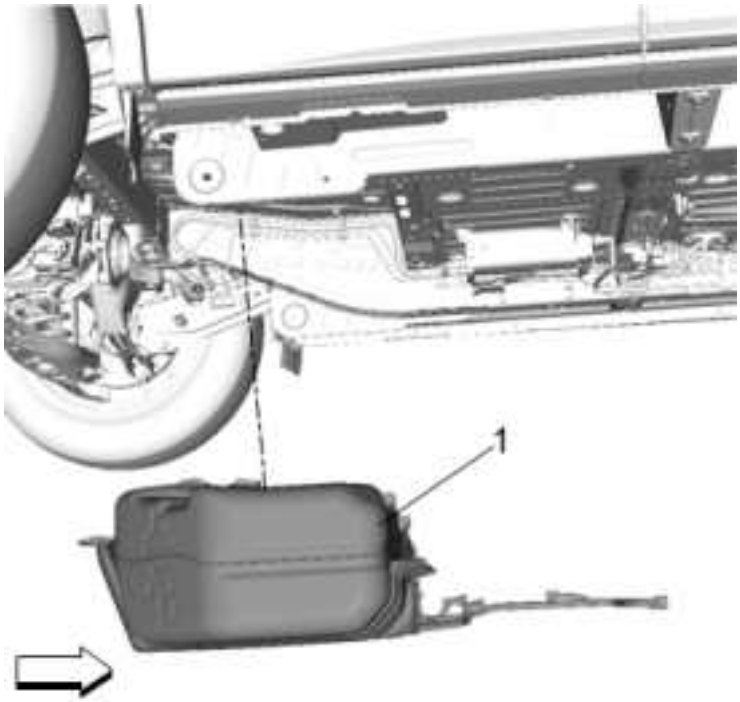

Fig. 99: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

1. Place a suitable adjustable jack under the fuel tank.
2. Install Fuel Tank (1)

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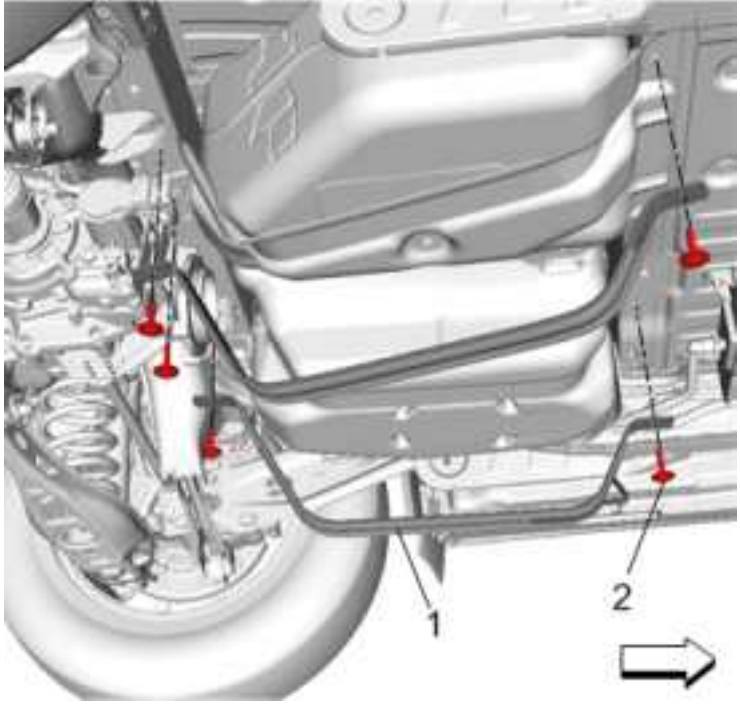

Fig. 100: Fuel Tank Strap And Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install Fuel Tank Strap (1)

CAUTION: **Refer to Fastener Caution .**

4. Install Fuel Tank Strap Bolt (2) and tighten 22 N.m (16 lb ft)

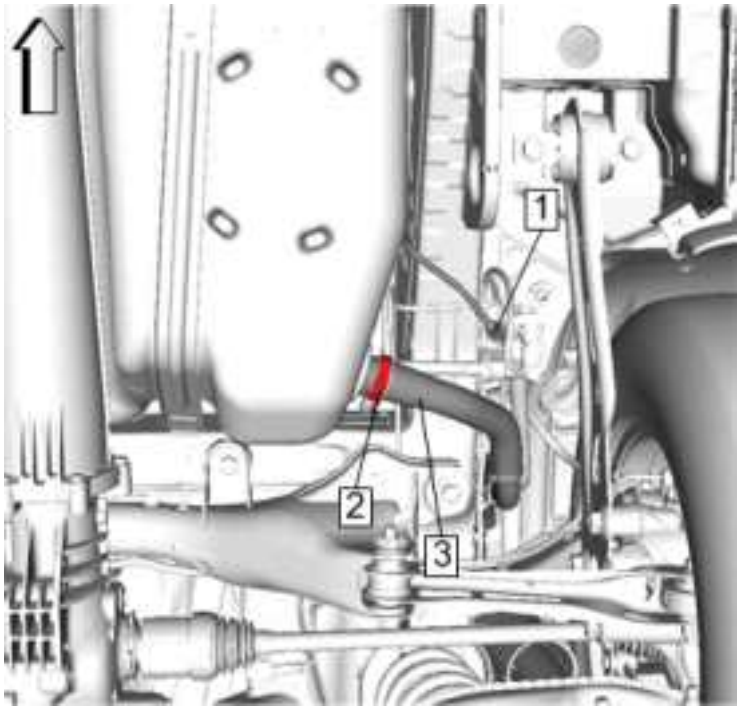

Fig. 101: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Install Fuel Tank Filler Hose (3)
6. Install Fuel Tank Filler Hose Clamp (2) and tighten 4 N.m (35.lb in)
7. Connect Fuel Tank Vent Hose (1) - **Plastic Collar Quick Connect Fitting Service**

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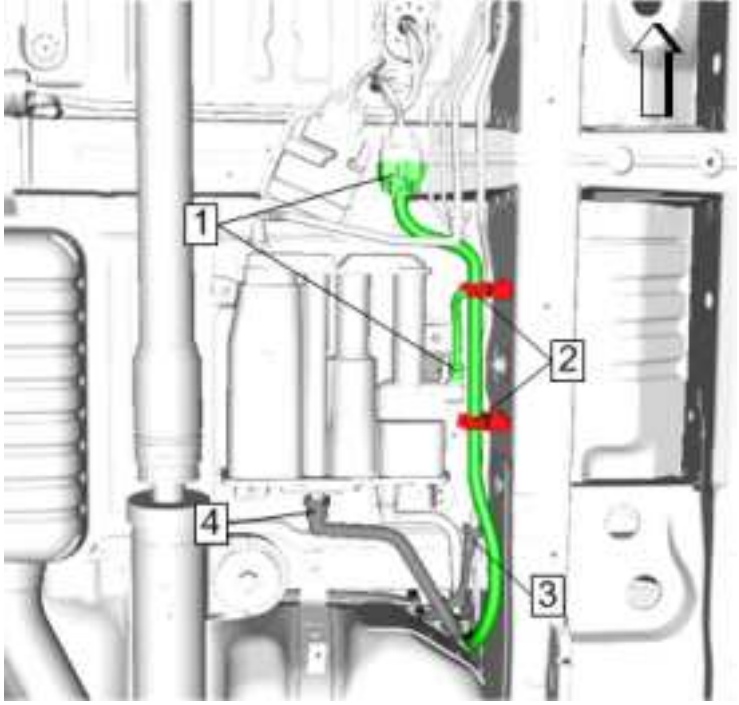

Fig. 102: Fuel Tank Fuel Pump Module Wiring Harness, Fuel Pump Fuel Feed Hose And Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

8. Connect Evaporative Emission Canister Vent Hose (4) -**Plastic Collar Quick Connect Fitting Service**
9. Connect Fuel Pump Fuel Feed Hose (3) - **Plastic Collar Quick Connect Fitting Service**
10. Install Fuel Tank Fuel Pump Module Wiring Harness (1) @Retainer - [2x]
11. Connect Fuel Tank Fuel Pump Module Wiring Harness (1) - [2x]
12. Install Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (All Wheel Drive)**
13. Install Driveline Torque Tube - **Driveline Torque Tube Replacement**
14. Install Exhaust Muffler Assembly - **Exhaust Muffler Replacement (LTG, LYX)**
15. Lower the vehicle.
16. Refill the fuel tank.
17. Inspect for fuel leaks.

FUEL TANK PRESSURE SENSOR REPLACEMENT (FWD)

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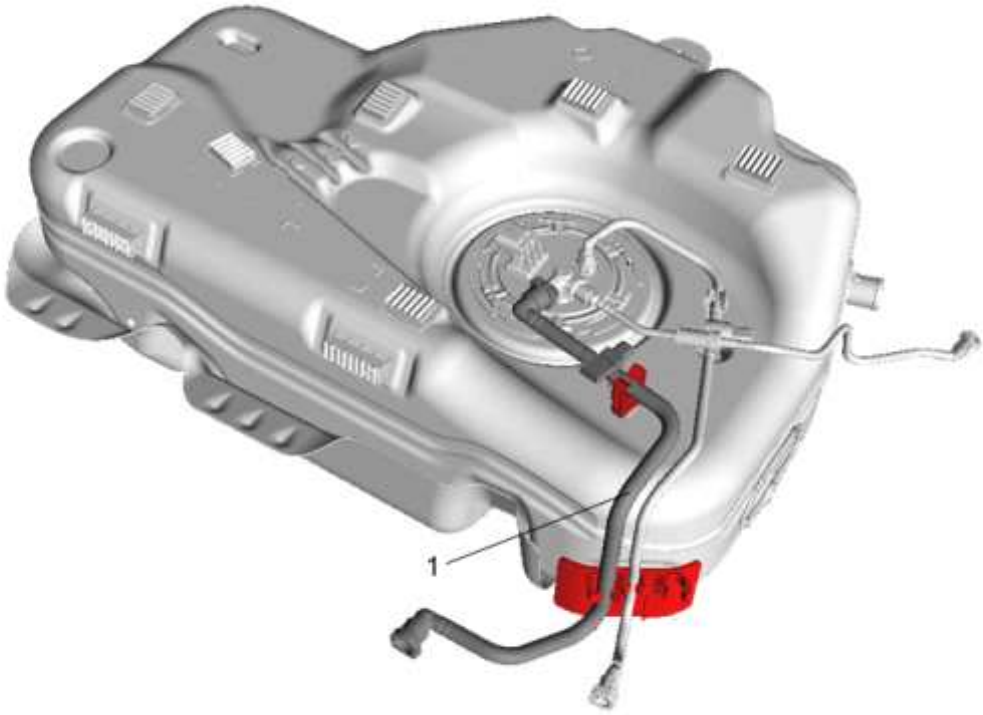

Fig. 103: Fuel Tank Pressure Sensor (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Fuel Tank Replacement (FWD)	
1	Fuel Tank Pressure Sensor **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the evaporative emission canister vent hose and remove from retainers. Plastic Collar Quick Connect Fitting Service **NOTE:** **Fuel tank pressure sensor is serviced as part of evap hose assembly.**

FUEL TANK PRESSURE SENSOR REPLACEMENT (AWD)

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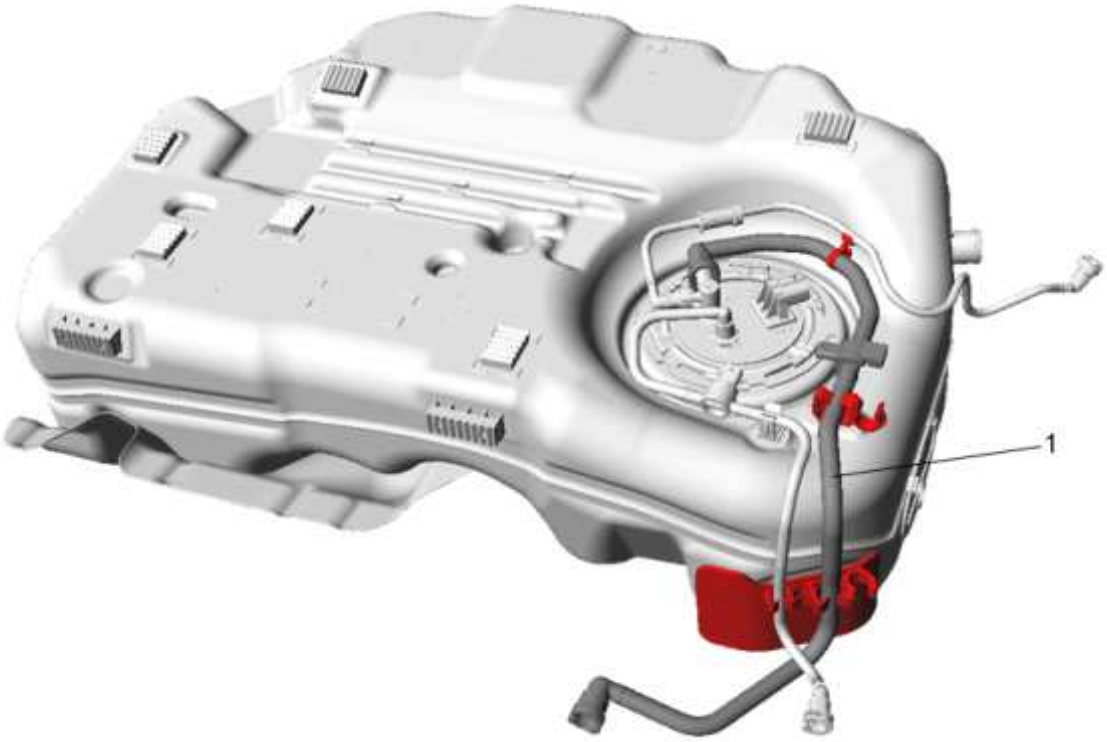

Fig. 104: Fuel Tank Pressure Sensor (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Fuel Tank Replacement (AWD)	
1	Fuel Tank Pressure Sensor **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the evaporative emission canister vent hose and remove from retainers. Plastic Collar Quick Connect Fitting Service **NOTE:** **Fuel tank pressure sensor is serviced as part of evap hose assembly.**

FUEL TANK FILLER HOSE REPLACEMENT (FWD)

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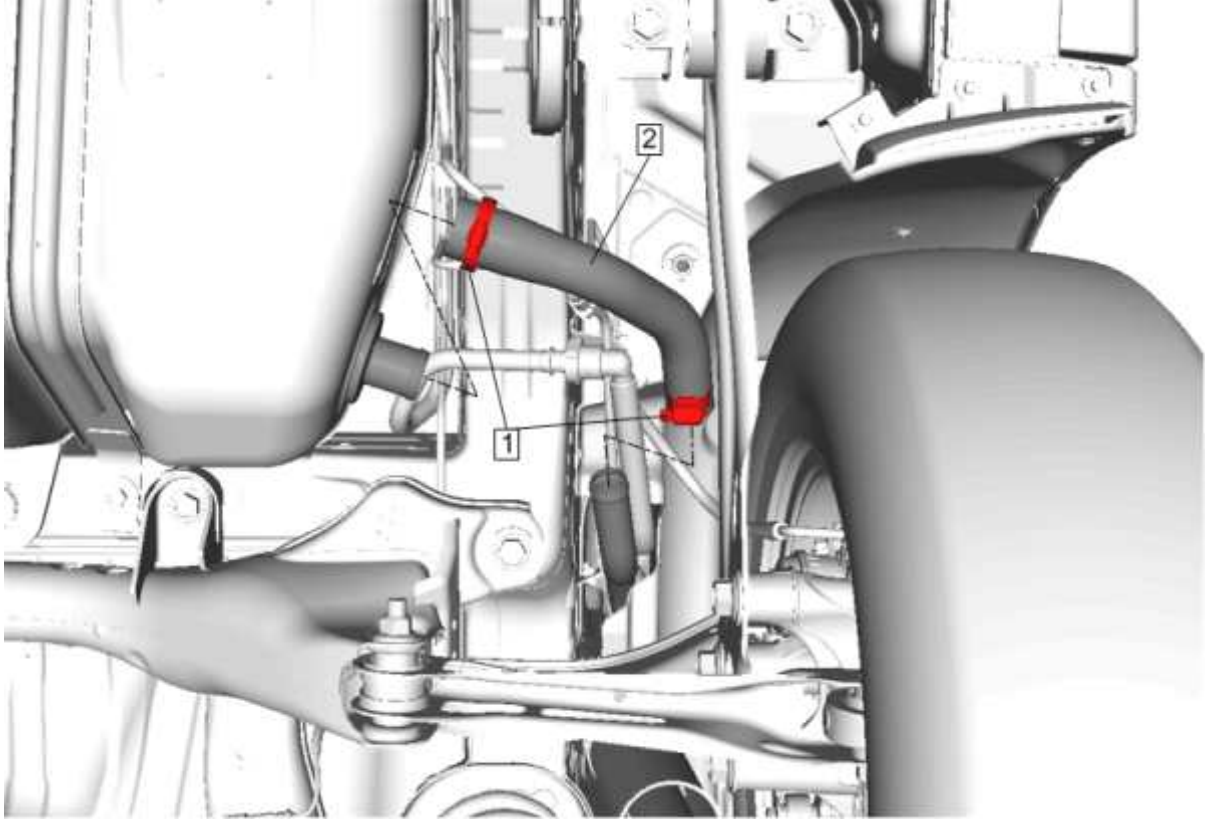

Fig. 105: Fuel Tank Filler Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedures** 1. Fuel Tank Draining 2. Lifting and Jacking the Vehicle	
1	Fuel Tank Filler Hose Clamp **CAUTION:** Refer to Fastener Caution . **Tighten** 4 N.m (35 lb in)
2	Fuel Tank Filler Hose

FUEL TANK FILLER HOSE REPLACEMENT (AWD)

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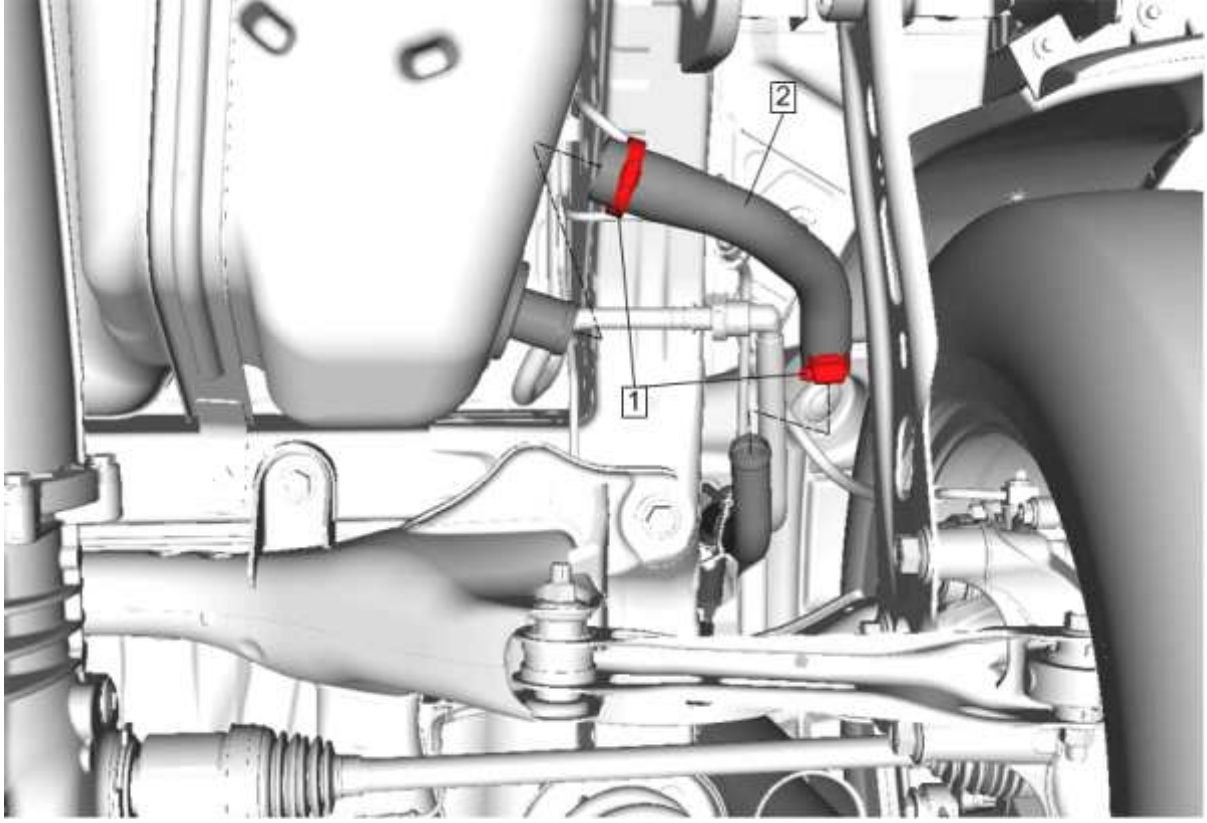

Fig. 106: Fuel Tank Filler Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedures** 1. Fuel Tank Draining 2. Lifting and Jacking the Vehicle	
1	Fuel Tank Filler Hose Clamp **CAUTION:** Refer to Fastener Caution . **Tighten** 4 N.m (35 lb in)
2	Fuel Tank Filler Hose

FUEL PUMP REPLACEMENT

Special Tools

EN-51365 High Pressure Fuel Pump Installation Alignment Gauge

Equivalent regional tools:Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools)

Removal Procedure

WARNING: **The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam**

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component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

WARNING: **Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.**

WARNING: **Wear safety glasses in order to avoid eye damage.**

CAUTION: **Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .**

1. Relieve the fuel system pressure. **Fuel Pressure Relief**
2. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
3. Remove Intake Manifold - **Intake Manifold Replacement**

NOTE: **High pressure fuel feed pipes are one time use only. ALWAYS install a NEW high pressure fuel feed pipe if the pipe is removed OR the fittings are loosened.**

4. Remove Fuel Feed Intermediate Pipe and DISCARD - **Fuel Feed Intermediate Pipe Replacement**

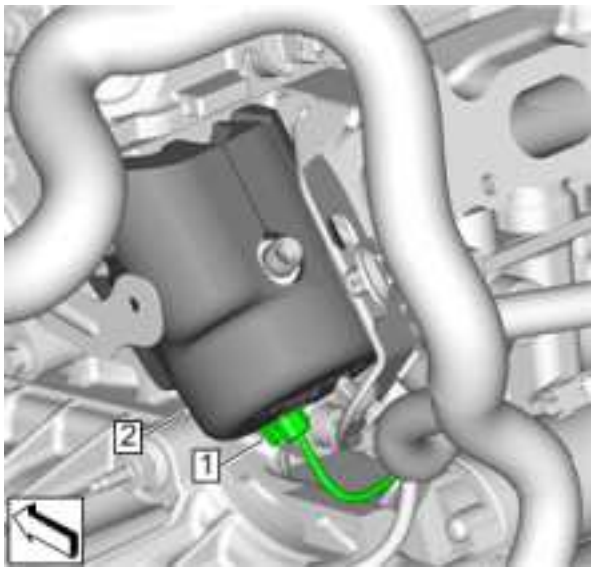

Fig. 107: Fuel Pump Insulator And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the electrical connector (1).
6. Remove the fuel pump insulator (2).

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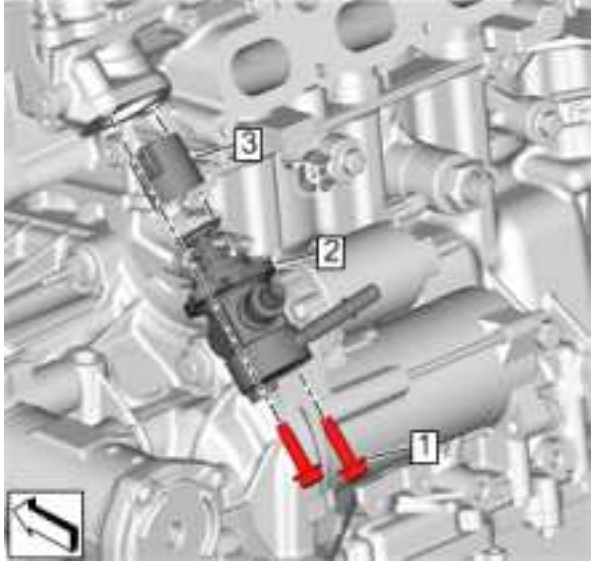

Fig. 108: Fuel Pump And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Alternately loosen the fuel pump bolts one turn at a time until the pump is fully disengaged from fuel pump lifter follower. Trying to remove the pump bolts without even side-to-side loosening may result in pump plunger damage**

7. Remove and DISCARD the fuel pump bolts (1).

NOTE: **Ensure that during removal of the fuel pump that the valve lifter follower does NOT fall apart.**

8. Remove the fuel pump (2).

NOTE:

- **The valve lifter follower MAY remain in the cylinder head bore after removing the fuel pump.**
- **If the valve lifter follower does NOT pull out of the cylinder head bore with the fuel pump, then remove it afterwards.**

9. Remove the valve lifter follower (3).

Fig. 109: Fuel Pump Housing Seal
Courtesy of GENERAL MOTORS COMPANY

10. Remove and DISCARD the fuel pump housing seal (1).

Installation Procedure

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1. Before continuing, lubricate the cylinder head bore with clean engine oil. **Adhesives, Fluids, Lubricants, and Sealers**

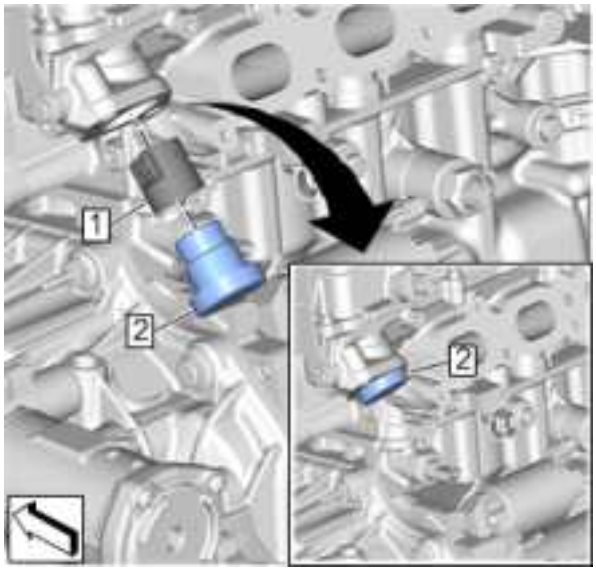

Fig. 110: Valve Lifter Follower
Courtesy of GENERAL MOTORS COMPANY

2. Lubricate the valve lifter follower (1) with clean engine oil and install it into the cylinder head bore. **Adhesives, Fluids, Lubricants, and Sealers**

NOTE:

- **The camshaft MUST be at the base circle position before the fuel pump is installed.**
- **At the base circle position, the EN-51365 alignment gauge will sit flush with the cylinder head.**

3. Install the **EN-51365** alignment gauge (2) and turn the crankshaft until the camshaft lobe is at the base circle position.
4. Remove the **EN-51365** alignment gauge (2) and valve lifter follower (1).

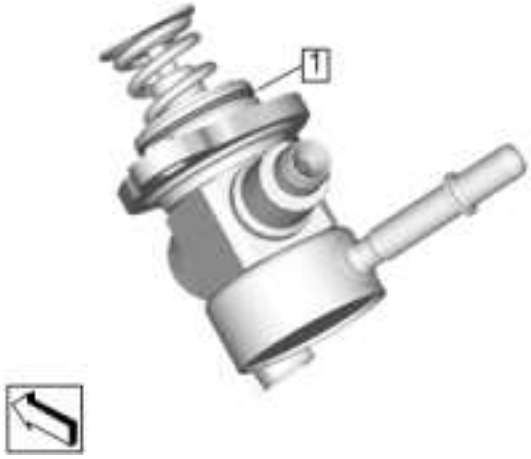

Fig. 111: Fuel Pump Housing Seal
Courtesy of GENERAL MOTORS COMPANY

5. Lubricate the NEW fuel pump housing seal (1) with clean engine oil and install it on the fuel pump. **Adhesives, Fluids, Lubricants, and Sealers**

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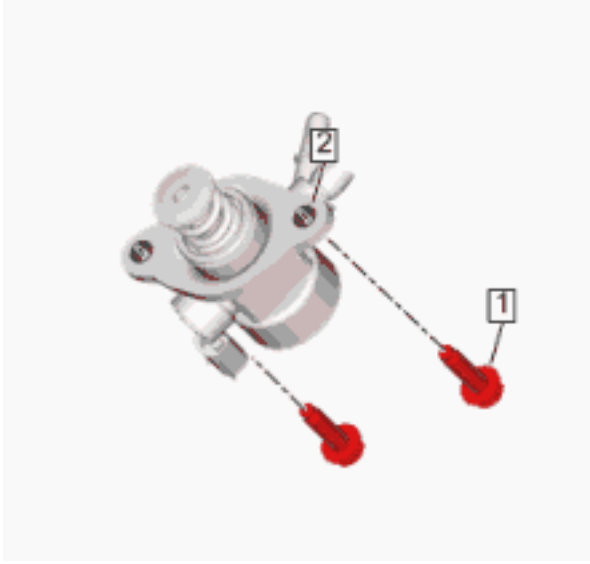

Fig. 112: Fuel Pump Bolts And Fuel Pump Bolt Retainers
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

NOTE:

- **ALWAYS make sure the fuel pump bolt retainers are present before installing the fuel pump bolts.**
- **If ANY fuel pump bolt retainers are missing or NOT suitable for reuse, replace the retainers as necessary.**

6. Install the NEW fuel pump bolts (1) through the fuel pump bolt retainers (2).

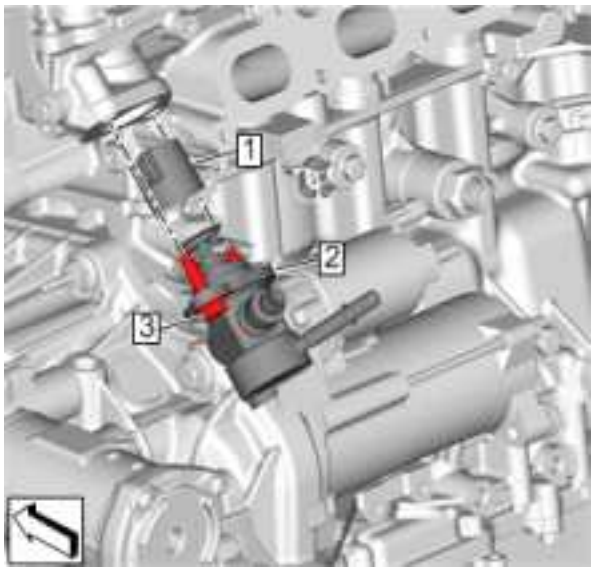

Fig. 113: Valve Lifter Follower, Fuel Pump Assembly And Fuel Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Lubricate the valve lifter follower (1) again with clean engine oil, if necessary, and install it into the cylinder head bore. Adhesives, Fluids, Lubricants, and Sealers
8. Install the fuel pump assembly (2) into the cylinder head and start the NEW fuel pump bolts (3) by hand.

CAUTION: **Refer to Fastener Caution .**

CAUTION: **Alternately hand-tighten the fuel pump bolts one turn at a time until the pump is fully seated. Trying to draw down the pump without**

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even side-to-side tightening may result in pump plunger damage.

9. Tighten the NEW fuel pump bolts (3) to 25 N.m (18 lb ft).

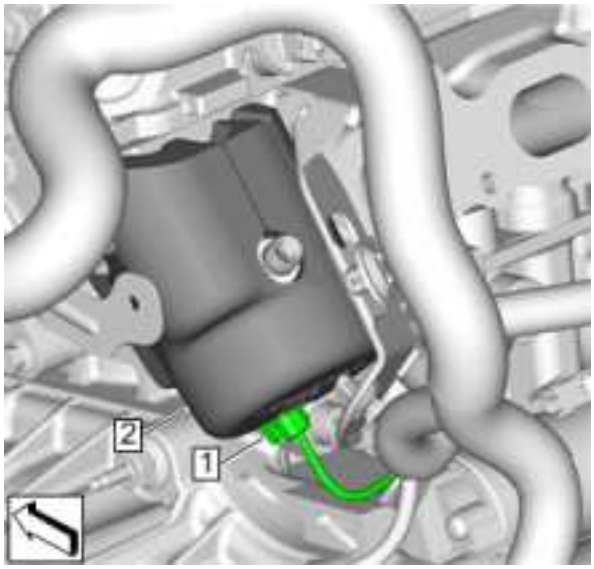

Fig. 114: Fuel Pump Insulator And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

10. Install the fuel pump insulator (2).
11. Connect the electrical connector (1).

NOTE: **High pressure fuel feed pipes are one time use only. ALWAYS install a NEW high pressure fuel feed pipe if the pipe is removed OR the fittings are loosened.**

12. Install the NEW fuel feed intermediate pipe. **Fuel Feed Intermediate Pipe Replacement**

NOTE: **The fuel feed front pipe will need to be disconnected after the fuel leak inspection to allow for installation of the intake manifold.**

13. Connect the fuel feed front pipe to the fuel pump. **Fuel Feed Front Pipe Replacement**
14. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
15. Inspect for leaks using the following procedure:
    1. Turn ON the ignition with the engine OFF for 2 seconds.
    2. Turn OFF the ignition for 10 seconds.
    3. Turn ON the ignition with the engine OFF.
    4. Inspect for fuel leaks.
16. Relieve the fuel system pressure. **Fuel Pressure Relief**
17. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
18. Disconnect the fuel feed front pipe from the fuel pump. **Fuel Feed Front Pipe Replacement**
19. Intake Manifold -**Intake Manifold Replacement**
20. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
21. Perform the fuel rail pressure relief valve learned values reset. **Fuel Rail Pressure Relief Valve Learned Values Reset**

FUEL PUMP FUEL FEED HOSE REPLACEMENT (FWD)

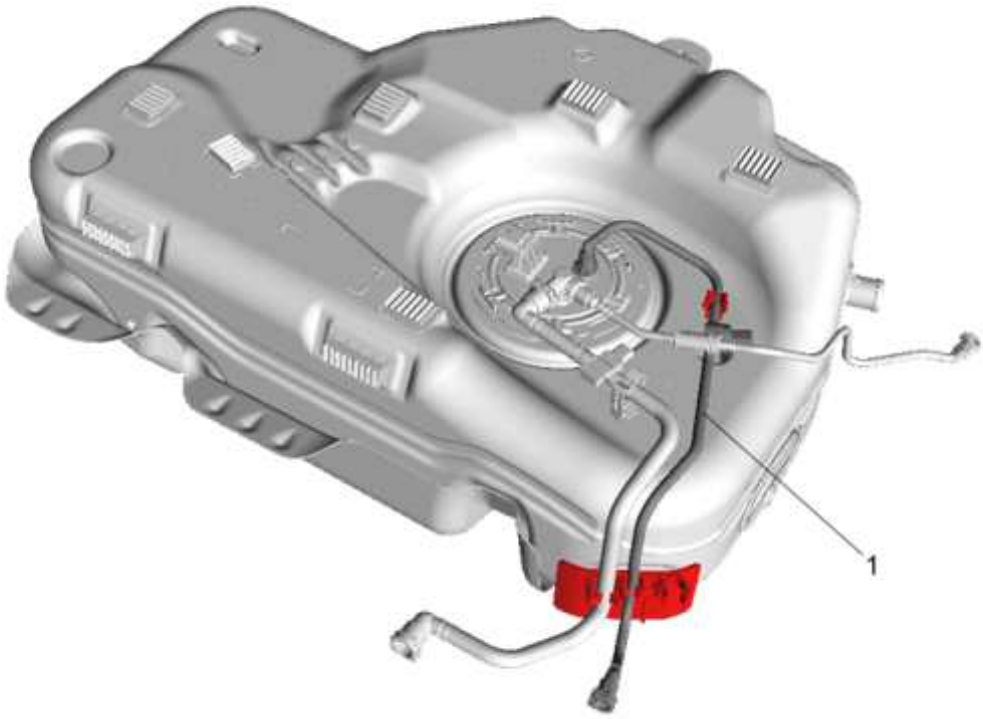

Fig. 115: Fuel Pump Fuel Feed Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Fuel Tank Replacement (FWD)	
1	Fuel Pump Fuel Feed Hose **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the fuel pump fuel feed hose and remove from retainers. Plastic Collar Quick Connect Fitting Service

FUEL PUMP FUEL FEED HOSE REPLACEMENT (AWD)

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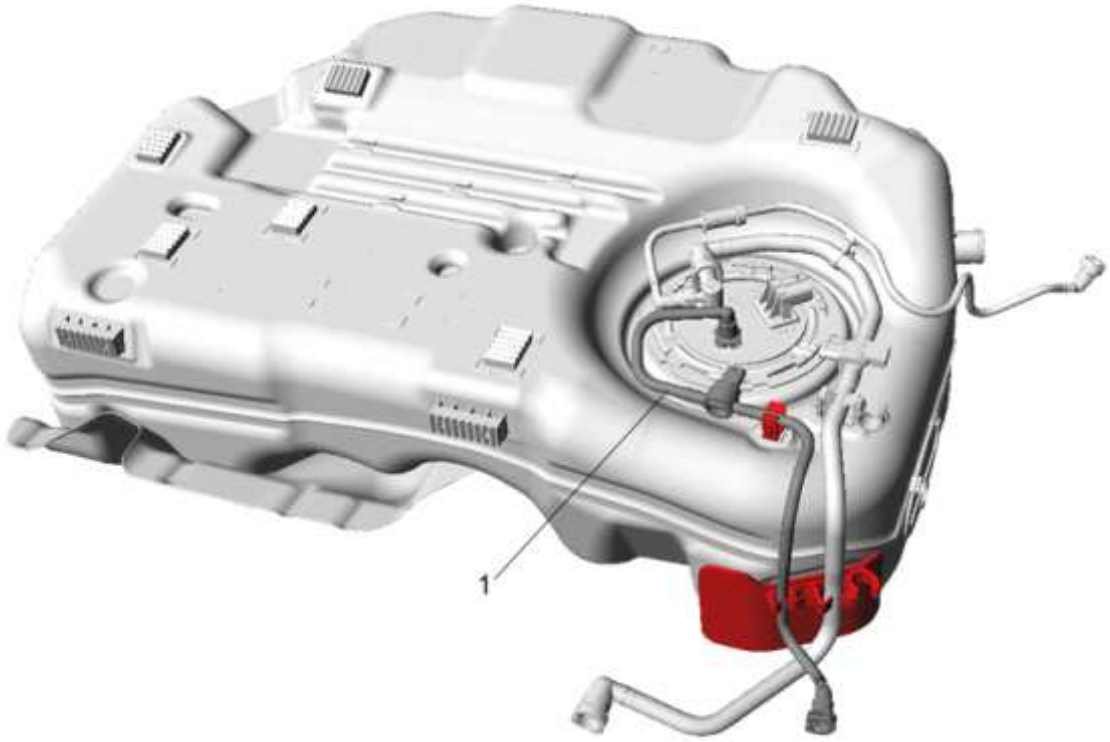

Fig. 116: Fuel Pump Fuel Feed Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Fuel Tank Replacement (AWD)	
1	Fuel Pump Fuel Feed Hose **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the fuel pump fuel feed hose and remove from retainers. Plastic Collar Quick Connect Fitting Service

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT

Special Tools

- **EN-51146** Fuel Injector Removal/Installation Kit
- **EN-51146 - 2 - 5** Calibration Tool
- **EN-51146 - 100** Fuel Injector Removal Plate

Equivalent regional tools:Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools)

Removal Procedure

WARNING: **Wear safety glasses in order to avoid eye damage.**

WARNING: **Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in**

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an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

CAUTION: **When working on the fuel rail and fuel injectors, always maintain a clean work surface. Failure to maintain a clean work surface can result in contaminant on the injector seals and cause leaks.**

1. Relieve the fuel system pressure. **Fuel Pressure Relief**
2. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
3. Remove Ignition Coil - **Ignition Coil Replacement**
4. Disconnect Fuel Injection Fuel Rail Wiring Harness@Engine Wiring Harness
5. Remove Fuel Feed Intermediate Pipe -**Fuel Feed Intermediate Pipe Replacement**

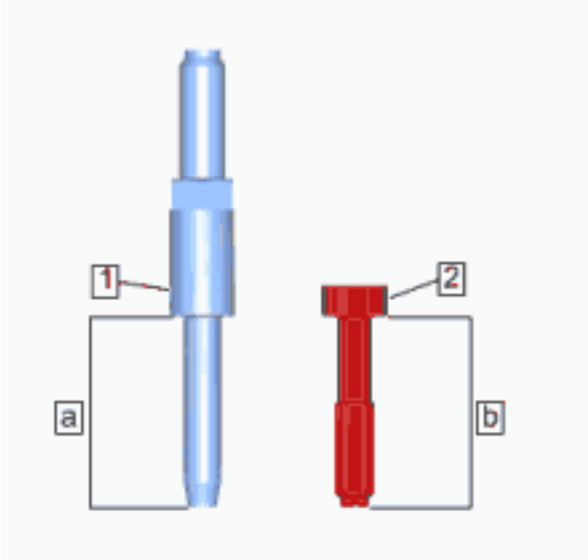

Fig. 117: Demounting Screw And Fuel Injector Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Adjust the length (a) of one **EN-51146 - 1 - 6** demounting screw (1) to match the length (b) of one NEW fuel injector bolt (2).

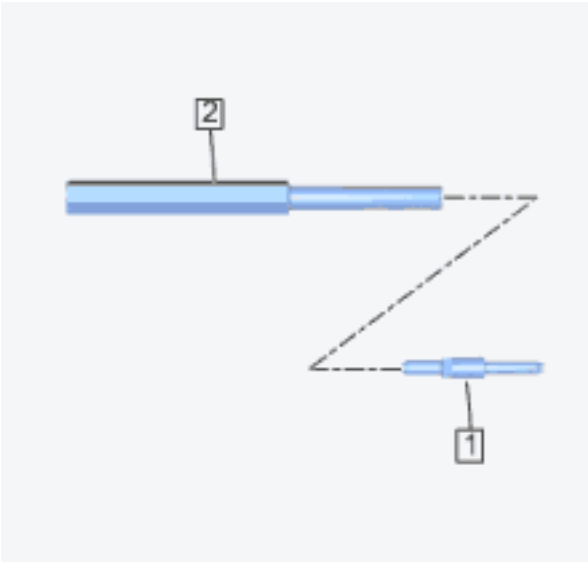

Fig. 118: Demounting Screw And Support
Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-51146 - 1 - 6** demounting screw (1) into a **EN-51146 - 1 - 1** support (2) and tighten to 7 N.m (62 lb in).

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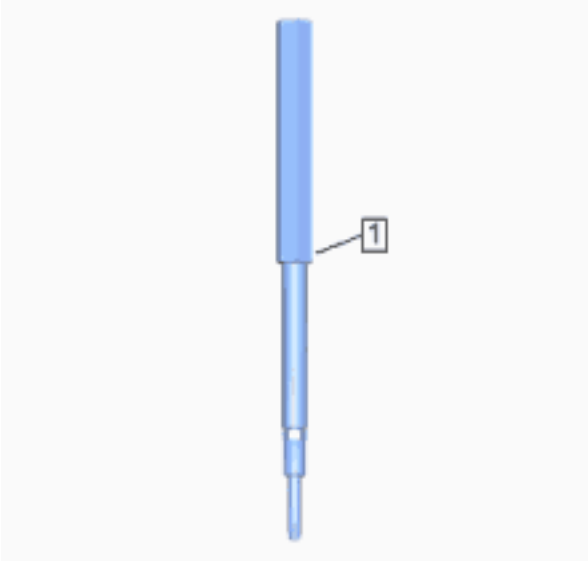

Fig. 119: Support
Courtesy of GENERAL MOTORS COMPANY

8. Repeat the previous instructions for a total of eight **EN-51146 - 1 - 6** demounting screw and **EN-51146 - 1 - 1** support combinations (1).

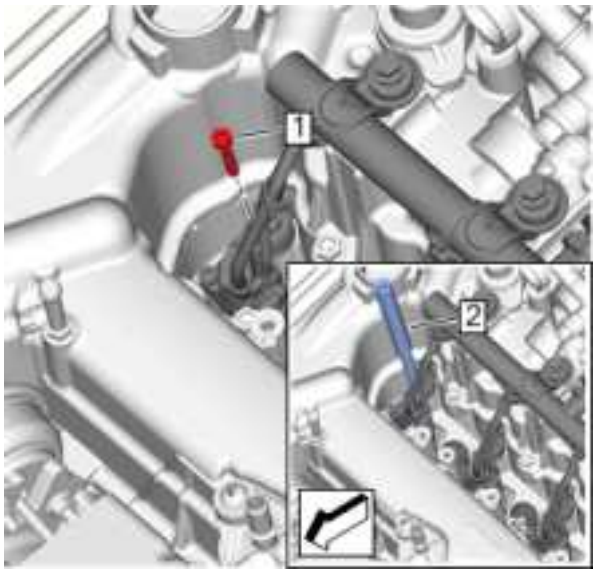

Fig. 120: Inner Fuel Injector Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do NOT loosen or remove both the inner and outer fuel injector bolts at the same time on any single fuel injector.**
- **Ensure the EN-51146 - 1 - 6 demounting screw and the EN-51146 - 1 - 1 support combination is properly installed in the inner fuel injector bolt hole before removing the corresponding outer fuel injector bolt.**

9. At Cylinder 1, remove and DISCARD the inner fuel injector bolt (1).
10. Install the **EN-51146 - 1 - 6** demounting screw and **EN-51146 - 1 - 1** support combination (2) into the inner fuel injector bolt hole and tighten to 5 N.m (44 lb in).

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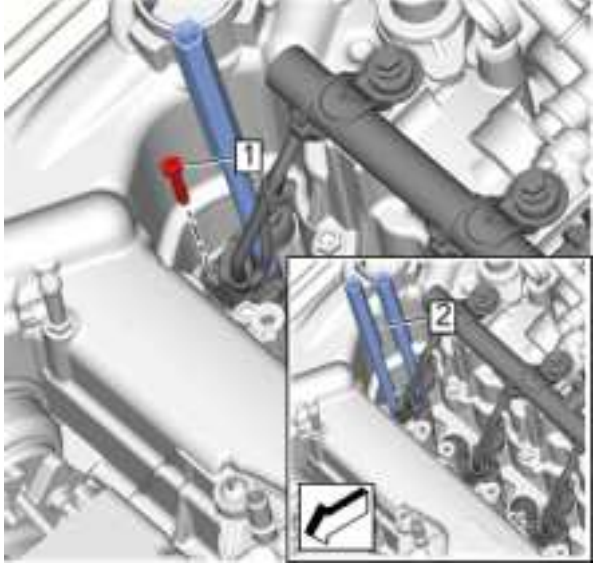

Fig. 121: Outer Fuel Injector Bolt
Courtesy of GENERAL MOTORS COMPANY

11. At Cylinder 1, remove and DISCARD the outer fuel injector bolt (1).
12. Install the **EN-51146 - 1 - 6** demounting screw and **EN-51146 - 1 - 1** support combination (2) into the outer fuel injector bolt hole and tighten to 5 N.m (44 lb in).

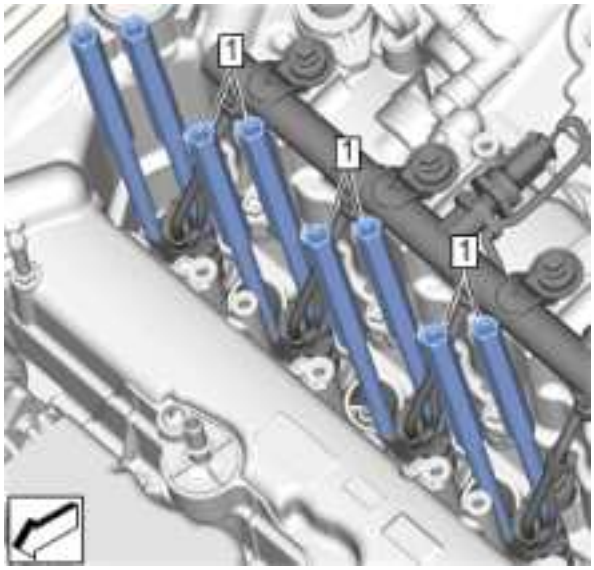

Fig. 122: Support
Courtesy of GENERAL MOTORS COMPANY

13. In order, from Cylinder 1 to Cylinder 4, repeat the previous instructions to install the remaining **EN-51146 - 1 - 6** demounting screw and **EN-51146 - 1 - 1** support combinations (1).

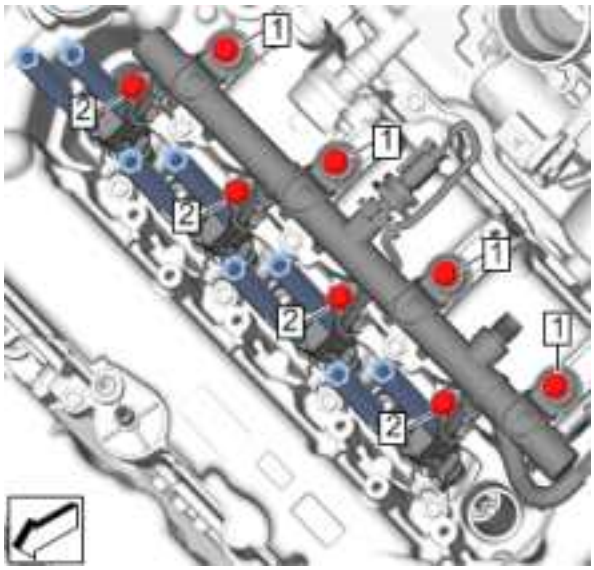

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Fig. 123: Upper And Lower Fuel Injection Fuel Rail Bolts
Courtesy of GENERAL MOTORS COMPANY

14. LOOSEN the upper fuel injection fuel rail bolts (1) completely from the cylinder head, but do NOT remove the bolts from the bolt retainers.
15. LOOSEN the lower fuel injection fuel rail bolts (2) completely from the cylinder head, but do NOT remove the bolts from the bolt retainers.

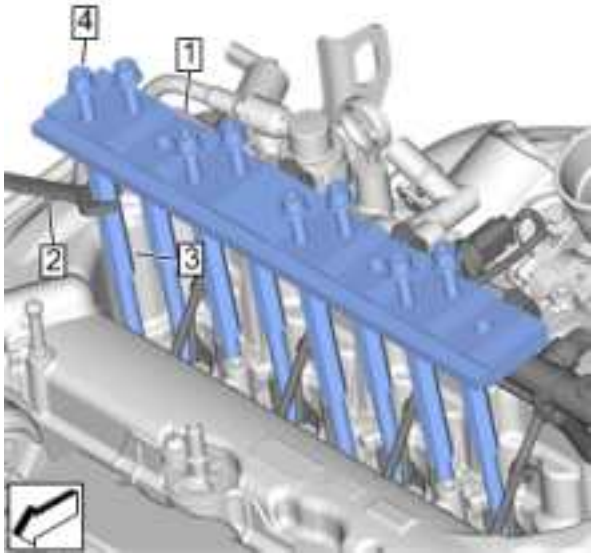

Fig. 124: Plate
Courtesy of GENERAL MOTORS COMPANY

16. Position the **EN-51146 - 100** plate (1).
17. Use a suitable wrench (2) to hold each **EN-51146 - 1 - 1** support (3) and tighten each corresponding plate bolt (4) to 5 N.m (44 lb in).

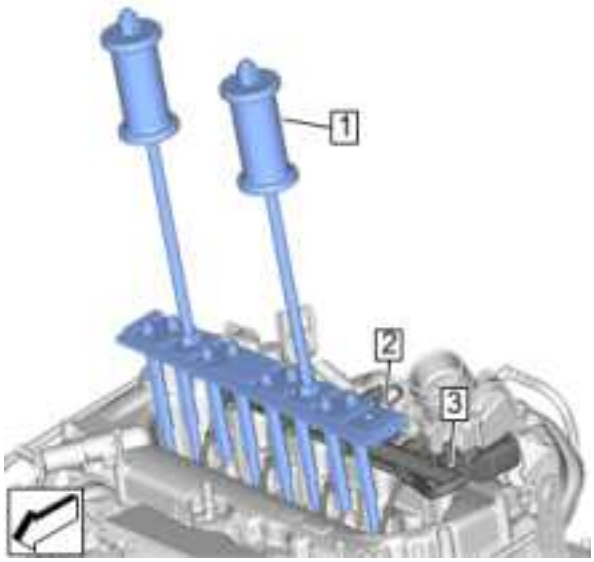

Fig. 125: Slider Hammers And Plate
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The alignment of the fuel injectors within the cylinder head bores is CRITICAL for fuel injection system function.**
- **ALWAYS use equal force on each slide hammer to ensure the fuel injectors are removed from the cylinder head bores without tilting.**

18. Install the **EN-51146 - 1 - 3** slide hammers (1) to the **EN-51146 - 100** plate (2) and apply slight upwards force equally to both hammers to remove the fuel injection fuel rail and fuel injectors as an assembly (3).

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Observe the alignment of the fuel injection fuel rail and fuel injectors while removing and allocate more force to the hammers as necessary.

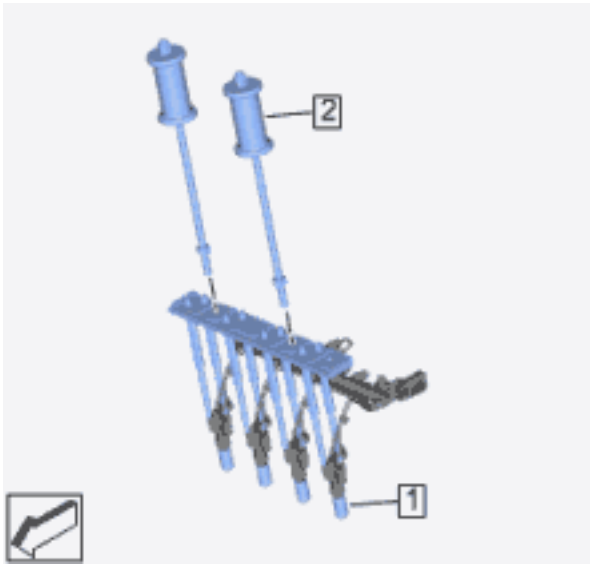

Fig. 126: Calibration Tools And Slide Hammers
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **After removing the fuel injection fuel rail and fuel injectors, position the assembly on a clean work surface with the fuel injectors pointing upwards.**
- **Do NOT allow the weight of the fuel injection fuel rail to rest on the fuel injectors.**

19. Install the **EN-51146 - 2 - 5** calibration tools (1) onto the fuel injector tips to protect the injectors.
20. Remove the **EN-51146 - 1 - 3** slide hammers (2).
21. Cover the cylinder head bores to prevent any contamination.

Installation Procedure

1. Clean ALL cylinder head bores and clean ANY fuel injectors that will be reused. **Fuel Injector and Fuel Injector Bore Cleaning and Inspection**

Fig. 127: Combustion Fuel Injector Seals
Courtesy of GENERAL MOTORS COMPANY

2. ANY fuel injectors being reused MUST have NEW combustion fuel injector seals (1) installed. **Fuel Rail and Injectors Installation**

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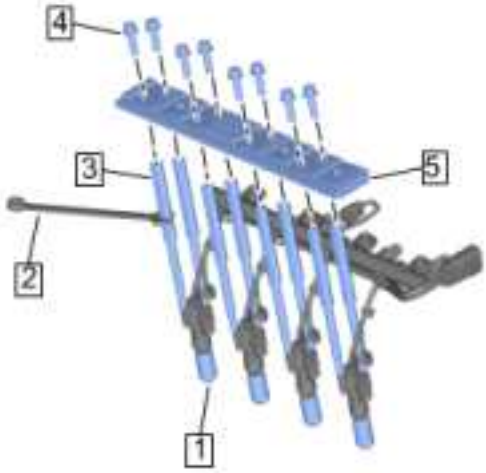

Fig. 128: Calibration Tools
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the EN-51146 - 100 plate is NOT installed, then it is likely that one or more fuel injectors have been replaced. Disregard the following steps for any fuel injectors that have already been replaced.**

3. Do NOT remove the **EN-51146 - 2 - 5** calibration tools (1) except for when servicing the combustion fuel injector seals.
4. Use a suitable wrench (2) to hold the **EN-51146 - 1 - 1** support (3) while removing the corresponding plate screw (4).
5. Use the previous instructions to remove ALL remaining plate screws (4).
6. Remove the **EN-51146 - 100** plate (5).

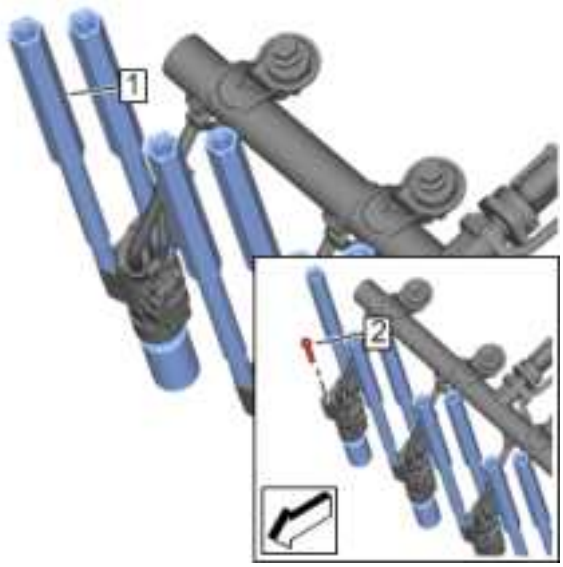

Fig. 129: Demounting Screw And Support Combination
Courtesy of GENERAL MOTORS COMPANY

7. At the fuel injector for Cylinder 1, remove the outer **EN-51146 - 1 - 6** demounting screw and **EN-51146 - 1 - 1** support combination (1).

CAUTION: **Refer to Fastener Caution .**

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

8. Perform the following steps to install the NEW outer fuel injector bolt (2):

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1. Apply one drop of thread locking adhesive to the bolt. **Adhesives, Fluids, Lubricants, and Sealers**
2. Install the bolt and tighten to 5 N.m (44 lb in).

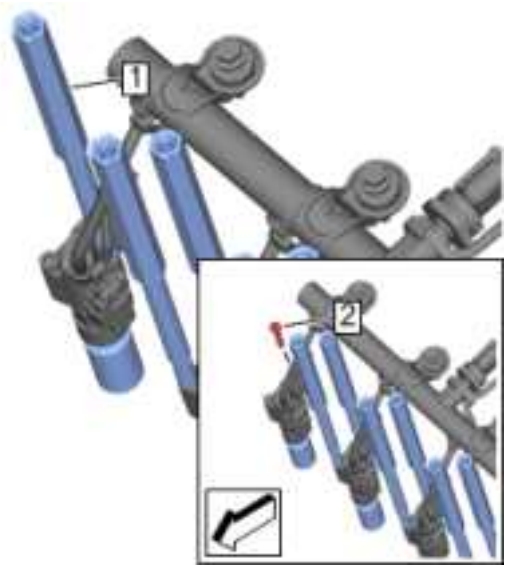

Fig. 130: Demounting Screw And Support Combination
Courtesy of GENERAL MOTORS COMPANY

9. At the fuel injector for Cylinder 1, remove the inner **EN-51146 - 1 - 6** demounting screw and **EN-51146 - 1 - 1** support combination (1).
10. Perform the following steps to install the NEW inner fuel injector bolt (2):
    1. Apply one drop of thread locking adhesive to the bolt. **Adhesives, Fluids, Lubricants, and Sealers**
    2. Install the bolt and tighten to 5 N.m (44 lb in).
11. As necessary, use the previous instructions to install NEW fuel injection bolts, in order, from Cylinder 1 to Cylinder 4.

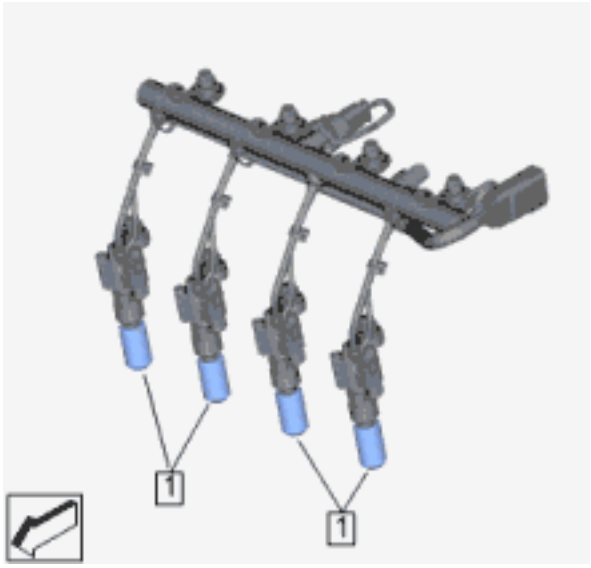

Fig. 131: Calibration Tools
Courtesy of GENERAL MOTORS COMPANY

12. Remove the **EN-51146 - 2 - 5** calibration tools (1) from the fuel injectors.

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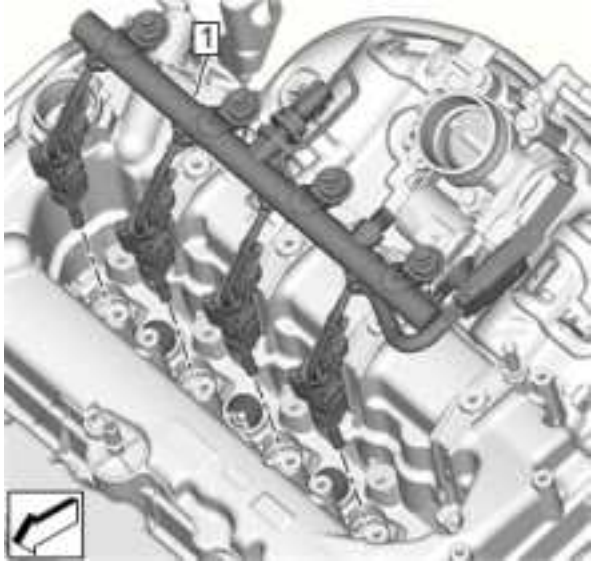

Fig. 132: Fuel Injection Fuel Rail And Fuel Injector Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The alignment of the fuel injectors within the cylinder head bores is CRITICAL for fuel injection system function.**
- **During installation of the fuel injectors, the injectors MUST remain positioned straight in the cylinder head bores.**

13. Carefully install the fuel injection fuel rail and fuel injectors as an assembly (1) into the cylinder head bores.

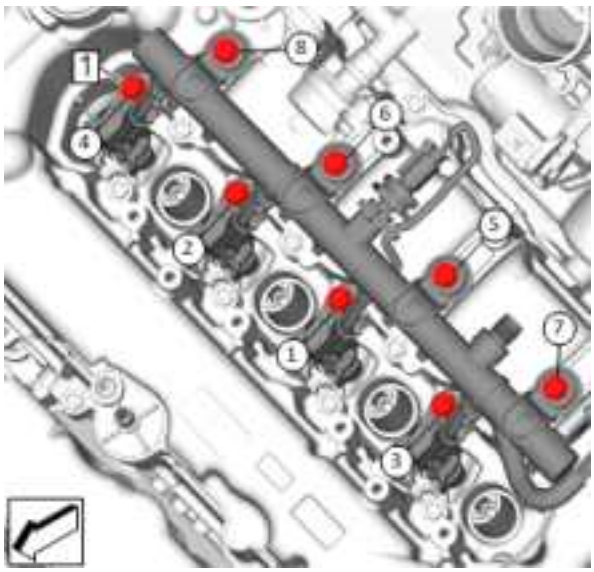

Fig. 133: Lower And Upper Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

14. Perform the following steps to install the fuel injection fuel rail bolts (1):
    1. Install and tighten the fuel rail bolts in the sequence shown in increments of one turn each until all bolts are seated.
    2. Tighten the lower fuel rail bolts in the sequence shown to 10 N.m (89 lb in).
    3. Tighten the upper fuel rail bolts in the sequence shown to 10 N.m (89 lb in).
15. Install Fuel Feed Intermediate Pipe - **Fuel Feed Intermediate Pipe Replacement**
16. Connect Fuel Injection Fuel Rail Wiring Harness@Engine Wiring Harness -
17. Install Ignition Coil - **Ignition Coil Replacement**
18. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
19. Inspect for fuel leaks using the following procedure:
    1. Turn ON the ignition with the engine OFF for 2 seconds.

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2. Turn OFF the ignition for 10 seconds.
3. Turn ON the ignition with the engine OFF.
4. Inspect for fuel leaks.

FUEL INJECTOR REPLACEMENT

Special Tools

- **EN-51146** Fuel Injector Removal/Installation Kit
- **EN-51146 - 2 - 5** Calibration Tool
- **EN-51146 - 100** Fuel Injector Removal Plate

Equivalent regional tools:Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools)

Removal Procedure

WARNING: **Wear safety glasses in order to avoid eye damage.**

WARNING: **Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.**

CAUTION: **When working on the fuel rail and fuel injectors, always maintain a clean work surface. Failure to maintain a clean work surface can result in contaminant on the injector seals and cause leaks.**

1. Remove the fuel injection fuel rail assembly. Fuel Injection Fuel Rail Assembly Replacement

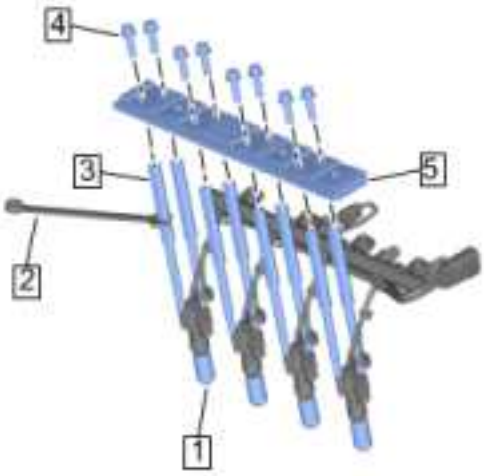

Fig. 134: Calibration Tools
Courtesy of GENERAL MOTORS COMPANY

2. Do NOT remove the **EN-51146 - 2 - 5** calibration tools (1) except for when servicing the combustion fuel injector seals.
3. Use a suitable wrench (2) to hold the **EN-51146 - 1 - 1** support (3) while removing the corresponding plate screw (4).
4. Use the previous instructions to remove ALL remaining plate screws (4).
5. Remove the **EN-51146 - 100** plate (5).

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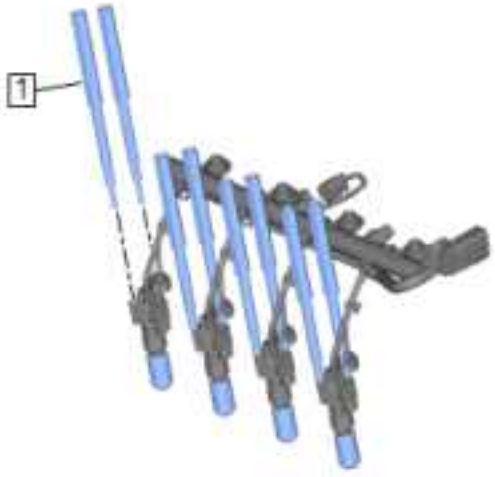

Fig. 135: Support Combinations
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The EN-51146 - 1 - 1 supports MUST remain installed at ANY fuel injectors that will NOT be removed or replaced.**

6. Remove the **EN-51146 - 1 - 6** demounting screw and **EN-51146 - 1 - 1** support combinations (1) from the inner and outer fuel injector bolt holes for ANY fuel injector being serviced or replaced.

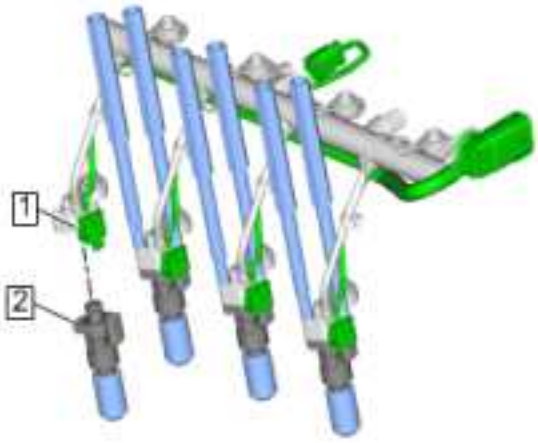

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Fig. 136: Wiring Harness Connector And Fuel Injector
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the wiring harness connector (1).
8. Remove the fuel injector (2) from the fuel injection fuel rail.

Cleaning Procedure

1. Clean ALL cylinder head bores and clean ANY fuel injectors that will be reused. **Fuel Injector and Fuel Injector Bore Cleaning and Inspection**

Installation Procedure

Fig. 137: Combustion Fuel Injector Seals
Courtesy of GENERAL MOTORS COMPANY

1. ANY fuel injectors being reused MUST have NEW combustion fuel injector seals (1) installed. **Fuel Rail and Injectors Installation**

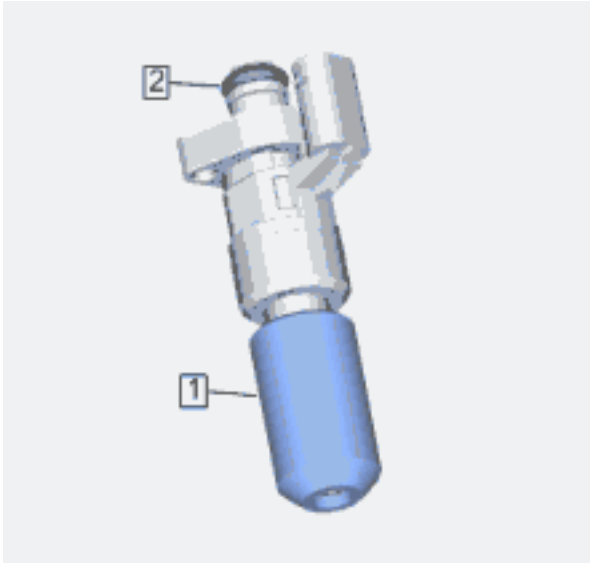

Fig. 138: Calibration Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **ALWAYS install a NEW fuel injector seal when the fuel injector is removed from the fuel injection fuel rail.**

2. Install the **EN-51146 - 2 - 5** calibration tool (1) on the fuel injector.
3. Lightly coat the NEW fuel injector seal (2) with clean engine oil. **Adhesives, Fluids, Lubricants, and Sealers**

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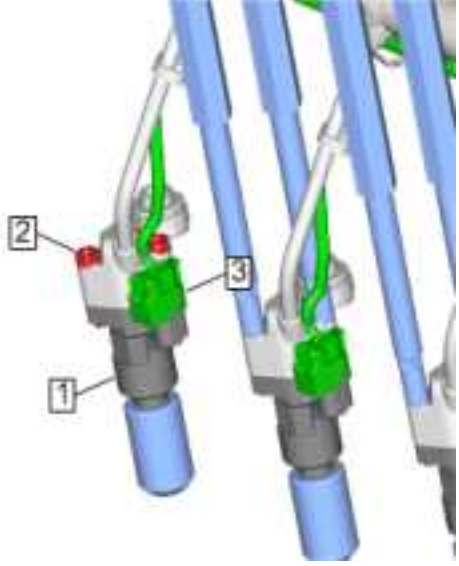

Fig. 139: Inner And Outer Fuel Injector Bolts With Wiring Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

4. Install the fuel injector (1) into the fuel injection fuel rail.

CAUTION: **Refer to Fastener Caution .**

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

5. Perform the following steps to install the NEW inner and outer fuel injector bolts (2):
    1. Apply one drop of thread locking adhesive to each bolt. Adhesives, Fluids, Lubricants, and Sealers
    2. Install the bolts and tighten to 5 N.m (44 lb in).
6. Connect the wiring harness connector (3).
7. Install the fuel injection fuel rail assembly. Fuel Injection Fuel Rail Assembly Replacement

FUEL INJECTOR WIRING HARNESS REPLACEMENT

Removal Procedure

1. Remove Fuel Injection Fuel Rail Assembly - Fuel Injection Fuel Rail Assembly Replacement

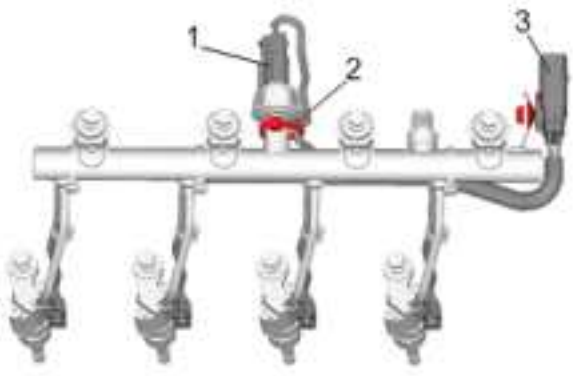

Fig. 140: Fuel Injector Wiring Harness, Connector And Tie Strap
Courtesy of GENERAL MOTORS COMPANY

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2. Disconnect the fuel injector wiring harness connector (1) from the fuel injection fuel rail fuel pressure sensor.
3. Cut the fuel injector wiring harness tie strap (2) and DISCARD.
4. Unclip the fuel injector wiring harness (3) from the fuel injection fuel rail.

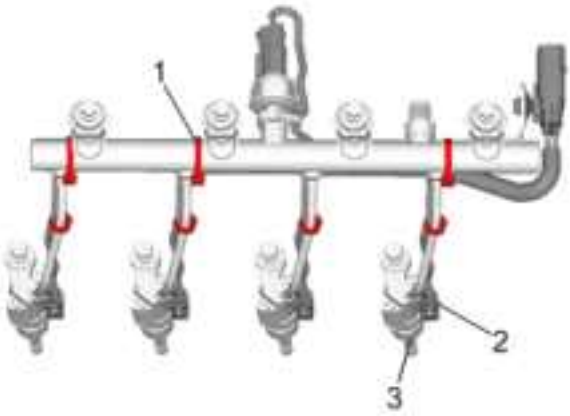

Fig. 141: Fuel Injectors, Wiring Harness And Tie Straps
Courtesy of GENERAL MOTORS COMPANY

5. Cut the remaining fuel injector wiring harness tie straps (1) and DISCARD.
6. Disconnect the fuel injector wiring harness connectors (2) from the fuel injectors (3).

Installation Procedure

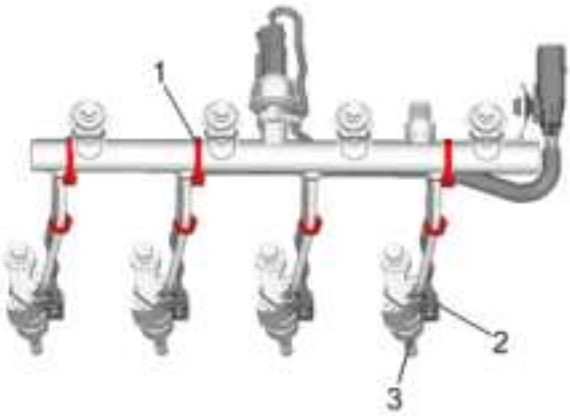

Fig. 142: Fuel Injectors, Wiring Harness And Tie Straps
Courtesy of GENERAL MOTORS COMPANY

1. Connect the fuel injector wiring harness connectors (2) to the fuel injectors (3).
2. Position the fuel injector wiring harness to the fuel injection fuel rail and install NEW wiring harness tie straps (1).

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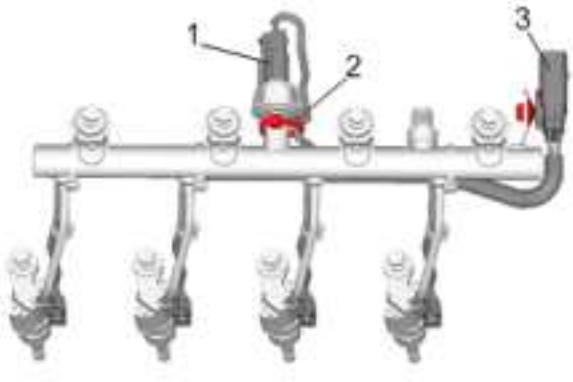

Fig. 143: Fuel Injector Wiring Harness, Connector And Tie Strap
Courtesy of GENERAL MOTORS COMPANY

3. Connect the fuel injector wiring harness connector (1) to the fuel injection fuel rail fuel pressure sensor.
4. Install a NEW wiring harness tie strap (1).
5. Clip the fuel injector wiring harness (3) to the fuel injection fuel rail.
6. Install Fuel Injection Fuel Rail Assembly - **Fuel Injection Fuel Rail Assembly Replacement**

FUEL INJECTION FUEL RAIL FUEL PRESSURE SENSOR REPLACEMENT

Removal Procedure

1. Relieve the fuel system pressure. **Fuel Pressure Relief**
2. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**

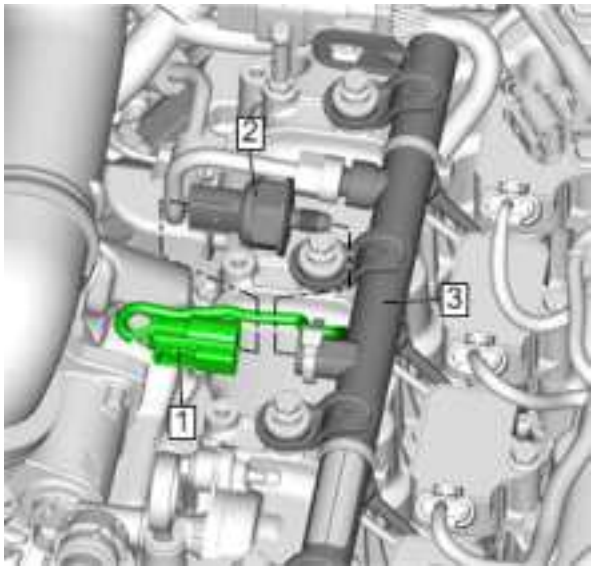

Fig. 144: Fuel Injection Fuel Rail Fuel Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the electrical connector (1).

CAUTION: **Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .**

NOTE:

- **Do NOT apply force to the plastic housing of the fuel injection fuel rail fuel pressure sensor. ONLY apply force to the attached hexagon.**

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- **Some fuel may leak from the fuel injection fuel rail orifice after the sensor is removed. Dry the area around the orifice using a lint free cloth.**
- **After removal, the area around the fuel injection fuel rail sealing surface should be inspected. The surface should be free of fuel, dirt, debris, and burrs.**

4. Remove and DISCARD the fuel injection fuel rail fuel pressure sensor (2).

Installation Procedure

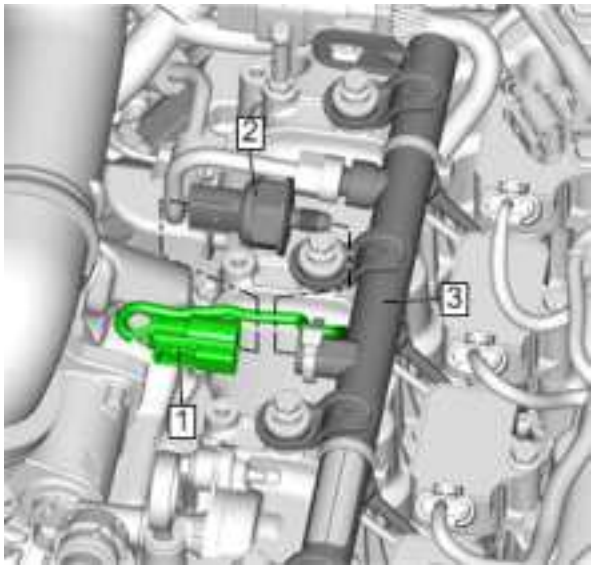

Fig. 145: Fuel Injection Fuel Rail Fuel Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener Tightening Caution .**

NOTE:

- **Do NOT apply force to the plastic housing of the fuel injection fuel rail fuel pressure sensor. ONLY apply force to the attached hexagon.**
- **BEFORE installation of the fuel injection fuel rail fuel pressure sensor, the fuel injection fuel rail threads MUST be clean and free of any fuel or the sensor will NOT seal properly.**

1. To install the NEW fuel injection fuel rail fuel pressure sensor (2) properly, perform the following steps:
    1. Lubricate the sensor threads and sealing surface with one drop of clean engine oil.
    2. Install the sensor and hand tighten.
    3. Remove the sensor.
    4. Re-lubricate the sensor threads and sealing surface with one drop of clean engine oil.
    5. Install the sensor and tighten to 33 N.m (24 lb ft).
2. Connect the electrical connector (1).

NOTE: **If a fuel leak occurs at the fuel injection fuel rail, the fuel rail will need to be replaced.**

3. Pressurize the fuel system and inspect for leaks.
4. Intake Manifold Cover - **Intake Manifold Cover Replacement**

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE (FWD)

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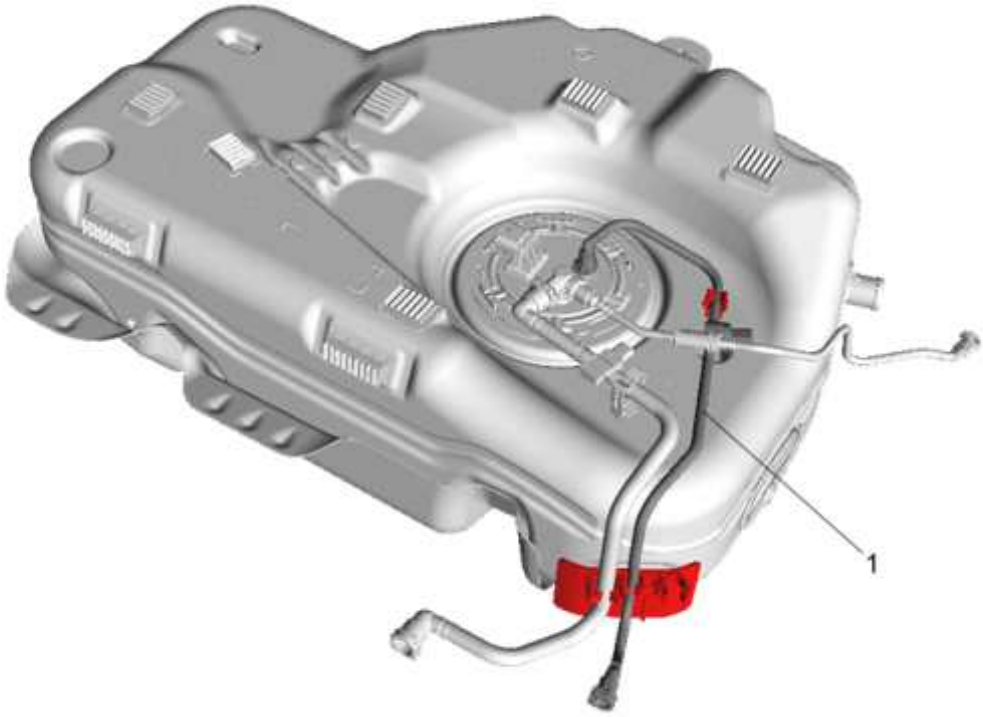

Fig. 146: Fuel Pump Fuel Feed Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Fuel Tank Replacement (FWD)	
1	Fuel Pressure Sensor **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the fuel hose and remove from retainers. Plastic Collar Quick Connect Fitting Service **NOTE:** **Fuel pressure sensor is serviced as part of fuel hose assembly.**

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE (AWD)

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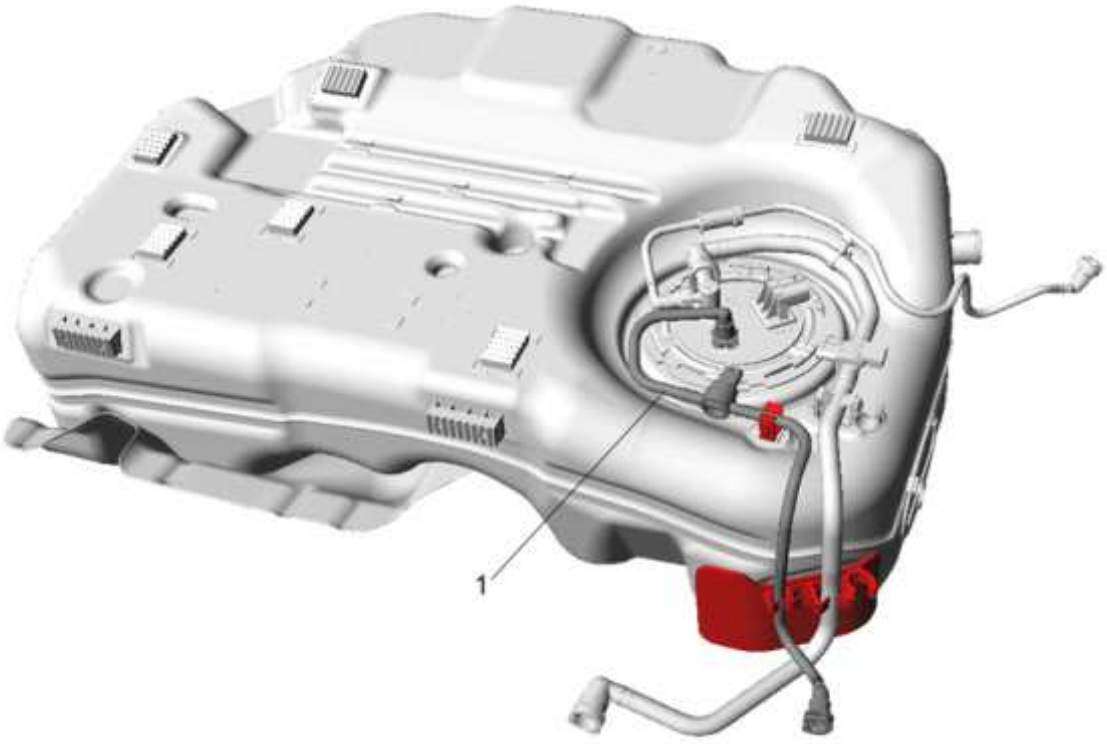

Fig. 147: Fuel Pressure Sensor - Fuel Feed Pipe (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Fuel Tank Replacement (AWD)	
1	Fuel Pressure Sensor **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the fuel hose and remove from retainers. Plastic Collar Quick Connect Fitting Service **NOTE:** **Fuel pressure sensor is serviced as part of fuel hose assembly.**

FUEL SYSTEM CLEANING

NOTE: **When flushing the fuel tank, treat the fuel and water mixture as a hazardous material. Handle the material in accordance with all local, state and federal laws and regulations.**

NOTE: **Whenever the fuel tank is cleaned, inspect the fuel pump fuel strainer. If the fuel pump fuel strainer is contaminated, replace the fuel pump fuel strainer and inspect the fuel pump.**

NOTE: **Always maintain cleanliness when servicing fuel system components.**

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1. Remove the fuel tank fuel pump module. **Fuel Tank Fuel Pump Module Replacement (FWD)Fuel Tank Fuel Pump Module Replacement (AWD)**.
2. Inspect the fuel pump inlet for dirt and debris. If dirt and debris are found, replace the fuel pump.
3. Flush fuel tank with hot water.
4. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to ensure that the removal of the water from the fuel tank is complete.
5. Allow tank to dry completely before reassembly.
6. Install the fuel tank fuel pump module. **Fuel Tank Fuel Pump Module Replacement (FWD)Fuel Tank Fuel Pump Module Replacement (AWD)**.

FUEL FEED FRONT PIPE REPLACEMENT

Removal Procedure

WARNING: **Refer to Diesel/Gasoline Vapors Warning .**

WARNING: **Refer to Safety Glasses Warning .**

1. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**
2. Relieve the fuel system pressure. **Fuel Pressure Relief**
3. Remove Charge Air Cooler Outlet Air Tube - **Charge Air Cooler Outlet Air Tube Replacement**

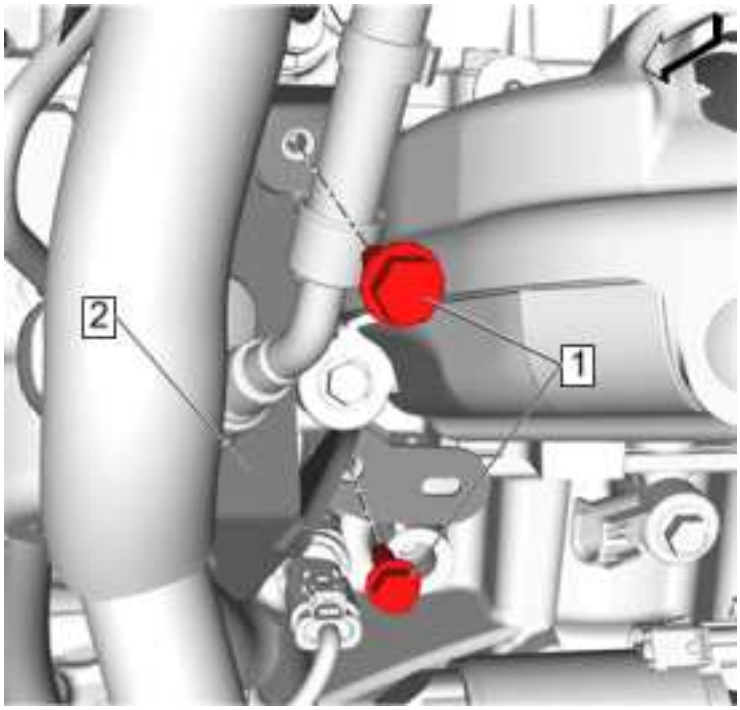

Fig. 148: Engine Control Module, Engine Wiring Harness Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove Engine Control Module and Engine Wiring Harness Bracket Bolt (1)
5. Reposition Engine Control Module and Engine Wiring Harness Bracket (2)

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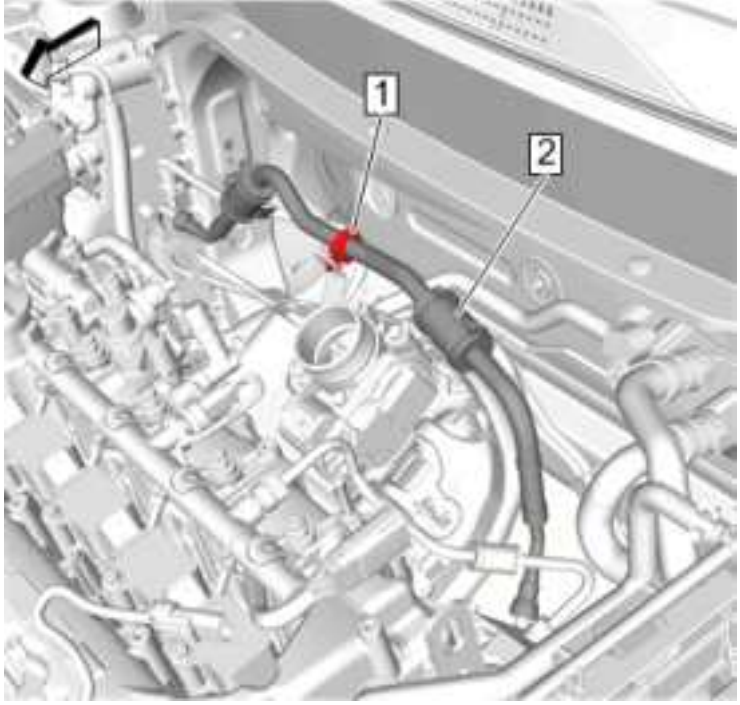

Fig. 149: Fuel Feed Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Remove Fuel Feed Front Pipe Retainer (1)
7. Disconnect Fuel Feed Front Pipe (2)**Metal Collar Quick Connect Fitting Service**

Installation Procedure

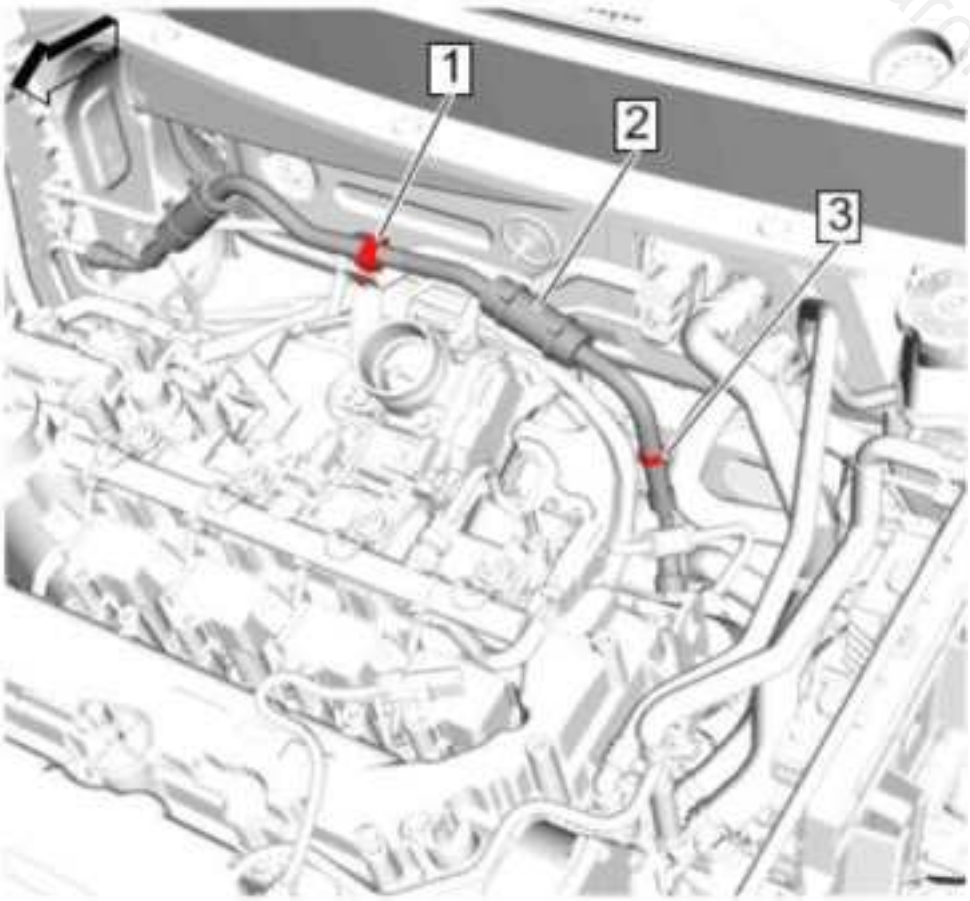

Fig. 150: Fuel Feed Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Fuel feed front pipe contains a check valve and needs to be installed properly to prevent engine performance issues.**
- **The fuel feed front pipe end with Oetiker clamp (3) must be connected to the high pressure pump on the engine.**

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1. Connect Fuel Feed Front Pipe (2) - Metal Collar Quick Connect Fitting Service
2. Install Fuel Feed Front Pipe Retainer (1).

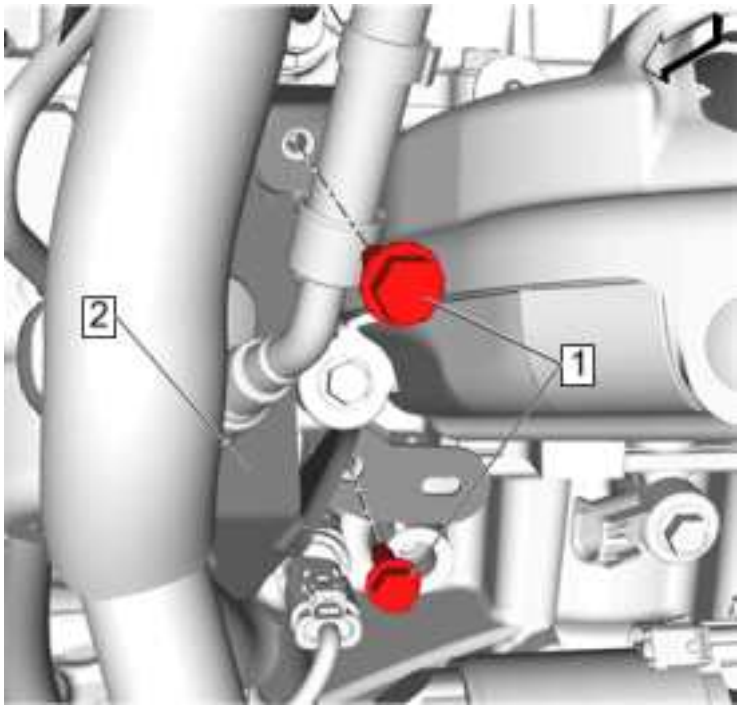

Fig. 151: Engine Control Module, Engine Wiring Harness Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install Engine Control Module and Engine Wiring Harness Bracket (1).

CAUTION: **Refer to Fastener Caution .**

4. Install Engine Control Module and Engine Wiring Harness Bracket Bolt (1) and tighten 9 N.m (80 lb in)
5. Install Charge Air Cooler Outlet Air Tube - Charge Air Cooler Outlet Air Tube Replacement
6. Install Intake Manifold Cover - Intake Manifold Cover Replacement
7. Cycle ignition to pressurize fuel system and check for fuel leaks.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT

Removal Procedure

WARNING: **The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.**

WARNING: **Refer to Diesel/Gasoline Vapors Warning .**

WARNING: **Refer to Safety Glasses Warning .**

NOTE: **High pressure fuel feed pipes are one time use only. ALWAYS install a NEW high pressure fuel feed pipe if the pipe is removed OR the fittings are loosened.**

1. Relieve the fuel system pressure. Fuel Pressure Relief
2. Remove Intake Manifold Cover - Intake Manifold Cover Replacement
3. Separate the charge air cooler outlet air tube from the throttle body and set aside. Charge Air Cooler Outlet Air Tube Replacement

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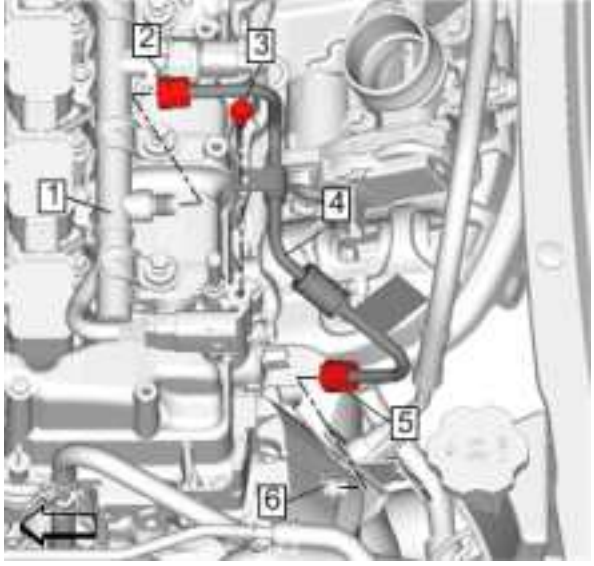

Fig. 152: High Pressure Fuel Feed Intermediate Pipe
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Lay a lint-free cloth under the fuel feed intermediate pipe to absorb any excess fuel spillage.**

4. Remove the fuel injection fuel feed pipe clip bolt (3).
5. Loosen the fuel feed intermediate pipe fittings (2, 5).
6. Remove the fuel feed intermediate pipe (4) from the fuel injection fuel rail (1) and the fuel pump (6).
7. Remove and DISCARD the fuel feed intermediate pipe (4).

Installation Procedure

1. Ensure ALL fittings are clean and dry prior to assembly.
2. Lubricate the fuel feed intermediate pipe fittings with silicon free engine oil.

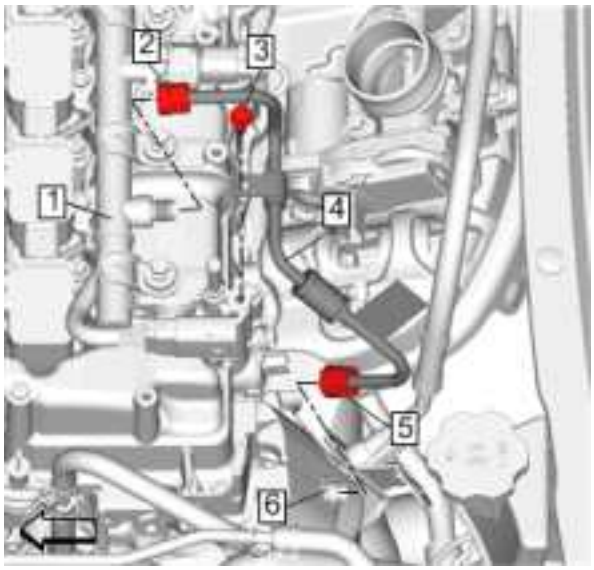

Fig. 153: High Pressure Fuel Feed Intermediate Pipe
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener Tightening Caution .**

3. To install the NEW fuel feed intermediate pipe (4) to the fuel injection fuel rail (1) and to the fuel pump (6), perform the following steps:
    1. Hand tighten the fuel feed intermediate pipe fitting (2) to the fuel injection fuel rail (1).
    2. Hand tighten the fuel feed intermediate pipe fitting (5) to the fuel pump (6).
    3. Tighten the fuel feed intermediate pipe fittings (2, 5) to 30 N.m (22 lb ft).

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CAUTION: **Refer to Fastener Caution .**

4. Install the fuel injection fuel feed pipe clip bolt (3) and tighten to 10 N.m (89 lb in).

NOTE: **If a fuel leak occurs at the fuel pump or the fuel injection fuel rail fitting, the corresponding component will need to be replaced.**

5. Inspect for leaks using the following procedure:
    1. Turn ON the ignition with the engine OFF for 2 seconds.
    2. Turn OFF the ignition for 10 seconds.
    3. Turn ON the ignition with the engine OFF.
    4. Inspect for fuel leaks.
6. Install the charge air cooler outlet air tube to the throttle body. **Charge Air Cooler Outlet Air Tube Replacement**
7. Install Intake Manifold Cover - **Intake Manifold Cover Replacement**

EVAPORATIVE EMISSION CANISTER REPLACEMENT (FWD)

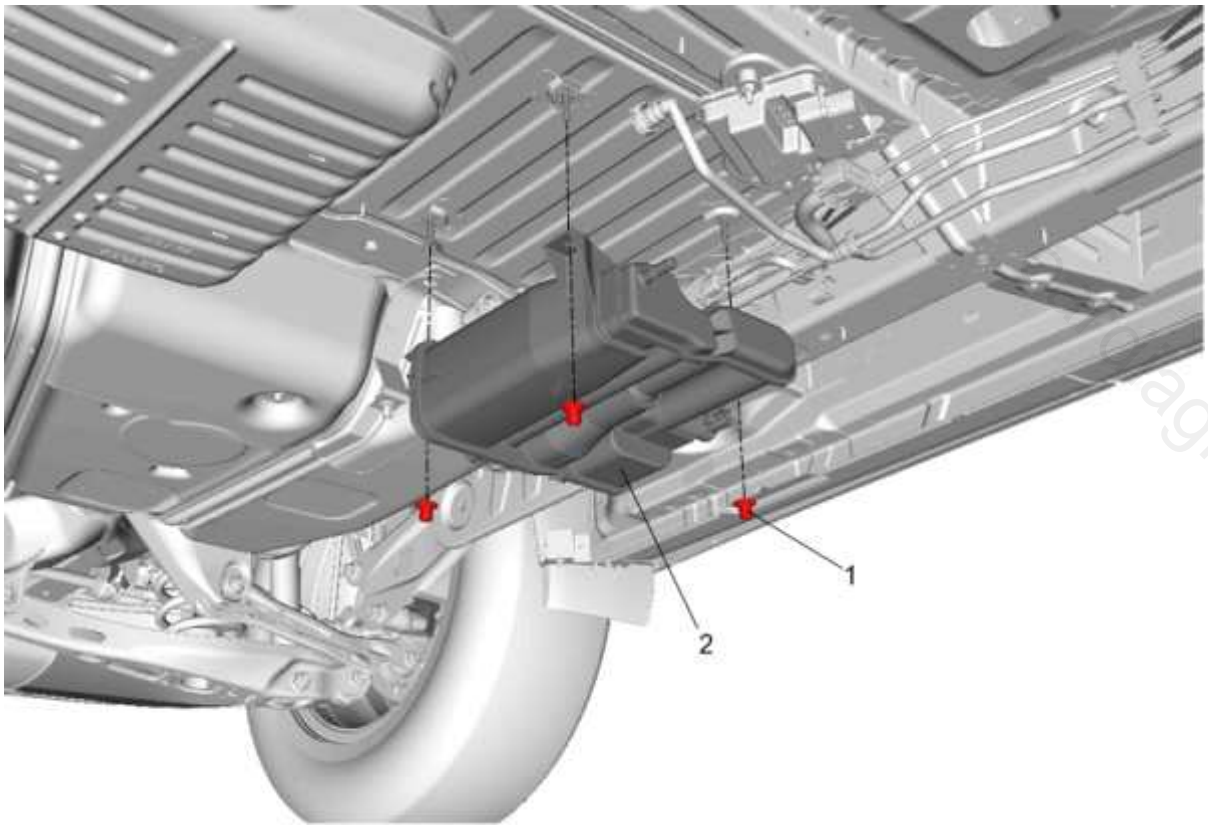

Fig. 154: Evaporative Emission Canister (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name

WARNING:
Refer to Diesel/Gasoline Vapors Warning .

WARNING:
Refer to Safety Glasses Warning .

Preliminary Procedures

1. Underbody Rear Air Deflector Replacement (Front Wheel Drive)
2. Disconnect Evaporative Emission Canister Purge Solenoid Valve Hose@Evaporative Emission Canister - Plastic Collar Quick Connect Fitting Service
3. Disconnect Evaporative Emission Canister Filter Pipe@Evaporative Emission Canister - Plastic Collar Quick Connect Fitting Service
4. Disconnect Evaporative Emission Canister Vent Hose@Evaporative Emission Canister - Plastic Collar Quick Connect Fitting Service

1	Evaporative Emission Canister Nut[3x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9N.m (80 lb in)
2	Evaporative Emission Canister **Procedure** Disconnect the electrical connector.

EVAPORATIVE EMISSION CANISTER REPLACEMENT (AWD)

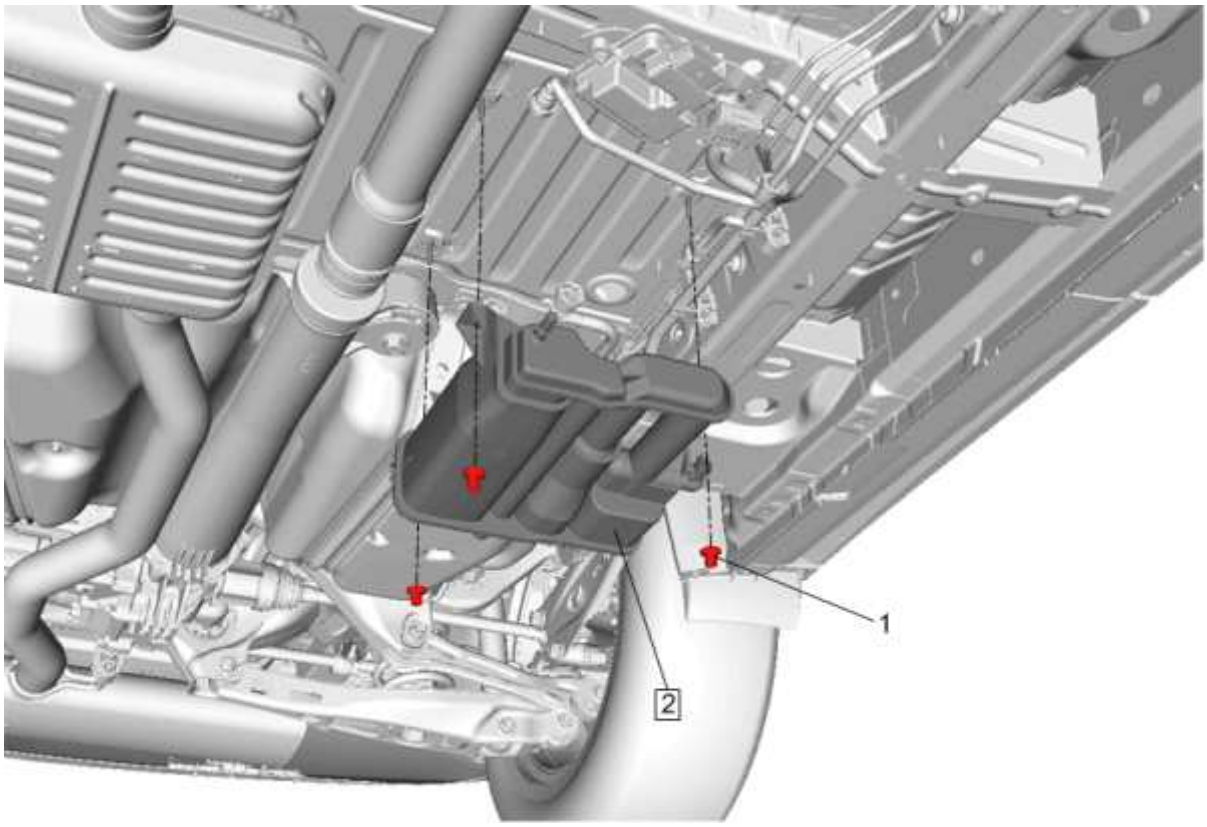

Fig. 155: Evaporative Emission Canister (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

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Callout	Component Name
	WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedures** 1. Underbody Rear Air Deflector Replacement (All Wheel Drive) 2. Disconnect Evaporative Emission Canister Purge Solenoid Valve Hose@Evaporative Emission Canister - Plastic Collar Quick Connect Fitting Service 3. Disconnect Evaporative Emission Canister Filter Pipe@Evaporative Emission Canister - Plastic Collar Quick Connect Fitting Service 4. Disconnect Evaporative Emission Canister Vent Hose@Evaporative Emission Canister - Plastic Collar Quick Connect Fitting Service
1	Evaporative Emission Canister Nut[3x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9N.m (80 lb in)
2	Evaporative Emission Canister **Procedure** Disconnect the electrical connector.

EVAPORATIVE EMISSION CANISTER FILTER PIPE REPLACEMENT (FWD)

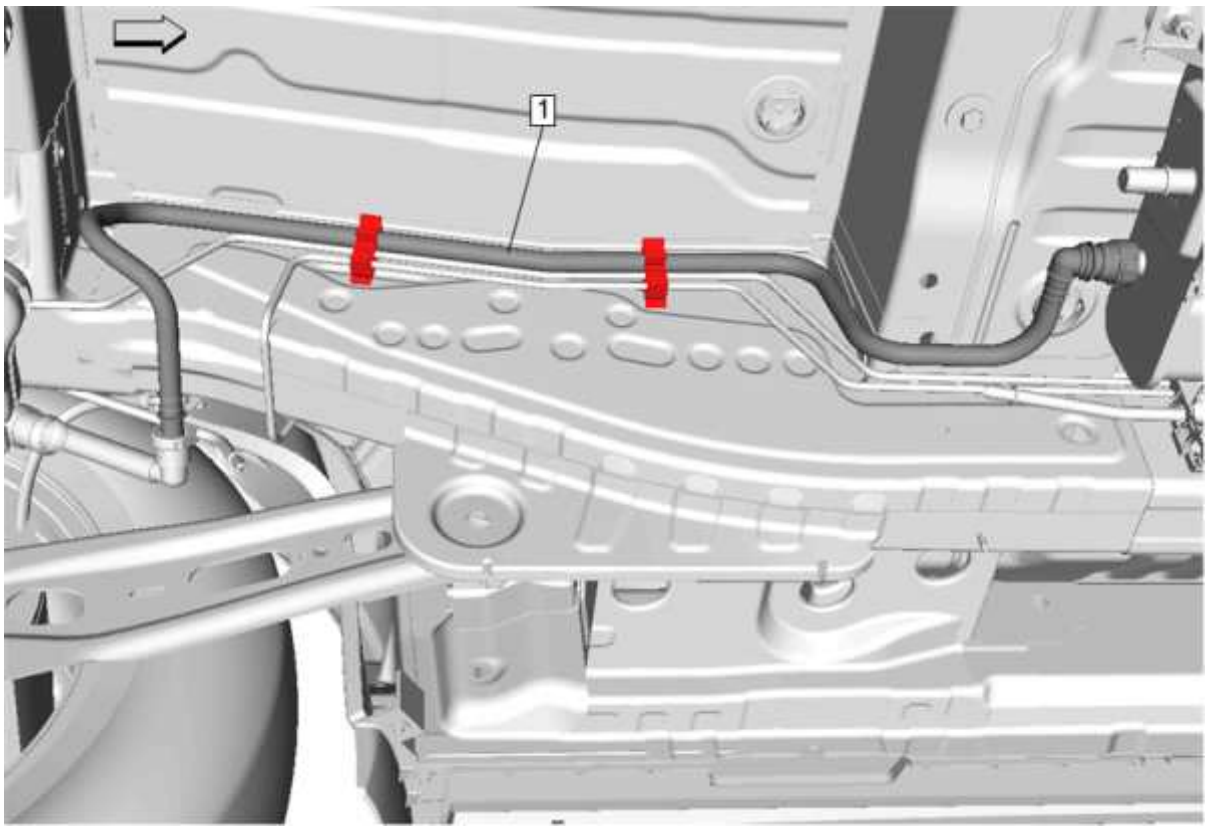

Fig. 156: Evaporative Emission Canister Filter Pipe (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

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Callout	Component Name
WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedure Fuel Tank Replacement (FWD)**	
1	Evaporative Emission Canister Filter Pipe **Procedure** Disconnect the evaporative emission canister filter pipe and remove from retainers. **Plastic Collar Quick Connect Fitting Service**

EVAPORATIVE EMISSION CANISTER FILTER PIPE REPLACEMENT (AWD)

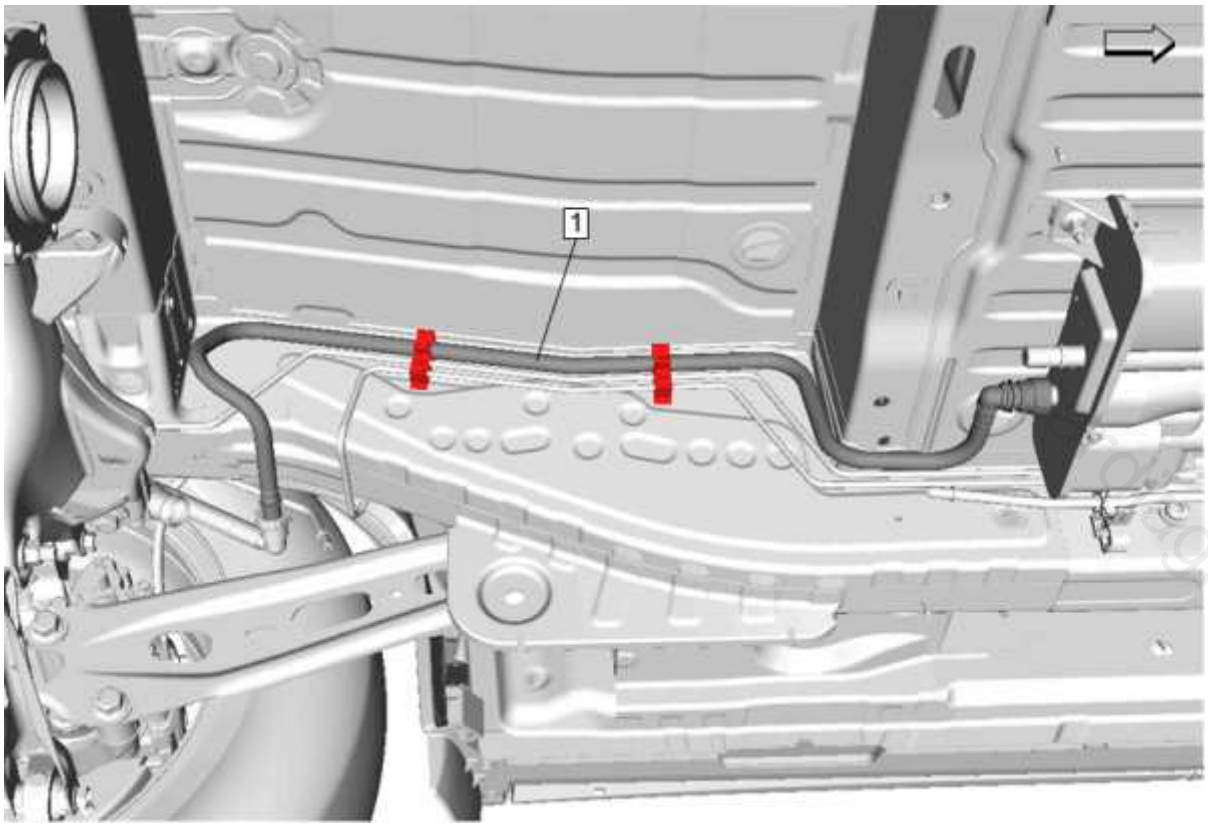

Fig. 157: Evaporative Emission Canister Filter Pipe (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedure Fuel Tank Replacement (AWD)**	
1	Evaporative Emission Canister Filter Pipe **Procedure** Disconnect the evaporative emission canister filter pipe and remove from retainers. **Plastic Collar Quick Connect Fitting Service**

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

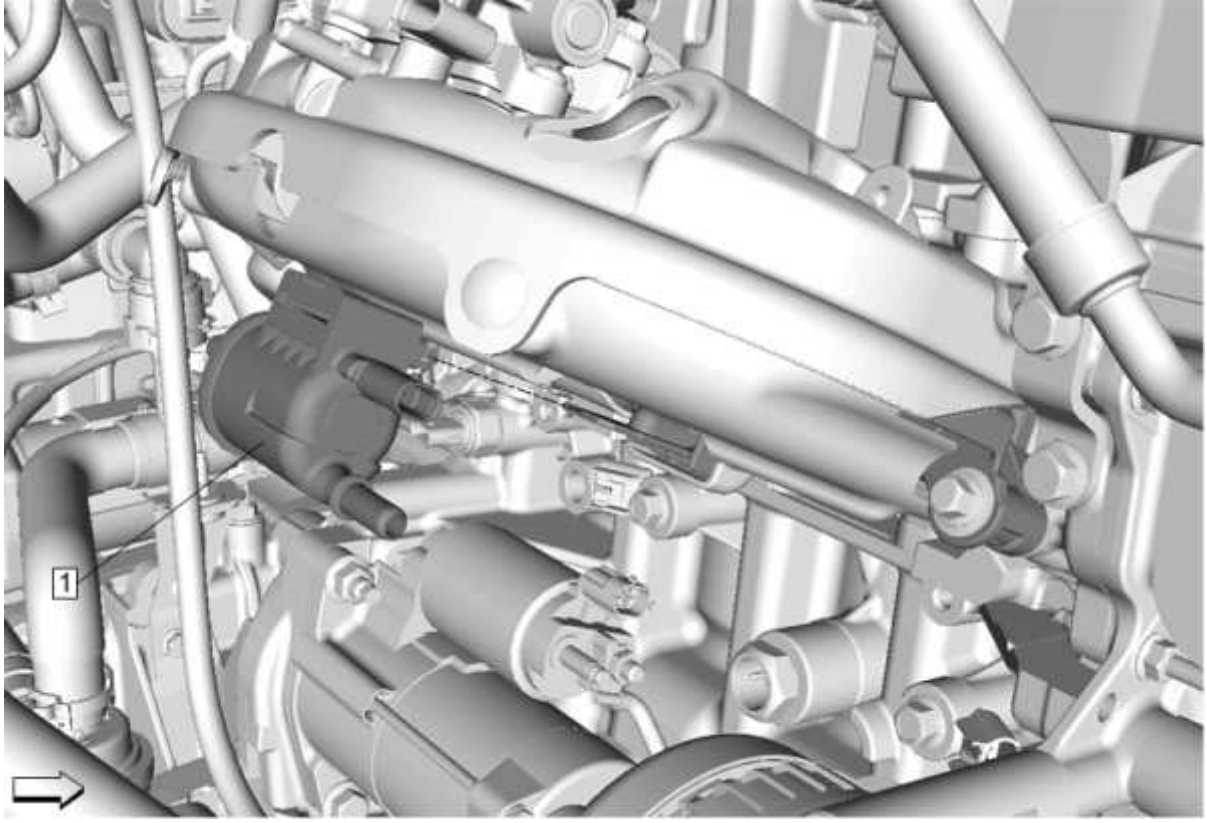

Fig. 158: Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Disconnect the evaporative emission pipe. Plastic Collar Quick Connect Fitting Service	
1	Evaporative Emission Canister Purge Solenoid Valve **Procedure** 1. Disconnect the electrical connector. 2. Release retaining tab.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE HOSE REPLACEMENT (FWD)

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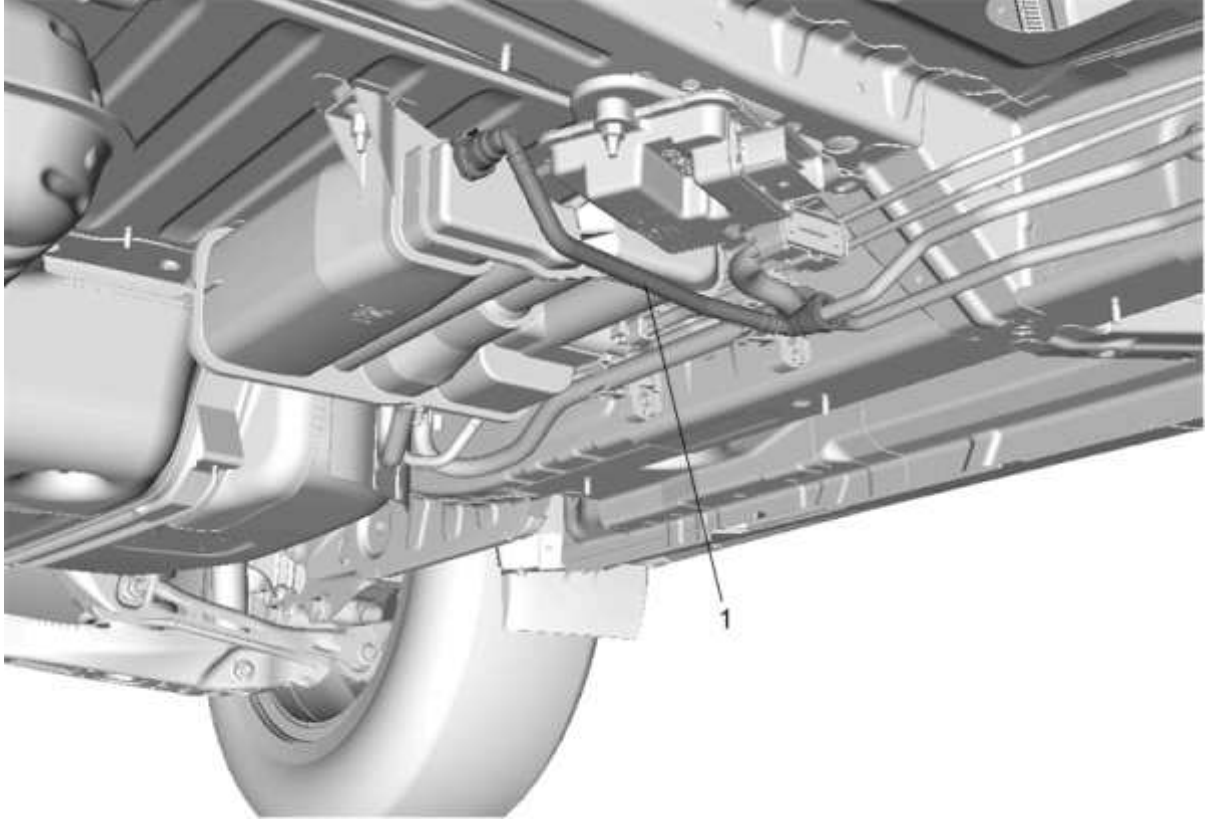

Fig. 159: Evaporative Emission Canister Purge Solenoid Valve Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Underbody Rear Air Deflector Replacement (Front Wheel Drive)	
1	Evaporative Emission Canister Purge Solenoid Valve Hose **Procedure** Disconnect the evaporative emission canister purge solenoid valve hose. Plastic Collar Quick Connect Fitting Service

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE HOSE REPLACEMENT (AWD)

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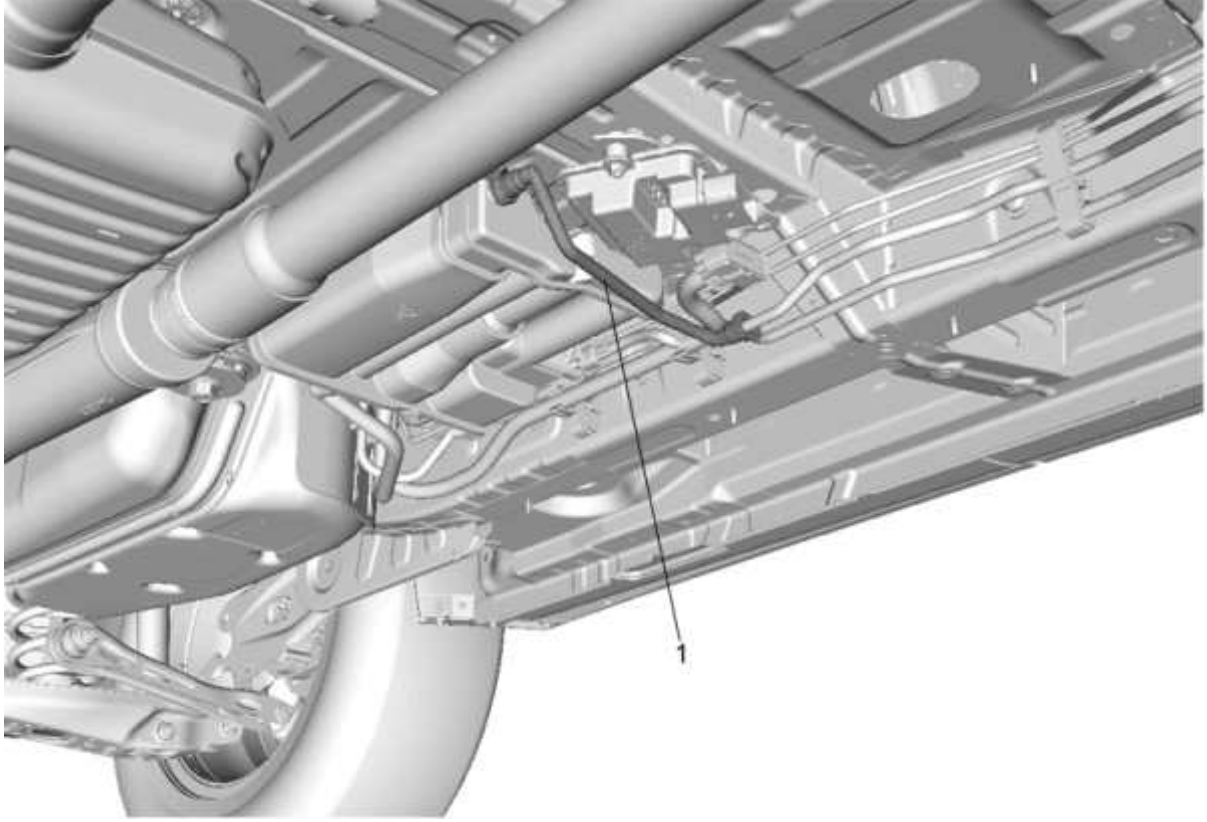

Fig. 160: Evaporative Emission Canister Purge Solenoid Valve Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Underbody Rear Air Deflector Replacement (All Wheel Drive)	
1	Evaporative Emission Canister Purge Solenoid Valve Hose **Procedure** Disconnect the evaporative emission canister purge solenoid valve hose. Plastic Collar Quick Connect Fitting Service

EVAPORATIVE EMISSION CANISTER PURGE TUBE REPLACEMENT

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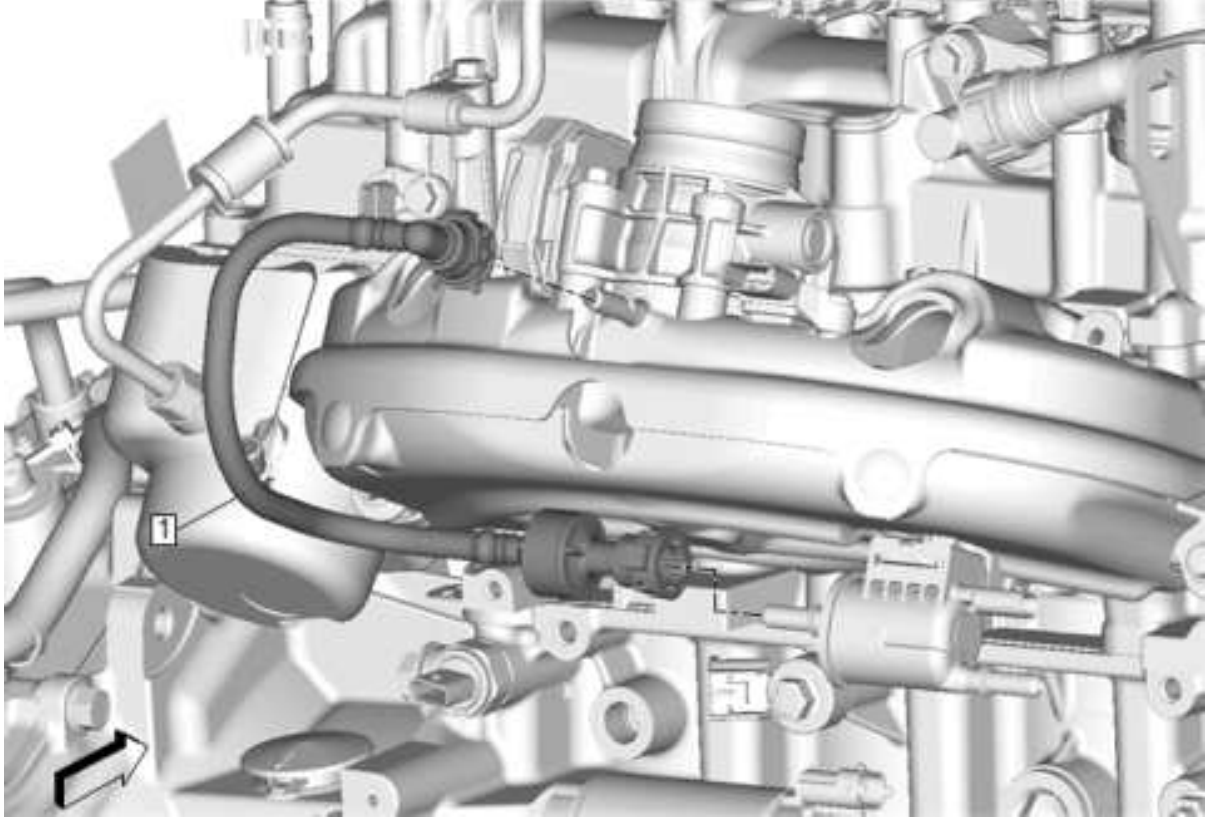

Fig. 161: Evaporative Emission Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Evaporative Emission Canister Purge Tube **Procedure** Disconnect the evaporative emission canister purge tube from the intake manifold and the evaporative emission canister purge valve. Plastic Collar Quick Connect Fitting Service

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

Fig. 162: Evaporative Emission Canister Vent Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedure Evaporative Emission Canister Replacement (FWD)Evaporative Emission Canister Replacement (AWD)**	
1	Evaporative Emission Canister Vent Solenoid Valve

EVAPORATIVE EMISSION CANISTER VENT HOSE REPLACEMENT (AT TANK FWD)

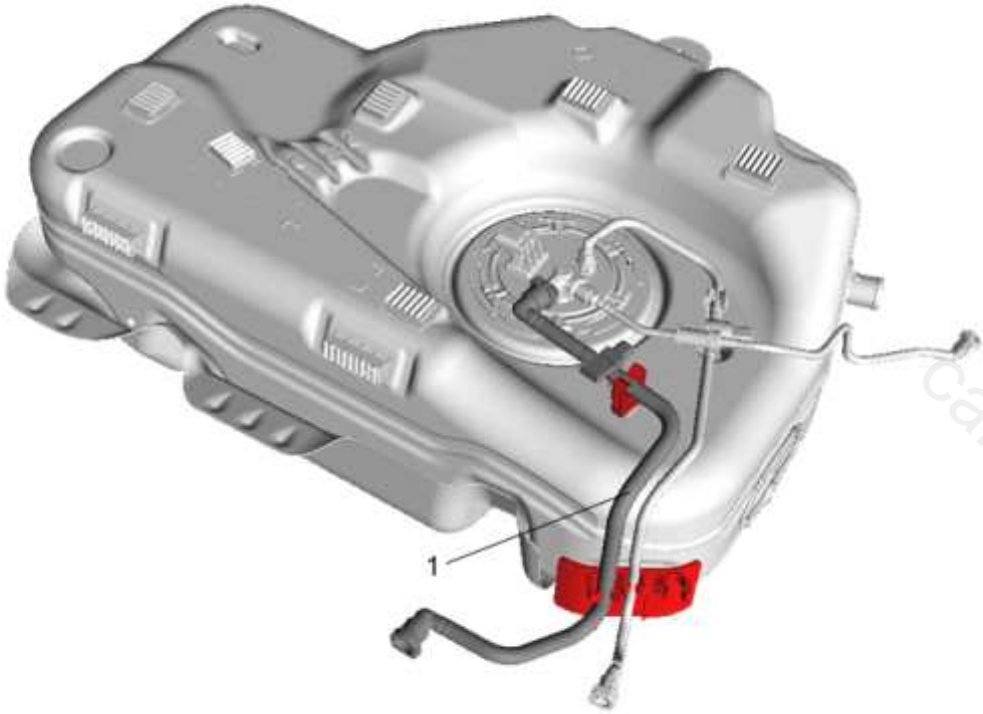

Fig. 163: Evaporative Emission Canister Vent Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedure Fuel Tank Replacement (FWD)**	
1	Evaporative Emission Canister Vent Hose **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the evaporative emission canister vent hose and remove from retainers. **Plastic Collar Quick Connect Fitting Service**

EVAPORATIVE EMISSION CANISTER VENT HOSE REPLACEMENT (AT TANK AWD)

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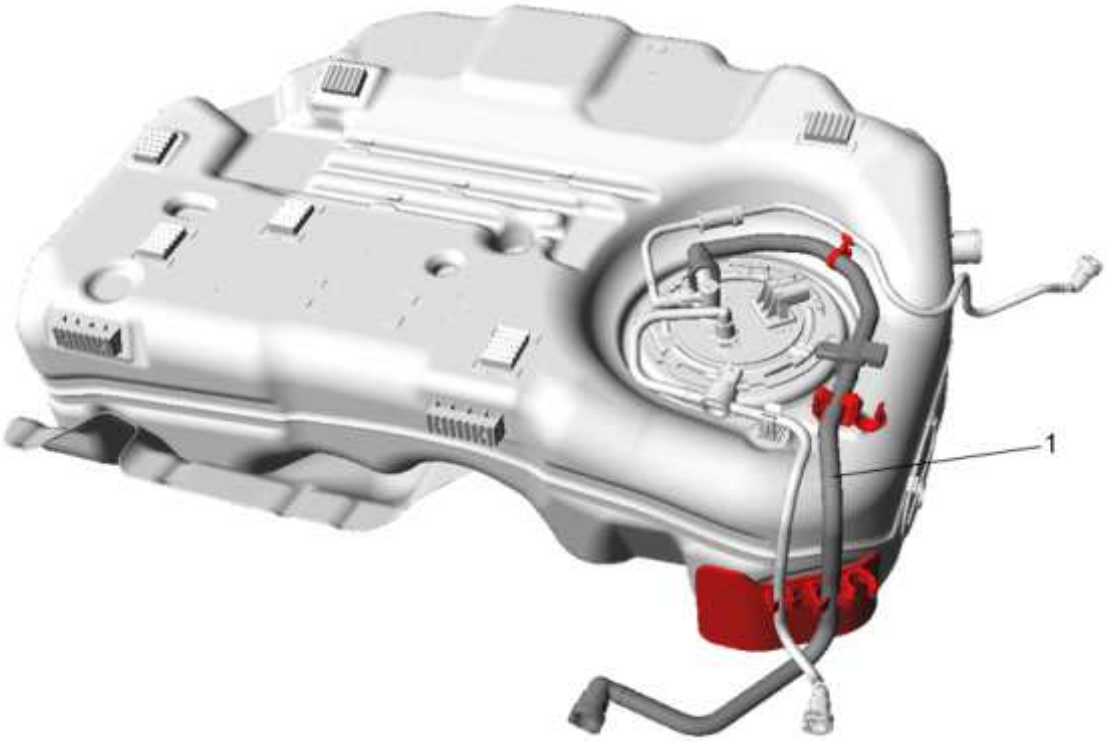

Fig. 164: Evaporative Emission Canister Vent Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Fuel Tank Replacement (AWD)	
1	Evaporative Emission Canister Vent Hose **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the evaporative emission canister vent hose and remove from retainers. Plastic Collar Quick Connect Fitting Service

EVAPORATIVE EMISSION CANISTER VENT HOSE REPLACEMENT (AT FILLER PIPE)

Removal Procedure

WARNING: Refer to Diesel/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1.
2. Remove Rear Wheelhouse Liner - Left Side -Rear Wheelhouse Liner Replacement- Left Side (Equinox) Rear Wheelhouse Liner Replacement- Left Side (Terrain)

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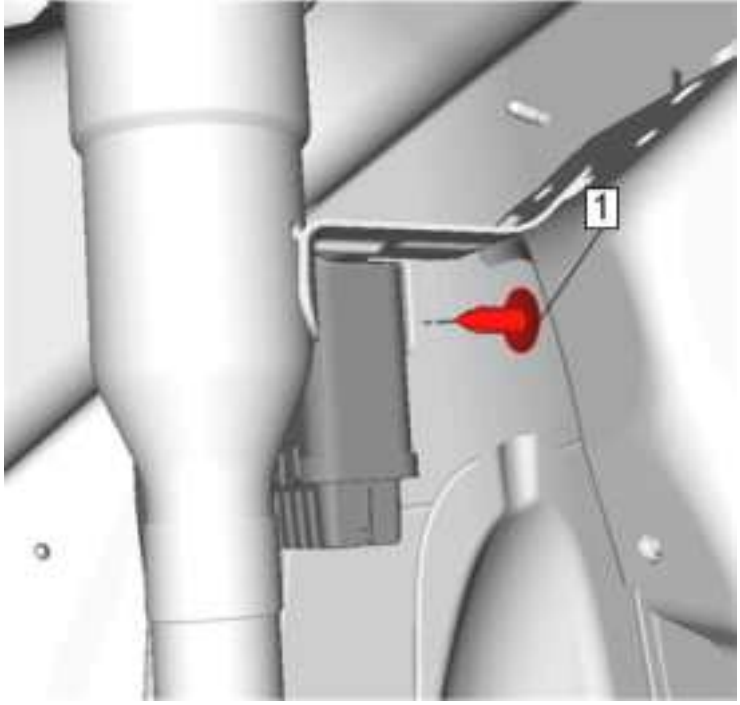

Fig. 165: Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Remove Retainer (1)

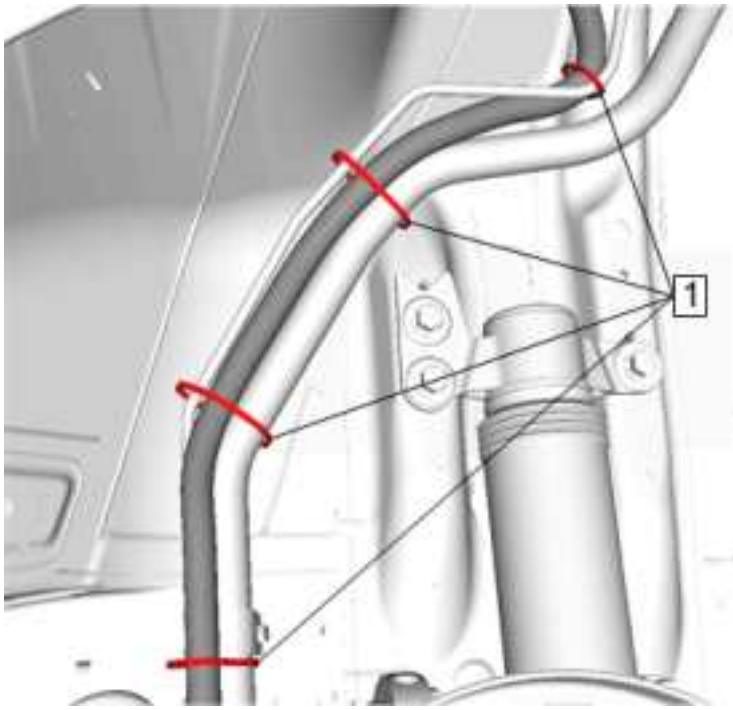

Fig. 166: Tie Strap
Courtesy of GENERAL MOTORS COMPANY

4. Remove Tie Strap (1) and DISCARD[4x]

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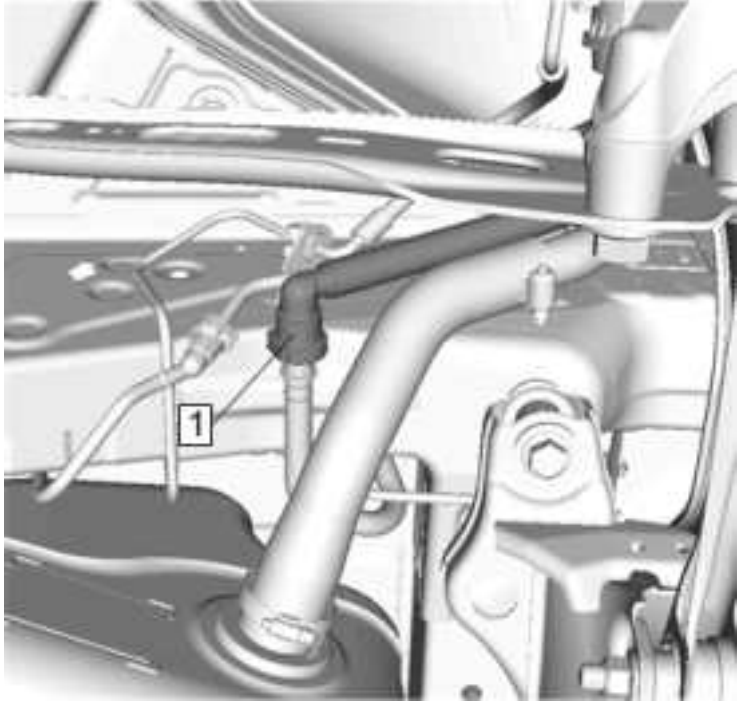

Fig. 167: Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect Evaporative Emission Canister Vent Hose (1) - **Plastic Collar Quick Connect Fitting Service**

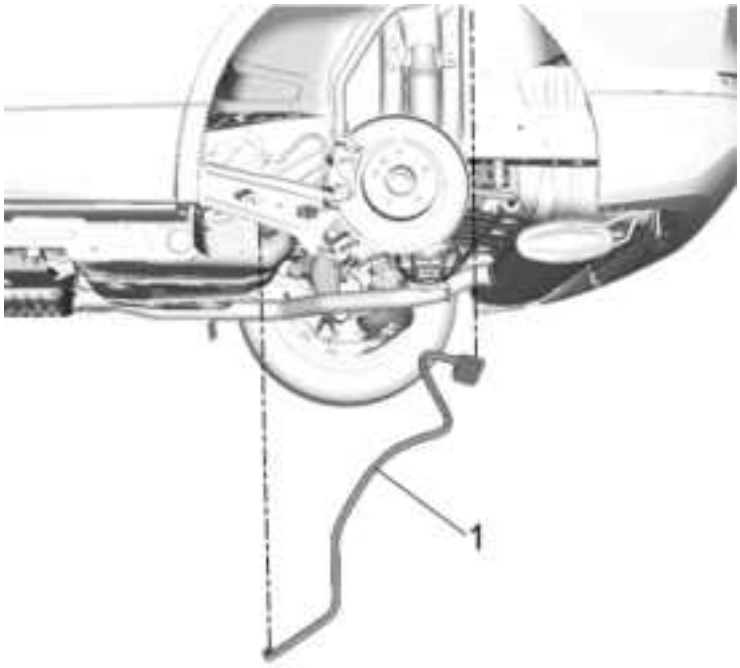

Fig. 168: Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove Evaporative Emission Canister Vent Hose (1) -

Installation Procedure

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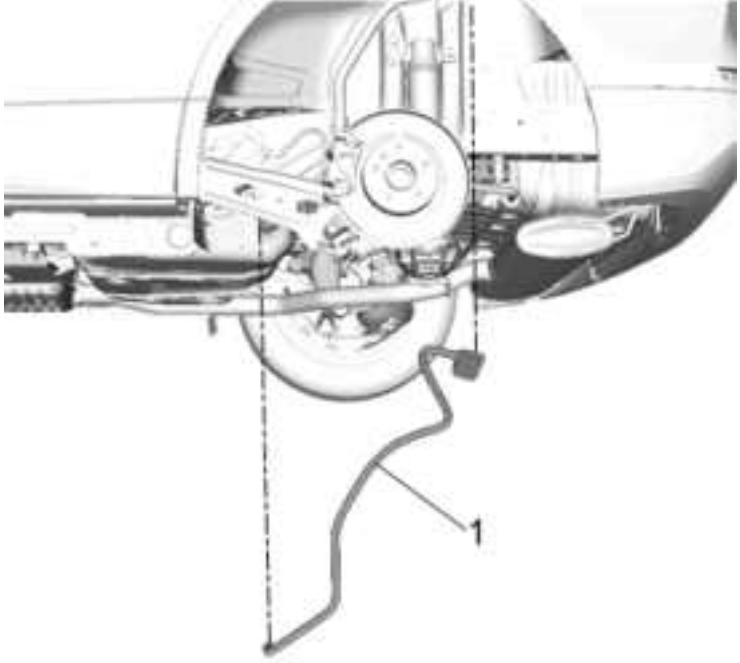

Fig. 169: Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install Evaporative Emission Canister Vent Hose (1)

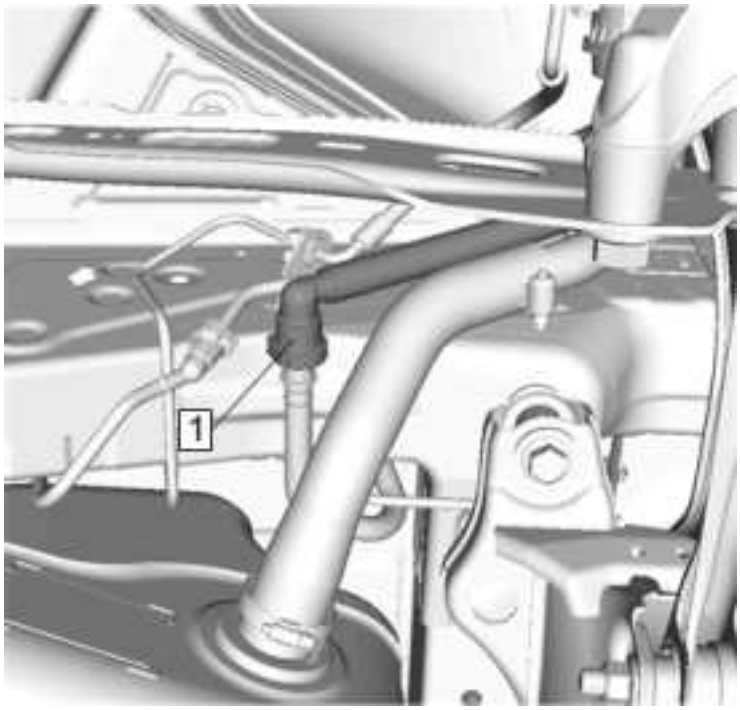

Fig. 170: Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

2. Connect Evaporative Emission Canister Vent Hose (1)**Plastic Collar Quick Connect Fitting Service**

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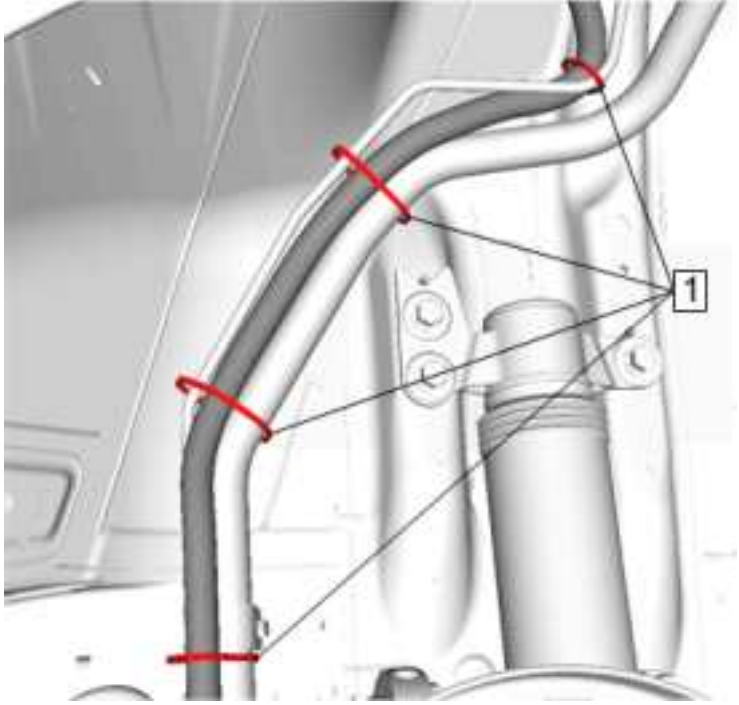

Fig. 171: Tie Strap
Courtesy of GENERAL MOTORS COMPANY

3. Install NEW Tie Strap (1) - [4x]

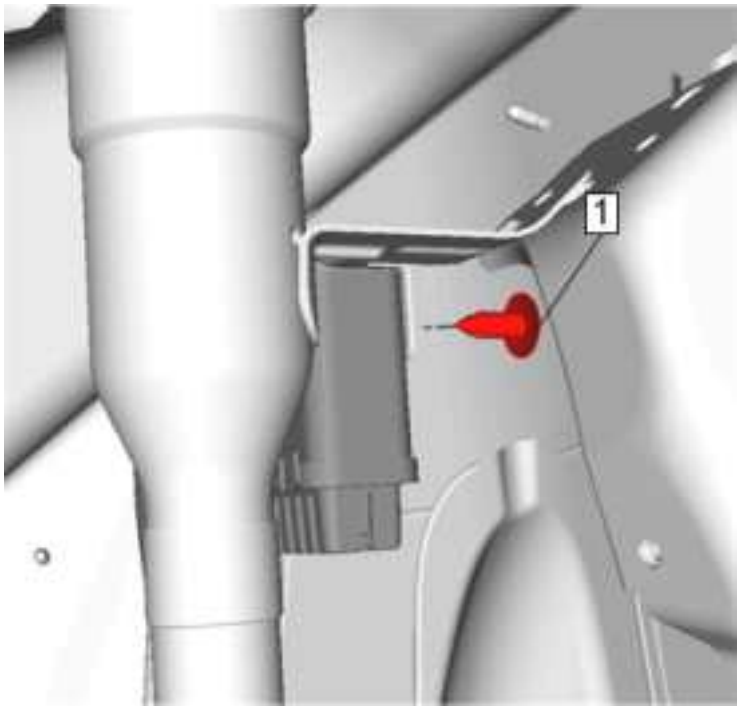

Fig. 172: Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Retainer(1) -
5. Install Rear Wheelhouse Liner - Left Side -**Rear Wheelhouse Liner Replacement- Left Side (Equinox)** **Rear Wheelhouse Liner Replacement- Left Side (Terrain)**

EVAPORATIVE EMISSION FRONT HOSE REPLACEMENT

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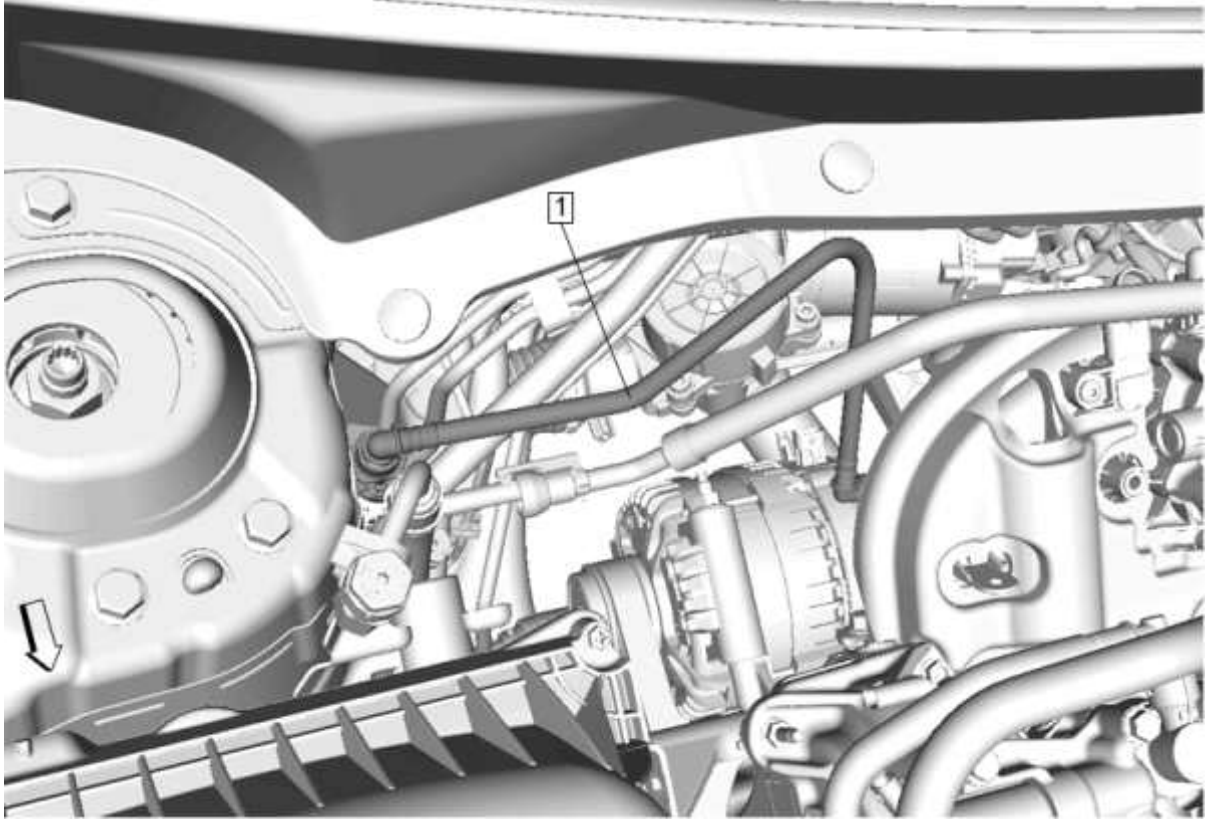

Fig. 173: Evaporative Emission Front Hose
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	**WARNING:** Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . Evaporative Emission Front Hose**Procedure** Disconnect evaporative emission front hose. Plastic Collar Quick Connect Fitting Service

EVAPORATIVE EMISSION FRONT PIPE REPLACEMENT (FWD)

Removal Procedure

WARNING: Refer to Diesel/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Remove Evaporative Emission Front Hose - Evaporative Emission Front Hose Replacement
2. Remove Exhaust Front Pipe - Exhaust Front Pipe Replacement (LYX)

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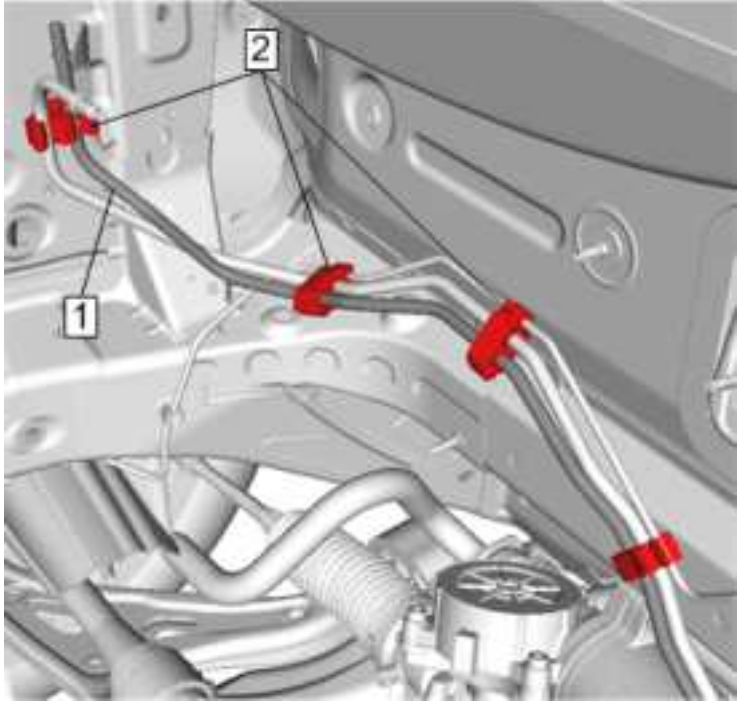

Fig. 174: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Remove Evaporative Emission Front Pipe(1)@Retainer(2) - [4x]
4. Raise and support the vehicle. **Lifting and Jacking the Vehicle** .

Fig. 175: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Remove Shield (1)

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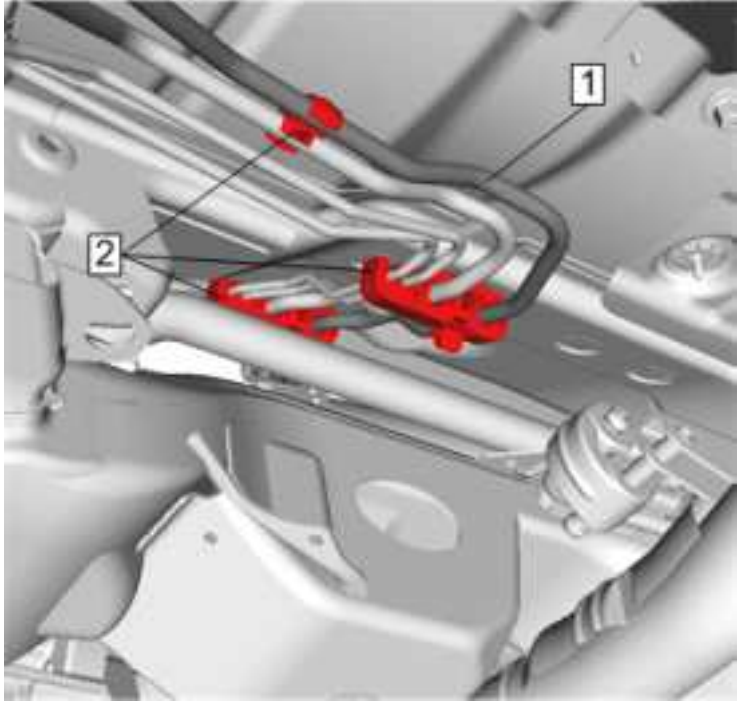

Fig. 176: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Remove Evaporative Emission Front Pipe(1)@Retainer(2) - [3x]
7. Remove Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (Front Wheel Drive)**

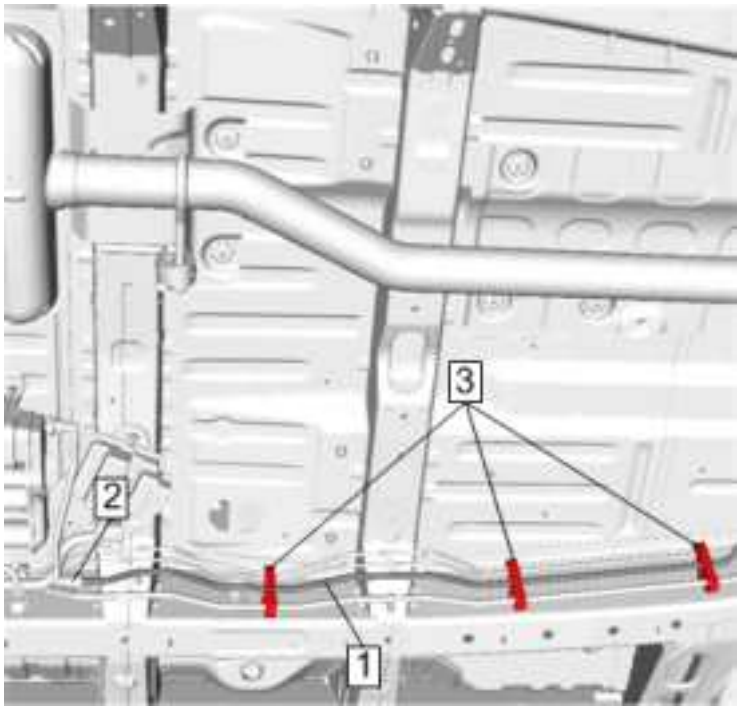

Fig. 177: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect Evaporative Emission Front Pipe(1)@Evaporative Emission Canister Purge Solenoid Valve Hose(2) - **Plastic Collar Quick Connect Fitting Service**
9. Remove Evaporative Emission Front Pipe(1)@Retainer(3) - [3x]

Installation Procedure

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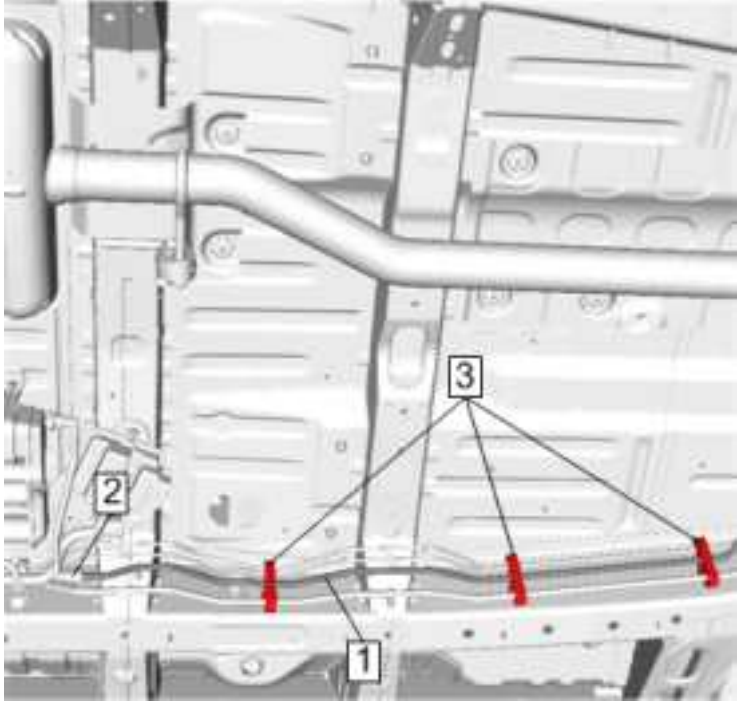

Fig. 178: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Install Evaporative Emission Front Pipe(1)@Retainer(3) - [3x]
2. Connect Evaporative Emission Front Pipe(1)@Evaporative Emission Canister Purge Solenoid Valve Hose(2) - **Plastic Collar Quick Connect Fitting Service**
3. Install Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (Front Wheel Drive)**

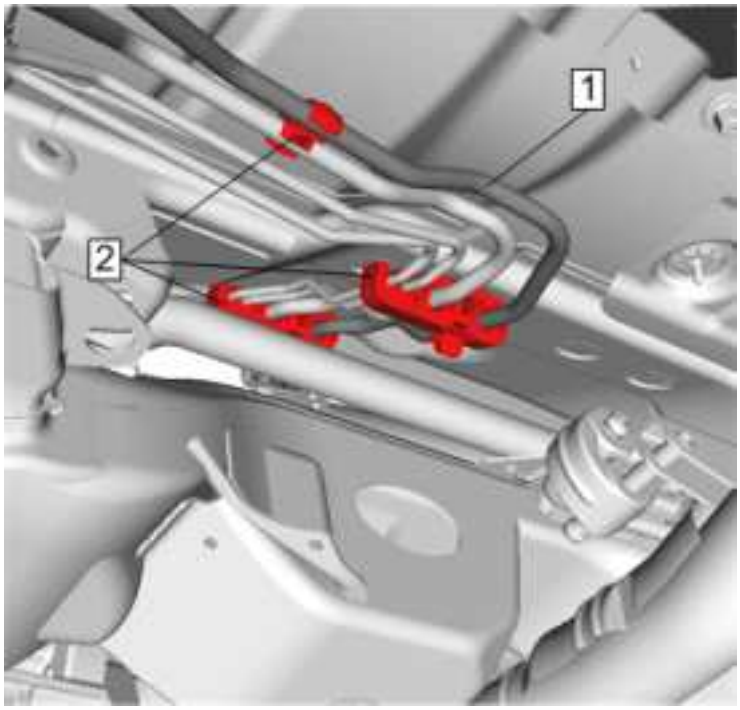

Fig. 179: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Evaporative Emission Front Pipe(1)@Retainer(2) - [3x]

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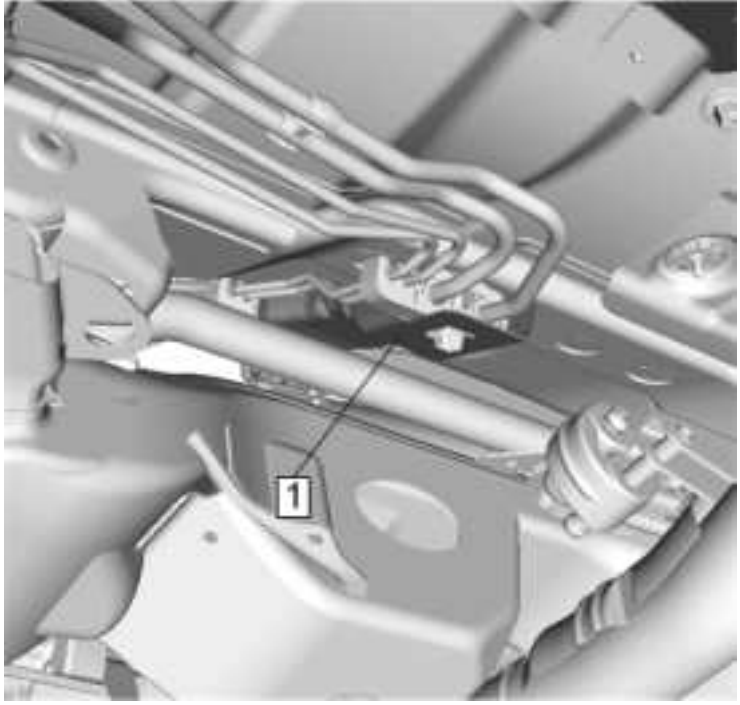

Fig. 180: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Install Shield (1)
6. Lower the vehicle.

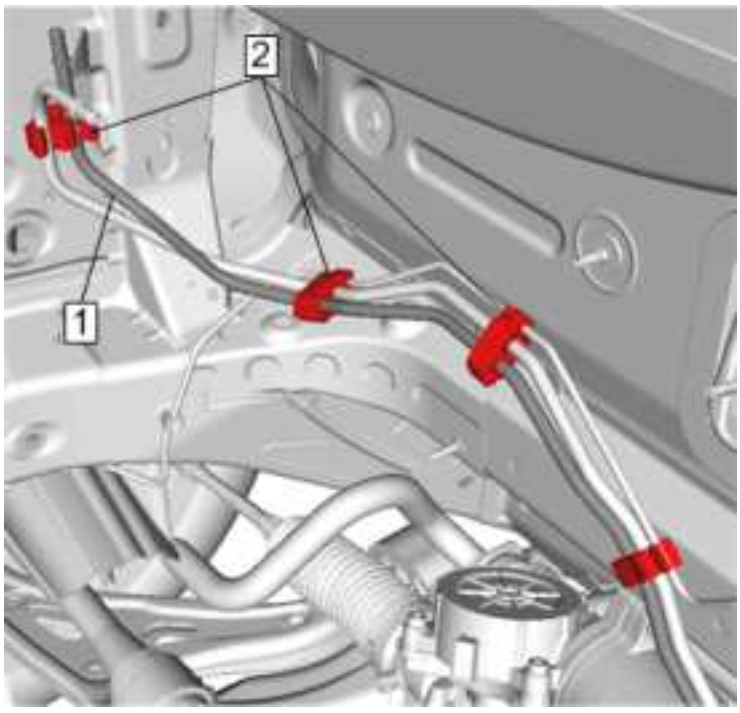

Fig. 181: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Install Evaporative Emission Front Pipe(1)@Retainer(2) - [4x]
8. Install Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LYX)**
9. Install Evaporative Emission Front Hose - **Evaporative Emission Front Hose Replacement**

EVAPORATIVE EMISSION FRONT PIPE REPLACEMENT (AWD)

Removal Procedure

WARNING: Refer to **Diesel/Gasoline Vapors Warning** .

WARNING: Refer to **Safety Glasses Warning** .

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1. Remove Evaporative Emission Front Hose - **Evaporative Emission Front Hose Replacement**

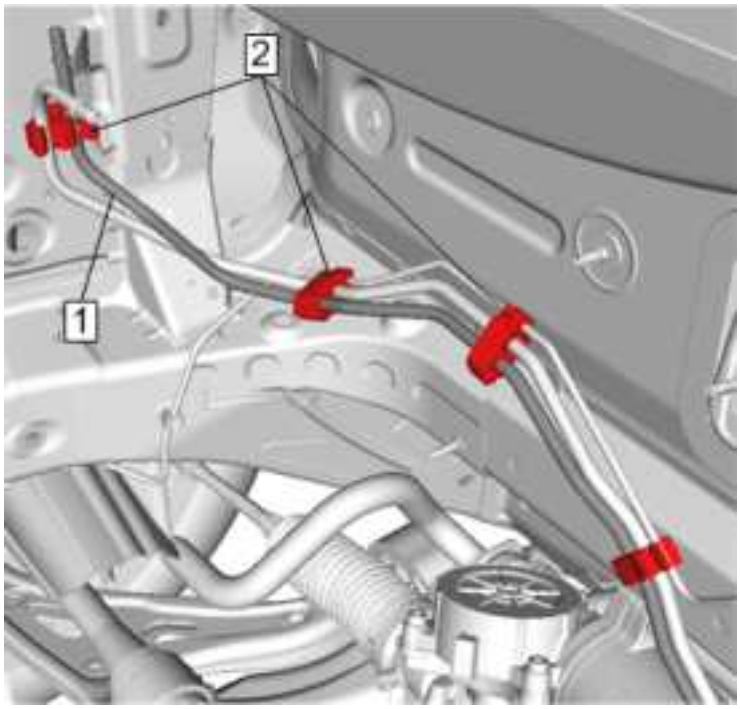

Fig. 182: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Remove Evaporative Emission Front Pipe(1)@Retainer(2) - [4x]
3. Raise and support the vehicle. **Lifting and Jacking the Vehicle** .

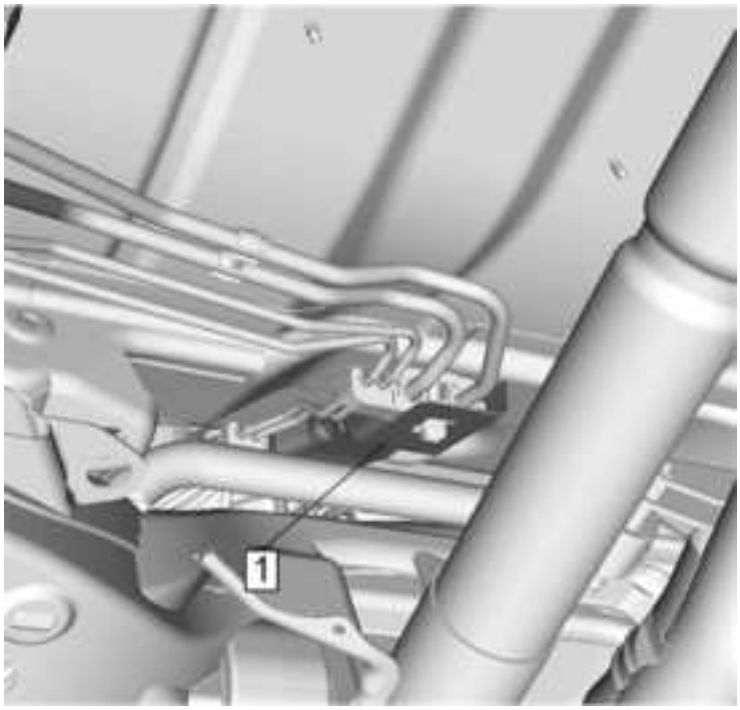

Fig. 183: Shield
Courtesy of GENERAL MOTORS COMPANY

4. Remove Shield (1) -

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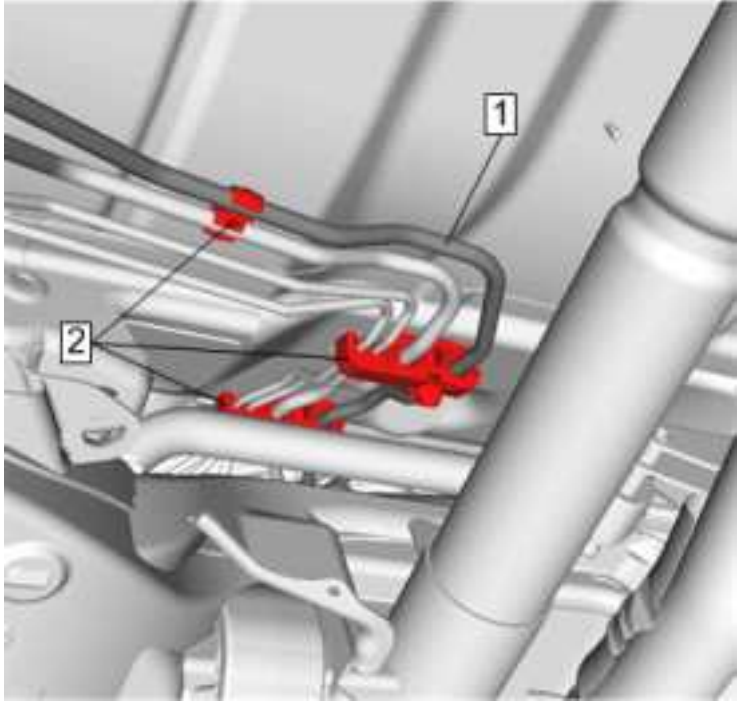

Fig. 184: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove Evaporative Emission Front Pipe(1)@Retainer(2) - [3x]
6. Remove Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (All Wheel Drive)**

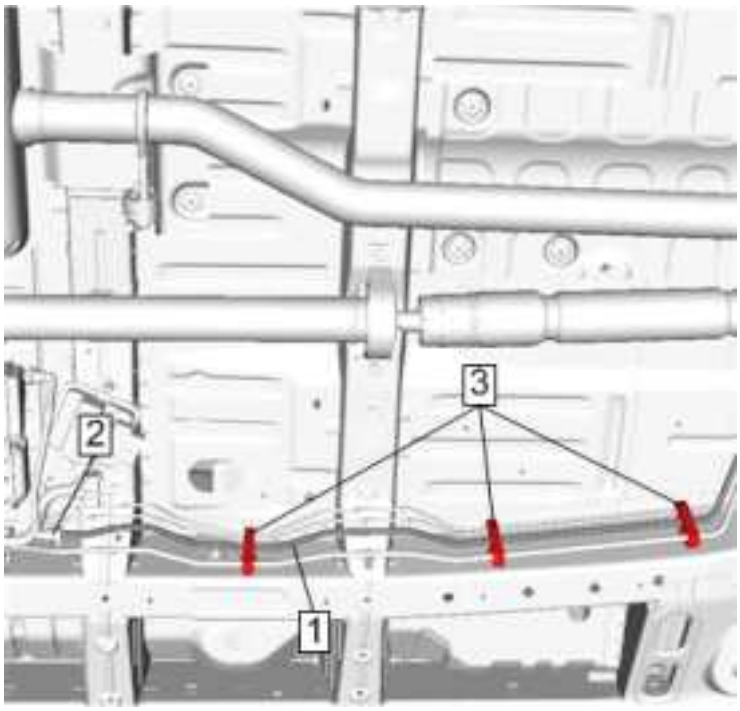

Fig. 185: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Evaporative Emission Front Pipe(1)@Evaporative Emission Canister Purge Solenoid Valve Hose(2) - **Plastic Collar Quick Connect Fitting Service**
8. Remove Evaporative Emission Front Pipe(1)@Retainer(3) - [3x]

Installation Procedure

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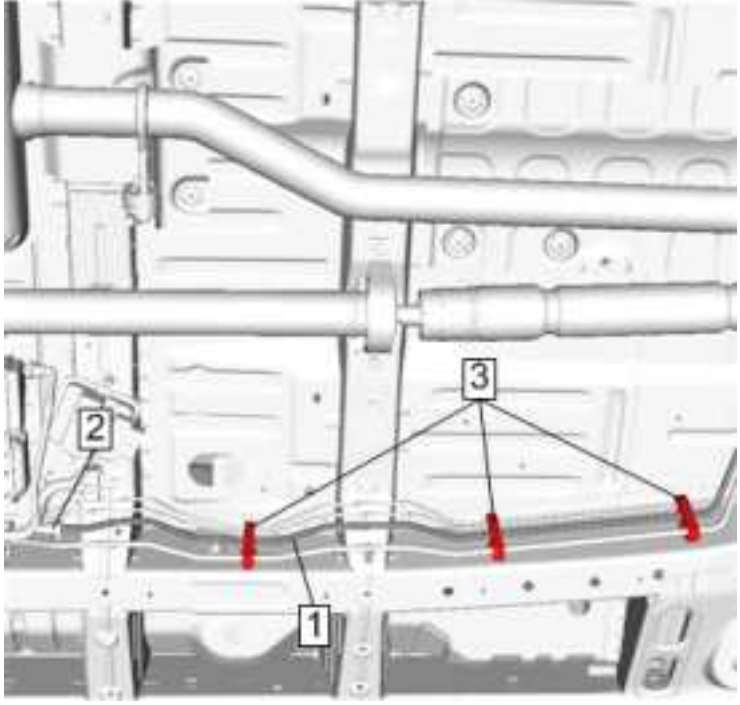

Fig. 186: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Install Evaporative Emission Front Pipe(1)@Retainer(3) - [3x]
2. Connect Evaporative Emission Front Pipe(1)@Evaporative Emission Canister Purge Solenoid Valve Hose(2) - **Plastic Collar Quick Connect Fitting Service**
3. Install Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (All Wheel Drive)**

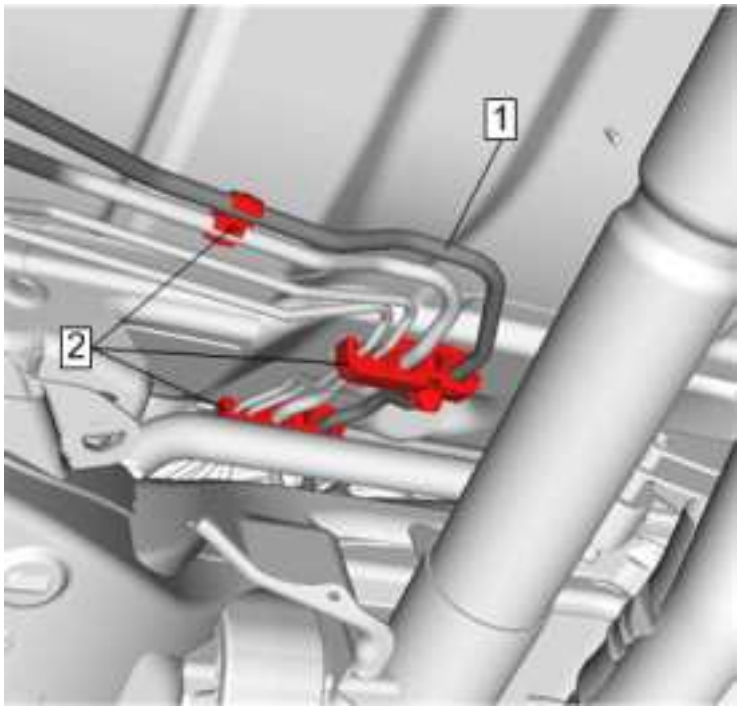

Fig. 187: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Evaporative Emission Front Pipe(1)@Retainer(2) - [3x]

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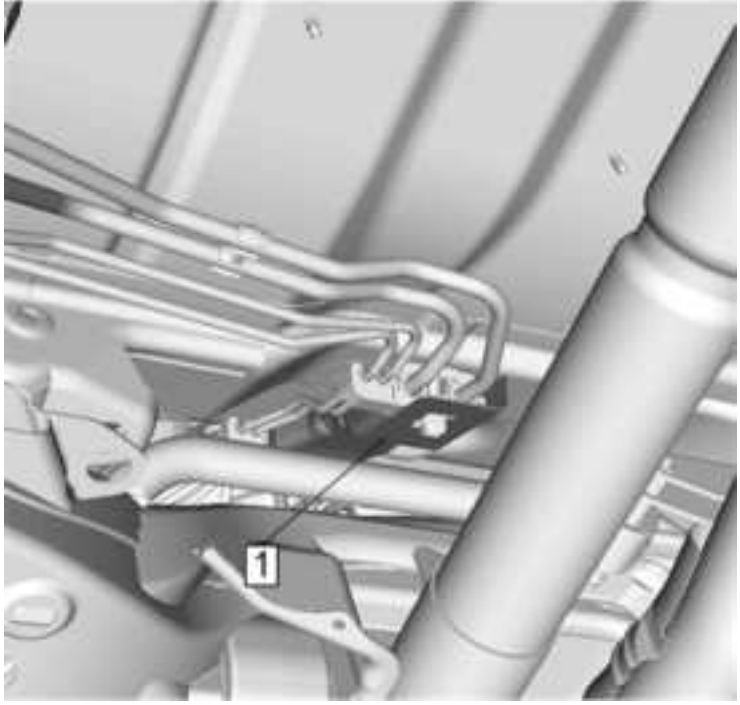

Fig. 188: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Install Shield (1)
6. Lower the vehicle.

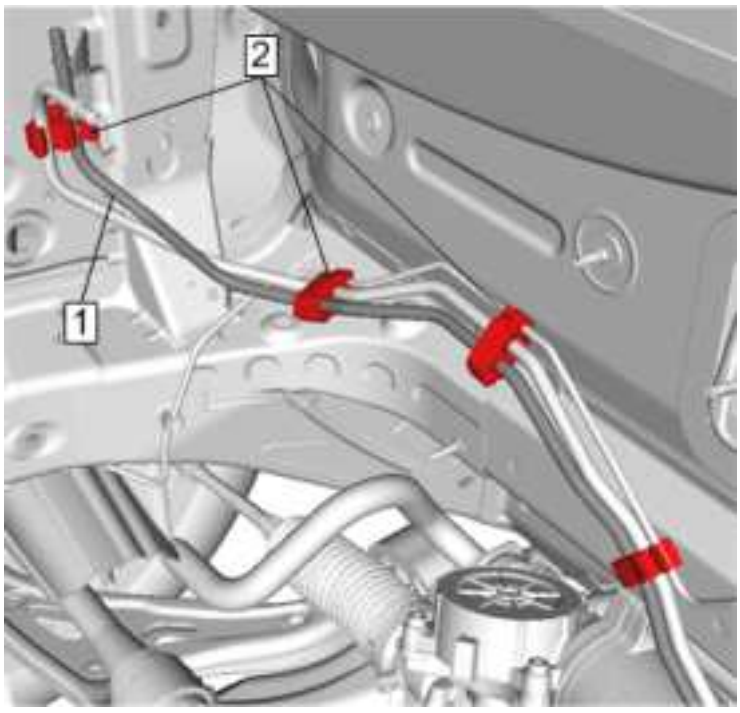

Fig. 189: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Install Evaporative Emission Front Pipe(1)@Retainer(2) - [4x]
8. Install Evaporative Emission Front Hose - **Evaporative Emission Front Hose Replacement**

IGNITION COIL REPLACEMENT

Removal Procedure

1. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**
2. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

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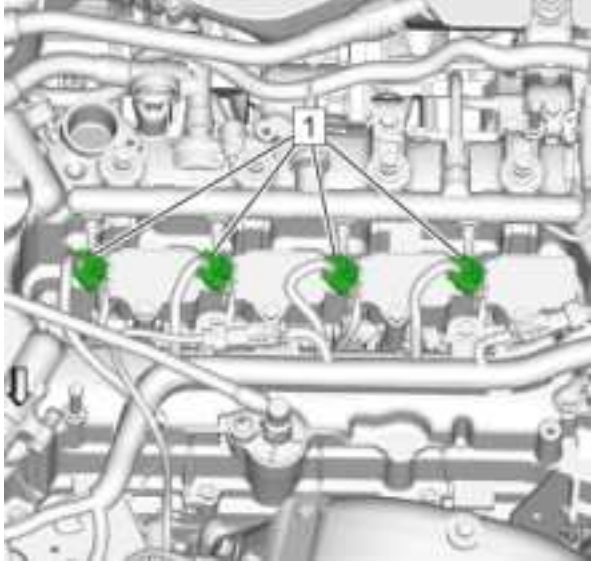

Fig. 190: Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the electrical connectors (1).

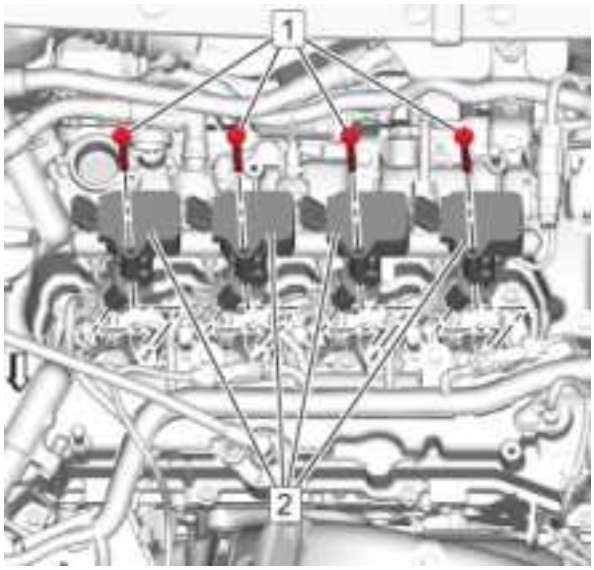

Fig. 191: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the ignition coil bolts (1).
5. Remove the ignition coils (2).

Installation Procedure

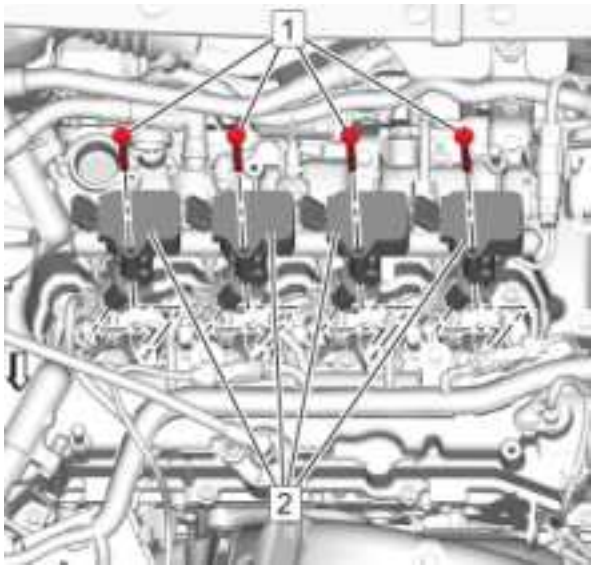

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Fig. 192: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coils (2).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolts (1) and tighten to 10 N.m (89 lb in).

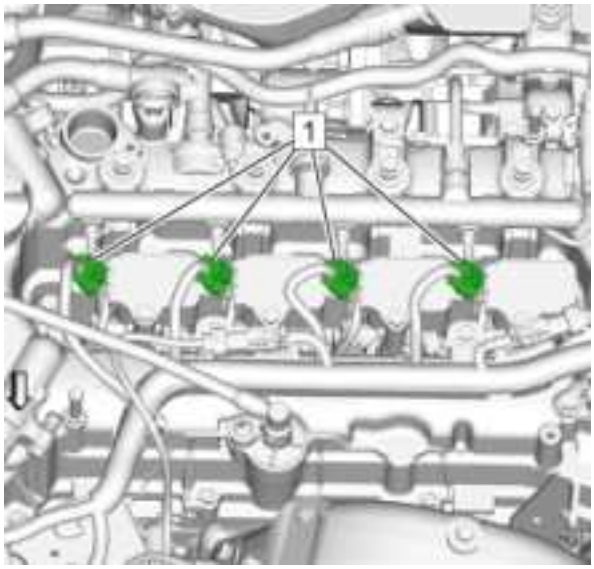

Fig. 193: Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

NOTE: The ignition coil wiring harness cylinders 1 and 3 are marked white.

3. Connect the electrical connectors (1).
4. Connect the battery negative cable. Battery Negative Cable Disconnection and Connection (KL9)
5. Install Intake Manifold Cover - Intake Manifold Cover Replacement

SPARK PLUG INSPECTION

Spark Plug Usage

1. Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to Ignition System Specifications for the correct spark plug.
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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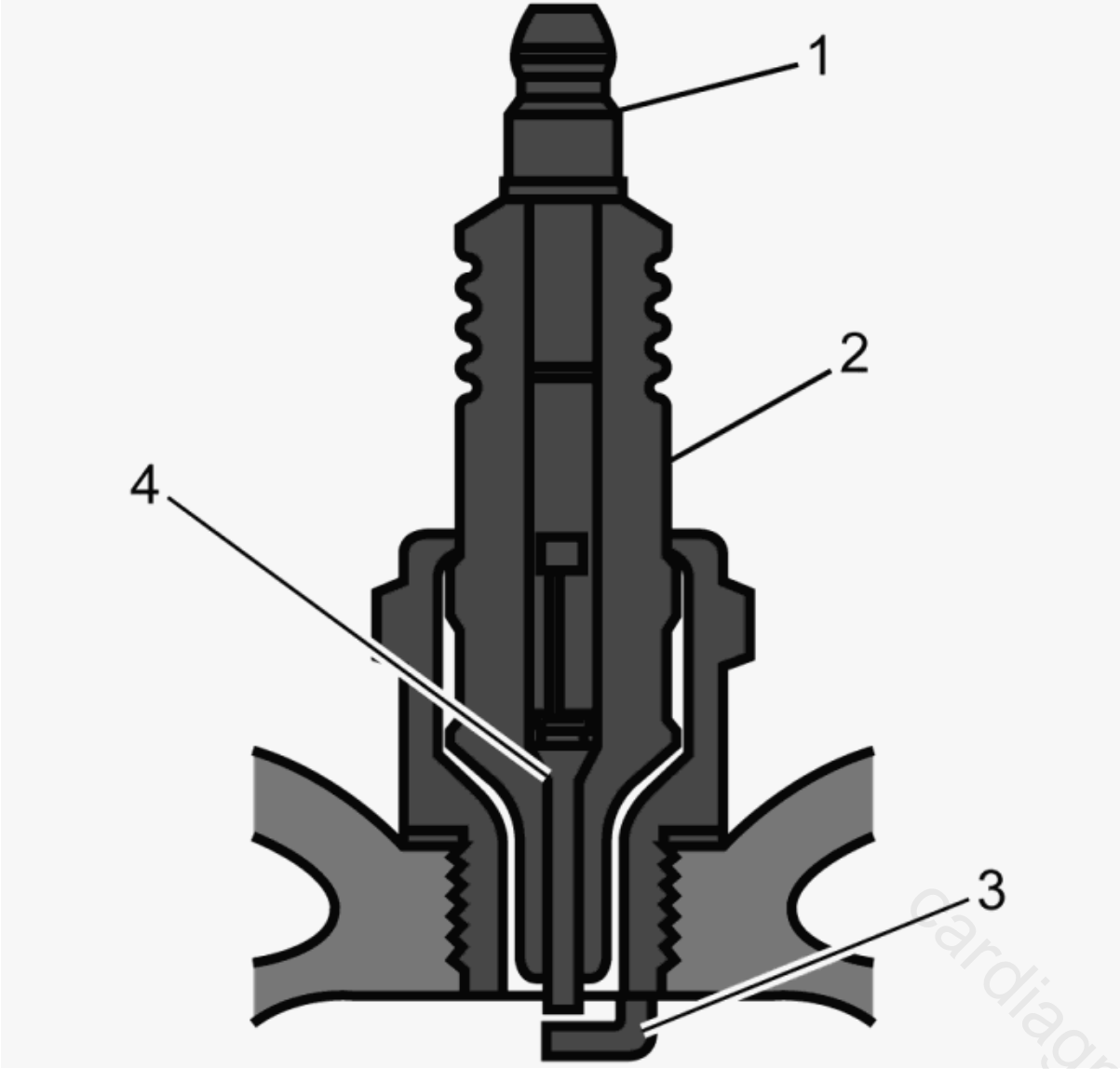

Fig. 194: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

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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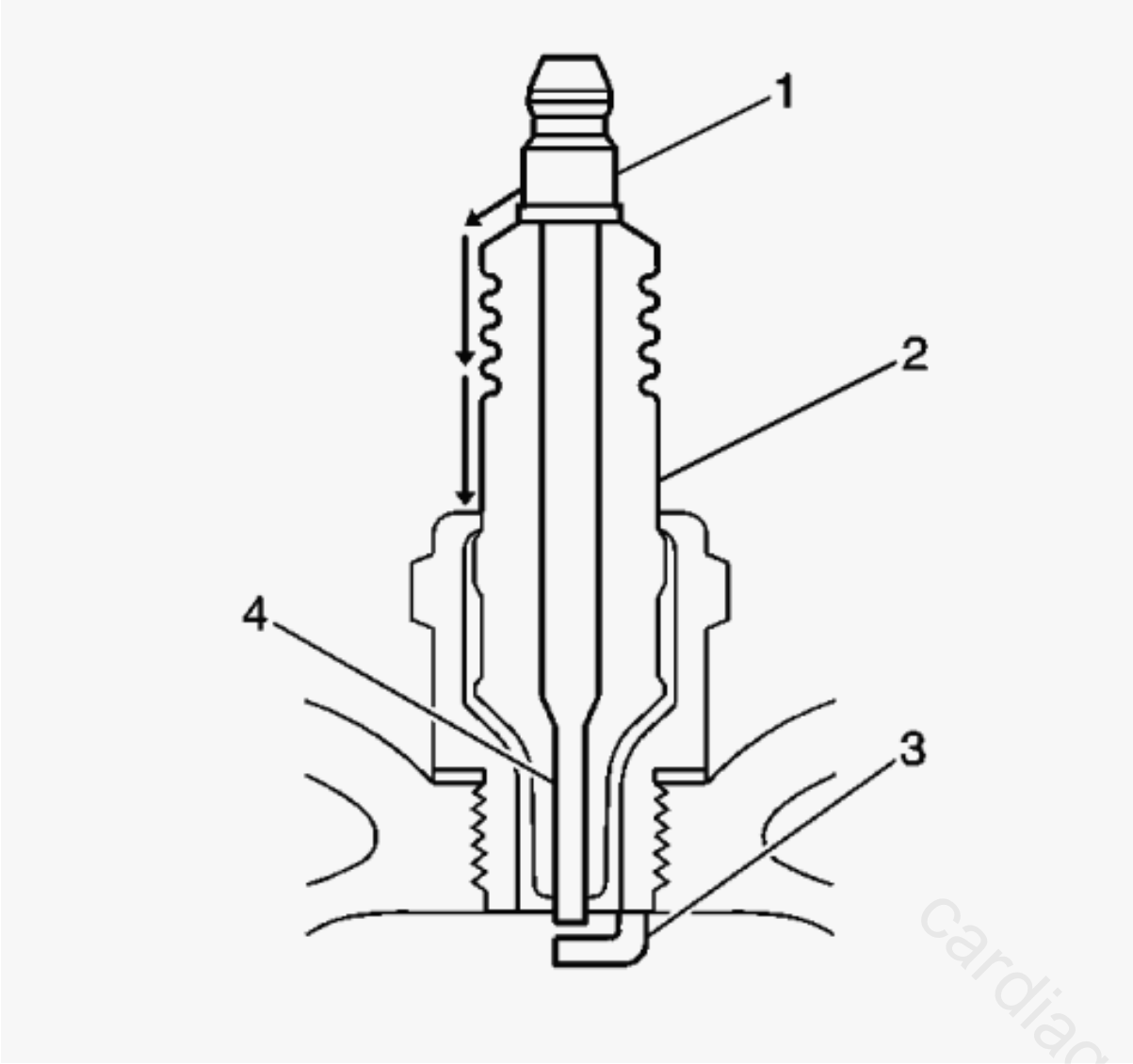

Fig. 195: Inspecting Spark Plug For Flashover Or Carbon Tracking Soot
Courtesy of GENERAL MOTORS COMPANY

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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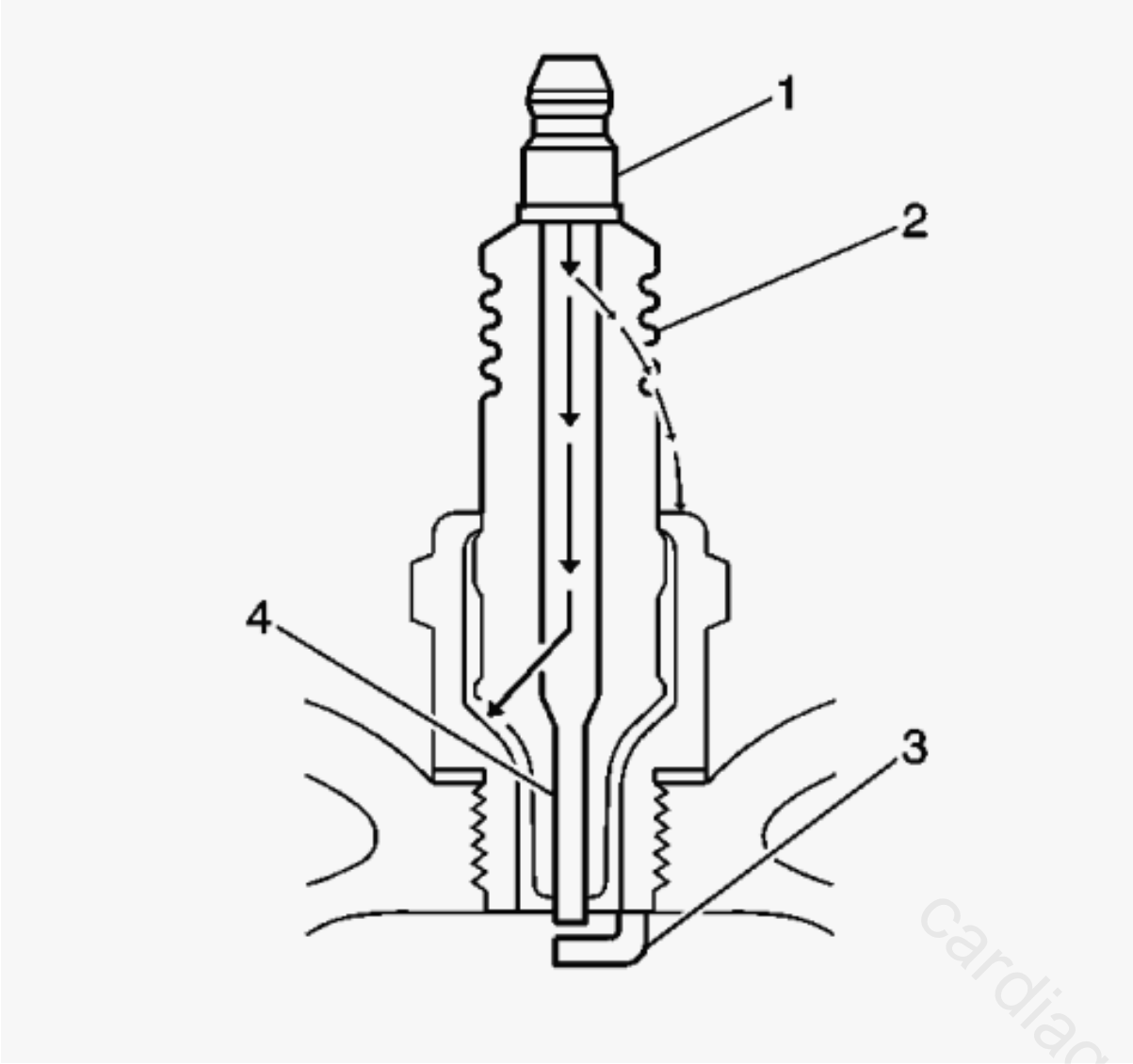

Fig. 196: Inspecting Spark Plug Insulator
Courtesy of GENERAL MOTORS COMPANY

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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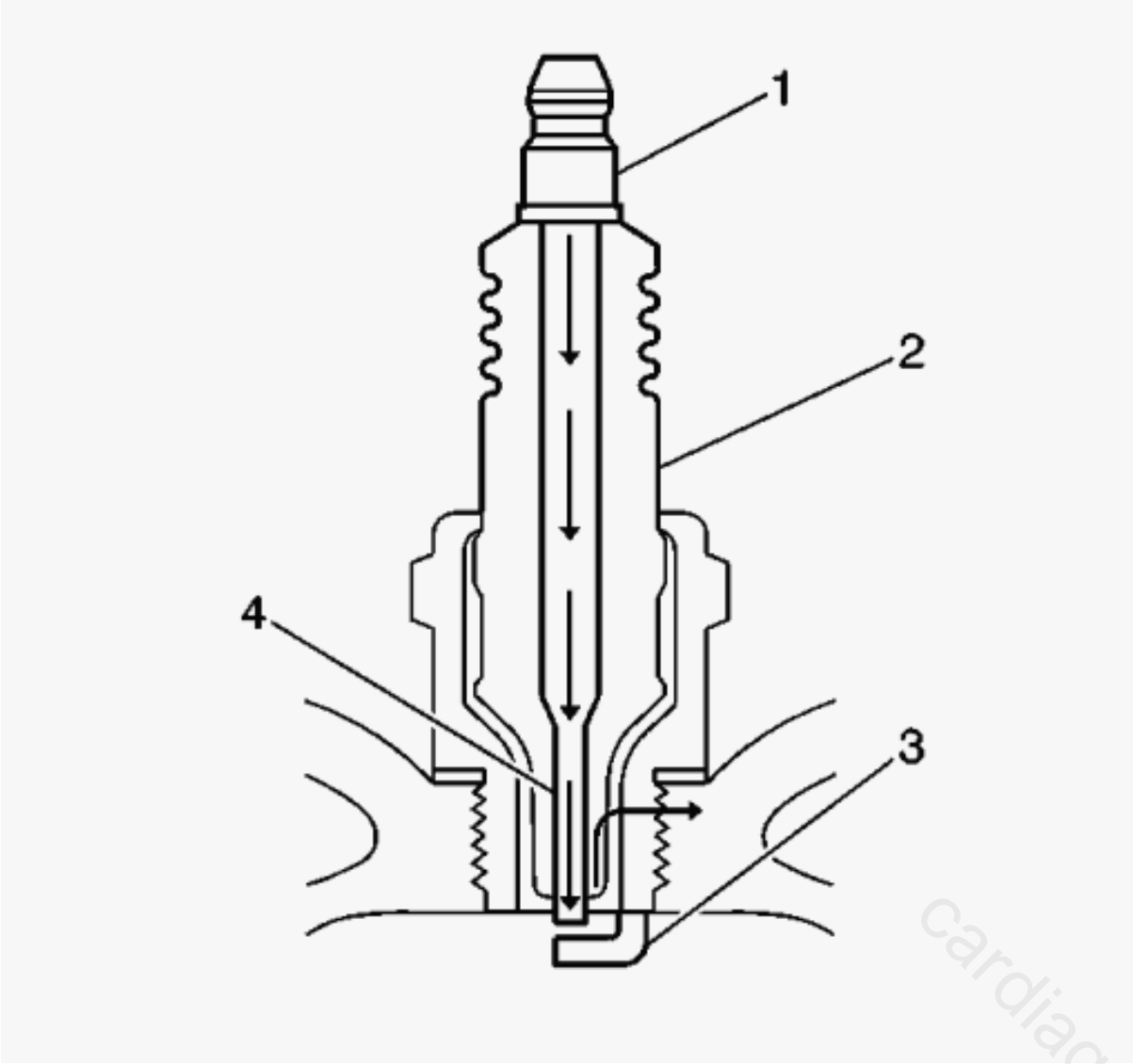

Fig. 197: Cutaway/Description View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

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. 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.
    - 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:

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- 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

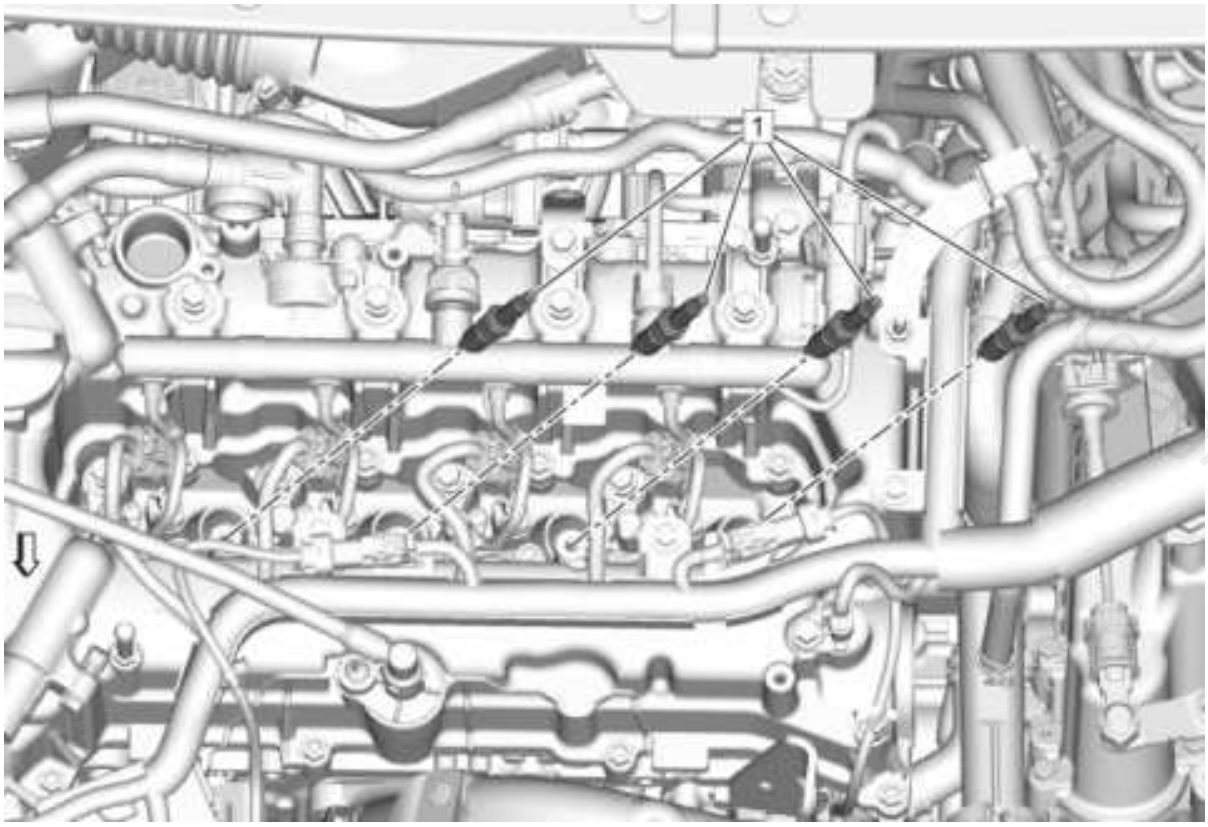

Fig. 198: Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Ignition Coil Replacement	
1	Spark Plug[4x] **CAUTION:** **Refer to:**Component Fastener Tightening Caution **Tighten** 17 N.m (13 lb ft)

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REPLACEMENT - INTAKE

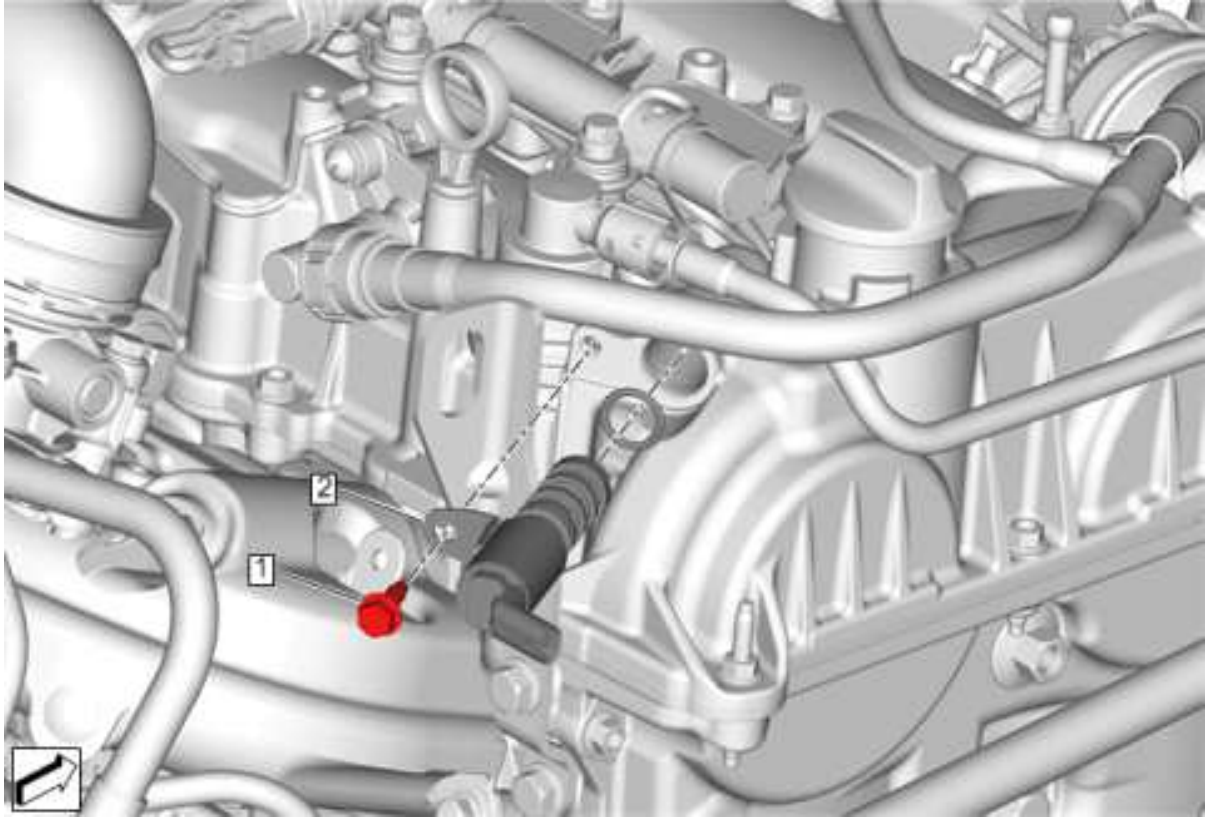

Fig. 199: Camshaft Position Actuator Solenoid Valve - Intake
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Intake Manifold Cover Replacement	
1	Camshaft Position Actuator Solenoid Valve Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve **Procedure** 1. Disconnect the electrical connector. 2. Install a NEW O-ring seal.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REPLACEMENT - EXHAUST

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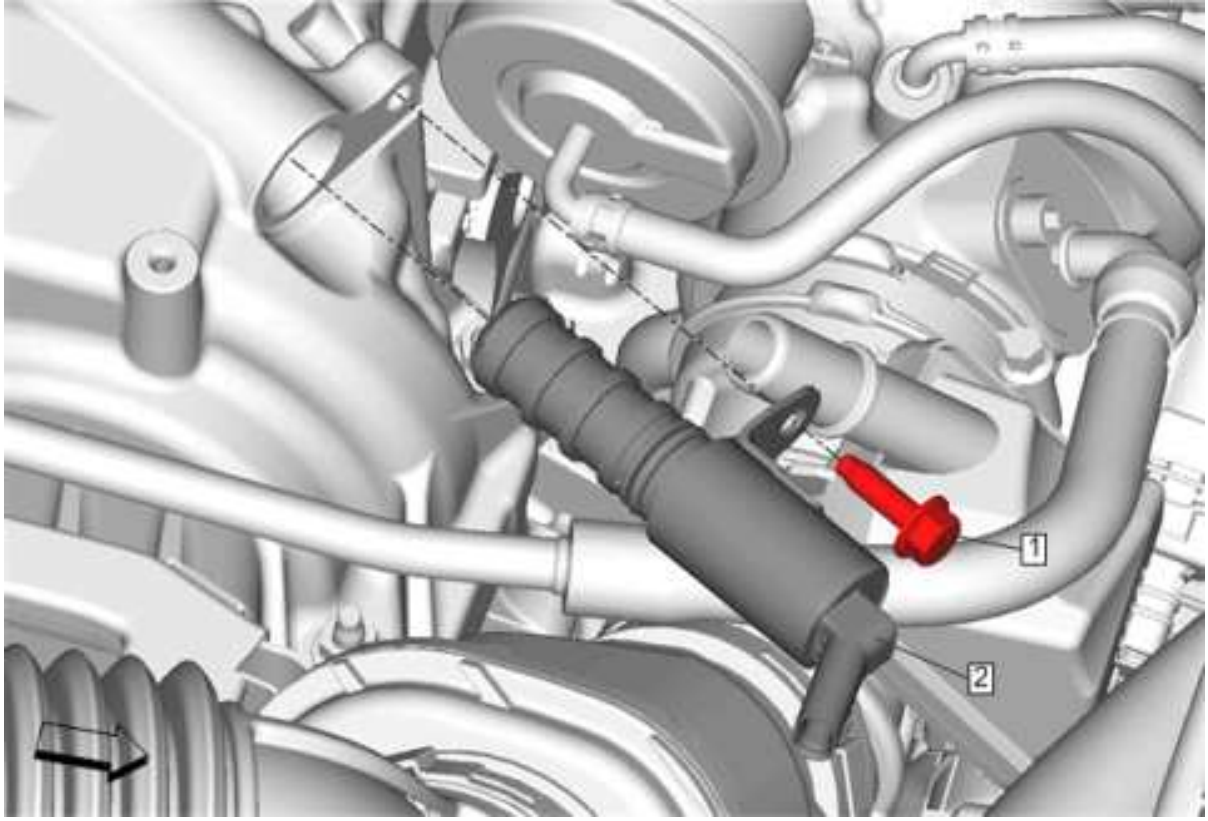

Fig. 200: Camshaft Position Actuator Solenoid Valve - Exhaust
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Intake Manifold Cover Replacement	
1	Camshaft Position Actuator Solenoid Valve Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve **Procedure** 1. Disconnect the electrical connector. 2. Install a NEW seal if reinstalling the solenoid valve.

CRANKSHAFT POSITION SENSOR REPLACEMENT (FWD)

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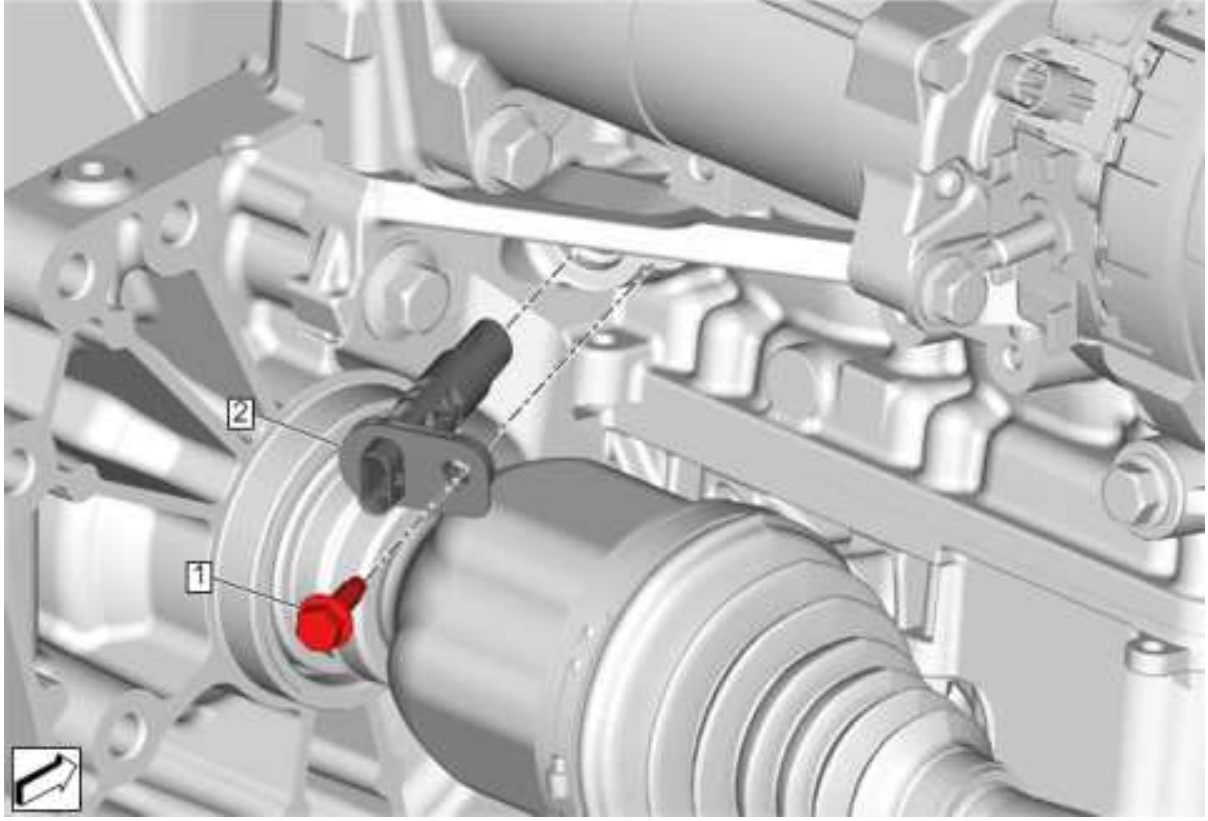

Fig. 201: Crankshaft Position Sensor (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Disconnect the battery negative cable. Battery Negative Cable Disconnection and Connection (KL9) 2. Raise and support the vehicle. Lifting and Jacking the Vehicle 3. Disconnect the electrical connector.	
1	Crankshaft Position Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Crankshaft Position Sensor **Procedure** Perform the crankshaft position variation learn. Crankshaft Position Variation Learn

CRANKSHAFT POSITION SENSOR REPLACEMENT (AWD)

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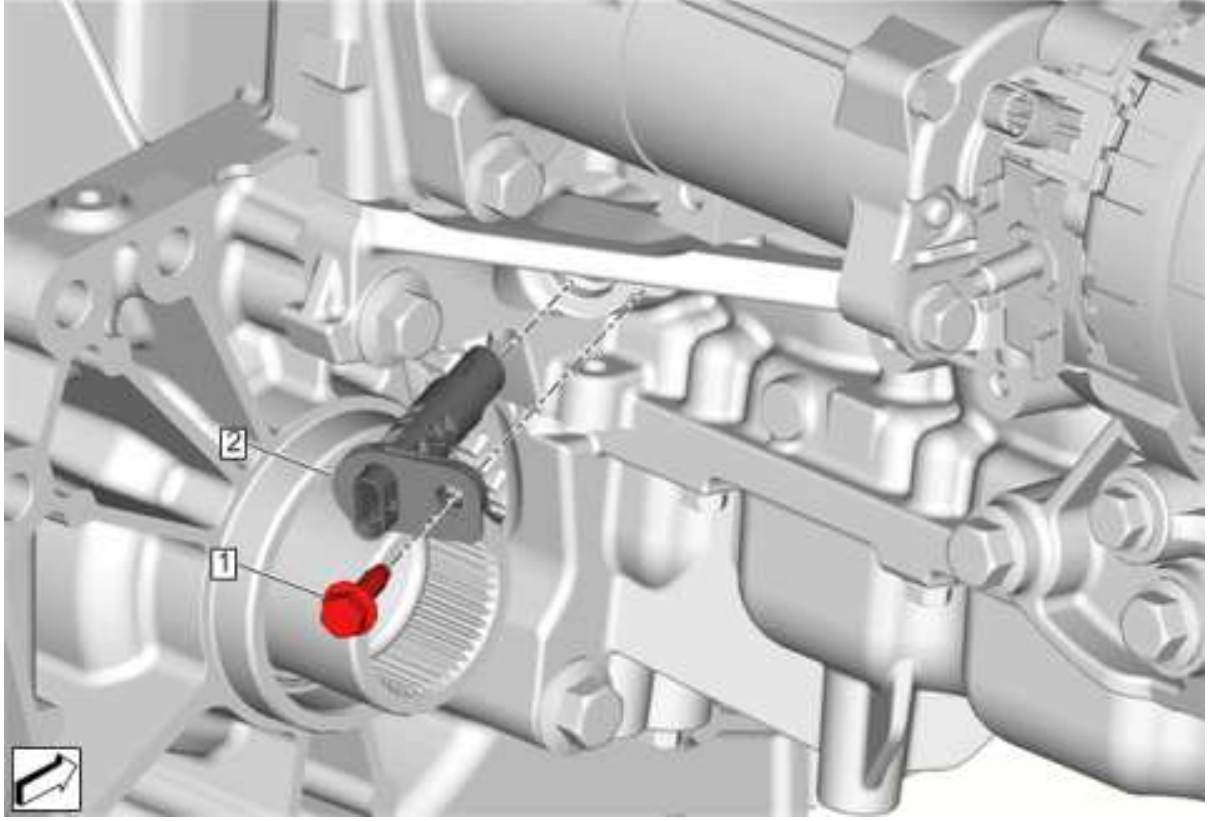

Fig. 202: Crankshaft Position Sensor (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Disconnect the battery negative cable. Battery Negative Cable Disconnection and Connection (KL9) 2. Power Transfer Unit Case Replacement (MNH Transmission with LYX Engine) 3. Disconnect the electrical connector.	
1	Crankshaft Position Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Crankshaft Position Sensor **Procedure** Perform the crankshaft position variation learn. Crankshaft Position Variation Learn

CAMSHAFT POSITION SENSOR REPLACEMENT - INTAKE

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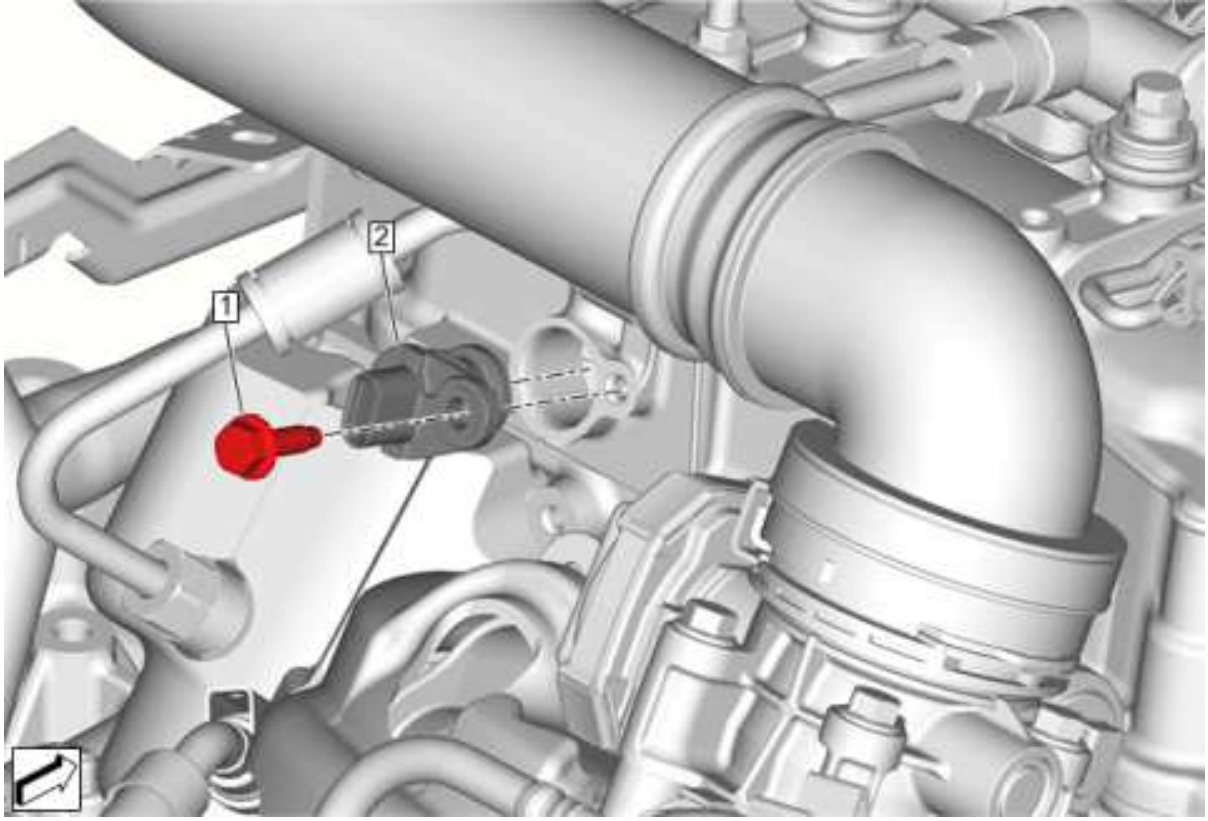

Fig. 203: Camshaft Position Sensor - Intake
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Intake Manifold Cover Replacement	
1	Camshaft Position Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Sensor **Procedure** 1. Disconnect the electrical connector. 2. Install a NEW seal if not replacing the sensor.

CAMSHAFT POSITION SENSOR REPLACEMENT - EXHAUST

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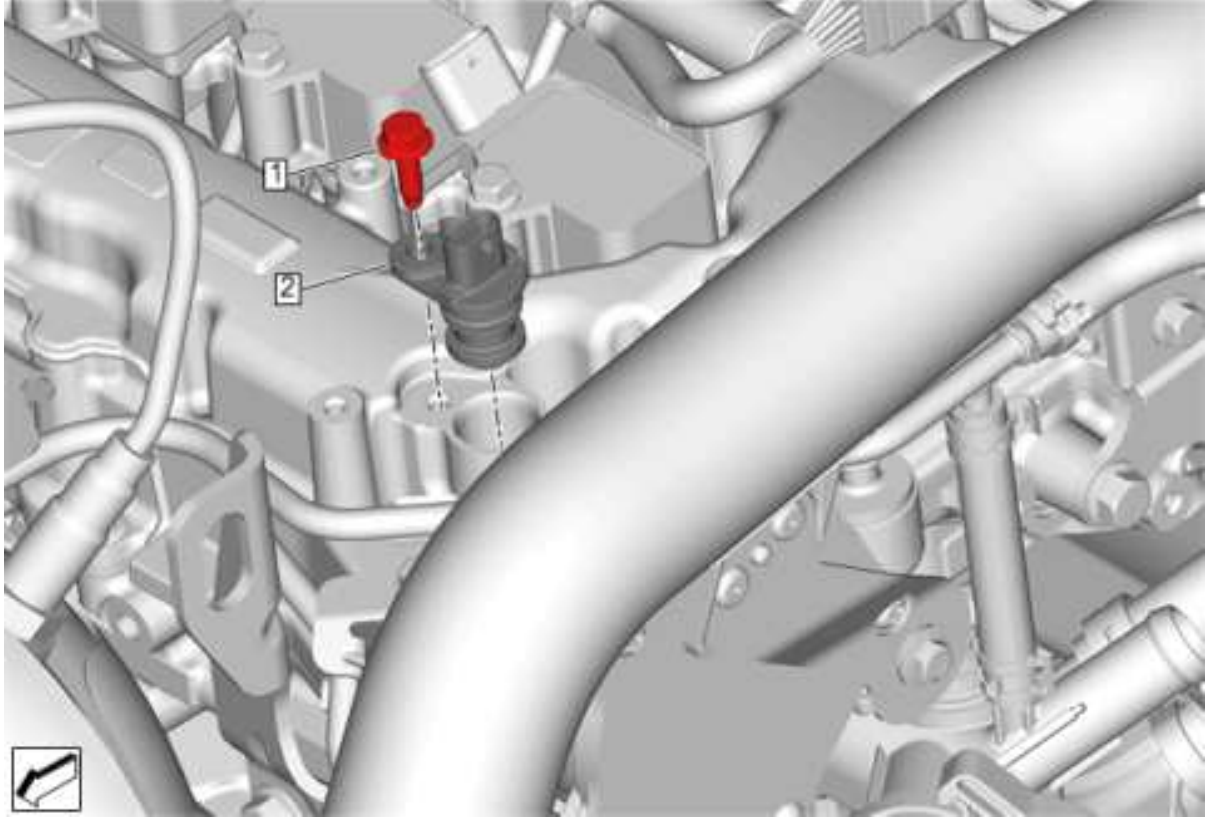

Fig. 204: Camshaft Position Sensor - Exhaust
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Intake Manifold Cover Replacement	
1	Camshaft Position Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Sensor **Procedure** 1. Disconnect the electrical connector. 2. Install a NEW seal if not replacing the sensor.

CAMSHAFT POSITION ACTUATOR LOCATING PIN CONTROL VALVE REPLACEMENT

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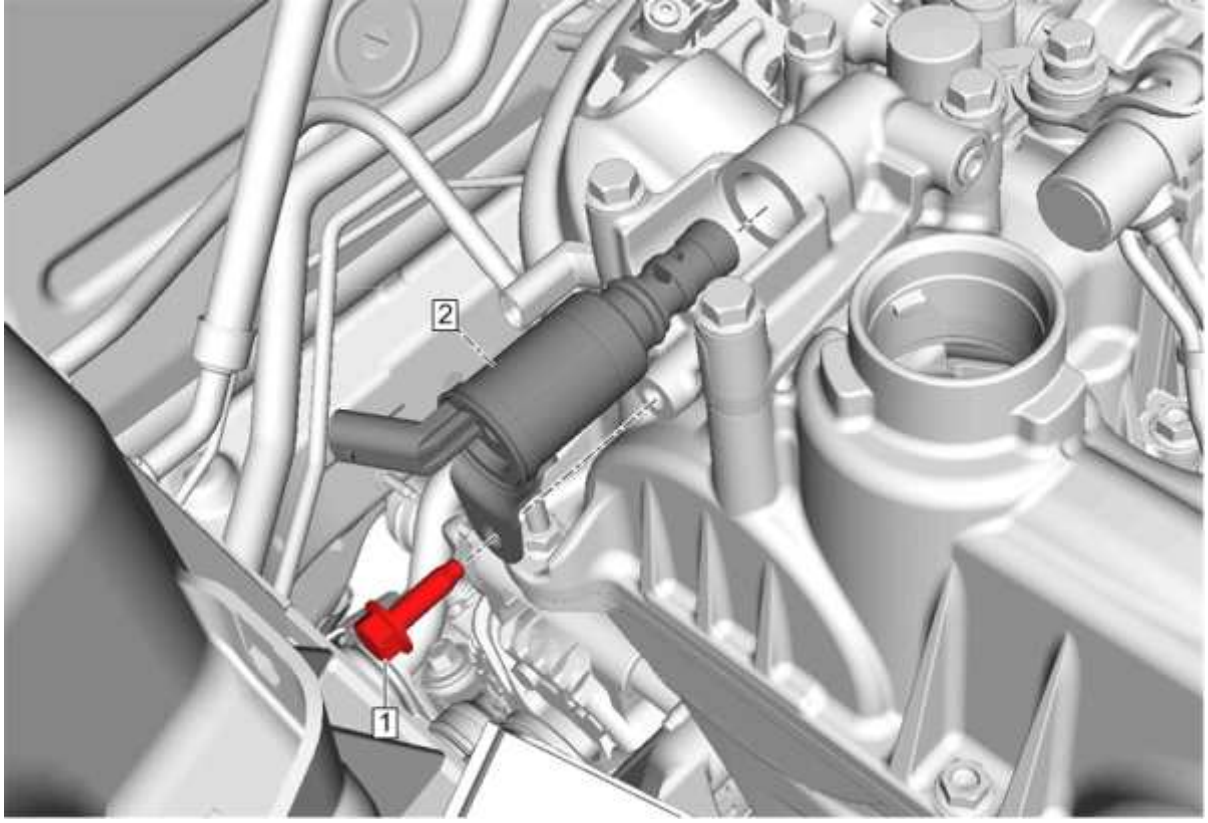

Fig. 205: Camshaft Position Actuator Locating Pin Control Valve
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Intake Manifold Cover Replacement	
1	Camshaft Position Actuator Locating Pin Control Valve Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Actuator Locating Pin Control Valve **Procedure** 1. Disconnect the electrical connector. 2. If reusing the OLD control valve, install a NEW seal. **NOTE:** **A NEW control valve will come with a NEW seal.**

VACUUM PUMP ASSEMBLY REPLACEMENT

Removal Procedure

1. Disconnect Power Brake Booster Vacuum Pipe@Vacuum Pump Assembly - Power Brake Booster Vacuum Pipe Replacement (LYX)
2. Remove Charge Air Cooler Outlet Air Tube - Charge Air Cooler Outlet Air Tube Replacement

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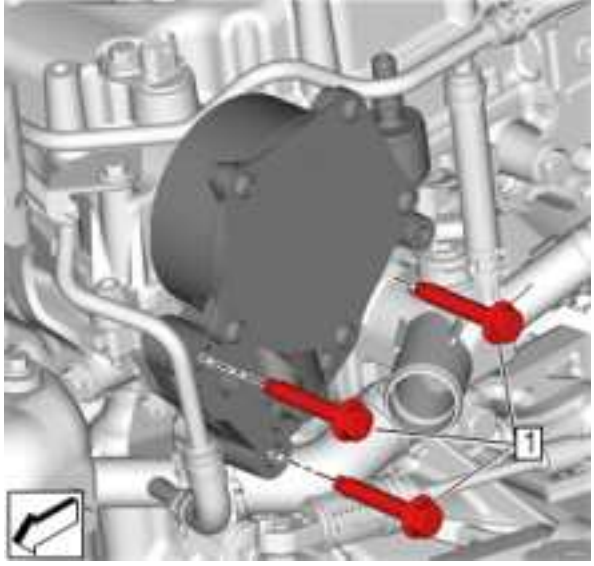

Fig. 206: Vacuum Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the vacuum pump bolts (1).

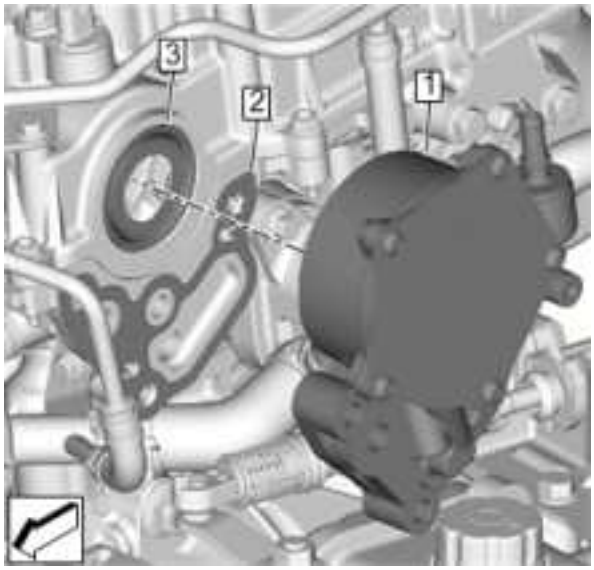

Fig. 207: Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

4. Remove the vacuum pump (1).
5. Remove and DISCARD the vacuum pump gasket (2).
6. Inspect the vacuum pump seal (3) and replace if necessary. **Vacuum Pump Seal Replacement**

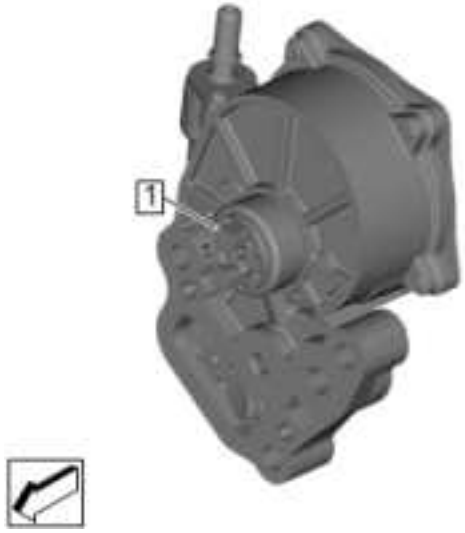

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Fig. 208: Vacuum Pump Shaft
Courtesy of GENERAL MOTORS COMPANY

7. If replacing the vacuum pump, turn the NEW vacuum pump shaft (1) to match the position of the OLD vacuum pump shaft to allow proper alignment with the engine camshaft.

Installation Procedure

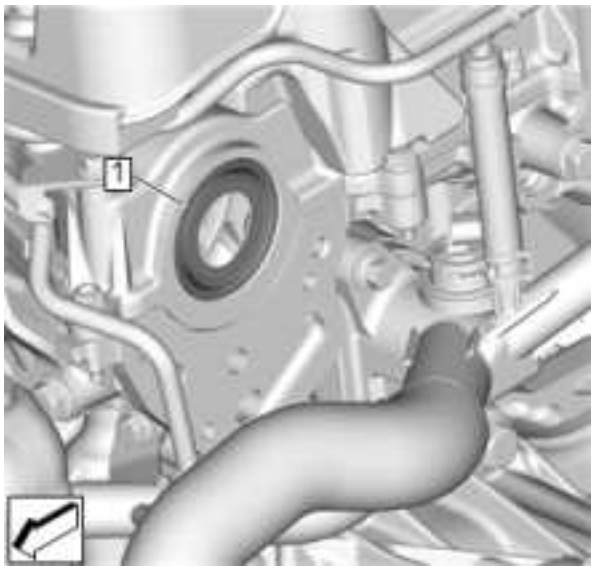

Fig. 209: Vacuum Pump Seal
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the vacuum pump seal (1) with clean engine oil before installing the vacuum pump. **Adhesives, Fluids, Lubricants, and Sealers**

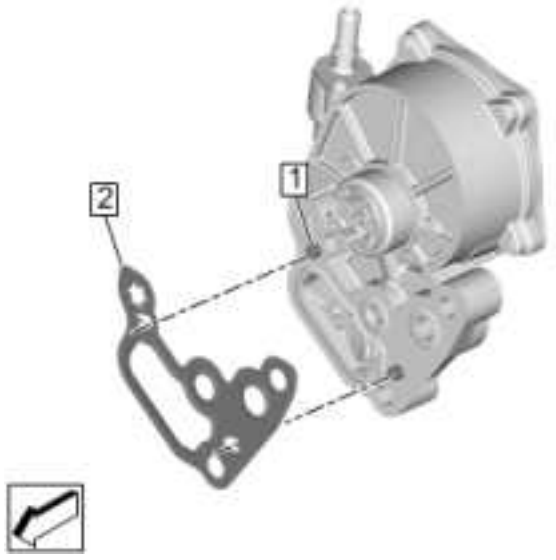

Fig. 210: Vacuum Pump Locating Pins & Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Before continuing, make sure that the vacuum pump locating pins (1) are installed in the vacuum pump.
3. Install the vacuum pump gasket (2) over the vacuum pump locating pins (1).

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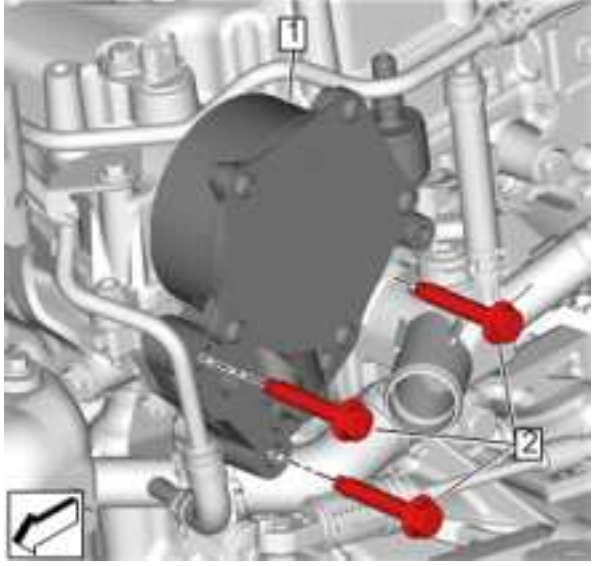


Fig. 211: Vacuum Pump And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the vacuum pump (1) and start the vacuum pump bolts (2) by hand.

CAUTION: **Refer to Fastener Caution .**

5. Tighten the vacuum pump bolts (2) to:
    1. First Pass: 15 N.m (11 lb ft)
    2. Final Pass: 25 N.m (18 lb ft)
6. Install Charge Air Cooler Outlet Air Tube - **Charge Air Cooler Outlet Air Tube Replacement**
7. Install Power Brake Booster Vacuum Pipe@Vacuum Pump Assembly - **Power Brake Booster Vacuum Pipe Replacement (LYX)**

VACUUM PUMP SEAL REPLACEMENT

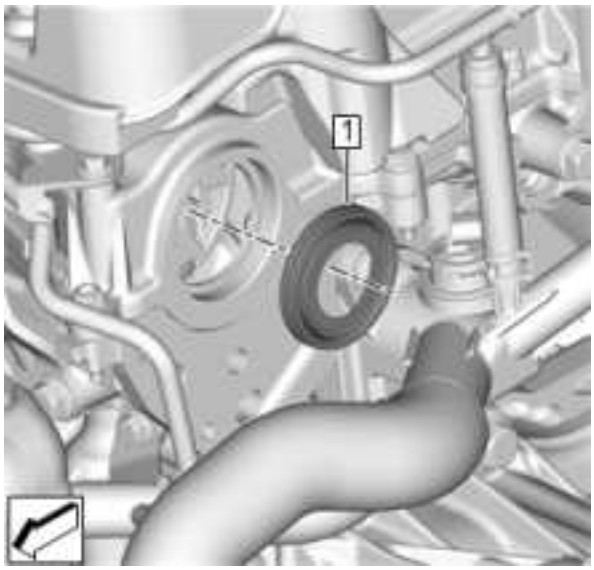
Special Tools

DT-45866 Seal Installer

Equivalent regional tools:**Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

Removal Procedure

1. Remove Engine Control Module Bracket - **Engine Control Module Bracket Replacement**
2. Reposition the engine wiring harness junction block.
3. Remove Vacuum Pump Assembly - **Vacuum Pump Assembly Replacement**



carsdiagn.com

Fig. 212: Vacuum Pump Seal
Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD the vacuum pump seal (1) with a suitable tool.

Installation Procedure

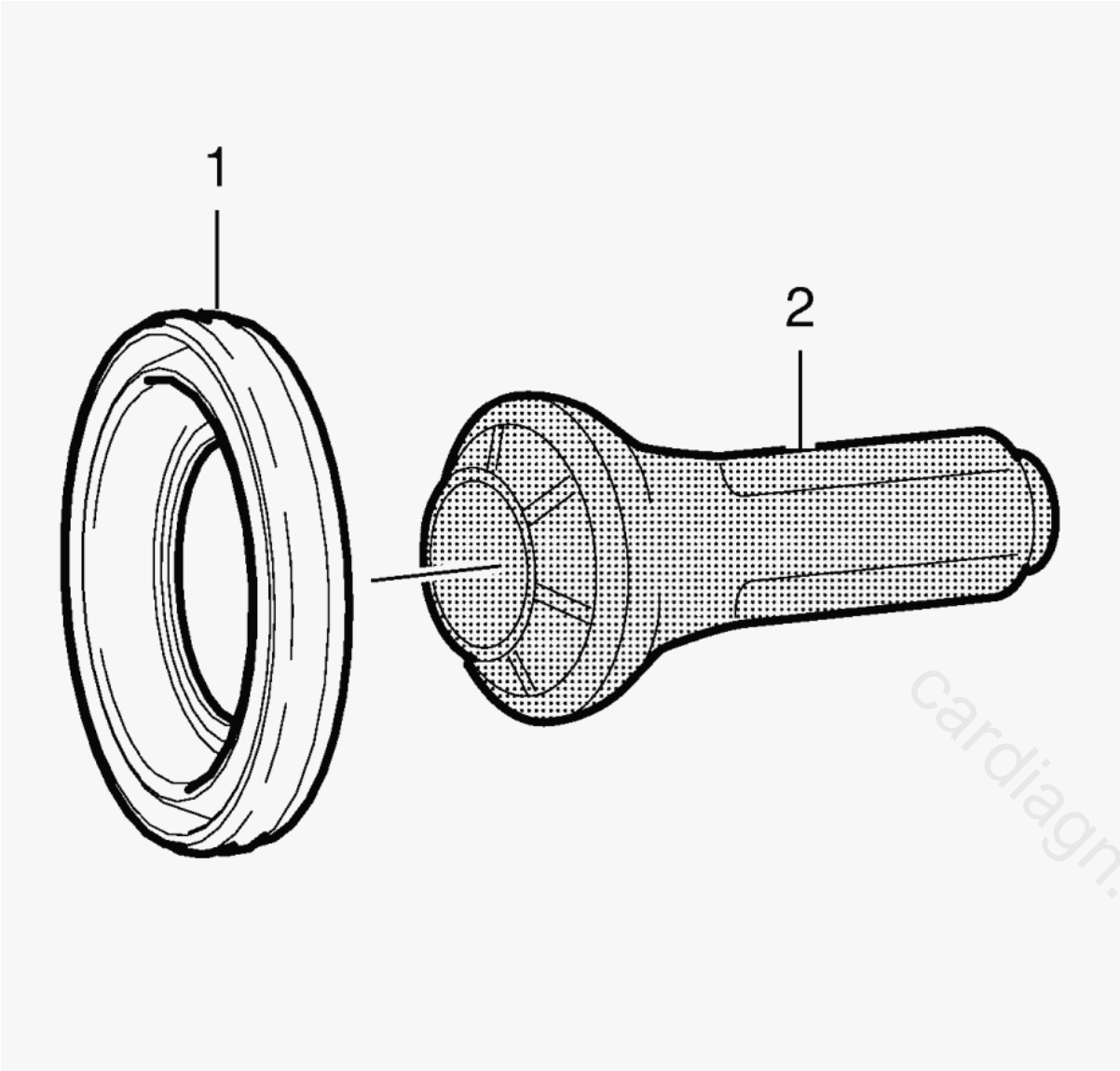


Fig. 213: Vacuum Pump Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Lubricate the NEW vacuum pump seal with clean engine oil before installing to the special tool.**

1. Install the NEW vacuum pump seal (1) to the **DT-45866** installer (2).

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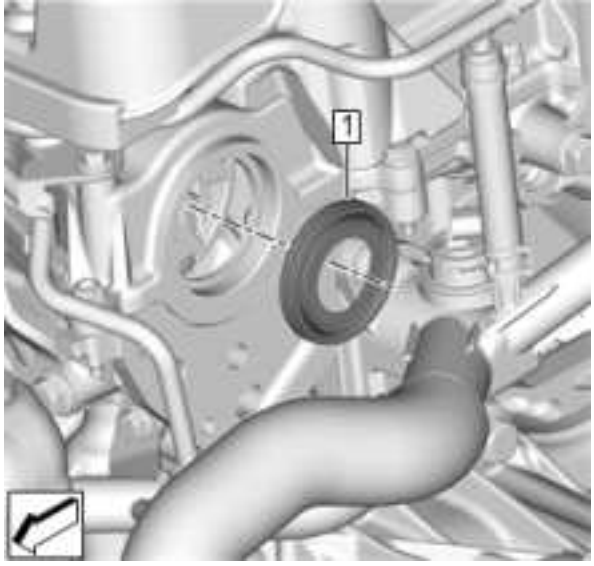

Fig. 214: Vacuum Pump Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The vacuum pump seal must NOT deform during the installation procedure.**
- **Ensure the vacuum pump seal is FULLY seated into the camshaft cover.**

2. Use the **DT-45866** installer to install the NEW vacuum pump seal (1) into the camshaft cover.
3. Install Vacuum Pump Assembly - **Vacuum Pump Assembly Replacement**
4. Position the engine wiring harness junction block.
5. Install Engine Control Module Bracket - **Engine Control Module Bracket Replacement**

AIR CLEANER ASSEMBLY REPLACEMENT

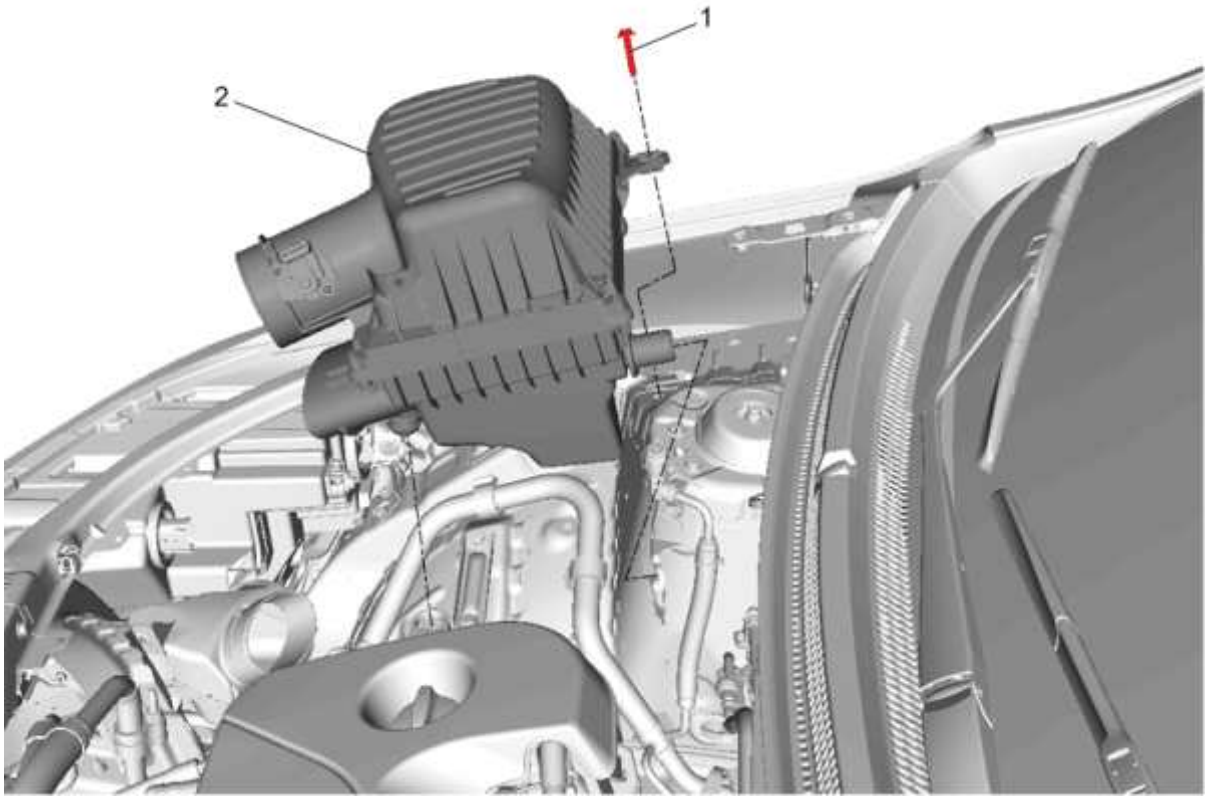

Fig. 215: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

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Callout	Component Name
Preliminary Procedure 1. Air Cleaner Outlet Duct Replacement 2. Intake Air Duct Replacement 3. Disconnect the electrical connector. 4. Remove the two wiring harness retainers from the air cleaner assembly.	
1	Air Cleaner Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Air Cleaner Assembly **Procedure** 1. Remove the air cleaner housing from the retainers. 2. Transfer parts as necessary.

AIR CLEANER ELEMENT REPLACEMENT

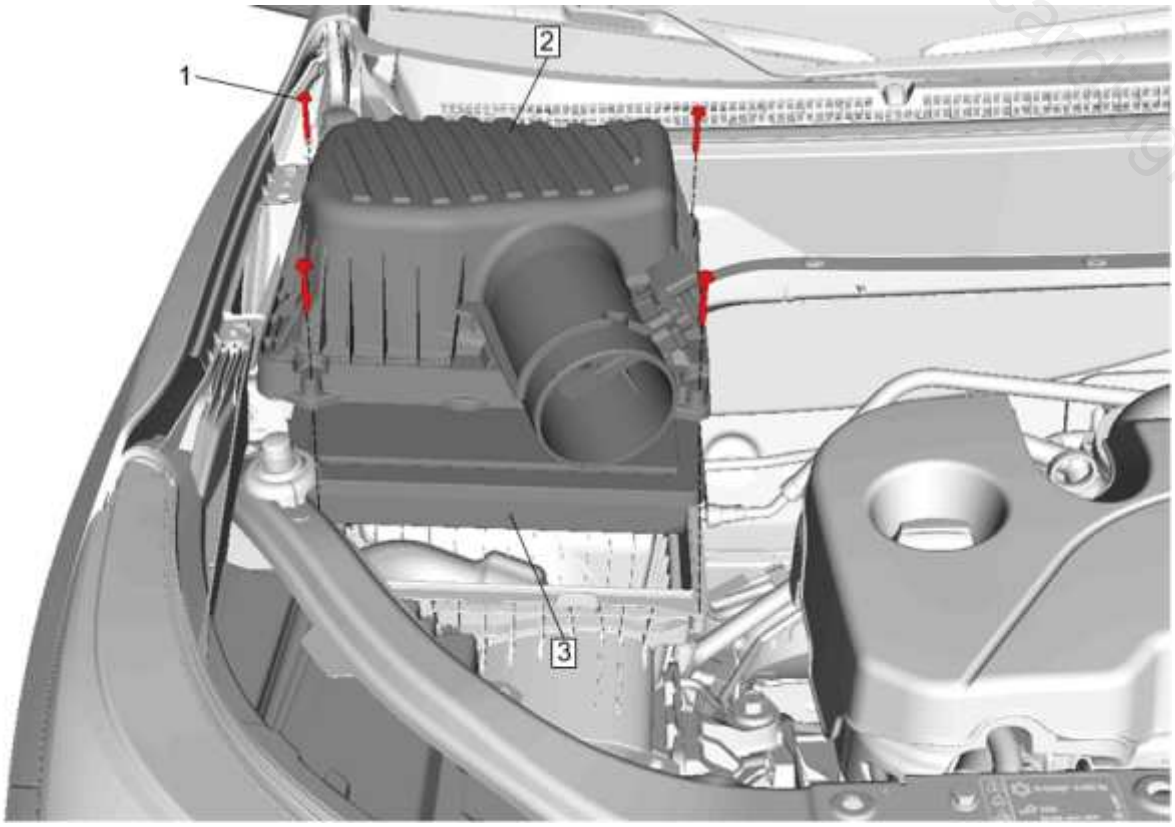

Fig. 216: Air Cleaner Element
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Air Cleaner Outlet Duct Replacement 2. Disconnect the electrical connector.	

Callout	Component Name
1	Air Cleaner Upper Housing Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 4 N.m (35 lb in)
2	Air Cleaner Upper Housing
3	Air Cleaner Element **NOTE:** **Align the tab on the filter element to the correct position on the lower housing.**

AIR CLEANER OUTLET DUCT REPLACEMENT

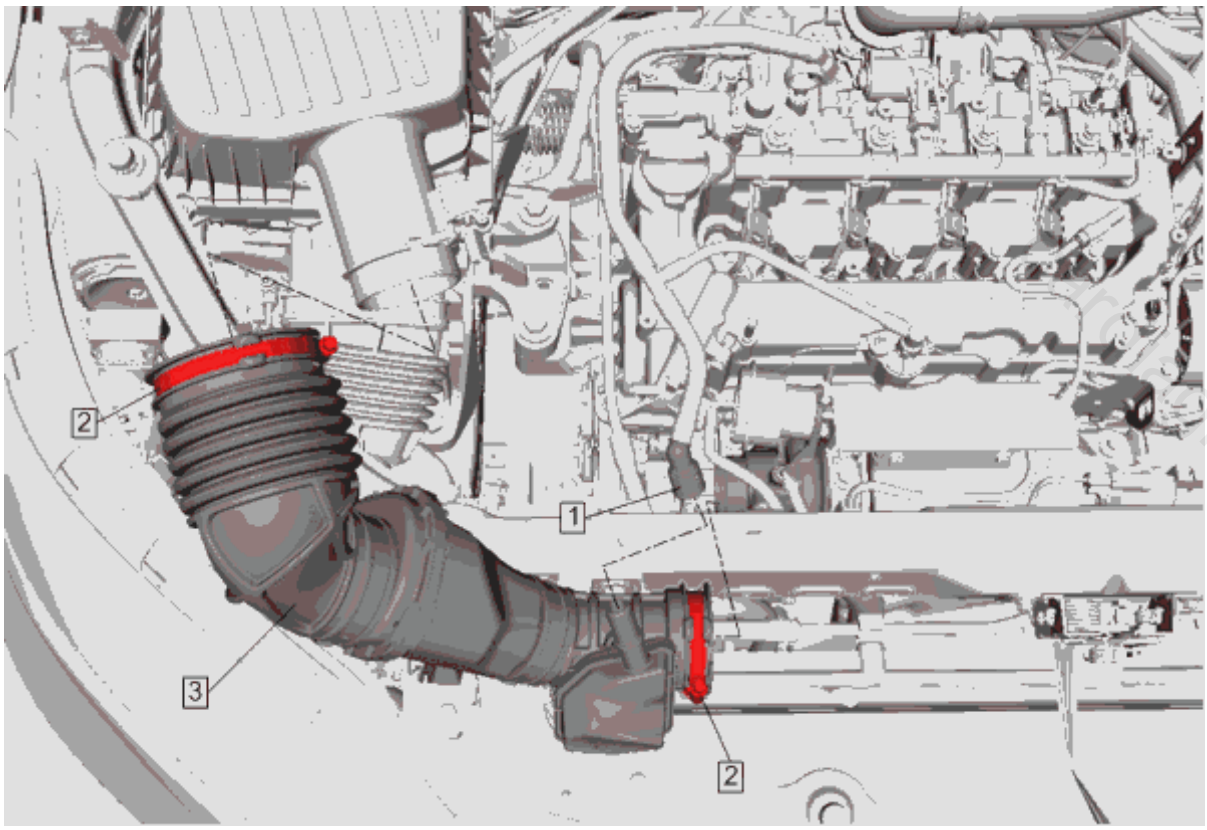

Fig. 217: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Positive Crankcase Ventilation Tube **Procedure** Disconnect Positive Crankcase Ventilation Tube@Air Cleaner Outlet Duct - **Positive Crankcase Ventilation Tube Replacement (Fresh Air)** **Positive Crankcase Ventilation Tube Replacement (Foul Air)**
2	Air Cleaner Outlet Duct Clamp [2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 3.5 N.m (31 lb in)

Callout	Component Name
3	Air Cleaner Outlet Duct

CHARGE AIR COOLER OUTLET AIR TUBE REPLACEMENT

Removal Procedure

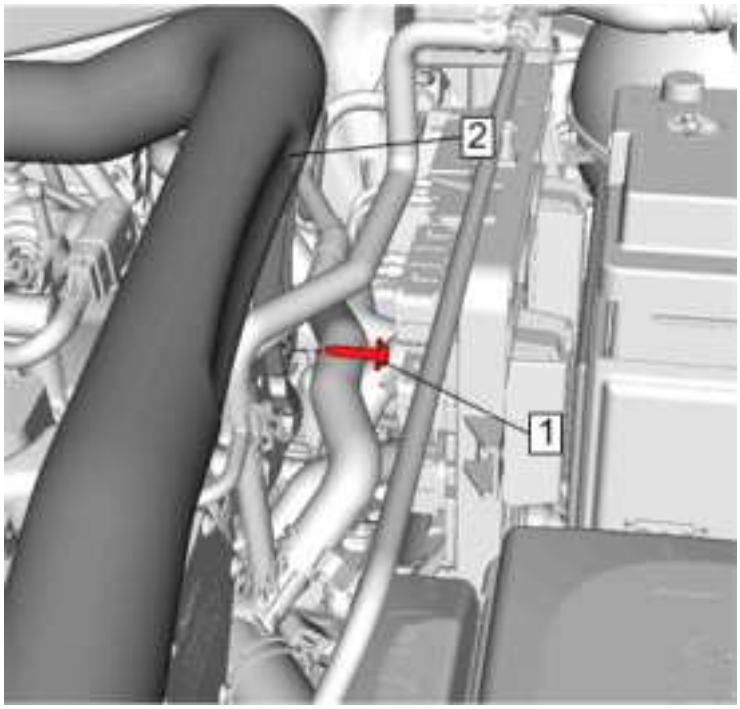

Fig. 218: Charge Air Cooler Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove Charge Air Cooler Bracket Bolt(1)@Charge Air Cooler Outlet Air Tube (2)

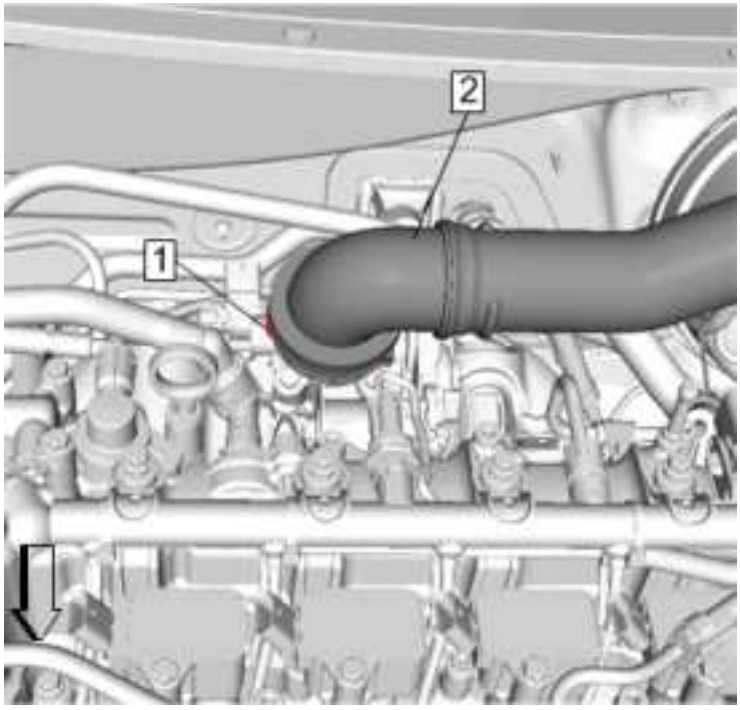

Fig. 219: Charge Air Cooler Outlet Air Tube And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

2. Release Retainer Spring (1)
3. Remove Charge Air Cooler Outlet Air Tube (2)
4. Remove Underbody Front Air Deflector - **Underbody Front Air Deflector Replacement (Equinox) Underbody Front Air Deflector Replacement (Terrain)**

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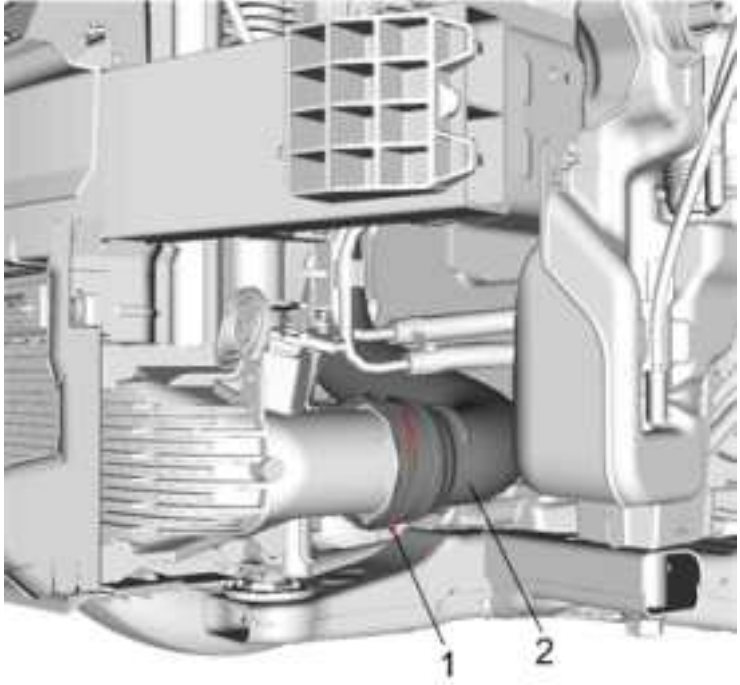

Fig. 220: Charge Air Cooler Outlet Air Tube And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

5. Release Retainer Spring (1)
6. Remove Charge Air Cooler Outlet Air Tube (2)
7. Remove the charge air cooler outlet air tube assembly (2) from the vehicle.

Installation Procedure

1. Install the charge air cooler outlet air tube assembly to the vehicle.

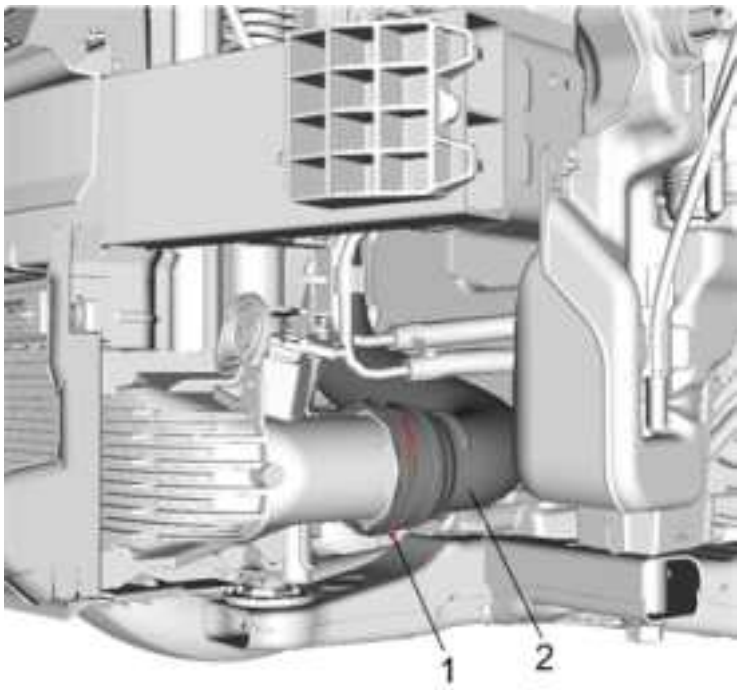

Fig. 221: Charge Air Cooler Outlet Air Tube And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

2. Install Charge Air Cooler Outlet Air Tube (2)
3. Engage Retainer Spring (1)
4. Install Underbody Front Air Deflector - **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**

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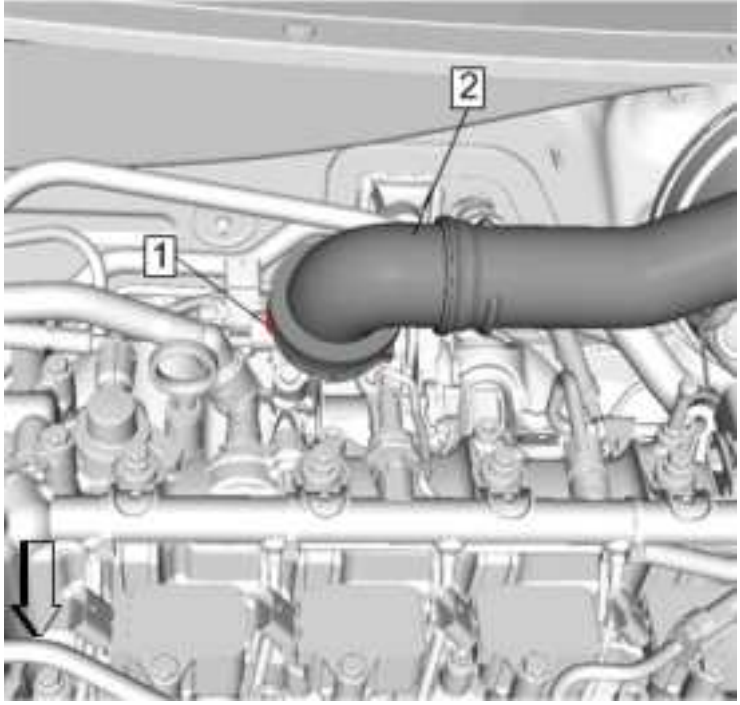

Fig. 222: Charge Air Cooler Outlet Air Tube And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

5. Install Charge Air Cooler Outlet Air Tube (2)
6. Engage Retainer Spring (1)

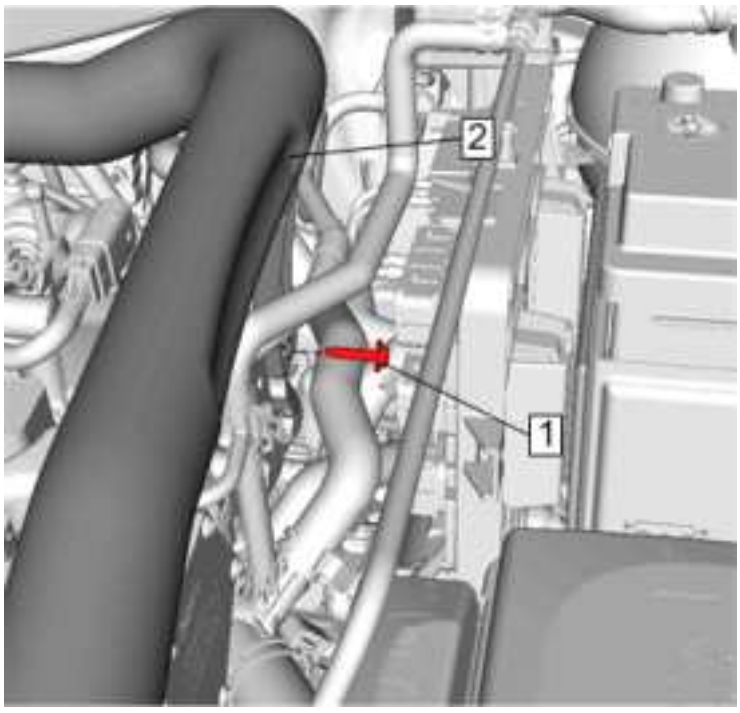

Fig. 223: Charge Air Cooler Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

7. Install Charge Air Cooler Bracket Bolt (1) @Charge Air Cooler Outlet Air Tube and tighten 9 N.m (80 lb in)

CHARGE AIR COOLER INLET AIR TUBE REPLACEMENT

Removal Procedure

1. Remove Underbody Front Air Deflector - **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**

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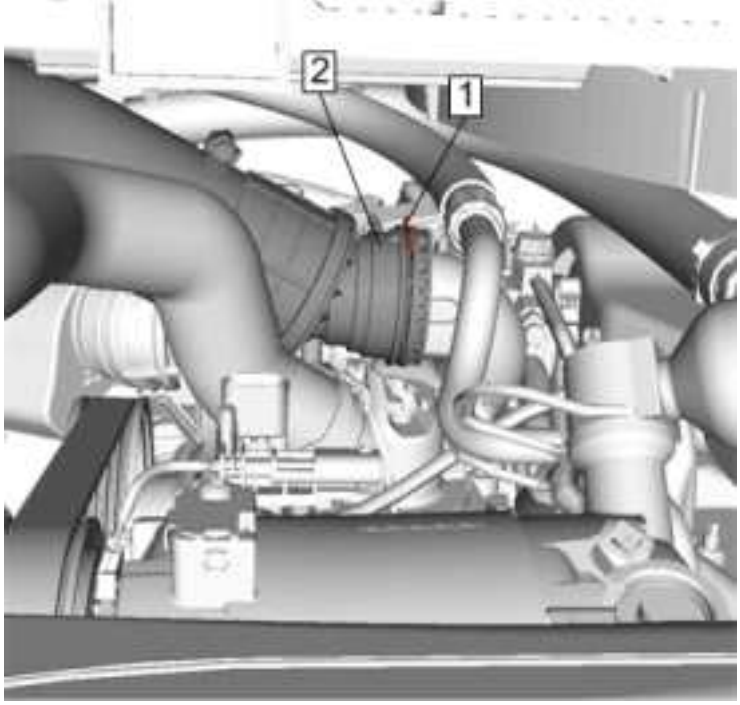

Fig. 224: Retainer Spring And Charge Air Cooler Inlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

2. Release Retainer Spring (1)
3. Remove Charge Air Cooler Inlet Air Tube (2)

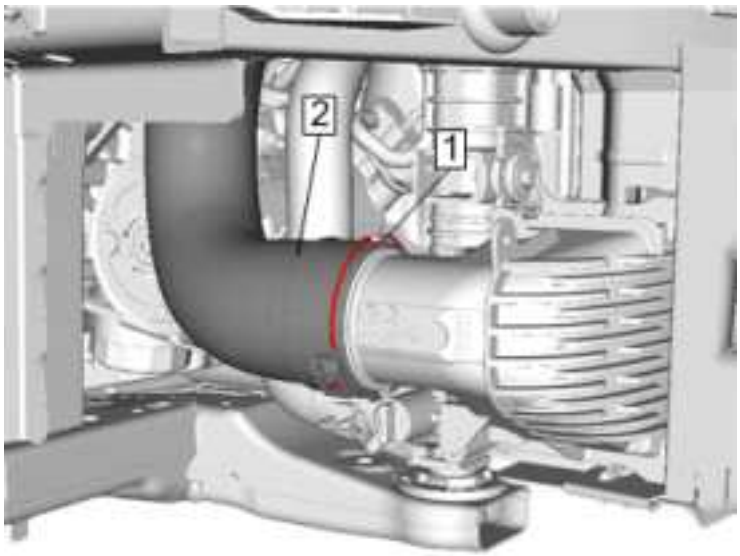

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Fig. 225: Retainer Spring And Charge Air Cooler Inlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

4. Release Retainer Spring (1)
5. Remove Charge Air Cooler Inlet Air Tube (2)

Installation Procedure

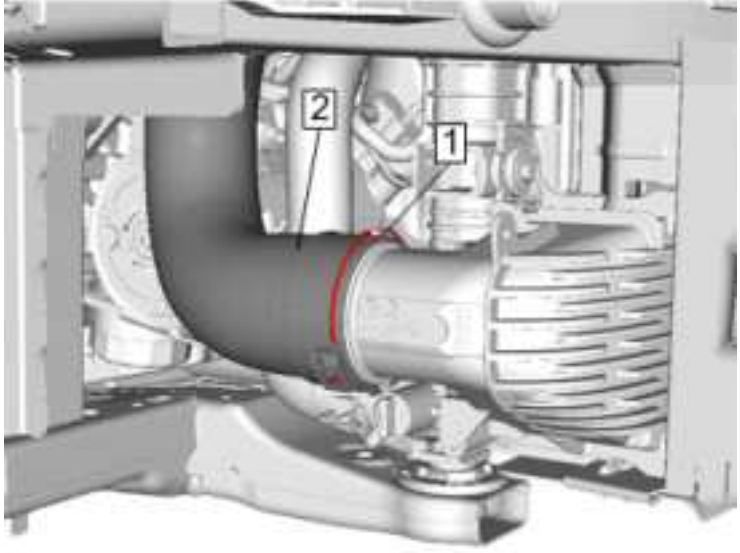

Fig. 226: Retainer Spring And Charge Air Cooler Inlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

1. Install Charge Air Cooler Inlet Air Tube (2)
2. Engage Retainer Spring (1)

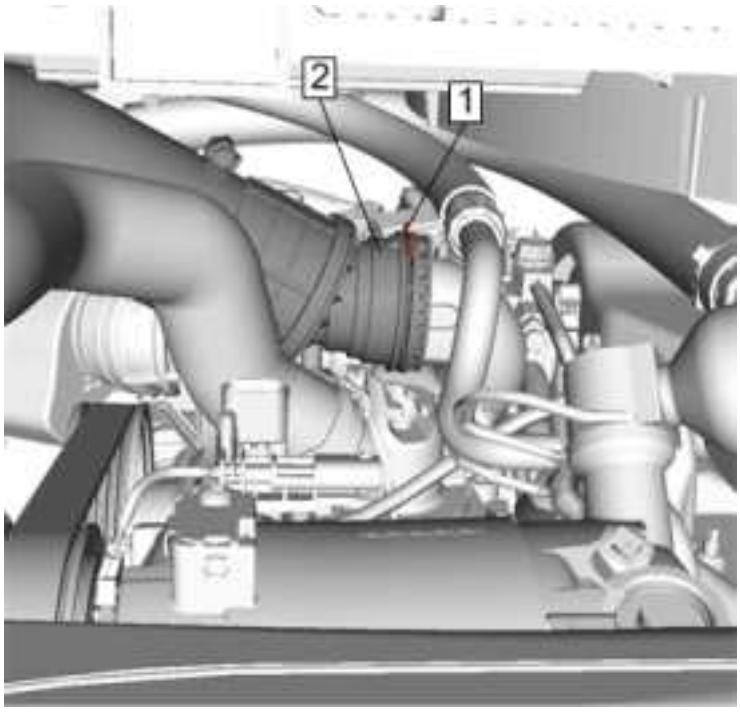

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Fig. 227: Retainer Spring And Charge Air Cooler Inlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

3. Install Charge Air Cooler Inlet Air Tube (2)
4. Engage Retainer Spring (1)
5. Install Underbody Front Air Deflector - **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**

CHARGE AIR COOLER REPLACEMENT

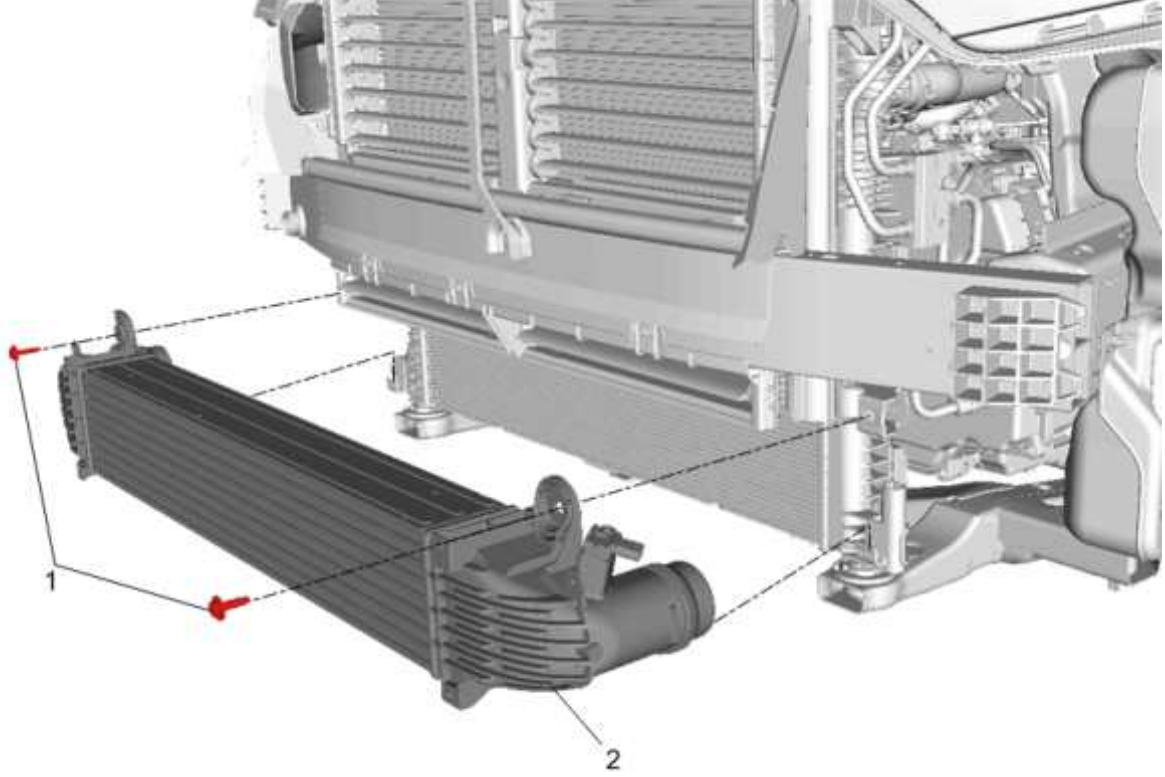

Fig. 228: Charge Air Cooler
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Radiator Air Lower Baffle Replacement (LH7 LTG LYX) 2. Disconnect Charge Air Cooler Outlet Air Tube@Charge Air Cooler - Charge Air Cooler Outlet Air Tube Replacement 3. Disconnect Charge Air Cooler Inlet Air Tube@Charge Air Cooler - Charge Air Cooler Inlet Air Tube Replacement 4. Disconnect the electrical connector.	
1	Charge Air Cooler Bolt[2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Charge Air Cooler

FUEL LEVEL SENSOR REPLACEMENT (FWD)

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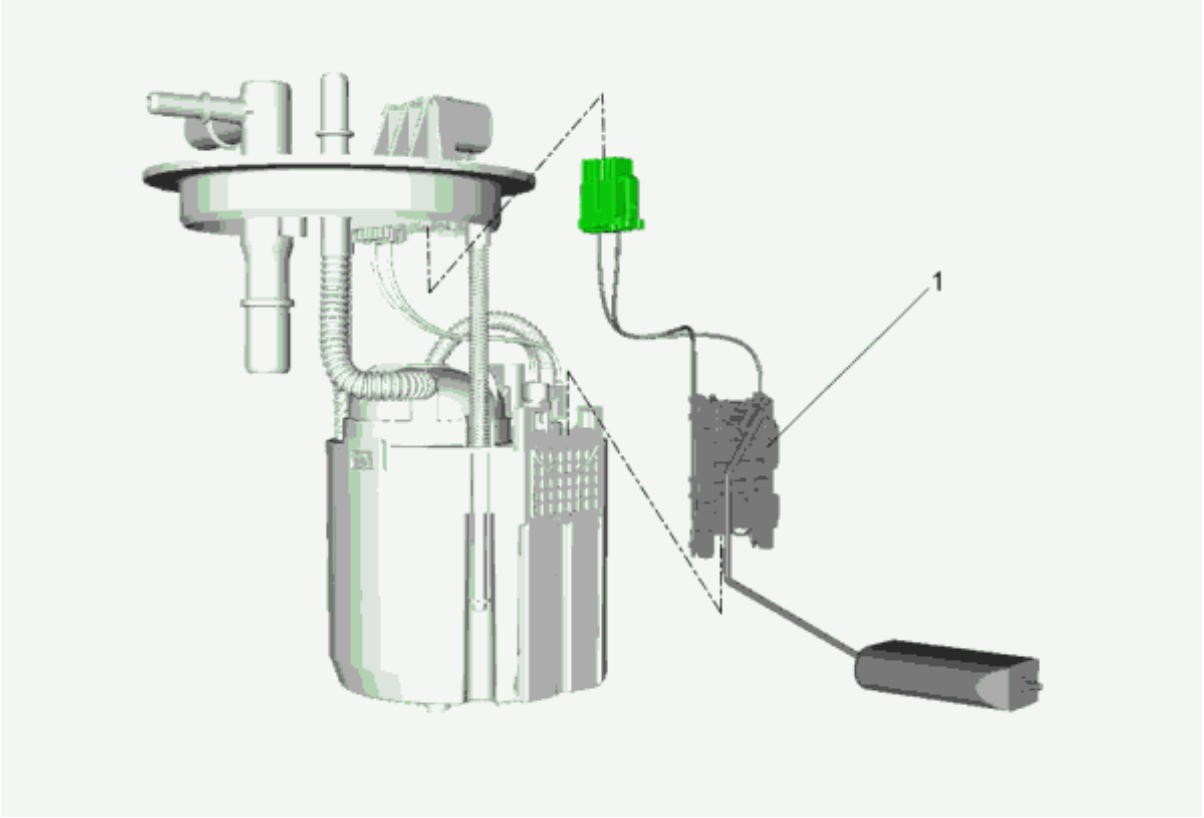

Fig. 229: Fuel Level Sensor (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Fuel Tank Fuel Pump Module Replacement (FWD)	
1	Fuel Level Sensor **Procedure** 1. Release tabs and slide fuel level sensor up to remove. 2. Disconnect the electrical connector.

FUEL LEVEL SENSOR REPLACEMENT (AWD)

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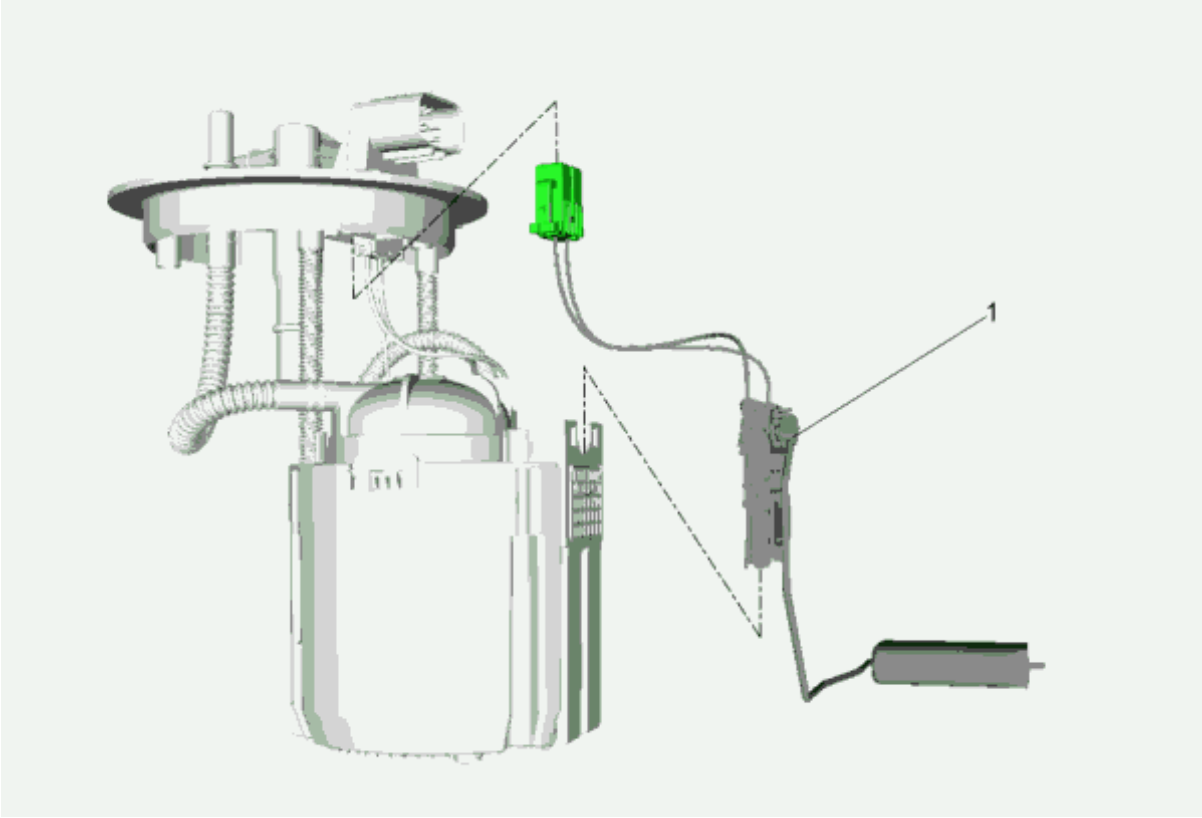

Fig. 230: Fuel Level Sensor (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Fuel Tank Fuel Pump Module Replacement (AWD)	
1	Fuel Level Sensor **Procedure** 1. Release tabs and slide fuel level sensor up to remove. 2. Disconnect the electrical connector.

FUEL PUMP POWER CONTROL MODULE REPLACEMENT (FWD)

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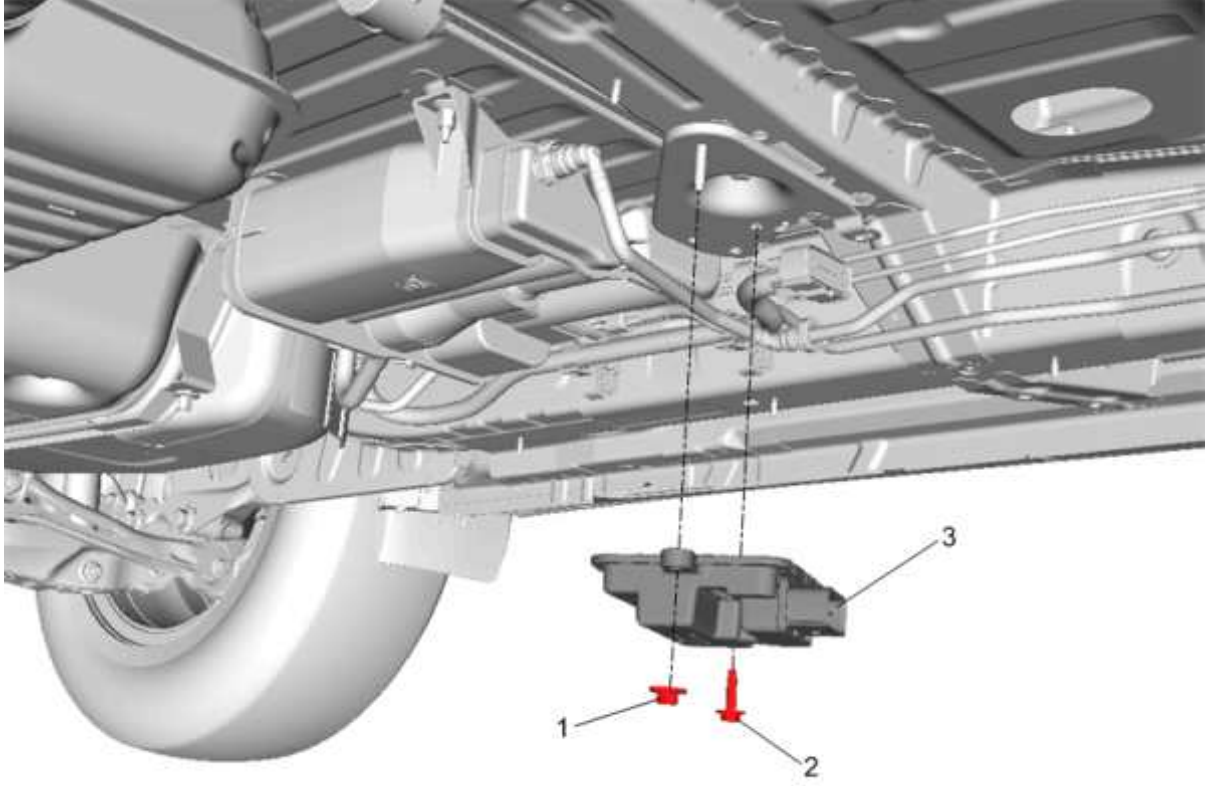

Fig. 231: Fuel Pump Power Control Module (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Underbody Rear Air Deflector Replacement (Front Wheel Drive)	
1	Fuel Pump Power Control Module Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Fuel Pump Power Control Module Bolt **Tighten** 9 N.m (80 lb in)
3	Fuel Pump Power Control Module **Procedure** 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Control Module References

FUEL PUMP POWER CONTROL MODULE REPLACEMENT (AWD)

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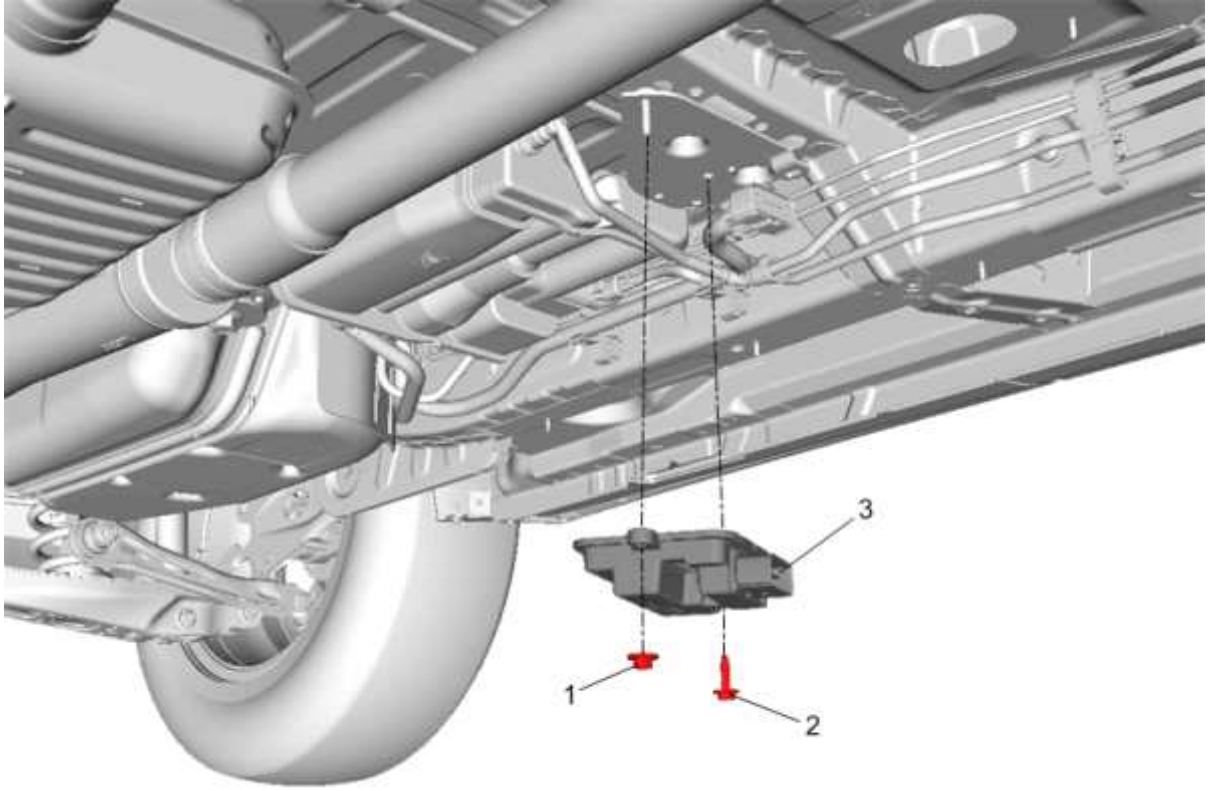

Fig. 232: Fuel Pump Power Control Replacement (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Underbody Rear Air Deflector Replacement (All Wheel Drive)	
1	Fuel Pump Power Control Module Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Fuel Pump Power Control Module Bolt **Tighten** 9 N.m (80 lb in)
3	Fuel Pump Power Control Module **Procedure** 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Control Module References

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 1

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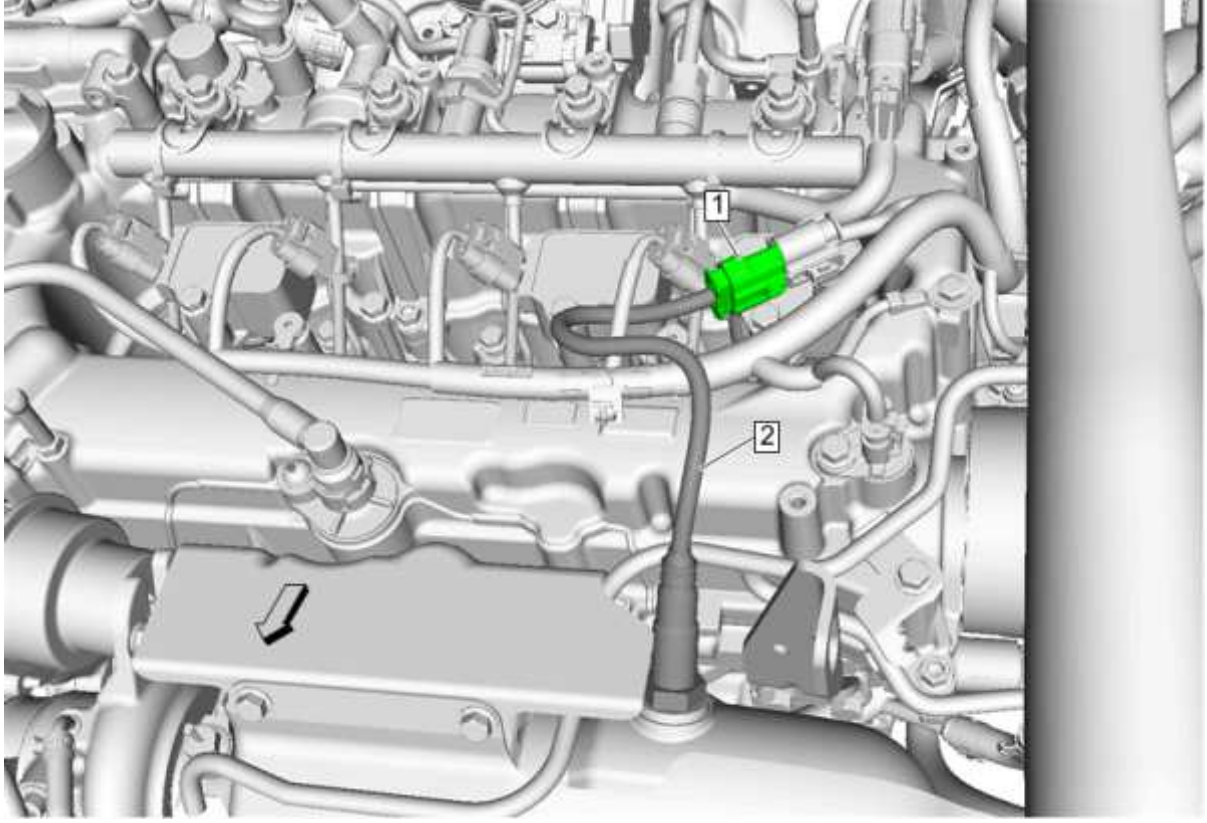

Fig. 233: Heated Oxygen Sensor - Sensor 1
Courtesy of GENERAL MOTORS COMPANY

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.

WARNING:
Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury.

Preliminary Procedure Intake Manifold Cover Replacement

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Callout	Component Name
1	Heated Oxygen Sensor **CAUTION:** **Refer to Component Fastener Tightening Caution .** **CAUTION:** **Refer to Heated Oxygen and Oxygen Sensor Caution .** **CAUTION:** **Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .** **CAUTION:** **The use of excessive force may damage the threads in the exhaust manifold/pipe.** **Procedure** 1. Disconnect the electrical connector. 2. If replacing, perform the HO2S heater resistance learned values reset. **HO2S Heater Resistance Learned Values Reset** **NOTE:** • **The heated oxygen sensor in-line connector and louvered end MUST be kept clear of all grease, dirt, and other contaminants. Do NOT use cleaning solvents of any type. Do NOT drop or roughly handle the sensor.** • **The heated oxygen sensor MAY be difficult to remove when the engine temperature is less than 48Â°C (120Â°F).** • **A special anti-seize compound is used on the heated oxygen sensor threads. The compound consists of liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound already applied to the threads. IF a sensor is removed and is to be reinstalled, the threads MUST have an anti-seize compound applied before installation. Adhesives, Fluids, Lubricants, and Sealers** **Tighten** 42 N.m (31 lb ft) **Special Tools** **EN-6179** Heated Oxygen Sensor Remover/Installer Equivalent regional tools:**Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 2

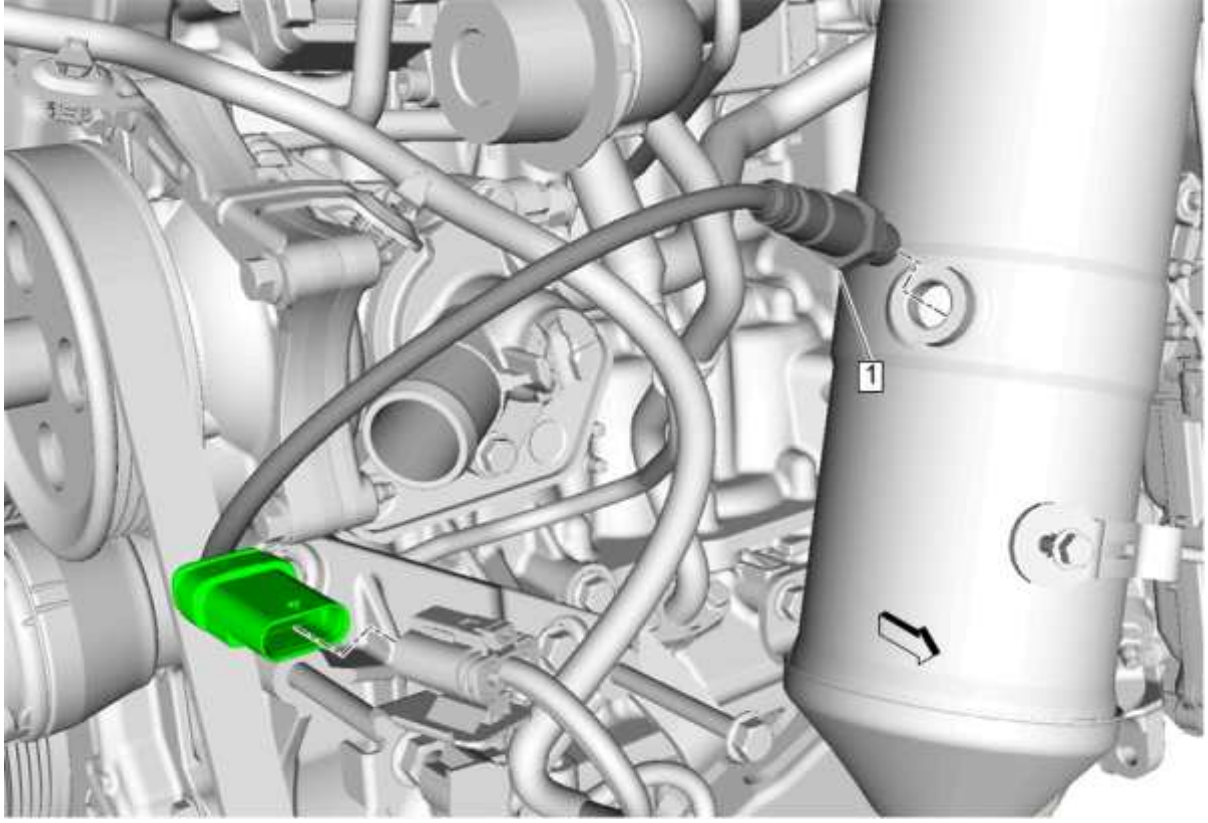

Fig. 234: Heated Oxygen Sensor - Sensor 2
Courtesy of GENERAL MOTORS COMPANY

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.

WARNING:
Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury.

Preliminary Procedure Raise and support the vehicle. Lifting and Jacking the Vehicle

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Callout	Component Name
1	Heated Oxygen Sensor **CAUTION:** **Refer to Component Fastener Tightening Caution .** **CAUTION:** **Refer to Heated Oxygen and Oxygen Sensor Caution .** **CAUTION:** **Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .** **CAUTION:** **The use of excessive force may damage the threads in the exhaust manifold/pipe.** **Procedure** 1. Disconnect the electrical connector. 2. If replacing, perform the HO2S heater resistance learned values reset. **HO2S Heater Resistance Learned Values Reset** **NOTE:** • **The heated oxygen sensor in-line connector and louvered end MUST be kept clear of all grease, dirt, and other contaminants. Do NOT use cleaning solvents of any type. Do NOT drop or roughly handle the sensor.** • **The heated oxygen sensor MAY be difficult to remove when the engine temperature is less than 48Â°C (120Â°F).** • **A special anti-seize compound is used on the heated oxygen sensor threads. The compound consists of liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound already applied to the threads. IF a sensor is removed and is to be reinstalled, the threads MUST have an anti-seize compound applied before installation. Adhesives, Fluids, Lubricants, and Sealers** **Tighten** 42 N.m (31 lb ft) **Special Tools** **EN-6179** Heated Oxygen Sensor Remover/Installer Equivalent regional tools:**Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

INTAKE AIR PRESSURE AND TEMPERATURE SENSOR REPLACEMENT

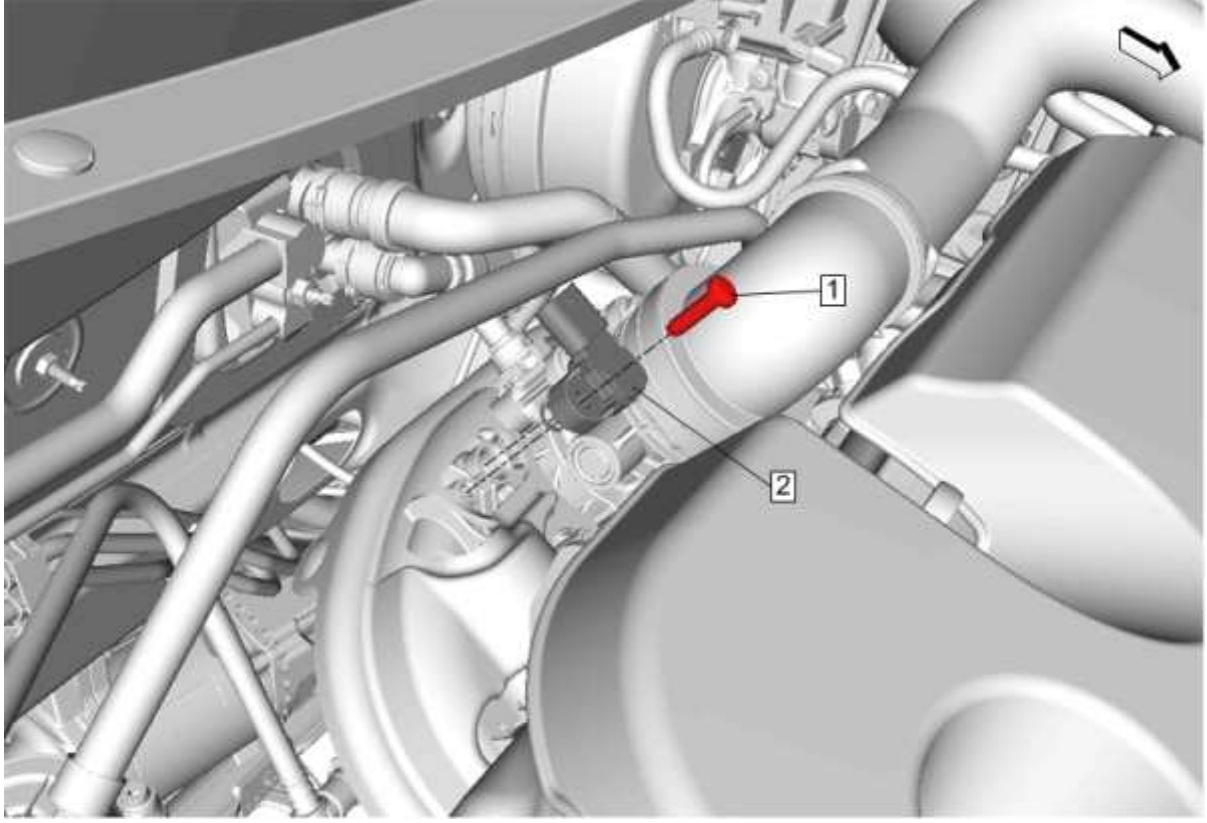

Fig. 235: Intake Air Pressure And Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Intake Air Pressure and Temperature Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 5 N.m (44 lb in)
2	Intake Air Pressure and Temperature Sensor **Procedure** 1. Disconnect the electrical connector. 2. Perform the intake system learned values reset. **Intake System Learned Values Reset**

MASS AIRFLOW SENSOR REPLACEMENT

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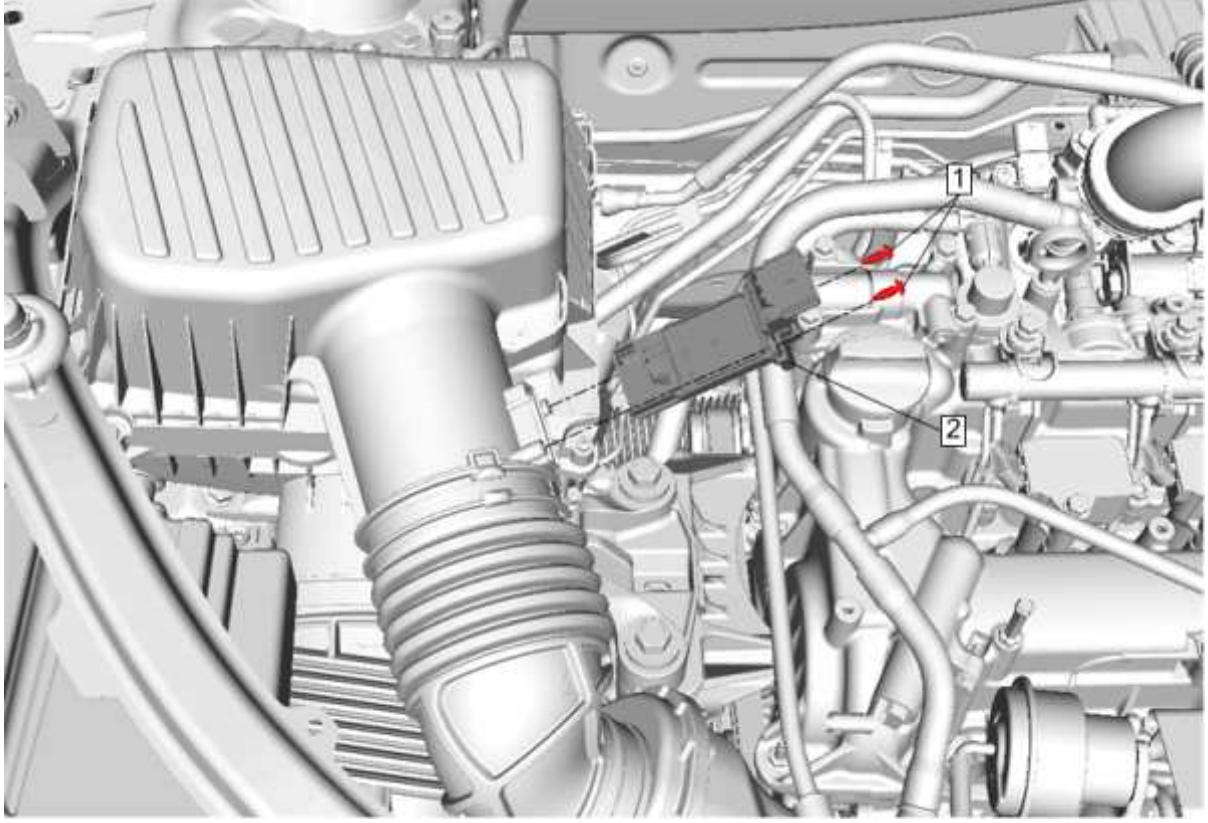

Fig. 236: Mass Airflow Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Mass Airflow Sensor Bolt [2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 4 N.m (35 lb in)
2	Mass Airflow Sensor **Procedure** 1. Disconnect the electrical connector. 2. Perform the intake system learned values reset. **Intake System Learned Values Reset**

ENGINE OIL PRESSURE SENSOR REPLACEMENT

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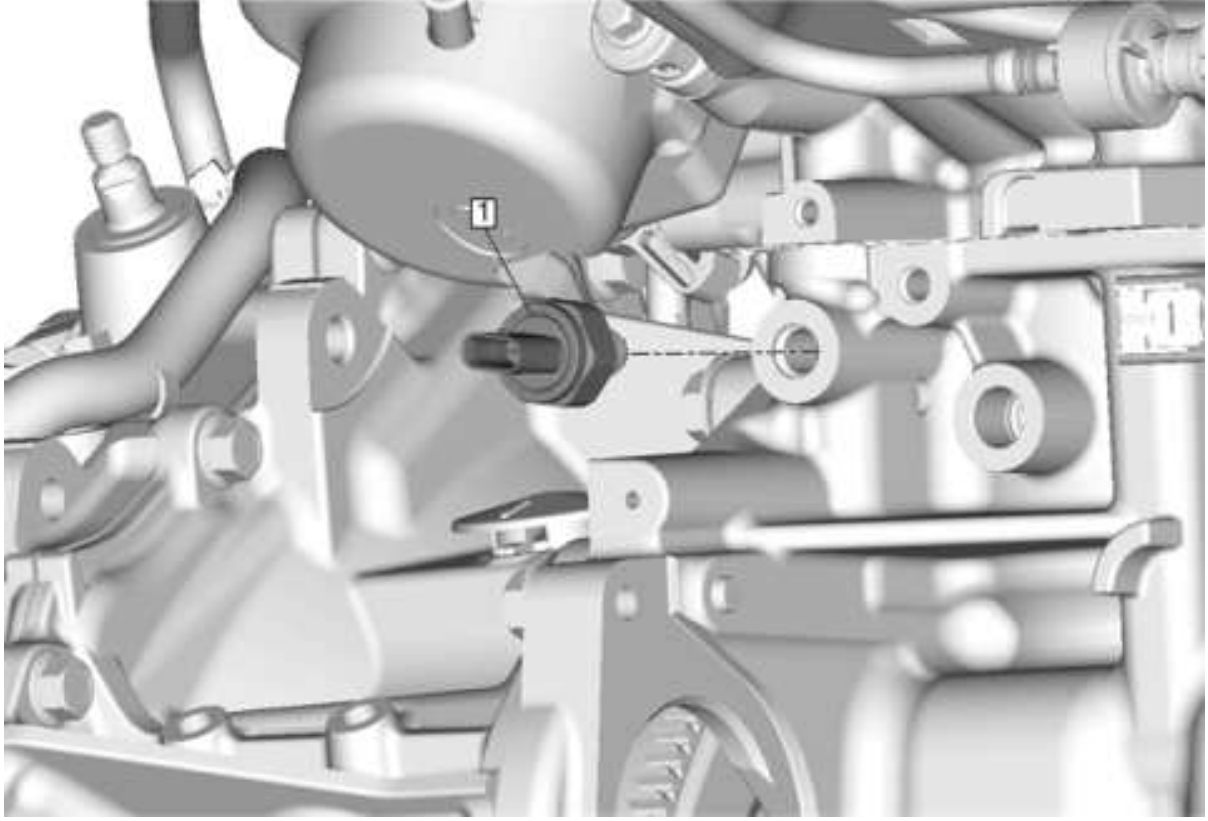

Fig. 237: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Starter Replacement (LYX - All Wheel Drive) Starter Replacement (LYX - Front Wheel Drive)	
1	Engine Oil Pressure Sensor **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** Disconnect the electrical connector. **Tighten** 35 N.m (26 lb ft)

INTAKE AIR BAFFLE REPLACEMENT

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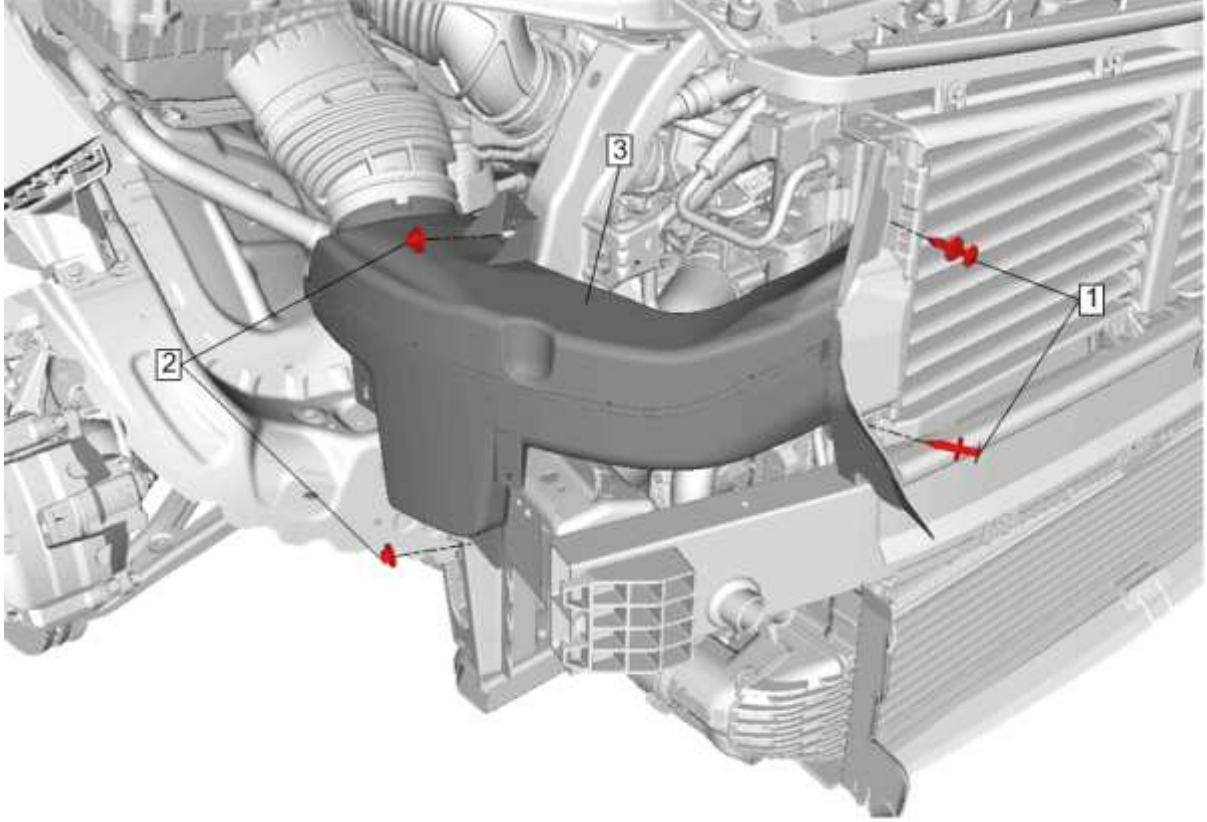

Fig. 238: Intake Air Baffle
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Headlamp Replacement (Chevrolet) Headlamp Replacement (GMC)	
1	Intake Air Baffle Retainer [2x]
2	Front Intake Air Duct Nut[2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
3	Intake Air Baffle **Procedure** Remove wiring harness retainers from intake air baffle.

INTAKE AIR DUCT REPLACEMENT

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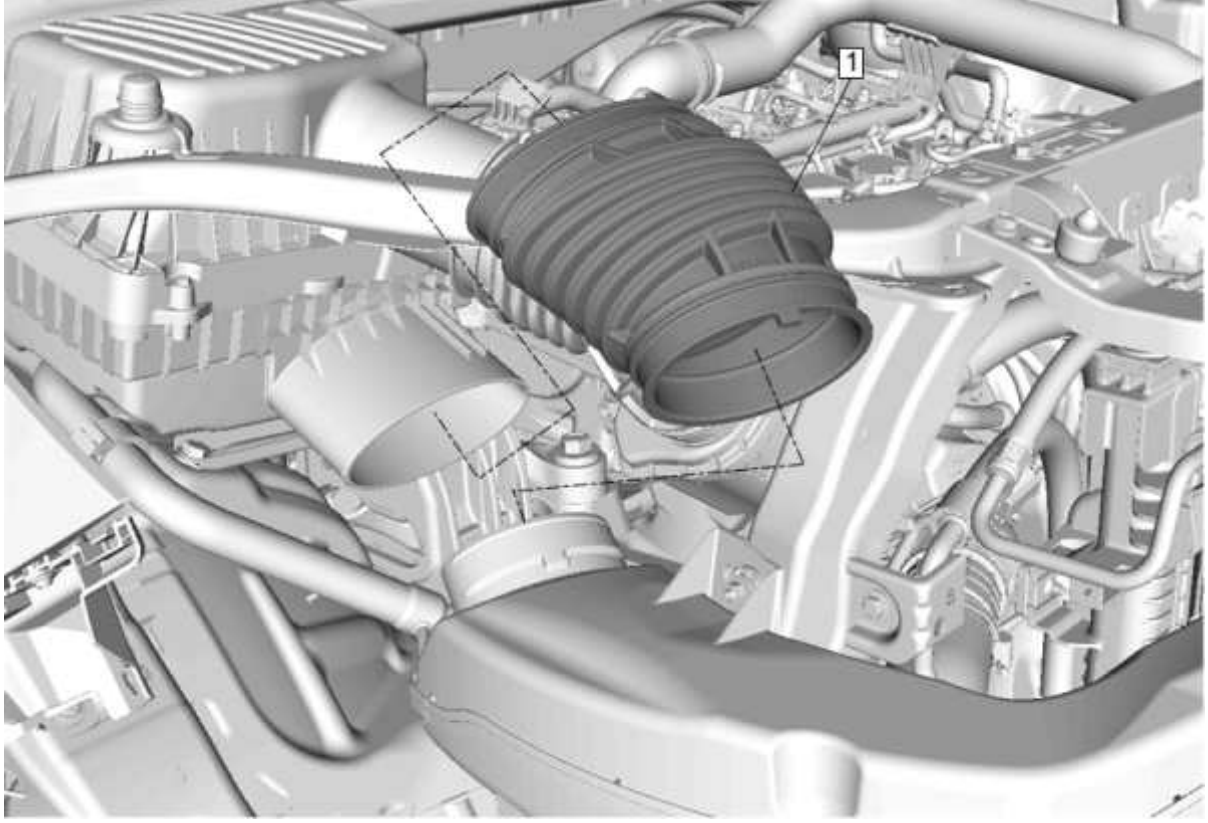

Fig. 239: Intake Air Duct
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure **Air Cleaner Outlet Duct Replacement**	
1	Intake Air Duct **Procedure** Perform the intake system learned values reset. **Intake System Learned Values Reset** **NOTE:** **Align the tab on the duct to the correct position on the intake air baffle.**

TURBOCHARGER AIR PRESSURE SENSOR REPLACEMENT

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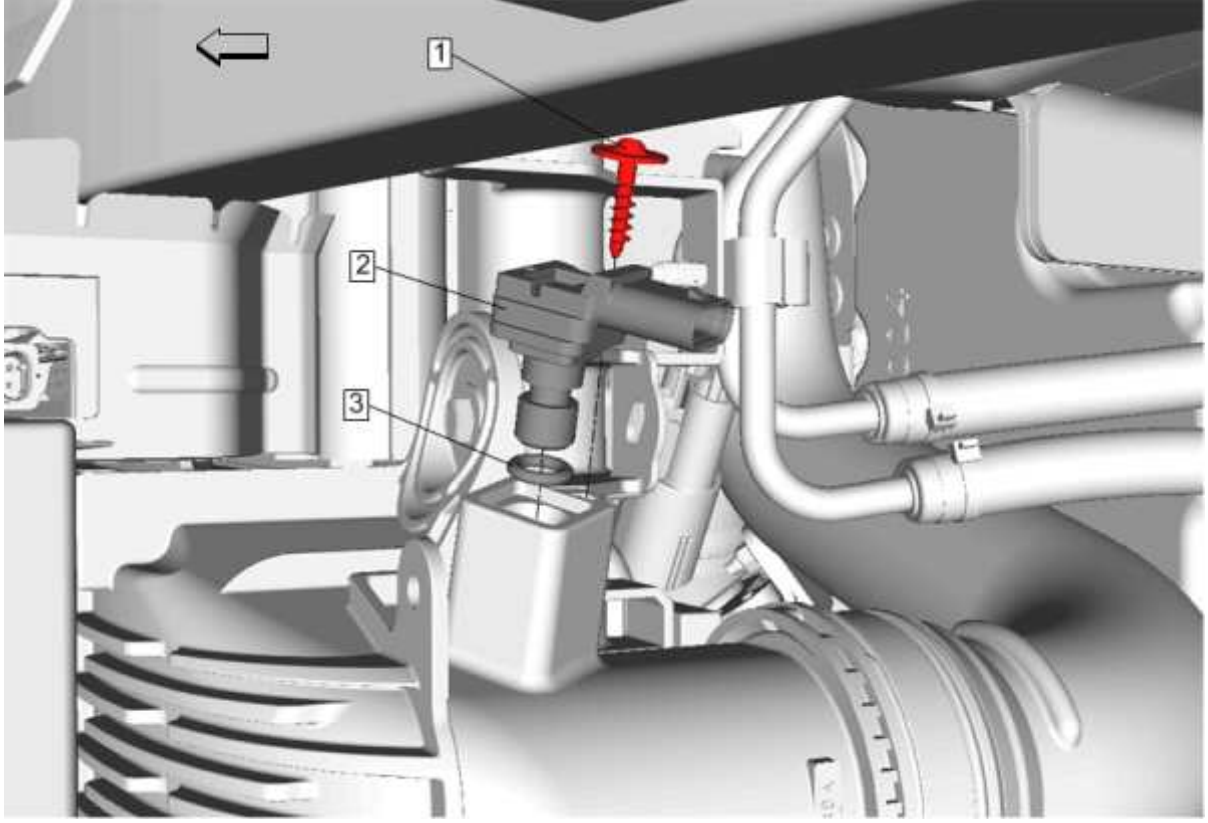

Fig. 240: Turbocharger Air Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Front Bumper Fascia Replacement (Equinox) Front Bumper Fascia Replacement (Terrain) 2. Disconnect the electrical connector.	
1	Turbocharger Air Pressure Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 3.8 N.m (34 lb in)
2	Turbocharger Air Pressure Sensor
3	Turbocharger Air Pressure Sensor Seal **Procedure** 1. DISCARD the seal. 2. Lubricate the NEW seal with clean engine oil. Adhesives, Fluids, Lubricants, and Sealers 3. Perform the intake system learned values reset. Intake System Learned Values Reset

TURBOCHARGER BYPASS VALVE SOLENOID REPLACEMENT

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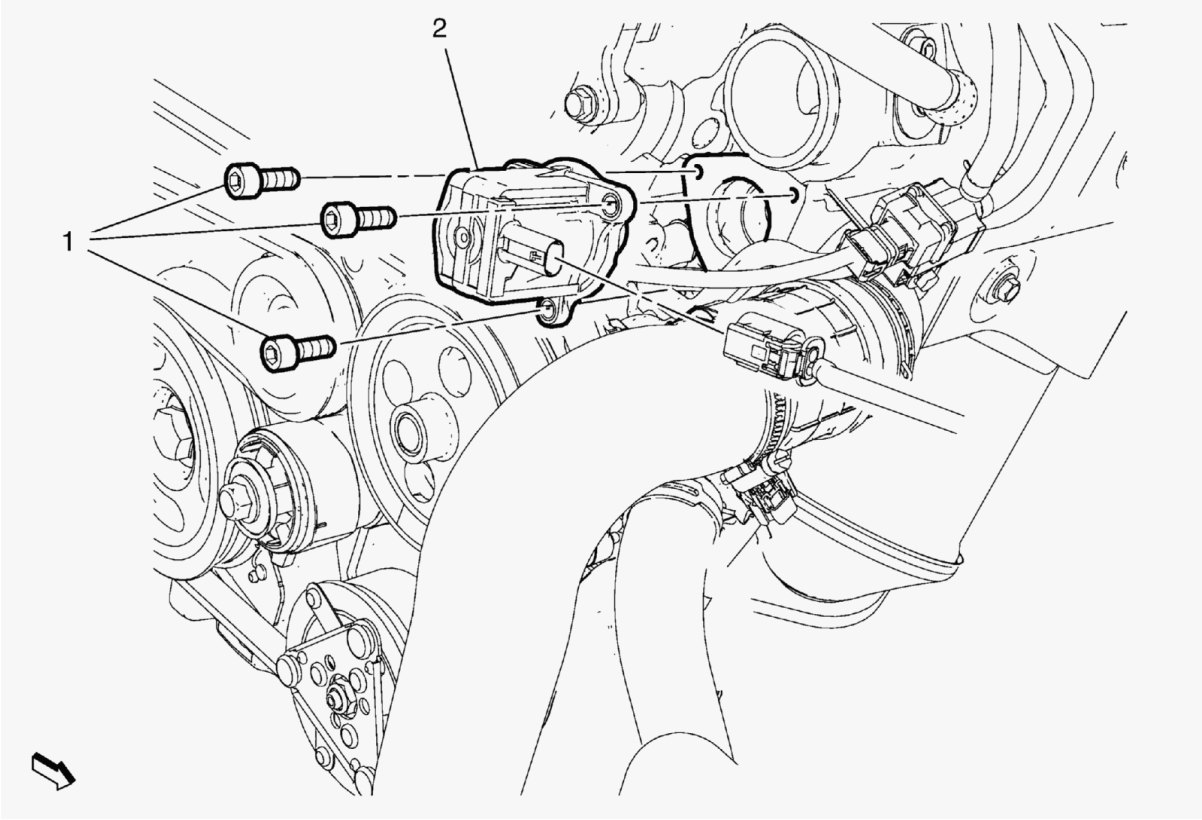

Fig. 241: Turbocharger Bypass Valve Solenoid
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Air Cleaner Outlet Duct Replacement	
1	Turbocharger Bypass Valve Solenoid Bolt [3x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Turbocharger Bypass Valve Solenoid **Procedure** 1. Disconnect the electrical connector. 2. Perform the intake system learned values reset. Intake System Learned Values Reset

TURBOCHARGER WASTEGATE ACTUATOR REPLACEMENT

Removal Procedure

1. Remove Turbocharger Heat Shield - Turbocharger Heat Shield Replacement

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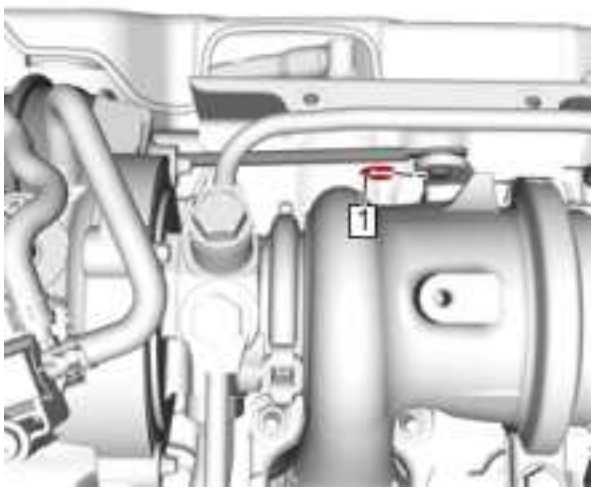

Fig. 242: Clip
Courtesy of GENERAL MOTORS COMPANY

2. Remove Clip (1)

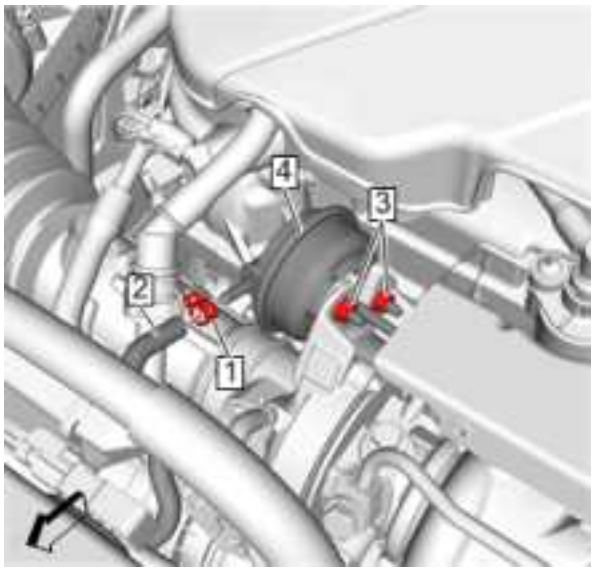

Fig. 243: Turbocharger Wastegate Actuator
Courtesy of GENERAL MOTORS COMPANY

3. Disengage Hose Clamp (1)**Hose Clamp Replacement Guidelines - Spring Type**
4. Disconnect Vacuum Hose (2)
5. Remove Turbocharger Wastegate Actuator Fastener (3)
6. Remove Turbocharger Wastegate Actuator (4)

Installation Procedure

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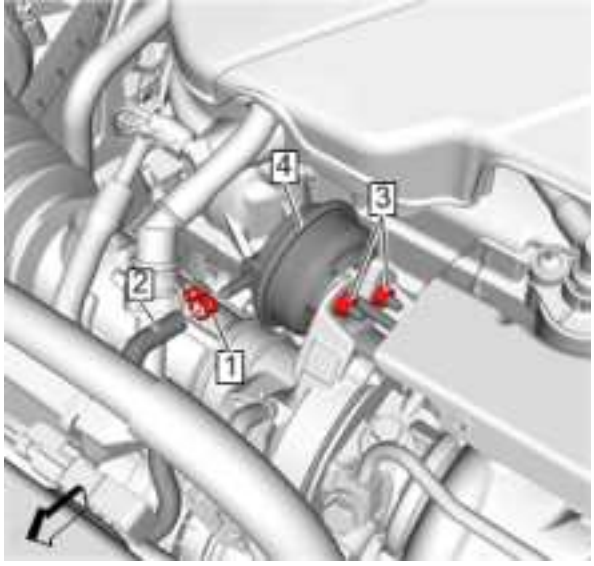

Fig. 244: Turbocharger Wastegate Actuator
Courtesy of GENERAL MOTORS COMPANY

1. Install Turbocharger Wastegate Actuator (4)

CAUTION: **Refer to Fastener Caution .**

2. Install Turbocharger Wastegate Actuator Fastener (3) and tighten 10 N.m (89 lb in)
3. Connect Vacuum Hose (2)
4. Engage Hose Clamp (1)**Hose Clamp Replacement Guidelines - Spring Type**

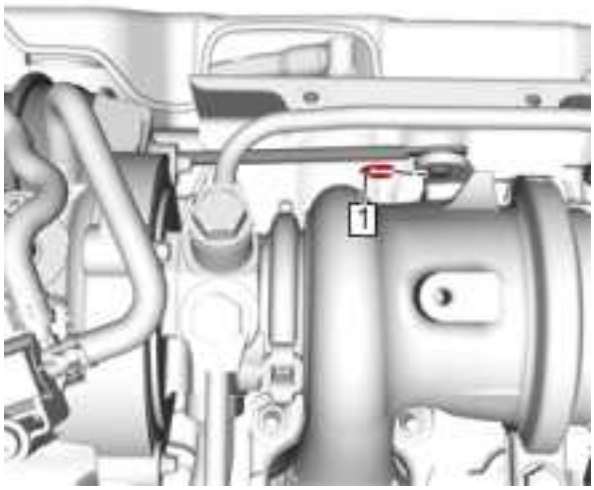

Fig. 245: Clip
Courtesy of GENERAL MOTORS COMPANY

5. Install Clip (1)
6. Install Turbocharger Heat Shield - **Turbocharger Heat Shield Replacement**

TURBOCHARGER WASTEGATE REGULATOR SOLENOID VALVE REPLACEMENT

Removal Procedure

1. Disconnect Battery Negative Cable - **Battery Negative Cable Disconnection and Connection (KL9)**
2. Disconnect the positive crankcase ventilation tube (foul air) from the turbocharger assembly and position away. **Positive Crankcase Ventilation Tube Replacement (Fresh Air)** **Positive Crankcase Ventilation Tube Replacement (Foul Air)**
3. Remove Air Cleaner Outlet Duct - **Air Cleaner Outlet Duct Replacement**

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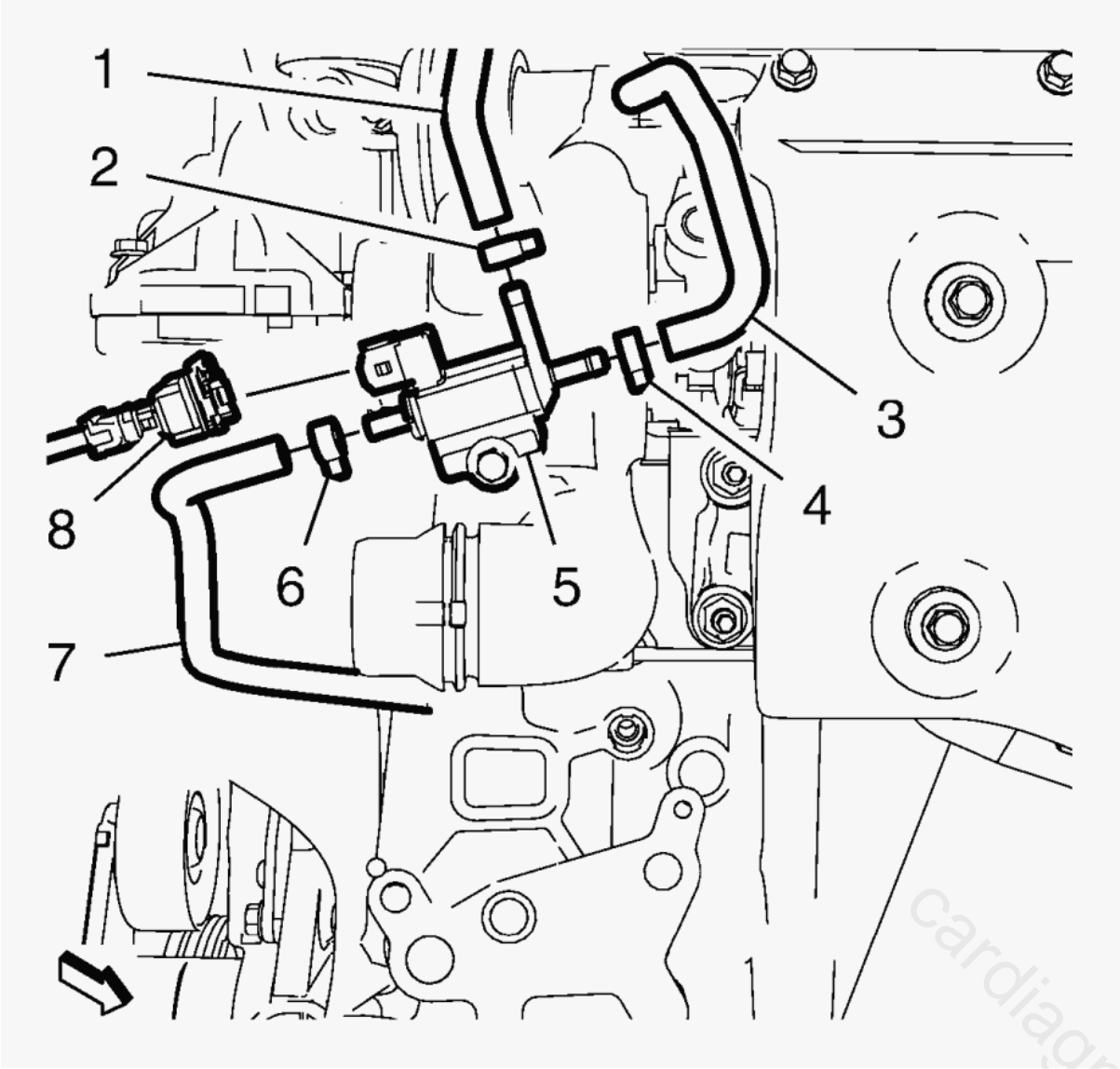

Fig. 246: Turbocharger Wastegate Regulator Solenoid Valve Components
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the turbocharger wastegate regulator solenoid valve electrical connector (8) from the turbocharger wastegate regulator solenoid valve (5).
5. Disengage Hose Clamp (2, 4, 6) - **Hose Clamp Replacement Guidelines - Spring Type**
6. Remove the 3 turbocharger wastegate regulator solenoid valve hoses (1, 3, 7) from the turbocharger wastegate regulator solenoid valve (5).

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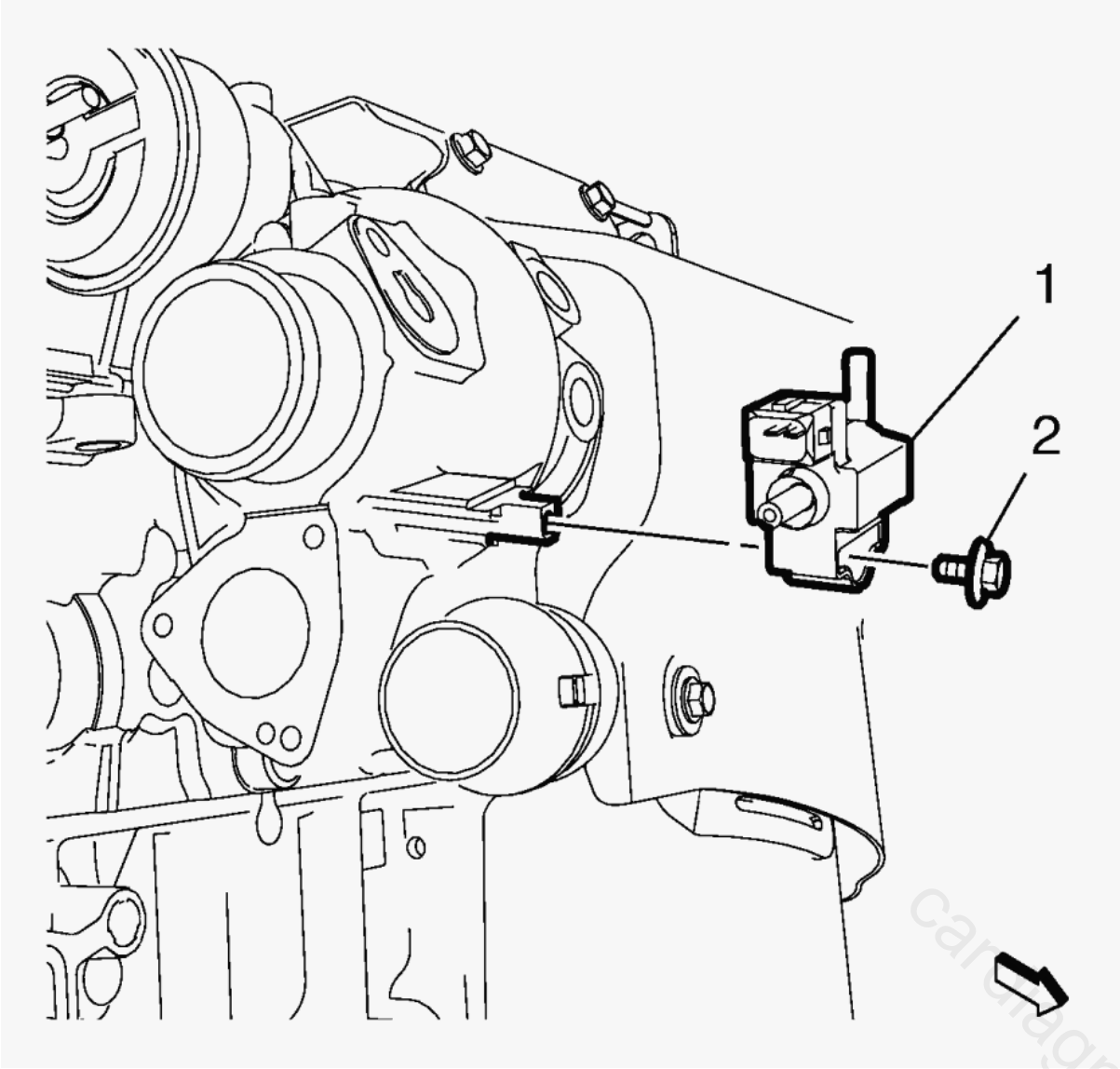

Fig. 247: Turbocharger Wastegate Regulator Solenoid Valve And Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove the turbocharger wastegate regulator solenoid valve bolt (2).
8. Remove the turbocharger wastegate regulator solenoid valve (1).

Installation Procedure

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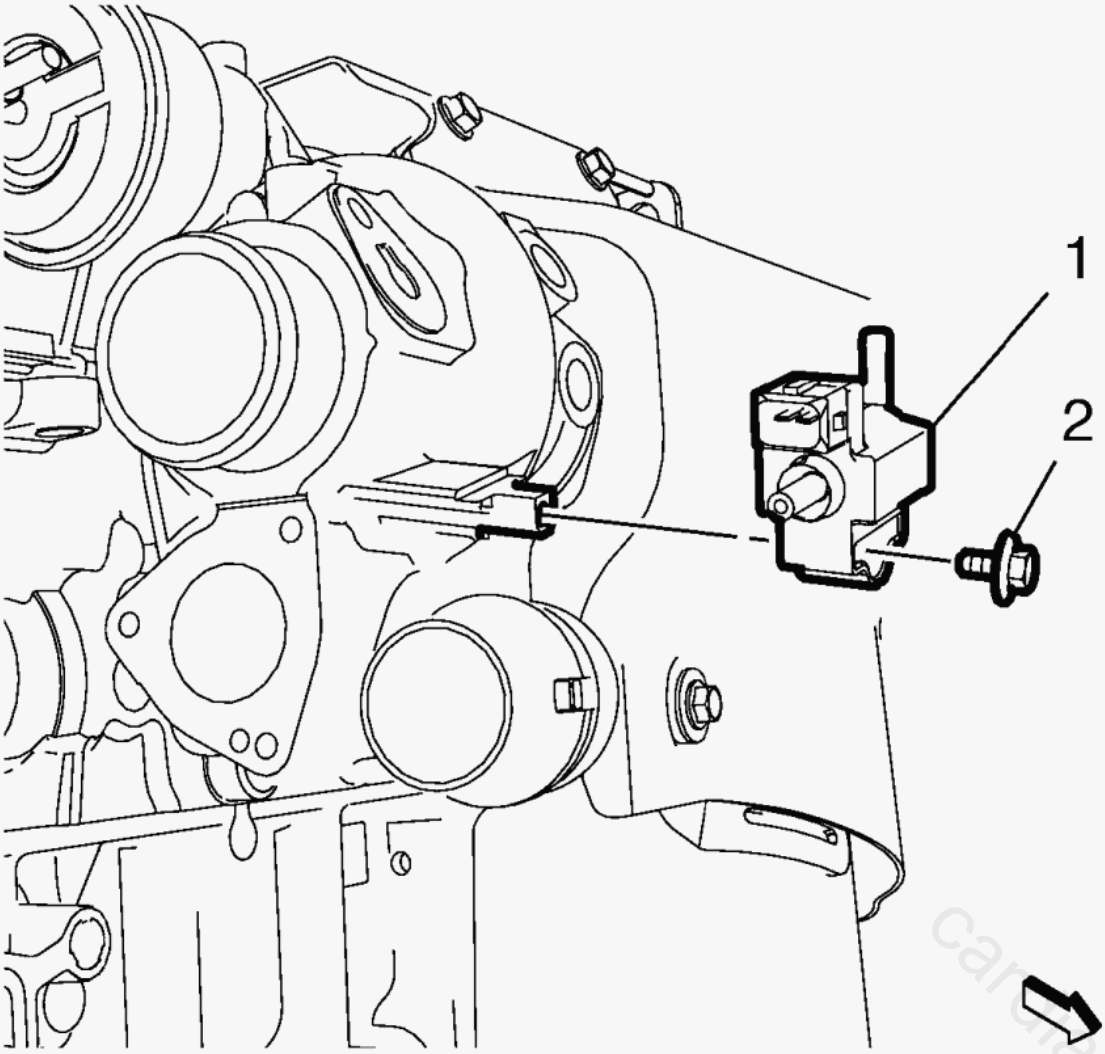

Fig. 248: Turbocharger Wastegate Regulator Solenoid Valve And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the turbocharger wastegate regulator solenoid valve (1).

CAUTION: **Refer to Fastener Caution .**

2. Install the turbocharger wastegate regulator solenoid valve bolt (2) and tighten to 8 N.m (71 lb in).

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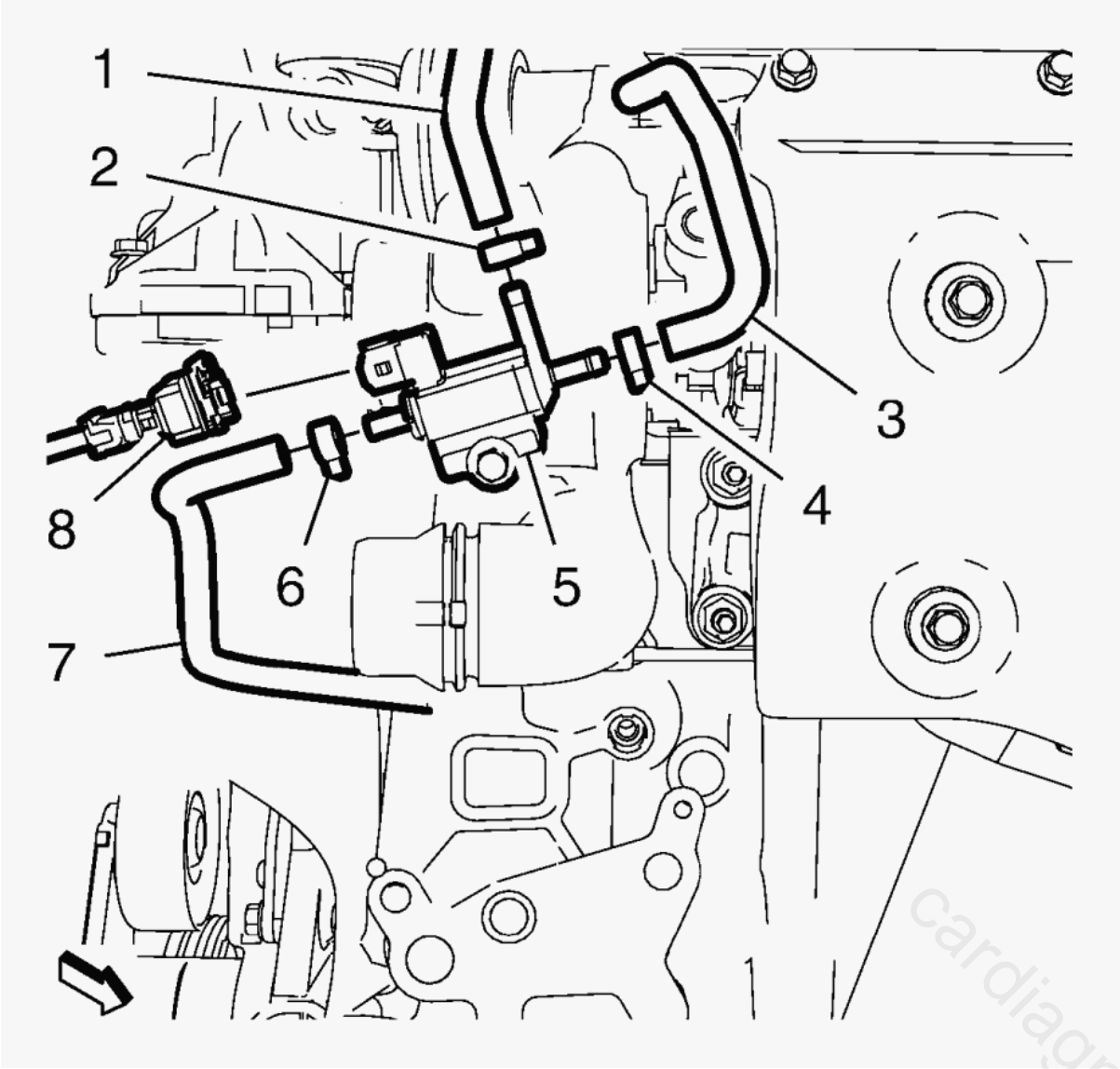

Fig. 249: Turbocharger Wastegate Regulator Solenoid Valve Components
Courtesy of GENERAL MOTORS COMPANY

3. Install the 3 turbocharger wastegate regulator solenoid valve hoses (1, 3, 7) to the turbocharger wastegate regulator solenoid valve (5).
4. Engage Hose Clamp (2, 4, 6) - **Hose Clamp Replacement Guidelines - Spring Type**
5. Connect the turbocharger wastegate regulator solenoid valve wiring harness plug (8) to the turbocharger wastegate regulator solenoid valve (5).
6. Install Air Cleaner Outlet Duct - **Air Cleaner Outlet Duct Replacement**
7. Connect the positive crankcase ventilation tube (foul air) to the turbocharger assembly. **Positive Crankcase Ventilation Tube Replacement (Fresh Air)** **Positive Crankcase Ventilation Tube Replacement (Foul Air)**
8. Connect Battery Negative Cable - **Battery Negative Cable Disconnection and Connection (KL9)**
9. Perform the Intake System Learned Values Reset. **Intake System Learned Values Reset**

TURBOCHARGER WASTEGATE REGULATOR SOLENOID VALVE HOSE REPLACEMENT (WASTEGATE SOLENOID TO ACTUATOR)

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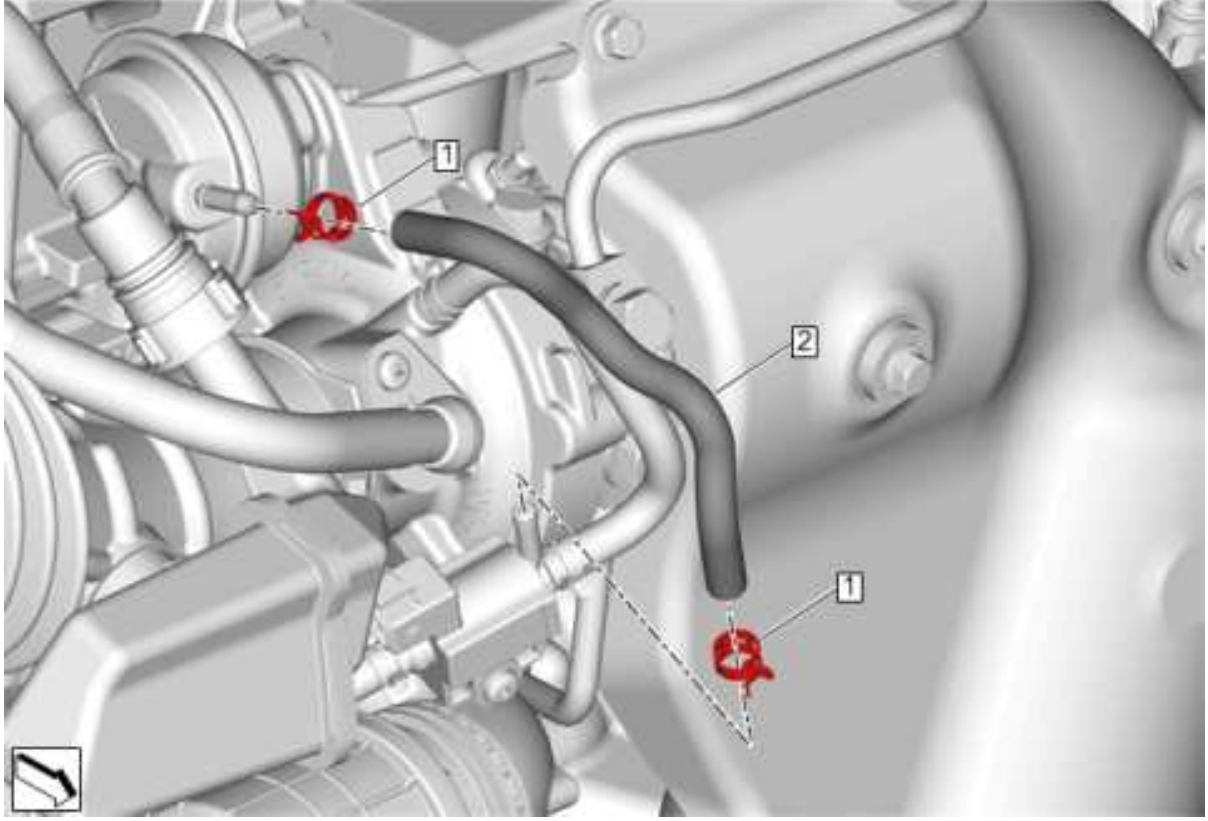

Fig. 250: Turbocharger Wastegate Regulator Solenoid Valve Hose (Wastegate Actuator to Solenoid Valve)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger Wastegate Regulator Solenoid Valve Hose Clamp
2	Turbocharger Wastegate Regulator Solenoid Valve Hose

TURBOCHARGER WASTEGATE REGULATOR SOLENOID VALVE HOSE REPLACEMENT (COMPRESSOR INLET TO SOLENOID)

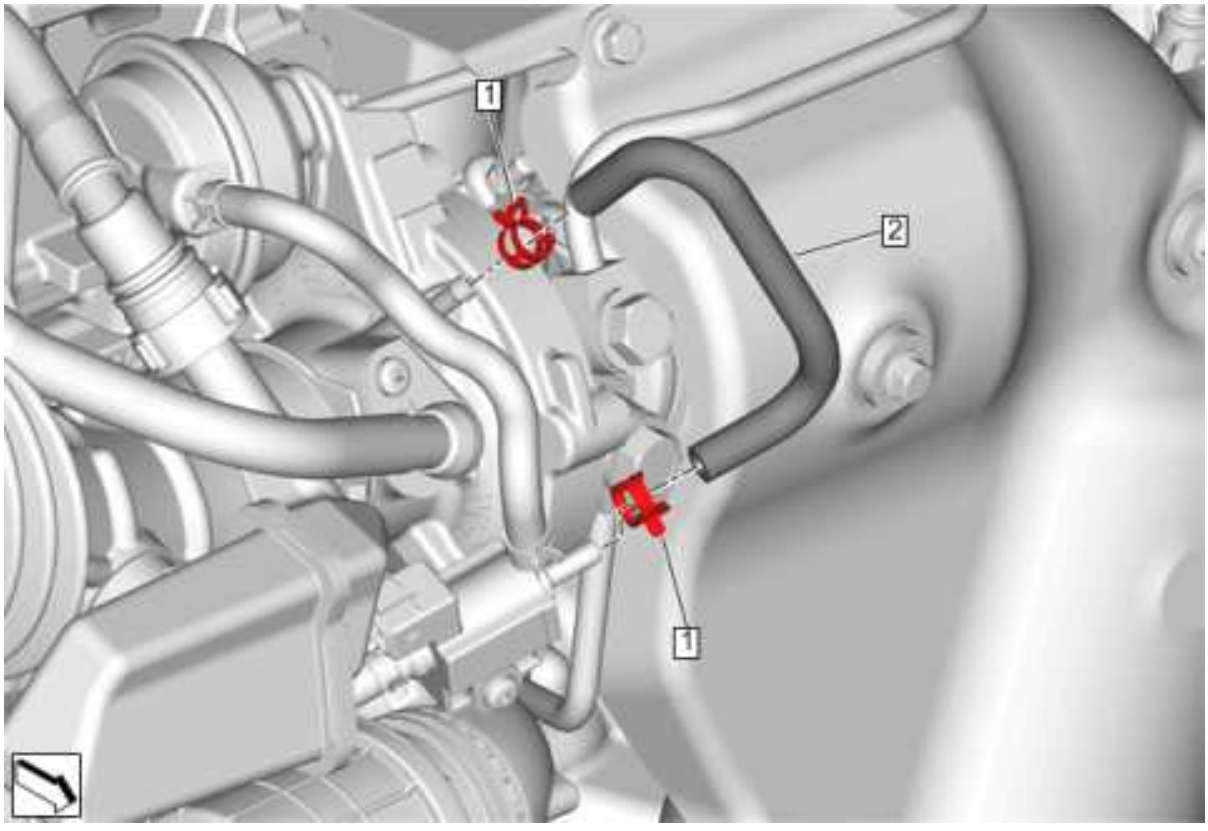

Fig. 251: Turbocharger Wastegate Regulator Solenoid Valve Hose (Compressor Inlet to Solenoid Valve)
Courtesy of GENERAL MOTORS COMPANY

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Callout	Component Name
1	Turbocharger Wastegate Regulator Solenoid Valve Hose Clamp
2	Turbocharger Wastegate Regulator Solenoid Valve Hose

TURBOCHARGER WASTEGATE REGULATOR SOLENOID VALVE HOSE REPLACEMENT (COMPRESSOR OUTLET TO SOLENOID)

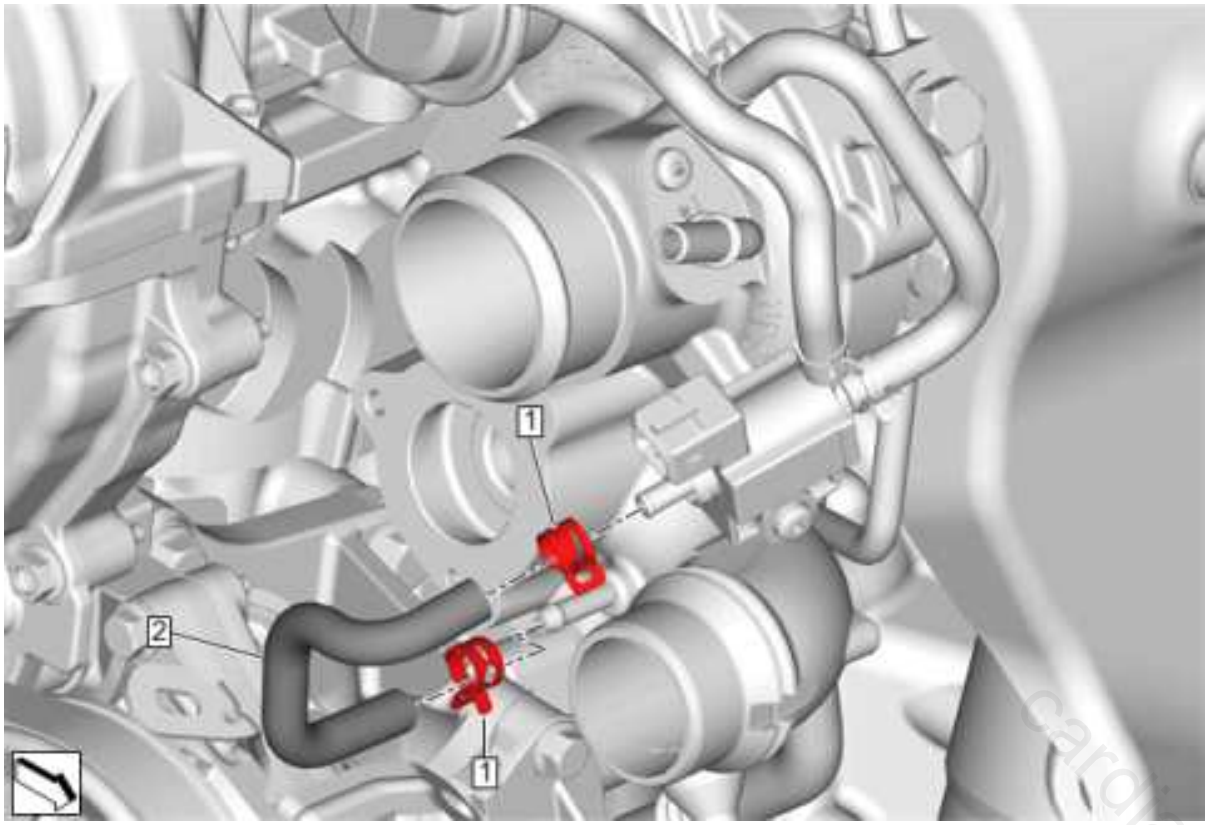

Fig. 252: Turbocharger Wastegate Regulator Solenoid Valve Hose (Compressor Outlet to Solenoid Valve)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Turbocharger Bypass Valve Solenoid Replacement	
1	Turbocharger Wastegate Regulator Solenoid Valve Hose Clamp
2	Turbocharger Wastegate Regulator Solenoid Valve Hose

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Back To Article

Engine Controls And Fuel - 1.5L (LYX) - Schematic And Routing Diagrams - Engine Controls Schematics - Equinox & Terrain

SCHEMATIC WIRING DIAGRAMS

ENGINE CONTROLS WIRING SCHEMATICS 1.5L (LYX)

Power, Ground, Serial Data, and MIL

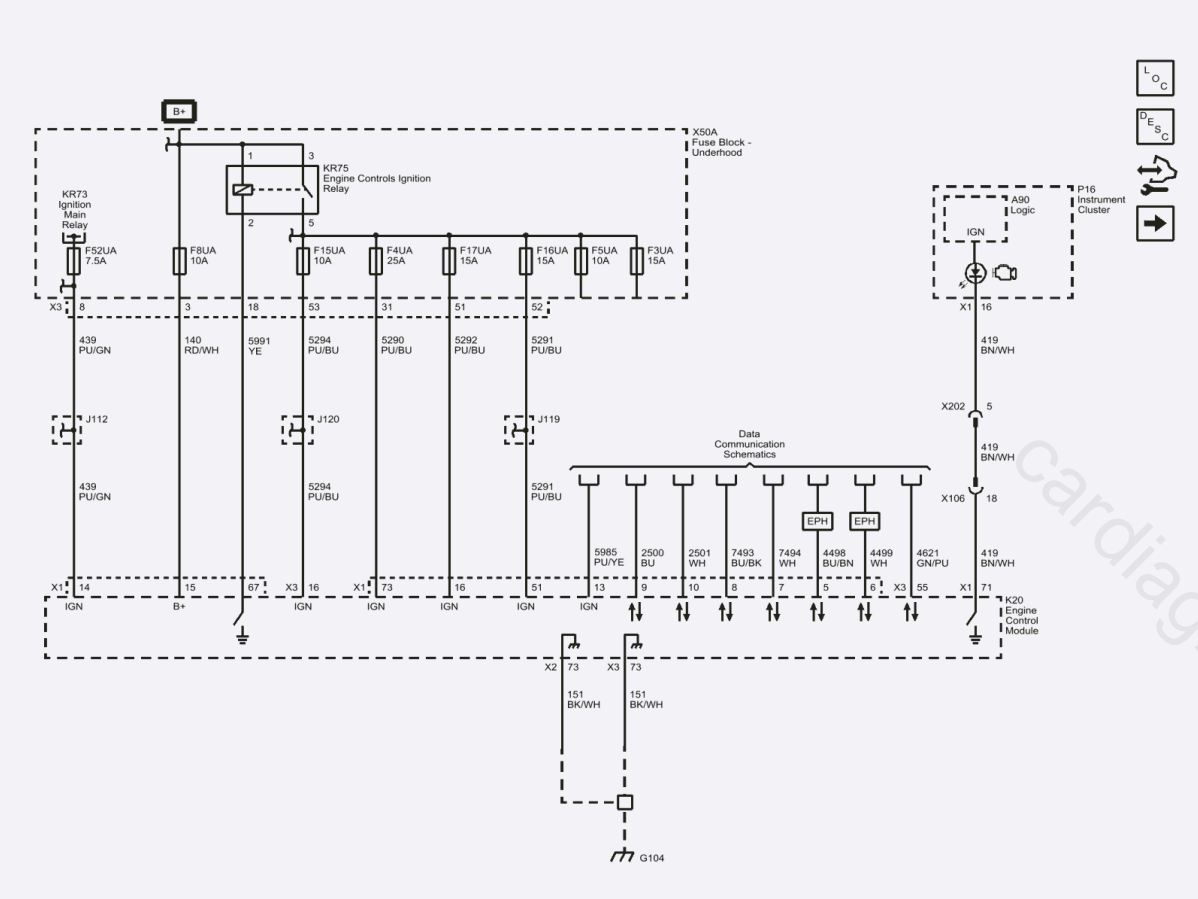

Fig. 1: Power, Ground, Serial Data, and MIL
Courtesy of GENERAL MOTORS COMPANY

5V1, 5V2, and Low Reference Bus (1 of 3)

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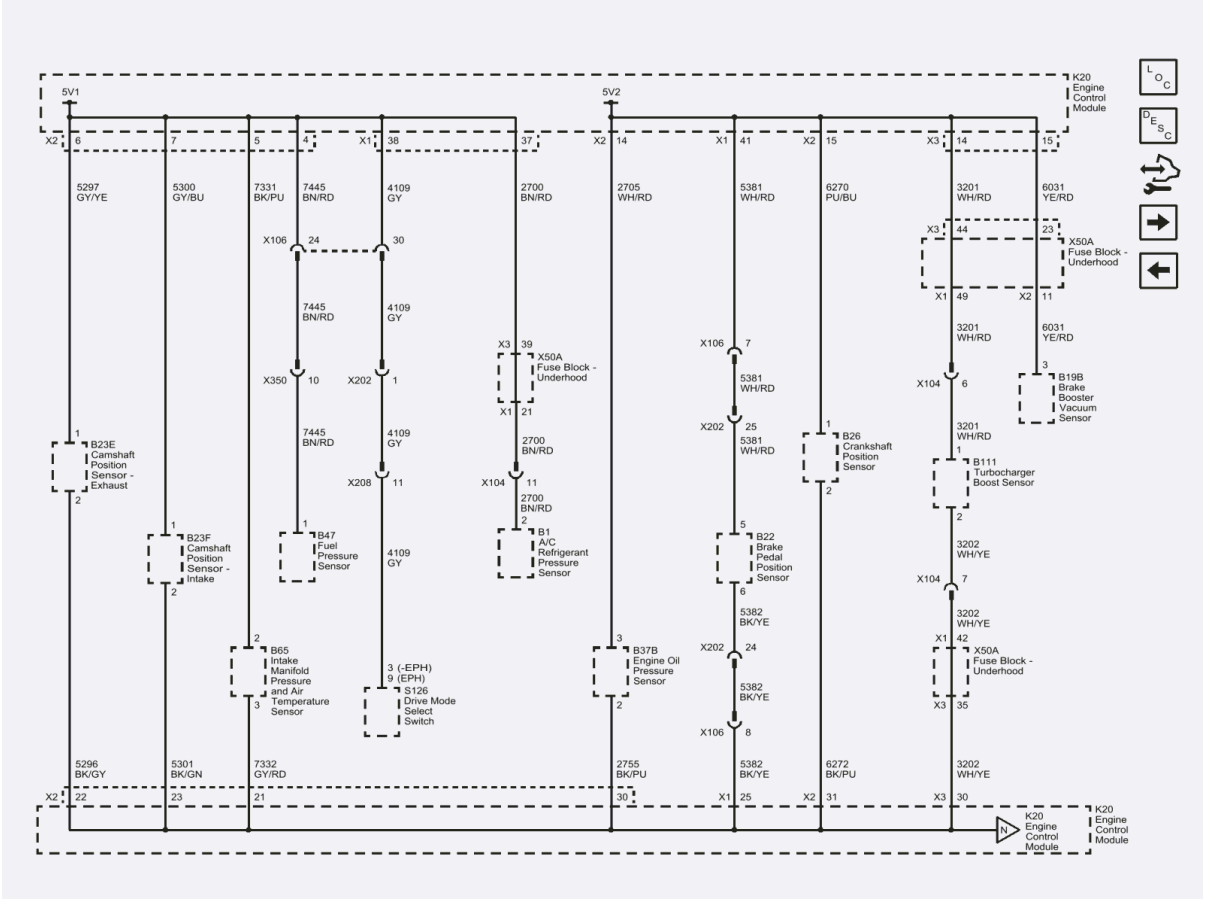

Fig. 2: 5V1, 5V2, and Low Reference Bus (1 of 3)
Courtesy of GENERAL MOTORS COMPANY

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5V3, 5V4, 5V5, and Low Reference Bus (2 of 3)

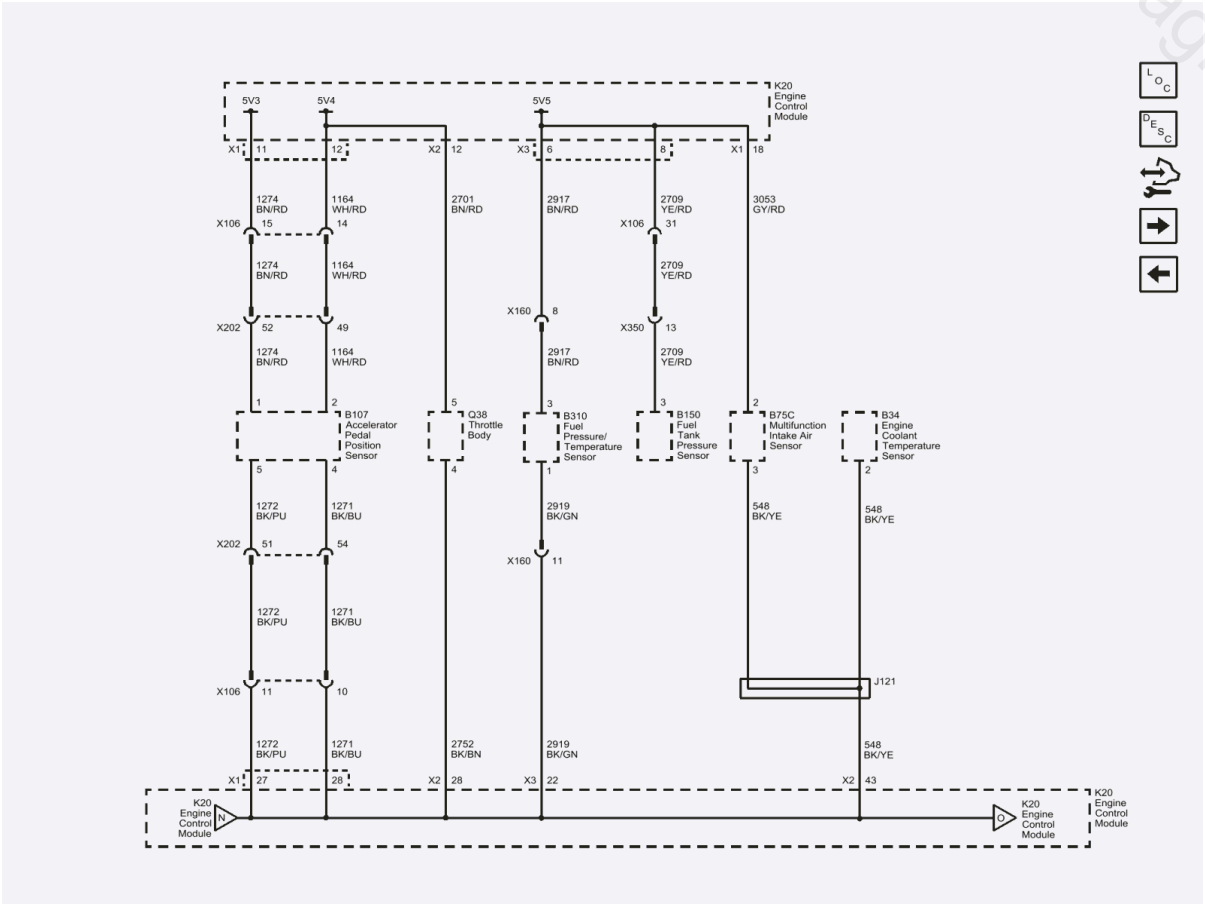

Fig. 3: 5V3, 5V4, 5V5, and Low Reference Bus (2 of 3)
Courtesy of GENERAL MOTORS COMPANY

Low Reference Bus (3 of 3)

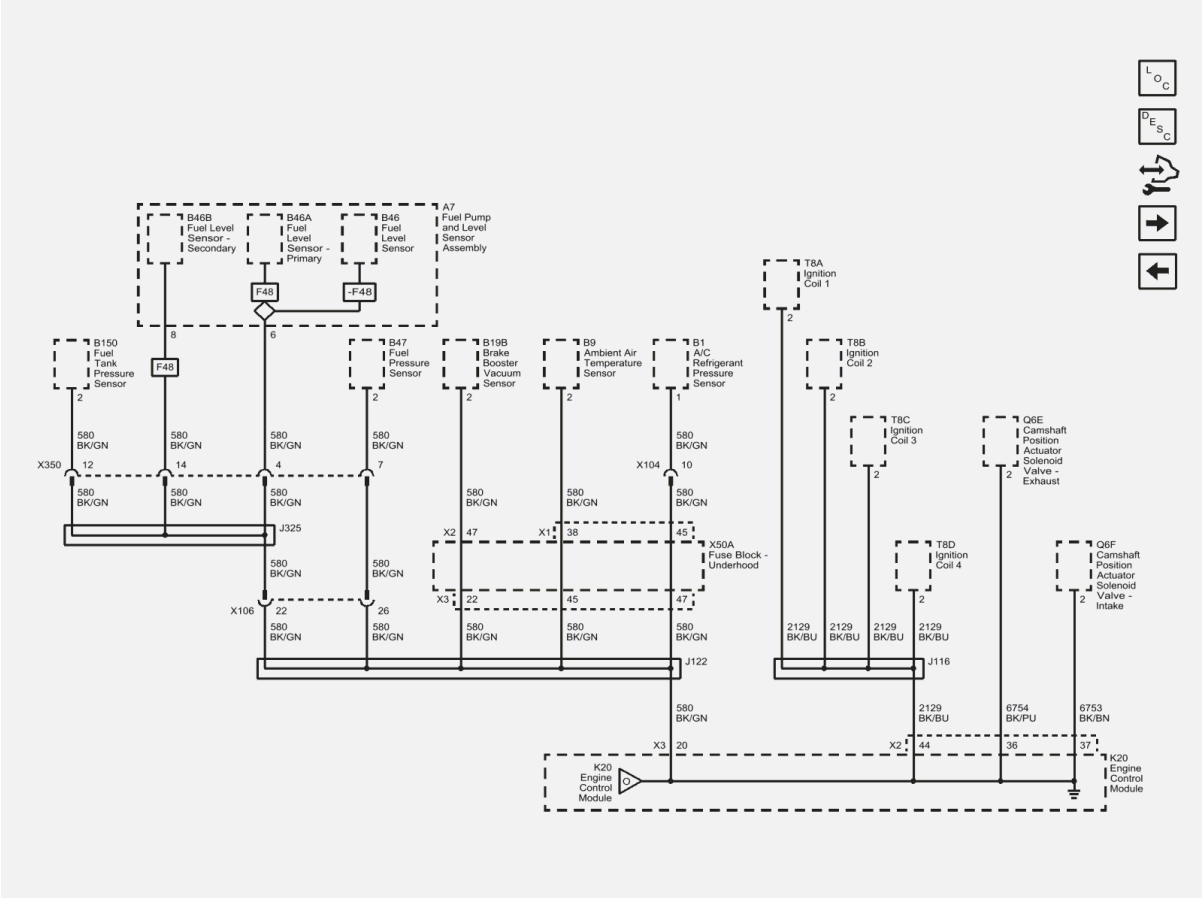

Fig. 4: Low Reference Bus (3 of 3)
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Pressure and Temperature

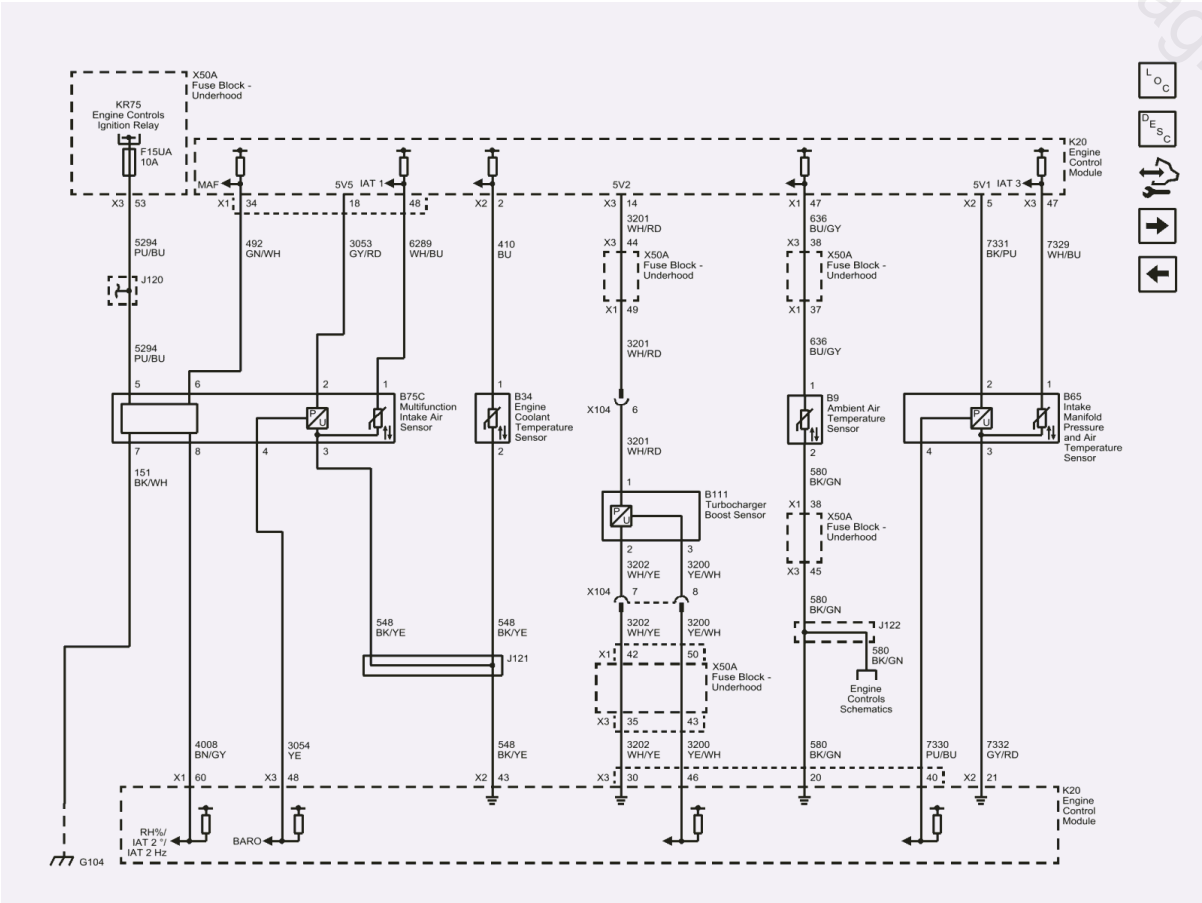

Fig. 5: Engine Data Sensors - Pressure and Temperature
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Throttle and Brake Sensor Controls

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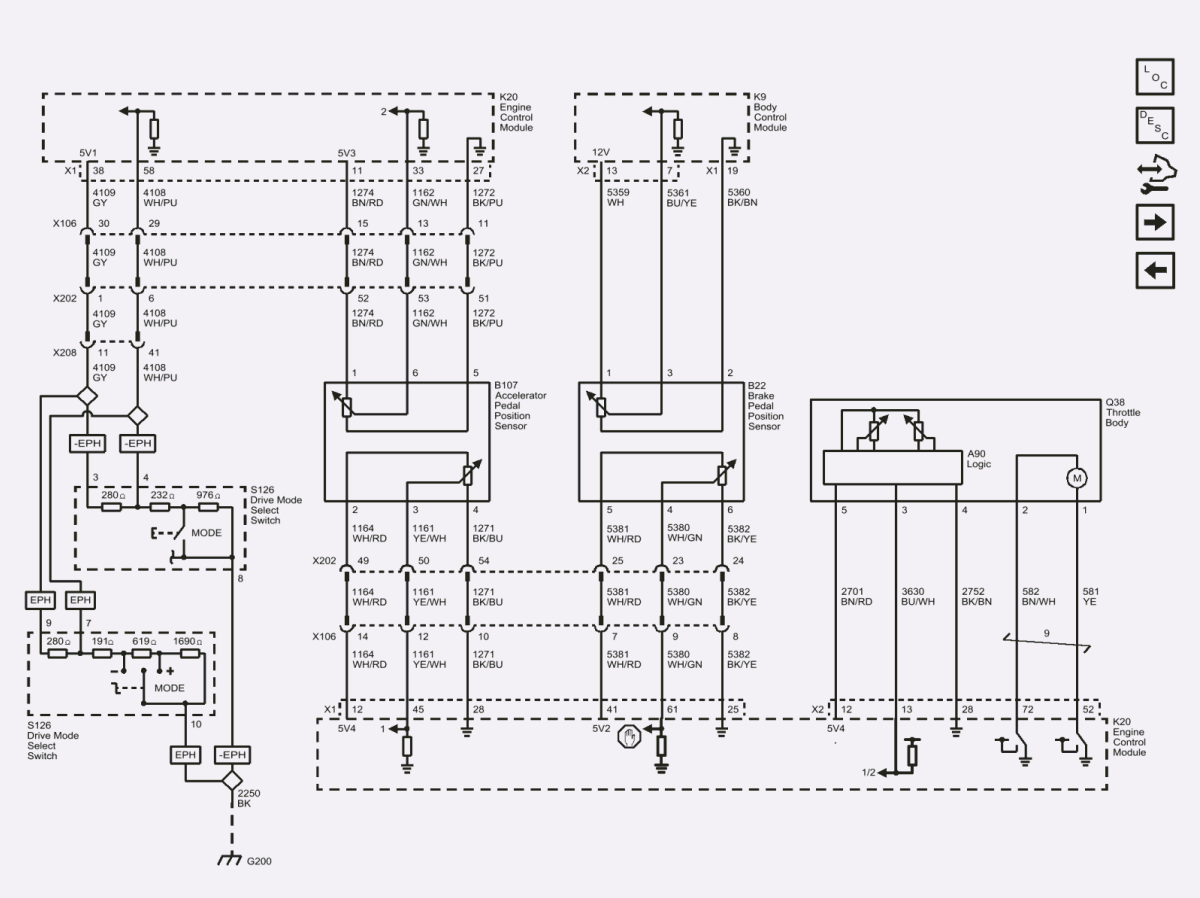

Fig. 6: Engine Data Sensors - Throttle and Brake Sensor Controls
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Oxygen Sensors

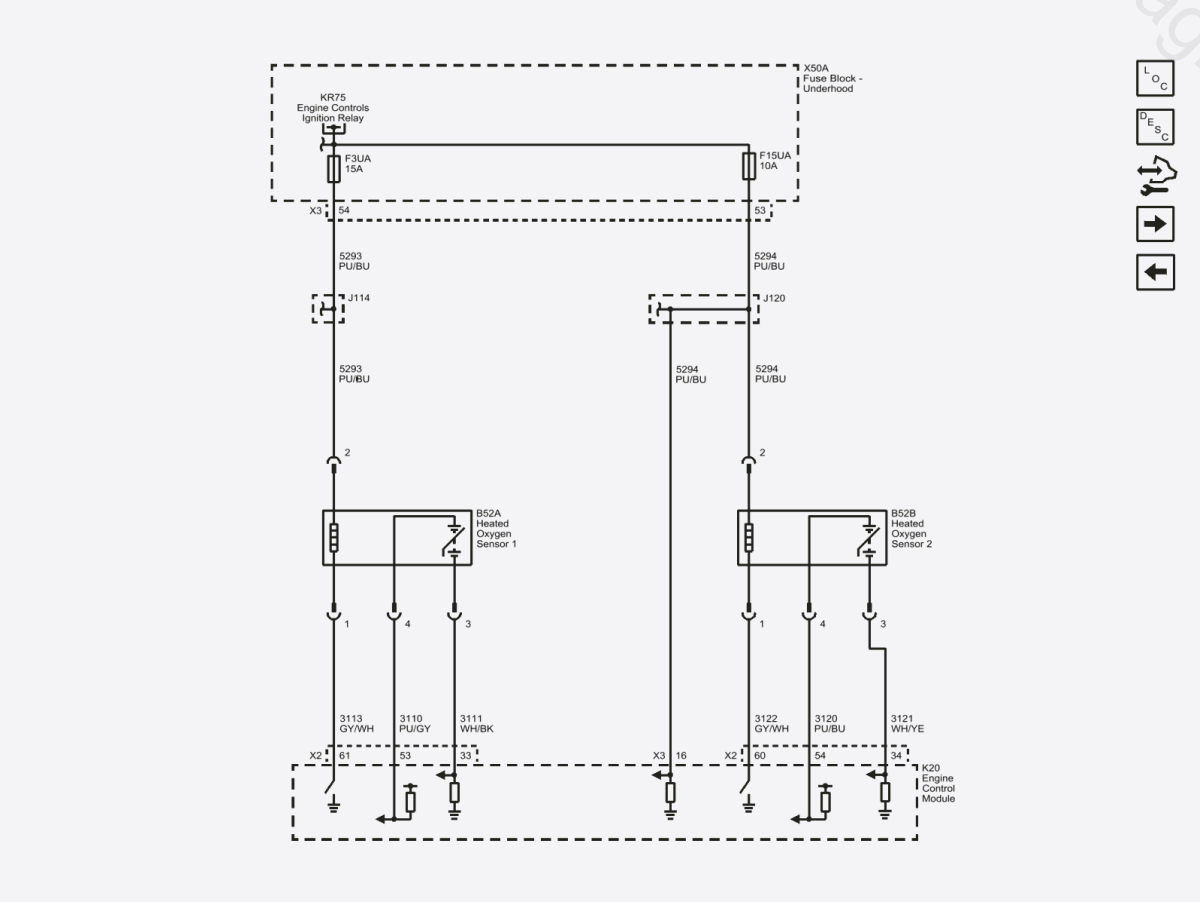

Fig. 7: Engine Data Sensors - Oxygen Sensors
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Ignition System

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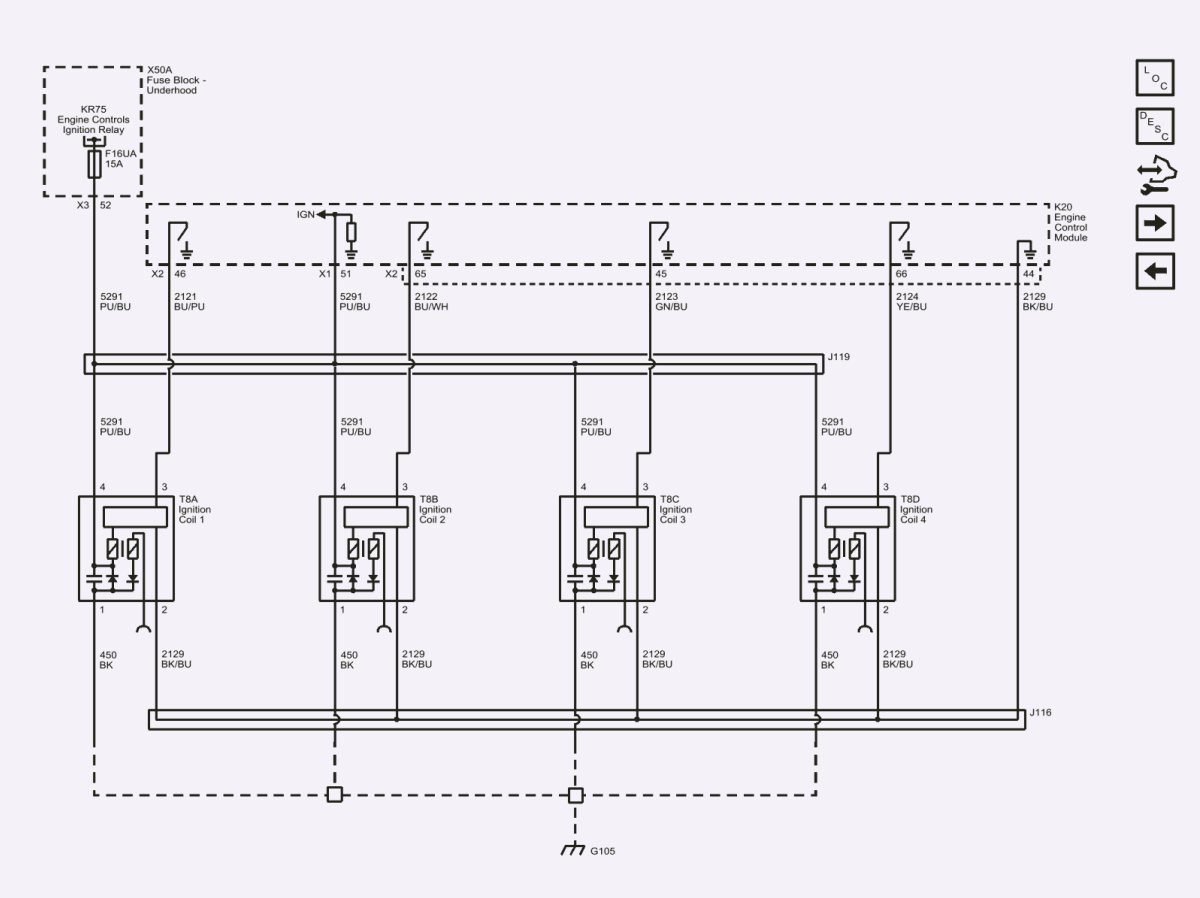

Fig. 8: Ignition Controls - Ignition System
Courtesy of GENERAL MOTORS COMPANY

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Ignition Controls - Camshaft, Crankshaft, Knock Sensors, and Camshaft Position Actuators

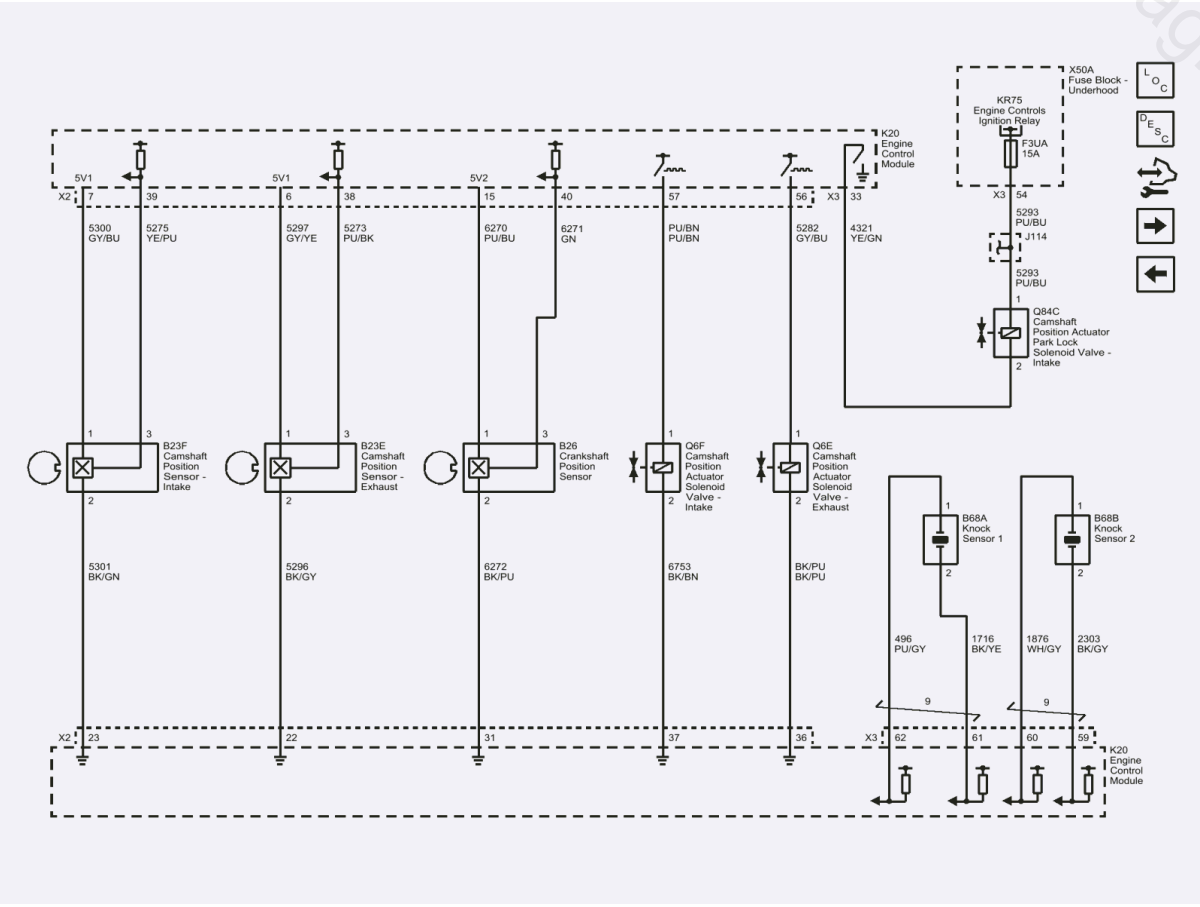

Fig. 9: Ignition Controls - Camshaft, Crankshaft, Knock Sensors, and Camshaft Position Actuators
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Injectors

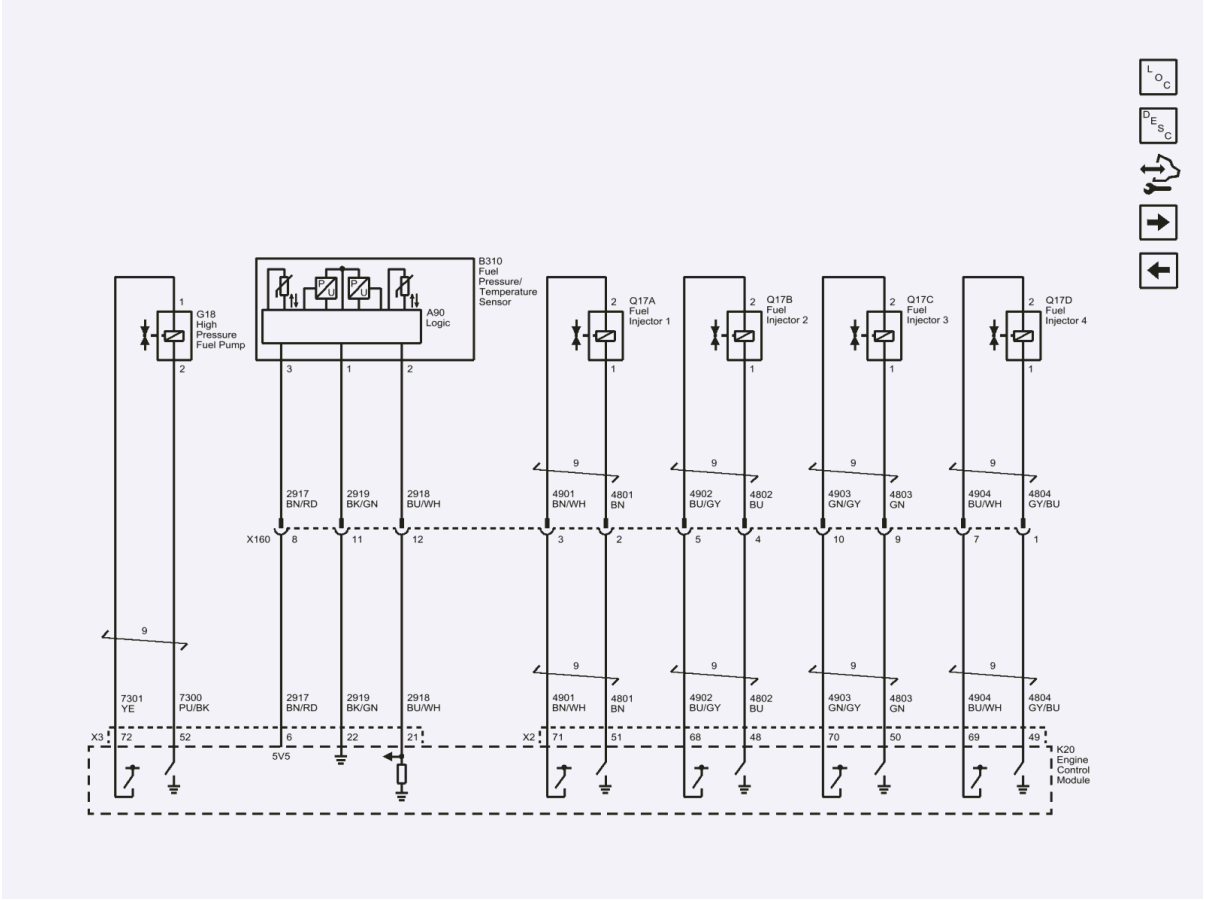

Fig. 10: Fuel Controls - Fuel Injectors
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Pump and Fuel Pump Controls

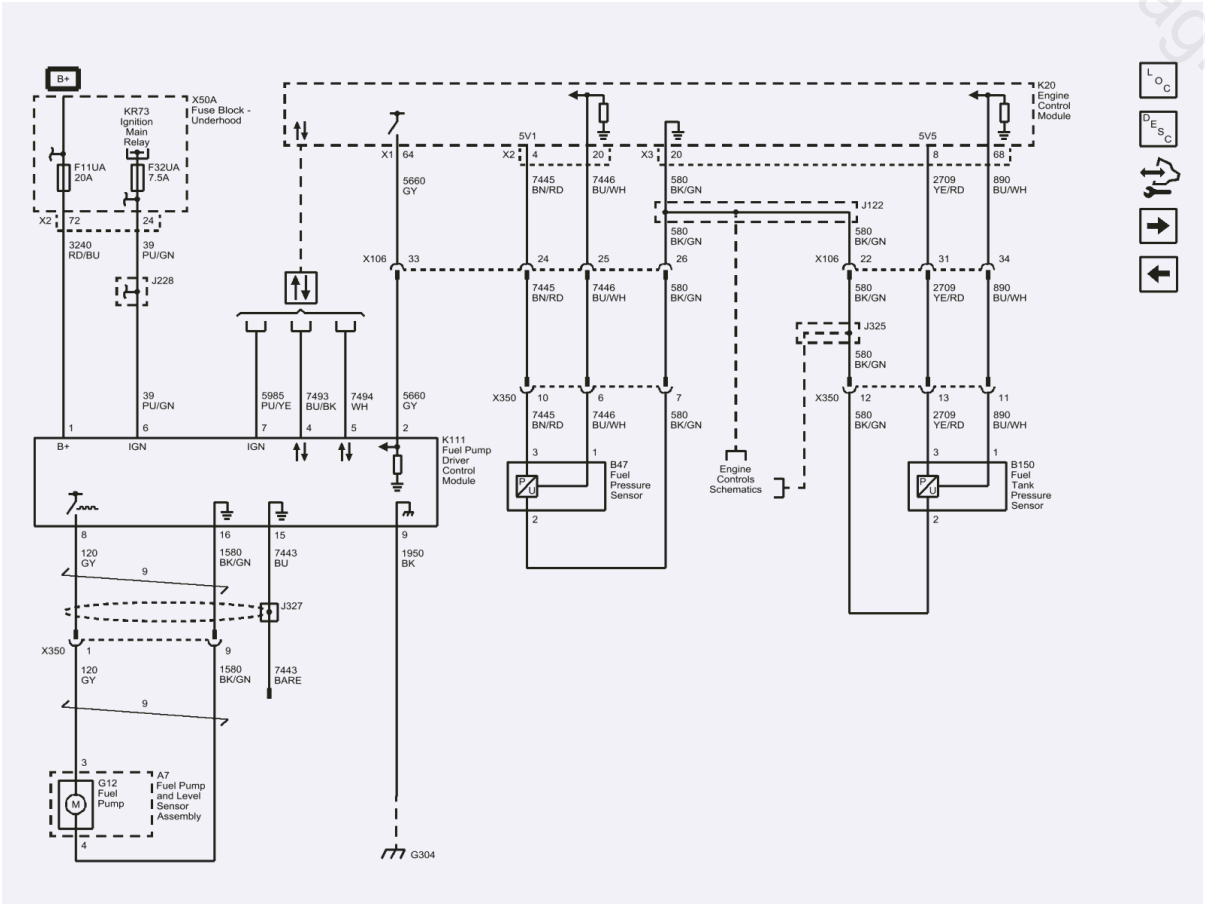

Fig. 11: Fuel Controls - Fuel Pump and Fuel Pump Controls
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Evaporative Emission, and Device Controls

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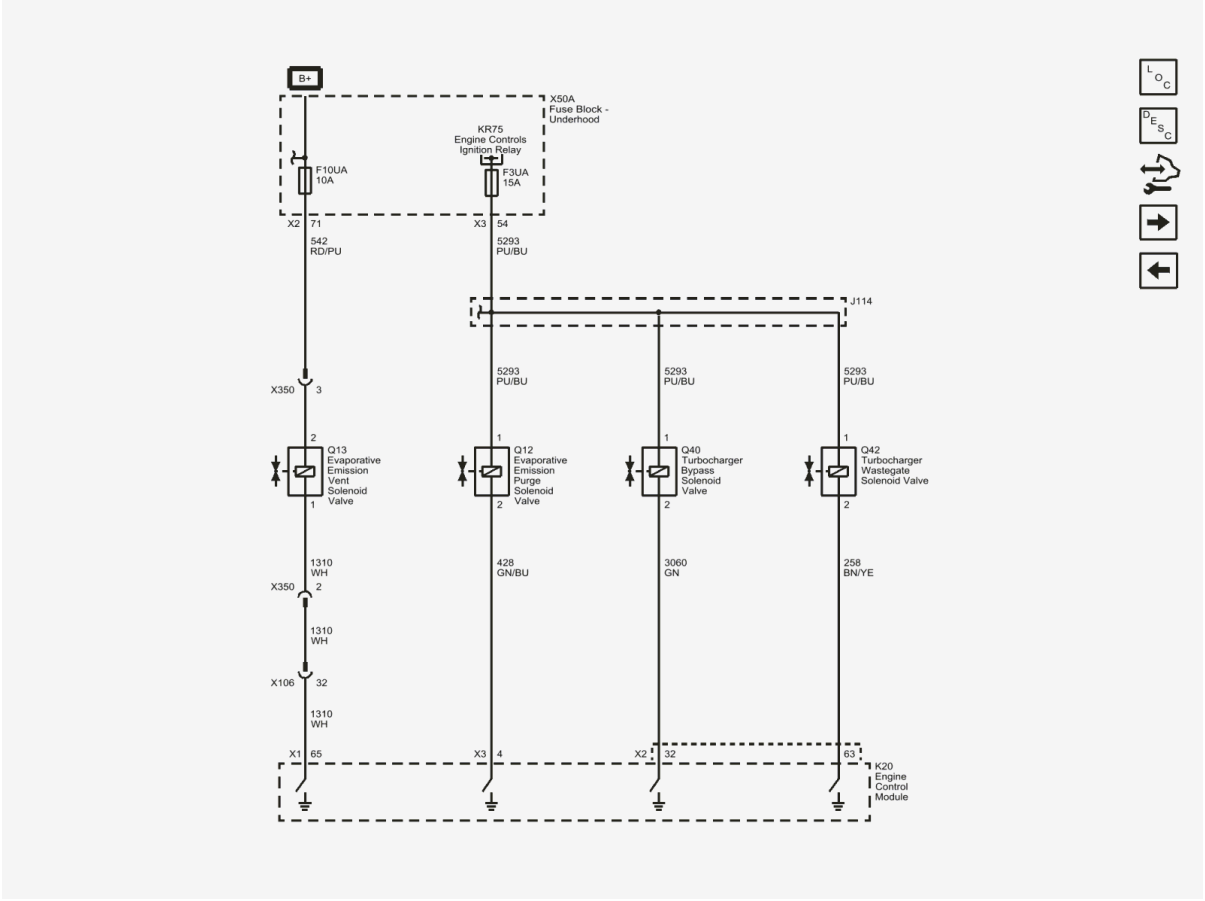


Fig. 12: Fuel Controls - Evaporative Emission, and Device Controls
Courtesy of GENERAL MOTORS COMPANY

cardiagn.com

Controlled/Monitored Subsystem References

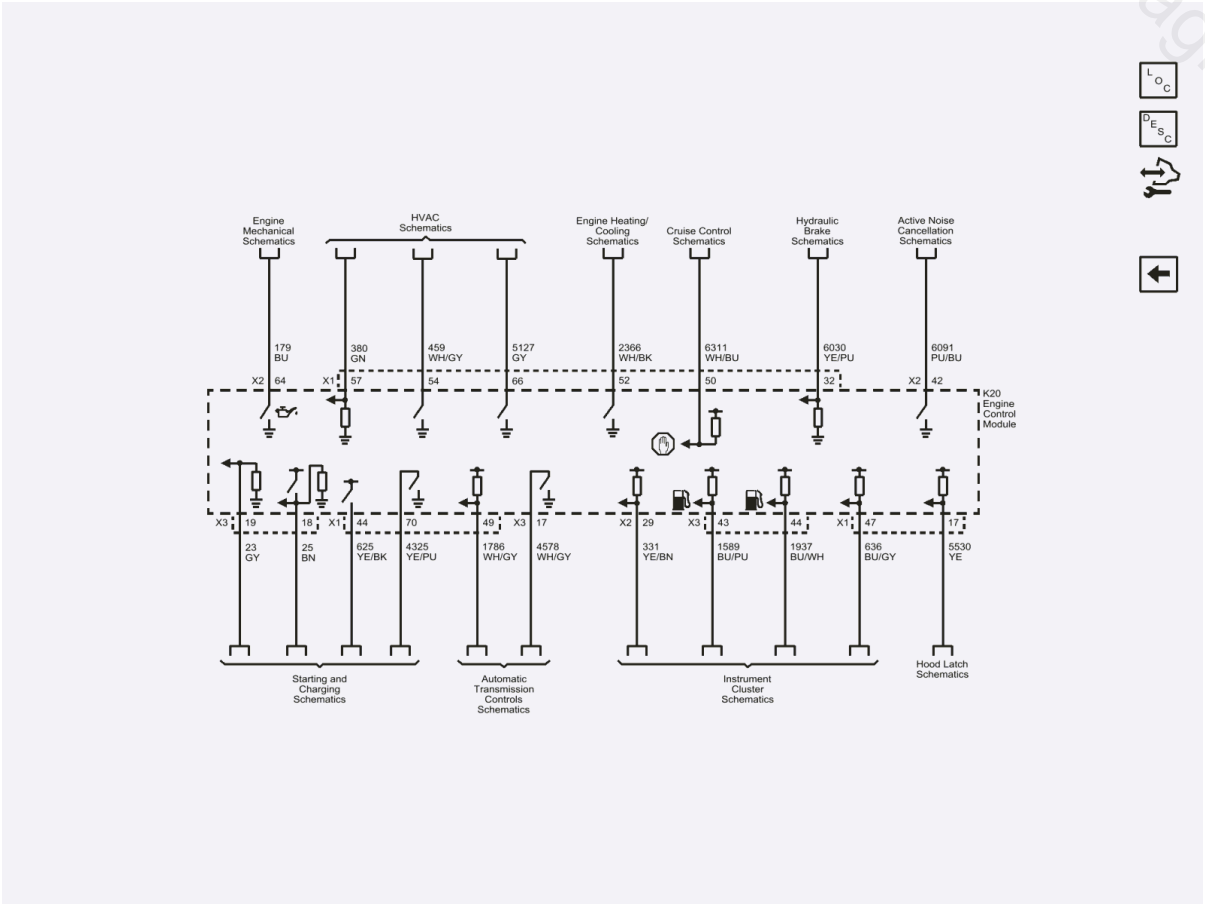
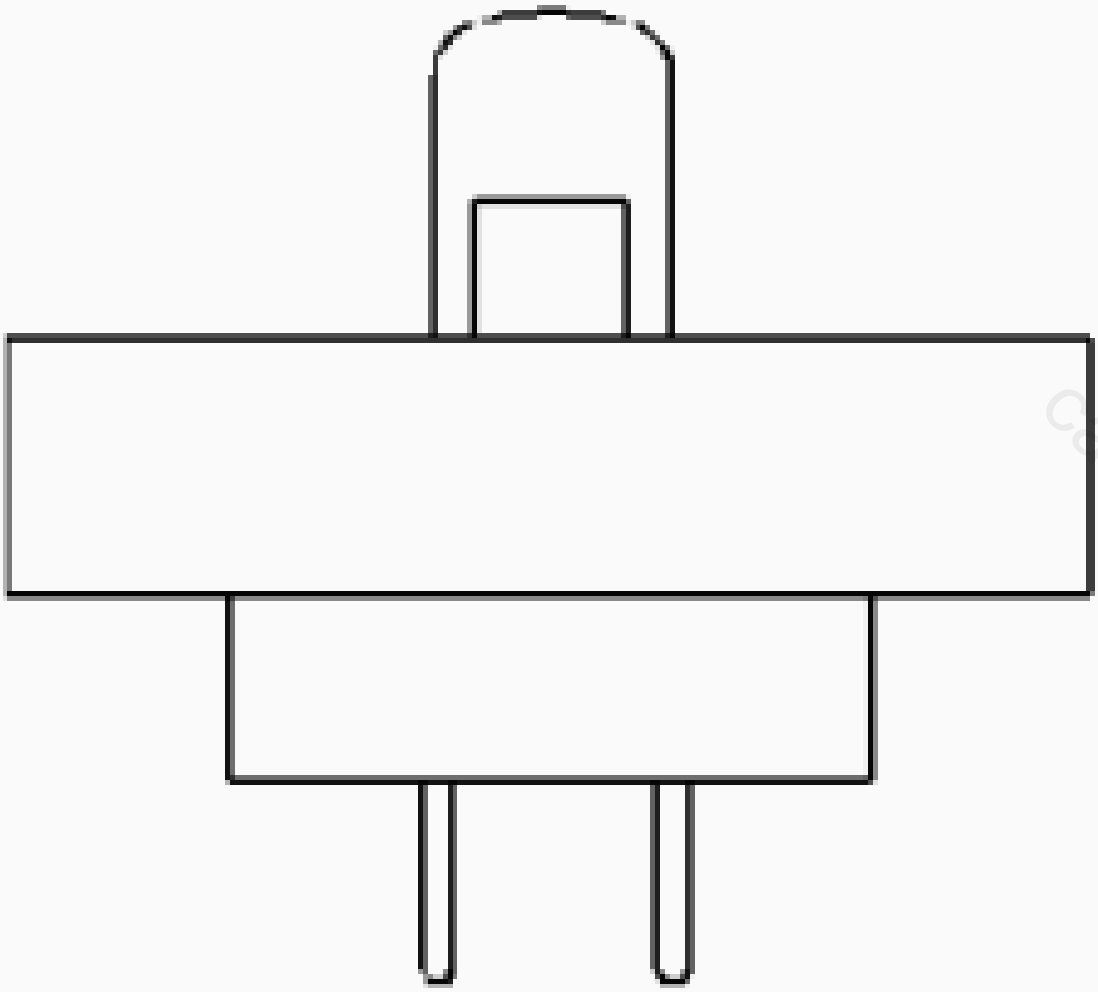


Fig. 13: Controlled/Monitored Subsystem References
Courtesy of GENERAL MOTORS COMPANY

cardiagn.com

SPECIAL TOOLS AND EQUIPMENT

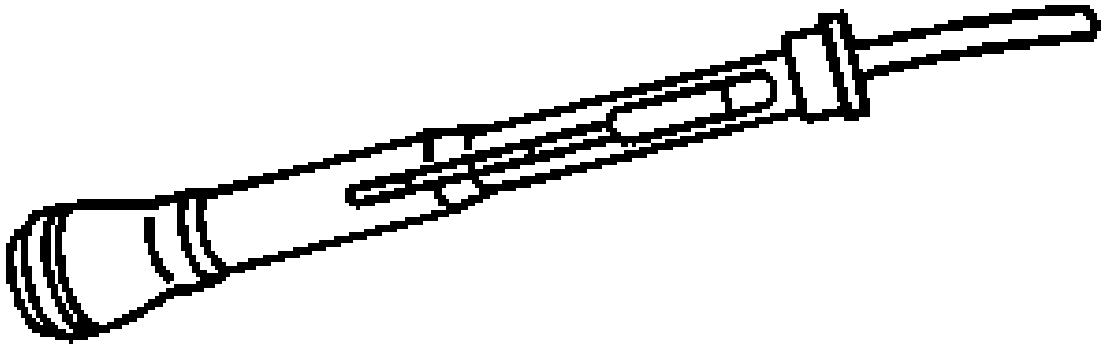
SPECIAL TOOLS (DIAGNOSTIC TOOLS)

Illustration	Tool Number/Description
	CH-34730-2C J-34730-2C Injector Test Lamp

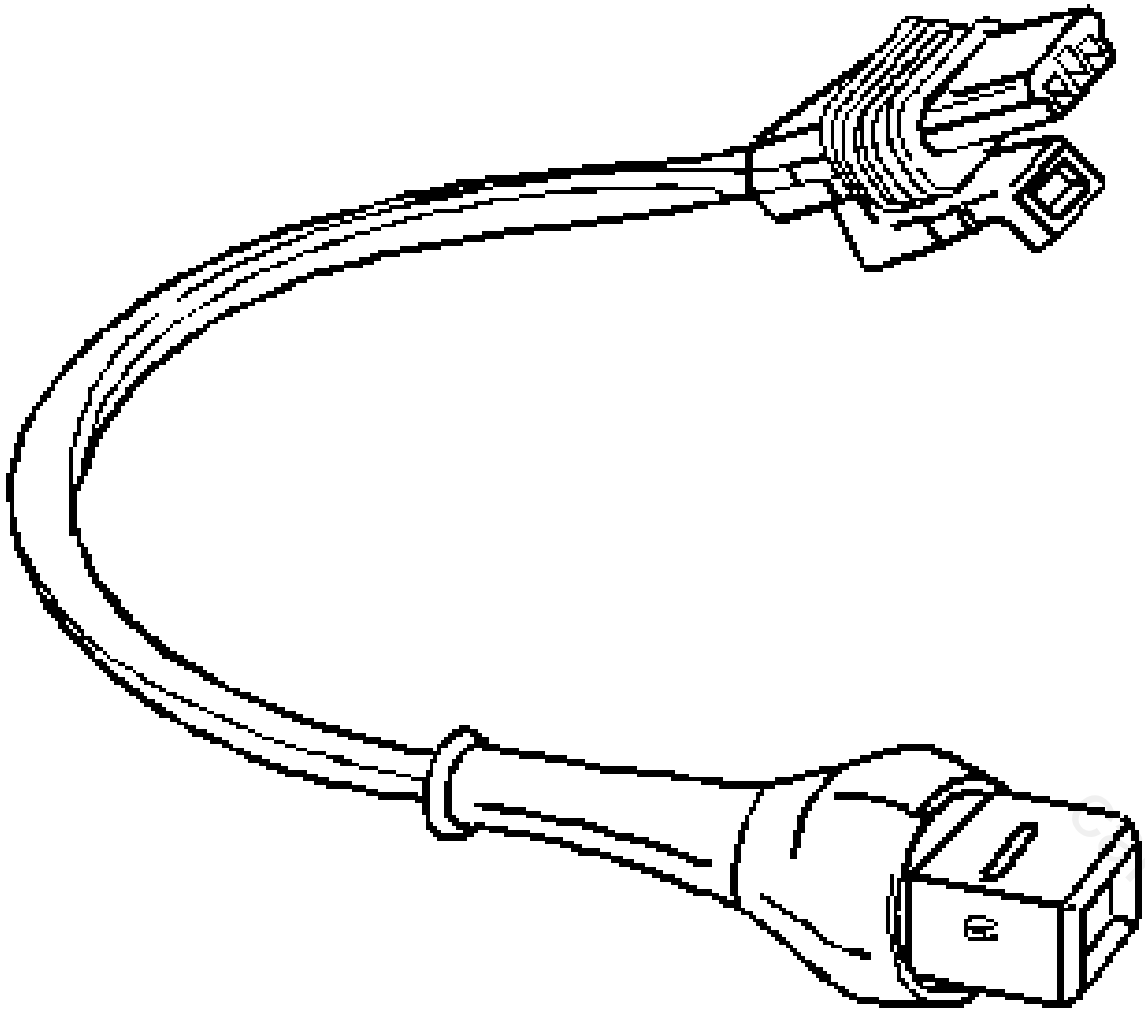
cardiagn.com

Illustration	Tool Number/Description
	CH-37287-1A Fuel Pressure Gauge Adapter 3/8"
	CH-38641-B J-38641-B Diesel Fuel Quality Tester

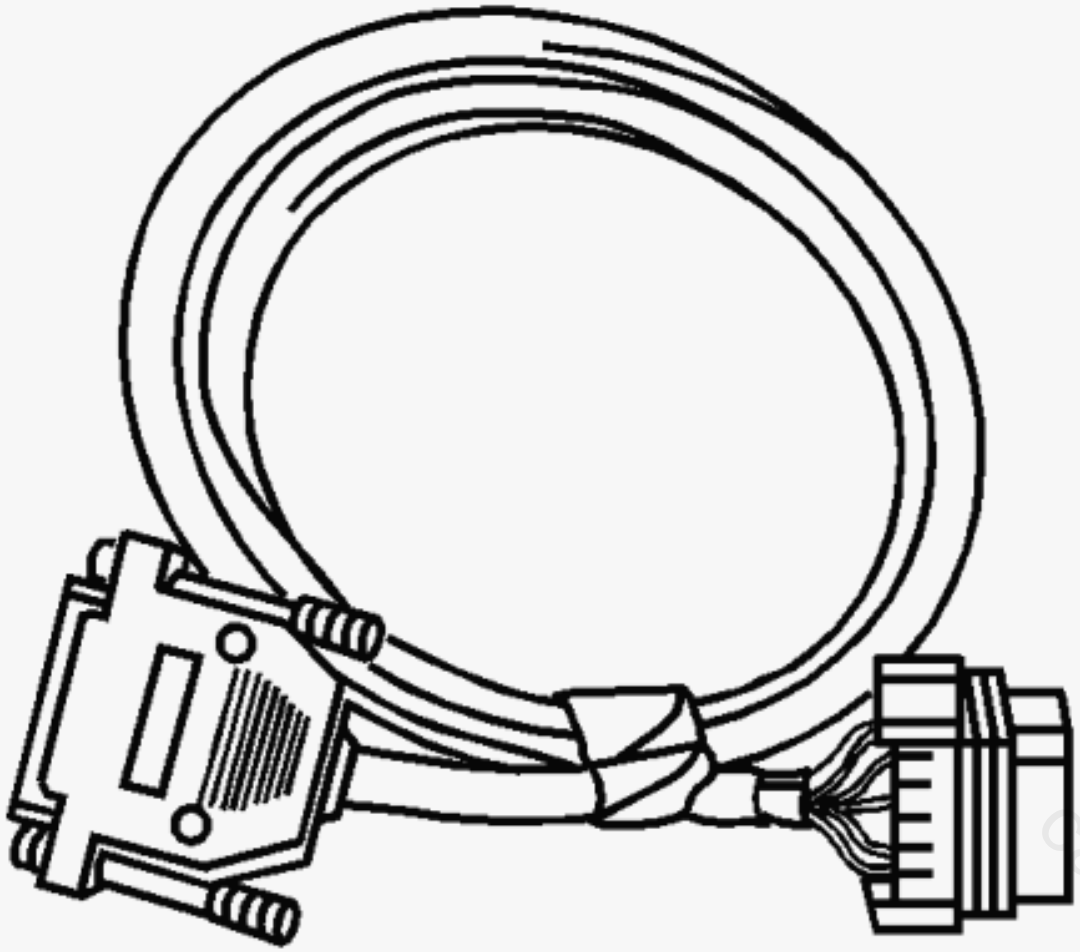
cardiagn.com

Illustration	Tool Number/Description
	

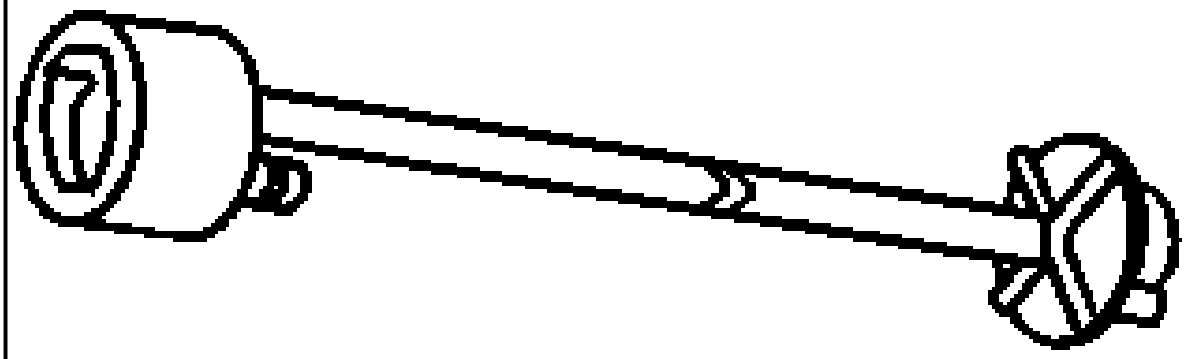
cardiagn.com

Illustration	Tool Number/Description
	CH-39021-301 J-39021-301 Fuel Injector Harness Adapter

carsdiagn.com

Illustration	Tool Number/Description
	CH-39021-460 J-39021-460 Fuel Injector Test Adapter

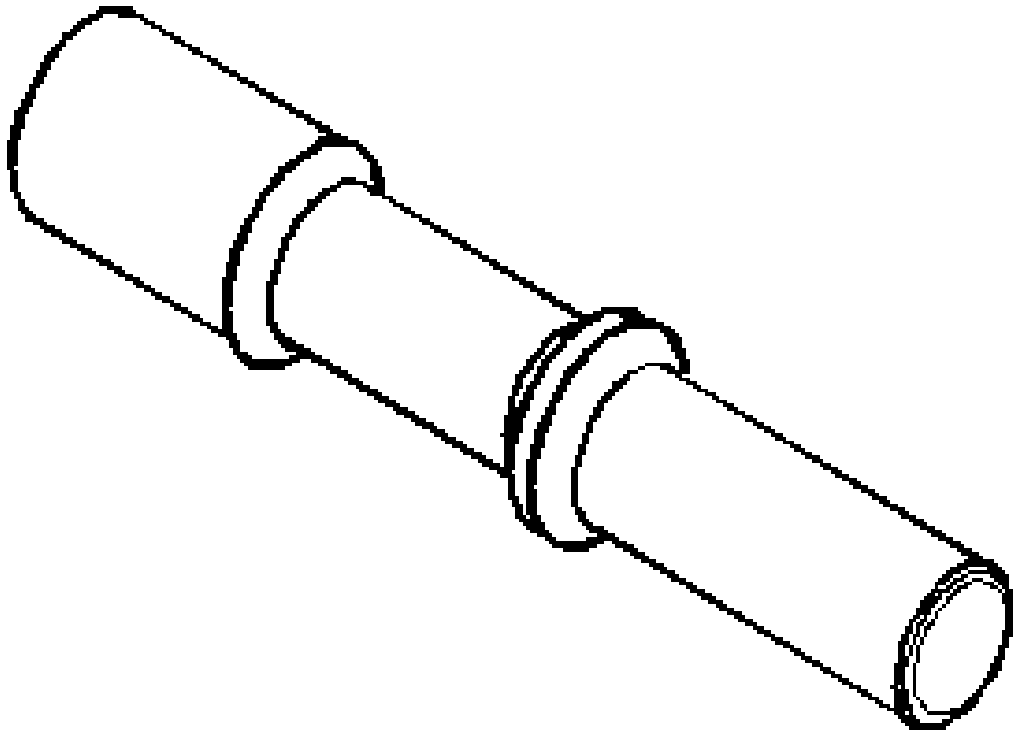
cardiagn.com

Illustration	Tool Number/Description
	CH-41415-30 GE-41415-30 J-41415-30 Fuel Tank Cap Adapter

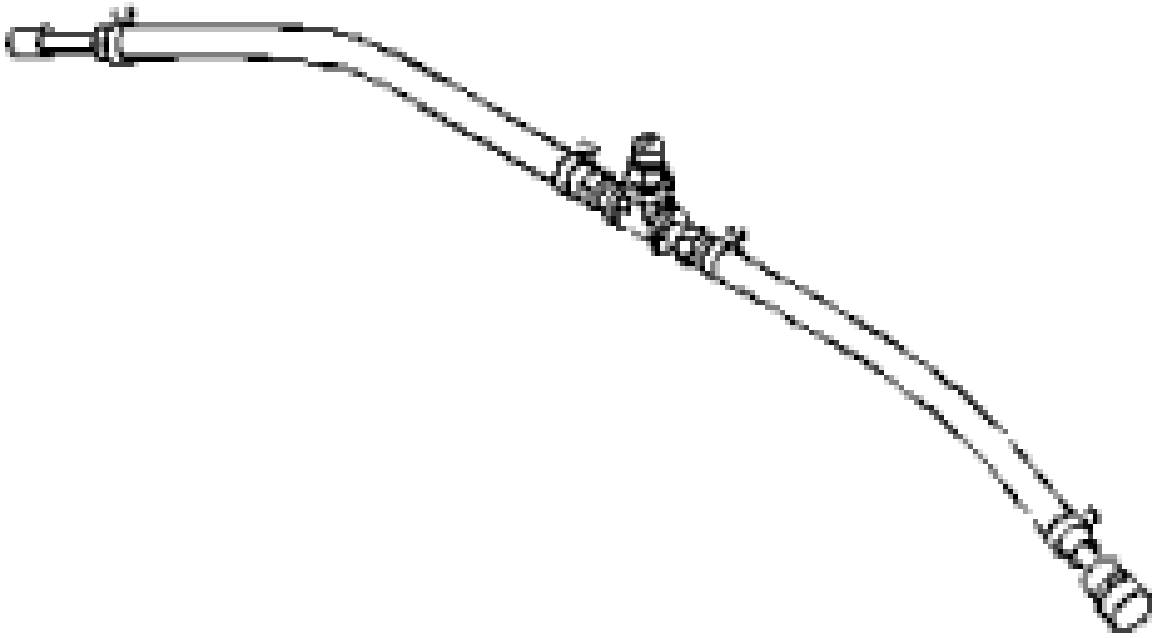
cardiagn.com

Illustration	Tool Number/Description
	CH-41769 J-41769 Fuel Line Quick Disconnect Tool
	CH-44284-2 J-44284-2 Fuel Flapper Door Holder

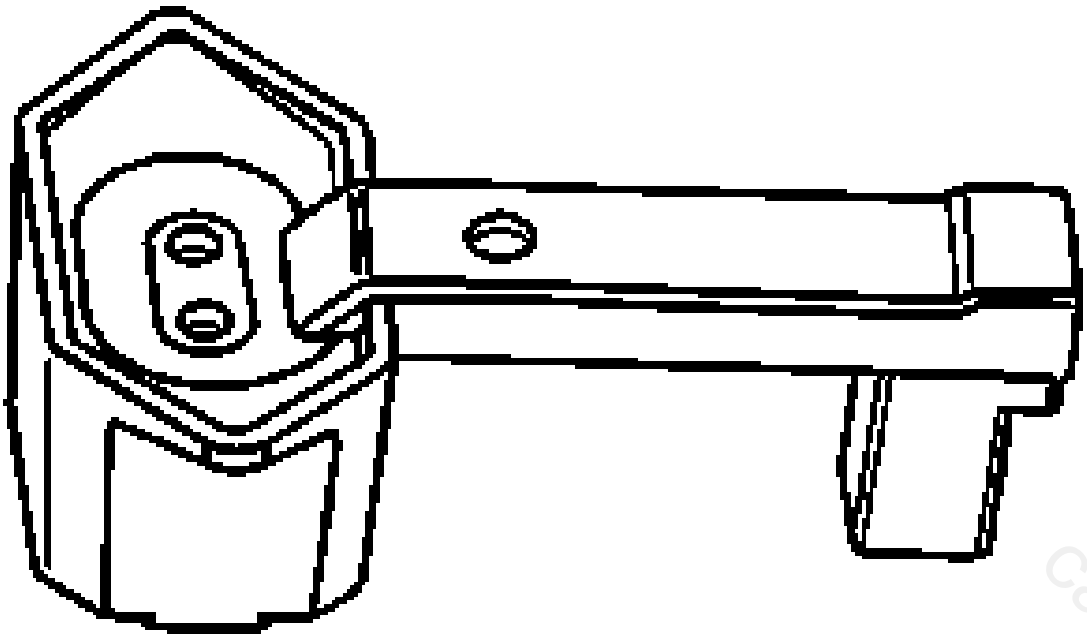
cardiagn.com

Illustration	Tool Number/Description
	

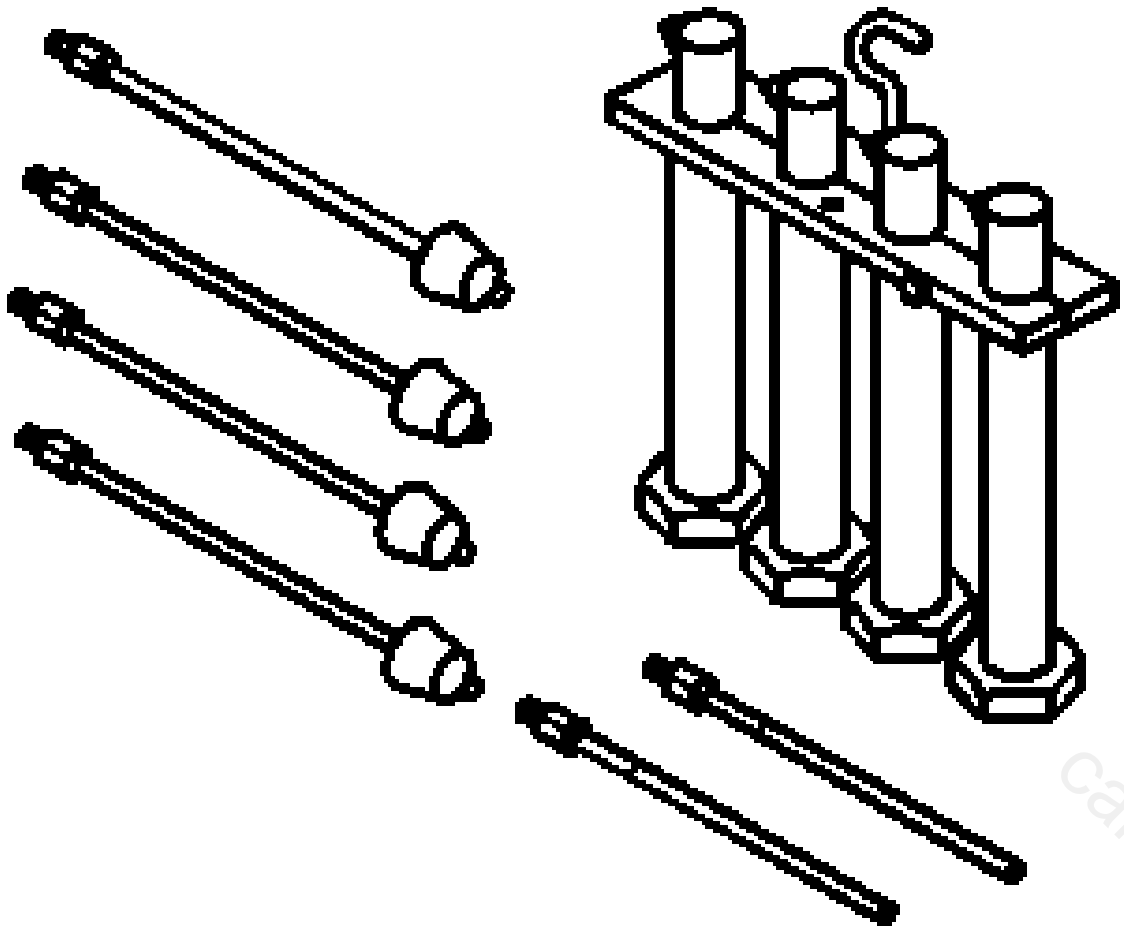
cardiagn.com

Illustration	Tool Number/Description
	CH-42982 J-42982 Fuel Pressure Gauge Adapter

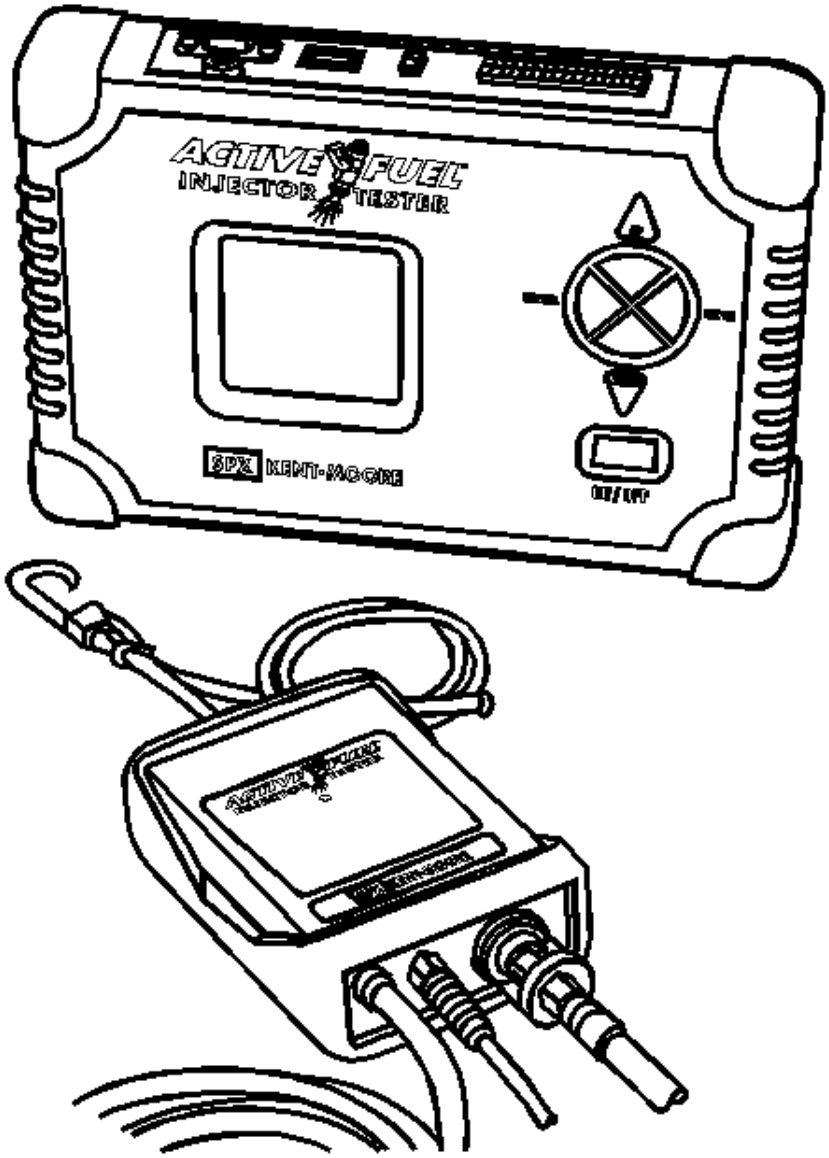
cardiagn.com

Illustration	Tool Number/Description
	CH-44175-A J-44175-A Fuel Composition Tester

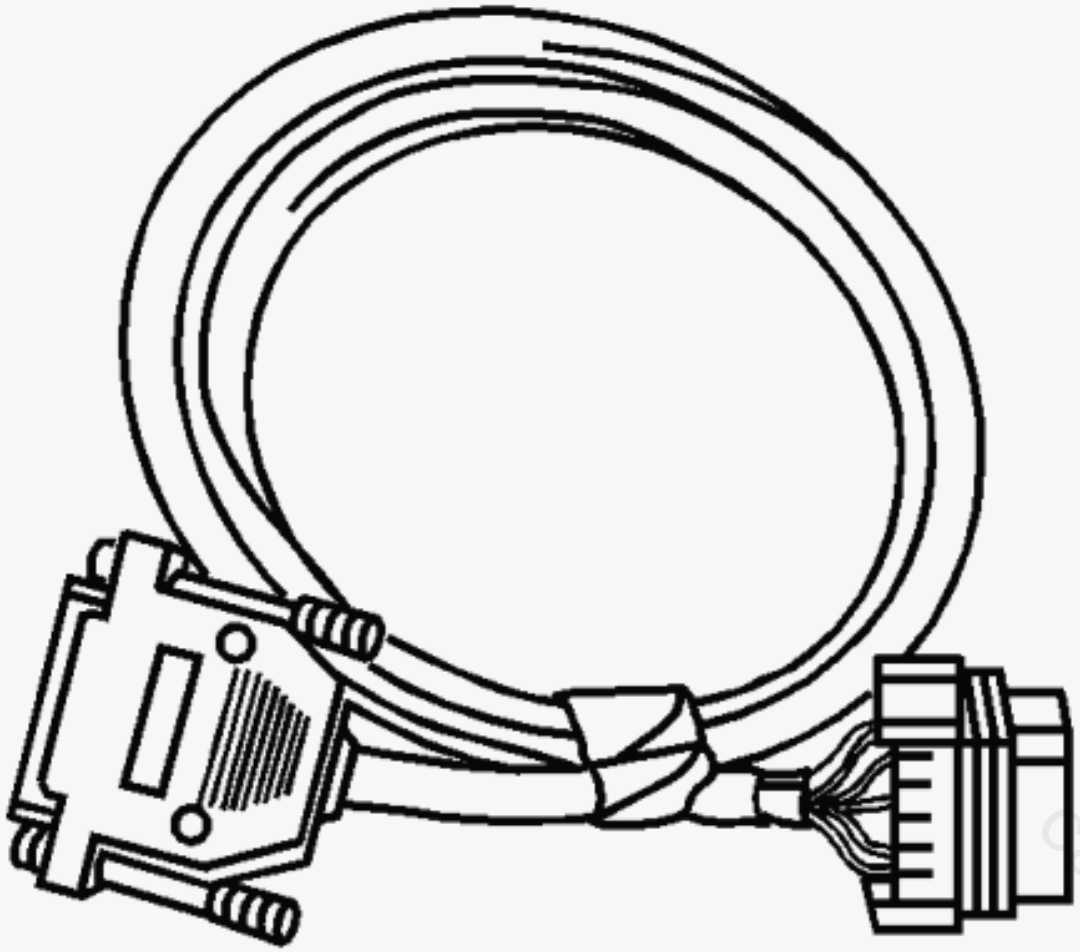
cardiagn.com

Illustration	Tool Number/Description
	CH-45873 J-45873 Fuel Return Volume Test Kit

cardiagn.com

Illustration	Tool Number/Description
	CH-47976 Active Fuel Injector Tester (AFIT)

cardiagn.com

Illustration	Tool Number/Description
	CH-47976-75 Fuel Injector Harness Adapter

cardiagn.com

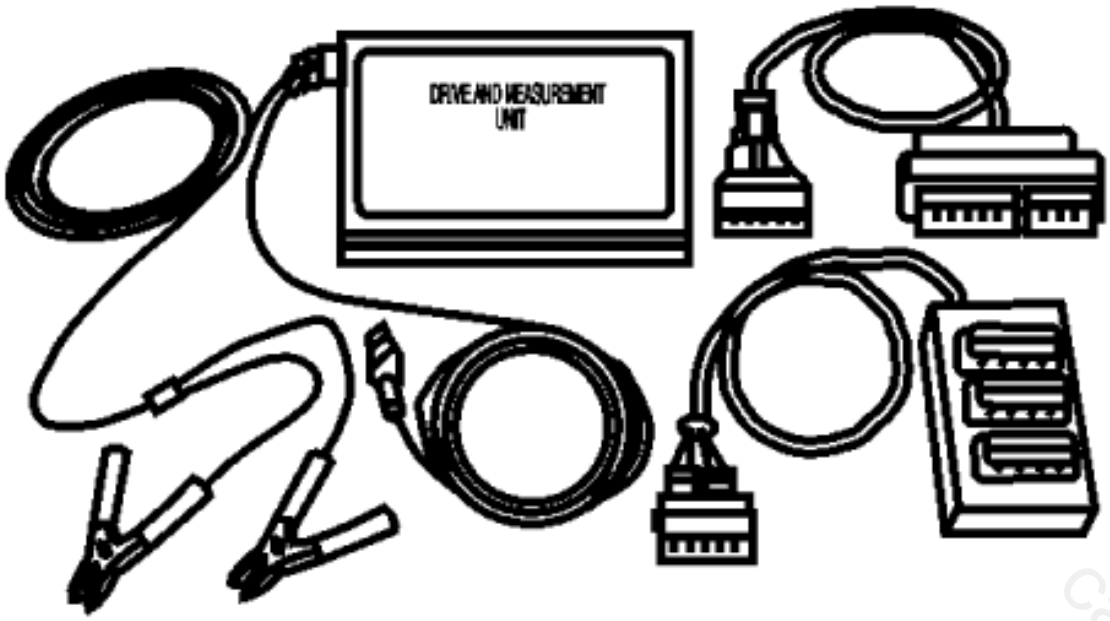
Illustration	Tool Number/Description
	CH-47976-500A Active Fuel Injection Tester (AFIT) SIDI Adapter Kit
	CH-47976-501 AFIT SIDI G1 Adapter Cable

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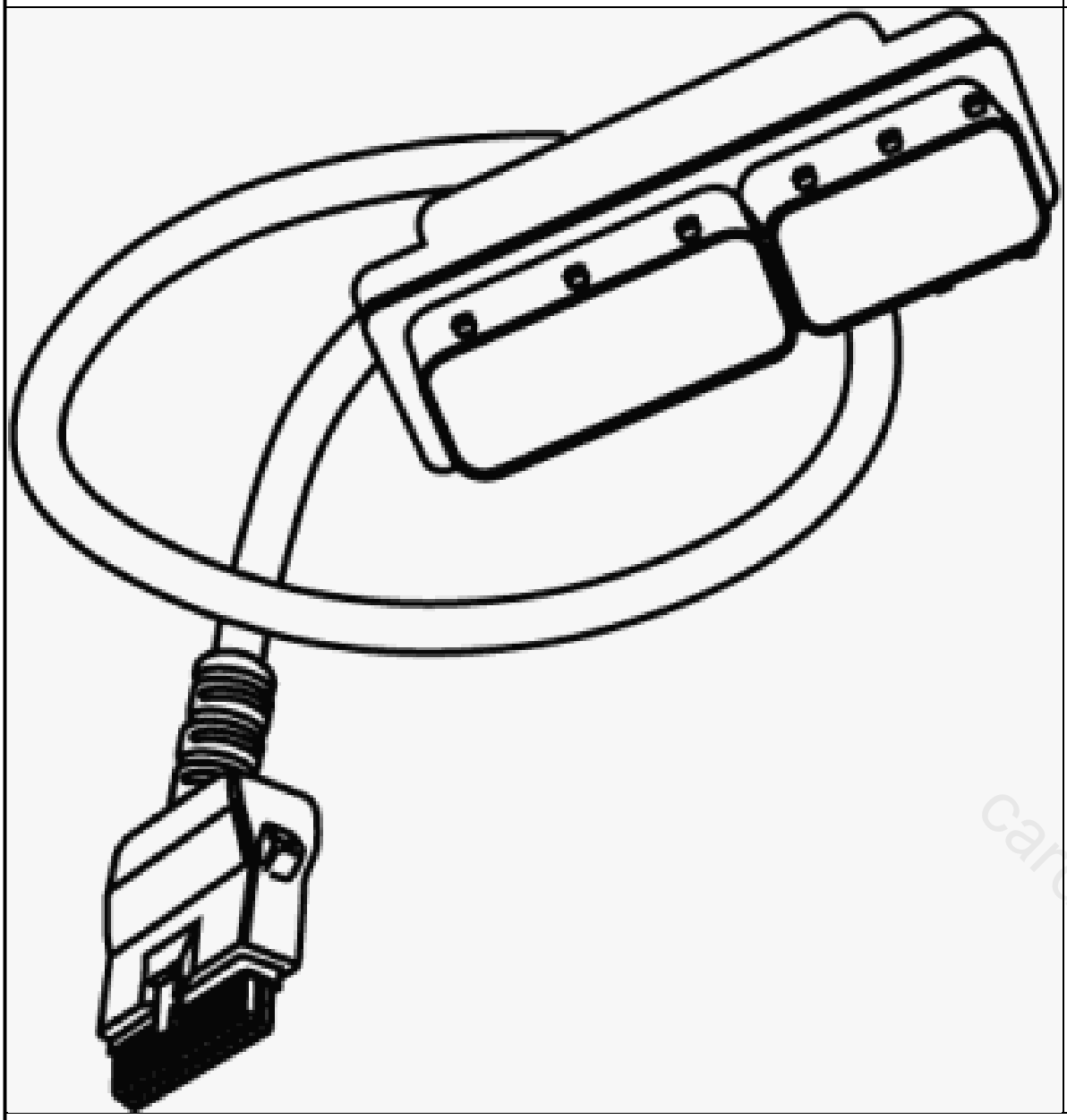
Illustration	Tool Number/Description
	

cardiagn.com

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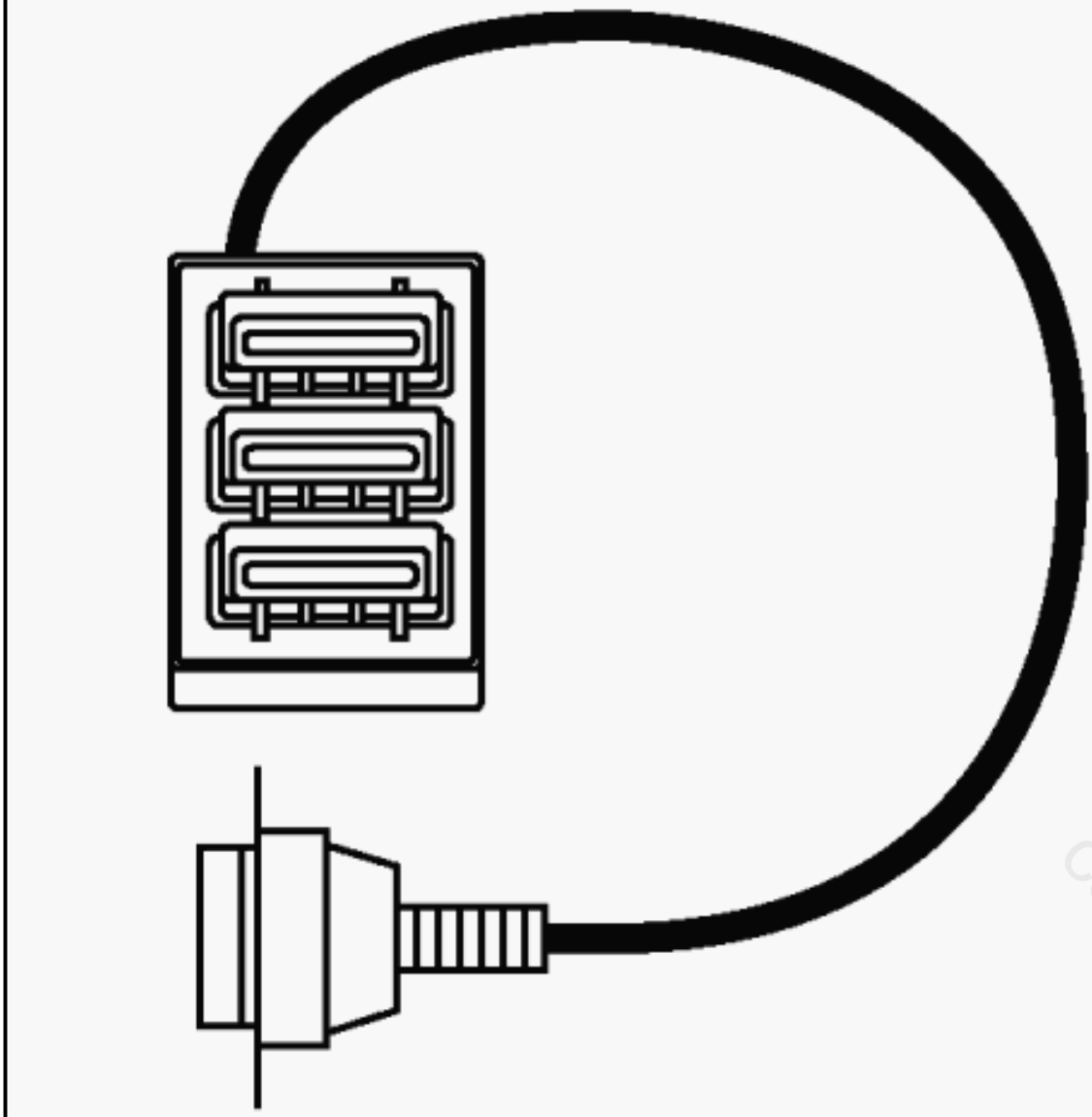
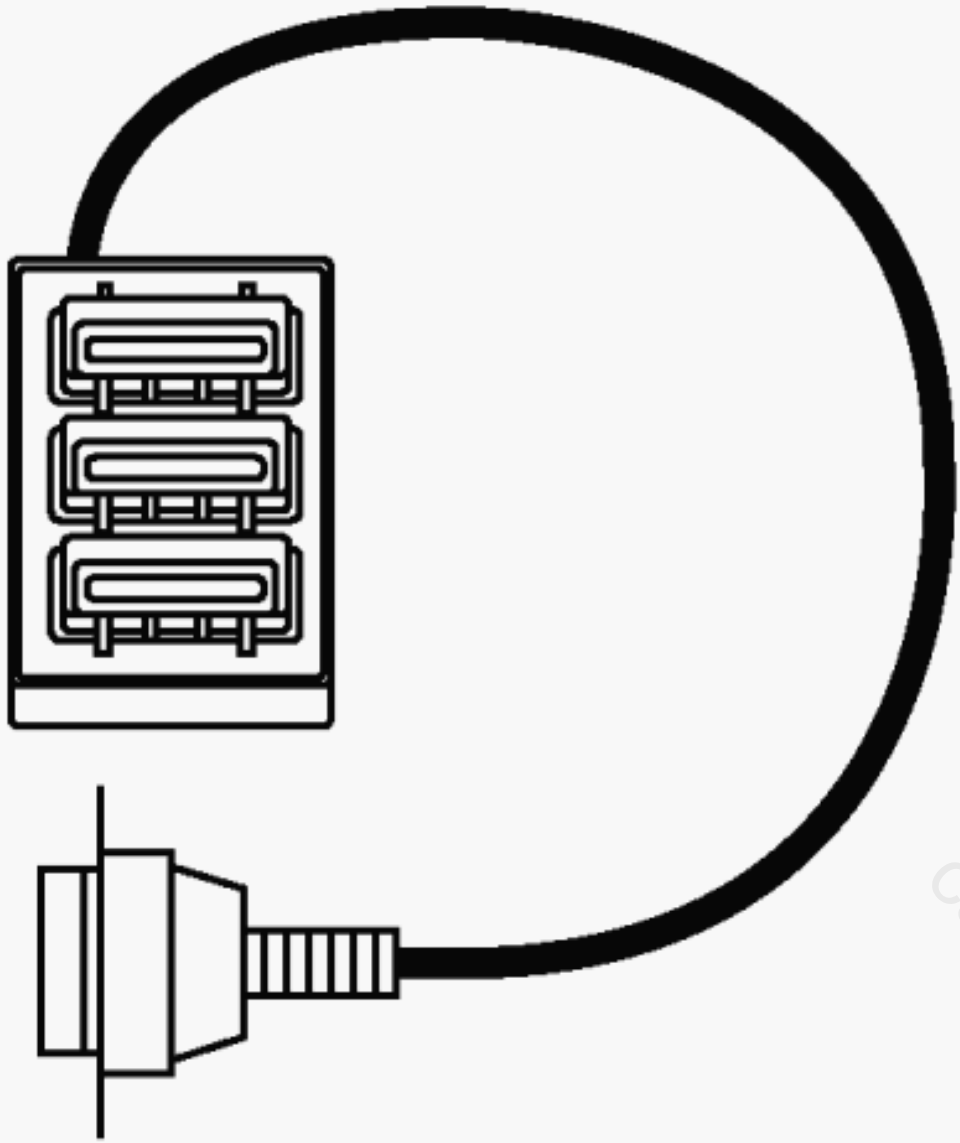
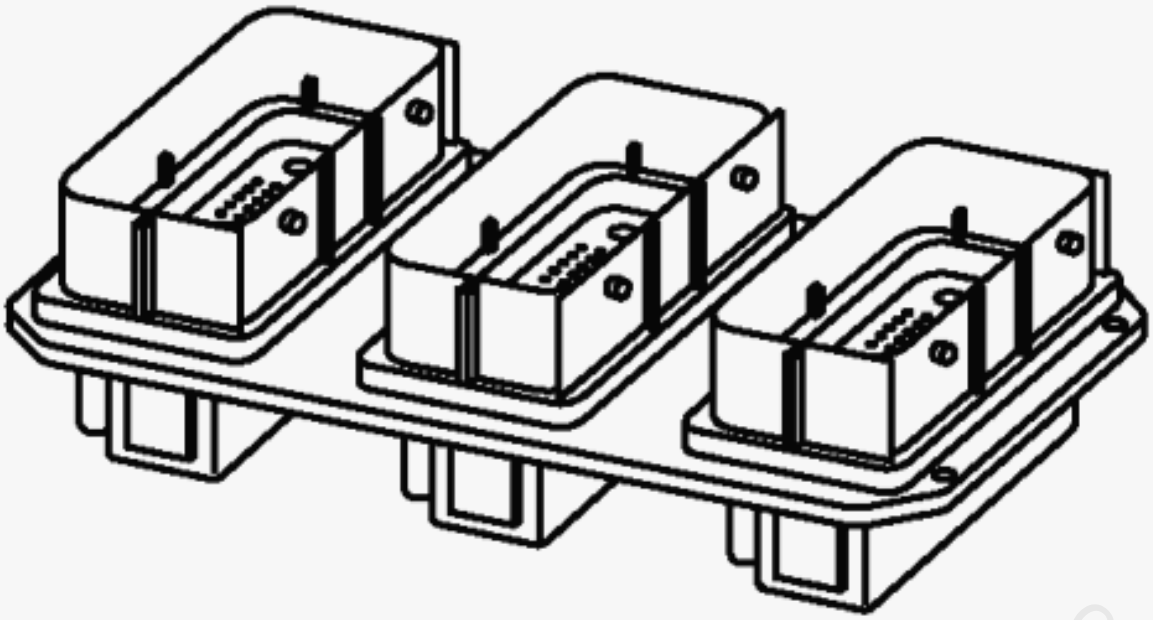
	CH-47976-502A AFIT SIDI E92 G2A Adapter Cable

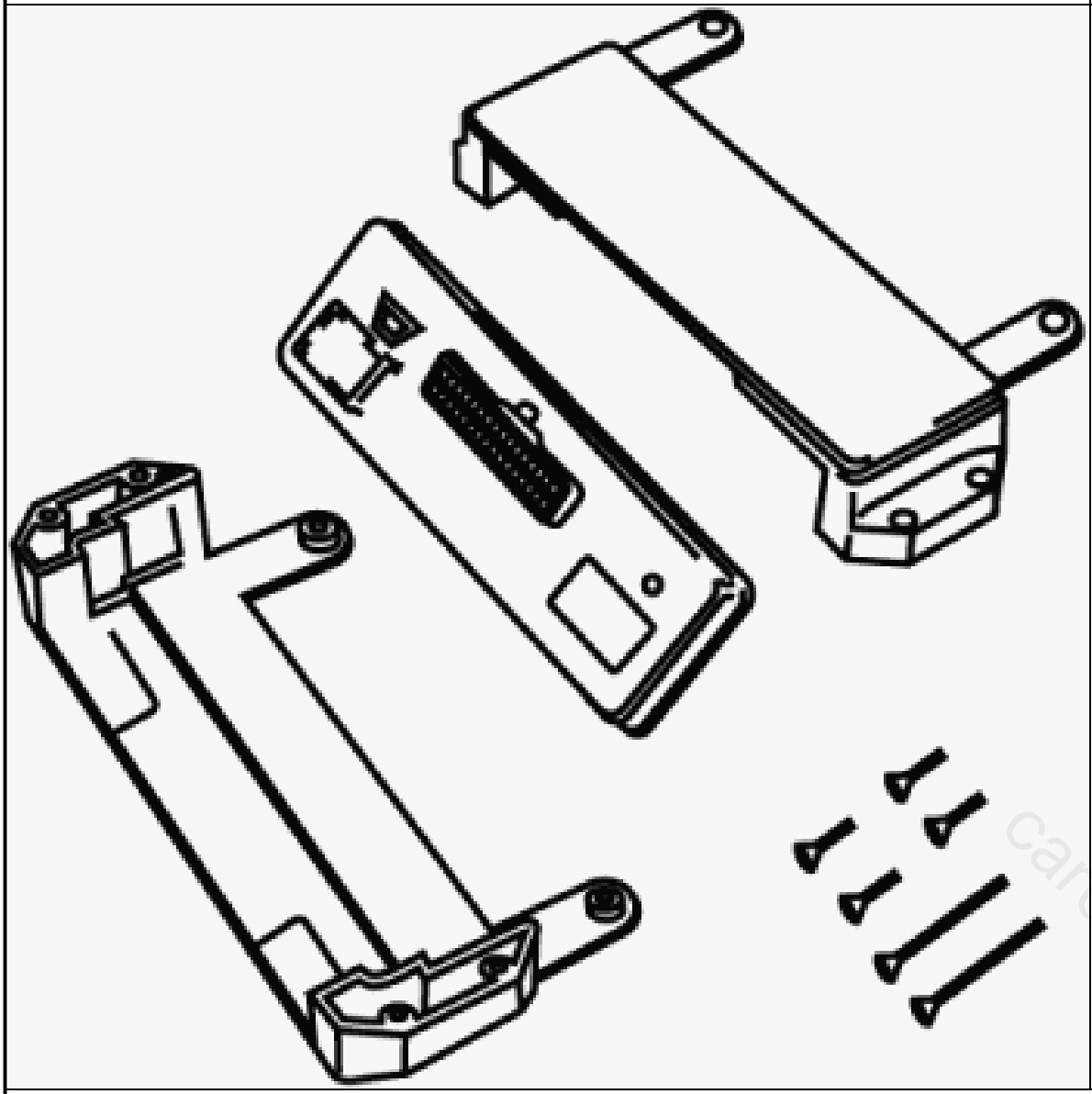
cardiagn.com

Illustration	Tool Number/Description
	CH-47976-503 AFIT SIDI E80 G3 Adapter Cable

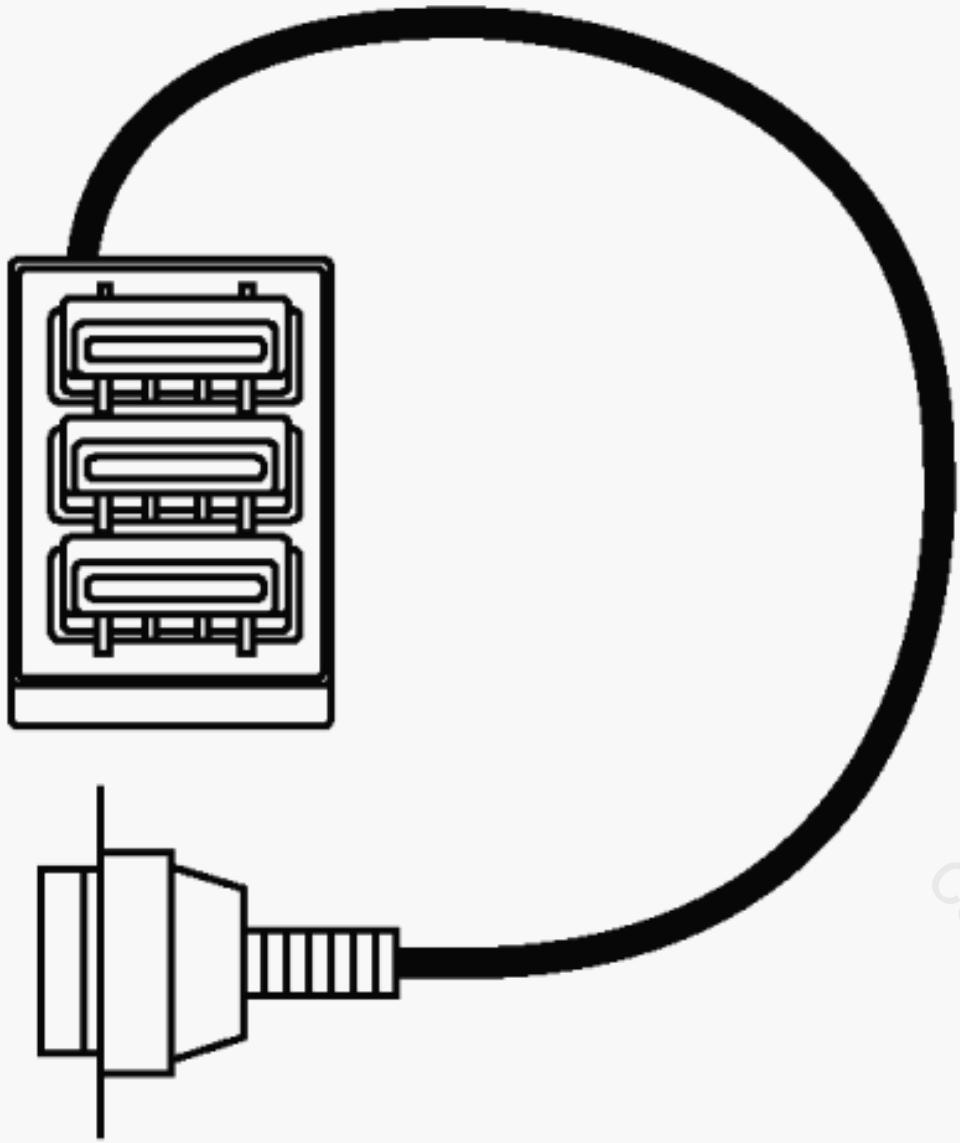
cardiagn.com

Illustration	Tool Number/Description
	CH-47976-504 E92/E39A G2B Start/Stop Adapter

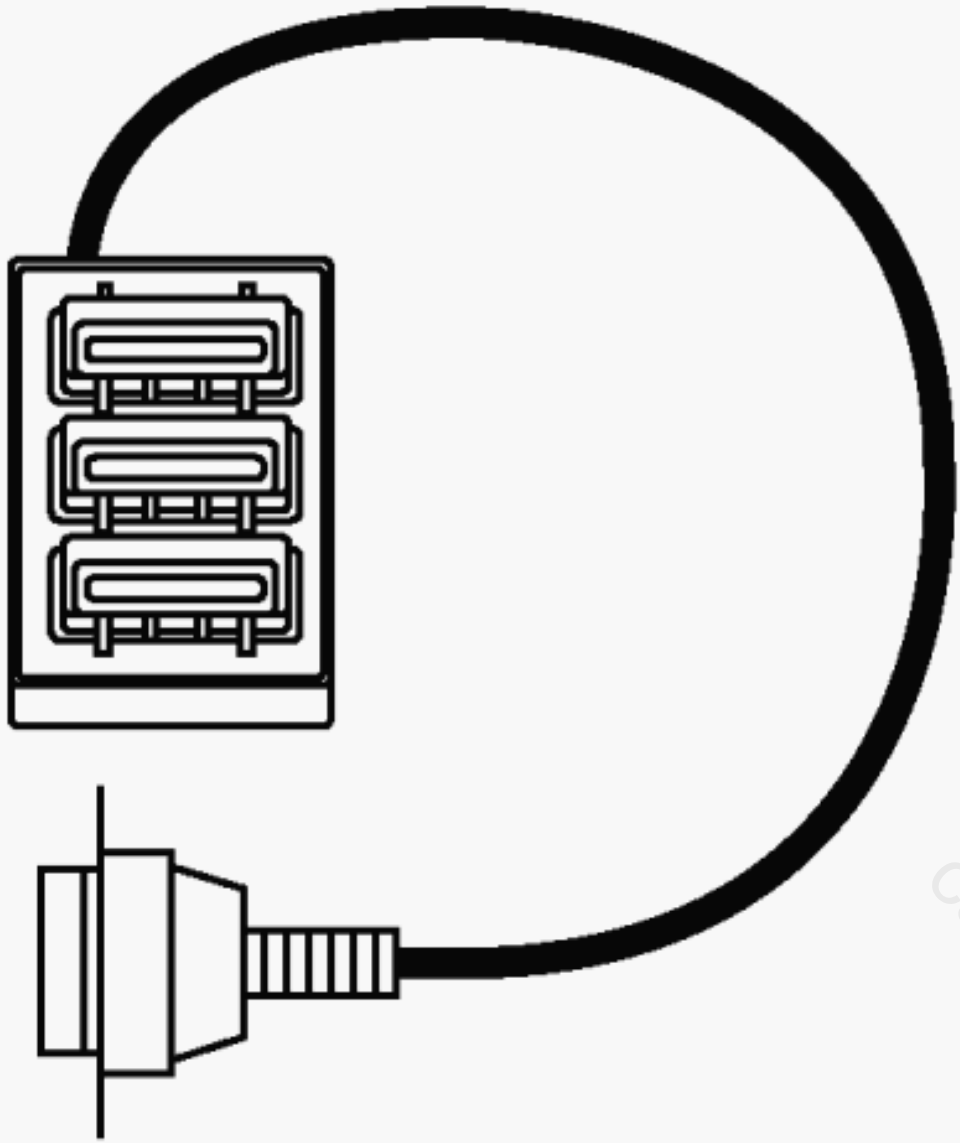
cardiagn.com

Illustration	Tool Number/Description
	CH-47976-507 AFIT Sent Adapter

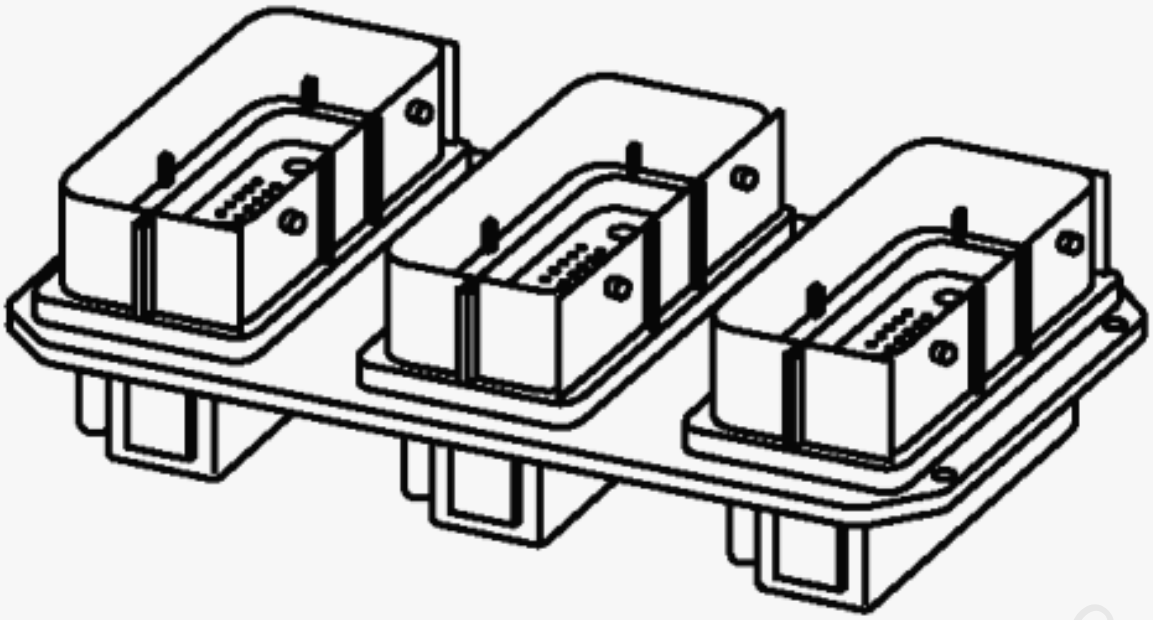
cardiagn.com

Illustration	Tool Number/Description
	CH-47976-509 AFIT SIDI E81 G4 Adapter Cable

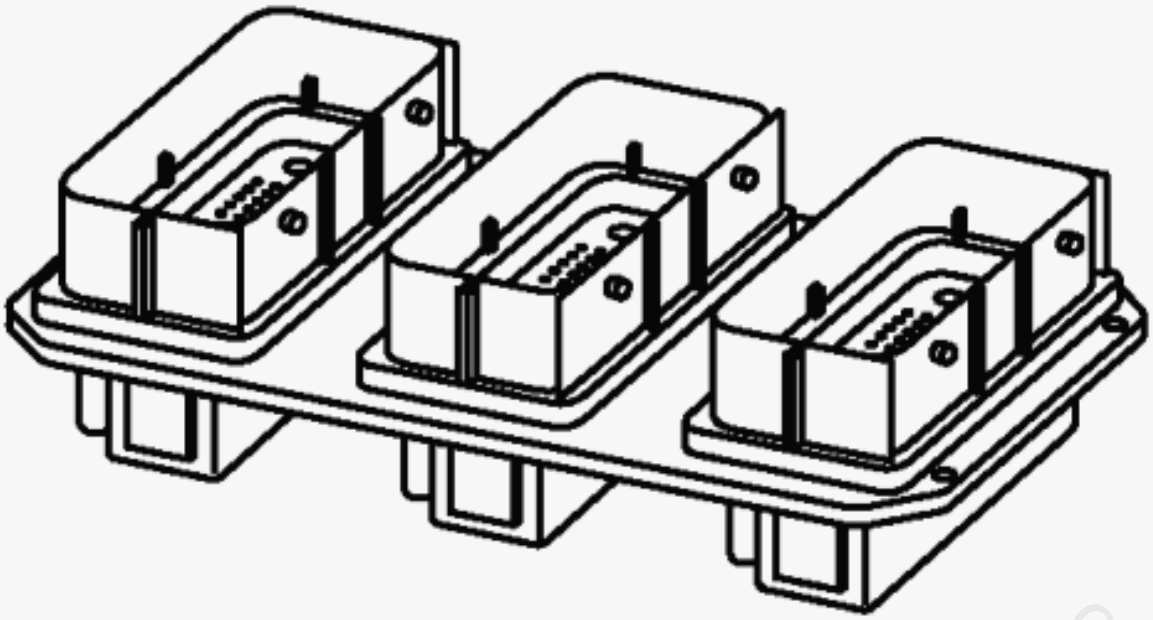
cardiagn.com

Illustration	Tool Number/Description
	CH-47976-511 AFIT SIDI E82 G5 Adapter Cable

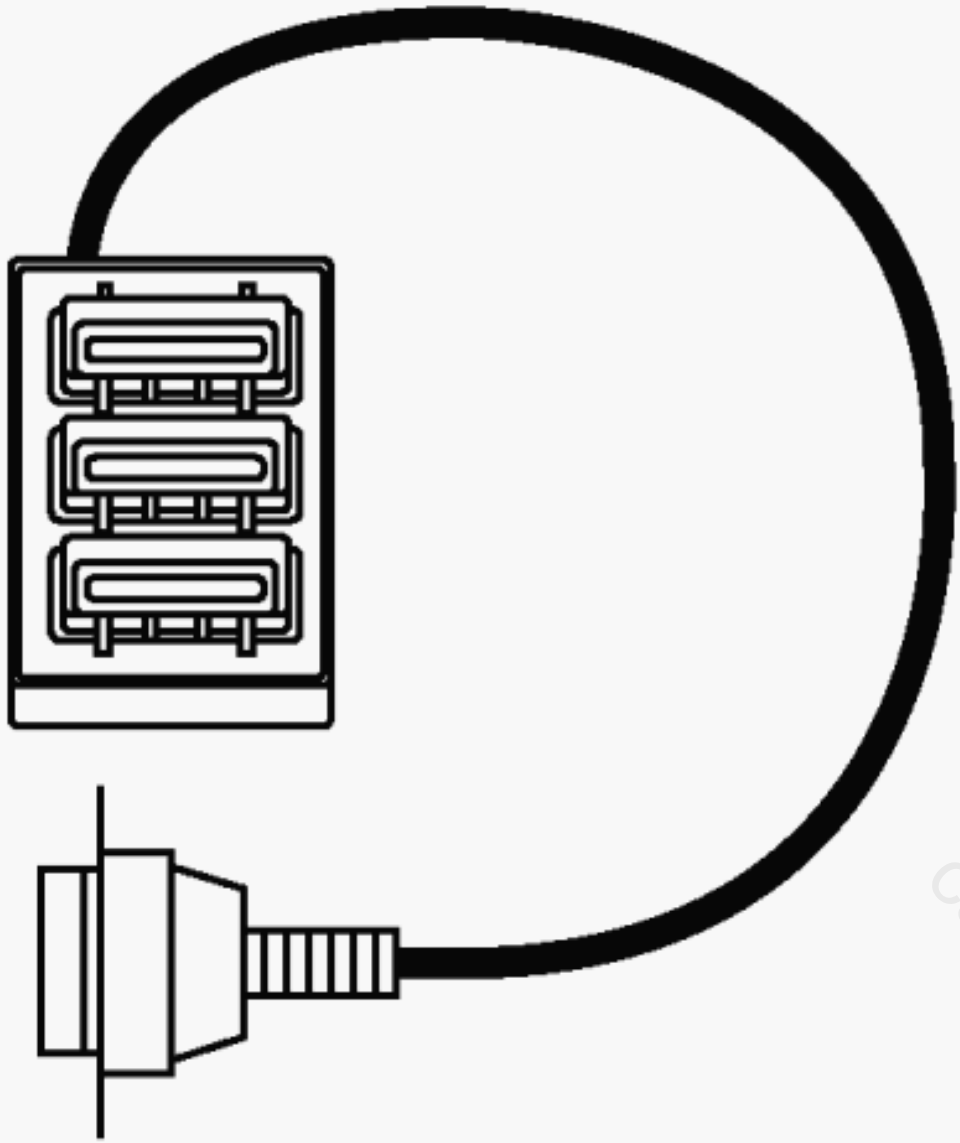
cardiagn.com

Illustration	Tool Number/Description
	CH-47976-512 E80 G3B Stop/Start Adapter

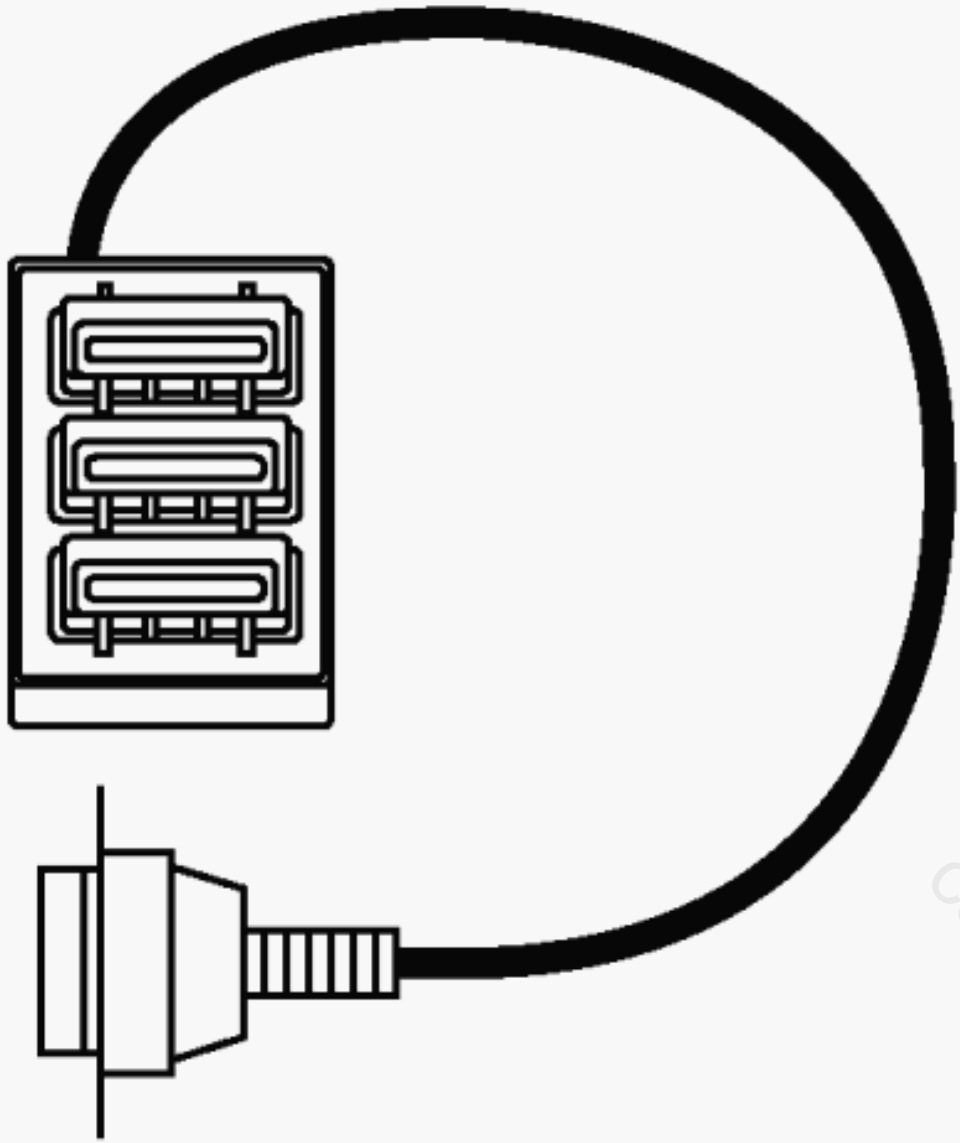
cardiagn.com

Illustration	Tool Number/Description
	CH-47976-513 E92 G2C Stop/Start and SENT Adapter

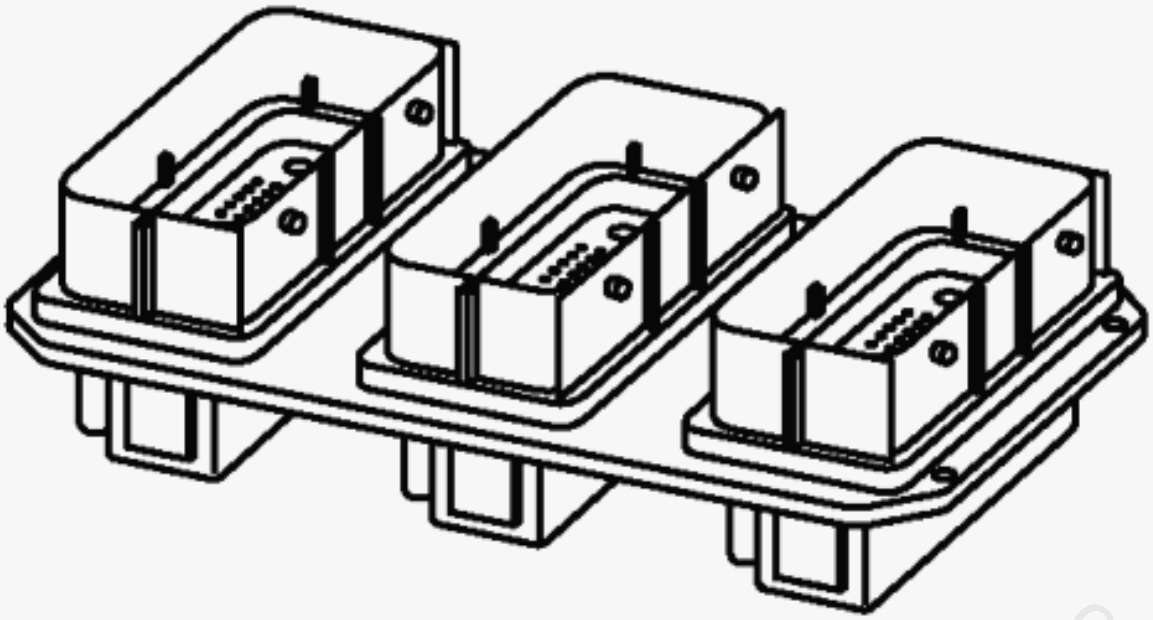
cardiagn.com

Illustration	Tool Number/Description
	CH-47976-514 AFIT SIDI E88 G6 Adapter Cable

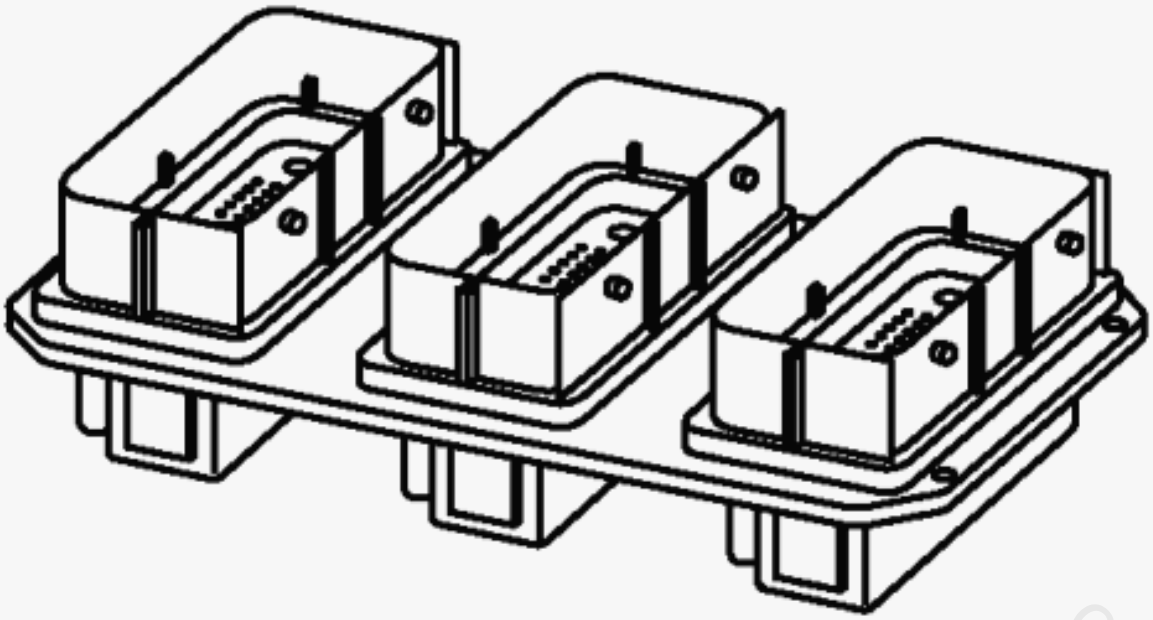
cardiagn.com

Illustration	Tool Number/Description
	CH-47976-515 AFIT Universal Cable

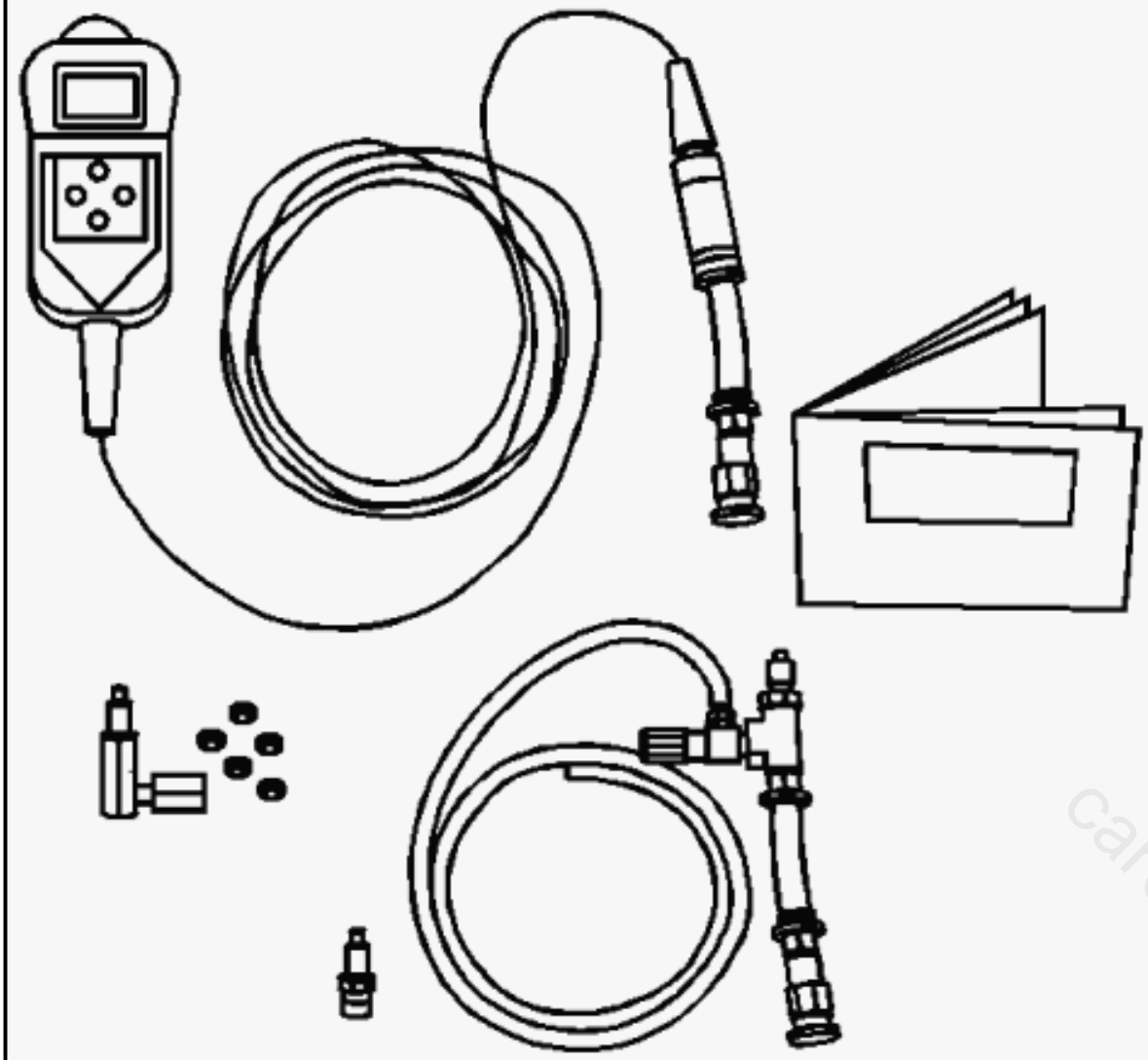
cardiagn.com

Illustration	Tool Number/Description
	CH-47976-516 AFIT E01 G7 Adapter Cable

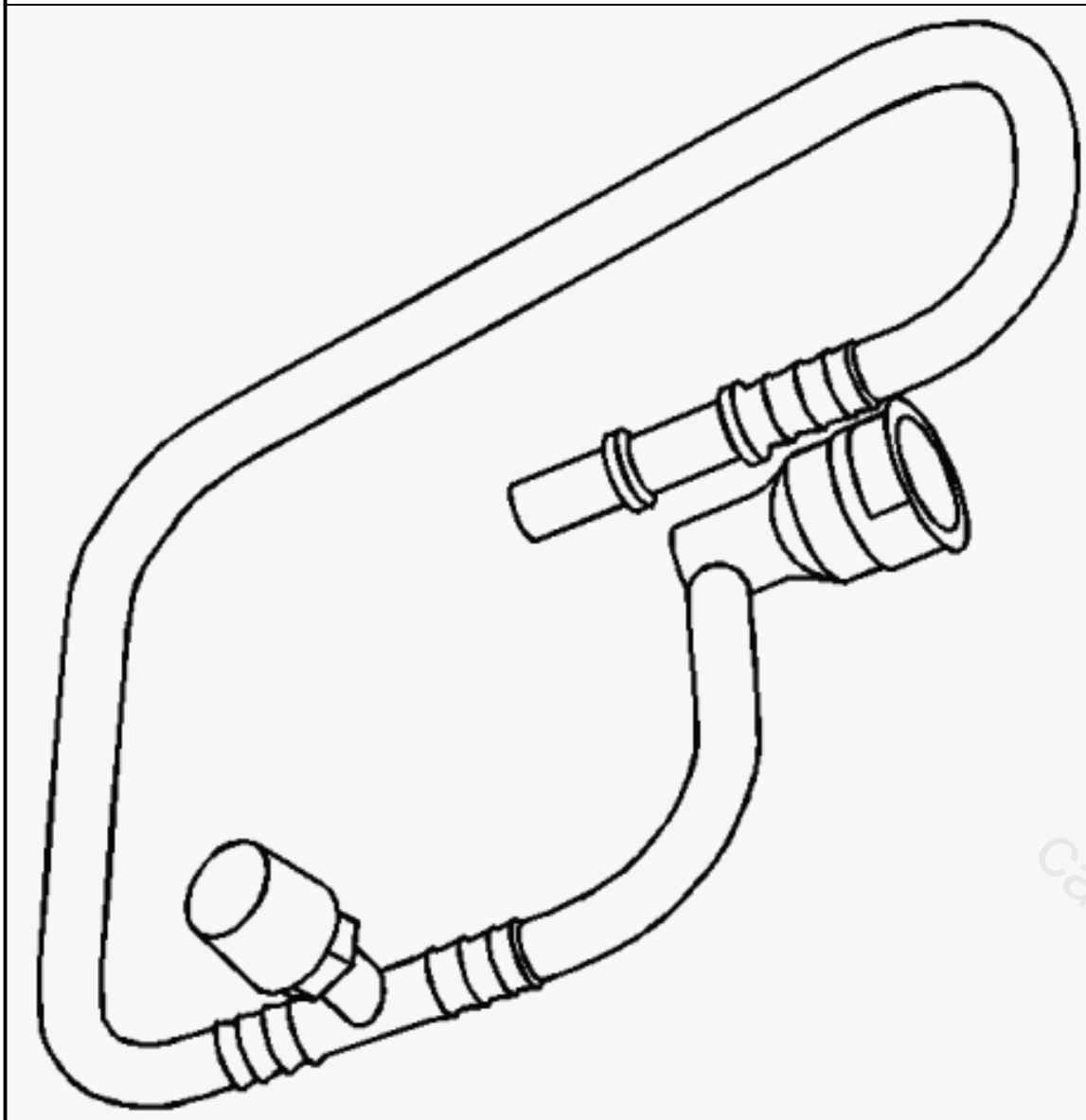
cardiagn.com

Illustration	Tool Number/Description
	CH-47976-517 AFIT E90 & E93 G8 Adapter Cable

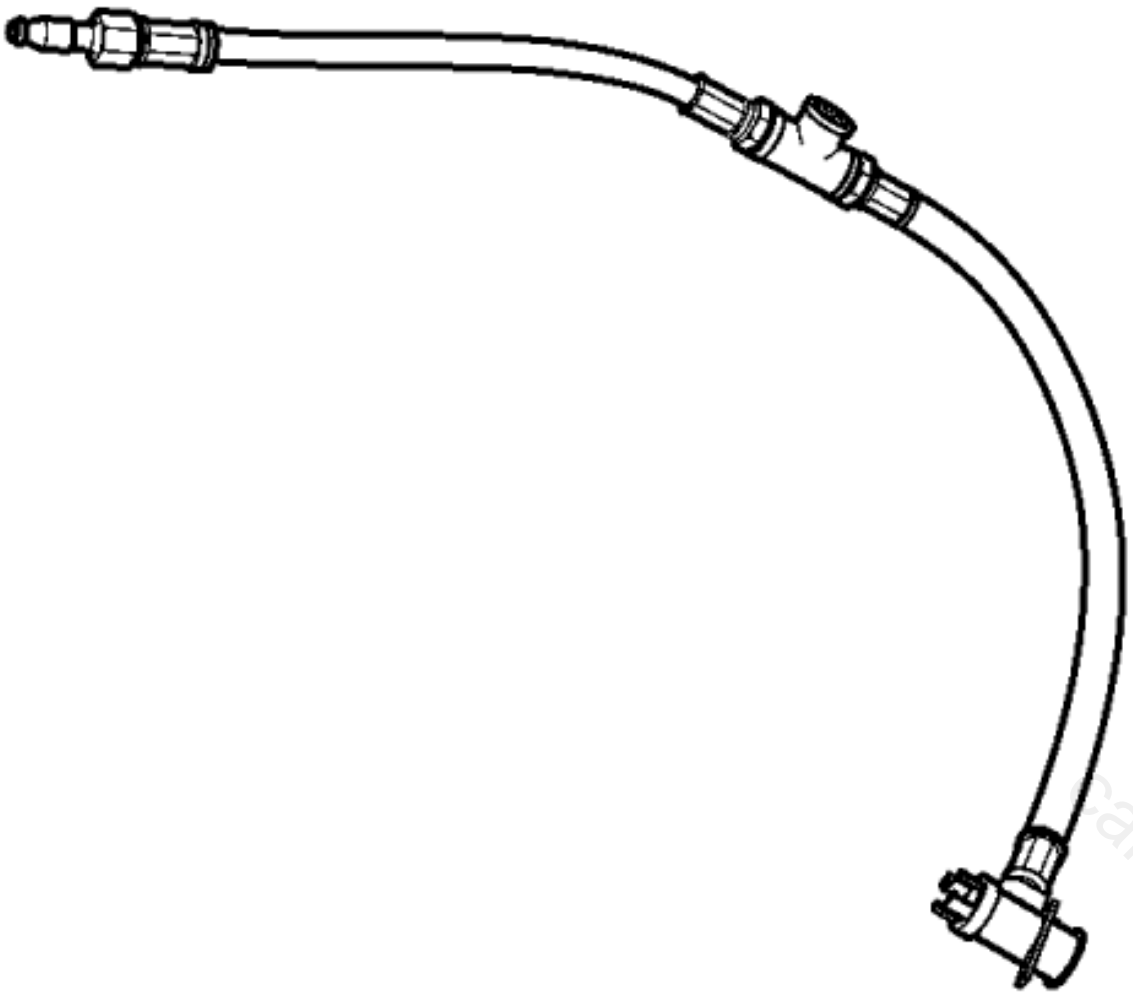
cardiagn.com

Illustration	Tool Number/Description
	CH-48027 Fuel Pressure Gauge

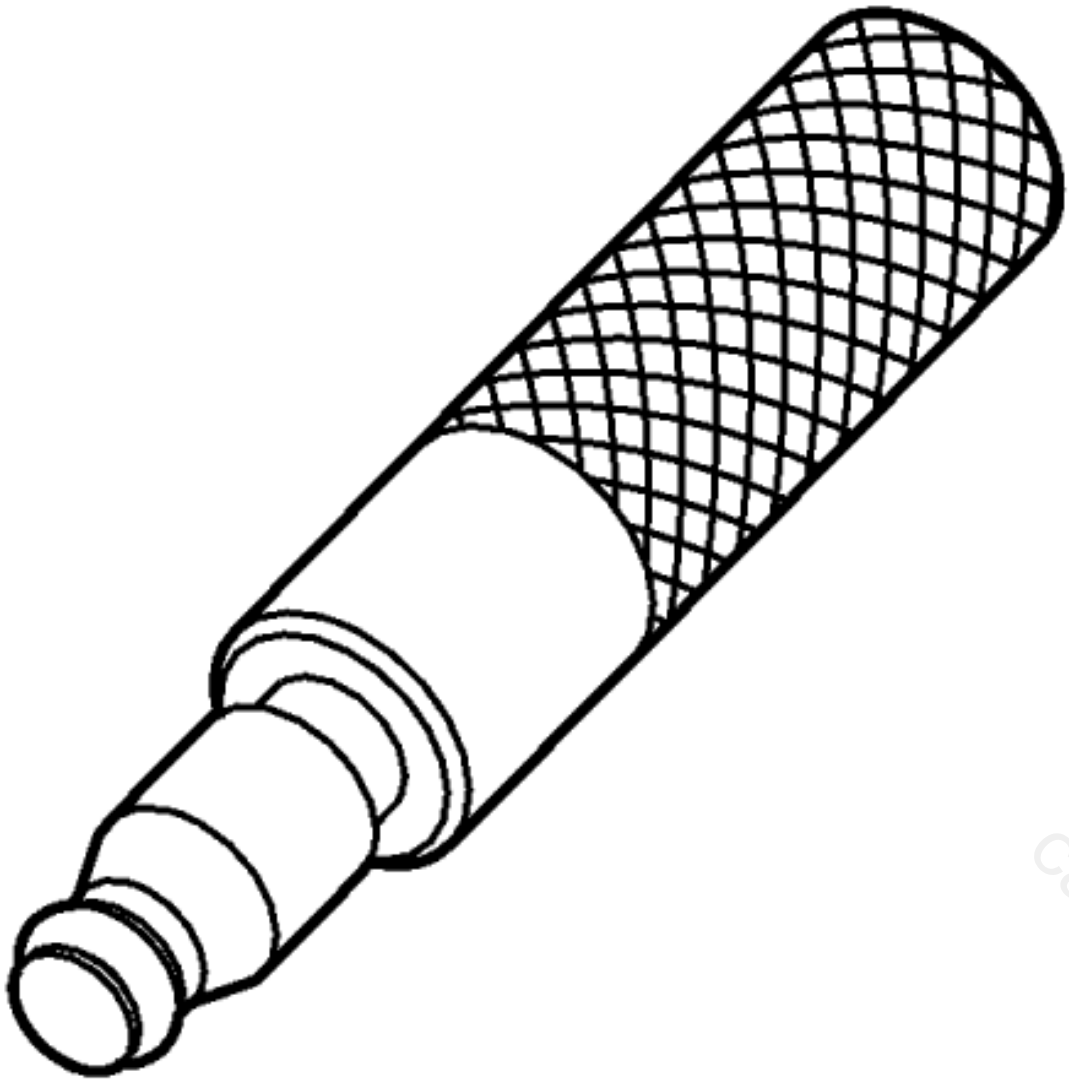
cardiagn.com

Illustration	Tool Number/Description
	CH-48096 EVAP Service Access Port Tool

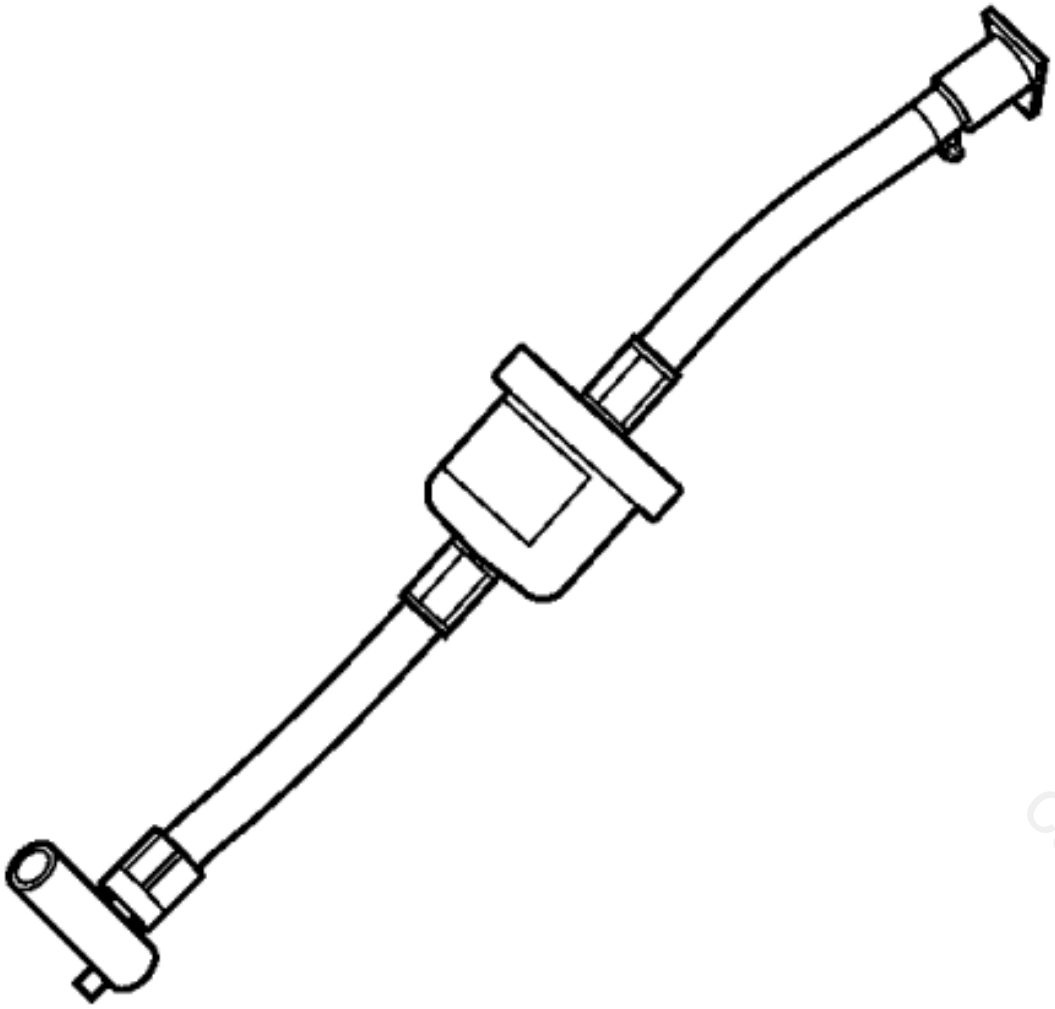
cardiagn.com

Illustration	Tool Number/Description
	CH-50375 Diesel Injector Return Line Pressure Adapter

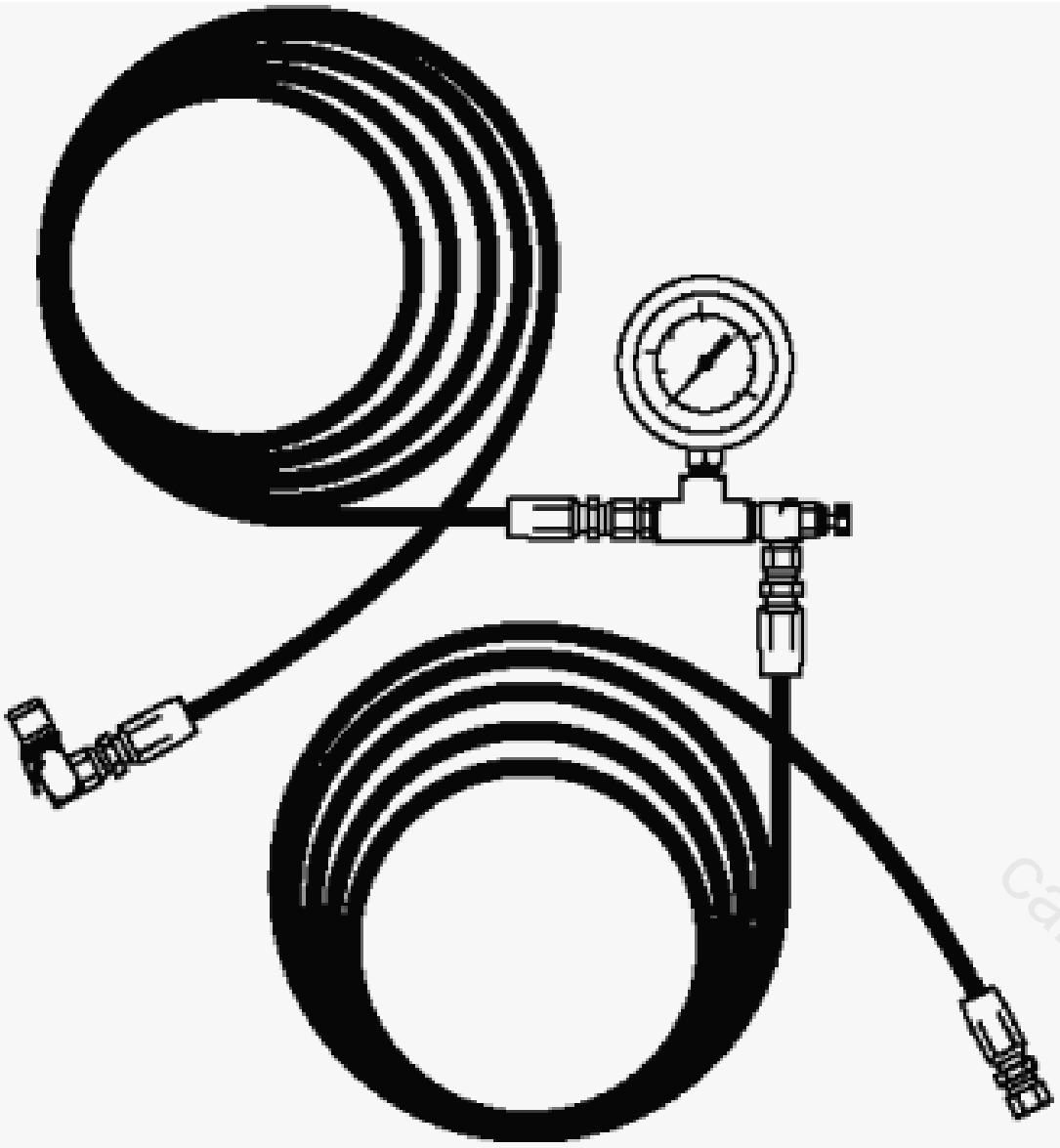
cardiagn.com

Illustration	Tool Number/Description
	CH-50377-A Injector Return Line Cap

cardiagn.com

Illustration	Tool Number/Description
	CH-50378 Injector Return Leakage Test Adapter

cardiagn.com

Illustration	Tool Number/Description
	CH-50933 Gauge Assembly, Liquid Propane Gas (LPG)

cardiagn.com

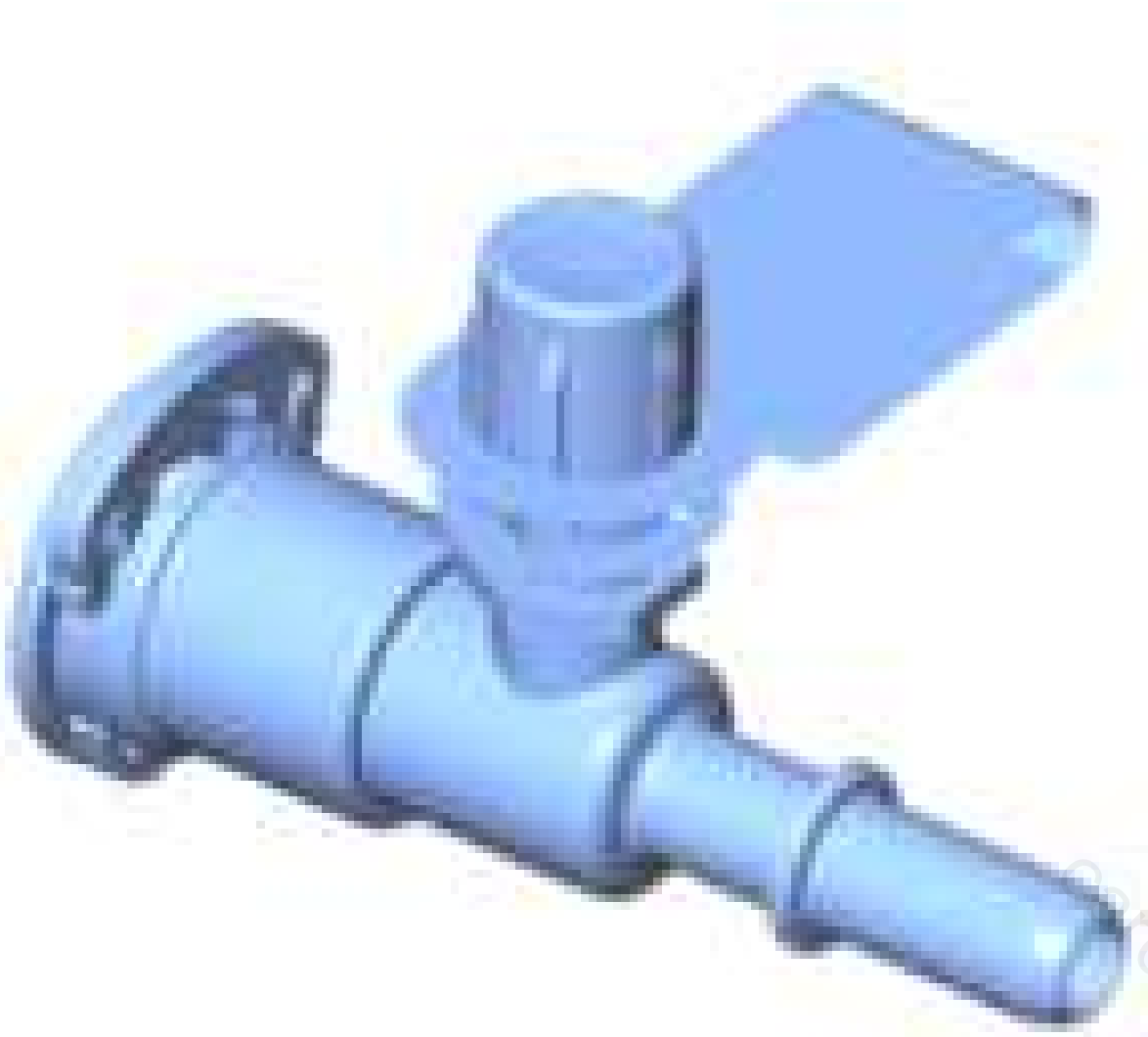
Illustration	Tool Number/Description
	CH-52519 EVAP Service Access Port Tool
	EL-26792 J-26792 HEI Spark Tester

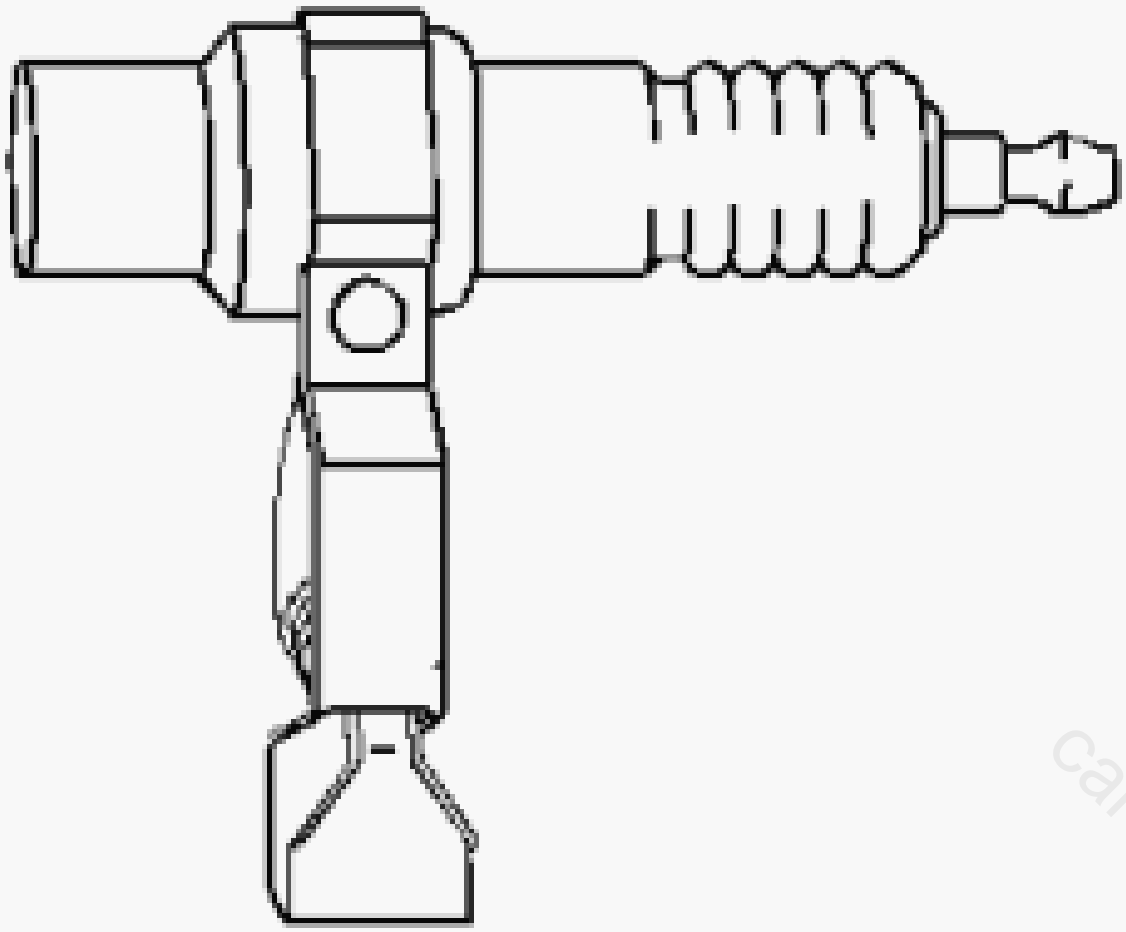
Illustration	Tool Number/Description
	EL-34730-405 J-34730-405 Injector Test Lamp

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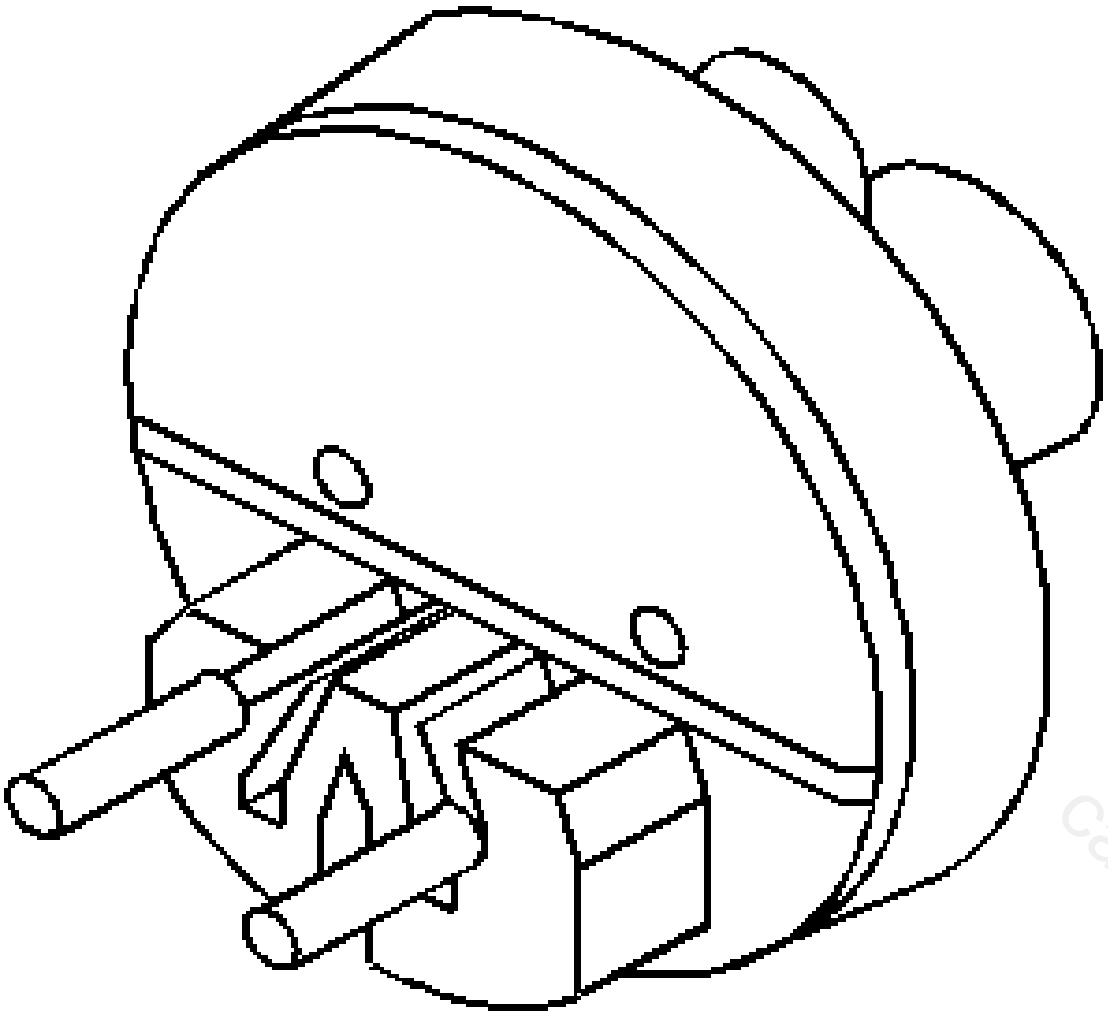
Illustration	Tool Number/Description
	

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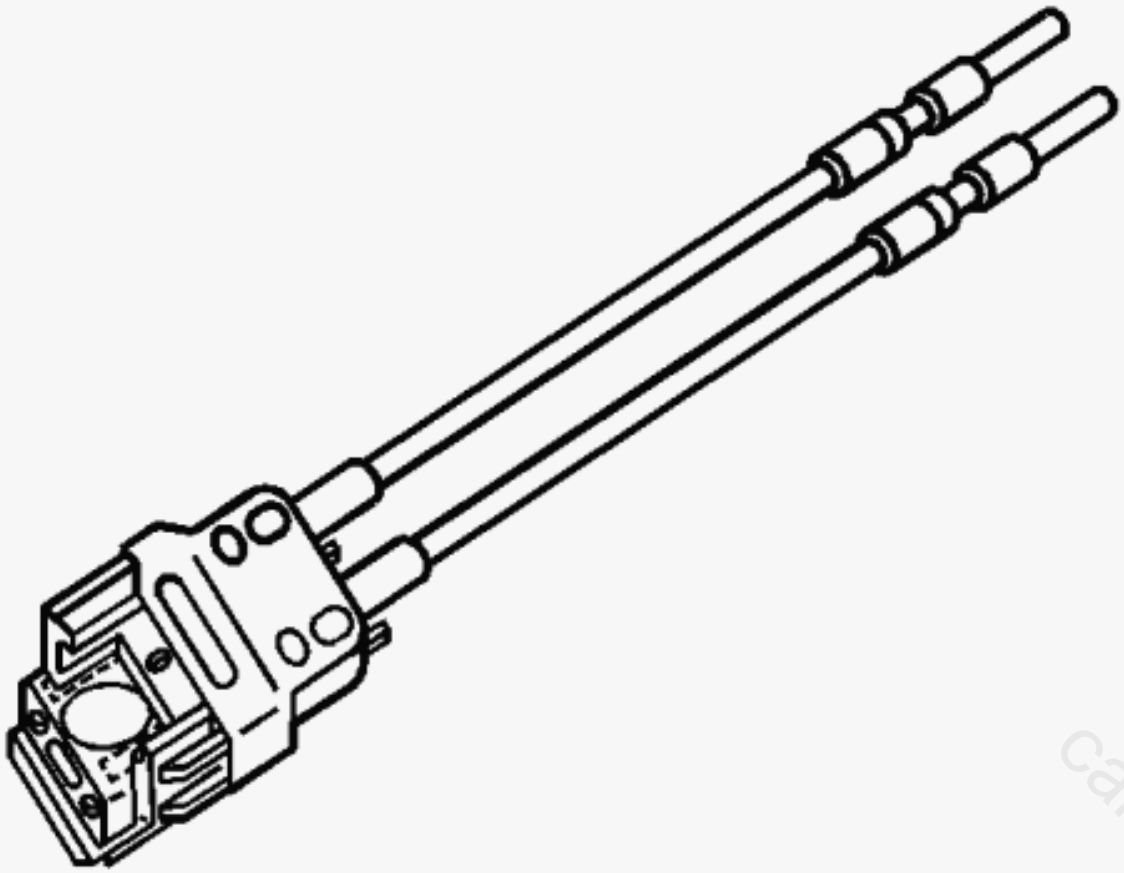	EL-36169-HD Heavy Duty Fused Jumper
	EL-38522-A J-38522-A Variable Signal Generator

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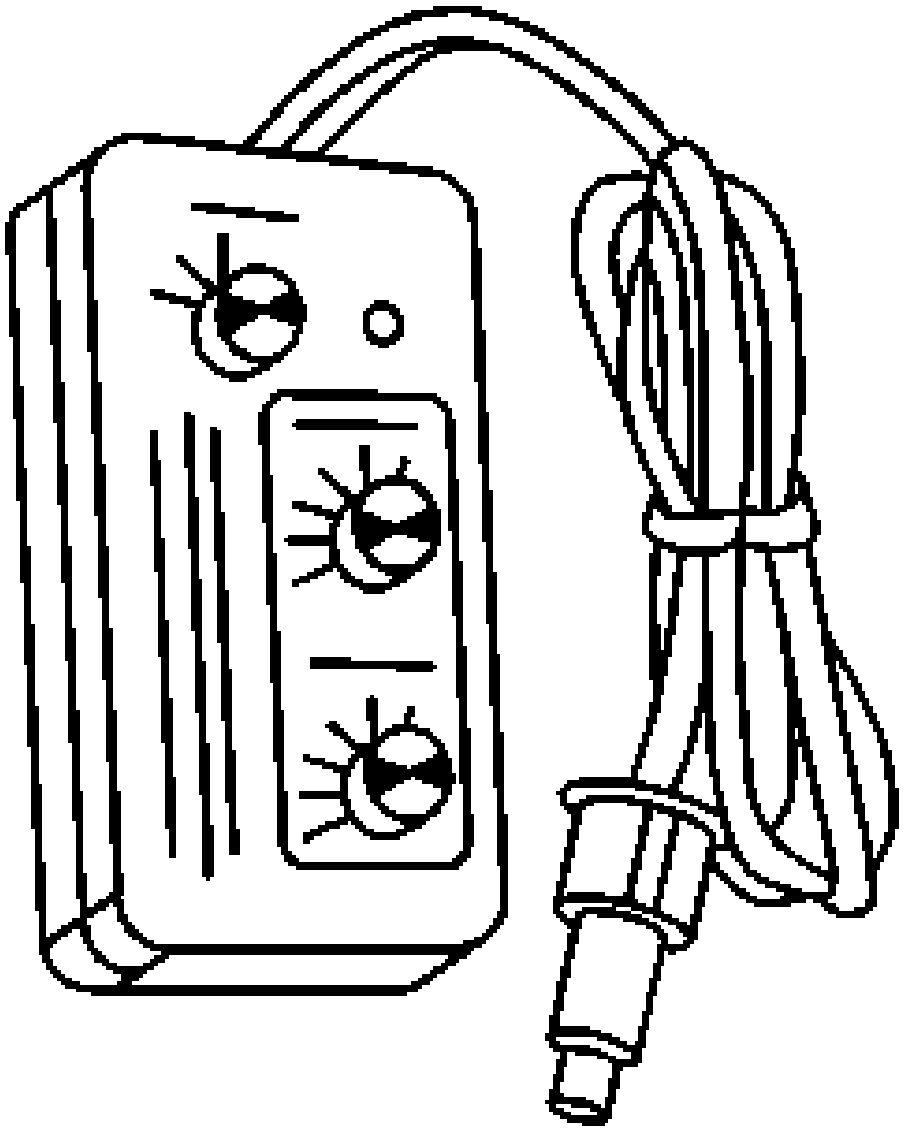
Illustration	Tool Number/Description
	

cardiagn.com

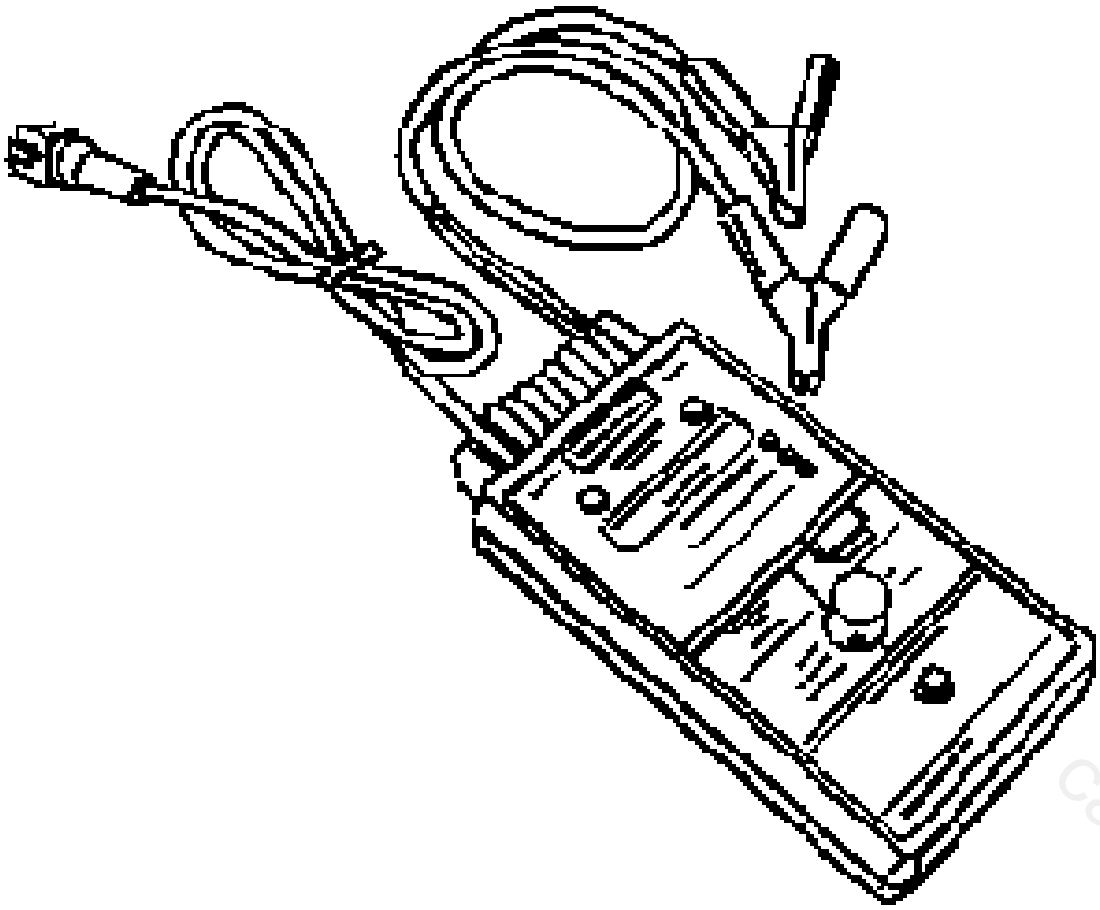
Illustration	Tool Number/Description
	EL-39021 J-39021 Fuel Injector Coil Balance Tester

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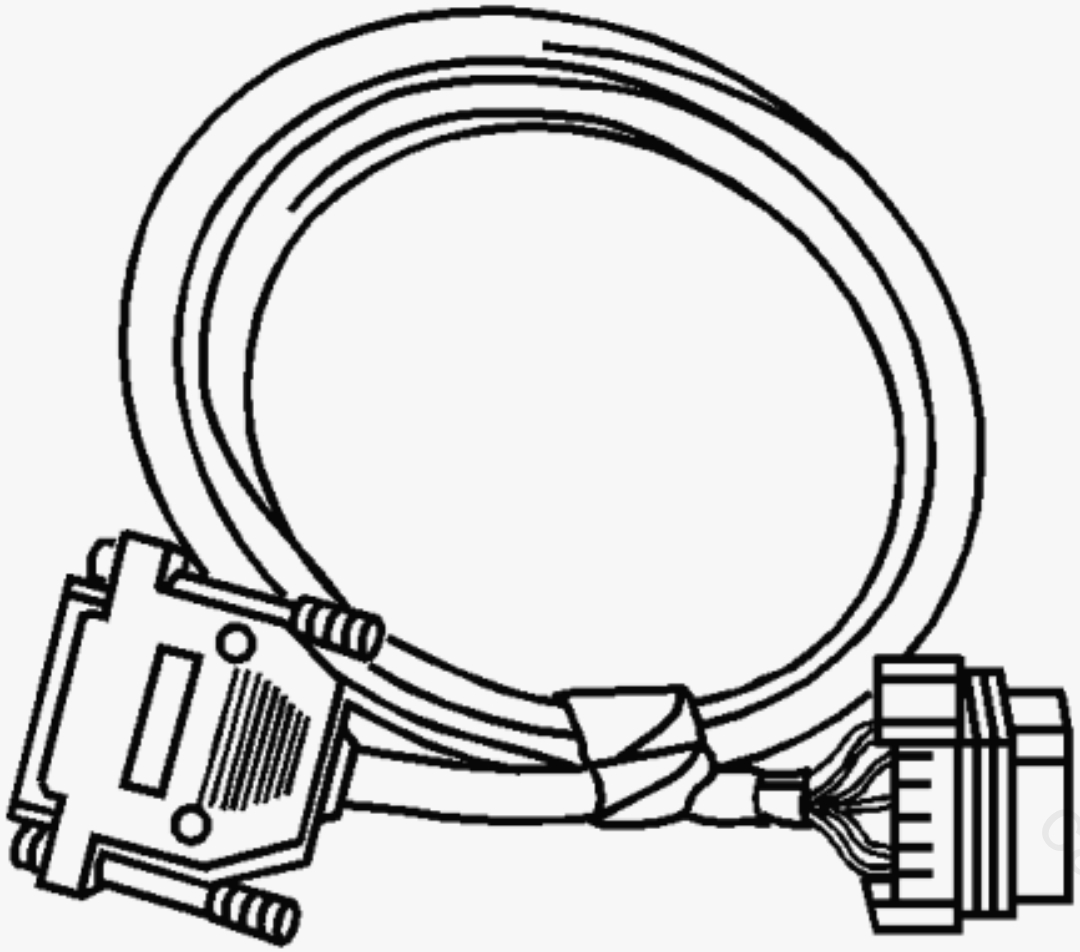
Illustration	Tool Number/Description
	EL-39021-460 J-39021-460 Fuel Injector Test Adapter

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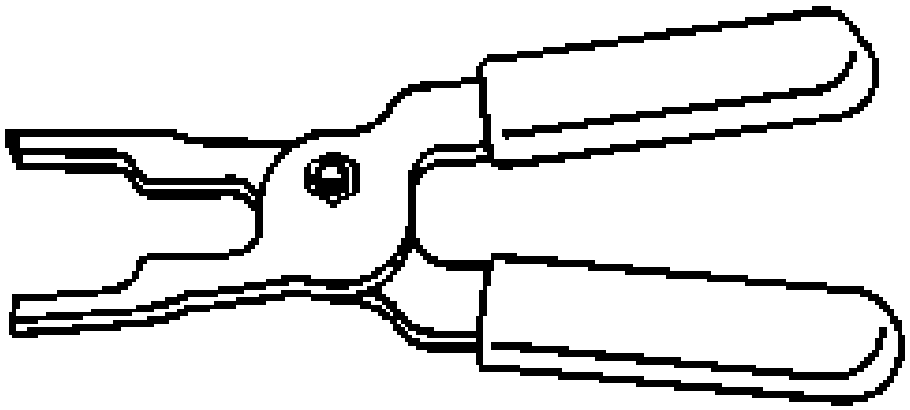
Illustration	Tool Number/Description
	EL-43244 J-43244 Relay Puller Pliers

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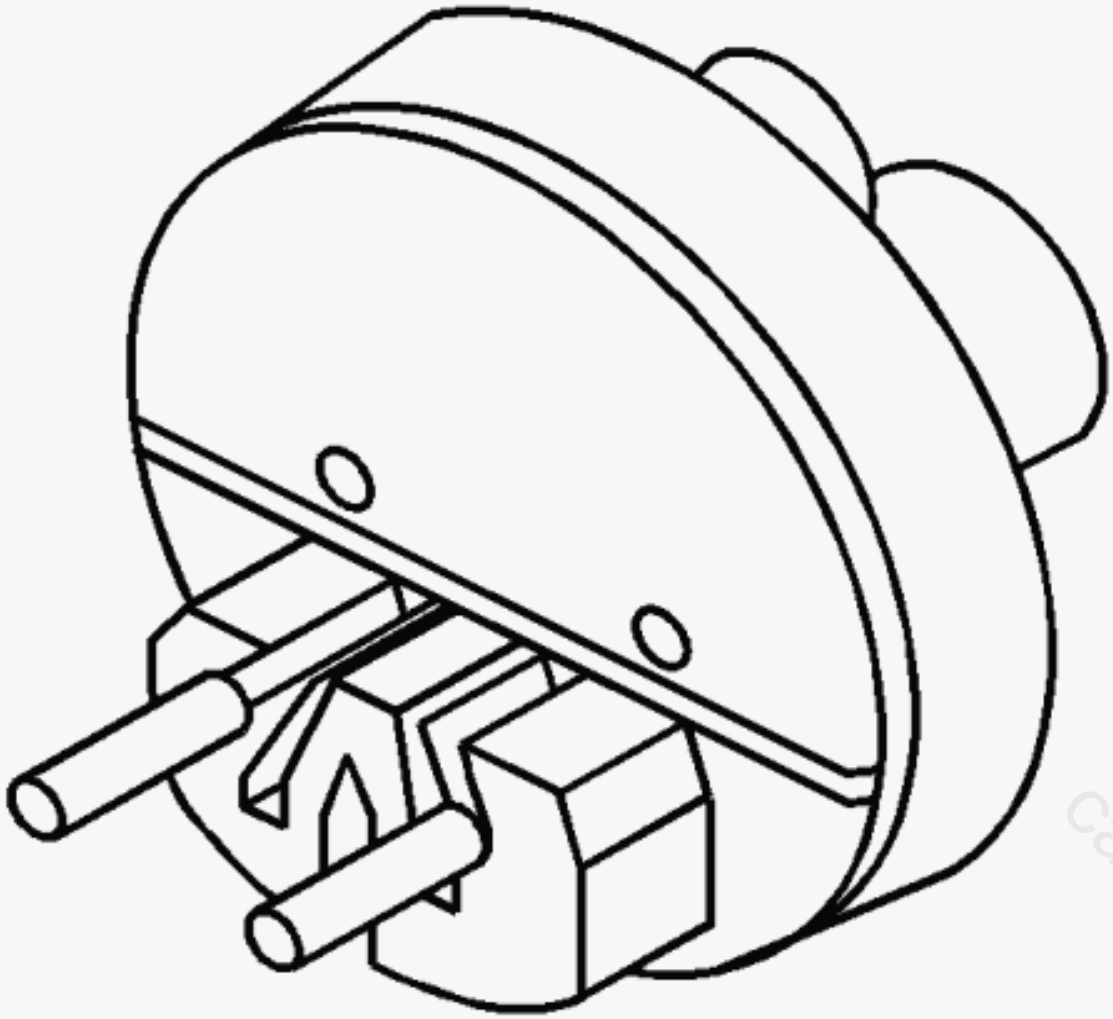
Illustration	Tool Number/Description
	EL-44603 J-44603 Injector Test Lamp

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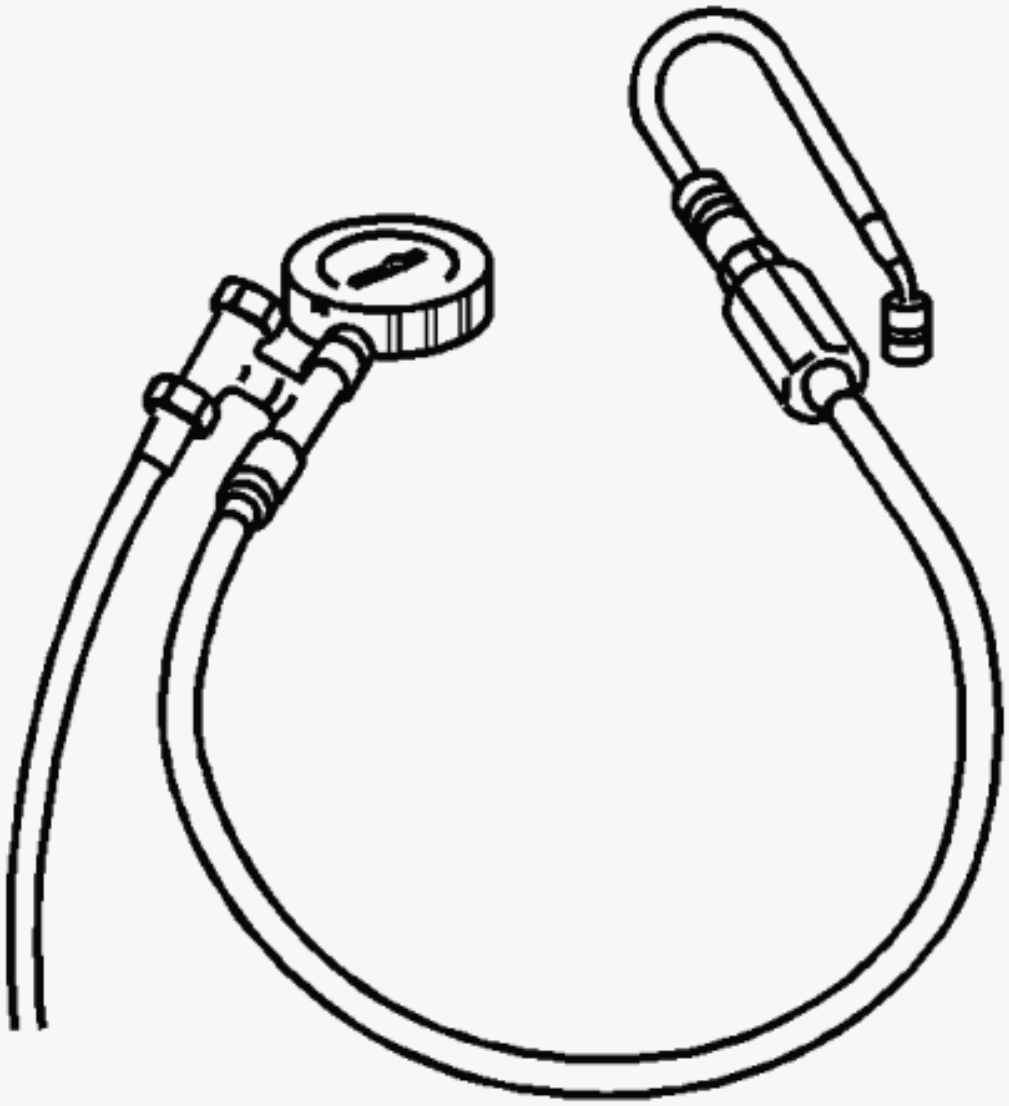
Illustration	Tool Number/Description
	EN-34730-91 J-34730-91 KM-J-34730-91 Pressure Tester
	EN-36012-A J-36012-A Ignition System Diagnosis Harness

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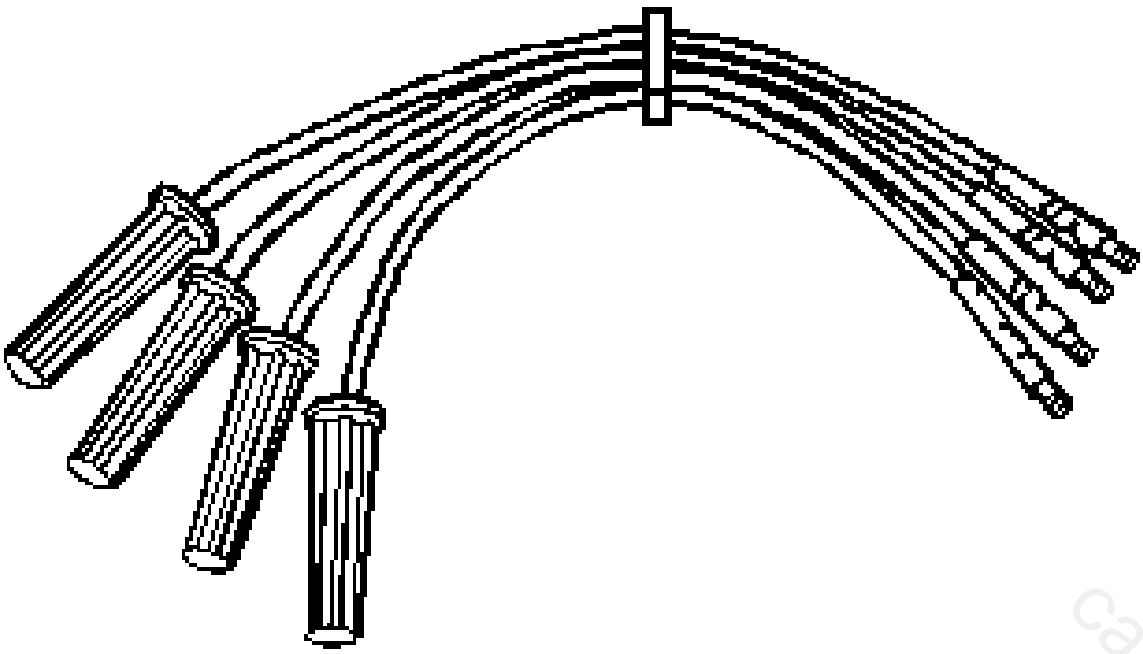
Illustration	Tool Number/Description
	
	EN-37287 J-37287 Fuel Line Shut-off Adapters

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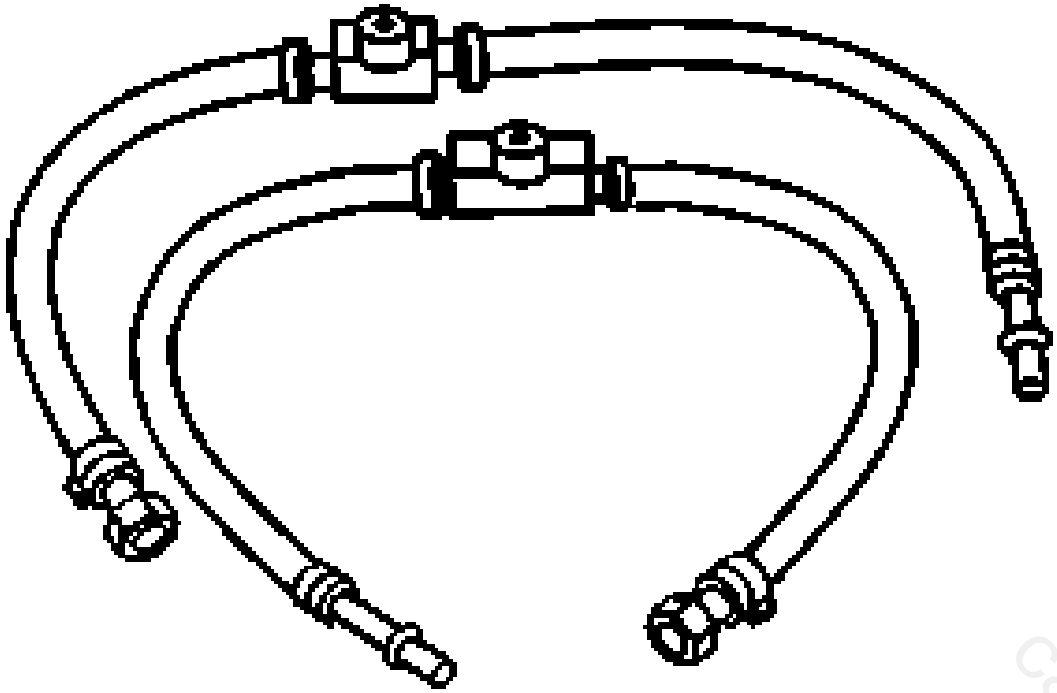
Illustration	Tool Number/Description
	

cardiagn.com

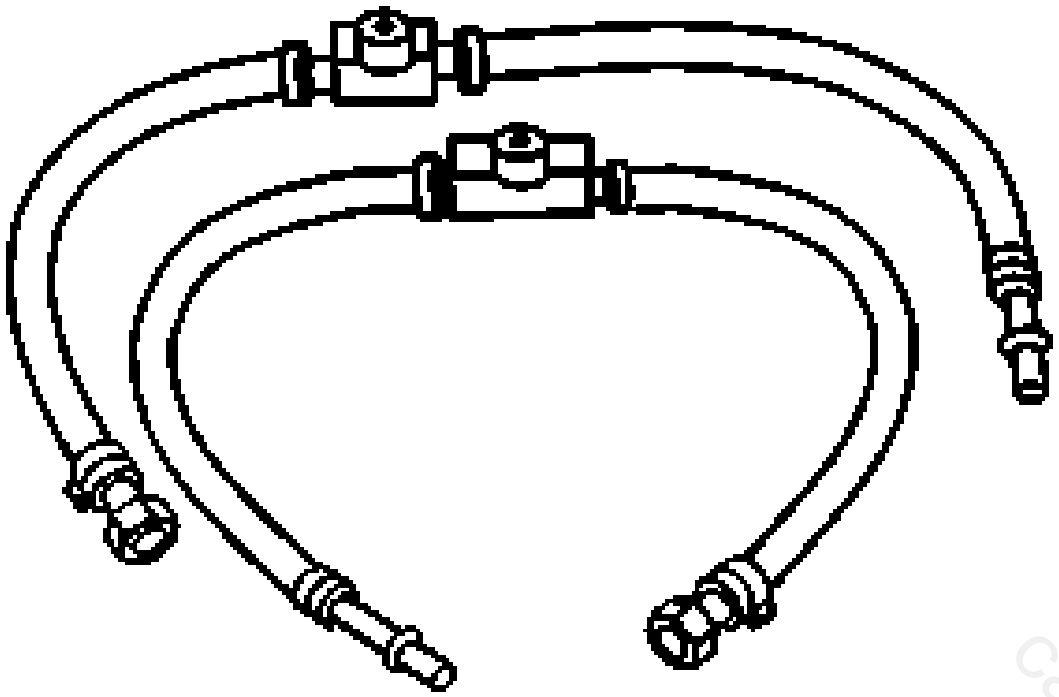
Illustration	Tool Number/Description
	EN-37287 - FF Fuel Line Shut-off Adapters

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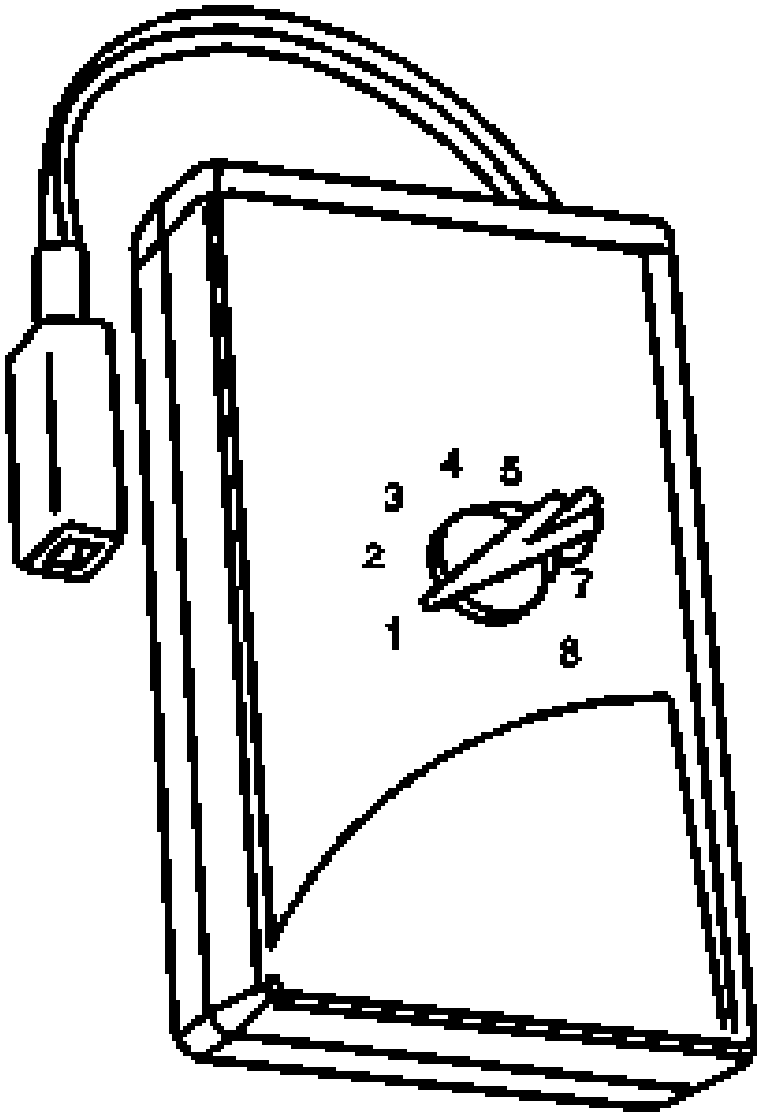
Illustration	Tool Number/Description
	EN-39021-210 J-39021-210 Injector Tester Adapter Box

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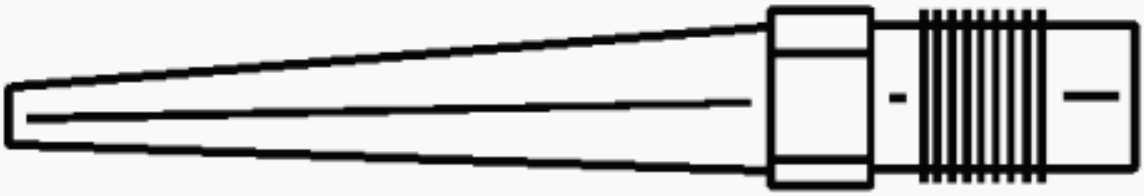
Illustration	Tool Number/Description
	EN-41413-311 J-41413-311 EVAP Plug

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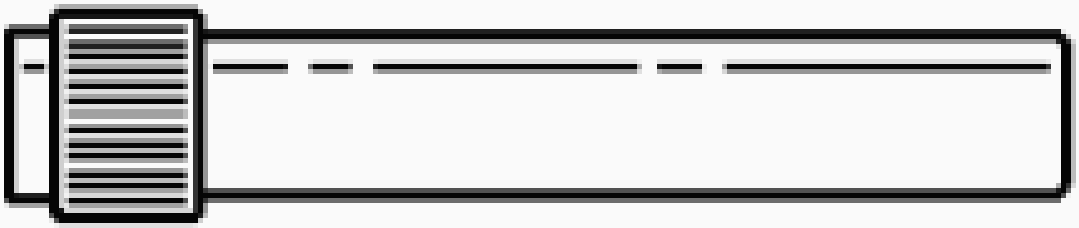
Illustration	Tool Number/Description
	EN-41413-VLV J-41413-VLV EVAP Service Port Vent Fitting
	EN-44602 J-44602 Injector Test Adapter

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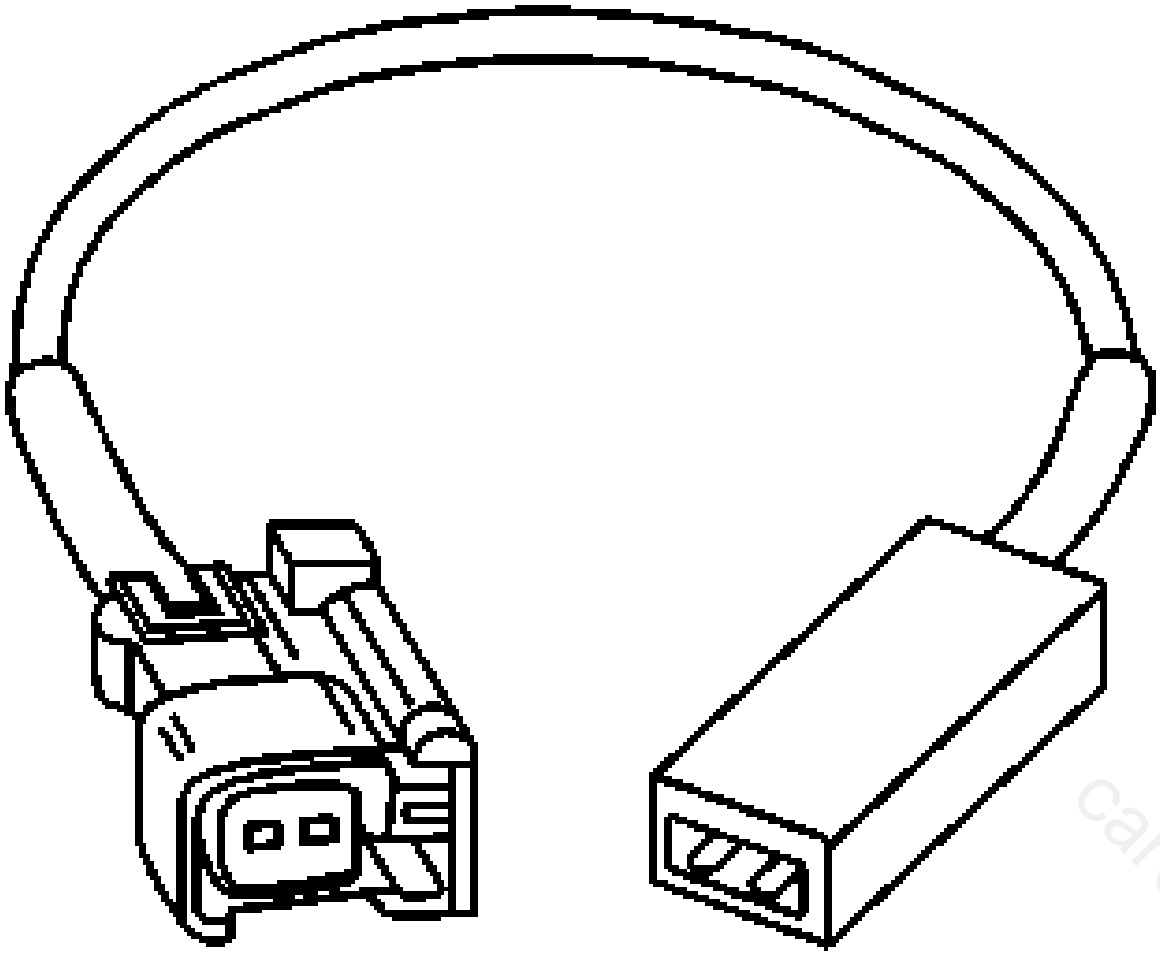
Illustration	Tool Number/Description
	

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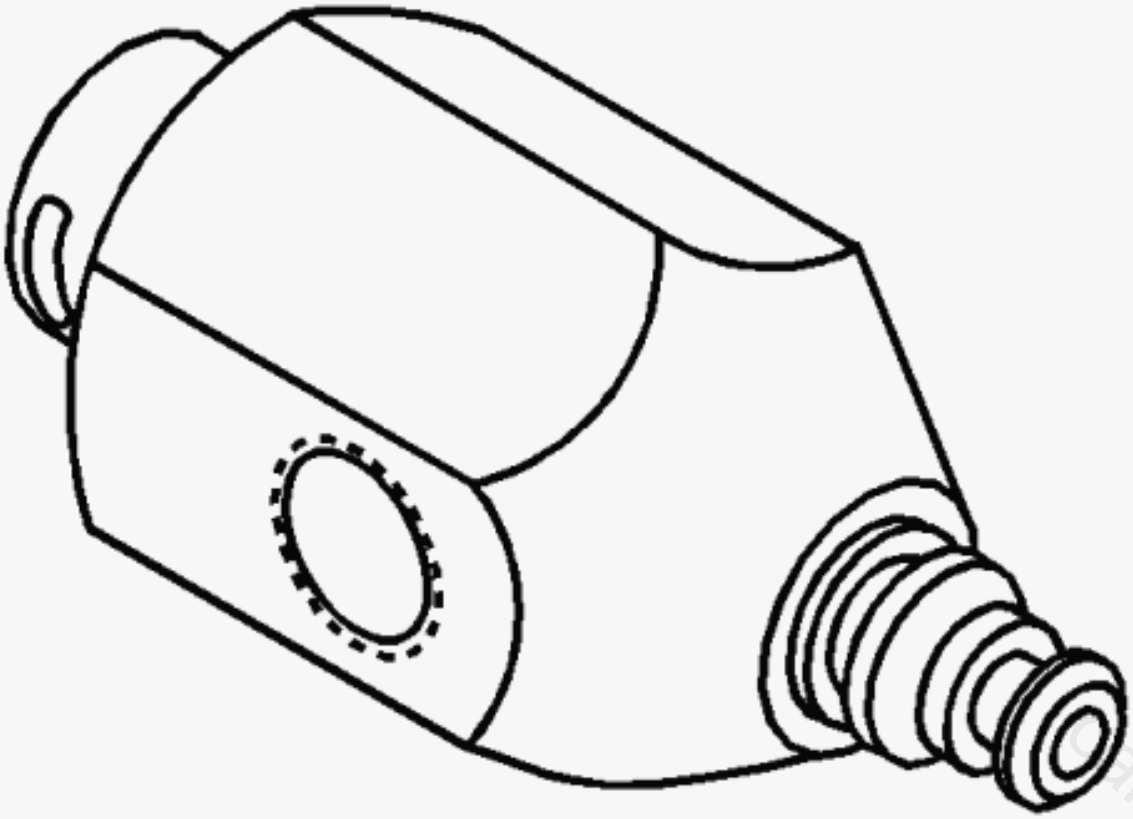
Illustration	Tool Number/Description
	EN-45873-30 J-45873-30 Injector Flow Test Adapter

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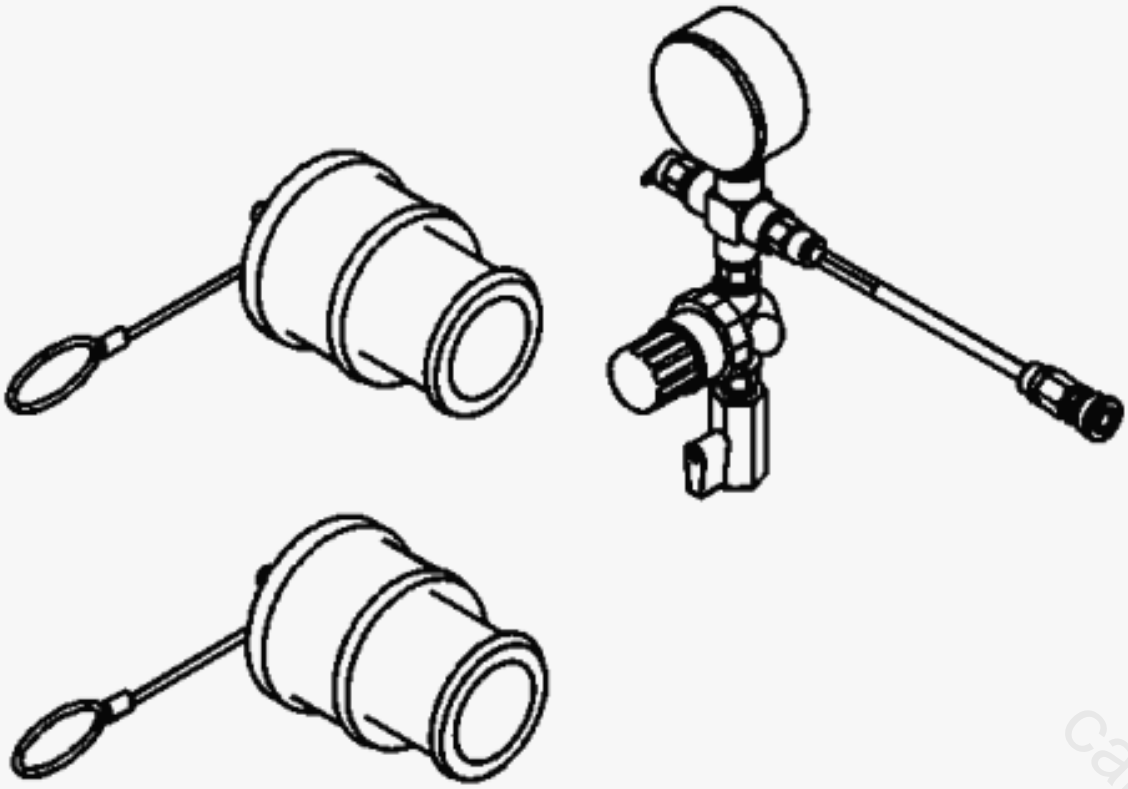
Illustration	Tool Number/Description
	EN-46091 J-46091 Charge Air Cooler Tester

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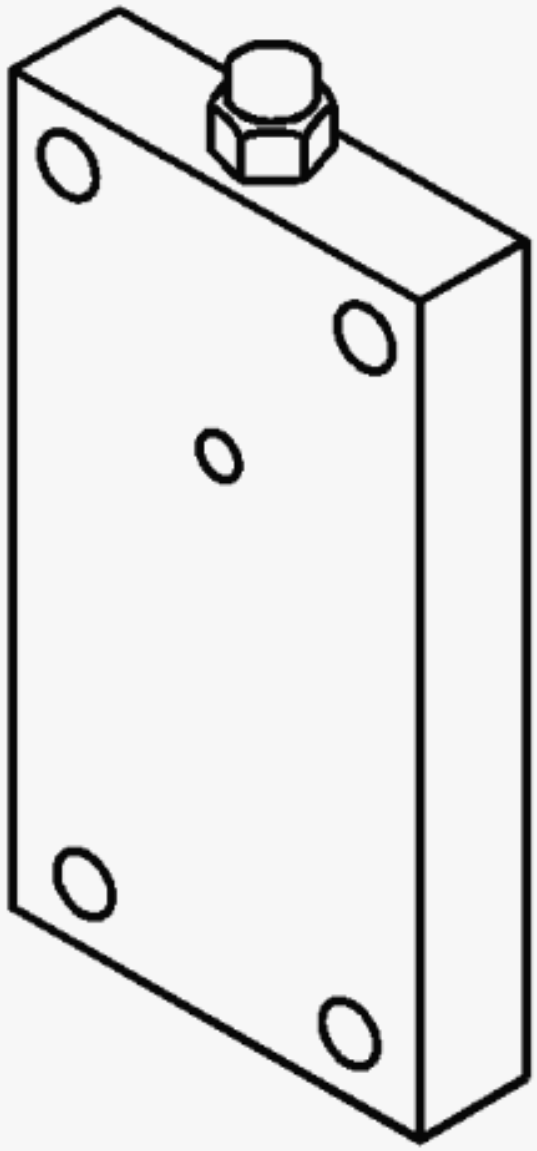
Illustration	Tool Number/Description
	EN-46091-5 J-46091-5 Charge Air Cooler Tester Adapter

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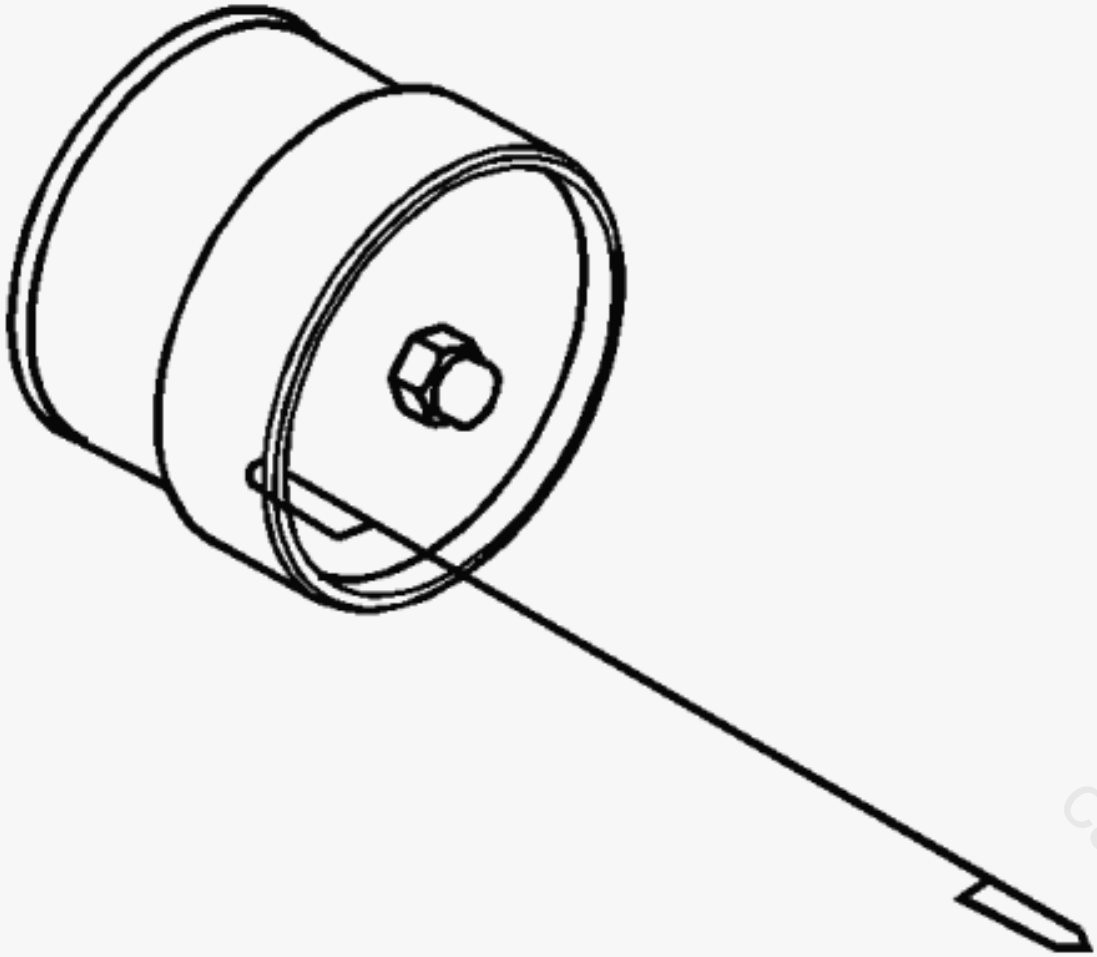
Illustration	Tool Number/Description
	EN-46091-10A Diesel Engine Pressure Test Adapter

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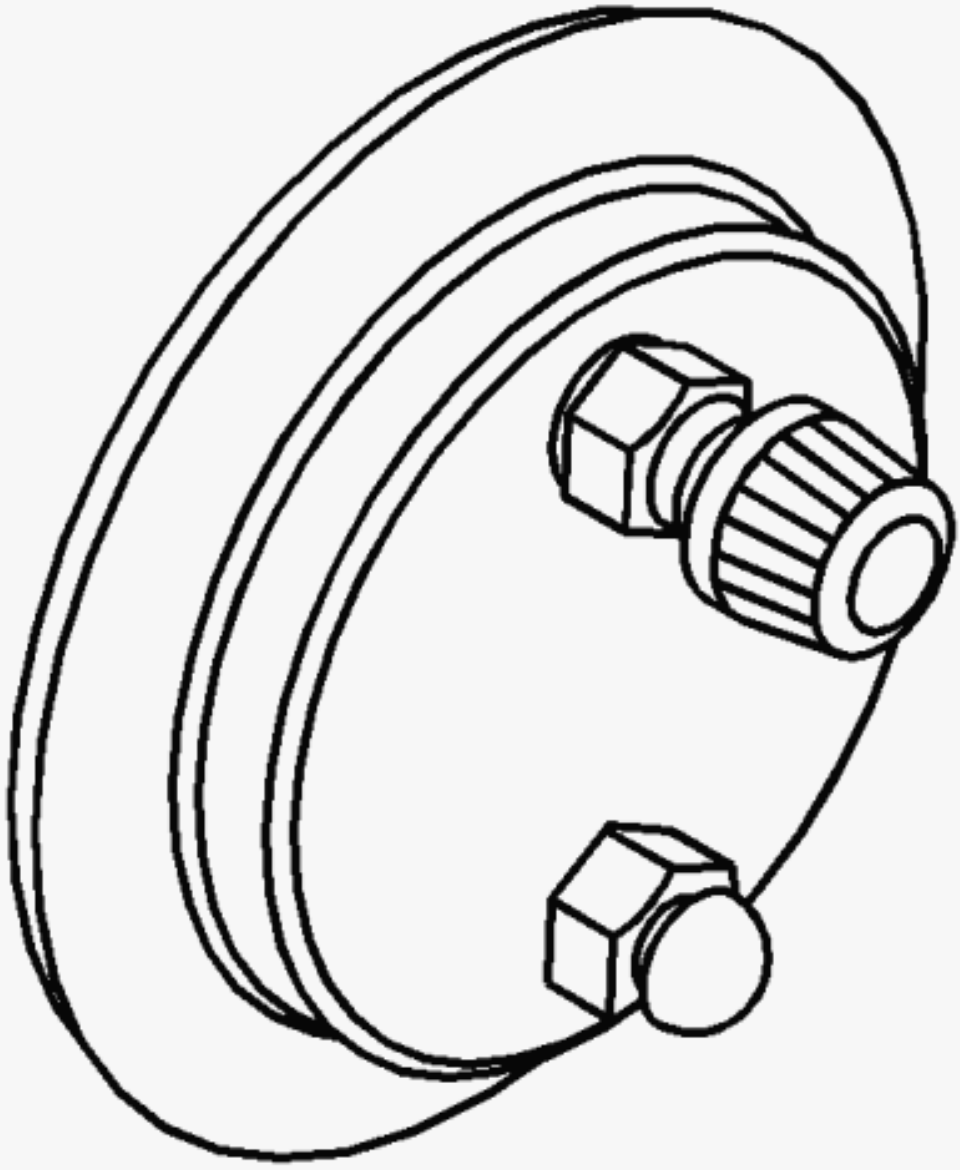
Illustration	Tool Number/Description
	EN-46091-15 J-46091-15 Engine Pressure Test Adapter

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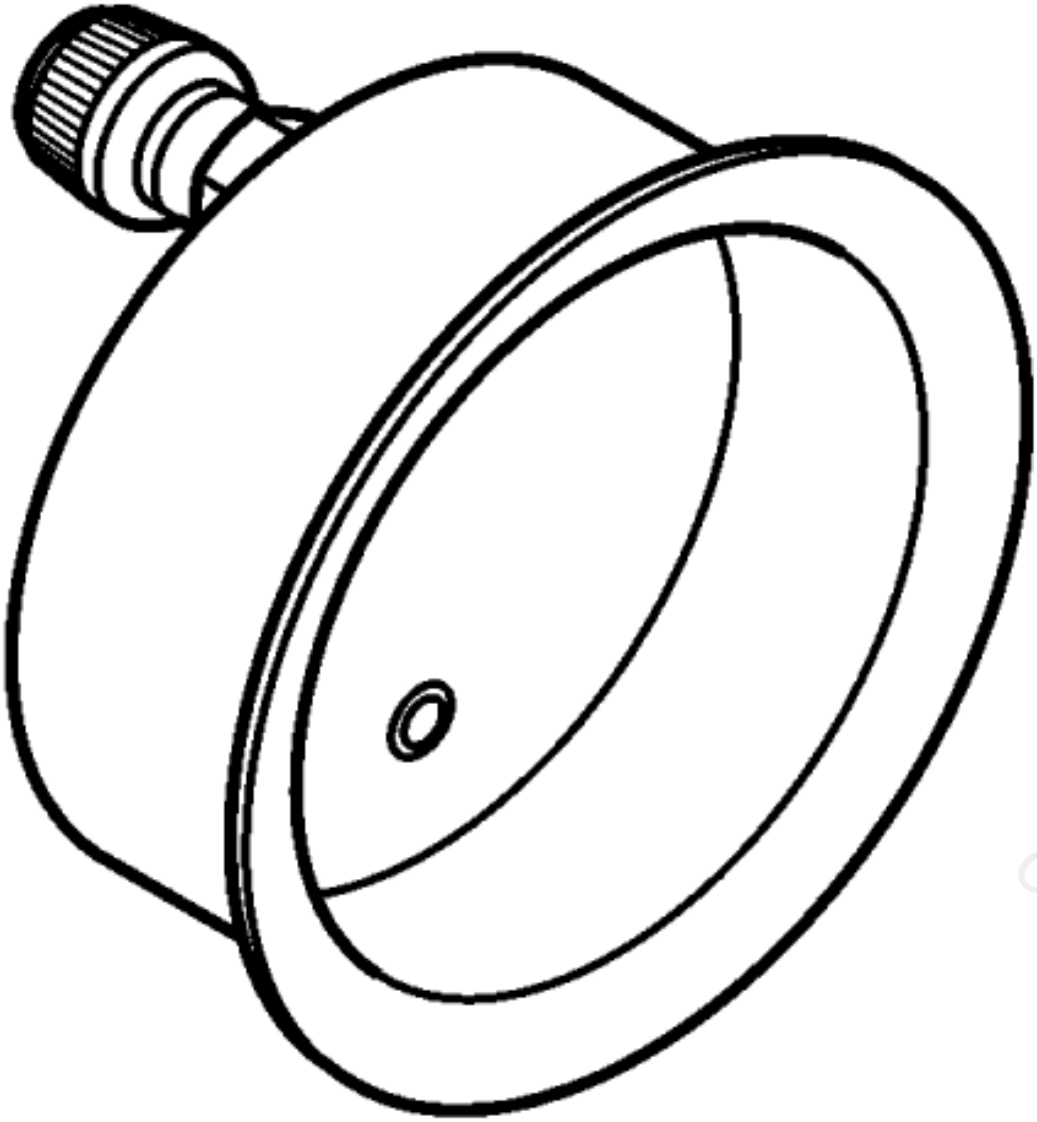
Illustration	Tool Number/Description
	EN-46091-15A J-46091-15A Diesel Engine Pressure Test Adapter

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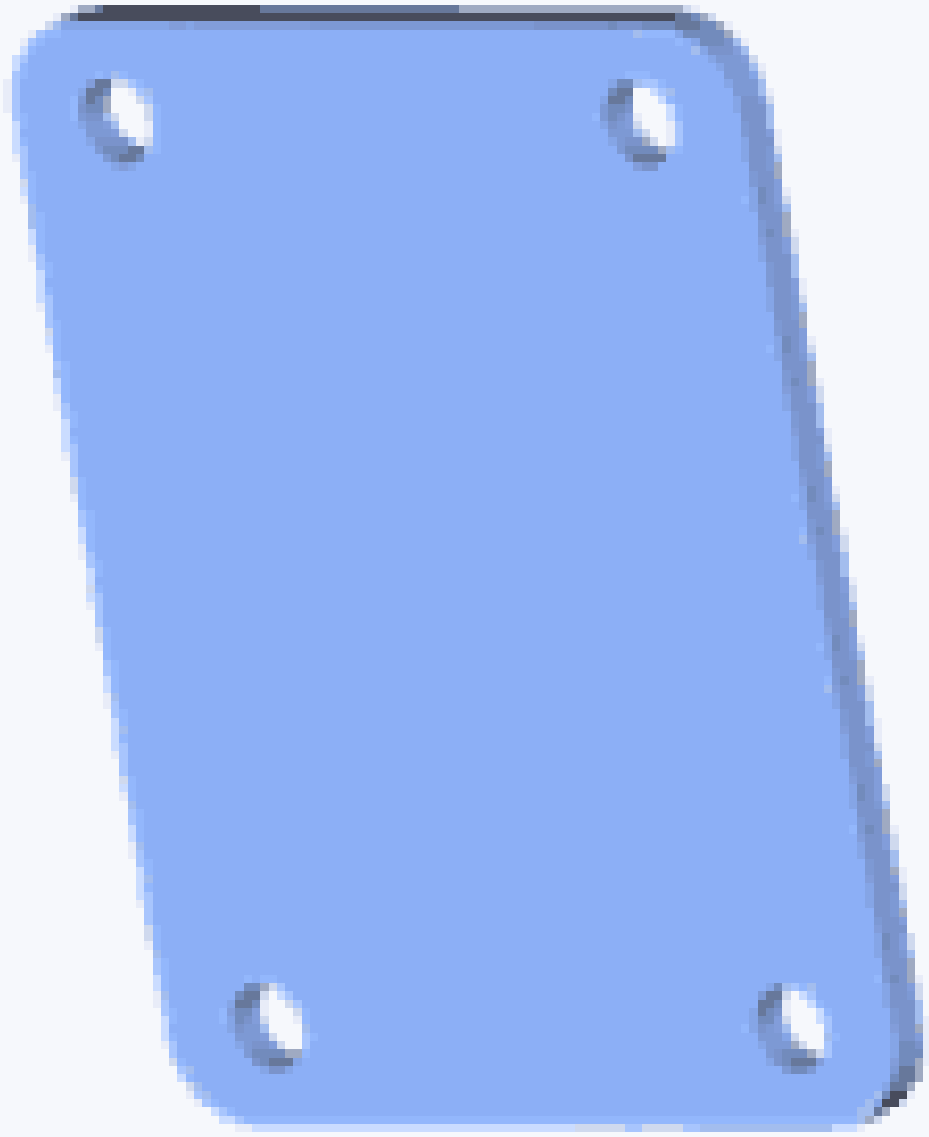
Illustration	Tool Number/Description
	EN-46091-25 J-46091-25 Diesel Engine Pressure Test Adapter

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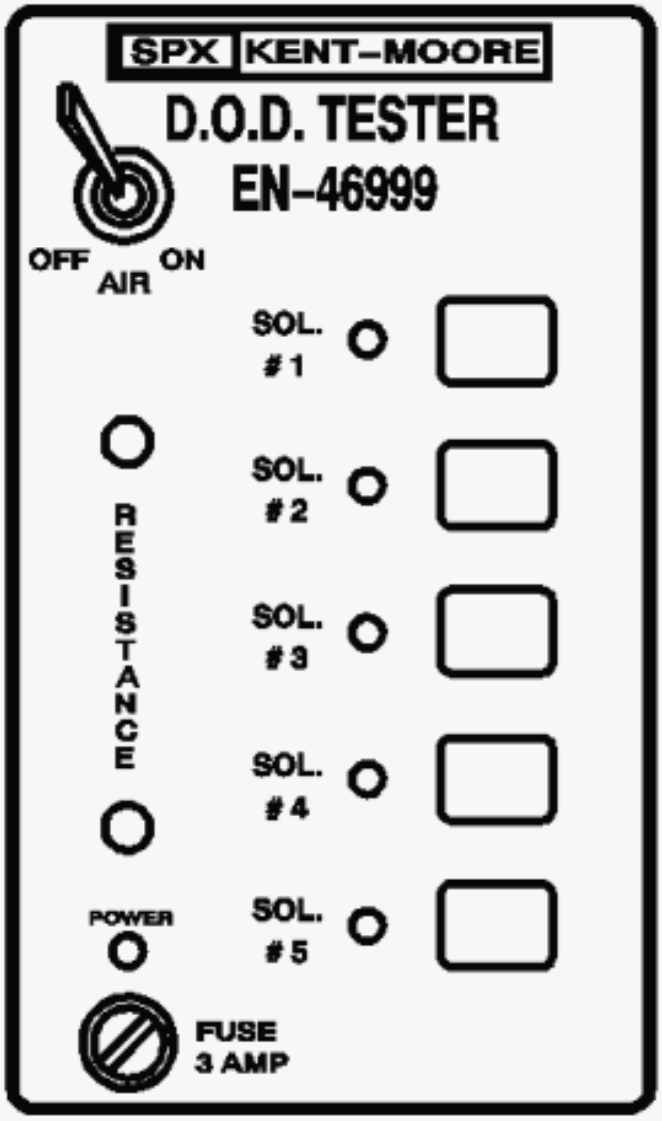
Illustration	Tool Number/Description
	EN-46999 Displacement On Demand Tester

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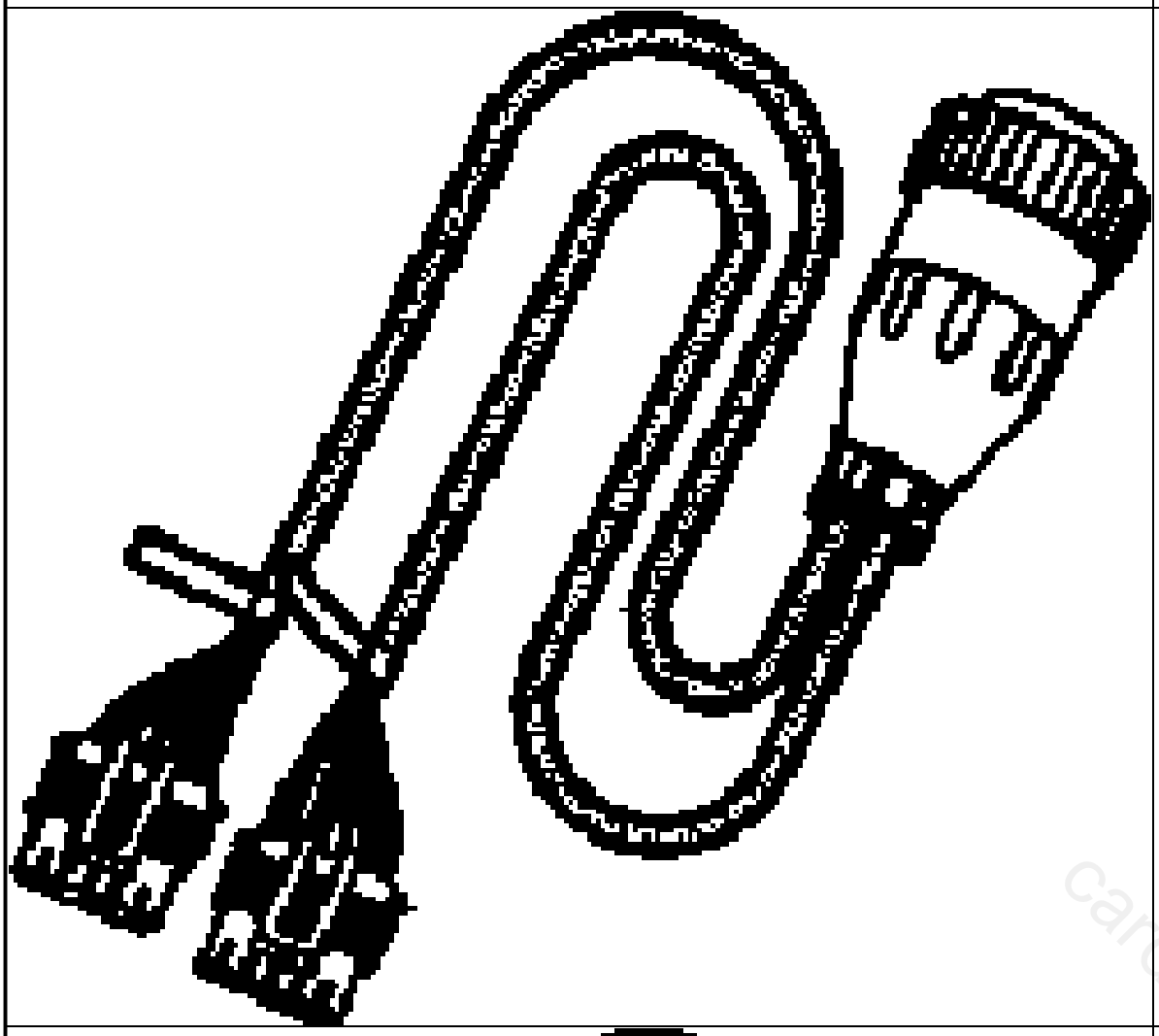
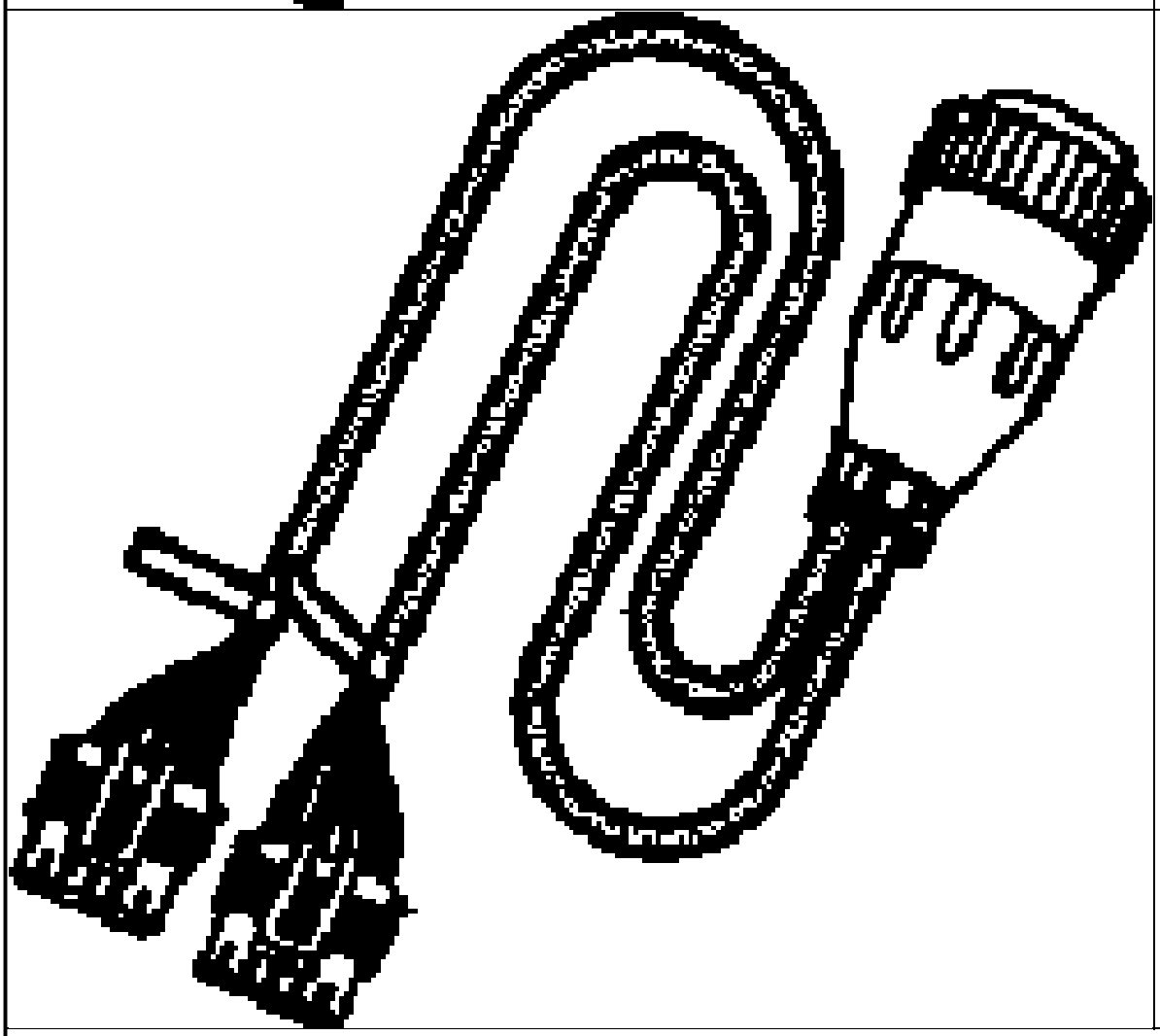
Illustration	Tool Number/Description
	EN-46999 - 15 Active Fuel Management Tester Harness - V6
	EN-46999 - 20 Active Fuel Management Tester Harness - Small Block V8

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Illustration	Tool Number/Description
	EN-47603 Compression Gauge Adapter

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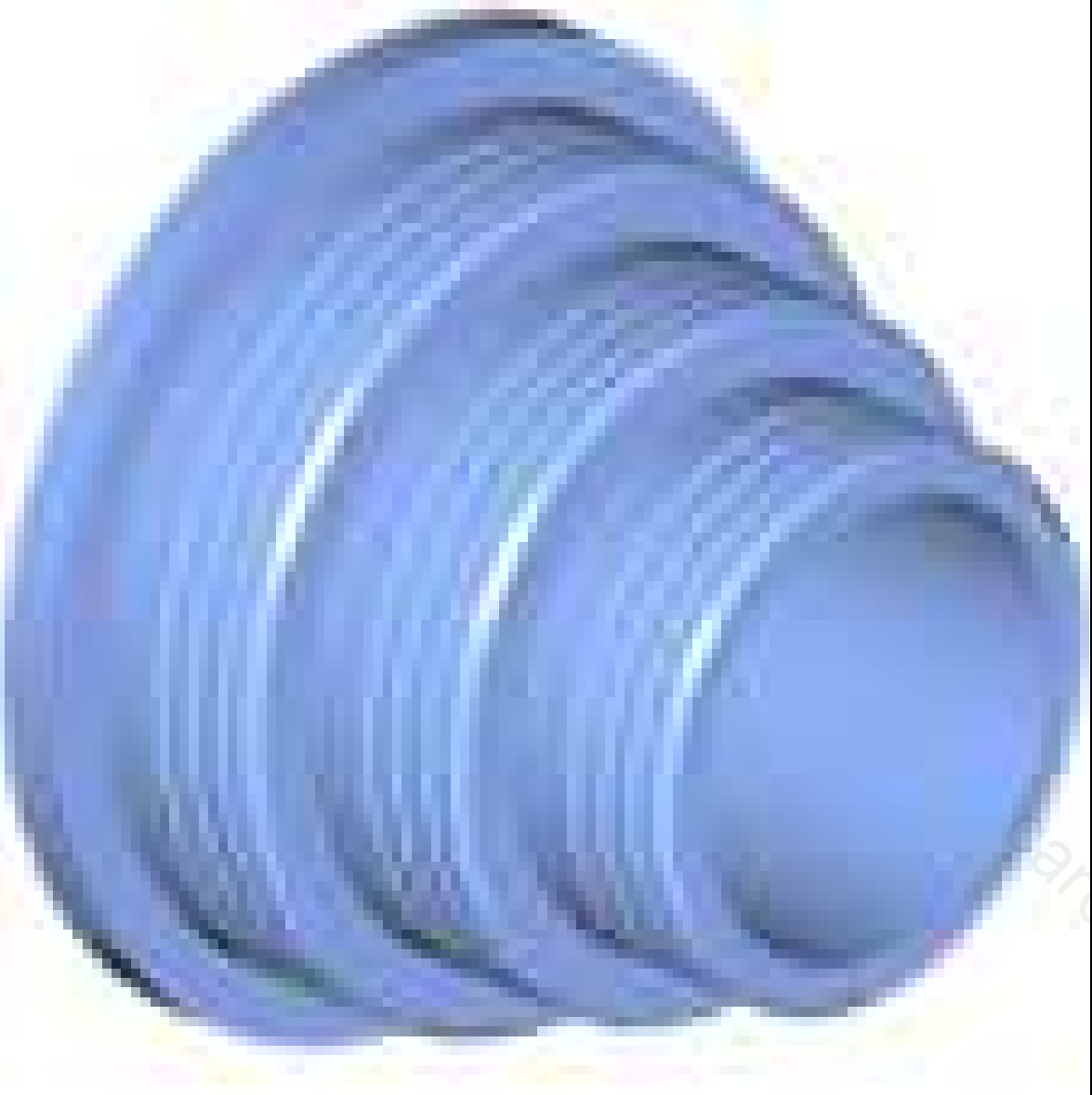
Illustration	Tool Number/Description
	EN-47656 - NA Pressure Test Plugs
	GE-23738-A J-23738-A Vacuum Pump

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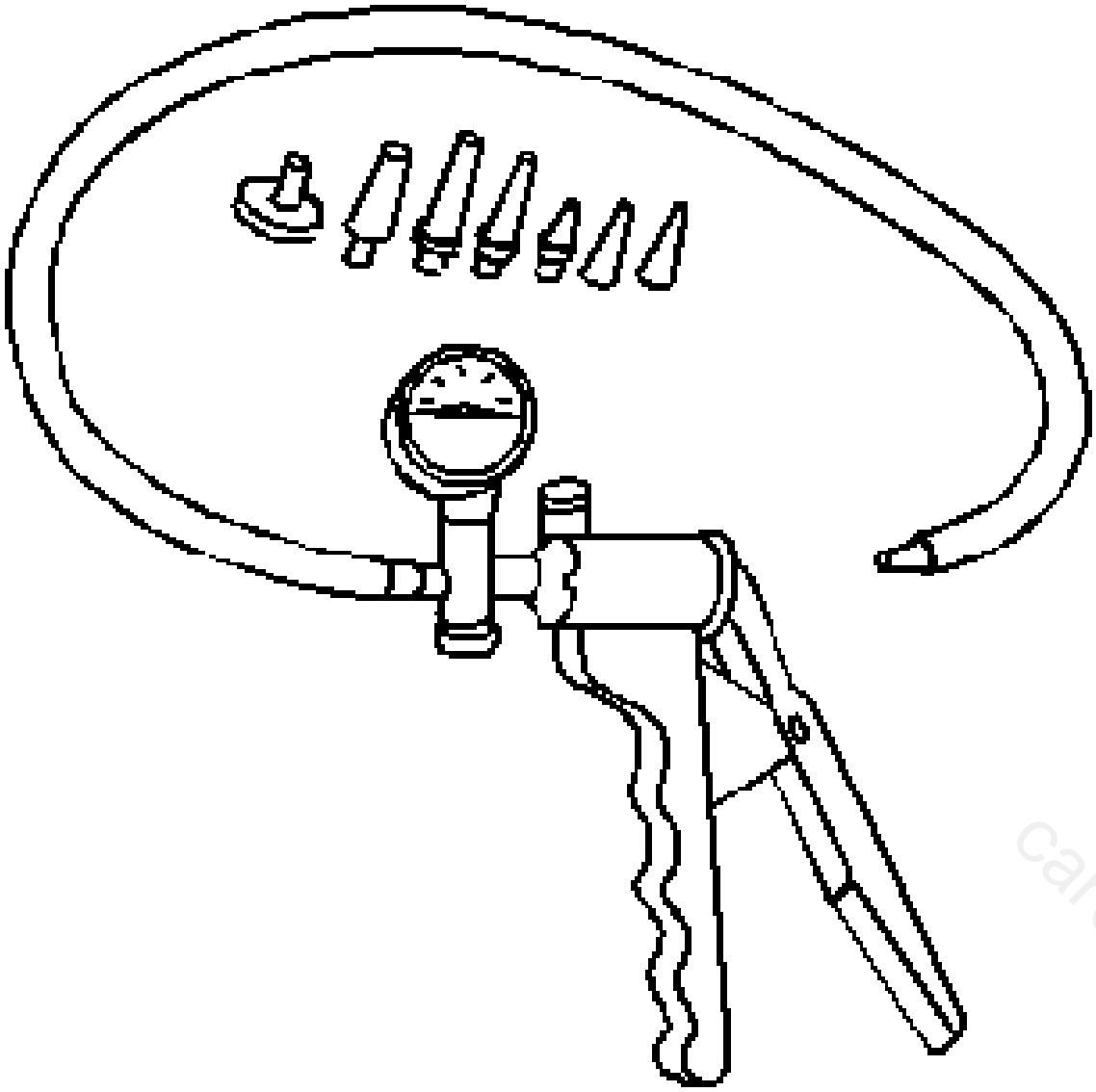
Illustration	Tool Number/Description
	

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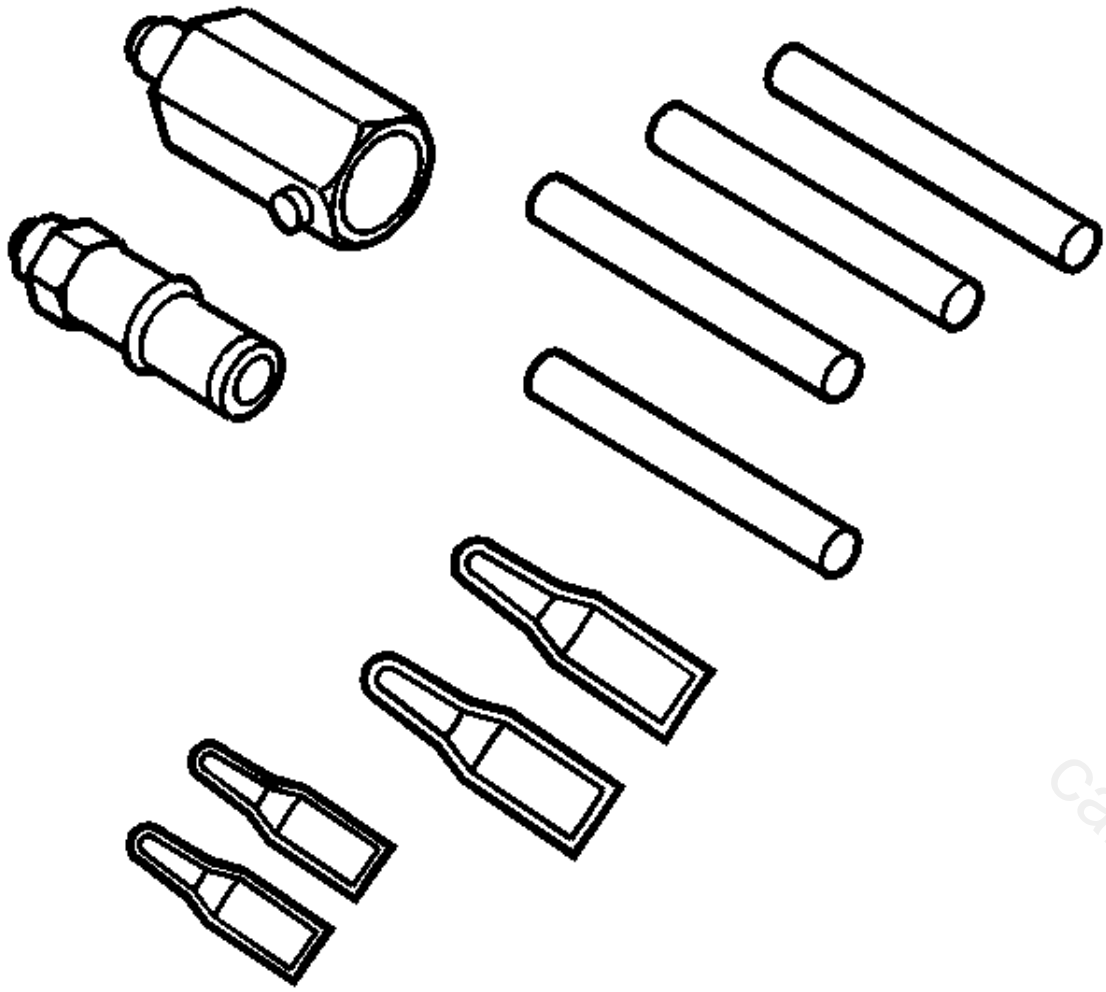
Illustration	Tool Number/Description
	GE-41413-300 EN-41413-300 J-41413-300 EVAP Cap and Plug Kit

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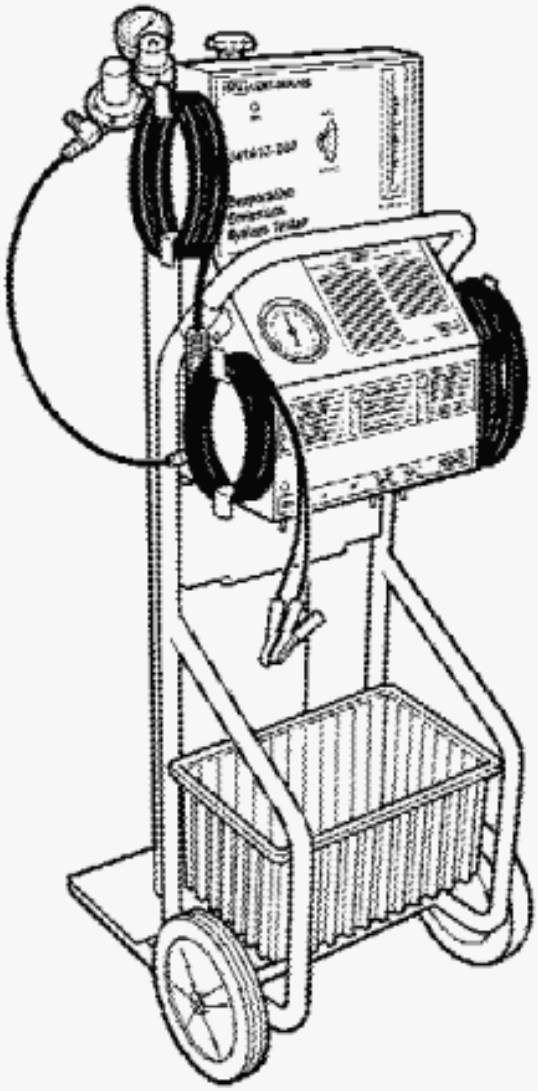
Illustration	Tool Number/Description
	GE-41413-A EN-41413-A J-41413-A Evaporative Emissions System Tester (EEST)
	GE-41413-B Evaporative Emissions System Tester (EEST)

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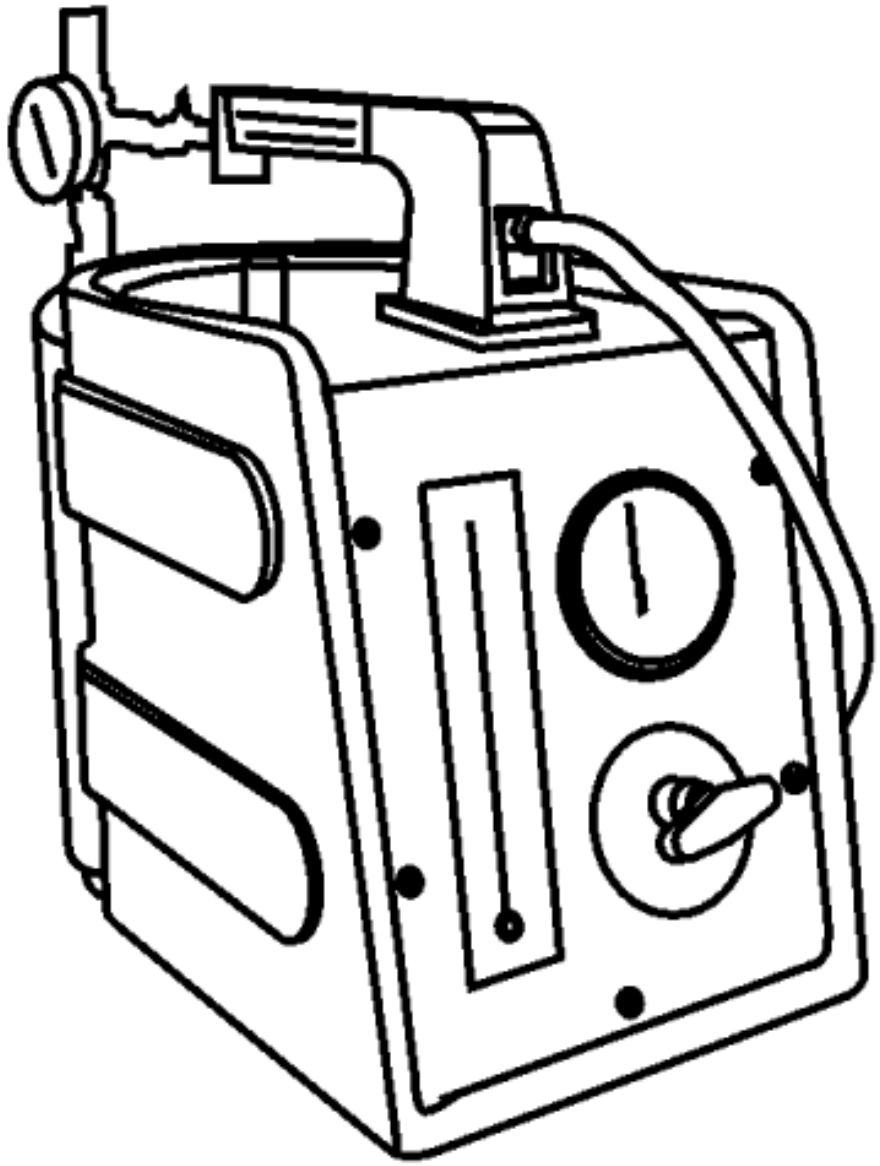
Illustration	Tool Number/Description
	

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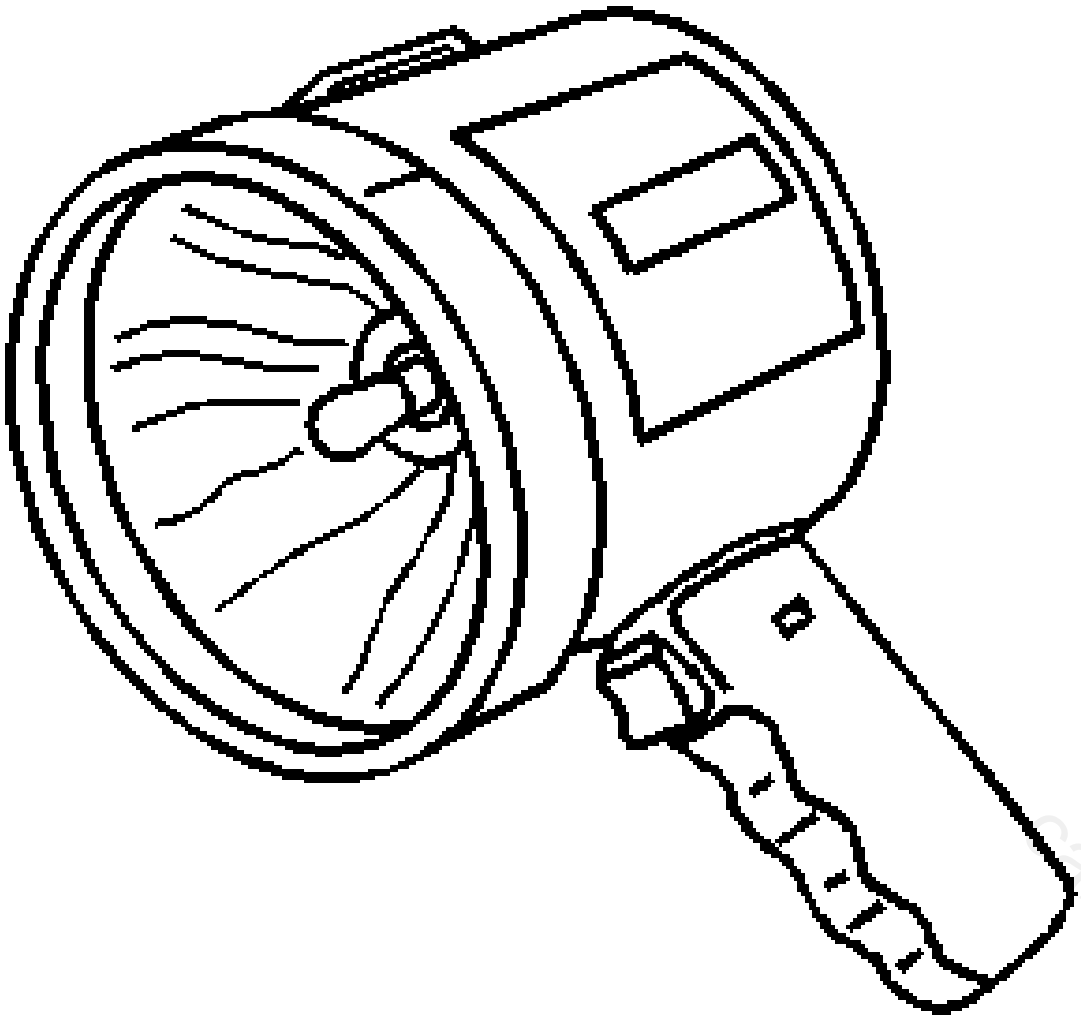
Illustration	Tool Number/Description
	GE-41413-SPT J-41413-SPT High Intensity White Light

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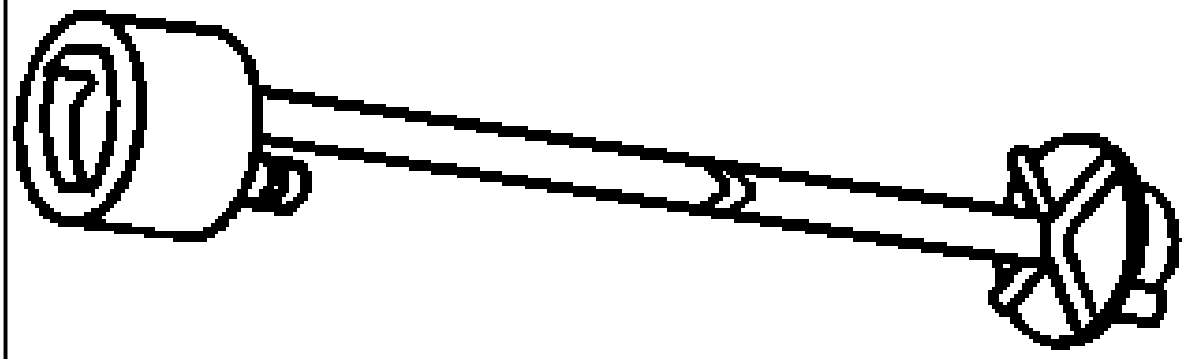
Illustration	Tool Number/Description
	GE-41415-50 J-41415-50 Fuel Tank Cap Adapter

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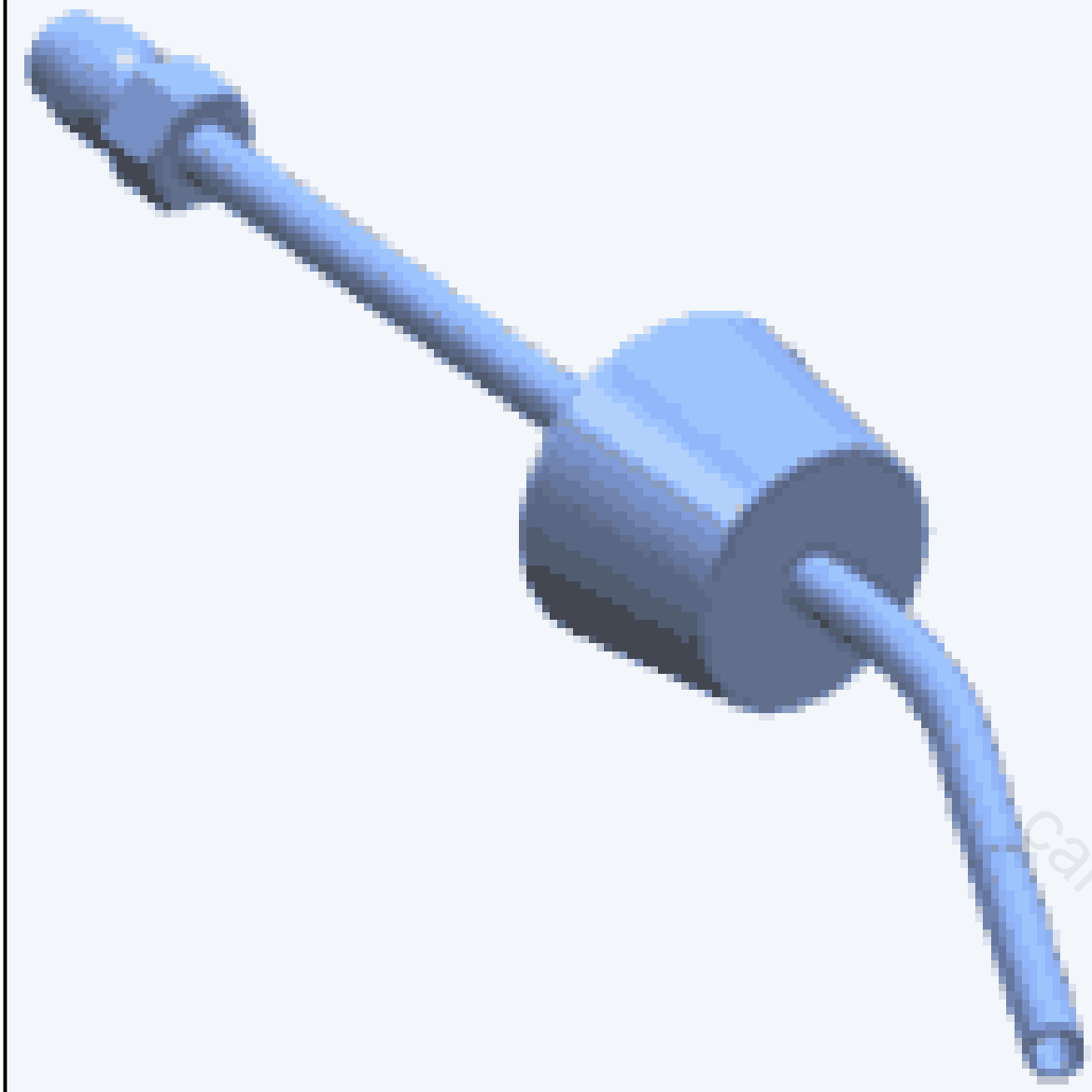
Illustration	Tool Number/Description
	GE-41415-60 Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter
	J-25070 Heat Gun 260 - 399Â°C (500 - 750Â°F)

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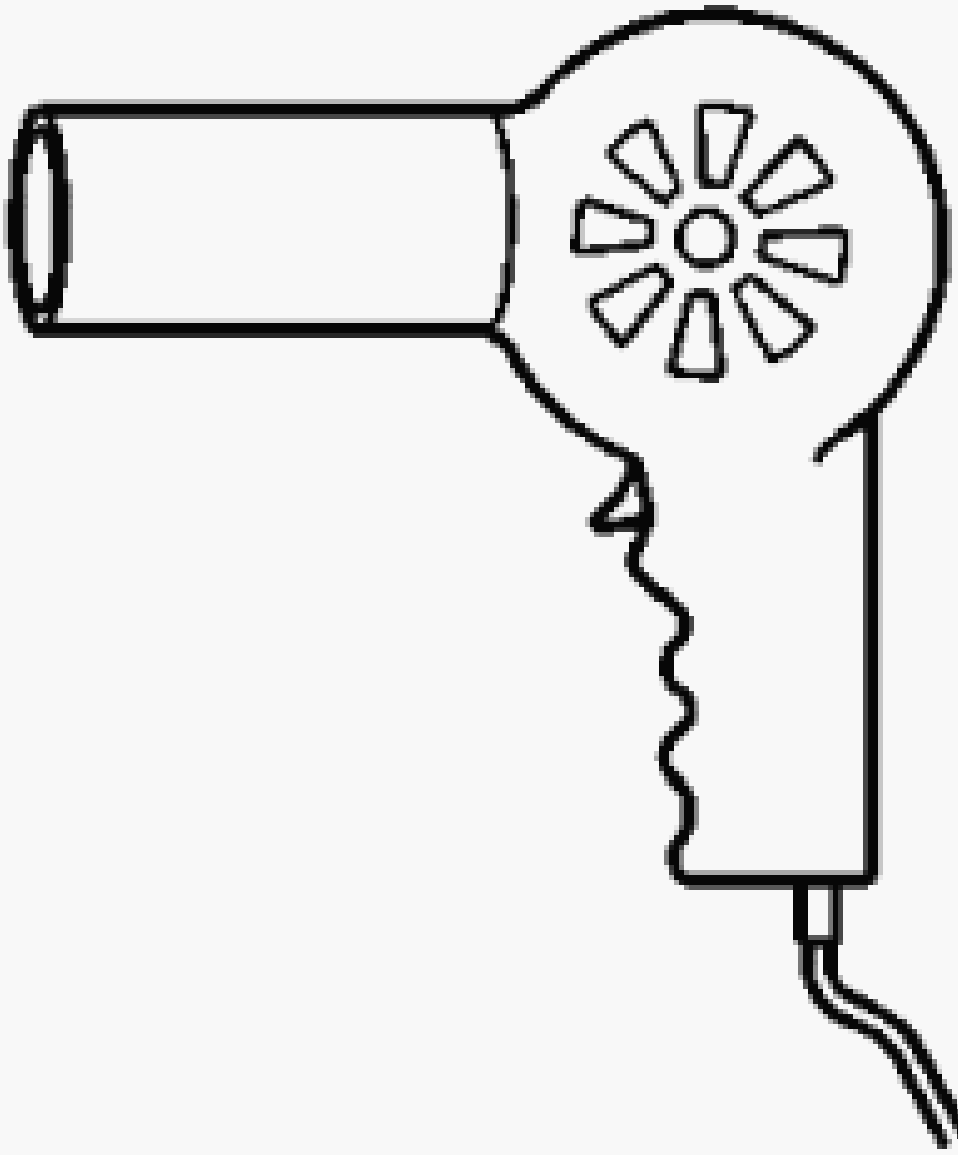
Illustration	Tool Number/Description
	
	J-34730-375 Injector Test Lamp

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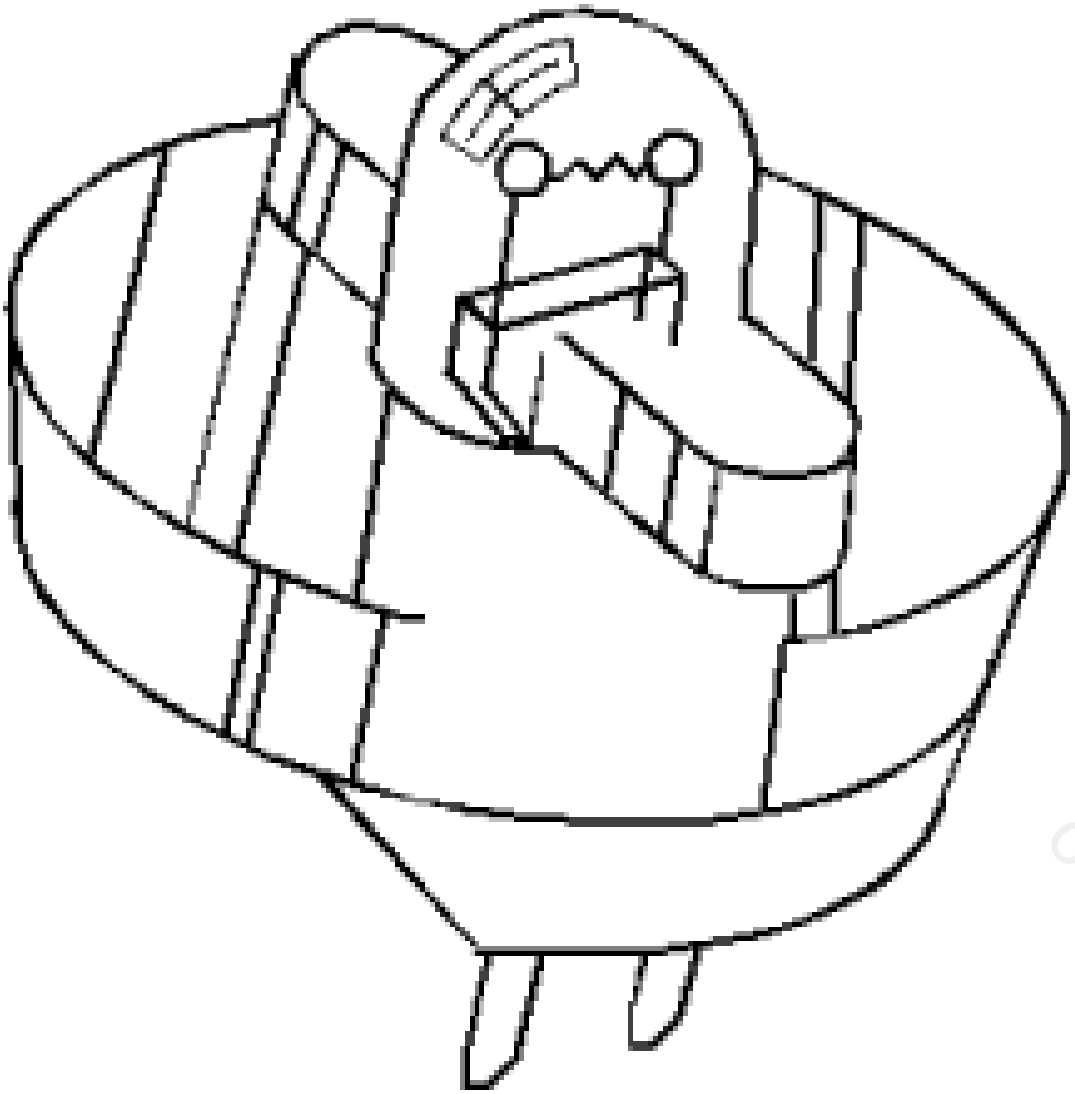
Illustration	Tool Number/Description
	

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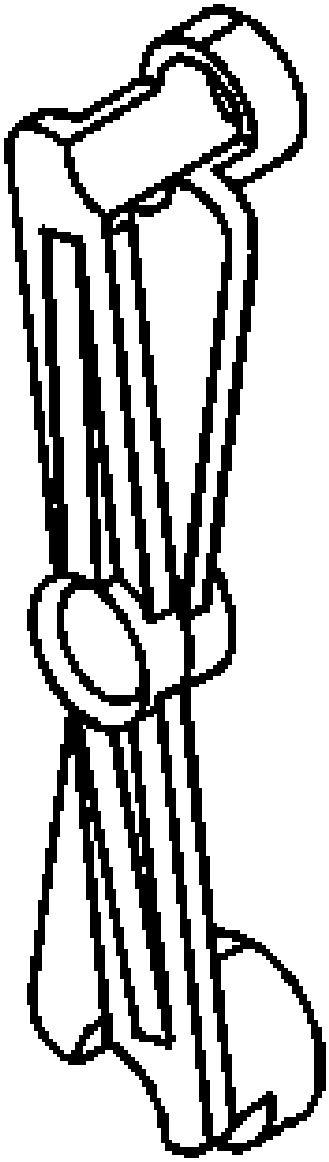
Illustration	Tool Number/Description
	J-44581 Fuel Line Disconnect Tool

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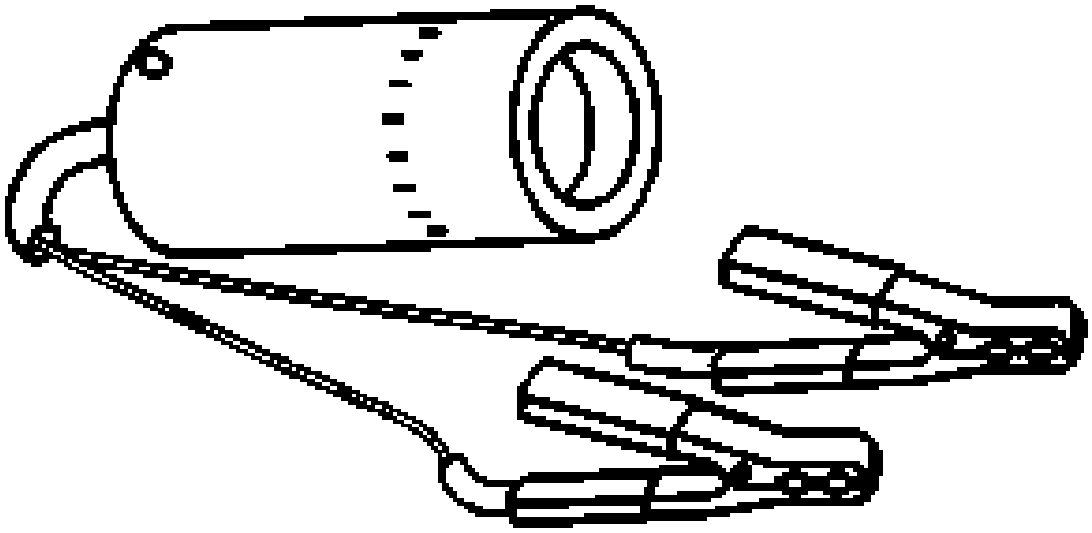
Illustration	Tool Number/Description
	J-28428 - E J 42220 CH 42220 Universal 12-Volt Leak Detection Lamp

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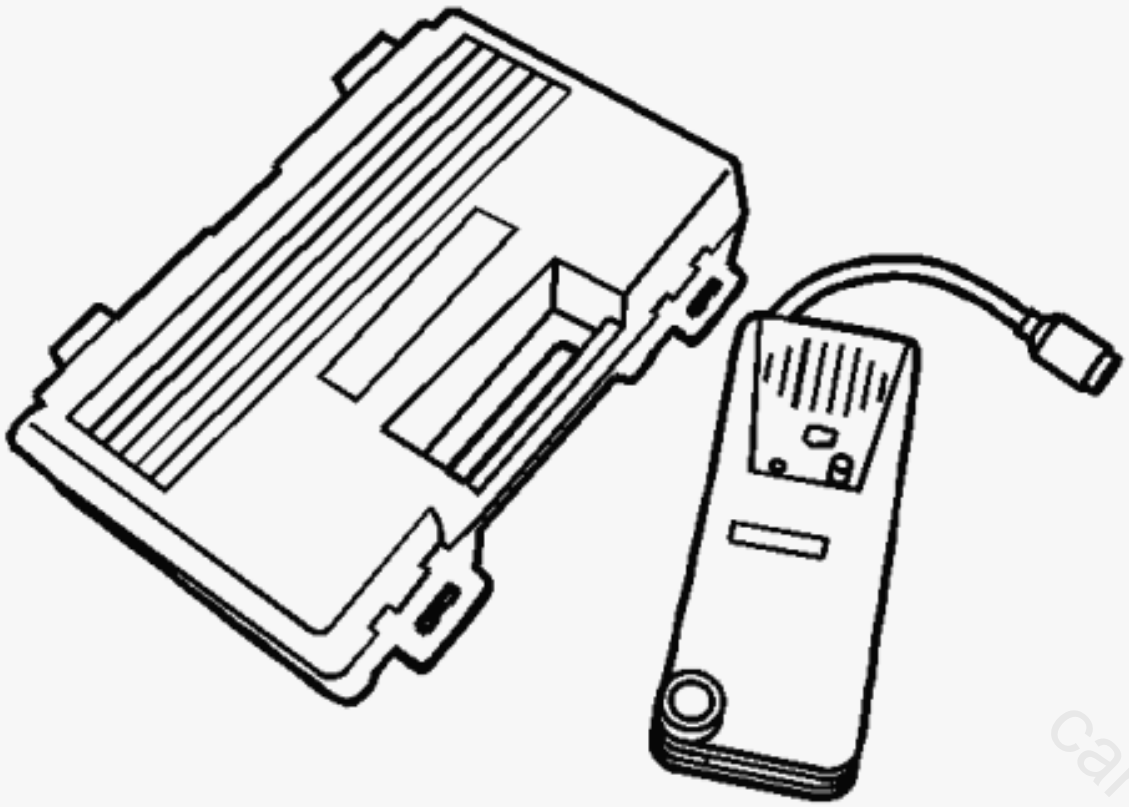
Illustration	Tool Number/Description
	J-45878 Combustible Gas Detector

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SPECIAL TOOLS (MECHANICAL TOOLS)

Illustration	Tool Number/ Description

Illustration	Tool Number/ Description
	CH-41769 J-41769 Fuel Line Quick Disconnect Tool

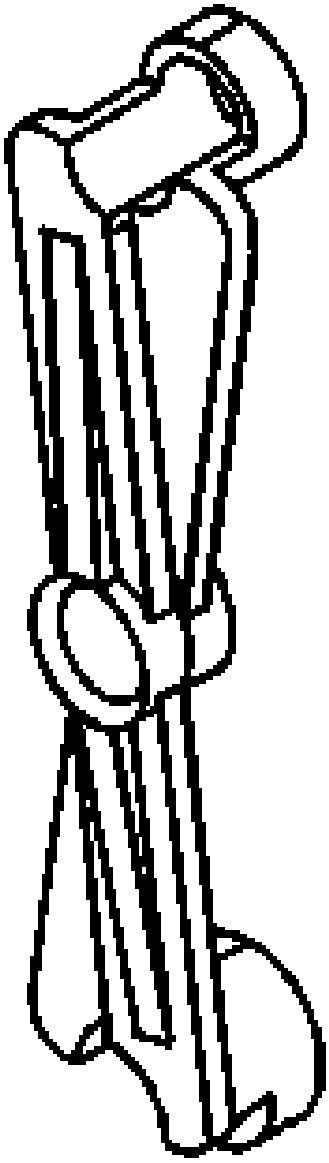
Illustration	Tool Number/ Description
	CH-44581 J-44581 Fuel Line Disconnect Tool

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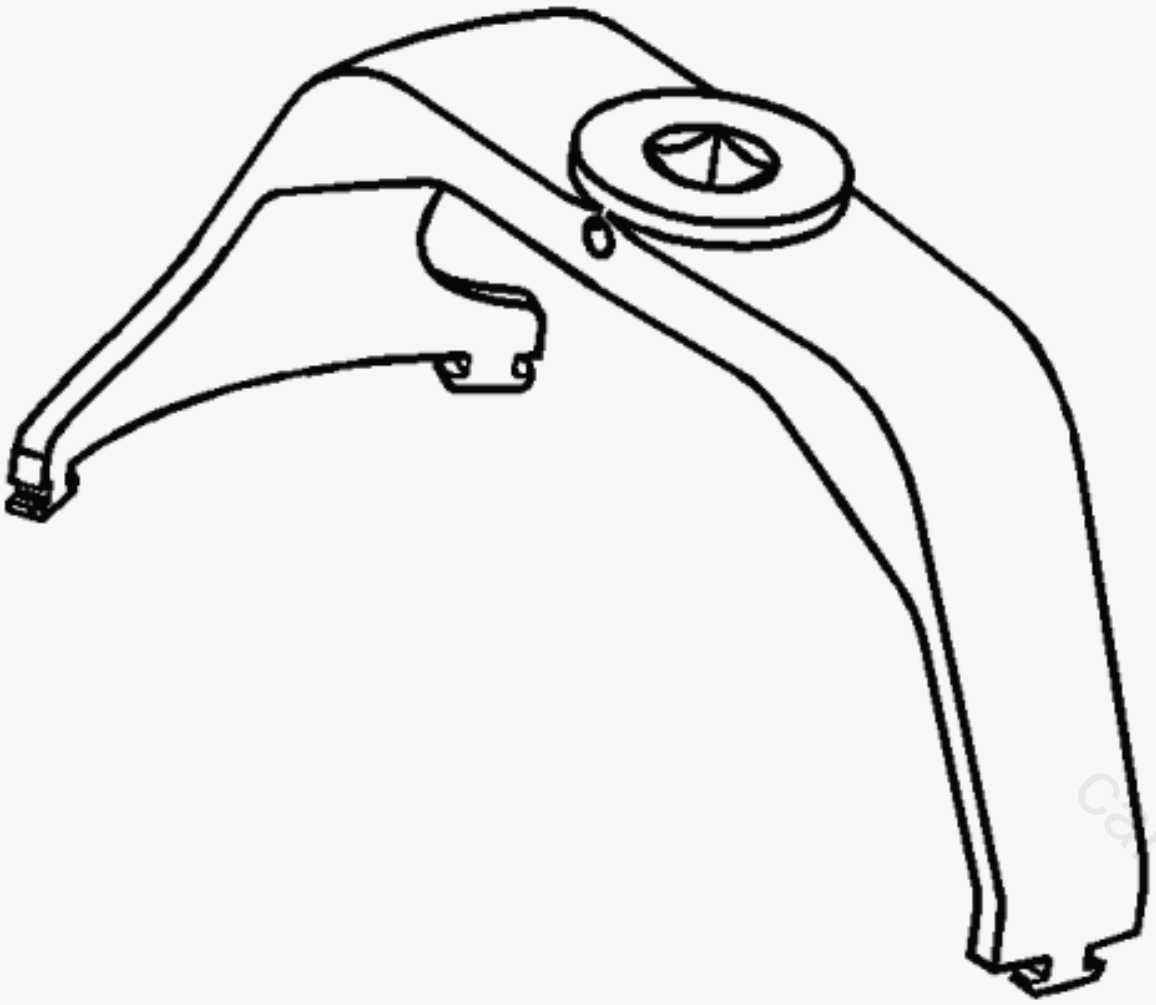
Illustration	Tool Number/ Description
	CH-52075 J-52075 Fuel Sender Lock Ring Wrench

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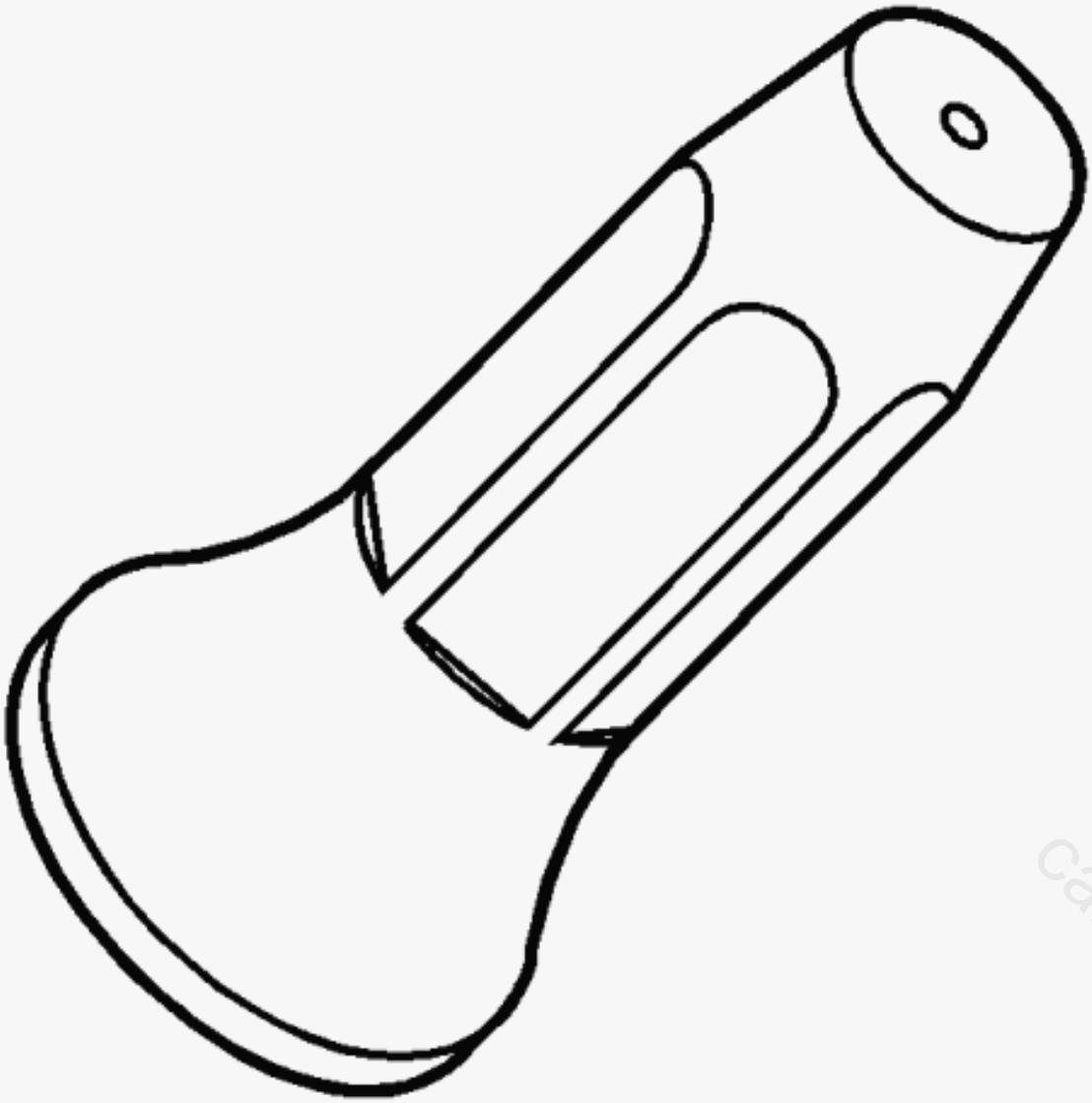
Illustration	Tool Number/ Description
	DT-45866 J-45866 7 - 0007829 Seal Installer

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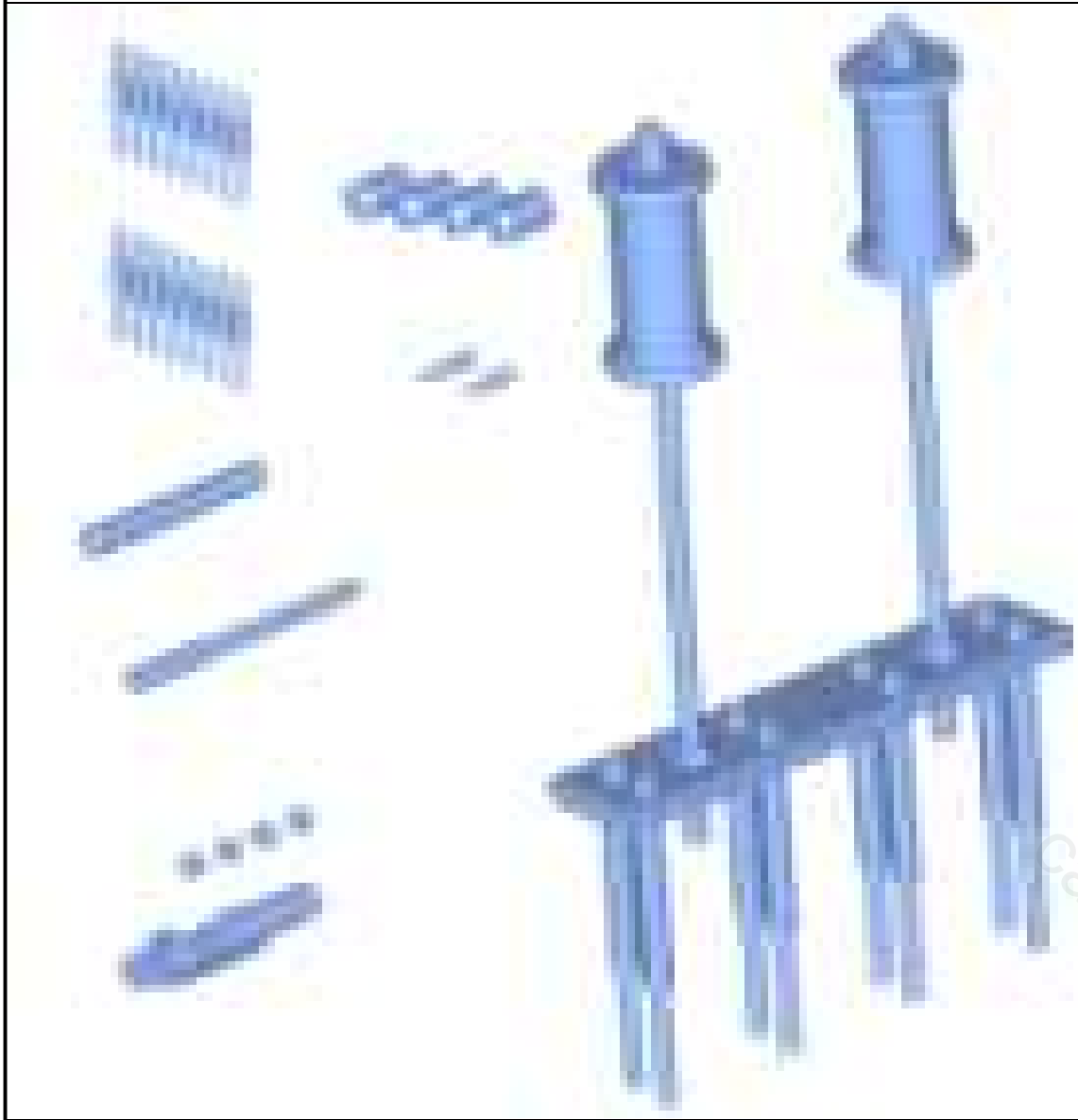
Illustration	Tool Number/ Description
	EN-51146 EN-51146 - BR Fuel Injector Removal / Installation Kit

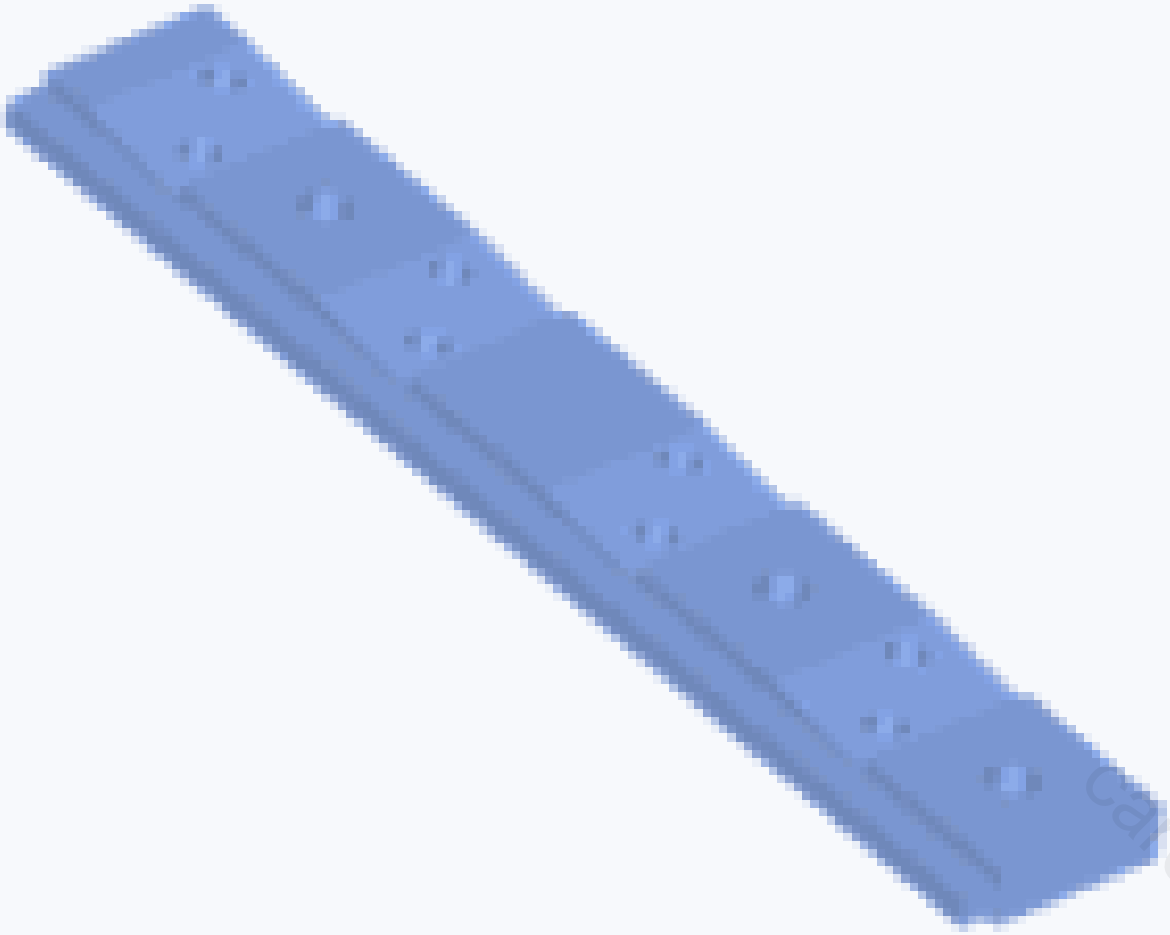
Illustration	Tool Number/ Description
	EN-51146 - 100 Fuel Injector Removal Plate

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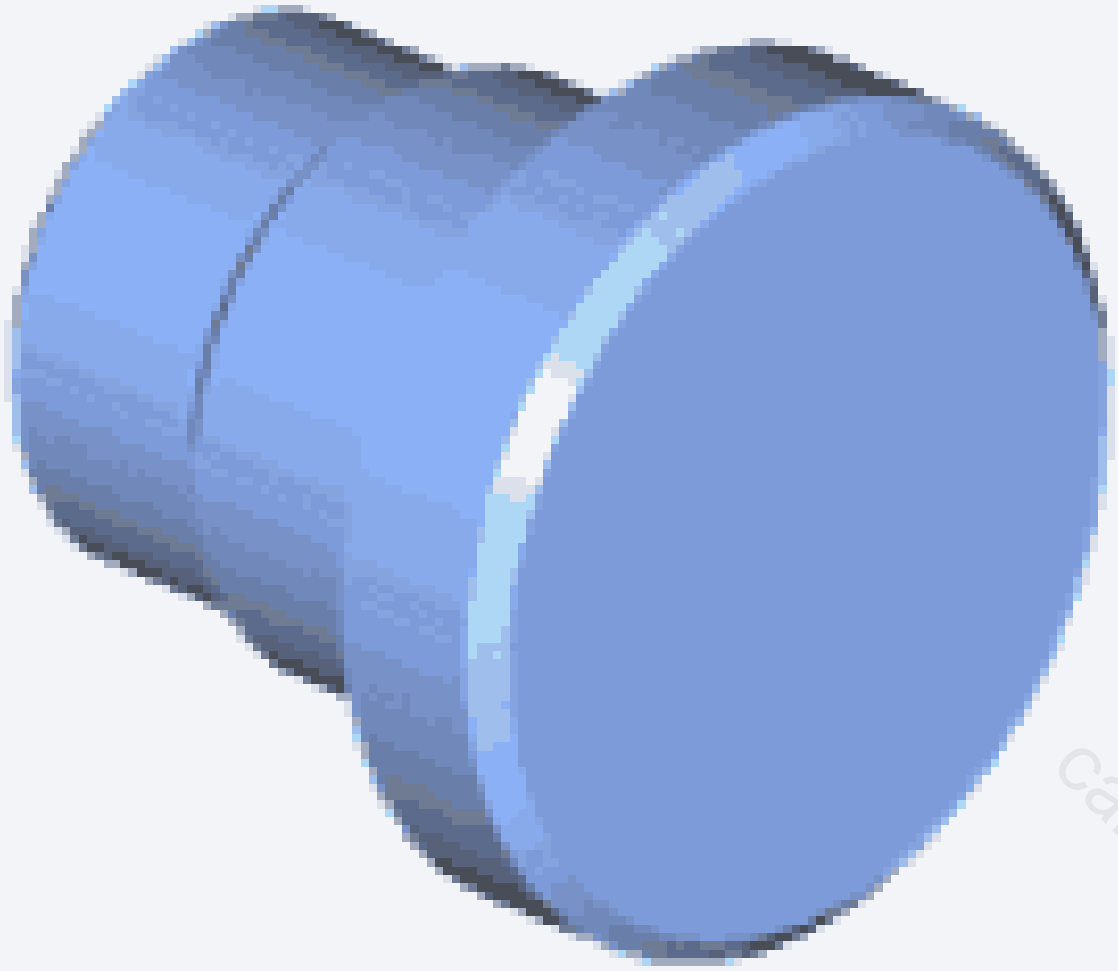
Illustration	Tool Number/ Description
	EN-51365 High Pressure Fuel Pump Installation Alignment Gauge

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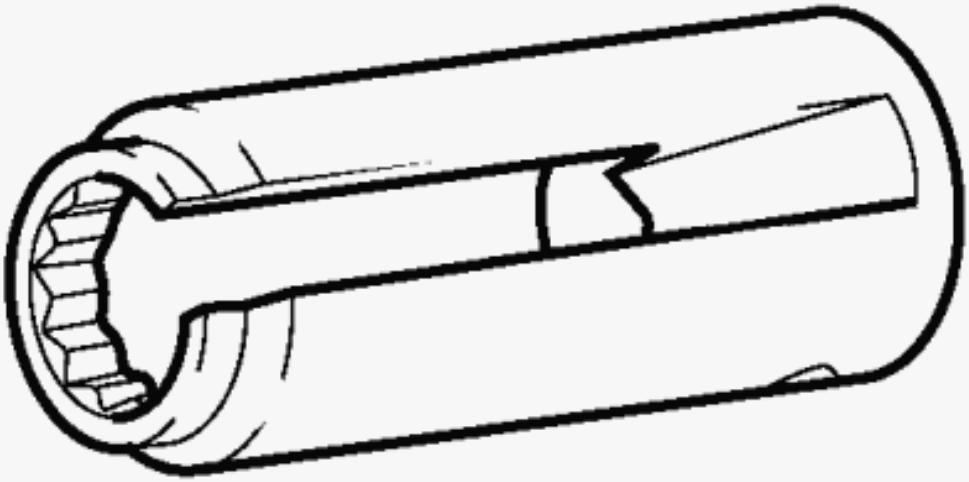
Illustration	Tool Number/ Description
	EN-6179 EN-39194 - C KM-6179 J-39174 - C EN-44626 J-44626 Heated Oxygen Sensor Remover / Installer

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SPECIFICATIONS

TEMPERATURE VERSUS RESISTANCE - INTAKE AIR TEMPERATURE SENSOR (HITACHI SENSOR)

Temperature CÂ°/FÂ°	Resistance Minimum Ohms	Resistance Maximum Ohms
Hitachi Intake Air Temperature (IAT) Sensor		
-40/-40	37, 527	49, 882
-20/-4	13, 110	16, 329
-10/14	8, 145	9, 851
0/32	5, 205	6, 122
20/68	2, 298	2, 570
25/77	1, 900	2, 100
40/104	1, 073	1, 226
60/140	537	639
80/176	289	356
100/212	165	210
120/248	99	129
140/284	62	83
150/302	49	67

TEMPERATURE VERSUS RESISTANCE - INTAKE AIR TEMPERATURE SENSOR (DELCO SENSOR)

Temperature CÂ°/FÂ°	Resistance Minimum Ohms	Resistance Maximum Ohms
Delco Intake Air Temperature (IAT) Sensor		
-40/-40	42, 661	54, 224
-20/-4	14, 039	17, 333
-10/14	8, 529	10, 399
0/32	5, 358	6, 458
20/68	2, 308	2, 727
25/77	1, 904	2, 236
40/104	1, 113	1, 292
60/140	571	655
80/176	309	351
100/212	175	197
120/248	103	116
140/284	67	73
150/302	54	59

TEMPERATURE VERSUS RESISTANCE - ENGINE COOLANT TEMPERATURE SENSOR

Temperature	Resistance
150Â°C (302Â°F)	47 to 49 ohms
140Â°C (284Â°F)	58 to 62 ohms
130Â°C (266Â°F)	76 to 80 ohms

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Temperature	Resistance
120Â°C (248Â°F)	98 to 104 ohms
110Â°C (230Â°F)	130 to 136 ohms
100Â°C (212Â°F)	174 to 182 ohms
90Â°C (194Â°F)	237 to 247 ohms
80Â°C (176Â°F)	327 to 341 ohms
70Â°C (158Â°F)	459 to 479 ohms
60Â°C (140Â°F)	656 to 686 ohms
50Â°C (122Â°F)	958 to 1002 ohms
45Â°C (113Â°F)	1167 to 1223 ohms
40Â°C (104Â°F)	1430 to 1500 ohms
35Â°C (95Â°F)	1763 to 1849 ohms
30Â°C (86Â°F)	2185 to 2295 ohms
25Â°C (77Â°F)	2725 to 2865 ohms
20Â°C (68Â°F)	3418 to 3604 ohms
15Â°C (59Â°F)	4318 to 4564 ohms
10Â°C (50Â°F)	5493 to 5823 ohms
5Â°C (41Â°F)	7041 to 7485 ohms
0Â°C (32Â°F)	9097 to 9701 ohms
-5Â°C (23Â°F)	11844 to 12678 ohms
-10Â°C (14Â°F)	15540 to 16700 ohms
-15Â°C (5Â°F)	20559 to 22183 ohms
-20Â°C (-4Â°F)	27439 to 29725 ohms
-30Â°C (-22Â°F)	50264 to 54924 ohms
-40Â°C (-40Â°F)	95953 to 105777 ohms

ALTITUDE VERSUS BAROMETRIC PRESSURE

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)	Barometric Pressure Measured in Pounds Per Square Inch (PSI)
Determine your altitude by contacting a local weather station or by using another reference source.			
4, 267	14, 000	56 - 64	8.1 - 9.3
3, 962	13, 000	58 - 66	8.4 - 9.6
3, 658	12, 000	61 - 69	8.8 - 10.0
3, 353	11, 000	64 - 72	9.3 - 10.4
3, 048	10, 000	66 - 74	9.6 - 10.7
2, 743	9, 000	69 - 77	10.0 - 11.2
2, 438	8, 000	71 - 79	10.3 - 11.5
2, 134	7, 000	74 - 82	10.7 - 11.9
1, 829	6, 000	77 - 85	11.2 - 12.3
1, 524	5, 000	80 - 88	11.6 - 12.8
1, 219	4, 000	83 - 91	12.0 - 13.2
914	3, 000	87 - 95	12.6 - 13.8
610	2, 000	90 - 98	13.1 - 14.2
305	1, 000	94 - 102	13.6 - 14.8
0	0 Sea Level	96 - 104	13.9 - 15.1
-305	-1, 000	101 - 105	14.6 - 15.2

IGNITION SYSTEM SPECIFICATIONS

Application	Specification
Ignition Type	Individual Ignition Coils

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Application	Specification
Firing Order	1 - 3 - 4 - 2
Spark Plug Torque	Refer to Fastener Specifications
Spark Plug Gap	Refer to Engine Mechanical Specifications
Spark Plug Type	Refer to Electronic Parts Catalog

FASTENER SPECIFICATIONS

Single Use Non-Threaded Fasteners/Components

NOTE:
All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application
Camshaft Position Actuator Locating Pin Control Valve Seal
Camshaft Position Actuator Solenoid Valve Seal
Camshaft Position Sensor Seal
Combustion Fuel Injector Seal
Engine Coolant Temperature Sensor Seal
Evaporative Emission Canister Vent Hose Tie Strap
Fuel Injector Seal
Fuel Injector Wiring Harness Tie Strap
Fuel Pump Housing Seal
Fuel Tank Fuel Pump Module O-ring
Throttle Body Seal
Turbocharger Air Pressure Sensor Seal
Vacuum Pump Gasket

Single Use Threaded Fastener/Component Tightening Specifications

NOTE:
All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application	Specification
	Metric (English)
Fuel Feed Intermediate Pipe/Fitting	30 N.m (22 lb ft)
Fuel Injection Fuel Rail Fuel Pressure Sensor **(In Sequence)**	33 N.m (24 lb ft)
Fuel Injector Bolt - Inner **(In Sequence)**	5 N.m (44 lb in)
Fuel Injector Bolt - Outer **(In Sequence)**	5 N.m (44 lb in)
Fuel Pump Bolt **(In Sequence)**	25 N.m (18 lb ft)

Reusable Threaded Fastener Tightening Specifications

NOTE:
All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Accelerator Pedal Position Sensor Bolt	9 N.m (80 lb in)
Air Cleaner Bolt	9 N.m (80 lb in)
Air Cleaner Outlet Duct Clamp	3.5 N.m (31 lb in)
Air Cleaner Upper Housing Bolt	4 N.m (35 lb in)

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NOTE:
All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Camshaft Position Actuator Locating Pin Control Valve Bolt	10 N.m (89 lb in)
Camshaft Position Actuator Solenoid Valve Bolt	10 N.m (89 lb in)
Camshaft Position Sensor Bolt	10 N.m (89 lb in)
Charge Air Cooler Bolt	9 N.m (80 lb in)
Charge Air Cooler Bracket Bolt	9 N.m (80 lb in)
Crankshaft Position Sensor Bolt	10 N.m (89 lb in)
Engine Oil Pressure Sensor	35 N.m (26 lb ft)
Engine Wiring Harness Bracket Bolt	9 N.m (80 lb in)
Evaporative Emission Canister Nut	9 N.m (80 lb in)
Front Intake Air Duct Nut	9 N.m (80 lb in)
Fuel Feed Front Pipe Bracket Bolt	9 N.m (80 lb in)
Fuel Feed Intermediate Pipe Bracket Bolt	10 N.m (89 lb in)
Fuel Pump Power Control Module Bolt	9 N.m (80 lb in)
Fuel Pump Power Control Module Nut	9 N.m (80 lb in)
Fuel Tank Filler Hose Clamp	4 N.m (35 lb in)
Fuel Tank Filler Pipe Ground Bolt	9 N.m (80 lb in)
Fuel Tank Strap Bolt	22 N.m (16 lb ft)
Heated Oxygen Sensor	42 N.m (31 lb ft)
Ignition Coil Bolt	10 N.m (89 lb in)
Intake Air Pressure and Temperature Sensor Bolt	5 N.m (44 lb in)
Knock Sensor Bolt	25 N.m (18 lb ft)
Mass Airflow Sensor Bolt	4 N.m (35 lb in)
Spark Plug	17 N.m (13 lb ft)
Throttle Body Bolt	10 N.m (89 lb in)
Turbocharger Air Pressure Sensor Bolt	3.8 N.m (34 lb in)
Turbocharger Bypass Valve Solenoid Bolt	9 N.m (80 lb in)
Turbocharger Wastegate Actuator Nut	10 N.m (89 lb in)
Turbocharger Wastegate Regulator Solenoid Valve Bolt	8 N.m (71 lb in)
Vacuum Pump Bolt	
• First Pass:	12 N.m (106 lb in)
• Final Pass:	25 N.m (18 lb ft)

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	English
Fuel Tank Capacity - AWD	59.0 liters	15.6 gallons
Fuel Tank Capacity - FWD	56.0 liters	14.8 gallons

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number

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Anti-Seize Compound	Lubricant	GM P/N 88862477 (Canadian P/N 88862478)
Camshaft Gear Access Hole Plug	Sealant	GM P/N 12346004 (Canadian P/N 10953480)
Coolant Temperature Sensor Threads	Sealant	GM P/N 12346004 (Canadian P/N 10953480)
Dielectric Grease for Spark Plug Wires	Lubricant	GM P/N 19260901 (Canadian P/N 19260902)
Fuel Injection Fuel Rail Bolt	Threadlocker	GM P/N 12345382 (Canadian P/N 10953489)
High Pressure Fuel Pump Bolt	Threadlocker	GM P/N 12345382 (Canadian P/N 10953489)
Silicon Free Engine Oil	5W-30	GM P/N 19293000 (Canadian P/N 19386321)
Top Engine Cleaner	Cleaner	GM P/N 1052626 (Canadian P/N 993026)

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