2018 ENGINE PERFORMANCE

Engine Controls And Fuel - 2.0L (LTG) - Description And Operation - Equinox & Terrain

DESCRIPTION AND OPERATION

CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

Circuit/System Description

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

- Engine power output
- Fuel economy
- Lower exhaust emissions

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

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

Camshaft Position Actuator System Operation

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

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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.

ENGINE CONTROL MODULE DESCRIPTION

The engine control module (ECM) interacts with many emission related components and systems. The ECM also monitors emission related components, and systems, for deterioration. The on-board diagnostics monitor the system performance and a diagnostic trouble code (DTC) sets if the system performance degrades.

The malfunction indicator lamp (MIL) operation and DTC storage are dictated by the DTC type. DTCs are ranked as a Type A, B or C. Types A and B DTCs are emissions related. A Type C DTC is non emissions related.

The ECM is the control center of the engine controls system. The ECM controls the following components:

- The fuel injection system
- The internal glow plug control module
- The emission control systems
- The fuel filter heater
- The on-board diagnostics
- The A/C and fan systems
- The throttle plate actuator
- The turbocharger boost actuator
- The switchable engine coolant pump (If applicable)
- The switchable oil pump (If applicable)

The ECM constantly monitors the information from various sensors and other inputs, and controls the systems that affect the vehicle performance and emissions. The ECM also performs diagnostic tests on various parts of the system. The ECM can recognize operational problems and alert the driver via the MIL. 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 engine control module (ECM) can supply 5 V, 12 V, or ground to various sensors or switches. Voltage is supplied through pull-up resistors to the regulated power supplies within the ECM. In some

cases an ordinary shop voltmeter will not give an accurate reading due to low input resistance. A DMM with at least 10 MΩ 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 the transistors or a device called an output driver module.

EEPROM

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

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

ECM Default Actions

When a malfunction occurs within the engine control system, the engine control module (ECM) maintains control of the system with Default Actions. Default Actions are calculated values, and/or calibrated default values, that are stored within the ECM. A certain level of engine performance is possible when a malfunction occurs dependent on the Default Actions taken. The ECM Default Actions prevent a complete loss of engine performance.

ECM Output Controls

The scan tool can control certain solenoids, valves, motors, and relays. The Output Controls can be found under the Control Functions selection of the scan tool. Some Output Controls may be disabled by the engine control module (ECM) during certain types of vehicle operation.

Data Link Connector (DLC)

The data link connector (DLC) provides the technician a means of accessing serial data for aid in diagnosis. This connector allows the technician to use a scan tool in order to monitor the various serial data parameters, and to display DTC information. The DLC is located inside the drivers compartment, underneath the dash.

Malfunction Indicator Lamp (MIL)

The malfunction indicator lamp (MIL) is located on the instrument cluster or the driver information center. The MIL is controlled by the engine control module (ECM) and illuminates when the ECM detects a condition that affects the vehicle emissions.

ECM Service Precautions

The engine control module (ECM) is designed to withstand the normal current draws that are associated with vehicle operation. Care must be used in order to avoid overloading any circuits during testing. Do not ground, or apply voltage, to any ECM circuits unless a diagnostic procedure instructs you to do so. Circuits should only be tested with a DMM.

Powertrain Expansion Bus

The ECM has an additional CAN bus, the powertrain expansion bus.

EVAPORATIVE EMISSION CONTROL SYSTEM DESCRIPTION

Typical Evaporative Emission (EVAP) System Hose Routing Diagram

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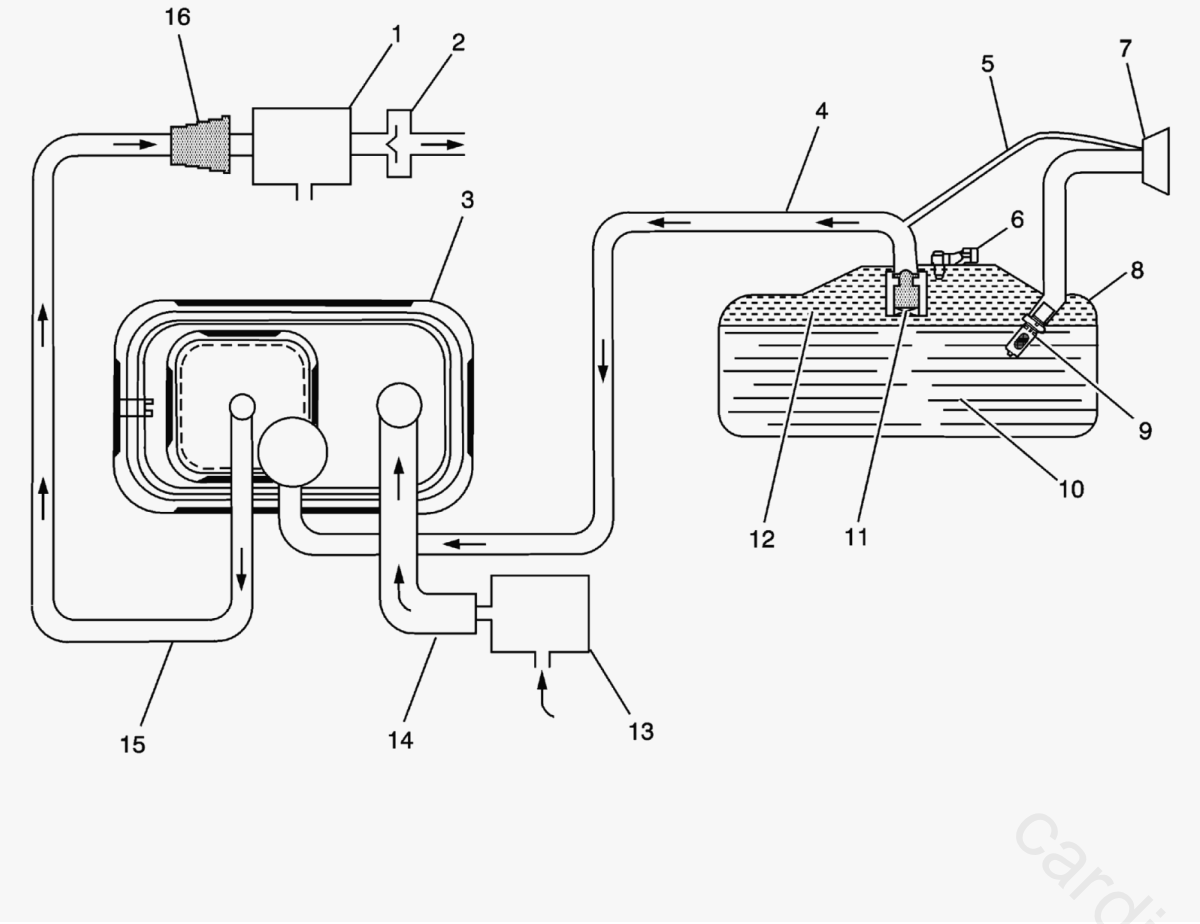

Fig. 1: View Of Typical Evaporative Emission (EVAP) System Hose Routing Diagram
Courtesy of GENERAL MOTORS COMPANY

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

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EVAP canister. With the normally open EVAP vent solenoid valve OFF, fresh air is drawn through the vent solenoid valve and the vent hose to the EVAP canister. Fresh air is drawn through the canister, pulling fuel vapors from the carbon. The air/fuel vapor mixture continues through the EVAP purge tube and EVAP purge solenoid valve into the intake manifold to be consumed during normal combustion. The ECM uses several tests to determine if the EVAP system is leaking or restricted.

Purge Solenoid Valve Leak Test

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

Large Leak Test

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

Canister Vent Restriction Test

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

Small Leak Test

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

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

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

EVAP System Components

The EVAP system consists of the following components:

EVAP Purge Solenoid Valve

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

Purge Tube Check Valve

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

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

EVAP Canister

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

Vapor Recirculation Tube

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

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

Fuel Tank Pressure Sensor

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

Fuel Fill Pipe Check Valve

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

EVAP Vent Solenoid Valve

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

Fuel Fill Cap

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

Capless Fuel Fill

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

Fill Limit Vent Valve

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

- The fuel limit vent valve is located on the inside top of the fuel tank
- This valve is not serviced separately
- Controls the fuel tank fill level by closing the primary vent from the fuel tank and forcing the fuel fill nozzle to shut off.
- Prevents liquid fuel from exiting the fuel tank via the EVAP pipe to the canister.

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- 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.

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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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FUEL SYSTEM DESCRIPTION

Fuel System Overview

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

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

Electronic Returnless Fuel System

The electronic returnless fuel system is a microprocessor controlled fuel delivery system which transports fuel from the tank to the fuel rail. It functions as an electronic replacement for a traditional, mechanical fuel pressure regulator. The pressure relief regulator valve within the fuel tank provides an added measure of over-pressure protection. Desired fuel pressure is commanded by the engine control module (ECM), and transmitted to the fuel pump power 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 Power Control Module

The fuel pump power control module is a serviceable GMLAN module. The fuel pump power 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 power 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 filter
- The pressure relief regulator valve

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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 power control module defaulting to 100% pulse width modulation (PWM) of the fuel pump. Due to variation in the fuel system pressures, the opening pressure for the pressure relief regulator valve is set higher than the pressure that is used on a mechanical returnless fuel system pressure regulator.

Nylon Fuel Pipes

WARNING: **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.)**

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.

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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 three-lobe cam on the camshaft. This pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2 to 15 MPa (290 to 2176 PSI), depending on engine speed and load. Output drivers in the ECM provide the pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by closing and opening the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail. When the control solenoid is NOT powered, the pump operates at 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 power control module when the ECM detects that the ignition is ON. The voltage from the ECM to the fuel pump power control module remains active for 2 s, unless the engine is in Crank or Run. While this voltage is being received, the fuel pump power control module closes the ground switch of the fuel tank fuel pump module and also supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel line pressure. The ECM calculates the air/fuel ratio based on inputs from the engine coolant temperature (ECT), manifold absolute pressure (MAP), mass air flow (MAF), and throttle position sensors. The system stays in starting mode until the engine speed reaches a predetermined RPM.

During a cold start, the 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.

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

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(MAF), and throttle position sensors. The system stays in Open Loop until meeting the following conditions:

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

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

Acceleration Mode

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

Deceleration Mode

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

Battery Voltage Correction Mode

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

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

Fuel Cutoff Mode

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

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

Fuel Trim

The ECM controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. The ECM monitors the heated oxygen sensor (HO2S) signal voltage while in Closed Loop and regulates the fuel delivery by adjusting the pulse width of the injectors based on this signal. The ideal fuel trim values are around 0% 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

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values change rapidly in response to the HO2S signal voltage. These changes fine tune the engine fueling. The long term fuel trim makes coarse adjustments to fueling in order to re-center and restore control to short term fuel trim. A scan tool can be used to monitor the short and long term fuel trim values. The long term fuel trim diagnostic is based on an average of several of the long term speed load learn cells. The ECM selects the cells based on the engine speed and engine load. If the ECM detects an excessively lean or rich condition, the ECM will set a fuel trim diagnostic trouble code (DTC).

THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

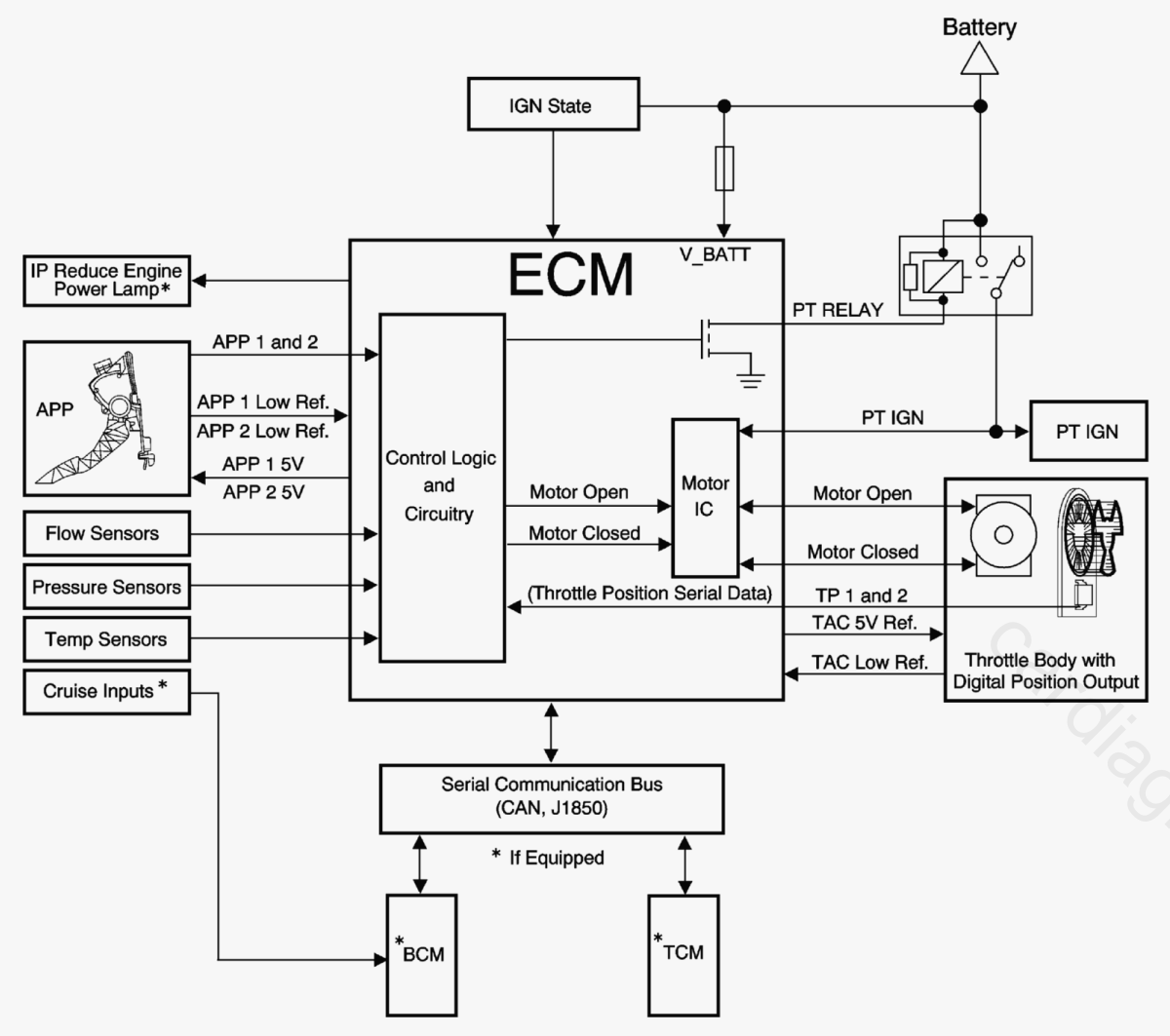

Fig. 2: Throttle Actuator Control (TAC) System Description
Courtesy of GENERAL MOTORS COMPANY

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:

- 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

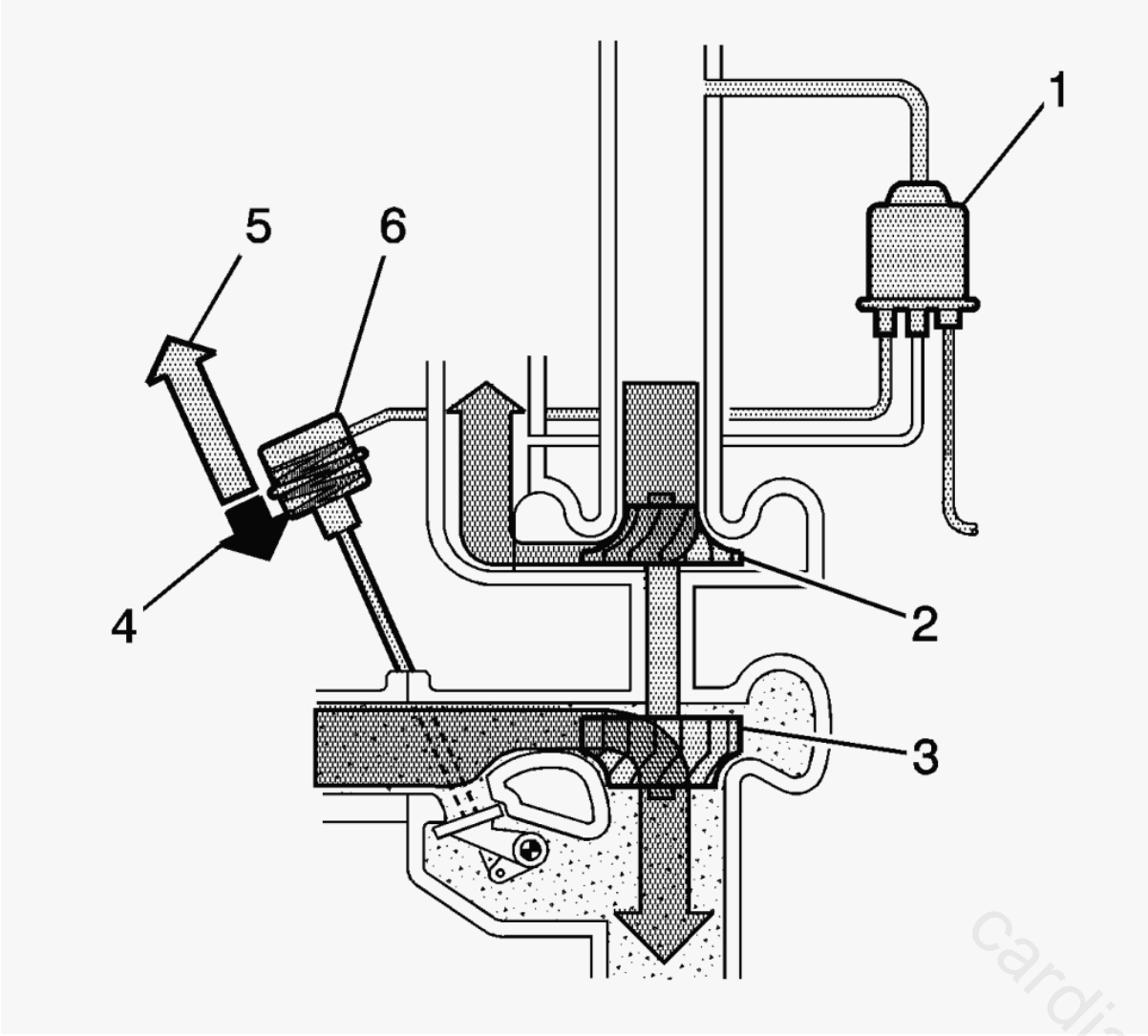

Fig. 3: TC Wastegate Closed
Courtesy of GENERAL MOTORS COMPANY

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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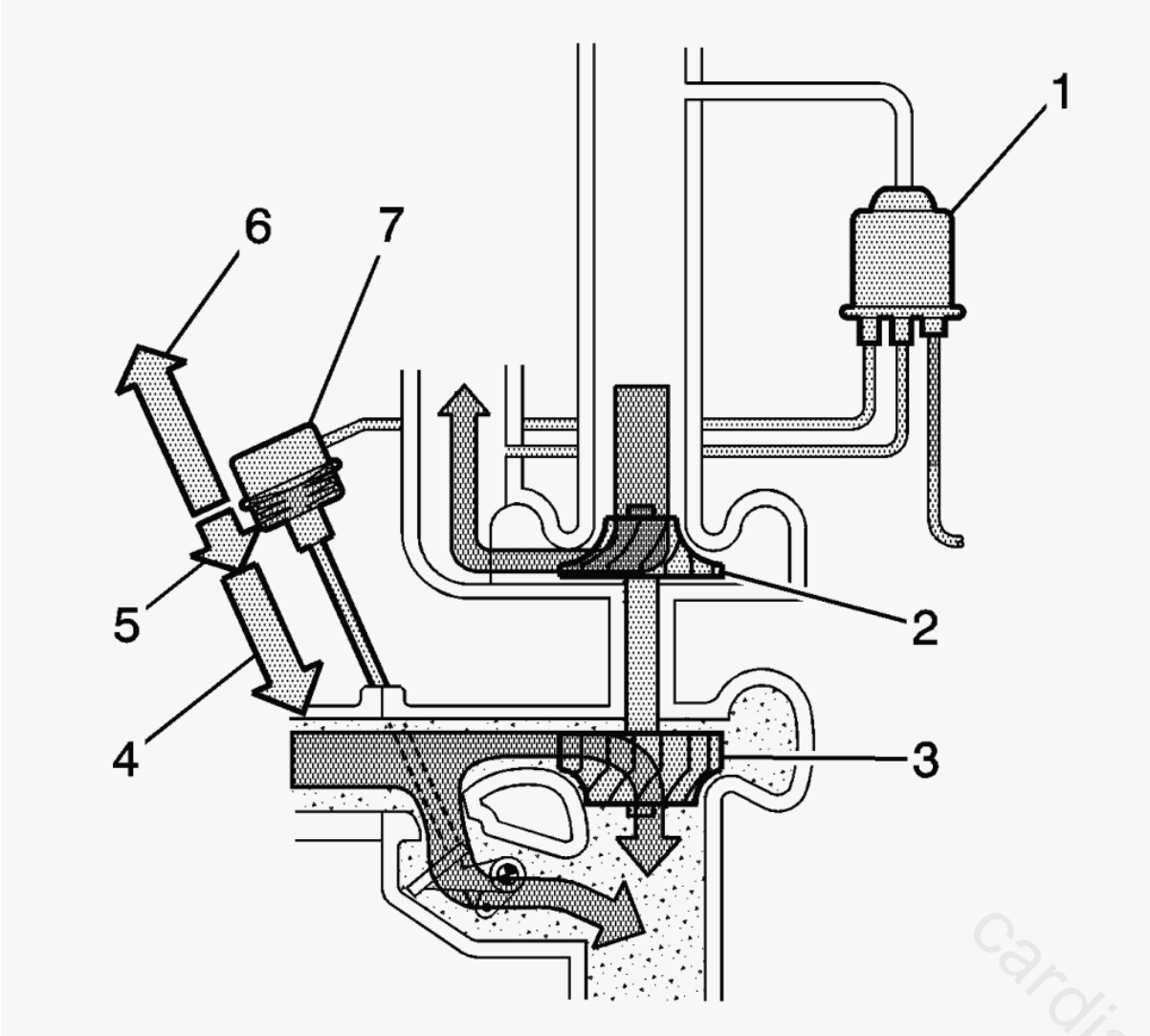

Fig. 4: TC Wastegate Open
Courtesy of GENERAL MOTORS COMPANY

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

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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.

SPEED LIMITING DESCRIPTION

A message will be displayed when the vehicle top speed has been limited to the speed indicated. The message will no longer display when the speed decreases below 5 kph of the indicated limited speed. The limited speed is a protection for various propulsion and vehicle systems, such as lubrication, thermal, suspension, Teen Driver, or tires.

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The ECM takes the lowest value from the following list to determine the final vehicle speed limit. The vehicle speed is not limited when the vehicle is in Park or Neutral.

Functions that will limit the vehicle speed

- Tire Rating
- Prop-shaft/Transfer case speed rating
- Protection from reduced lubrication
- Electric motor speed rating
- Powertrain Thermal Protection
- Diesel Exhaust Fluid legislated limits
- Valet or Teen Driver Modes
- OnStar Stolen Vehicle Feature
- Commercial Truck / Rental Vehicle Speed Limits
- Powertrain control system faults
- Braking system faults
- Damping system faults
- Leveling system faults

System Components

Engine Control Module (ECM)

The engine control module monitors the inputs from various modules on the serial data to determine the final top speed limiting value by selecting the lowest requested top speed limit.

Body Control Module (BCM)

The body control module monitors the top speed limiting requests from serial data communication modules (listed below) along with internally set values (tire, propshaft, valet, and teen limits) to

determine the lowest top speed limit and transmits the value to engine control module for final top speed limit determination.

Electronic Brake Control Module (EBCM)

The electronic brake control module (EBCM) monitors the brake system to determine if a speed limiting signal should be sent to the BCM.

Suspension and Damping System

The suspension and damping system monitors the active suspension to determine if a speed limiting signal should be sent to the BCM.

OnStar Enhanced Services

The OnStar Module communicates with OnStar to determine if a speed limiting signal should be sent to the ECM.

Automatic Leveling Control

The automatic leveling control monitors the leveling system to determine if a speed limiting signal should be sent to the BCM.

Integrated Chassis Control Module

The integrated chassis control module monitors chassis controls to determine if a speed limiting signal should be sent to the BCM.

Rear Driveline Control Module / Transfer Case Control Module

The rear driveline control module / transfer case control module monitors the rear driveline or transfer case to determine if a speed limiting signal should be sent to the BCM.

Hybrid Module

The hybrid module monitors the hybrid system to determine if a speed limiting signal should be sent to the ECM.

Transmission Control Module

The transmission control module monitors the transmission to determine if a speed limiting signal should be sent to the ECM.

Driver Information Center

The driver information center alerts the driver when the top vehicle speed is being limited.

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DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0010, P0013, P2088, P2089, P2090, OR P2091: CAMSHAFT POSITION ACTUATOR SOLENOID VALVE CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P0010

Intake Camshaft Position Actuator Solenoid Valve Control Circuit

DTC P0013

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit

DTC P2088

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage

DTC P2089

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage

DTC P2090

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage

DTC P2091

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

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

Circuit/System Description

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

Circuit	Description

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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

- 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

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

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

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

Conditions for Clearing the DTC

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

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

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

Circuit/System Verification

NOTE:

- **The engine oil level and the oil pressure are critical to the correct operation of the system. Verify the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic.**
- **The engine oil condition has a major impact on the camshaft actuator system. Debris in the oil can interfere with the camshaft position actuator solenoid valve and the mechanical camshaft actuator operation. Inspect for dirty or degraded engine oil.**
- **If a crankshaft or camshaft position sensor DTC is set, the scan tool camshaft position actuator output control will be disabled.**

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

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

   - **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 20Â° and back to 0Â°.
   - Intake Camshaft Position Actuator - From 0 to 20Â° and back to 0Â°.
   - Verify the scan tool parameter:
   - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OKorNot Run
   - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status = OKorNot Run
   - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status = OKorNot Run
   - Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OKorNot Run
   - Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status = OKorNot Run
   - Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status = OKorNot Run

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- **If not the specified state**

  Refer to Circuit/System Testing below

- **Go to next step: If the specified state**

6. Perform the scan tool control function:
   - Exhaust Camshaft Position Actuator - From 0 to 20Â° and back to 0Â°.
   - Intake Camshaft Position Actuator - From 0 to 20Â° and back to 0Â°.
   - Verify the 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 below

   - **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)

   - **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 below

   - **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 Ω between the test points:Low Reference circuit terminal 2/B & Ground
   - **If 10 Ω or greater**
   1. Disconnect the appropriate electrical connector:K20 Engine Control Module
   2. Test for less than 2 Ω between the test points:Low Reference circuit terminal 2/B @ Component harness & The other end of the circuit @ Control module harness
      - If 2 Ω or greater - Repair the open/high resistance in the circuit.
      - If less than 2 Ω - Replace the component:K20 Engine Control Module
   - **Go to next step: If less than 10 Ω**

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4. Ignition - On / Vehicle - In Service Mode
5. Perform the scan tool control function:
    - Exhaust Camshaft Position Actuator Solenoid Valve - Off
    - Intake Camshaft Position Actuator Solenoid Valve - Off

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

    - **If the test lamp turns On**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Disconnect the appropriate electrical connector:K20 Engine Control Module
    3. Ignition - On / Vehicle - In Service Mode
    4. Test for less than 1 V between the test points:Control circuit terminal 1/A @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component:K20 Engine Control Module
    - **Go to next step: If the test lamp does not turn On**
6. Remove - Test Lamp
7. Perform the scan tool control function:
    - Exhaust Camshaft Position Actuator Solenoid Valve - On
    - Intake Camshaft Position Actuator Solenoid Valve - On
    - Verify the scan tool parameter:
    - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OKorNot Run
    - Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OKorNot Run
    - **If not the specified state**
    1. Ignition/Vehicle - Off
    2. Disconnect the appropriate electrical connector:K20 Engine Control Module
    3. Test for infinite resistance between the test points:Control circuit terminal 1/A @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component:K20 Engine Control Module
    - **Go to next step: If the specified state**
8. Connect a 3 A fused jumper wire between the test points:Control circuit terminal 1/A & Ground
9. Perform the scan tool control function:
    - Exhaust Camshaft Position Actuator Solenoid Valve - On
    - Intake Camshaft Position Actuator Solenoid Valve - On
    - Verify the scan tool parameter:
    - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = Malfunction
    - Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = Malfunction
    - **If not the specified state**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the appropriate electrical connector:K20 Engine Control Module
    3. Test for less than 2 Ω between the test points:Control circuit terminal 1/A @ Component harness & The other end of the circuit @ Control module harness
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - Replace the component:K20 Engine Control Module
    - **Go to next step: If the specified state**

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10. Verify DTC P0011, P0014 is not set.
    - **If the DTC is set**
    1. Ignition/Vehicle - Off
    2. Remove the component:Q6 Camshaft Position Actuator Solenoid Valve
    3. Verify 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.**

    4. Swap the two components:
        - Q6E Camshaft Position Actuator Solenoid Valve - Exhaust
        - Q6F Camshaft Position Actuator Solenoid Valve - Intake
    5. 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.**

    6. Perform the scan tool control function:
        - Exhaust Camshaft Position Actuator - From 0 to 20Â° and back to 0Â°.
        - Intake Camshaft Position Actuator - From 0 to 20Â° and back to 0Â°.
        - Verify the 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**
11. Test or replace the component:Q6 Camshaft Position Actuator Solenoid Valve

Component Testing

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector:Q6 Camshaft Position Actuator Solenoid Valve
3. Test for 5 to 12 Ω between the test points:Control terminal 1/A & Low Reference terminal 2/B
    - **If not between 5 to 12 Ω**

      Replace the component:Q6 Camshaft Position Actuator Solenoid Valve

    - **Go to next step: If between 5 to 12 Ω**
4. Test for infinite resistance between the test points:Each terminal of the component & The component's housing
    - **If less than infinite resistance**

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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 7.5 A fused jumper wire between the test points:Control terminal 1/A & B+

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

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

     Replace the component:Q6 Camshaft Position Actuator Solenoid Valve

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

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0011

Intake Camshaft Position System Performance

DTC P0014

Exhaust Camshaft Position System Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Control	P0010, P0013, P2088, P2090	P0010, P0013	P0010, P0013, P055B	P0010, P0013, P2089, P2091	P0011, P0014

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Low Reference	-	P0010, P0013	P0010, P0013	-	-

Circuit/System Description

The camshaft position actuator system enables the engine control module (ECM) to change the timing of the camshafts while the engine is operating. The camshaft position actuator solenoid valves are each supplied a dedicated pulse width modulated (PWM) control circuit and low reference circuit from the ECM. The ECM operates each camshaft position actuator solenoid valve by controlling the amount of solenoid valve signal duty cycle to control the oil flow that applies the pressure to advance or retard the camshafts.

Conditions for Running the DTC

- DTC P0010, P0013, P0016, P0017, P0335, P0336, P0340, P0341, P0365 or P0366 is not set.
- The ignition voltage is greater than 11 V.
- The engine is operating.
- The desire camshaft position is not changing greater than 3.0 degrees for at least 3 s.
- Both of the desired and actual camshaft position actuator values cannot be greater than 29 degrees or less than 6 degrees.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

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

  If equipped with a turbocharger = Type A DTC

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

Conditions for Clearing the DTC

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

If equipped with a turbocharger = Type A DTC

Diagnostic Aids

- A low oil level or condition may set this DTC.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain can cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

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Description and Operation

Camshaft Actuator System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

NOTE:

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

1. Verify the engine has the proper oil condition, level and pressure. Refer to **Oil Pressure Diagnosis and Testing** .
   - **If the oil condition, level and oil pressure are not correct**

     Repair as necessary.

   - **Go to next step: If the oil condition, level and oil pressure are correct**
2. Verify DTC P0010, P0011, P0013, P0014, P0016, P0017, P0335, P0336, P0340, P0341, P0365, P0366, P2088, P2089, P2090 or P2091 is not set.
   - **If any DTCs other than P0011 or P0014 are set**

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

   - **If only DTC P0011 or P0014 is set**
   1. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   2. Verify the DTC does not set.
      - If the DTC sets, refer to Circuit/System Testing below.
      - If the DTC does not set, all OK.
   - **Go to next step: If none of the DTCs are set**
3. All OK.

Circuit/System Testing

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

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve, ignition ON.
2. Verify a test lamp illuminates between the control circuit terminal 1 or A and ground when commanding the appropriate Camshaft Position Actuator Solenoid Valve On with a scan tool.
   - **If the test lamp does not illuminate**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

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2. Test for less than 2 Ω in the control circuit end to end.
   - If 2 Ω or greater, repair the open/high resistance or short to ground in the circuit.
   - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If the test lamp illuminates**
3. Ignition OFF.
4. Remove the appropriate Q6 Camshaft Position Actuator Solenoid Valve. Inspect the Camshaft Position Actuator Solenoid Valve and mounting area for the following conditions:
   - For a torn, restricted, incorrect positioned, or missing screens at the Q6 Camshaft Position Actuator Solenoid Valve
   - For engine oil leaks between the oil sealing lands of the Q6 Camshaft Position Actuator Solenoid Valve
   - For oil seepage at the Q6 Camshaft Position Actuator Solenoid Valve connector
     - **If a condition is found**

       Replace the Q6 Camshaft Position Actuator Solenoid Valve.

     - **Go to next step: If a condition is not found**

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

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

     Replace or repair the mechanical camshaft position actuator.

   - **Go to next step: If the Camshaft Position Variance parameter is less than 2 degrees**
8. Test or replace the Q6 Camshaft Position Actuator Solenoid Valve.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 7 - 12 Ω between the control terminal 1 or A and the low reference circuit terminal 2 or B.
   - **If not between 7 - 12 Ω**

     Replace the Q6 Camshaft Position Actuator Solenoid Valve.

   - **Go to next step: If between 7 - 12 Ω**
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
   - **If less than infinite resistance**

     Replace the Q6 Camshaft Position Actuator Solenoid Valve.

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

Repair Instructions

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

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

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

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- 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 9 degrees retarded in relationship to the crankshaft.

Action Taken When the DTC Sets

DTCs P0016 and P0017 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0016 and P0017 are Type B DTCs.

Diagnostic Aids

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

Reference Information

Description and Operation

Camshaft Actuator System Description

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0010, 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.
   - 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 Exhaust Solenoid Valve Replacement**
- **Camshaft Position Actuator Intake Solenoid Valve Replacement**
- **Camshaft Position Sensor Replacement - Exhaust**
- **Camshaft Position Sensor Replacement - Intake**
- **Crankshaft Position Sensor Replacement**
- **Timing Chain Tensioner Replacement**

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

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 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

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P0030, P0031, P0036, P0037, P0132, P0135, P0138, P0141, P103B, P103C	P0030, P0031, P0036, P0037, P0132, P0135, P0138, P0141, P103B, P103C	-	P0135, P0141
Control	P0030, P0031, P0036, P0037, P0132, P0135, P0138, P0141	P0030, P0031, P0036, P0037, 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.
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 5 s

P0053

- 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 32 V

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

P103B, P103C

- Engine = Cranking or Running
- 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 2.5 A - For greater than 10 s

P103B

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

P103C

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

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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, P103C without setting the DTC for the component:B52 Heated Oxygen Sensor

Reference Information

Schematic Reference

Engine Controls 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

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

   - **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 = OKorNot Run
   - HO2S 1, 2 Heater Control Circuit Low Voltage Test Status = OKorNot Run
   - HO2S 1, 2 Heater Control Circuit Open Test Status = OKorNot 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 2.4 A

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

     Refer to Circuit/System Testing - Test 1

   - **Go to next step: If between 0.3 and 2.4 A**
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**

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Refer to step 2

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

7. All OK.

Circuit/System Testing

Test 1

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:
   - {B52A Heated Oxygen Sensor 1}Ignition circuit terminal 5 & Ground
   - {B52B Heated Oxygen Sensor 2}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 Ω between the test points:
      - {B52A Heated Oxygen Sensor 1}Ignition circuit terminal 5 & Output terminal @ Fuse
      - {B52B Heated Oxygen Sensor 2}Ignition circuit terminal 2 & Output terminal @ Fuse
      - If 2 Ω or greater - Repair the open/high resistance in the circuit.
      - If less than 2 Ω - Verify the fuse is OK and there is voltage at the fuse.
   - **If the test lamp does not turn On and the circuit fuse is open**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   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:
   - {B52A Heated Oxygen Sensor 1}Ignition circuit terminal 5 & Control circuit terminal 6
   - {B52B Heated Oxygen Sensor 2}Ignition circuit terminal 2 & Control circuit terminal 1
   - **If the test lamp turns On**

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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:
    - {B52A Heated Oxygen Sensor 1}Control circuit terminal 6 @ Component harness & Ground
    - {B52B Heated Oxygen Sensor 2}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:
        - {B52A Heated Oxygen Sensor 1}Control circuit terminal 6 @ Component harness & Ground
        - {B52B Heated Oxygen Sensor 2}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 Ω 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:
    - {B52A Heated Oxygen Sensor 1}Ignition circuit terminal 5 & Control circuit terminal 6
    - {B52B Heated Oxygen Sensor 2}Ignition circuit terminal 2 & Control circuit terminal 1
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 Ω between the test points:
        - {B52A Heated Oxygen Sensor 1}Control circuit terminal 6 @ Component harness & The other end of the circuit @ Control module harness
        - {B52B Heated Oxygen Sensor 2}Control circuit terminal 1 @ Component harness & The other end of the circuit @ Control module harness
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - 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

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

      Repair the open/high resistance in the circuit:

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

DTC P0033, P0034, OR P0035: TURBOCHARGER BYPASS 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.

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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
Ignition Voltage Circuit	P0033, P0034, P0243, P0245, P0443, P06DA, P06DB*	P0033	P0033	-	-
Turbocharger Bypass Valve Solenoid Control Circuit	P0034	P0033	P0033	P0035, P0690	P0033
* Ignition fuse opens. 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 between 11 - 32 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 10 s.

Action Taken When the DTCs Set

- DTCs P0033, P0034 and P0035 are Type A DTCs with emission package RPOs NT7, NU5 and NQL.
- DTCs P0033, P0034 and P0035 are Type C DTCs with emission package RPOs NE4 and NE9.

Conditions for Clearing the MIL/DTCs

- DTCs P0033, P0034 and P0035 are Type A DTCs with emission package RPOs NT7, NU5 and NQL.
- DTCs P0033, P0034 and P0035 are Type C DTCs with emission package RPOs NE4 and NE9.

Reference Information

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Engine Controls Wiring Schematics

Connector End View Reference

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Description and Operation

Turbocharger System Description

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

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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 below

    - **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 Inactive and Active 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 below

    - **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 below

    - **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: **An 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.

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- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K20 Engine Control Module.

- **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 Active 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 Active 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

1. Install a 10 A fused jumper wire between the ignition terminal 1 of the Q40 Turbocharger Bypass Solenoid Valve and 12 V. Install a jumper wire between the control terminal 2 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.

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

DTC P0068 OR P1101: AIR 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 P0068

Throttle Body Air Flow Performance

DTC P1101

Intake Air Flow System Performance

Circuit/System Description

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

Conditions for Running the DTC

DTC P0068

- The engine speed is at least 800 RPM.
- The ignition voltage is at least 6.4 V.
- The 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
- The engine speed is between 575 - 6, 600 RPM
- The engine coolant temperature (ECT) is between -7 to +129Â°C (+19 to +264Â°F).
- The 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.

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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, 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**
2. If you were sent here from DTC P0068, P0106, P0121, P0236 or P1101; refer to Circuit/System Testing.
3. Ignition ON, verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90%.
   - **90% or greater**

     Refer to **Throttle Body Cleaning** .

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

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

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

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

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

     Refer to Step 10.

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- **Go to next step: If equipped with a turbocharger**

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 within 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 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 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**
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** for further diagnosis.

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

      Refer to Circuit/System Testing below.

    - **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 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

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- 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

Repair Instructions

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

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

DTC P0089, P00C6, P228C OR P228D: 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

Circuit/System Description

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a three-lobe cam on the intake camshaft. This high pressure fuel pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2 to 15 MPa (290 to 2, 176 psi), depending on engine speed and load. Output drivers in the ECM provide the pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by closing and opening the control valve at specific times during pump strokes. This effectively regulates

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the portion of each pump stroke that is delivered to the fuel rail. When the control solenoid is NOT powered, the pump operates at maximum flow allowing the engine to operate at the lower fuel supply pressure provided by the fuel tank fuel pump. In the event of pump control failure, the high pressure system is protected by a relief valve in the pump that prevents the pressure from exceeding 17.5 MPa (2, 538 psi).

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

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

Conditions for Running the DTC

P0089, P228C or P228D

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

P00C6

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

Conditions for Setting the DTC

P0089

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

P00C6

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

P228C

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

P228D

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

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Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

- DTCs P0089 and P00C6 are Type B DTCs.
- DTCs P228C and P228D are Type A DTCs.

Diagnostic Aids

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

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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. Attempt to start and idle the engine.
2. Observe the DTC information with a scan tool. DTCs P0089, P00C6, P228C and P228D should not set.
    - **If any of the DTCs are set**

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Refer to Circuit/System Testing below.

- **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 below.

   - **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 and P228D do not set.
   - **If any of the DTCs set**

     Refer to Circuit/System Testing below.

   - **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 below.

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

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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.**

2. Test for 0.3 - 0.7 Ω at 20Â°C (68Â°F) between the high control circuit terminal 1 and the low control circuit terminal 2.

- **If not between 0.3 - 0.7 Ω**

  Replace the G18 High Pressure Fuel Pump.

- **Go to next step: If between 0.3 - 0.7 Ω**

3. Test for infinite resistance between each terminal and the G18 High Pressure Fuel Pump housing.
   - **If less than infinite resistance**

     Replace the G18 High Pressure Fuel Pump.

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

Repair Instructions

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

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

DTC P0090, P0091, P0092, P00C8, P00C9 OR P00CA: 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 P0090

Fuel Pressure Regulator Control Circuit

DTC P0091

Fuel Pressure Regulator Control Circuit Low Voltage

DTC P0092

Fuel Pressure Regulator Control Circuit High Voltage

DTC P00C8

Fuel Pressure Regulator High Control Circuit

DTC P00C9

Fuel Pressure Regulator High Control Circuit Low Voltage

DTC P00CA

Fuel Pressure Regulator High Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Pressure Fuel Pump Actuator High Control	P0091, P0092, P00C9	P0090, P00C8	P0092, P00CA	-

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

Circuit/System Description

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a three-lobe cam on the camshaft. This high pressure fuel pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2 - 15 MPa (290 - 2, 176 psi), depending on engine speed and load. Output drivers in the ECM provide the pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by closing and opening the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail.

It is important to note that the high pressure fuel pump is a trailing-edge control system, meaning that if the control solenoid is NOT powered, the pump operates at maximum flow rate. In the event of pump control failure, the high pressure system is protected by a relief valve in the pump that prevents the pressure from exceeding 17.5 MPa (2, 538 psi).

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

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

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Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The engine speed is greater than 50 RPM.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTC

P0090

- The ECM detects an open circuit in the high pressure fuel pump actuator low control circuit.
- The DTC sets when the above condition is present for 4 s.

P0091

- The ECM detects a short to ground in the high pressure fuel pump actuator low control circuit.
- The DTC sets when the above condition is present for 4 s.

P0092

- The ECM detects a short to voltage in the high pressure fuel pump actuator low control circuit.
- The DTC sets when the above condition is present for 4 s.

P00C8

- The ECM detects an open circuit in the high pressure fuel pump actuator high control circuit.
- The DTC sets when the above condition is present for 4 s.

P00C9

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

- The DTC sets when the above condition is present for 4 s.

P00CA

- The ECM detects a short to voltage in the high pressure fuel pump actuator high control circuit.
- The DTC sets when the above condition is present for 4 s.

Action Taken When the DTC Sets

- DTCs P0090, P0091, P0092, P00C8, P00C9 and P00CA are Type A DTCs.
- A message center or an indicator displays Reduced Engine Power.

Conditions for Clearing the DTC

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

Diagnostic Aids

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

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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.

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

3. Command the Fuel Pressure Regulator ON and OFF with a scan tool while observing the following control circuit status parameters:
   - Fuel Pressure Regulator Control Circuit High Voltage Test Status
   - Fuel Pressure Regulator Control Circuit Open Test Status
   - Fuel Pressure Regulator Control Circuit Low Voltage Test Status
   - Fuel Pressure Regulator High Control Circuit High Voltage Test Status
   - Fuel Pressure Regulator High Control Circuit Open Test Status
   - Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing below.

   - **Go to next step: If OK or Not Run is displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing below

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

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2. Test for less than 2 Ω in the high control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.
- **Go to next step: The parameters change**

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

Component Testing

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

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

2. Test for 0.3 - 0.7 Ω at 20Â°C (68Â°F) between the high control circuit terminal 1 and the low control circuit terminal 2.
    - **If not between 0.3 - 0.7 Ω**

      Replace the G18 High Pressure Fuel Pump.

    - **Go to next step: If between 0.3 - 0.7 Ω**
3. Test for infinite resistance between each terminal and the G18 High Pressure Fuel Pump housing.
    - **If less than infinite resistance**

      Replace the G18 High Pressure Fuel Pump.

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

Repair Instructions

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

- **Fuel Pump Replacement**
- **Control Module References** for K20 Engine Control Module replacement, setup and programming
- Perform the Fuel Rail Pressure Relief Valve Reset procedure, if supported on the scan tool.

DTC P0096 OR P0111: INTAKE AIR TEMPERATURE (IAT) SENSOR

Diagnostic 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 P0096

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Intake Air Temperature (IAT) Sensor 2 Performance

DTC P0111

Intake Air Temperature (IAT) Sensor 1 Performance

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0113*, P0114, P2199	P0111, P2199
Low Reference	-	P0113, P2199, P2227, P2229	P0113*, P0114	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

IAT Sensor 2 and Intake Air Humidity

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 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 and 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 Voltage	-40Â°C (-40Â°F) 10 Hz 0%	-40Â°C (-40Â°F) 10 Hz 0%	-
Signal	-40Â°C (-40Â°F) 10 Hz 100%	-40Â°C (-40Â°F) 10 Hz 0%	-40Â°C (-40Â°F) 10 Hz* 0%
Ground	-	-40Â°C (-40Â°F) 10 Hz 0%	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

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

The 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
- 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	10 Hz	-40Â°C (-40Â°F)
Warm	302 Hz	104Â°C (219Â°F)

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Conditions for Running the DTCs

P0096 and P0111

- DTCs P0097, P0098, P0112, P0113, P0117, P0118, P00EA, P00EB, P1682, P16A7, P16BC or P2610 are not set.
- The vehicle has been OFF at least 8 hours.
- Ignition voltage is at least 11 V for 1 s.
- The DTCs run once per ignition cycle when the conditions above are met.

Conditions for Setting the DTCs

P0096

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

  AND

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

P0111

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

  AND

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

Action Taken When the DTC Sets

- DTC P0096 is a Type B DTC.
- DTC P0111 is a Type B DTC.
- The ECM commands the cooling fans ON.

Conditions for Clearing the DTCs

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

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls 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**

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)** .

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Circuit/System Verification

1. Ignition On.
2. Verify that DTC P0097, P0098, P0112, P0113, P0117, P0118, P00EA, P00EB, P1682, P16A7, P16BC or P2610 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. 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
   - **If not within 30Â°C (54Â°F)**

     Refer to Circuit/System Testing below.

   - **Go to next step: If within 30Â°C (54Â°F)**
5. Engine running.
6. 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 below.

   - **Go to next step: If between: -38 and +149Â°C (-36 and +300Â°F)**
7. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
8. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

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

1. Check the integrity of the entire air induction system and verify that none of the following conditions exist:
   - A restricted or collapsed air intake duct
   - An intake manifold leak
   - A misaligned or damaged air intake duct
   - Any water intrusion in the induction system
   - **If a condition exists**

     Repair or replace component as necessary.

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- **Go to next step: If no condition exists**

2. Ignition Off, and all vehicle systems Off, it may take up to 2 min. for all vehicle systems to power down.
3. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
4. 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**
5. 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**
6. Ignition On
7. 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, 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**
8. Ignition On.
9. Verify the scan tool Intake Air Temperature 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, replace the K20 Engine Control Module.
   - **Go to next step: If colder than -39Â°C (-38Â°F).**
10. Ignition Off, install a 3 A fused jumper wire between the IAT 1 signal circuit terminal 1 and the low reference circuit terminal 3.
11. Ignition On.
12. Verify the scan tool Intake Air Temperature Sensor 1 parameter is warmer than 148Â°C (298Â°F).
    - **If colder than 148Â°C (298Â°F).**
    1. Ignition Off, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition On.
    3. Test for less than 1 V between the signal circuit and ground.

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- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V

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 warmer than 148Â°C (298Â°F).**

13. Ignition On.

NOTE: **The intake air temperature sensor 2 signal circuit is pulled up with low current voltage within the controller. Normally, a voltage near B+ can be measured on the circuit with a DMM, but the current will not be high enough to illuminate a test lamp.**

14. 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%**
15. Ignition Off, install a 3 A fused jumper wire between the IAT 2 signal circuit terminal 8 and the low reference circuit terminal 3.
16. Ignition On.
17. 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%**
18. 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. Connect a DMM between the IAT sensor 1 signal terminal 1 and the low reference terminal 3

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

3. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor** table for Hitachi Sensors. The resistance values should be in range of the table values.

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- **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.

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.

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:
   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.
5. 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**
6. All OK.

Repair Instructions

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

- **Mass Airflow Sensor Replacement** for multifunction intake air sensor replacement

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

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

Diagnostic Instructions

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

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%	-

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Circuit	Short to Ground	Open or High Resistance	Short to Voltage
*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:

- Humidity sensor
- IAT sensor 2
- MAF sensor

The multifunction intake air sensor houses the following:

- BARO pressure sensor
- Humidity sensor
- IAT sensor 1
- IAT sensor 2
- MAF 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 P0641, P0651, P0685, P0686, P0687, P1682, P0690, P0697, P06A3, P16A7, P06D2 or P16BC are not set.
- The ignition is ON, or the engine is running.
- The Ignition 1 voltage is at least 11 V for atleast 1 s.

The DTCs run continuously within the enabling conditions

Conditions for Setting the DTCs

P0097

NOTE: The scan tool display range is between -40 and +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.

Action Taken When the DTC Sets

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

Conditions for Clearing the MIL/DTC

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

Diagnostic Aids

- With the ignition On, or vehicle in Service Mode, 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

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

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, P0685, P0686, P0687, P1682, P0690, P0697, P06A3, P16A7, P06D2 or P16BC 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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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
   - Start-Up IAT Sensor 2
   - Start-Up IAT Sensor 3
   - **If not within 30Â°C (54Â°F)**

     Refer to Circuit/System Testing below.

   - **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
   - IAT Sensor 3
   - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

     Refer to Circuit System Testing below.

   - **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 below.

   - **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.

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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 low current voltage within the controller. Normally, a voltage near B+ 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.

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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:
   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**
   1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, 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, P0237, P0238, P2227, P2228, P2229, P2230 or P2610 are not set.
- The engine is not 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

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

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTCs P0106, P0107, P0108, P0237, P0238, P2227, P2228, P2229, P2230 or P2610 are not set.
   - **If a DTC is set**

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

   - **Go to next step: If no DTC is set**
3. Ignition ON.
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
   - Turbo 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 diagnostic procedure.

Control Module References for ECM 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

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

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
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 inlet air temperature and is displayed by the scan tool as Â°C (Â°F). The IAT sensor 3 is integrated with the B111B Turbocharger Boost/Intake Air Temperature sensor. 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

- DTCs P0097, P0098, P00EA, P00EB P0112, P0113, P0117, P0118, P0641, P0651, P0697, P06A3, P06D2 P1682, P16A7, P16BC or P2610 are not set.
- The vehicle has been OFF at least 8 hours.
- Ignition voltage is at least 11 V for at least 1 s.
- These DTCs run 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 30Â°C (54Â°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 (77Â°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 (77Â°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

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- 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 (77Â°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 (77Â°F).

  AND

- 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

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

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. Ignition ON.
2. Verify that DTC P0097, P0098, P00EA, P00EB P0112, P0113, P0117, P0118, P0641, P0651, P0697, P06A3, P06D2 P1682, P16A7, P16BC or P2610 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. 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
   - **If not within 30Â°C (54Â°F)**

     Refer to Circuit/System Testing below.

   - **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
   - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

     Refer to Circuit System Testing below.

   - **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 below.

   - **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. Check the integrity of the entire air induction system and verify that none of the following conditions exist:
   - A loose or disconnected charge air cooler hose or pipe; where equipped

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- 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 restricted or collapsed air intake duct
- A misaligned or damaged air intake duct
- Any water intrusion in the induction system
- An Intake Manifold Resonator with a leaking seal, or a cracked or broken housing
- **If a condition exists**

  Repair or replace component as appropriate.

- **Go to next step: If no condition exists**

2. Ignition OFF, and all vehicle systems OFF, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
3. Test for less than 2 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**
4. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.
   - **If 2 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **Go to next step: If less than 2 Ω**
5. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
   2. Test for less than 2 Ω in the ignition voltage circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
   2. Test for infinite resistance between the ignition voltage circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
   - **Go to next step: If a test lamp illuminates**
6. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature signal 1 circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.

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

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

- **If greater than 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**

7. 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).**

8. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3.
9. 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, 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).**

10. 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**

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

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

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

          Replace the K20 Engine Control Module.

        - **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**
12. 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+
13. 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
14. 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**
15. 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.
16. Test for less than 2 Ω between the 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**
17. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature signal 3 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

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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**

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**

18. Ignition ON, verify the scan tool IAT Sensor 3 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 2 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If colder than -39Â°C (-38Â°F).**
19. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 2 and the low reference circuit terminal 1.
20. Verify the scan tool IAT Sensor 3 parameter is warmer than 148Â°C (298Â°F).
    - **If colder than 148Â°C (298Â°F).**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If warmer than 148Â°C (298Â°F).**
21. Test or replace the appropriate sensor.

Component Testing

Multifunction Intake Air Sensor

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

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

2. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor** table for Hitachi Sensors. The resistance values should be in range of the table values.
    - **If not within the specified range**

      Replace the B75C Multifunction Intake Air Sensor.

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

3. All OK.

Multifunction Intake Air Sensor

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

     Replace the B75C Multifunction Intake Air Sensor.

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

Turbocharger Boost/Intake Air Temperature Sensor

1. Ignition OFF, disconnect the harness connector at the B111B Turbocharger Boost/Intake Air Temperature sensor.

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

2. Test the IAT sensor 3 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor** table for Delco Sensors. The resistance values should be in range of the table values.
   - **If not within the specified range**

     Replace the B111B Turbocharger Boost/Intake 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 turbocharger boost/intake air temperature sensor replacement
- **Mass Airflow Sensor Replacement** for multifunction intake air 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)	-60Â°C (-76Â°F)	-60Â°C (-76Â°F)*
Low Reference	-	-60Â°C (-76Â°F)	-60Â°C (-76Â°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 inlet air temperature and is displayed by the scan tool as Â°C (Â°F). The IAT sensor 3 is integrated with the B111B Turbocharger Boost/Intake Air Temperature sensor. 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

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.

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

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.

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Conditions for Clearing the DTCs

DTCs P00EA, P00EB and P00EC are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

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 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. 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
   - **If not within 30Â°C (54Â°F)**

     Refer to Circuit/System Testing below.

   - **Go to next step: If within 30Â°C (54Â°F)**
5. Engine idling, verify the following scan tool parameters are between: -60 and +149Â°C (-76 and +300Â°F).
   - IAT Sensor 1
   - IAT Sensor 2

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- IAT Sensor 3
- **If not between: -60 and +149Â°C (-76 and +300Â°F)**

  Refer to Circuit System Testing below.

- **Go to next step: If between: -60 and +149Â°C (-76 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 below.

   - **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 B111B Turbocharger Boost/Intake Air Temperature sensor.
2. 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**
3. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature signal 3 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**
4. Ignition ON, verify the scan tool IAT Sensor 3 parameter is colder than -60Â°C (-76Â°F).
   - **If warmer than -60Â°C (-76Â°F).**

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

- **Go to next step: If colder than -60Â°C (-76Â°F).**

5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 2 and the low reference circuit terminal 1.
6. Verify the scan tool IAT Sensor 3 parameter is warmer than 148Â°C (298Â°F).
    - **If colder than 148Â°C (298Â°F).**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If warmer than 148Â°C (298Â°F).**
7. Test or replace the B111B Turbocharger Boost/Intake Air Temperature sensor.

Component Testing

Turbocharger Boost/Intake Air Temperature Sensor

1. Ignition OFF, disconnect the harness connector at the B111B Turbocharger Boost/Intake Air Temperature sensor.

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

2. Test the IAT sensor 3 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor** table for Delco sensors. The resistance values should be in range of the table values.
    - **If not within the specified range.**

      Replace the B111B Turbocharger Boost/Intake 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 B111B Turbocharger Boost/Intake Air Temperature sensor replacement
- **Control Module References** for control module replacement, programming and setup.

DTC P00F4, P00F5, P00F6: INTAKE AIR HUMIDITY SENSOR CIRCUIT

Diagnostic Instructions

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

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- **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 and 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	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

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 and 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+			

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 1	-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 Multifunction Intake Air sensor:

- BARO pressure sensor
- Humidity sensor

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- IAT sensor 1
- IAT sensor 2
- MAF sensor

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 intake air humidity sensor. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for these sensors:

- Humidity sensor
- IAT sensor 2
- MAF sensor

Conditions for Running the DTCs

P00F4, P00F5 and P00F6

- DTC P1682, P16A7 or P16BC is not active.
- The ignition is ON.
- The Ignition voltage is at least 11 V for longer than 0.9 s.

The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

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 sets when the condition exists for greater than 5 s.

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Action Taken When the DTC Sets

- DTCs P00F4, P00F5 and P00F6 are Type B DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P00F4, P00F5 and P00F6 are Type B DTCs.

Diagnostic Aids

- The Intake Air Humidity Signal parameter displays the measured humidity within the air intake system and may differ from atmospheric humidity measured outside the air intake system.
- With the Vehicle in Service Mode, 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.
- With the Vehicle in Service Mode, 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.

Reference Information

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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

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

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 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** for further diagnosis.

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

   - **Go to next step: If within 30Â°C (54Â°F)**
4. Engine Running.
5. Verify the scan tool Intake Air Humidity Sensor parameter is between 5 and 90%.
   - **If not between 5 and 90%**

Refer to Circuit/System Testing below.

- **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 below.

   - **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**

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NOTE: **The intake air temperature sensor 2 signal circuit is pulled up with low current voltage within the controller. Normally, a voltage near B+ 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, connect 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. Ignition Off, disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test the Intake Air Humidity Sensor by varying the air humidity in the intake duct near the sensor, while observing the scan tool Intake Air Humidity Sensor parameter. The parameter should change and be within 5 - 95%.
   - **If not within the specified range**

     Replace the B75C Multifunction Intake Air Sensor.

   - **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.

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2. Ignition Off, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
    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.
5. 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**
6. All OK.

Repair Instructions

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

- **Mass Airflow Sensor Replacement** for B75C Multifunction Intake Air sensor replacement
- **Control Module References** for 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

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

Typical Scan Tool Data

MAF Sensor

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

Circuit Description

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

The 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.

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Conditions for Running the DTCs

- DTC P00E9, P00EA, P00EB, P00EC, P0097, P0098, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P010C, P010D, P0237, P0238, P0335, P0336, P0404, P0405, P0406, P042E, P0401, P111E, P2227, P2228, P2229, P2230, is not set
- The engine speed is between 400 - 6, 000 RPM.
- The engine coolant temperature (ECT) is between -7 to +129Â°C (+19 to +264Â°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 1 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.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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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)** .

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Circuit/System Verification

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

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

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

     Refer to **Throttle Body Cleaning** .

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

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

   - **Go to next step: If Agree**
5. Determine the current vehicle testing altitude.

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

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

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

      Refer to Step 10.

    - **Go to next step: If equipped with a turbocharger**
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 within range**
9. Engine idling.
10. Verify the scan tool Boost Pressure Sensor parameter increases with accelerator pedal input.
    - **If the Boost Pressure Sensor parameter does not increase**

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

    - **Go to next step: If the Boost Pressure Sensor parameter does increase**
11. Verify the scan tool MAP Sensor pressure parameter is between 26 - 52 kPa (3.8 - 7.5 PSI) and changes with accelerator pedal input.
    - **If not 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 Circuit/System Testing below.

    - **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 below.

    - **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 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
    - 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 appropriate.

    - **Go to next step: If no condition is found**
2. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.
3. Test for less than 2 Ω between the ground circuit terminal 7 and ground.
    - **If 2 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **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 volts between the signal circuit terminal 6 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.

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- 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**

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

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

          Replace the K20 Engine Control Module.

        - **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**
7. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
    - Red lead to the signal circuit terminal 6 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
8. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
    - Signal switch to 5 V
    - Frequency switch to 5 kHz
    - Duty Cycle switch to 50% (Normal)
9. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4, 950 - 5, 050 Hz.
    - **If not between 4, 950 - 5, 050 Hz.**

      Replace the K20 Engine Control Module.

    - **Go to next step: If between 4, 950 - 5, 050 Hz.**
10. Test or replace the B75C Multifunction Intake Air sensor.

Repair Instructions

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

- **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 (MAF) SENSOR CIRCUIT 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

DTC P0102

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Mass Air Flow (MAF) Sensor Circuit Low Frequency

DTC P0103

Mass Air Flow (MAF) Sensor Circuit High Frequency

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	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
**Where used.					

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Parameter Normal Range:** 1, 900 - 10, 000 Hz			
Ignition Voltage	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

Circuit/System Description

The mass air flow (MAF) sensor is integrated with the multifunction intake air sensor. The MAF sensor is an air flow meter that measures the amount of air in the sensor bore. The engine control module (ECM) uses the MAF sensor signal to provide the correct fuel delivery for all engine speeds and loads. A small quantity of air entering the engine indicates a deceleration or idle condition. A large quantity of air entering the engine indicates an acceleration or high load condition.

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

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

The multifunction intake air sensor houses the following:

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

Conditions for Running the DTC

- The engine is running for at least 1 s.
- The engine speed is at least 300 RPM.

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- 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 800 Hz (about 0.59 g/s) for at least 300 cylinder firing events.

P0103

The ECM detects that the MAF Sensor signal parameter is at least 14, 500 Hz (about 772.9 g/s) for at least 300 cylinder firing events.

Action Taken When the DTCs Set

DTCs P0102 and P0103 are Type A DTCs.

Conditions for Clearing the MIL/DTCs

DTCs P0102 and P0103 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls 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**

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

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1. Engine idling, observe the scan tool MAF Sensor parameter at operating temperature. The reading should be between 2.5 - 5.5 g/s.
    - **If not between 2.5 - 5.5 g/s**

      Refer to Circuit/System Testing below.

    - **Go to next step: If between 2.5 - 5.5 g/s**
2. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
    1. Engine idling
    2. Increase the engine speed slowly to 3, 000 RPM and then back to idle.
    3. Review Stored Data
    4. Observe the MAF Sensor parameter frame by frame with a scan tool.
    - **The MAF Sensor parameter does not change smoothly and gradually**

      Refer to Circuit/System Testing below.

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

      Refer to Circuit/System Testing below.

    - **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 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**

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4. Ignition ON, test for 4.8 - 5.2 volts between the signal circuit terminal 6 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If between 4.8 - 5.2 V**
5. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
    - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
    1. 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**
6. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
    - Red lead to the signal circuit terminal 6 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
7. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
    - Signal switch to 5 V
    - Frequency switch to 5 kHz
    - Duty Cycle switch to 50% (Normal)
8. Engine idling, verify the scan tool MAF Sensor parameter is between 4, 950 - 5, 050 Hz.
    - **If not between 4, 950 - 5, 050 Hz.**

      Replace the K20 Engine Control Module.

    - **Go to next step: If between 4, 950 - 5, 050 Hz.**
9. Test or replace the B75C Multifunction Intake Air sensor.

Repair Instructions

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

- **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 (MAP) 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

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, P0697	P0106, P0107	P0106, P0108, P0697	P0106
Signal	P0106, P0107	P0108	P0108	P0106
Low Reference	-	P0108	-	P0106

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: • Engine - Idling - At normal operating temperature • Accessories=Off **Parameter Normal Range:** 26 to 52 kPa (3.8 to 7.6 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)	-

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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
B74 Manifold Absolute Pressure Sensor	The sensor is a 3-wire capacitive pressure transducer. Electronics in the sensor convert pressure into an analog voltage signal.
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 sensor measures the pressure in the intake manifold. The signal is used to determine the engine load. When the engine is idling or decelerating, the sensor pressure should be low. When the engine is off or under wide-open throttle conditions the pressure should be the same or close to the barometric pressure.

Conditions for Running the DTC

- DTC P0102, P0103, P0107, P0108, P010C, P010D, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0335, P0336, P0401, P0405, P0406, P042E = Not set
- Intake Air Temperature = -20 to 125Â°C (-4 to 257Â°F)
- Engine Coolant Temperature... = -20 to 125Â°C (-4 to 257Â°F)
- Engine Speed. = 500 to 8000 RPM

  or

- DTC P0107, P0108, P2227, P2228, P2229, P2230, P2610 = Not set
- Ignition On - Engine Off

Frequency the DTC runs = Continuously

Conditions for Setting the DTC

The difference between the manifold absolute pressure measured by the manifold absolute pressure sensor and a calculated value based on the throttle position exceeds the allowed range.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Engine Control Module Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Special Tools

EN-23738-A Vacuum Pump

Equivalent regional tools: **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

Circuit/System Verification

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1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0107, P0108 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 P0101, P0121, P1101 - Refer to Circuit/System Testing.
4. Verify the scan tool parameter:Throttle Body Idle Air Flow Compensation = Less than 90%
    - **If 90% or greater**

      Refer to:**Throttle Body Cleaning**

    - **Go to next step: If less than 90%**
5. Perform the scan tool control function:Throttle Sweep - Start

   Verify the scan tool parameter:Throttle Position Sensors 1 and 2 = Agree

    - **If not the specified state**

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

    - **Go to next step: If the specified state**
6. Determine the current vehicle testing altitude.
7. Verify the scan tool parameter:MAP Sensor = The value should be within the range listed in the table: **Altitude Versus Barometric Pressure**
    - **If not in the specified range**

      Refer to Circuit/System Testing below

    - **Go to next step: If in the specified range**
8. Engine - Idling - At normal operating temperature
9. Verify the scan tool parameter:MAP Sensor = 26 to 52 kPa (3.8 to 7.6 PSI) and changes
    - **If not between 26 and 52 kPa (3.8 and 7.6 PSI) or does not change**

      Refer to Circuit/System Testing below

    - **Go to next step: If between 26 and 52 kPa (3.8 and 7.6 PSI) and changes**
10. Observe the following scan tool parameter:MAF Sensor & Engine Speed.
11. Increase the engine speed slowly to 3, 000 RPM and then back to idle.
12. Verify the scan tool parameter:MAF Sensor = The value should change smoothly and gradually as the engine speed is increased and decreased.
    - **If the value does not change smoothly and gradually**

      Refer to **DTC P0101**

    - **Go to next step: If the value changes smoothly and gradually**
13. Verify the scan tool parameter:MAP Sensor = The value should not spike or drop out.

    Perform the action while monitoring the parameter:

    - Wiggle the harness and connector:B74 Manifold Absolute Pressure 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**

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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 below

    - **Go to next step: If the DTC is not set**
16. 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. Verify the following conditions do not exist:
    - Collapsed or restricted intake air duct.
    - Leaking or restricted component:Exhaust System
    - Leaking, missing or damaged O-ring on the components listed below:
        - B74 Manifold Absolute Pressure Sensor
    - Engine vacuum leaks.
    - An engine mechanical condition. - Wear of timing chain, tensioner or sprockets. If one or more cylinders indicate low compression

      Refer to **Symptoms - Engine Mechanical**

    - **If a condition exists - Repair or replace as necessary**
    - **Go to next step: If no condition exists**
3. Disconnect the electrical connector:B74 Manifold Absolute Pressure Sensor
4. Test for less than 10 Ω between the test points:Low Reference circuit terminal 2 & Ground
    - **If 10 Ω or greater**
    1. Disconnect the electrical connector:K20 Engine Control Module
    2. Test for less than 2 Ω between the test points:Low Reference circuit terminal 2 @ Component harness & Terminal 21 X2 @ Control module harness
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - Replace the component:K20 Engine Control Module
    - **Go to next step: If less than 10 Ω**
5. Ignition - On / Vehicle - In Service Mode
6. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 1 & Low Reference circuit terminal 2
    - **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 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 Ω between the test points: 5 V Reference circuit terminal 1 @ Component harness & Terminal 5 X2 @ Control module harness
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - Replace the component:K20 Engine Control Module
    - **If greater than 5.2 V**

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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 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**

7. Verify the scan tool parameter:MAP Sensor = Greater than 4.7 V
    - **If 4.7 V or less**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector:K20 Engine Control Module
    3. Test for infinite resistance between the test points:Signal circuit terminal 3 @ 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**

8. Connect a 3 A fused jumper wire between the test points:Signal circuit terminal 3 & Low Reference circuit terminal 2
9. Verify the scan tool parameter:MAP Sensor = Less than 0.2 V
    - **If 0.2 V or greater**

    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    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:Signal circuit terminal 3 @ 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 Ω between the test points:Signal circuit terminal 3 @ Component harness & Terminal 40 X3 @ Control module harness
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - Replace the component:K20 Engine Control Module

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

10. Test or replace the component:B74 Manifold Absolute Pressure Sensor

Component Testing

Dynamic Test - Using Vehicle Harness

1. Ignition/Vehicle - Off
2. Remove the component:B74 Manifold Absolute Pressure Sensor - Leave the electrical connector connected.
3. Install the special tool: **EN-23738-A** Vacuum Pump @ B74 Manifold Absolute Pressure Sensor
4. Ignition - On / Vehicle - In Service Mode
5. Use the special tool to achieve a gauge reading between -13 and -21 kPa (-0.13 and -0.21 bar, -3.8 and -6.2 in Hg).

   Verify the scan tool parameter:MAP Sensor = Decreases between 13 and 21 kPa (1.8 and 3.0 PSI)

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

      Replace the component:B74 Manifold Absolute Pressure Sensor

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- **Go to next step: If the parameter decreases between 13 and 21 kPa (1.8 and 3.0 PSI)**

6. Use the special tool to achieve a gauge reading between -30 and -38 kPa (-0.3 and -0.38 bar, -8.8 and -11.2 in Hg).

   Verify the scan tool parameter:MAP Sensor = Decreases between 30 and 38 kPa (4.4 and 5.5 PSI)

   - **If the parameter does not decrease between 30 and 38 kPa (4.4 and 5.5 PSI)**

     Replace the component:B74 Manifold Absolute Pressure Sensor

   - **Go to next step: If the parameter decreases between 30 and 38 kPa (4.4 and 5.5 PSI)**

7. All OK.

Dynamic Test - Using Jumper Wires

1. Ignition/Vehicle - Off
2. Remove the component:B74 Manifold Absolute Pressure Sensor
3. Connect a 3 A fused jumper wire between the test points: 5 V Reference terminal 1 & 5 V
4. Connect a jumper wire between the test points:Low Reference terminal 2 & Ground
5. Connect a DMM between the test points:Signal terminal 3 @ B74 Manifold Absolute Pressure Sensor & Ground
6. Install the special tool: **EN-23738-A** Vacuum Pump @ B74 Manifold Absolute Pressure Sensor
7. Use the special tool to achieve a gauge reading between -55 and -47 kPa (-0.55 and -0.47 bar, -13.8 and -16.2 in Hg).

   Verify the DMM displays between 0.2 and 4.9 V. - The value should not spike or drop out.

   - **If not between 0.2 and 4.9 V or has spikes or drops out**

     Replace the component: B74 Manifold Absolute Pressure Sensor

   - **Go to next step: If between 0.2 and 4.9 V and there are no spikes or drops out**

8. All OK.

Repair Instructions

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

- **Manifold Absolute Pressure Sensor Replacement**
- For control module replacement, programming and setup, refer to **Control Module References**

DTC P0107 OR P0108: MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT 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

NOTE: **This procedure may also diagnose malfunctions that are not detected by a DTC.**

DTC P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

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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, P0697	P0106, P0107	P0106, P0108, P0697	P0106
Signal	P0106, P0107	P0108	P0108	P0106
Low Reference	-	P0108	-	P0106

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: • Engine - Idling - At normal operating temperature • All accessories Off. **Parameter Normal Range:** 26 to 52 kPa (3.8 to 7.6 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
B74 Manifold Absolute Pressure Sensor	The sensor is a 3-wire capacitive pressure transducer. Electronics in the sensor convert pressure into an analog voltage signal.
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 sensor measures the pressure in the intake manifold. The signal is used to determine the engine load.

When the engine is idling or decelerating, the sensor pressure should be low. When the engine is off or under wide-open throttle conditions the pressure should be the same or close to the barometric pressure.

Conditions for Running the DTC

Ignition = On

DTCs run continuously when the above condition is met.

Conditions for Setting the DTC

P0107

MAP Sensor = Less than 0.2 V - For greater than 4 s

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P0108

MAP Sensor = Greater than 4.5 V - For greater than 4 s

Actions Taken When the DTC Sets

DTCs P0107, P0108 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0107, P0108 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Engine Control Module Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0641, P0651, P0697, P06A3, 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**
3. Verify the scan tool parameter:MAP Sensor = The value should be within the range listed in the table: **Altitude Versus Barometric Pressure**
   - **If not in the specified range**

     Refer to Circuit/System Testing below

   - **Go to next step: If in the specified range**
4. Engine - Idling - At normal operating temperatureAll accessories Off.
5. Verify the scan tool parameter:MAP Sensor = 26 to 52 kPa (3.8 to 7.6 PSI)
   - **If not between 26 and 52 kPa (3.8 and 7.6 PSI)**

     Refer to Circuit/System Testing below

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- **Go to next step: If between 26 and 52 kPa (3.8 and 7.6 PSI)**

6. Verify the scan tool parameter:MAP Sensor = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector:B74 Manifold Absolute Pressure 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**

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 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 electrical connector:B74 Manifold Absolute Pressure Sensor
3. Test for less than 10 Ω between the test points: Low Reference circuit terminal 2 & Ground
   - **If 10 Ω or greater**
   1. Disconnect the electrical connector:K20 Engine Control Module
   2. Test for less than 2 Ω between the test points:Low Reference circuit terminal 2 @ Component harness & Terminal 21 X2 @ Control module harness
      - If 2 Ω or greater - Repair the open/high resistance in the circuit.
      - If less than 2 Ω - Replace the component:K20 Engine Control Module
   - **Go to next step: If less than 10 Ω**
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 1 & Low Reference circuit terminal 2
   - **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 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 Ω between the test points: 5 V Reference circuit terminal 1 @ Component harness & Terminal 5 X2 @ Control module harness
      - If 2 Ω or greater - Repair the open/high resistance in the circuit.
      - If less than 2 Ω - 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

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3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 1 V between the test points: 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:MAP Sensor = Greater than 4.7 V
    - **If 4.7 V or less**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector:K20 Engine Control Module
    3. Test for infinite resistance between the test points:Signal circuit terminal 3 @ 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 3 & Low Reference circuit terminal 2
8. Verify the scan tool parameter:MAP Sensor = Less than 0.2 V
    - **If 0.2 V or greater**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    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:Signal circuit terminal 3 @ 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 Ω between the test points: Signal circuit terminal 3 @ Component harness & Terminal 40 X3 @ Control module harness
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - Replace the component:K20 Engine Control Module
    - **Go to next step: If less than 0.2 V**
9. Replace the component:B74 Manifold Absolute Pressure Sensor

Repair Instructions

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

- **Manifold Absolute Pressure Sensor Replacement**
- For control module replacement, programming and setup, refer to **Control Module References**

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0112

Intake Air Temperature (IAT) Sensor 1 Circuit Low Voltage

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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+. **Where used.				

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
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 149Â°C (300Â°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

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**

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only if the ignition has been OFF for 8 hours or more.

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

     Refer to Circuit/System Testing below.

   - **Go to next step: If within 30Â°C (54Â°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
   - IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3; where equipped
   - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

     Refer to Circuit/System Testing below.

   - **Go to next step: If between: -38 and +149Â°C (-36 and +300Â°F)**
4. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing below.

   - **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. 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. 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 5 Ω**
3. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature sensor 1 signal circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.

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- 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**

4. 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).**
5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3.
6. 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, 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).**
7. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

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

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

2. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor** 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**
3. All OK.

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

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117	P0118, P0119	P0118*, P0119	P0116, P0128
Low Reference	-	P0113, P0118, P0119, P2199	-	P0128
*ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

ECT Sensor

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

Circuit/System Description

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

Conditions for Running the DTC

P0117

- The ignition is ON.

  OR

- The engine is running.

This DTC runs continuously within the enabling conditions.

P0118

- The ignition is ON.

  OR

- The engine is running for greater than 10 s.

  OR

- The engine run time is less than 10 s when the IAT is warmer than - 7Â°C (19Â°F).

This DTC runs continuously within the enabling conditions.

P0119

- No active DTCs set.
- The ignition is ON.

This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

P0117

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

P0118

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

P0119

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

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Diagnostic Aids

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

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

Reference Information

Schematic Reference

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Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

     Refer to Circuit/System Testing below.
   - **Go to next step: If warmer than -40Â°C (-40Â°F) and colder than 150Â°C (302Â°F) and changes**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing below.
   - **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 B34 Engine Coolant Temperature sensor harness connector at the sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal A or 2 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Ignition ON.

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4. Verify the scan tool ECT Sensor parameter is colder than -39Â°C (-38Â°F).
    - **If warmer than -39Â°C (-38Â°F)**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If colder than -39Â°C (-38Â°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149Â°C (300Â°F).
    - **If 149Â°C (300Â°F) or colder**
    1. Ignition OFF, remove the jumper wire, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If warmer than 149Â°C (300Â°F)**
7. Test or replace the B34 Engine Coolant Temperature Sensor.

Component Testing

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

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

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

Diagnostic Instructions

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

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- **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			

Circuit	Short to Ground	Open	Short to Voltage
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

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0335 or P0336 is not set.
- The engine speed is between 500 - 6, 800 RPM.
- The engine coolant temperature (ECT) is -7 to +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 1 voltage is stuck within normal operating range for greater than 1 s.

P0122

The ECM detects the throttle position sensor 1 signal voltage is less than 0.33 V for greater than 1 s.

P0123

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

P0222

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

P0223

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

P16A0

The ECM detects a low voltage circuit condition on the throttle position sensor signal circuit for greater than 1 s.

P16A1

The ECM detects a high voltage circuit condition on the throttle position sensor signal circuit for greater than 1 s.

P16A2

The ECM detects an incorrect message was received over the throttle position sensor signal circuit for greater than 1 s.

P2135

- The ECM detects that throttle position sensors 1 and 2 disagree greater than 7 - 10 percent for greater than 1 s.

  OR

- The ECM detects that the TP sensor 1 and 2 learned minimum throttle position is greater than 5 percent of the 5 volt reference voltage.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

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Diagnostic Aids

- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- If the accelerator pedal is pressed to the wide open throttle position, the throttle blade angle or Throttle Position angle is limited to less than 40 percent.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON,
2. Verify that DTC P0601 - P0606, P06A3 and P16F3 is not set.
    - **If a DTC is set**

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

    - **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 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 below

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

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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**

      Test or replace the Q38 Throttle Body Assembly.

    - **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 below.

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

      Refer to **DTC P0106**.

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

      Refer to **DTC P0101**.

    - **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 3 kPa (0.4 psi)**

      Refer to **DTC P0236**.

    - **Go to next step: If the parameters are within 3 kPa (0.4 psi)**
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 20 kPa (2.9 psi)**

      Refer to **DTC P0236**

    - **Go to next step: If the parameters are within 20 kPa (2.9 psi)**
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.

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

      Refer to Circuit/System Testing below.

    - **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 Assembly. 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. 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 5 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If between 4.8 - 5.2 V**
5. Ignition ON.
6. Test for 4.8 - 5.2 V between the signal circuit terminal 3 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.

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2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
- **Go to next step: If between 4.8 - 5.2 V**

7. Test or replace the Q38 Throttle Body Assembly.

Repair Instructions

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

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Ignition OFF and all vehicle systems OFF. It may take up to 2 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.
    - **If Agree is not displayed**

      Test or replace the Q38 Throttle Body Assembly.

    - **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

Diagnostic Fault Information

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

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Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The ignition is ON, or the engine is running **Parameter Normal Range:** Varies with ambient temperature, within a range of -39 to 149Â°C (-38 to 300Â°F)			
ECT Sensor Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)

Circuit/System Description

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

The ECM uses the start-up ECT and the start-up intake air temperature (IAT) to begin the diagnostic calculation. The air flow into the engine is accumulated, and vehicle speed, distance, and engine run time are also factored in to determine if the ECT does increase normally and reach the calibrated target temperatures.

Conditions for Running the DTC

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

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Conditions for Setting the DTC

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

  OR

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

Action Taken When the DTC Sets

- DTC P0128 is a Type B DTC.
- The cooling fans will be commanded ON.
- The AC compressor will be commanded OFF.

Conditions for Clearing the MIL/DTC

DTC P0128 is a Type B DTC.

Diagnostic Aids

- DTC P0128 occurring with insufficient vehicle interior heating is an indication of improper thermostat operation.
- A slight to moderate resistance in the ECT sensor signal circuit or low reference circuit will affect this diagnostic. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

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

   - **Go to next step: If DTC P00B3, P00B6, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117 or P0118 is not set**
2. Verify the cooling system is filled to the correct coolant level. Refer to **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)** , and **Loss of Coolant** .
   - **If the coolant level is not correct**

     Repair as necessary

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

     Replace the Engine Coolant Thermostat.

   - **Go to next step: If greater than 80Â°C (176Â°F)**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing below.

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

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Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the B34 Engine Coolant Temperature sensor harness connector at the sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal A or 2 and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **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 X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If colder than -39Â°C (-38Â°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149Â°C (300Â°F).
    - **If 149Â°C (300Â°F) or colder**
    1. Ignition OFF, remove the jumper wire, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If warmer than 149Â°C (300Â°F)**
7. Test the B34 Engine Coolant Temperature Sensor.

    Refer to **Component Testing**.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table. The resistance values should be in range of the table values.
    - **If not within the specified range**

      Replace the B34 Engine Coolant Temperature Sensor.

    - **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.

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- **Go to next step: If infinite resistance**

4. Refer to **Thermostat Diagnosis** .

Repair Instructions

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

- **Engine Coolant Temperature Sensor Replacement**
- **Engine Coolant Thermostat Housing Replacement (LTG)**
- **Control Module References** for ECM replacement, setup and programming

DTC P0131, P0132, P015A, P015B, P223C OR P223E: HO2S

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 Descriptors

DTC P0131

HO2S Circuit Low Voltage Sensor 1

DTC P0132

HO2S Circuit High Voltage Sensor 1

DTC P015A

HO2S Delayed Response Rich to Lean Sensor 1

DTC P015B

HO2S Delayed Response Lean to Rich Sensor 1

DTC P223C

HO2S Pump Current Control Performance Bank 1 Sensor 1

DTC P223E

HO2S Reference Resistance Out of Range Bank 1 Sensor 1

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal - Terminal 2	P0131	P223E	P0132	P015A, P015B, P223C
Signal - Terminal 3	P0131	P223C	P0132	P015A, P015B, P223C
Signal - Terminal 7	P223C	P223C	P0132	P015A, P015B, P223C
Low Reference - Terminal 1	-	P223C, P223E	P0132	P015A, P015B, P223C

Typical Scan Tool Data

HO2S 1

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine=Running **Parameter Normal Range:** Between Lambda 0.8 and 1.1			
Signal - Terminal 2	Lambda 2	Between Lambda 0.67 and 1	Lambda 1
Signal - Terminal 3	Lambda 1	Lambda 1	Lambda 1
Signal - Terminal 7	Lambda 2	Lambda 1	Lambda 1
Low Reference - Terminal 1	Lambda 1	Lambda 1	Lambda 1

Circuit/System Description

The wide band heated oxygen sensor (HO2S) measures the amount of oxygen in the exhaust system and provides more information than the switching style HO2S. The wide band sensor consists of an oxygen sensing cell, an oxygen pumping cell, and a heater. The exhaust gas sample passes through a diffusion gap between the sensing cell and the pumping cell. The engine control module (ECM) supplies a voltage to the HO2S and uses this voltage as a reference to the amount of oxygen in the exhaust system. An electronic circuit within the ECM controls the pump current through the oxygen pumping cell in order to maintain a constant voltage in the oxygen sensing cell. The ECM monitors the voltage variation in the sensing cell and attempts to keep the voltage constant by increasing or decreasing the amount of current flow, or oxygen ion flow, to the pumping cell. By measuring the amount of current required to maintain the voltage in the sensing cell, the ECM can determine the concentration of oxygen in the exhaust. The HO2S voltage is displayed as a lambda value. A lambda value of 1 is equal to a stoichiometric air fuel ratio of 14.7:1. Under normal operating conditions, the lambda value will remain around 1. When the fuel system is lean, the oxygen level will be high and the lambda signal will be high or more than 1. When the fuel system is rich, the oxygen level will be low, and the lambda signal will be low or less than 1. The ECM uses this information to maintain the correct air/fuel ratio. If the ECM detects that the HO2S signal voltage is low, this DTC sets.

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.

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Conditions for Running the DTC

P0131, P0132

- DTC P0030, P0031, P0032, P0135 = Not set
- Ignition Voltage = 10 to 32 V
- Engine Running
- DTCs run continuously when the above conditions are met for greater than 4 s.

P015A, P015B

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0131, P013A, P013B, P013E, P013F, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176, P2270, P2271 = Not set
- P015A has run and passed for P015B to run.
- Ignition Voltage = 10 to 32 V
- Engine Coolant Temperature = Warmer than 62Â°C (144Â°F)
- Intake Air Temperature = Warmer than -40Â°C (-40Â°F)
- Fuel Level Sensor = Greater than 10%
- Engine Run Time = Greater than 120 s
- Engine Speed = 950 to 2950 RPM
- Vehicle Speed = 66 to 124 km/h (41 to 77 MPH)
- Mass Air Flow = 2 to 15 g/s
- Barometric Pressure = Greater than 70 kPa (10 PSI)

- Fuel Control Loop Status = Closed Loop Fuel Control
- Device controls are not active.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- HO2S 1 Heater Command = On For greater than 20 s
- After the above conditions are met for 2 s the fuel mixture is forced rich.
- At the end of the forced rich fuel state, decel fuel cut-off is active, without driver initiated accelerator pedal input.
- DTCs run once per drive cycle when the above conditions are met.

P223C

- DTC P0030, P0031, P0032, P0135 = Not set
- Ignition Voltage = 10 to 32 V
- Engine Running
- The DTC runs when time in decel fuel cut-off is greater than 5 s and less than 12 s, when the above conditions are met for 7 s.

P223E

- DTC P0030, P0031, P0032, P0135 = Not set
- Ignition Voltage = 10 to 32 V
- Engine Running
- DTC runs continuously when the above conditions are met for greater than 30 s.

Conditions for Setting the DTC

P0131

The engine control module detects that the heated oxygen sensor pump current or reference voltage circuit is shorted to ground for greater than 4 s.

P0132

The engine control module detects that the heated oxygen sensor pump current, reference voltage, or reference ground circuit is shorted to voltage for greater than 4 s.

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.

P223C

The engine control module detects an open circuit fault to the pump current, reference voltage, reference ground, or trim circuit or a trim circuit short to ground, by detecting that the pump current is less than 0.10 mA or greater than 4.18 mA for greater than 7 s..

P223E

The engine control module detects that the heated oxygen sensor reference cell is colder than 700Â°C (1292Â°F) or warmer than 1000Â°C (1832Â°F) for greater than 4 s.

Actions Taken When the DTC Sets

- DTCs P0131, P0132, P223C, P223E are Type B DTCs.
- DTCs P015A, P015B are Type A DTCs.

Conditions for Clearing the DTC

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- DTCs P0131, P0132, P223C, P223E are Type B DTCs.
- DTCs P015A, P015B are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls 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

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Verify no other DTCs are 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. Engine running.
4. Fuel Control Loop Status = Closed Loop
5. Verify the scan tool parameter:HO2S 1 = Between Lambda 0.8 and 1.1
   - **If not between Lambda 0.8 and 1.1**

     Refer to Circuit/System Testing below

   - **Go to next step: If between Lambda 0.8 and 1.1**
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 below

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

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performed.

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector:B52 Heated Oxygen Sensor
3. Test for less than 10 Ω between the test points:Low Reference circuit terminal 1 & Ground
   - **If 10 Ω or greater**
   1. Disconnect the electrical connector:K20 Engine Control Module
   2. Test for less than 2 Ω between the test points:Low Reference circuit terminal 1 @ Component harness & Terminal X3 38 @ Control module harness
      - **If 2 Ω or greater - Repair the open/high resistance in the circuit.**
      - **If less than 2 Ω - Test or replace the component:** K20 Engine Control Module
   - **Go to next step: If less than 10 Ω**
4. Disconnect the electrical connector:K20 Engine Control Module
5. Test for infinite resistance between the test points:Signal circuit terminal 2 @ Component harness & Ground
   - **If less than infinite resistance**

     Repair the short to ground on the circuit:
   - **Go to next step: If infinite resistance**
6. Ignition - On / Vehicle - In Service Mode
7. Test for less than 1 V between the test points:Signal circuit terminal 2 @ Component harness & Ground
   - **If 1 V or greater**

     Repair the short to voltage on the circuit:
   - **Go to next step: If less than 1 V**
8. Ignition/Vehicle - Off
9. Test for less than 2 Ω between the test points:Signal circuit terminal 2 @ Component harness & Terminal X3 36 @ Control module harness
   - **If 2 Ω or greater - Repair the open/high resistance in the circuit.**
   - **Go to next step: If less than 2 Ω**
10. Test for infinite resistance between the test points:Signal circuit terminal 3 @ Component harness & Ground
    - **If less than infinite resistance**

      Repair the short to ground on the circuit:
    - **Go to next step: If infinite resistance**
11. Ignition - On / Vehicle - In Service Mode
12. Test for less than 1 V between the test points:Signal circuit terminal 3 @ Component harness & Ground
    - **If 1 V or greater**

      Repair the short to voltage on the circuit:
    - **Go to next step: If less than 1 V**
13. Ignition/Vehicle - Off
14. Test for less than 2 Ω between the test points:Signal circuit terminal 3 @ Component harness & Terminal X3 37 @ Control module harness
    - **If 2 Ω or greater - Repair the open/high resistance in the circuit.**
    - **Go to next step: If less than 2 Ω**
15. Test for infinite resistance between the test points:Signal circuit terminal 7 @ Component harness & Ground

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- **If less than infinite resistance**

  Repair the short to ground on the circuit:

- **Go to next step: If infinite resistance**

16. Ignition - On / Vehicle - In Service Mode
17. Test for less than 1 V between the test points:Signal circuit terminal 7 @ Component harness & Ground
    - **If 1 V or greater**

      Repair the short to voltage on the circuit:

    - **Go to next step: If less than 1 V**
18. Ignition/Vehicle - Off
19. Test for less than 2 Ω between the test points:Signal circuit terminal 7 @ Component harness & Terminal X3 35 @ Control module harness
    - **If 2 Ω or greater - Repair the open/high resistance in the circuit.**
    - **Go to next step: If less than 2 Ω**
20. Verify none of the conditions listed below exist:
    - Water intrusion in the following components or their wiring harnesses:B52 Heated Oxygen Sensor
    - Fuel pressure low or high. Refer to **Fuel System Diagnosis**
    - Contaminated or poor quality fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**
    - Fuel saturation of the evaporative emission (EVAP) canister
    - Exhaust leaks
    - Engine vacuum leaks.
    - Oil consumption Refer to **Oil Consumption Diagnosis**
    - Coolant consumption Refer to **Loss of Coolant**
    - **If a condition exists**

      Repair as necessary

    - **Go to next step: If no conditions exist**
21. Test or replace the component: B52A Heated Oxygen Sensor 1
22. Perform the scan tool configuration/reset function:HO2S Heater Resistance Reset
23. Operate the vehicle within the 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**

      Test or replace the component:K20 Engine Control Module

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

Repair Instructions

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

- **Heated Oxygen Sensor Replacement - Sensor 1**
- **Control Module References** for ECM replacement, programming and setup

DTC P0137, P0138, P013A, P013B, P013E, P013F, P2270 OR P2271: HO2S

Diagnostic Instructions

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

DTC Descriptors

DTC P0137

HO2S Circuit Low Voltage Sensor 2

DTC P0138

HO2S Circuit High Voltage Sensor 2

DTC P013A

HO2S Slow Response Rich to Lean Sensor 2

DTC P013B

HO2S Slow Response Lean to Rich Sensor 2

DTC P013E

HO2S Delayed Response Rich to Lean Sensor 2

DTC P013F

HO2S Delayed Response Lean to Rich Sensor 2

DTC P2270

HO2S Signal Stuck Lean Sensor 2

DTC P2271

HO2S Signal Stuck Rich Sensor 2

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Diagnostic Fault Information

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

Typical Scan Tool Data

HO2S Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200 - 800 mV			
HighSignal	0.00 V	1.7 - 2.1 V	1.7 - 2.1 V
LowSignal	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 2 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

P0137

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

P0138

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition voltage is between 10 - 32 V.
- Ignition is OFF for greater than 8 h.
- The fuel system is operating in Closed Loop.
- Ethanol content is less than 87%.
- The fuel level is greater than 10%.
- The engine run time is greater than 30 s.
- The engine is not in Power Enrichment.
- The DTCs run continuously after an initial delay of 3 min when the above conditions are met for 5 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, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The Ignition voltage is between 10 - 32 V.
- The engine is OFF for greater 8 h.

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- 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, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The Ignition voltage is between 10 - 32 V.
- The engine is OFF for greater 8 h.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- After the above conditions are met, fuel enrich mode is continued.
- The DTCs run once per ignition cycle when the above conditions are met.

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 engine is OFF for greater 8 h.
- The fuel level is greater than 10%.
- The pedal position is less than 4%.
- The engine speed is between 950 - 2, 950 RPM.
- The engine airflow is between 3 - 12 g/s.
- The vehicle speed is between 66 - 124 km/h (41 - 77 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 80 s.
- The predicted catalytic converter temperature is between 500 - 850Â°C (932 - 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 engine is OFF for greater 8 h.
- The fuel level is greater than 10%.
- The fueling state is in Closed Loop.
- 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

P0137

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

P0138

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

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 36 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 88 grams.

P013E

The engine control module detects an initial delayed response to a change from rich to lean such that the heated oxygen sensor voltage has not decreased to 450 mV within a calibrated value of accumulated air flow.

P013F

The engine control module detects an initial delayed response to a change from lean to rich such that the heated oxygen sensor voltage has not increased above 350 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 P0137, P0138, P013E, P013F, P2270, and P2271 are Type B DTCs.
- DTCs P013A and P013B are Type A DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0137, P0138, P013E, P013F, P2270, and P2271 are Type B DTCs.
- DTCs P013A and P013B are Type A DTCs.

Reference Information

Schematic Reference

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Engine Controls 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 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. Engine running.
4. Verify the scan tool HO2S 1 or 2 parameters are between 50 - 1, 050 mV.
   - **If not between 50 - 1, 050 mV.**

     Refer to Circuit/System Testing below.
   - **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 below.
   - **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 appropriate B52 Heated Oxygen Sensor harness connector. It may take up to 2 minutes for all vehicle systems to power down. Ignition ON.
2. Test for 1.7 - 3.0 V between the high signal circuit terminal 4 and ground.
   - **If less than 1.7 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the high signal circuit terminal 4 and ground.
      - If less than infinite resistance repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the high signal circuit end to end.

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

- **If greater than 3.0 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the high signal circuit terminal 4 and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If between 1.7 - 3.0 V**

3. Verify the scan tool HO2S 1 or 2 parameter is between 1.7 - 2.1 V.
   - **If less than 1.7 V**

   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the low signal circuit terminal 3 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.

   - **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 HO2S 1 or 2 parameter displays 0.0 V.
   - **If greater than 0.0 V**

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

   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If 0.0 V**

6. Verify none of the conditions listed below exist:
   - Water intrusion in the B52 Heated Oxygen Sensor harness connector
   - Low or high fuel system pressure - Refer to **Fuel System Diagnosis** .
   - Fuel that is contaminated - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
   - Fuel saturation of the evaporative emission (EVAP) canister
   - Exhaust leaks
   - Engine vacuum leaks
   - Engine oil consumption - Refer to **Oil Consumption Diagnosis** .
   - Engine coolant consumption - Refer to **Loss of Coolant** .
   - **If any of the conditions exist**

     Repair as necessary.

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

     Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

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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

Circuit/System Description

The engine control module (ECM) controls a Closed Loop air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. The ECM monitors the heated oxygen sensor (HO2S) signal voltage, and adjusts the fuel delivery based on the signal voltage while in Closed Loop. A change made to the fuel delivery changes the long and short term fuel trim values. The short term fuel trim values change rapidly in response to the HO2S signal voltages. These changes fine tune the engine fueling. The long term fuel trim values change in response to trends in the short term fuel trim The long term fuel trim makes coarse adjustments to fueling in order to re-center and restore control to short term fuel trim. The ideal fuel trim values are around 0 %. A positive fuel trim value indicates that the ECM is adding fuel in order to compensate for a lean condition. A negative fuel trim value indicates that the ECM is reducing the amount of fuel in order to compensate for a rich condition.

Conditions for Running the DTC

- DTCs P0030, P0053, P0101, P0102, P0103, P0106, P0107, P0108, P0131 - P0135, P015A, P015B, P0178, P0179, P0201 - P0204, P0236, P0237, P0238, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300 - P0304, P0411, P0442, P0455, P0458, P0496, P0506, P0507, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2269, P2440, P2444, or P2A00 are not set.
- The engine is in Closed Loop status.
- The catalyst monitor diagnostic intrusive test, post 02 diagnostic intrusive test, device control, and evaporative emission leak test are not active.
- The engine coolant temperature (ECT) is between -20 and +130Â°C (-4 and +266Â°F).
- The intake air temperature (IAT) is between -20 and +150Â°C (-4 and +302Â°F).
- The manifold absolute pressure (MAP) is between 15 - 255 kPa (2.2 - 37 psi).
- The engine speed is between 400 - 6, 600 RPM.
- The mass air flow (MAF) is between 1 - 512 g/s.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 psi).
- The fuel level is greater than 10 %.
- This diagnostic runs continuously when the above conditions have been met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTCs P0171 and P0172 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0171 and P0172 are Type B DTCs.

Diagnostic Aids

- The normal Short Term Fuel Trim and Long Term Fuel Trim parameters should be between +10 and -10 % with 0 % the optimum, with the engine running at operating temperature.
- Any un-metered air into the engine causes this DTC to set. Thoroughly inspect all areas of the engine for vacuum leaks.
- A MAF sensor condition can cause this DTC without setting a MAF DTC. If there is a MAF sensor condition, the MAF sensor parameters will appear to be within range.
- Verify that the air filter is the correct one for this application. Verify that the engine oil fill cap is in place and that it is tight. Verify that the engine oil dip stick is fully seated.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

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

    - **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 below.

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- **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 below.

    - **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** .
        - Split, kinked or improperly connected vacuum hoses.
        - Insufficient fuel in the tank
        - Low fuel pressure. Refer to **Fuel System Diagnosis** .
        - Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.
        - Leaks in the air induction system and the air intake ducts
        - Missing air filter element
        - Cracked EVAP canister
        - Evaporative pipes obstructed or leaking
        - Leaks in the crankcase ventilation system. Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
            - If a condition is found, repair as necessary.
            - If no condition is found, inspect the engine for a mechanical condition. Refer to **Symptoms - Engine Mechanical** .
    - **If less than -10%**
    1. Ignition OFF.
    2. Inspect for the conditions listed below:
        - Mass air flow (MAF) sensor signal skewed. If the Short Term Fuel Trim parameters for both banks changes greater than 20% when the MAF sensor is disconnected, refer to **DTC P0101**.
        - Fuel contamination - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .

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- Missing, restricted, or leaking exhaust components - Refer to **Symptoms - Engine Exhaust** .
- Malfunctioning fuel injectors - Refer to **Fuel Injector Diagnosis**
- Collapsed or restricted air intake duct
- Excessive fuel pressure - Refer to **Fuel System Diagnosis**
- Dirty or restricted air filter
- Objects blocking the throttle body
- Improper operation of the evaporative emissions control system
- Excessive fuel in the crankcase - Change engine oil as necessary and inspect for the following:

  G18 High Pressure Fuel Pump = Leaking

  Q17 Fuel Injector = Leaking - Refer to **Fuel Injector 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** .
- **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.

Repair Instructions

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

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

DTC P018B, P018C, OR 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

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P018C, P0192, P0340, P0365, P0452, P0522, P0532, P055C, P0641, P2227, P2228	P018C	P018D, P0193, P0453, P0523, P0533, P055D, P0641, P2227	P018B
Signal	P018C	P018C	P018D	P018B
Low Reference	-	P0073, P018D, P0453, P0463, P0533, P0558	P018D	P018B

Circuit/System Description

The fuel pressure sensor is located on the 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

P018B

- DTC P018C, P018D, P0231, P0232, P023F, P0606, P0641 or P1255 is not set.
- The engine is running for greater than 5 s.
- The fuel pump enable circuit is commanded ON.
- Low fuel level warning not present.
- The DTC runs continuously when the conditions above are met.

P018C or P018D

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

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Conditions for Setting the DTC

P018B

The engine control module does not detect a normal fuel pressure change 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 A DTCs.

Conditions for Clearing the DTC

DTC P018B, P018C and P018D are Type A DTCs.

Diagnostic Aids

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The

Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC 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 below.

   - **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 parameter does not change**

     Refer to Circuit/System Testing below.

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

     Refer to Circuit/System Testing below.

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- **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 B47 Fuel Pressure 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. 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. 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 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 1 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3, wait 15 seconds.
7. Verify the scan tool Fuel Pressure Sensor parameter is greater than 4.8 V.
   - **If 4.8 V or less**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 1 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 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**

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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 (AWD)** **Fuel Pressure Sensor Replacement - Fuel Feed Pipe (FWD)**
- **Control Module References** for control module replacement, programming and setup.

DTC P0191 OR P0192: FUEL RAIL PRESSURE SENSOR

Diagnostic Instructions

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

DTC Descriptors

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

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Circuit/System Description

The fuel rail pressure 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 rail pressure sensor internal microprocessor allows 4 separate sensor outputs from one 3 wire sensor. The engine control module (ECM) supplies the fuel rail pressure 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 rail pressure sensor to the ECM.

Conditions for Running the DTC

P0191 - Condition 1

- The engine is not cranking.
- The ignition voltage is greater than 11 V.
- The vehicle speed is less than or equal to 1 km/h (0.62 MPH).
- The low side fuel pressure is greater than or equal to 250 kPa (36 PSI).
- The Accelerator Pedal Position is 0% for 2.5 s.
- The engine is running for greater than 30 s.

P0191 - Condition 2 and 3

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

P0191 - Condition 4

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0192, P0193, P0201, P0202, P0203, P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0335, P0336, P0340, P0341, P0351 - P0354, P0365, P0366, P0506, P0507, P0628, P0697, P06A3, P0722, P0723, P1248, P1249, P124A, P124B, P1682, P2122, P2123, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157 is not set.
- The engine is not cranking.
- The vehicle speed is greater than or equal to 30 km/h (18.64 MPH).
- The engine speed is greater than or equal to 2, 000 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The intake air temperature (IAT) is warmer than -20Â°C (-4Â°F).

P0192

- The engine is running.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously within the enabling conditions.

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Conditions for Setting the DTC

P0191 - Condition 1

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

P0191 - Condition 2

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

P0191 - Condition 3

The difference between the commanded high pressure and the measured high pressure is greater than or equal to 3 MPa (435 PSI) and the modeled injection pressure is greater than or equal to 1.6 MPa (232 PSI) with the high pressure fuel pump actuator commanded ON. The condition exists for greater than 3 s.

P0191 - Condition 4

The difference between the measured maximum high pressure and the measured minimum high pressure is less than or equal to 0.1 MPa (14.5 PSI) with the high pressure fuel pump actuator commanded ON. The condition exists for greater than 30 s with the engine running or greater than 10 s with the engine cranking.

P0192

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

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.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify DTC P0641 is not set.
    - **If the DTC is set**

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

    - **Go to next step: If the DTC is not set**
3. Engine idling.
4. Verify DTC P0191 or P0192 is not set.
    - **If any of the DTCs are set**

      Refer to Circuit/System Testing below.

    - **Go to next step: If none of the DTCs are set**
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze

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Frame/Failure Records data.

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

     Refer to Circuit/System Testing below.

   - **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 fuel injector multi-way harness connector X160. It may take up to 2 mins for all vehicle systems to power down.

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

2. Test for less than 5 Ω between the low reference circuit terminal 5 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **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 11 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition On.
   2. Test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If between 4.8 - 5.2 V**
5. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
   - **If 0.02 V or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition On.
   2. Test for less than 1 V between the signal circuit terminal 12 and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If less than 0.02 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 12 and the 5 V reference circuit terminal 11.
7. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is greater than 4.96 V.
   - **If 4.96 V or less**

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1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal 12 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **Go to next step: If greater than 4.96 V**

8. Connect the fuel injector multi-way harness connector X160.
9. Disconnect the B47B Fuel Rail Pressure Sensor connector.

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

10. 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**
11. Ignition On.
12. 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**
13. Ignition On.
14. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
    - **If 0.02 V or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition On.
    2. Test for less than 1 V between the signal circuit terminal 2 and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If less than 0.02 V**
15. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the 5 V reference circuit terminal 3.
16. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is greater than 4.96 V.

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- **If 4.96 V or less**

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

- **Go to next step: If greater than 4.96 V**

17. Replace the B47B Fuel Rail Pressure Sensor.

Repair Instructions

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

- **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0201, 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 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 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

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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 from Supply Circuit to Control Circuit
Fuel Injector 1 Control +	P0300, P2147	P0201, P0300	P0300, P2148	P1248
Fuel Injector 1 Control -	P0261, P0300	P0201, P0300	P0262, P0300, P2148	P0300, P1248
Fuel Injector 2 Control +	P0300, P2150	P0202, P0300	P0300, P2151	P1249
Fuel Injector 2 Control -	P0264, P0300	P0202, P0300	P0265, P0300, P2151	P0300, P1249
Fuel Injector 3 Control +	P0300, P2153	P0203, P0300	P0300, P2154	P124A
Fuel Injector 3 Control -	P0267, P0300	P0203, P0300	P0268, P0300, P2154	P0300, P124A
Fuel Injector 4 Control +	P0300, P2156	P0204, P0300	P0300, P2157	P124B
Fuel Injector 4 Control -	P0270, P0300	P0204, P0300	P0271, P0300, P2157	P0300, P124B

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the high control circuits. The ECM energizes each fuel injector by grounding the low control circuit of the fuel injector. The ECM monitors the status of the fuel injector circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

Conditions for Running the DTC

- DTC P062B is not set.
- The engine is running for greater than 5 s.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously once the above conditions are met.

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Conditions for Setting the DTC

P0201, P0202, P0203, or P0204

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

P0261, P0264, P0267 or P0270

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

P0262, P0265, P0268 or P0271

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

P1248, P1249, P124A or P124B

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

P2147, P2150, P2153 or P2156

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

P2148, P2151, P2154 or P2157

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

Action Taken When the DTC Sets

DTCs P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156 and P2157 are Type

A DTCs.

Conditions for Clearing the DTC

DTCs P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156 and P2157 are Type A DTCs.

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Diagnosis** .
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

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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 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**

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

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3. Engine idling.
4. Verify with a scan tool the parameters listed below do not increment.
    - Cylinder 1 Current Misfire Counter
    - Cylinder 2 Current Misfire Counter
    - Cylinder 3 Current Misfire Counter
    - Cylinder 4 Current Misfire Counter
    - **If a parameter increments**

      Refer to Circuit/System Testing below.

    - **Go to next step: If a parameter does not increment**
5. Verify with a scan tool the parameters listed below display OK or Not Run.
    - Cylinder 1 Injector Control Circuit Status
    - Cylinder 2 Injector Control Circuit Status
    - Cylinder 3 Injector Control Circuit Status
    - Cylinder 4 Injector Control Circuit Status
    - **If OK or Not Run is not displayed**

      Refer to Circuit/System Testing below.

    - **Go to next step: If OK or Not Run is displayed**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
7. Verify the DTC does not set
    - **If the DTC sets**

      Refer to Circuit/System Testing below.

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

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the harness connector at the K20 Engine Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for infinite resistance between the appropriate Q17 Fuel Injector control + circuit and ground.
    - **If less than infinite resistance**
    1. Disconnect the harness connector of the Q17 Fuel Injector.
    2. Test for infinite resistance between the Q17 Fuel Injector control + circuit and ground.
        - If less than infinite, repair the short to ground in the circuit.
        - If infinite resistance
    3. Test for infinite resistance between the Q17 Fuel Injector control - circuit and ground.
        - If less than infinite, repair the short to ground in the circuit.
        - If infinite, replace the Q17 Fuel Injector.
    - **Go to next step: If infinite resistance**
3. Ignition ON.
4. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
    - **If 1 V or greater**
    1. Disconnect the harness connector of the Q17 Fuel Injector, ignition ON.
    2. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, repair the short to voltage on the control - circuit.
    - **Go to next step: If less than 1 V**

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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.

Component Testing

Fuel Injector Diagnosis

Repair Instructions

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

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

DTC P0231, P0232 OR P023F: FUEL PUMP CONTROL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **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	P0171, P0232, P023F	P0171, P0232, P023F	P0171, P0232, P023F, P2635	P023F, P2635
Low Reference	-	P0232, P023F, P0506	P0232, P023F, P0506	P023F, P2635

Circuit/System Description

The engine control module (ECM) supplies voltage to the fuel pump driver control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump driver control module remains active for 2 s, unless the engine is in crank or run. While this voltage is being received, the fuel

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pump driver control module supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC

P0231

- The ignition voltage is between 9 - 32 V.
- The fuel pump enable circuit is commanded ON.
- The fuel pump 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.
- The DTC runs once per trip.

P023F

- The ignition voltage is between 9 - 32 V.
- The fuel pump enable circuit is commanded ON.

Conditions for Setting the DTC

P0231

The fuel pump driver control module detects that the fuel pump current is greater than 14.48 A for 1 s.

P0232

The fuel pump driver control module detects that the fuel pump control 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 current is less than 0.5 A and the fuel pump duty cycle is greater than 20 percent 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

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Engine Controls Wiring Schematics

Connector End View Reference

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Fuel System Description

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. 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 below.

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

     Refer to Circuit/System Testing below.

   - **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.

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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.
        - 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**

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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.

- **Fuel Pump Power Control Module Replacement (AWD)** **Fuel Pump Power Control Module Replacement (FWD)** 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 P0234 OR P0299: ENGINE OVERBOOST OR UNDERBOOST

Diagnostic 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 is integrated with the intake air temperature (IAT) sensor 3. 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, 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, on the boost pressure signal circuit. 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 vehicle is operated at wide-open throttle (WOT) the turbocharger can increase the pressure to near 240 kPa (34.8 psi). The lowest pressure that occurs is when the vehicle is idling or decelerating, and it is equal to BARO.

Conditions for Running the DTCs

- DTC P0010, P0011, P0013, P0014, P0016, P0017, P0033, P0034, P0035, P0068, P00C8, P00C9, P0111, P0112, P0113, P0114, P0116, P0122, P0123, P0128, P0222, P0223, P0236, P0237, P0238, P0243, P0245, P0246, P0601, P0604, P0606, P1682, P16A0, P16A1, P16F3, P2101, P2176, P2227, P2228, P2229, P2230 or P2261 is not set.
- The driver requested boost pressure level exceeds the level of the base boost pressure.

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- The engine speed is between 1, 600 - 6, 000 RPM.
- The desired boost pressure is between 140 - 300 kPa (20.3 - 43.5 psi)
- The Barometric Pressure (BARO) is between 60 - 120 kPa (8.7 - 17.4 psi).
- The Engine Coolant Temperature (ECT) is between -40 to +120Â°C (-40 to +248Â°F).
- The Intake Air Temperature (IAT) is between -40 to +80Â°C (-40 to +176Â°F)
- The turbocharger wastegate is not under output device control.
- The turbocharger bypass valve is not under output device control.
- The DTCs run continuously when the above conditions have been met.

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 DTC Sets

- P0234 and P0299 are Type A DTCs with emission package RPOs NT7, NU5 and NQL.
- P0234 and P0299 are Type C DTCs with emission package RPOs NE4 and NE9.
- 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

- P0234 and P0299 are Type A DTCs with emission package RPOs NT7, NU5 and NQL.
- P0234 and P0299 are Type C DTCs with emission package RPOs NE4 and NE9.

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 solution of dish soap and water in a spray bottle to pinpoint any air leaks.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

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**

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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

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 not within the range.**

     Refer to **DTC P2227-P2230** .
   - **Go to next step: If within the range.**
4. Verify the scan tool MAP Sensor and BARO Sensor 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).**
5. Verify the scan tool Boost Pressure Sensor and BARO Sensor parameters are within 3 kPa (0.4 psi).
   - **If not within 3 kPa (0.4 psi).**

     Refer to **DTC P0236**.
   - **Go to next step: If within 3 kPa (0.4 psi).**
6. 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 **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**

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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 15 - 100% 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 15 - 100% 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. 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 below.

    - **Go to next step: If within 20 kPa (2.9 psi)**
11. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
12. Verify a DTC does not set.
    - **If a DTC sets**

      Refer to Circuit/System Testing below

    - **Go to next step: If a DTC does not set**
13. 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
   - 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. Refer to **Symptoms - Engine Exhaust** .
   - Exhaust leak between the turbocharger and the exhaust manifold
   - Restricted or leaking turbocharger oil supply line

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- Loose or incorrect installation of any components
- **If a condition exists**

  Repair or replace the affected component as necessary.

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

2. Ignition Off, disconnect the turbocharger wastegate solenoid valve supply 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 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 turbocharger wastegate solenoid valve supply 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, remove the Q40 Turbocharger Bypass Solenoid Valve from the turbocharger, ignition On.
8. Verify the Q40 Turbocharger Bypass Solenoid 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 **Camshaft Cover and Compressor Air Intake Turbocharger Cleaning and Inspection**
   - 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 (1st Design Tamper-Proof PCV System)**
- **Turbocharger Bypass Valve Solenoid Replacement**

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- 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 is integrated with the turbocharger boost/intake air temperature sensor. 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

- 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, 000 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 50 kPa (7.3 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 DTC Sets

- P0236 is a Type B DTC with emission package RPOs NT7, NU5 and NQL.
- P0236 is a Type C DTC with emission package RPOs NE4 and NE9.

Conditions for Clearing the MIL/DTC

- P0236 is a Type B DTC with emission package RPOs NT7, NU5 and NQL.
- P0236 is a Type C DTC with emission package RPOs NE4 and NE9.

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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Turbocharger System Description

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC P0641 is not set.
   - **If the DTC is set**

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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 Airflow Compensation parameter is less than 90%.
   - **If 90% or greater**

     Refer to **Throttle Body 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.
   - **BARO is not in range**

     Refer to **DTC P2227-P2230** .

   - **Go to next step: BARO is within range**
7. Verify the scan tool MAP Sensor pressure and BARO parameters are within 3 kPa (0.4 psi).
   - **The parameters are not within 3 kPa (0.4 psi).**

     Refer to **DTC P0106**.

   - **Go to next step: The parameters are 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 26 - 52 kPa (3.8 - 7.5 psi) or does not change**

     Refer to **DTC P0106**.

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

      Refer to **DTC P0101**.

    - **Go to next step: The MAF Sensor parameter changes smoothly and gradually**
11. 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 below

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- **Go to next step: The parameters are 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.
    - **The parameters are not within 20 kPa (2.9 psi)**

      Refer to Circuit/System Testing below.

    - **Go to next step: The parameters are 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 below.

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

Circuit/System Testing

1. Verify that DTC P0237 or P0238 is not set.
    - **If a DTC is set**

      Refer to **DTC P0237 or P0238**.

    - **Go to next step: If none of the DTCs are set**
2. Verify the conditions listed below do not exist:
    - Loose clamps, cracks, or other damage in the air intake duct 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**
3. Replace the B111B turbocharger boost/intake air temperature sensor.

Repair Instructions

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

- **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 P0237 OR P0238: TURBOCHARGER BOOST SENSOR CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

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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, P0651*	P0237	P0236, P0237, P0651*	P0236
Intake Air Pressure Signal	P0236, P0237	P0236, P0237	P0236, P0238, P0651*	P0236
Low Reference	-	P00EB, P0236, P0238	-	-
* Message center or an indicator may display ENGINE POWER IS REDUCED. Engine may experience Crank - NO Start condition.				

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 under various operating conditions			
5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	0 kPa (0 psi)
Boost Pressure Sensor	0 kPa (0 psi)	0 kPa (0 psi)	392 kPa (56.9 psi)
Low Reference	-	387 kPa (56.1 psi)	-

Circuit Description

The boost pressure sensor is integrated with the Turbocharger Boost/Intake Air Temperature sensor. 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

The ECM detects that the boost pressure sensor voltage is less than 0.9 V for greater than 5 s.

P0238

The ECM detects that the boost pressure sensor voltage is greater than 3.9 V for greater than 5 s.

Action Taken When the DTC Sets

- P0237 and P0238 are Type B DTCs with emission package RPOs NT7, NU5 and NQL.
- P0237 and P0238 are Type C DTCs with emission package RPOs NE4 and NE9.
- 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

- P0237 and P0238 are Type B DTCs with emission package RPOs NT7, NU5 and NQL.
- P0237 and P0238 are Type C DTCs with emission package RPOs NE4 and NE9.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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Turbocharger System Description

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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. 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** .

   - **Go to next step: If none of the DTCs are set**
2. 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**
3. 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 below

   - **Go to next step: The parameters are within 3 kPa (0.4 psi).**

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4. 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 below.

    - **Go to next step: The parameters are within 20 kPa (2.9 psi)**
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 a DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing below.

    - **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 B111B Turbocharger Boost/Intake Air Temperature sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference 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.

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

    -
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, 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 Boost Pressure Sensor voltage parameter is greater than 4.7 V.
    - **If 4.7 V or less**

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

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

6. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 1.
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 harness connector at the K20 Engine Control Module, Ignition ON.
    2. Test for less than 1 V between the signal circuit terminal 4 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open or high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

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

8. Test or replace the B111B Turbocharger Boost/Intake Air Temperature sensor.

Repair Instructions

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

- **Intake Air Pressure and Temperature Sensor Replacement** for B111B Turbocharger Boost/Intake Air Temperature sensor replacement
- **Control Module References** for control module replacement, programming, and setup

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DTC P0243, P0245 OR P0246: TURBOCHARGER WASTEGATE 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 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

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	P0033, P0034, P0243, P0245, P0443, P06DA, P06DB*	P0243	P0243	-	-
Turbocharger Wastegate Solenoid Control	P0245	P0243	P0243	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 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 DTCs

- Ignition is On or the engine is running.
- Battery voltage is between 11 - 32 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

- P0243, P0245 and P0246 are Type A DTCs with emission package RPOs NT7, NU5 and NQL.
- P0243, P0245 and P0246 are Type C DTCs with emission package RPOs NE4 and NE9.
- 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

- P0243, P0245 and P0246 are Type A DTCs with emission package RPOs NT7, NU5 and NQL.
- P0243, P0245 and P0246 are Type C DTCs with emission package RPOs NE4 and NE9.

Reference Information

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Engine Controls Wiring Schematics

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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 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 15 - 100% with a scan tool.
   - **If a series of clicks in increasing frequency are not heard or felt**

     Refer to Circuit/System Testing below.

   - **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 15 - 100 % 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 below.

   - **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 below

   - **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 15 - 100% 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 15 - 100% 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 P0300, P0301, P0302, P0303, OR 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

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Circuit/System Description

The engine control module (ECM) uses information from the crankshaft position sensor and the camshaft position sensor to determine when a engine cylinder misfire is occurring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM can detect individual cylinder misfire events.

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

Conditions for Running the DTC

- DTC P0010, P0011, P0013, P0014, P0016, P0017, P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0122, P0123, P0191, P0192, P0193, P0222, P0223, P0335, P0336, P0340, P0341, P0365, P0366, P0601, P0604, P0606, P0651, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2227, P2228, P2229 or P2230 is not set.
- The engine speed is less than 1, 000 RPM and DTC P0315 is set.
- The engine speed is greater than 1, 050 RPM.

- The crankshaft position and camshaft position sensors are synchronized.
- The engine coolant temperature (ECT) is between -12 and 127Â°C (10 - 261Â°F).
- If the ECT is colder than -12Â°C (10Â°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 ECM is not detecting a rough road signal.
- The fuel level is at least 11%.
- The ECM is not in fuel cut-off or deceleration fuel cut-off mode.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0300

The ECM detects a crankshaft rotation speed variation indicating a misfire rate sufficient to cause emissions levels to exceed a predetermined value or a misfire rate high enough to cause catalyst damage.

P0301, P0302, P0303 or P0304

The ECM detects a crankshaft rotation speed variation indicating a single cylinder misfire rate sufficient to cause emissions levels to exceed mandated standards.

Action Taken When the DTC Sets

- DTCs P0300 - P0304 are Type B DTCs.
- The ECM will flash the malfunction indicator lamp (MIL) when a catalyst damaging level of misfire is present.
- If a hybrid application, engine idle speed will increase to between 1750-2500 RPM.

Conditions for Clearing the DTC

DTCs P0300 - P0304 are Type B DTCs.

Diagnostic Aids

- A misfire DTC could be caused by an excessive vibration from sources other than the engine. Inspect for the conditions listed below:
  - A tire or wheel that is out of round or out of balance
  - Variable thickness brake rotors
  - An unbalanced drive shaft
  - Certain rough road conditions
  - Transmission operation
  - A damaged or defective accessory drive component or belt
- High resistance in the circuits of the injectors may set a misfire DTC without setting an injector DTC. Test the injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- If the condition is intermittent, observing the scan tool IC Circuit Test and Fuel Injector Circuit Test Status parameters may help isolate the condition. The circuit test status parameters will change from OK or Not Run to Fault/Malfunction if a condition exists.
- A condition in the heated O2 sensor (HO2S) heater control circuits may set a DTC P0300.

Reference Information

Description and Operation

- **Electronic Ignition System Description**
- **Fuel System Description**

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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

EL26792 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.**

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

1. If this is a hybrid application, skip to step 4.
2. Engine Running at normal operating temperature.
3. Verify there is no abnormal engine noise.
   - **If abnormal engine noise is present**

     Refer to **Symptoms - Engine Mechanical** .

   - **Go to next step: If abnormal engine noise is not present**
4. Perform the scan tool **Crankshaft Position Variation Learn** procedure.
5. Verify no DTCs are set.
   - **If any DTCs other than P0300 - P0304 are set**

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

   - **If DTC P0300 - P0304 is set**

     Refer to Circuit/System Testing below.

   - **Go to next step: If no DTCs are set**
6. Verify the scan tool Cylinder 1 - 4 Current Misfire Counter parameters do not increment.
   - **If increments**

     Refer to Circuit/System Testing below.

   - **Go to next step: If does not increment**
7. Engine Running, perform the Cylinder Power Balance Test with a scan tool.
8. Verify the engine speed changes when each injector is disabled and then enabled.
   - **If engine speed does not change**

     Refer to Circuit/System Testing below.

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- **Go to next step: If engine speed does change**

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

      Refer to Circuit/System Testing below.

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

Circuit/System Testing

1. Verify none of the following conditions listed below exist:
    - Damage, carbon tracking, or fluid intrusion of the spark plug boots and/or spark plugs
    - Vacuum hose splits, kinks, and incorrect connections
    - Engine vacuum leaks
    - Crankcase ventilation system for vacuum leaks
    - Fuel pressure that is too low or too high. Refer to **Fuel System Diagnosis** .
    - Contaminated fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
    - Exhaust system restrictions
        - **If a condition exists**

          Repair or replace as necessary.

        - **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 T8 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**

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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

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 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 P0315

Crankshaft Position System Variation Not Learned

Circuit/System 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.

Conditions for Running the DTC

Engine = Running

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

Conditions for Setting the DTC

Crankshaft Position Variation Learn = Not Learned

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

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Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

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

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Perform the scan tool learn/reset function: **Crankshaft Position Variation Learn**
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.

   - **If the DTC sets**

     Replace the component: K20 Engine Control Module

   - **Go to next step: If the DTC is not set**
4. 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 P0324, P0326, P0331, P06B6 OR P06B7: KNOCK 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 P0324

Knock Sensor System Performance

DTC P0326

Knock Sensor 1 Performance

DTC P0331

Knock Sensor 2 Performance

DTC P06B6

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Control Module Knock Sensor Processor 1 Performance

DTC P06B7

Control Module Knock Sensor Processor 2 Performance

Diagnostic Fault Information

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

Circuit/System Description

The knock sensors enable the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The knock sensors produce an alternating current (AC) voltage signal that varies depending on the vibration level during engine operation. The ECM adjusts the spark timing based on the amplitude and the frequency of the two knock sensor signals. The ECM receives each knock sensor signal through a dedicated circuit. The ECM learns a minimum knock sensor noise level for all of the engine speed ranges and monitors the normal knock sensor signal. The ECM monitors the internal knock sensor processor test circuits which perform the open circuit diagnostic.

Conditions for Running the DTCs

P0324

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

AND

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

OR

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

P0326 and P0331

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

AND

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

OR

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

OR

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

P06B6 and P06B7

- Engine is running for 2 s or greater.
- Engine speed is between 400 - 8, 500 RPM for 150 or more cumulative revolutions.
- Engine air flow is between 20 - 2000 mg per cylinder.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0324

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

P0326

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

P0331

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

P06B6 and P06B7

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

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Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Reference Information

Description and Operation

Electronic Ignition System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine Running.
2. Verify DTC P0325, P0327, P0328, P0330, P0332, P0333, P06B6 or P06B7 is not set.

- **If DTC P0325, P0327, P0328, P0330, P0332 or P0333 is set with P06B6 or P06B7**

  Refer to **DTC P0325, P0327, P0328, P0330, P0332 or P0333**.

- **If only DTC P06B6 or P06B7 is set**

  Replace the K20 Engine Control Module.

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

3. Ignition OFF.
4. Verify none of the conditions listed below exist:
   - B68 Knock Sensor or wiring harness damage.
   - Incorrect B68 Knock Sensor installation. Refer to **Fastener Specifications** .
   - B68 Knock Sensor and engine mounting surface burrs, casting flash, and foreign material.
   - Close proximity of hoses, brackets, and engine wiring.
   - Loose brackets.
   - Loose or broken accessory drive belts, brackets, components.
   - An engine mechanical condition. Refer to **Symptoms - Engine Mechanical** .
   - Contaminated or poor quality fuel.
   - **If a condition exists**

     Repair or replace as necessary.

   - **Go to next step: If no conditions exist**
5. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - **If the DTC sets**

     Test or replace the appropriate B68 Knock Sensor.

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

Repair Instructions

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

- **Knock Sensor Replacement (Position 1)** **Knock Sensor Replacement (Position 2)**
- **Control Module References** for engine control module replacement, programming, and setup.

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0325

Knock Sensor 1 Circuit

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 P0332

Knock Sensor 2 Circuit Low Voltage

DTC P0333

Knock Sensor 2 Circuit High Voltage

Diagnostic Fault Information

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

Circuit/System Description

The knock sensors enable the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The knock sensors produce an alternating current (AC) voltage signal that varies depending on the vibration level during engine operation. The ECM adjusts the spark timing based on the amplitude and the frequency of the two knock sensor signals. The ECM receives each knock sensor signal through a dedicated circuit. The ECM learns a minimum knock sensor noise level for all of the engine speed ranges and monitors the normal knock sensor signal. The ECM monitors the internal knock sensor processor test circuits which perform the open circuit diagnostic.

Conditions for Running the DTCs

P0325 and P0330

- Engine is running for 2 s or greater.
- Engine speed is between 400 - 5, 500 RPM for 75 or more cumulative revolutions.
- Engine air flow is between 20 - 2000 mg per cylinder.
- The engine coolant temperature (ECT) is -40Â°C (-40Â°F) or warmer.
- The intake air temperature (IAT) sensor 1 is -40Â°C (-40Â°F) or warmer.

P0327, P0328, P0332 and P0333

Engine speed is less than 8, 500 RPM.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0325

The ECM detects knock sensor 1 signal circuit is open.

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P0327

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

P0328

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

P0330

The ECM detects knock sensor 2 signal circuit is open.

P0332

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

P0333

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

Action Taken When the DTCs Set

- DTCs P0325, P0327, P0328, P0330, P0332 and P0333 are Type B DTCs.
- The ignition timing is retarded to reduce the potential of engine damaging spark knock.

Conditions for Clearing the DTCs

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

Diagnostic Aids

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

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

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

DTC Type Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine Running.
2. Verify DTC P0325, P0327, P0328, P0330, P0332 or P0333, is not set.
   - **If the DTC is set**

     Refer to Circuit/System Testing below.

   - **Go to next step: If the DTC is not set**
3. Verify the appropriate B68 Knock Sensor mounting bolt is properly tightened. Refer to **Fastener Specifications** .
   - **If not tightened to the correct specification**

     Repair a necessary.

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

     Repair the wiring harness or connectors.

   - **Go to next step: If No is displayed**
5. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

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

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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 low signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **Go to next step: If between 1 - 2 V**

3. Test for 2 - 4 V between the high signal circuit terminal 1 or A and ground.
    - **If less than 2 V**

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

    - **If greater than 4 V**

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

    - **Go to next step: If between 2 - 4 V**

4. Test or replace the B68 Knock Sensor.

Repair Instructions

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

- **Knock Sensor Replacement (Position 1)** **Knock Sensor Replacement (Position 2)**
- **Control Module References** for engine control module replacement, programming, and setup.

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Back To Article

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0335 OR P0336: CRANKSHAFT POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **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	P0236, P0558, P0651, P118C, P24BB	P0336
Signal	P0335, P0506	P0335, P0506	P0335	P0336
Low Reference	-	P0335, P0506	-	P0336

Circuit/System Description

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with 2 missing teeth for the reference gap. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the crankshaft position sensor output depends on the velocity of the crankshaft. The crankshaft position sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel, to the ECM as each tooth on the wheel rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM also uses crankshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control camshaft phasing, and to detect cylinder misfire.

Conditions for Running the DTC

P0335 Condition 1

- DTCs P0101, P0102 and P0103 are not set.

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OR

- 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.

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Condition 2

The ECM does not detect the synchronization gap on the reluctor wheel for greater than 0.4 s.

Condition 3

The ECM does not detect the synchronization gap on the reluctor wheel for 1.5 s after the starter was engaged.

Condition 4

The ECM detects less than 51 or greater than 65 crankshaft position sensor pulses during 1 engine revolution for 8 out of 10 engine revolutions.

Action Taken When the DTC Sets

- DTCs P0335 and P0336 are Type B DTCs.
- The camshaft position sensor is used to determine engine position.
- The camshaft actuators are commanded to the parked position.

Conditions for Clearing the DTC

DTCs P0335 and P0336 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Electronic Ignition System Description

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC 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.

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4. Verify the scan tool Crankshaft Position Active Counter parameter increments.
    - **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 X2 harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If 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 X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference 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**

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1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance.
3. Test for less than 2 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 X2 harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **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 Sensor Active Counter parameter increments while rapidly tapping the fused jumper wire end to ground.
    - **If the counter does not increment**

      Replace the K20 Engine Control Module.

    - **Go to next step: If the counter increments**
8. Verify DTC P0336 is not set.
    - **If the DTC is set**

      Inspect for the conditions listed below:

    - Excessive play or looseness of the B26 Crankshaft Position Sensor or the reluctor wheel
    - Improper installation of the B26 Crankshaft Position Sensor
    - Foreign material passing between the B26 Crankshaft Position Sensor and the reluctor wheel
    - Damaged reluctor wheel
    - Excessive air gap between the B26 Crankshaft Position Sensor and the reluctor wheel
    - Engine oil for debris
    - Timing chain, tensioner, and sprockets for wear or damage
        - If any of the conditions above are found, repair as necessary.
        - If all components test normal, test or replace the B26 Crankshaft Position Sensor.
    - **Go to next step: If the DTC is not set**
9. Test or replace the B26 Crankshaft Position Sensor.

Repair Instructions

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

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

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

Diagnostic Instructions

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

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- 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 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 System Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641*	P0340, P0365	P0641*	-
Signal	P0340, P0365	P0340, P0365	P0340, P0365	P0341, P0366
Low Reference	-	P0340, P0365	P0340, P0365	-
*Additional DTCs may set.				

Circuit/System Description

For an overview of the component/system, refer to **Electronic Ignition 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
B23 Camshaft Position Sensor	The sensor contains a hall-effect sensor and additional electronics that processes the signal. It detects the change of strength of the magnetic field caused by the reluctor ring. When the strength changes, the sensor changes the amount of current it consumes. This results in a square wave signal of the current, while the voltage stays constant. The control module detects the frequency in which the current changes, which is proportional to the rotational speed.
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.
Reluctor Ring	There are 4 equally spaced teeth on the edge of the camshaft position reluctor ring mounted on the camshaft.

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The ECM uses information from the crankshaft position sensor and the camshaft position sensor(s) for sequencing and timing of the spark events.

Conditions for Running the DTC

P0340, P0365 Condition 1

- DTC P0101, P0102, P0103 = Not set
- MAF Sensor = Greater than 1.5 g/s

Condition 2

- M64 Starter Motor = Active
- Camshaft Position Sensor = Signal received

Condition 3

- Engine = Running
- M64 Starter Motor = Inactive

Condition 4

- DTC P0335, P0336, P0641, P0651 = Not set
- Crankshaft = Synchronized
- M64 Starter Motor = Active

Condition 5

- DTC P0335, P0336, P0641, P0651 = Not set
- Crankshaft = Synchronized

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

P0341, P0366 Condition 1

- DTC P0335, P0336, P0641, P0651 = Not set
- Crankshaft = Synchronized
- M64 Starter Motor = Active

Condition 2

- DTC P0335, P0336, P0641, P0651 = Not set
- Crankshaft = Synchronized

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

Conditions for Setting the DTC

P0340, P0365 Condition 1

Camshaft Position Sensor = No Signal - For greater than 5.5 s

Condition 2

Camshaft Position Sensor = No Signal - For greater than 4 s - Starter is engaged.

Condition 3

Camshaft Position Sensor = Less than 4 pulses - For greater than 3 s

Condition 4

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Camshaft Position Sensor = No Signal - During the first 2 engine revolutions.

Condition 5

Camshaft Position Sensor = No Signal - During 200 engine revolutions.

P0341, P0366 Condition 1

Camshaft Position Sensor = Less than 4 pulses - During 2 engine revolutions.

Condition 2

Camshaft Position Sensor = Greater than 6 pulses - During 2 engine revolutions.

Condition 3

Camshaft Position Sensor = Less than 398 pulses - Greater than 402 pulses - During 200 engine revolutions.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

- Camshaft Position Actuator = Park position
- Control module command = Reduced Engine Power

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

The cranking period may take longer.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

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1. Ignition - On / Vehicle - In Service Mode
2. Verify DTC P0641 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 DTC P0341, P0366 is not set.
    - **If the DTC is set**

      Refer to Circuit/System Testing

    - **Go to next step: If the DTC is not set**
5. Verify the scan tool parameter:
    - Exhaust Camshaft Position Active Counter = Increments
    - Intake Camshaft Position Active Counter = Increments
    - **If the parameter value does not increment**

      Refer to Circuit/System Testing

    - **Go to next step: If the parameter value increments**
6. Verify the scan tool parameter:Exhaust Camshaft Position Active CounterorIntake Camshaft Position Active Counter = Increments

   Perform the action while monitoring the parameter:

    - Wiggle the harness and connector:B23 Camshaft Position Sensor
    - Wiggle the harness and connector:K20 Engine Control Module
    - **If the parameter value does not increment**

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

    - **Go to next step: If the parameter value increments**
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.

   Verify the DTC does not set.

    - **If the DTC sets**

      Refer to Circuit/System Testing below

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

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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: B23 Camshaft Position Sensor
3. Test for less than 10 Ω between the test points: Low Reference circuit terminal 2 & Ground
    - **If 10 Ω or greater**
    1. Disconnect the appropriate electrical connector: K20 Engine Control Module

2. Test for less than 2 Ω between the test points: Low Reference circuit terminal 2 @ Component harness & The other end of the circuit @Control module harness
    - If 2 Ω or greater - Repair the open/high resistance in the circuit.
    - If less than 2 Ω - Replace the component:K20 Engine Control Module
- **Go to next step: If less than 10 Ω**

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 1 & Ground
    - **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 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 Ω between the test points: 5 V Reference circuit terminal 1 @ Component harness & The other end of the circuit @ Control module harness
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - 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 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. Test for 4.8 and 5.2 V between the test points: Signal circuit terminal 3 & Ground
    - **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: Signal circuit terminal 3 @ 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 Ω between the test points: Signal circuit terminal 3 @ Component harness & The other end of the circuit @ Control module harness
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - 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:Signal circuit terminal 3 @ 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**
7. Verify DTC P0341, P0366 is not set.
    - **If the DTC is set**

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Verify the following conditions do not exist:

- B23 Camshaft Position Sensor & Reluctor Ring - Excessive play/Foreign material passing between the components/Incorrect air gap /Incorrect installation/Loose/Visible Damage
- Engine Oil - Contaminated/Dirty
- Timing Chain or Timing Belt - Visible Damage /Worn
- Timing Chain Tensioner or Timing Belt Tensioner - Visible Damage /Worn
  - If a condition exists - Repair or replace as necessary
  - If no condition exists - Test or replace the component:B23 Camshaft Position Sensor
- **Go to next step: If the DTC is not set**

8. Test or replace the component:B23 Camshaft Position Sensor

Repair Instructions

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

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

DTC P034A OR P034B: CRANKSHAFT POSITION 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 P034A

Crankshaft Position Sensor - Engine Start Position Incorrect

DTC P034B

Crankshaft Position Sensor - Crankshaft Direction Incorrect

Circuit/System Description

The engine control module monitors the speed and the direction of rotation of the crankshaft during an autostop event and memorizes the crankshaft angle at which the engine stopped to be able to start the engine quicker.

Conditions for Running the DTC

P034A

- DTC P0335, P0336, P0651 = Not set
- Engine = Running - After an autostop event.
- Crankshaft position is being verified.

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

P034B

- DTC P0335, P0336, P0651 = Not set
- Engine Speed = 400 to 2, 000 RPM
- MAF Sensor = Greater than 1.5 g/s

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- Crankshaft Position Sensor = Signal received

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 4 s

Conditions for Setting the DTC

P034A Condition 1

The difference between the memorized and actual crankshaft position was greater than 2 reluctor ring teeth during 2 autostart events in one ignition cycle.

Condition 2

The difference between the memorized and actual crankshaft position was greater than 1 reluctor ring teeth during 4 autostart events in one ignition cycle.

P034B

The direction of rotation of the crankshaft has changed more than 3 times within 10 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

A DTC may set depending on certain driving conditions and would not require a component replacement. The Circuit/System Verification must be performed.

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 DTC P0335, P0336, P0651 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. Operate the vehicle within the 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**

     Test or replace the component:B26 Crankshaft Position Sensor

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

Repair Instructions

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

Crankshaft Position Sensor Replacement

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 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 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

DTC P2310

Ignition Coil 4 Control Circuit High Voltage

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 3/C @ T8A Ignition Coil 1	P0300, P2300	P0300, P0351	P0300, P2301	P0300
Control - Terminal 3/C @ T8B Ignition Coil 2	P0300, P2303	P0300, P0352	P0300, P2304	P0300
Control - Terminal 3/C @ T8C Ignition Coil 3	P0300, P2306	P0300, P0353	P0300, P2307	P0300
Control - Terminal 3/C @ T8D Ignition Coil 4	P0300, P2309	P0300, P0354	P0300, P2310	P0300
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
*Additional DTCs may set.				

Circuit/System Description

For an overview of the component/system, refer to **Electronic Ignition System Description**

Circuit	Description
Control	The output circuit is switched to ground to activate the component.
Ground	Chassis Ground

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.
T8 Ignition Coil	The ignition system on this engine uses ignition coils with integrated power transistors.

The ECM controls the spark event for each cylinder through individual ignition coil control circuits. When the ECM commands the ignition control circuit On, electrical current flows through the primary winding of the ignition coil, creating a magnetic field. When a spark event is requested, the ECM commands the ignition control circuit Off, interrupting current flow through the primary winding. The collapsing magnetic field created by the primary winding induces a high voltage in the secondary winding, which is connected to the spark plugs.

Conditions for Running the DTC

- Engine = Running
- Ignition Voltage = Greater than 11 V

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

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

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Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component 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

Special Tools

J-26792 Ignition Spark Tester

Equivalent regional tools: **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

Circuit/System Verification

1. Engine - Running
2. Verify the scan tool parameter:
    - Ignition Coil 1-4 Control Circuit High Voltage Test Status = OK or Not Run
    - Ignition Coil 1-4 Control Circuit Low Voltage Test Status = OK or Not Run
    - Ignition Coil 1-4 Control Circuit Open Test Status = OK or Not 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:
    - Ignition Coil 1-4 Control Circuit High Voltage Test Status = OKorNot Run
    - Ignition Coil 1-4 Control Circuit Low Voltage Test Status = OKorNot Run
    - Ignition Coil 1-4 Control Circuit Open Test Status = OKorNot Run
    - Perform the action while monitoring the parameter:
    - Wiggle the harness and connector:T8 Ignition Coil
    - Wiggle the harness and connector:K20 Engine Control Module
    - **If not the specified state**

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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 below

   - **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 appropriate electrical connector:T8 Ignition Coil
3. Test for less than 10 Ω between the test points: Ground circuit terminal 1/A & Ground
   - **If 10 Ω or greater**
   1. Disconnect the ground connection:Ground terminal
   2. Test for less than 2 Ω between the test points: Ground circuit terminal 1/A @ Component harness & The other end of the circuit @Ground terminal
      - 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 10 Ω**
4. Ignition - On / Vehicle - In Service Mode
5. Verify a test lamp does not turn On between the test points:Control circuit terminal 3/C & B+
   - **If the test lamp turns On**
   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 3/C @ 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:Ignition Coil 1-4 Control Circuit High Voltage Test Status = OKorNot Run
   - **If not the specified state**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K20 Engine Control Module
   3. Test for less than 1 V between the test points:Control circuit terminal 3/C @ 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

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10. Connect a 3 A fused jumper wire between the test points:Control circuit terminal 3/C & Ignition circuit terminal 4/D
11. Engine - Running
12. Verify the scan tool parameter: Ignition Coil 1-4 Control Circuit High Voltage Test Status = OK or Not Run
    - **If not the specified state**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for less than 2 Ω between the test points:Control circuit terminal 3/C @ Component harness & The other end of the circuit @ Control module harness
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - Replace the component: K20 Engine Control Module
    - **Go to next step: If the specified state**
13. Test or replace the component:T8 Ignition Coil

Component Testing

NOTE: **Circuit/System Testing must be performed before proceeding with Component Testing.**

1. Ignition/Vehicle - Off
2. Remove the appropriate component:T8 Ignition Coil - Leave the electrical connector connected.
3. Install the special tool: **J-26792** Ignition Spark Tester
4. Engine - Running

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

5. Verify there is spark at the special tool.
    - **If there is no spark**

      Replace the component:T8 Ignition Coil

    - **Go to next step: If there is spark**
6. All OK.

Repair Instructions

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

- **Ignition Coil Replacement**
- For control module replacement, programming and setup, refer to **Control Module References**

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

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

Conditions for Running the DTC

- DTC P0030, P0031, P0032, P0036, P0037, P0038, P0053, P0054, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0141, P015A, P015B, P0171, P0172, P0201, P0202, P0203, P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P1248, P1249, P124A, P124B, P16F3, P2101, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2270, or P2271 is not set.
- The engine speed is between 950 - 2, 950 RPM to enable the catalyst diagnostic. Once the engine speed is in range, the engine speed must be between 900 - 3, 050 RPM to keep the test enabled.
- Accelerator pedal position is at most 4%.
- Ethanol estimation is not active.
- Evaporative emission (EVAP) purge is not active.
- Post HO2S heater is ON for greater than 180 s.
- Mass air flow (MAF) is between 2 - 13 g/s.
- System voltage is between 10 - 32 V.
- Vehicle speed is between 64 - 126 km/h (40 - 78 MPH) to enable the catalyst diagnostic. To keep the test enabled the vehicle speed is between 56 - 132 km/h (35 - 82 MPH).
- Catalyst calculated temperature is between 500 - 900Ã‚Â°C (932 - 1, 652Ã‚Â°F).
- Engine is operating in closed loop.
- Engine is operating in DFCO.

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

Conditions for Setting the DTC

The ECM determines that the efficiency of the catalyst has degraded below a calibrated threshold.

Action Taken When the DTC Sets

DTC P0420 is a Type A DTC.

Conditions for Clearing the DTC

DTC P0420 is a Type A DTC.

Diagnostic Aids

Inspect for the following conditions, which may cause a catalytic converter to degrade:

- Engine misfire
- High engine oil or high coolant consumption
- Retarded spark timing
- Weak or poor spark

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- Lean fuel mixture
- Rich fuel mixture
- Damaged oxygen sensor or wiring harness

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify there are no other DTCs set.
   - **If other DTCs are set**

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

   - **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. Verify the Catalyst Monitor Test Result parameter displays Passed when performing the steps listed below:
   1. Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.

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

   2. Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.
   3. Verify the scan tool Catalyst Monitor Test Result displays Passed.
   - **If No Result is displayed**

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

   - **If Failed is displayed**

     Refer to Circuit /System Testing

   - **Go to next step: If Passed is displayed**
6. All OK.

Circuit/System Testing

1. Verify the conditions listed below do not exist with the catalytic converter:
   - Dents
   - Severe discoloration caused by excessive temperatures
   - Road damage
   - Internal rattles caused by damaged catalyst substrate

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- 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
   - Restrictions
   - 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.

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Repair Instructions

- **Warm Up Three-Way Catalytic Converter Replacement (LTG)**
- **Exhaust Leakage**
- **Heated Oxygen Sensor Replacement - Sensor 2**
- Perform the HO2S Heater Learn procedure with a scan tool after replacing a heated oxygen sensor.
- **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. Verify the Catalyst Monitor Test Result displays Passed when performing the steps listed below:
   1. Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.

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

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

- **If No Result is displayed**

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

- **If Failed is displayed**

  Refer to Circuit /System Testing

- **Go to next step: If Passed is displayed**

8. All OK.

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

Diagnostic Instructions

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

DTC Descriptor

DTC P0442

Evaporative Emission (EVAP) System Small Leak Detected

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Circuit/System Description

The engine off natural vacuum (EONV) test is the small leak detection diagnostic for the evaporative emission (EVAP) system. This diagnostic tests the EVAP system for a small leak when the key is turned OFF and the correct conditions are met. Heat from the exhaust system is transferred into the fuel tank while the vehicle is operating. When the vehicle is turned OFF and the EVAP system is sealed a change in the fuel tank vapor temperature occurs which results in a corresponding pressure change in the fuel tank vapor space. This change is monitored by the engine control module (ECM) using the fuel tank pressure (FTP) sensor input. With a leak in the system, the amount of pressure change will be less than that of a sealed system.

Conditions for Running the DTC

- DTCs P010B, P012B, P012C, P012D, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P012B, P012C, P012D, P0222, P0223, P0236, P0237, P0238, P0443, P0446, P0449, P0452, P0453, P0455, P0458, P0459, P0461, P0462, P0463, P0496, P0498, P0499, P0502, P0503, P0722, P0723, P111E, P117D, P017C, P017D, P017B, P117B, P117F, P117E, P117C, P2066, P2067, P2068, P1221, P222B, P222C, P222D, P222E, P262B. are not set.
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant sensor (ECT) is greater than 63Ã‚Â°C (145Ã‚Â°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 8Ã‚Â°C (14Ã‚Â°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 - 34Ã‚Â°C (32 - 93Ã‚Â°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 FTP Sensor parameter for vacuum decay.

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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 Port Access Tool

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

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

Circuit/System Testing

NOTE:

- **Refer to the GE 41413-A operation manual for detailed instructions in Evaporative Emission System Diagnosis.**
- **Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize or produce smoke from a leak.**
- **Ensure that the underbody temperature of the vehicle and the tester are similar.**

1. Disconnect the purge tube at the quick connector on the EVAP canister side of the Q12 Evaporative Emission Canister Purge Solenoid Valve and install the **CH 48096** .
2. Connect the **GE 41413-A** to the **CH 48096** .
3. Command the EVAP Purge/Seal function to Not Venting or System Seal with a scan tool to seal the EVAP system.
4. Use the flow meter on the **GE 41413-A** calibrated to 0.51 mm (0.020 in) to determine if there is a leak.
    - **If a leak is detected**
    1. Use the **GE 41413-A** to apply smoke to the EVAP system at the purge tube service port until the leak is located using the **GE 41413-SPT** .
        - If leak is detected, repair or replace the affected component as necessary.
    - **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

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Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

P0443

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

P0458

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

P0459

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

Action Taken When the DTC Sets

DTC P0443, P0458 and P0459 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0443, P0458 and P0459 are Type B DTCs.

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **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. Command the EVAP Purge Solenoid Valve from 0 to 50% and back to 0% with a scan tool while observing the following control circuit status parameters:
   - EVAP Purge Solenoid Valve Control Circuit Open Test Status
   - EVAP Purge Solenoid Valve Control Circuit Low Voltage Test Status
   - EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing below

   - **Go to next step: If Malfunction is not displayed**
3. Verify the EVAP Purge Solenoid Valve control circuit parameters above do not display Malfunction when moving the related harnesses and connectors of the Q12 Evaporative Emission Purge Solenoid Valve.
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing below

   - **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 below

   - **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 Q12 Evaporative Emission Purge Solenoid Valve. Ignition ON,
2. Verify that a test lamp illuminates between the ignition voltage circuit terminal A or 1 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**

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

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

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

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

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

    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.

    - **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**

    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 2 and the ignition circuit terminal A or 1.
7. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the EVAP Purge Solenoid Valve to 50% with a scan tool.
    - **If Malfunction is not displayed**

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

    - **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 B or 2 and the ignition circuit terminal A or 1.
    - **If not between 10-30 Ω**

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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 A or 1 and 12 V. Install a jumper wire between the control terminal B or 2 and ground.
3. Verify the Evaporative Emission Purge Solenoid Valve turns on & off/clicks and flows vacuum.
   - **If it does not turn on & off/click or flow vacuum.**

     Replace the Q12 Evaporative Emission Purge Solenoid Valve.

   - **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 control module replacement, programming and setup

DTC P0446: EVAPORATIVE EMISSION (EVAP) VENT SYSTEM PERFORMANCE

Diagnostic Instructions

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

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

The 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

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ECM Command	EVAP Purge Solenoid Valve	EVAP Vent Solenoid Valve
ON	Open	Closed, Not Venting
OFF	Closed	Open, Venting

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 35Ã‚Â°C (95Ã‚Â°F).
- The startup intake air temperature (IAT) is between 4-30Ã‚Â°C (39-86Ã‚Â°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 (0.62 kPa) of pressure or less than -5 in H2O (-1.24 kPa) of vacuum for 60 s.

  OR

- If fuel tank pressure sensor reading is less than -12 in H2O (-2.98 kPa) of vacuum for 5 s before 10 L (2.6 gal) of purge volume has passed through the system.
- After setting the DTC for the first time, 2 L (0.5 gal) of fuel must be consumed before setting the DTC for the second time.

Action Taken When the DTC Sets

DTC P0446 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0446 is a Type B DTC.

Diagnostic Aids

An intermittent condition could be caused by:

- A damaged EVAP vent housing
- A temporary blockage at the EVAP vent solenoid valve inlet
- Pinched vent hose

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH-44284-2** Fuel Flapper Door Holder
- **GE-41415-60** Capless Fuel Fill Adapter
- **GE-41413-A** Evaporative Emissions System Tester (EEST)

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

Circuit/System Verification

NOTE: **This vehicle has a capless fuel fill design that requires the use of CH-44284 - 2 Fuel Flapper Door Holder to hold the two flapper valves open.**

- **Install this tool so that the raised rib nests just inside the flapper door outer lip. The flappers will hold it in place.**
- **Be careful the force of the flapper doesn't push the tool back out.**
- **Do not insert tool any further into the fuel neck or it may get stuck or fall into the lower fill tube.**

1. Ignition ON.
2. Verify DTC P0449 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. Ignition OFF, install the **CH-44284-2** in the fuel fill neck. Ignition ON.
4. Verify the scan tool Fuel Tank Pressure Sensor voltage parameter is within 1.3-1.7 V.
   - **If not between the 1.3-1.7 V**

     Refer to P0452, P0453 within DTC P0451-P0454.

   - **Go to next step: If between the 1.3-1.7 V**
5. Remove the **CH-44284-2** . Engine idling at operating temperature for 5 min,
6. Verify the scan tool Fuel Tank Pressure Sensor parameter does not increase to greater than 2.5 V when commanding the EVAP Purge Solenoid Valve to 50%.
   - **If greater than 2.5 V**

     Refer to Circuit System Testing below.

   - **Go to next step: If 2.5 V or less**

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

      Refer to Circuit System Testing below.

    - **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.**

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

NOTE: **The GE-41415-60 is a dual purpose tool used for EVAP testing and diesel induction leak testing. It has two positions for the rubber stopper, identified on the tube by a letter A and B. Slide the stopper to just above either line depending on the test performed.**

- **Letter A position line is for diesel induction leak testing**
- **Letter B position line is for EVAP testing**

1. 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: **Install the GE-41415-60 , with the tube pointing toward the ground, into the capless fuel fill opening. Wedge the stopper into the opening with just enough force to retain this tools threaded end pointing out, parallel within the opening.**

3. Install the **GE-41415-60** into the fuel tank filler neck. Connect the GE-41413-A to the GE-41415-60.
4. Command the EVAP Purge/Seal function to Not Venting or 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 H20 (1.24 kPa).
7. Verify the scan tool Fuel Tank Pressure Sensor parameter is 0 in H20 (0 kPa) 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 H20**

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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 Vent Solenoid Valve Replacement**
- **Evaporative Emission Canister Replacement (AWD)** **Evaporative Emission Canister Replacement (FWD)**
- **Fuel Tank Pressure Sensor Replacement (AWD)** **Fuel Tank Pressure Sensor Replacement (FWD)**

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.

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

     Refer to Circuit/System Testing below

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- **Go to next step: If Malfunction is not displayed**

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

      Refer to Circuit/System Testing below

    - **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 below

    - **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**
    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.

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- 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

Diagnostic Instructions

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

DTC Descriptors

DTC P0451

Fuel Tank Pressure Sensor Performance

DTC P0452

Fuel Tank Pressure Sensor Circuit Low Voltage

DTC P0453

Fuel Tank Pressure Sensor Circuit High Voltage

DTC P0454

Fuel Tank Pressure Sensor Circuit Intermittent

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Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P018C, P0192, P0340, P0365, P0452, P0522, P0532, P055C, P0641, P06D2, P16E5, P2227, P2228	P0451	P0446, P0452	P018D, P0193, P0453, P0523, P0533, P055D, P0641, P06D2, P2227	-
Signal	P0452	P0451	P0452, P0453	P0453	P0451, P0454
Low Reference	-	P0446, P0451	P0073, P018D, P0446, P0453, P0463, P0533, P0558	-	P0451

Typical Scan Tool Data

Fuel Tank Pressure Sensor Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF **Parameter Normal Range:** 1.3 - 1.7 V			
5 V Reference	0 V	0 V	4.2 - 5 V
Signal	0 V	0 V	5 V
Low Reference	-	4.5 V	-

Circuit/System Description

The fuel tank pressure sensor measures vapor pressure or vacuum in the evaporative emission (EVAP) system. The engine control module (ECM) supplies a 5 V reference and a low reference circuit to the fuel tank pressure sensor. The fuel tank pressure sensor signal voltage varies depending on EVAP system pressure or vacuum. The controller also uses this fuel tank pressure signal to determine atmospheric pressure for use in the engine-off small leak test, DTC P0442. Before using this signal as an atmospheric reference it must first be re-zeroed.

Conditions for Running the DTC

P0451

- DTC P0451 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- The number of times this test runs can range from 0 - 2 per engine-off period. The length of the test can be up to 10 min.

P0452 and P0453

DTC P0452 and P0453 run continuously when the ignition is ON.

P0454

- DTC P0454 runs only when the engine-off natural vacuum small leak test, P0442 executes.
- This test can run once per engine-off period. The length of the test can be up to 10 min.
- A refueling event is not detected. A refueling event is confirmed if the fuel level has a persistent change of 10% for 30 s during a 10 min refueling rationality test.

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Conditions for Setting the DTC

P0451

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

P0452

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

P0453

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

P0454

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

Action Taken When the DTC Sets

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

Diagnostic Aids

P0451 and P0454

- A restriction in the EVAP canister or vent lines could prevent fuel vapor pressure from bleeding off fast enough. If the vent system cannot bleed off pressure fast enough, the re-zero procedure may not complete successfully, which could cause this DTC to set.
- Ensure that the reference port on the fuel tank pressure sensor is unobstructed.
- An fuel tank pressure sensor that is skewed or does not have a linear transition from low to high may cause this DTC to set. Scan tool control functions, snapshot, and plot functions can help detect erratic sensor response. To test the sensor signal under vacuum conditions, use the Quick Snapshot and the Purge/Seal functions to capture data while commanding purge to 20%, then plot the data to look for erratic sensor operation. A similar test can be done for the pressure side of the sensor operation by applying pressure with the **GE-41413-A** while taking a snapshot.

Reference Information

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH-44284-2** Fuel Flapper Door Holder
- **GE-41413-A** Evaporative Emission System Tester

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

Circuit/System Verification

NOTE: **This vehicle has a capless fuel fill design that requires the use of CH-44284-2 to hold the two flapper valves open.**

- **Install this tool so that the raised rib nests just inside the flapper door outer lip. The flappers will hold it in place.**
- **Be careful the force of the flapper doesn't push the tool back out.**
- **Do not insert tool any further into the fuel neck or it may get stuck or fall into the lower fill tube.**

1. Install CH-44284-2 in the fuel fill neck.
2. Ignition ON, engine OFF.
3. Verify the scan tool Fuel Tank Pressure Sensor parameter is between 1.3 and 1.7 V.
   - **If not between 1.3 - 1.7 V**

     Refer to Circuit/System Testing below

   - **Go to next step: If between 1.3 - 1.7 V**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, this may take up to 2 min, for all vehicle systems to power down. Disconnect the harness connector at the B150 Fuel Tank Pressure Sensor.
2. Test for less than 5 Ω of resistance between the low reference circuit terminal 2 and ground.
   - **If 5 Ω or greater**

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1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the 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. 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 (AWD)** **Fuel Tank Pressure Sensor Replacement (FWD)**
- **Control Module References** for control module replacement, programming and setup

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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.

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 before a calibrated amount of purge volume has passed through the system.

Conditions for Running the DTC

- DTCs P0068, P00C8, P00C9, P00CA, P0090, P0091, P0092, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114 P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P012B, P012C, P012D, P017B, P017C, P017D, P0191, P0192, P0193, P0222, P0223, P06A3, P06DB, P06DE, P0A1D, P0443, P0449, P0452, P0454, P0453, P0458, P0459, P0498, P0499, P0502, P0503, P0601, P0604, P0606, P0697, P0722, P0723, P111E, P117B, P117C, P117D, P117E, P117F, P160D, P160E P1682, P16A0, P16A1, P16A2, P16F3, P1104, P127A, P127C, P127D, P15F2, P1221, P2100, P2101, P2102, P2103, P2122, P2123, P2127, P2128, P2135, P2138, P215B, P2176, P2227, P2228, P2229, P2230, P228C, P228D, U0073, U0074, U0293, U1817 is not set.
- The ignition voltage is greater than 11 V
- The barometric pressure (BARO) is greater than 70 kPa
- The fuel level is between 10 - 90%
- The cold startup engine coolant temperature (ECT) and the startup intake air temperature (IAT) are within 8Ã‚Â°C (14Ã‚Â°F)
- The engine coolant temperature (ECT) at start-up is less than 35Ã‚Â°C (95Ã‚Â°F)
- The intake air temperature (IAT) is between 4 - 34Ã‚Â°C (39 - 93Ã‚Â°F)
- DTC P0455 runs once per cold start shortly after purge is enabled followed by vent system performance test P0446

Conditions for Setting the DTC

- The EVAP system is not able to achieve or maintain a calibrated level of vacuum, less than 2.74 kPa (11 in H20), before a calibrated amount of purge volume has passed through the system..
- After setting the DTC for the first time, 2 L (0.5 gal) of fuel must be consumed before setting this DTC a second time.

Action Taken When the DTC Sets

DTC P0455 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0455 is a Type B DTC.

Diagnostic Aids

- Inspect for a loose, missing or damaged, capless fuel fill flappers.

- A blockage or restriction in the EVAP purge solenoid valve, purge pipe, canister, or vapor pipe, can cause this DTC to set.
- The EVAP system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. For example, when injecting smoke at the service port open the fuel fill flapper valves with **CH-44284-2** , or temporarily leave the vent open, until smoke is observed, then close the system and continue testing. If using the capless fuel fill adapter at the filler neck, use the **J-41413-VLV** at the service port to allow the system to fill faster.
- To help locate intermittent leaks using the **GE-41413-A** , move all EVAP components while observing smoke with the **GE-41413-SPT** .
- Individual components can be isolated and tested using adapters in the **GE-41413-300** .
- When servicing the EVAP system, test pressure must not exceed 13 in H20 (0.5 PSI) as pressure in excess of this could cause system components to perform inaccurately.
- A condition may exist where a leak in the EVAP system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the EVAP system and then observe the Fuel Tank Pressure Sensor parameter for vacuum decay.

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH-44284-2** Fuel Flapper Door Holder
- **CH-48096** Evaporative Emissions Service Access Port Tool
- **GE-41415-60** Capless Fuel Fill Adapter
- **GE-41413-A** Evaporative Emissions System Tester (EEST)
- **GE-41413-SPT** High Intensity White Light
- **GE-41413-300** Evaporative Emissions Cap and Plug Kit
- **J-41413-VLV** Evaporative Emissions Service Port Vent Tool

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

Circuit/System Verification

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

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

NOTE:

- **Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize or produce smoke from a leak.**
- **Refer to the GE-41413-A operation manual for detailed instructions in Evaporative Emission System Diagnosis.**

NOTE: **This vehicle has a capless fuel fill design that requires the use of CH-44284-2 to hold the two flapper valves open.**

- **Install this tool so that the raised rib nests just inside the flapper door outer lip. The flappers will hold it in place.**
- **Be careful the force of the flapper doesn't push the tool back out.**
- **Do not insert tool any further into the fuel neck or it may get stuck or fall into the lower fill tube.**

NOTE: **The GE-41415-60 is a dual purpose tool used for EVAP testing and diesel induction leak testing. It has two positions for the rubber stopper, identified on the tube by a letter A and B. Slide the stopper to just above either line depending on the test performed.**

- **Letter A position line is for diesel induction leak testing**
- **Letter B position line is for EVAP testing**

1. Disconnect the purge tube at the quick connector on the EVAP canister side of the Q12 Evaporative Emission Purge Solenoid Valve. Install the **CH-48096** between the disconnected purge tube and the purge solenoid valve.
2. Connect the **GE-41413-A** to the **CH-48096** .
3. Ignition ON, command the EVAP Purge/Seal function to Not Venting or System Seal with a scan tool to seal the system.
4. Verify that there is no leak in the EVAP system using the flow meter on the **GE-41413-A** , calibrated to 0.51 mm (0.020 in).
   - **If a leak is detected**
   1. Apply smoke to the **CH-48096** with the **GE-41413-A** .
   2. Locate the leak using the **GE-41413-SPT** .
      - When the leak is located, repair or replace the affected component as necessary.
   - **Go to next step: If no leak detected**

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

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NOTE: **Install the GE-41415-60 , with the tube pointing toward the ground, into the capless fuel fill opening. Wedge the stopper into the opening with just enough force to retain this tools threaded end pointing out, parallel within the opening.**

5. Install the **GE-41415-60** into the capless fuel fill opening.
6. Connect the **GE-41413-A** nitrogen/smoke hose to the **GE-41415-60** .
7. Engine idling, command the Purge/Seal function to Not Venting 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.**

8. Command the EVAP Purge Solenoid Valve to 10-30% with a scan tool.
9. Verify the vacuum/pressure gauge on the **GE-41413-A** and the scan tool Fuel Tank Pressure Sensor parameter both show vacuum.
   - **If the vacuum/pressure gauge shows vacuum but the Fuel Tank Pressure Sensor parameter does not show vacuum**

     Replace the B150 Fuel Tank Pressure Sensor.

   - **If both do not show vacuum**

     Repair the restriction in the purge path.

   - **Go to next step: If both show vacuum**
10. Verify that the Fuel Tank Pressure Sensor parameter increases to greater than 3.2 V, and the pressure values are similar between the scan tool Fuel Tank Pressure Sensor and the vacuum/pressure gauge on the **GE-41413-A** .
    - **If not within the specified range**

      Replace the B150 Fuel Tank Pressure Sensor.

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

Repair Instructions

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

Fuel Tank Pressure Sensor Replacement (AWD) **Fuel Tank Pressure Sensor Replacement (FWD)**

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

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valve OFF and the vent solenoid valve ON. The ECM monitors the fuel tank pressure (FTP) sensor to determine if a vacuum is being drawn on the EVAP system. If vacuum in the EVAP system is more than a predetermined value within a predetermined time, this DTC sets.

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

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

Conditions for Running the DTC

- DTCs P00C8, P00C9, P010C, P010D, P16A0, P16A1, P16A2, P160E, P160D, P16F3, P0068, P0101, P0102, P0103, P0111, P0112, P0113, P0114 P0116, P0117, P0118, P0122, P0123, P0125, P0128, P0191, P0192, P0193, P0222, P0223, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0601, P0604, P0606, P0722, P0723, P1104, P1682, P2100, P2101, P2102, P2103, P2135, P2176, P2227, P2228, P2229, P2230 are not set.
- The ignition voltage is between 11 - 32 V.
- The engine OFF time is greater than 8 h,
- The barometric pressure (BARO) is greater than 70 kPa.
- The fuel level is between 10 - 90 %.
- The startup engine coolant temperature (ECT) is less than 35Ã‚Â°C (95Ã‚Â°F).
- The startup intake air temperature (IAT) is between 4 - 30Ã‚Â°C (39 - 86Ã‚Â°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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

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

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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 below

   - **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 FTP sensor with a scan tool. The FTP sensor parameter should be less than 1.7 V after 90 s.
   - **If not within specifications**

     Replace the Q12 Evaporative Emission Purge Solenoid Valve

   - **Go to next step: If within Specifications**
5. All OK

Repair Instructions

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

Evaporative Emission Canister Purge Solenoid Valve Replacement

DTC P0506 OR P0507: IDLE SPEED LOW/HIGH

Diagnostic Instructions

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

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

Conditions for Running the DTC

- DTCs P0068, P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0171, P0172, P0174, P0175, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268. P0270, P0271, P0273, P0274, P0276, P0277, P0300 - P0306, P0351 - P0356, P0461 - P0464, P0496, P0627, P0628, P0629, P0722, P1516, P2066 - P2068, are not set.
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant temperature (ECT) is greater than 60Ã‚Â°C (140Ã‚Â°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 -20Ã‚Â°C (-4Ã‚Â°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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
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 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 below.

   - **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 below.

   - **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 below.

   - **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.

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- **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

DTC P050D

Cold Start Rough Idle

Circuit/System Description

During a cold start, the engine control module (ECM) commands dual-pulse mode during Open Loop operation to improve cold start emissions. In dual-pulse mode, the injectors are energized twice during each injection event. As with misfire diagnosis, in dual-pulse mode the ECM monitors the crankshaft position sensor and the camshaft position sensors to calculate crankshaft rotation speed. In normal operation, optimum fuel delivery during dual-pulse mode produces a steady crankshaft rotation speed. If the variations exceed a calibrated value, the code will be set.

Conditions for Running the DTC

- DTCs P0010, P0011, P0013, P0014, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101 - P0103, P0106 - P0108, P0112, P0113, P0117 - P0118, P0122, P0123, P0128, P0171, P0172, P0192, P0193, P0201 - P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301 - P0304, P0335, P0336, P0351 - P0354, P0506, P0507, P0628, P0697, P06A3, P0722, P0723, P1248, P1249, P124A, P124B, P182E, P1915, P2122, P2123, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157 are not set.
- The catalyst temperature is less than 500Ã‚Â°C (932Ã‚Â°F).
- The engine coolant temperature is warmer than -12Ã‚Â°C (10.4Ã‚Â°F).
- The barometric pressure is greater than 75 kPa.

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- The engine speed is between 250 - 3000 RPM.
- The accelerator pedal position is less than 1 percent.
- The engine is running for less than 20 s and a cold start has been detected.
- DTC P050D runs once per cold start.

Conditions for Setting the DTC

This DTC will set if the ECM detects variations in crankshaft rotation speed caused by the lack of adequate fuel delivery during dual-pulse mode.

Action Taken When the DTC Sets

- DTC P050D is a Type B DTC.
- The ECM disables dual pulse mode and energizes the fuel injector as it would for a warm engine.

Conditions for Clearing the DTC

DTC P050D is a Type B DTC.

Diagnostic Aids

- This DTC may be set with a misfire DTC, however the existence of this DTC is a higher priority and indicates the condition to diagnose is related to fuel and/or injectors, not the ignition/spark system.
- A restricted fuel injector may cause this DTC to set.
- High resistance in the circuits of the injectors could set this DTC without setting an injector DTC. Test the injector circuits of the affected cylinders for a high resistance if you suspect a condition.
- A drop in system voltage during cold start may set this DTC.

Reference Information

Schematic Reference

Engine Controls 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

NOTE: **Circuit/System Verification requires cold start. Do not start vehicle prior to connecting scan tool and preparing to evaluate the condition during engine crank.**

1. Start the engine and verify that the scan tool Cylinder 1-4 Current Misfire Counters are not incrementing during first 500 engine cycles.

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- **If Cylinder 1-4 Current Misfire Counters are incrementing**

  Refer to Circuit/System Testing below.

- **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 below.

   - **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.
   - If the fuel pressure is OK
2. Verify that the fuel is not contaminated - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
   - If the fuel is contaminated, clean the fuel system - Refer to **Fuel System Cleaning** .
   - If the fuel is not contaminated
3. Replace fuel injectors as indicated by high misfire counts.

Repair Instructions

Fuel Injector Replacement

Repair Verification

NOTE: **Repair Verification requires cold start.**

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 seconds.
5. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to the **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.

DTC P057B, P057C, P057D, OR P057E: BRAKE PEDAL POSITION SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P057B

Brake Pedal Position Sensor Performance

DTC P057C

Brake Pedal Position Sensor Circuit Low Voltage

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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
Signal	P057C	P057C	P057D	P057B, P057E
5 V Reference	P057C P0651	P057C	P0651	-
Low Reference	-	P057D	P057D	-

Typical Scan Tool Data

Brake Pedal Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. **Normal Range:** 0.25 - 4.75 V			
5 V Reference	0 V	0 V	-
Signal	0 V	0 V	5 V
Low Reference	-	5 V	-

Circuit/System Description

The brake pedal position (BPP) sensor is part of the engine brake pedal override feature. The engine control module (ECM) continuously monitors the vehicle speed and the position of the brake pedal. These two main inputs, along with other ECM inputs are used to determine if the vehicle is decelerating at the proper speed and rate with the brake pedal applied. When the engine brake pedal override system is active, the ECM reduces engine torque to assist in reducing vehicle speed.

The BPP sensor is a six wire sensor, and is part of a dual brake position sensor. One BPP Sensor is used for the stop lamps and the other BPP Sensor is used for the engine brake pedal override feature. The BPP Sensor for engine brake pedal override communicates with the ECM. The ECM supplies a 5 V reference circuit, low reference circuit, and signal circuit to the BPP sensor. The BPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage greater than 0.25 V when the brake pedal is released to a voltage less than 4.75 V when the brake pedal is fully applied.

For information on the Stop Lamps side of the BPP Sensor, refer to **Exterior Lighting Systems Description and Operation** .

Conditions for Running the DTC

P057B

- DTCs P057C, or P057D are not set.
- Ignition voltage is greater than 10 V.
- Shift lever has been in Park at least once during key ON.
- Shift lever is not in Park.
- Vehicle speed is greater than 8 Km/h (5 mph).
- Accelerator Pedal Position is less than 5%.
- DTC runs once per key cycle when above conditions are met.

P057C, P057D or P057E

- Ignition voltage is greater than 10 V.

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- DTC runs continuously when above condition is met.

Conditions for Setting the DTC

P057B

ECM detects the BPP sensor signal is stuck in a range for greater than 1 s.

P057C

ECM detects the BPP sensor voltage is less than 0.25 V greater than 1 s.

P057D

ECM detects the BPP sensor voltage is greater than 4.75 V greater than 1 s.

P057E

ECM detects the BPP sensor value varies greater than a calibrated value.

Action Taken When the DTC Sets

- P057B, P057C, P057D, and P057E are Type A DTCs.
- Brake Pedal Position Sensor parameter defaults to 0%.

Conditions for Clearing the DTC

P057B, P057C, P057D and P057E are Type A DTCs

Reference Information

Schematic Reference

- **Engine Controls Wiring Schematics**
- **Exterior Lights Wiring Schematics**

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **The Brake Pedal Position sensor scan tool data is located in the ECM automatic transmission data list.**

1. Ignition ON.
2. Verify DTC P0641, P0651, P0697 or P06A3 is not set.

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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. Transmission in Park, and service brake pedal released.
4. Verify the scan tool Brake Pedal Position Sensor parameter in the ECM displays greater than 0.25 V.
   - **If 0.25 V or less**

     Refer to Circuit/System Testing below.

   - **Go to next step: If greater than 0.25 V**
5. Verify the scan tool Brake Pedal Position Sensor parameter voltage changes as the brake pedal is applied and displays less than 4.75 V when the brake pedal is fully applied.
   - **If the voltage does not change, or is greater than 4.74 V**

     Refer to Circuit/System Testing below.

   - **Go to next step: If the voltage changes and less than 4.75 V**
6. Verify the scan tool Brake Pedal Position Sensor Learned Release Position parameter is within 0.1 V of the Brake Pedal Position Sensor parameter when the brake pedal is fully released.
   - **If difference is greater than 0.1 V**

     Perform the **Brake Pedal Position Sensor Calibration** .

   - **Go to next step: If difference is 0.1 V or less**
7. Verify the Brake Pedal Position Sensor parameter transitions smoothly without any spikes or dropouts when slowly applying and releasing the brake pedal.
   - **If parameter does not transition smoothly or has spikes or dropouts**

     Refer to Circuit/System Testing below.

   - **Go to next step: If parameter transitions smoothly and there are no spikes or dropouts**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B22 Brake Pedal Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

NOTE: **All terminal references are for the vehicle harness brake pedal position sensor connector.**

2. Test for less than 10 Ω between the low reference circuit terminal 6 and ground.
   - **If 10 Ω or greater**
     1. Disconnect the harness connector at the K20 Engine Control Module.
     2. Test for less than 2 Ω in the low reference circuit end to end.

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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 10 Ω**

3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 5 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance.
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If between 4.8 - 5.2 V**
5. Verify the scan tool Brake Pedal Position Sensor parameter is less than 0.25 V.
   - **If 0.25 V or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 0.25 V between the signal circuit terminal 4 and ground.
      - If 0.25 V or greater, repair the short to voltage on the circuit.
      - If less than 0.25 V, replace the K20 Engine Control Module.
   - **Go to next step: If less than 0.25 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 5.
7. Verify the scan tool Brake Pedal Position Sensor parameter is greater than 4.8 V.
   - **If 4.8 V or less**
   1. Ignition OFF, remove the jumper wire, and disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 4 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance.
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
      - **Go to next step: If greater than 4.8 V**
8. Replace the B22 Brake Pedal Position Sensor.

Repair Instructions

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

- **Brake Pedal Position Sensor Replacement**
- Perform the **Brake Pedal Position Sensor Calibration** following the replacement of the ECM or BPP sensor, or any repair that effects the BPP sensor alignment.
- **Control Module References** for Engine Control Module replacement, programming and setup.

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DTC P05CC OR P05CE: COLD START INTAKE/EXHAUST CAMSHAFT POSITION SYSTEM PERFORMANCE

Diagnostic Instructions

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

DTC Descriptors

DTC P05CC

Cold Start Intake Camshaft Position System Performance

DTC P05CE

Cold Start Exhaust Camshaft Position System Performance

Circuit/System Description

The camshaft position actuator system enables the engine control module (ECM) to change the timing of the camshafts while the engine is operating. The camshaft position actuator solenoid valves are each supplied a dedicated pulse width modulated (PWM) control circuit and low reference circuit from the ECM. The ECM operates each camshaft position actuator solenoid valve by controlling the amount of solenoid valve signal duty cycle to control the oil flow that applies the pressure to advance or retard the camshafts.

Conditions for Running the DTC

- DTC P0010, P0016, P0017, P0018, P0019, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390 or P0391, is not set.
- Ignition voltage is greater than 11 V.
- Engine is running.
- Desired camshaft position is greater than 0 degrees.
- Desired camshaft position is not changing greater than 4.5Ã‚Â° for at least 1 s.
- Both of the desired and actual camshaft position actuator values cannot be greater than 20 degrees or less than 5 degrees.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects the difference between the desired and actual camshaft position angle is greater than 4.5 degrees for greater 1 s.

Action Taken When the DTC Sets

DTCs P05CC and P05CE are type B DTCs.

Conditions for Clearing the DTC

DTCs P05CC and P05CE are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Component View Reference

Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 35616-200 Test Lamp Kit

Diagnostic Aids

- A low oil level or condition may set this DTC.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain can cause this DTC to set.

Circuit/System Verification

NOTE:

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

1. Verify the engine has the proper oil condition, level, and pressure. Refer to **Oil Pressure Diagnosis and Testing** .
   - **If the oil condition, level, and oil pressure are not correct**

     Repair as necessary

   - **Go to next step: If the oil condition, level, and oil pressure are correct**

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

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2. Verify DTC P0010, P0016, P0017, P0018, P0019, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390 or P0391, 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. Engine Running at normal operating temperature.
4. Verify the scan tool parameters below are less than 2Ã‚Â° in each of the commanded states when commanding the Camshaft Position Actuator from 0 - 20Ã‚Â° and back to 0Ã‚Â°.
    - Intake Camshaft Position Variance
    - Exhaust Camshaft Position Variance
    - **If 2Ã‚Â° or greater**

      Refer to Circuit/System Testing.

    - **Go to next step: If less than 2Ã‚Â°**
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 DTCs does not set**
7. All OK.

Circuit/System Testing

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

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

4. Verify that a test lamp does not illuminate between the control circuit terminal 1 or A and ground.
    - **If the test lamp illuminates**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp does not illuminate**
5. Remove the test lamp.
6. Ignition ON.

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7. Verify the scan tool Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status changes between OK and Not Run when commanding the Camshaft Position Actuator Solenoid Valve On and Off.
    - **If the parameter does not change**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance or short to ground in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If the parameter changes**

    NOTE: **If debris is found on Q6 Camshaft Position Actuator Solenoid Valve screens, clean the screens and reinspect for damage. If the screens are not damaged, reinstall in the engine.**

8. Ignition OFF, remove the Q6 Camshaft Position Actuator Solenoid Valve.
9. Verify the following conditions do not exist:
    - Damaged, restricted, or missing screens on the Q6 Camshaft Position Actuator Solenoid Valve.
    - Surface damage or an engine oil leak between the oil sealing lands of the Q6 Camshaft Position Actuator Solenoid Valve.
    - Oil seepage at the Q6 Camshaft Position Actuator Solenoid Valve connector.
    - **If a condition is found.**

      Replace the Q6 Camshaft Position Actuator Solenoid Valve.

    - **Go to next step: If a condition is not found**

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

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

      Replace the mechanical camshaft position actuator.

    - **Go to next step: If less than 2Ã‚Â°**
13. Test or replace the Q6 Camshaft Position Actuator Solenoid Valve.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 7-12 Ω between the control terminal 1 or A and the low reference circuit terminal 2 or B.
    - **If not between 7-12 Ω**

      Replace the Q6 Camshaft Position Actuator Solenoid Valve.

    - **Go to next step: If between 7-12 Ω**
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
    - **If not infinite resistance**

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Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **Go to next step: If infinite resistance**

4. All OK.

Repair Instructions

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

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

DTC P0601, P0602, P0603, P0604, P0606, P062B, P062F, P0630, P064D, P16F3 OR P262B: CONTROL MODULE

Diagnostic Instructions

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

DTC Descriptors

DTC P0601

Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P0606

Control Module Processor Performance

DTC P062B

Control Module Fuel Injector Control Performance

DTC P062F

Control Module Long Term Memory Performance

DTC P0630

VIN Not Programmed or Mismatched - Engine Control Module (ECM)

DTC P064D

Control Module H02S System Circuitry Performance

DTC P16F3

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Control Module Redundant Memory Performance

DTC P262B

Control Module Power Off Timer Performance

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). This diagnostic also addresses if the ECM is not programmed.

Conditions for Running the DTCs

P0601, P0602, P0630

These DTCs run continuously when the ignition is in ON.

P0603, P062F

These DTCs run once per ignition cycle.

P0604, P064D

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.

Actions Taken When the DTC Sets

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P0630 and P16F3 are Type A DTCs.
- DTC P062F is a Type C DTC.
- DTCs P064D and P262B are Type B DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P0630 and P16F3 are Type A DTCs.
- DTC P062F is a Type C DTC.
- DTCs P064D and P262B are Type B DTCs.

Diagnostic Aids

Low voltage or a momentary loss of power or ground to the ECM may cause a DTC to set. Verify the following:

- The battery cables are clean and tight, and the battery is fully charged. Refer to **Battery Inspection/Test** .
- The ECM ground circuits do not have an open or high resistance.

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- The ECM power circuits do not have an open, short to ground, or high resistance.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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Circuit/System Verification

1. Ignition ON, clear the DTC information with a scan tool.
2. Verify no other DTCs are set.
   - **If any other DTCs are set**

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

   - **Go to next step: If no other DTCs are set**
3. Verify DTC P0602 or P0630 is not set.
   - **If any of the DTCs are set**
   1. Program the K20 Engine Control Module. Refer to **Control Module References** .
   2. Verify DTC P0602 or P0630 is not set.
      - If any of the DTCs are set, replace the K20 Engine Control Module.
      - If none of the DTCs are set
   3. All OK.
   - **Go to next step: If none of the DTCs are set**
4. Verify DTC P0601, P0603, P0604, P0606, P062B, P062F, P064D, 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**
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 P0627, P0628, 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	P0171, P0506, P0628, P12A6	P0171, P0269, P0506, P0627, P0629, P12A6	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.
- The DTCs run continuously when the conditions above are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for 2.5 s.

Action Taken When the DTC Sets

DTCs P0627, P0628 and P0629 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0627, P0628 and P0629 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0627, P0628 or P0629 is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing below.

   - **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 below.

   - **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 below.

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

Circuit/System Testing

1. Ignition OFF, disconnect the K111 Fuel Pump Driver Control Module harness connector.
2. Ignition ON for 10 s.

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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 diagnostic procedure.

- **Fuel Pump Power Control Module Replacement (AWD)** **Fuel Pump Power Control Module Replacement (FWD)**
- **Control Module References** for control module replacement, programming and setup.

DTC P0641, P0651, P0697, P06A3 OR P06D2: 5V REFERENCE 1-5 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 P0641

5V Reference 1 Circuit

DTC P0651

5V Reference 2 Circuit

DTC P0697

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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 one or more sensors. A short to ground or short to voltage on one external 5V reference circuit can affect all the components connected to the same internal 5V reference circuit.

Conditions for Running the DTC

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

Conditions for Setting the DTC

The ECM detects a short to ground or voltage on any of the 5V reference circuits for greater than 0.5 s.

Action Taken When the DTC Sets

DTCs P0641, P0651, P0697, 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 components listed below:

- Air conditioning (A/C) refrigerant pressure sensor
- Center console multifunction switch (if equipped)
- Exhaust and intake camshaft position sensors
- Fuel pressure sensor
- Manifold absolute pressure sensor

The 5V reference 2 circuit provides 5 V to the sensors listed below:

- Brake booster vacuum sensor
- Brake pedal position sensor
- Crankshaft position sensor
- Engine oil pressure sensor
- Turbocharger boost/intake air temperature 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
- Fuel tank pressure sensor

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- Multifunction intake air 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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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Circuit/System Verification

1. Ignition ON.
2. Verify scan tool 5V Reference 1-5 Circuit Status parameters do not display Malfunction.
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing below.

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

     Refer to Circuit/System Testing below.

   - **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.

- **Accelerator Pedal with Position Sensor Assembly Replacement**
- **Air Conditioning Cycling and Fan Control Refrigerant Pressure Sensor Replacement**
- **Brake Pedal Position Sensor Replacement**
- **Camshaft Position Sensor Replacement - Exhaust**
- **Camshaft Position Sensor Replacement - Intake**
- **Crankshaft Position Sensor Replacement**
- **Engine Oil Pressure Sensor Replacement**
- **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**
- **Fuel Tank Pressure Sensor Replacement (AWD)** **Fuel Tank Pressure Sensor Replacement (FWD)**
- **Fuel Pressure Sensor Replacement - Fuel Feed Pipe (AWD)** **Fuel Pressure Sensor Replacement - Fuel Feed Pipe (FWD)**
- **Intake Air Pressure and Temperature Sensor Replacement** for turbocharger boost/intake air temperature sensor replacement.
- **Manifold Absolute Pressure Sensor Replacement**
- **Throttle Body Assembly 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

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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 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.

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 below.

    - **Go to next step: If Malfunction is not displayed**
3. Engine running.
4. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - The MIL Control Circuit Low Voltage Test Status
    - The MIL Control Circuit Open Test Status
    - The MIL Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing below.

    - **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.

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- **If the malfunction indicator lamp does not turn ON and OFF**

  Refer to Circuit/System Testing below.

- **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.
   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

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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-P0687, P0689, P0690 OR P1682: ENGINE CONTROLS IGNITION RELAY 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 P0685

Engine Controls Ignition Relay Control Circuit

DTC P0686

Engine Controls Ignition Relay Control Circuit Low Voltage

DTC P0687

Engine Controls Ignition Relay Control Circuit High Voltage

DTC P0689

Engine Controls Ignition Relay Feedback Circuit Low Voltage

DTC P0690

Engine Controls Ignition Relay Feedback Circuit High Voltage

DTC P1682

Ignition 1 Switch Circuit 2

Diagnostic Fault Information

Engine Controls Ignition Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Relay Coil Supply Voltage	P0689, P1682, 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

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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

P0685, P0686, P0687

The DTC runs when Ignition 1 signal voltage is greater than 11 V.

P0689

- DTC P0685 is not set.
- The engine controls ignition relay is commanded ON.
- Ignition 1 signal voltage is greater than 11 V.
- The DTC runs continuously when the above conditions are met.

P0690

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

P1682

- The engine controls ignition relay is commanded ON.
- Ignition voltage is greater than 5.5 V.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

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P0685

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 s.

P0686

The ECM detects a short to ground on the control circuit for greater than 2 s.

P0687

The ECM detects a short to voltage on the control circuit for greater than 2 s.

P0689

The ECM detects the engine controls ignition relay feedback circuit is less than 5 V.

P0690

The ECM detects the engine controls ignition relay feedback circuit is greater than 4 V for greater than 5 s.

P1682

The ECM detects that the voltage level difference is greater than 3 V between the engine controls ignition relay feedback and ignition 1 signal circuits for greater than 1 s.

Action Taken When the DTC Sets

- DTCs P0685, P0686, P0687, and P0690 are Type B DTCs.
- DTC P0689 is a Type C DTC.
- DTC P1682 is a Type A DTC.

Conditions for Clearing the DTC

- DTCs P0685, P0686, P0687 and P0690 are Type B DTCs.
- DTC P0689 is a Type C DTC.
- DTC P1682 is a Type A DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

- **Engine Controls Wiring Schematics**
- 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**

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- Electrical Center Identification Views
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **A short to voltage on other components may cause DTC P0690 to set. If any other DTC is set, diagnose that DTC first.**
- **If you were sent here from Engine Cranks But Does Not Run, proceed to Circuit/System Testing.**

1. Ignition ON, observe the scan tool DTC information. Verify DTC P0685, P0686, P0687, P0689, P0690 or P1682 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing.

   - **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.

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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.

   - **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 P1682 to set.**
     - **A short to voltage on any of the circuits supplied by the engine controls ignition relay can cause DTC P0690 to set.**
3. Ignition ON.

4. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal 87 and ground.
    - **If the test lamp illuminates**
    1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
    2. Ignition ON.
    3. Test for less than 1 V between ground and connector terminal 16.
        - 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 end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω
    3. Test for infinite resistance between the relay switch ignition voltage circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **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.
        - 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:

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- **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.

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

DTC P0700: TRANSMISSION CONTROL MODULE REQUESTED MIL ILLUMINATION

Diagnostic Instructions

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

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- 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

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

DTC C1201, P1000, P1001, P1003, P1008, P1009, P100A, P100E, P103D, P103E, P10B6, P10B7, P10B8, P10B9, P10BF, P10C6, P10C7, P10C8, P10F5, P1100, P1103, P117A, P11FF, P1200, P128C, P128D, P128E, P128F, P129E, P12A8, P130F, P135C, P135D, P135E, P135F, P1436, P143A, P143B, P1472, P14A0, P14B6, P14BD, P14CD, P14CE, P14D4, P14D5, 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: 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

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

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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

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

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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

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

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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

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

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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

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

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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

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.

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- 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

Engine Coolant Temperature Sensor Not Plausible

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117	P0118, P0119	P0118*, P0119	P0116, P0128
Low Reference	-	P0113, P0118, P0119, P2199, P2227, P2229	-	P0128
*ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

ECT Sensor Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** -39 to +120Ã‚Â°C (-38 to +248Ã‚Â°F)			
ECT Sensor	150Ã‚Â°C (302Ã‚Â°F)	-40Ã‚Â°C (-40Ã‚Â°F)	-40Ã‚Â°C (-40Ã‚Â°F)
Low Reference	-	-40Ã‚Â°C (-40Ã‚Â°F)	-40Ã‚Â°C (-40Ã‚Â°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.

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 50Ã‚Â°C (+122Ã‚Â°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 75Ã‚Â°C (+167Ã‚Â°F).
- The previous accumulated MAF is greater than 6, 000 grams.
- The previous engine run time is greater than 600 seconds.

This DTC runs continuously 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 10Ã‚Â°C (18Ã‚Â°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

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**

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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. 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 9Ã‚Â°C (16Ã‚Â°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 +120Ã‚Â°C (-38 to +248Ã‚Â°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

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 -39Ã‚Â°C (-38Ã‚Â°F).
   - **If warmer than -39Ã‚Â°C (-38Ã‚Â°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 -39Ã‚Â°C (-38Ã‚Â°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 149Ã‚Â°C (300Ã‚Â°F).
   - **If warmer than 149Ã‚Â°C (300Ã‚Â°F)**
   1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, Ignition ON.

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2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V
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.

- **Engine Coolant Temperature Sensor Replacement**
- **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 seconds, 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 7 - 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

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The fuel pump driver control module detects a driver temperature greater than 302Ã‚Â°F (150Ã‚Â°C) for less than 0.5 s.

Action Taken When the DTC Sets

DTC P1255 is a Type A DTC.

Conditions for Clearing the DTC

DTC P1255 is a Type A DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC 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.

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3. Verify DTC P1255 is not set.
    - If DTC P1255 is set, replace the K111 Fuel Pump Driver Control Module.
    - If DTC P1255 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 DTC P1255 is not set.
    - **If DTC P1255 is set**

      Replace the K111 Fuel Pump Driver Control Module.

    - **Go to next step: If DTC P1255 is not set.**
6. All OK.

Repair Instructions

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

Fuel Pump Power Control Module Replacement (AWD) **Fuel Pump Power Control Module Replacement (FWD)**

DTC P127C, P128A, P128B, P128C, P128D, P128F, P16E4 OR P16E5: FUEL RAIL PRESSURE SENSOR

Diagnostic Instructions

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

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Sensor Communication Circuit 3 High Voltage

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:** 3.9-4.2 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 rail pressure 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 rail pressure sensor internal microprocessor allows 4 separate sensor outputs from one 3 wire sensor. The engine control module (ECM) supplies the fuel rail pressure 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 rail pressure sensor to the ECM.

Conditions for Running the DTC

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.

P127C, P16E4 or P16E5

- Ignition is ON.
- No DTC clear code.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P127C

The engine control module detects fuel pressure sensor 2 SENT digital read value is less than 94 for less than 1 s.

P128A

The engine control module detects fuel pressure sensor 1 SENT digital read value is greater than 4, 089 for greater than 3 s.

P128B

The engine control module detects fuel pressure sensor 2 SENT digital read value is greater than 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 less than 1 s.

P128D

The engine control module detects communication errors on the fuel pressure sensor temperature 2 SENT signal circuit for less 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 fuel pressure sensor SENT signal shorted low for greater than 3 s.

P16E5

The engine control module detects fuel pressure sensor SENT signal shorted high for greater than 3 s.

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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 rail pressure sensor circuits could cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Fuel System Description

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

     Refer to DTC P0641, P0651, P0697, P06A3 or P06D2 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, P128A, P128B, P128C, P128D, P128F, P16E4, or P16E5 are not set.
   - **If DTC P128A, P128B, P128C, P128D, or P128F are the only DTCs set**

     Test or replace the B310 Fuel Pressure/Temperature Sensor.

   - **If DTC P0183, P0184, P0187, P0188, P111F, P126E, P126F, 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 rail pressure sensor harness connector causes additional DTCs to set.**

1. 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. Vehicle 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**

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3. Vehicle in Service Mode.
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. 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. Vehicle OFF, disconnect the X3 harness connector at the K20 Engine Control Module, vehicle in Service Mode.
    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. Vehicle OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Vehicle OFF, disconnect the X3 harness connector at the K20 Engine Control Module, vehicle in Service Mode.
    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 the B310 Fuel Pressure/Temperature Sensor.
- **Control Module References** for control module replacement, programming, and setup

DTC P129D: FUEL PUMP DRIVER CONTROL MODULE IGNITION 1 SWITCH CIRCUIT LOW VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

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DTC P129D

Fuel Pump Driver Control Module Ignition 1 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 A DTC.

Conditions for Clearing the DTC

DTC P129D is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

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2. Verify DTC P129D is not set.
    - **If the DTC is set**

      Refer to Circuit/System Testing below.

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

Circuit/System Testing

1. Ignition ON.
2. Verify DTC P0562 is not set.
    - **If the DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. Ignition OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module, ignition ON.
4. 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.
        - If the fuse is good, all OK.
    - **Go to next step: If the test lamp illuminates**
5. 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 (AWD) **Fuel Pump Power Control Module Replacement (FWD)**

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

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0171, P0506, P0628, P12A6	P0171, P0506, P12A6	P12A6	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 7 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 0.5 s.

Action Taken When the DTC Sets

DTC P12A6 is a Type A DTC.

Conditions for Clearing the DTC

DTC P12A6 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

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Description and Operation

Fuel System Description

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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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 below.

    - **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 below.

    - **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 K111 Fuel Pump Driver Control Module.
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.

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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 diagnostic procedure.

- **Fuel Pump Power Control Module Replacement (AWD)** **Fuel Pump Power Control Module Replacement (FWD)**
- **Control Module References** for ECM replacement, setup and programming

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
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.

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

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

Scan Tool Reference

Control Module References

Circuit/System Verification

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

     Refer to Circuit/System Testing.

   - **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 below.

   - **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.**

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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

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 +56Ã‚Â°C (10 - 132Ã‚Â°F).
- The calculated 3-way catalyst temperature is colder than 500Ã‚Â°C (932Ã‚Â°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, 000Ã‚Â°C (1832Ã‚Â°F) when the engine run time is greater than 17 s.
- Vehicle speed is less than 1.6 km/h (1 mph).

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- 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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Vehicle OFF, allow the engine to cool to be within the temperatures listed in the Conditions for Running the DTC.
2. Engine running.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
    - **If the DTC sets**

    1. Verify that none of the conditions listed below exists with the air intake system:
        - Damage, restriction, or modification
        - Dirty or deteriorating air filter element
        - Crankcase ventilation system for correct operation
        - Water intrusion
        - Vacuum leak and other unmetered air downstream of the mass air flow (MAF) sensor
        - Intake manifold leak
        - If any of the conditions exist

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Repair as necessary.

- If none of the conditions exist

2. Verify that none of the conditions listed below exists with the exhaust system:
   - Exhaust leak
   - Damaged, restricted, or modified exhaust system - Refer to **Symptoms - Engine Exhaust** .
   - If any of the above conditions exist

     Repair as necessary.

   - If none of the conditions exist
3. If all of the above conditions test normal, inspect for an engine mechanical condition that could alter the air flow into the combustion chamber. Refer to **Symptoms - Engine Mechanical** .

- **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 P150C: TRANSMISSION CONTROL MODULE ENGINE SPEED REQUEST SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

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

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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** .

   - **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 POSITION 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 P1516

Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance

DTC P2101

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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 - Terminal 1/A	P1516, P2101, P2119	P1516, P2101	P1516, P2101	P1516, P2101, P2176
Control - Terminal 2/B	P1516, P2101	P1516, P2101	P1516, P2101	P1516, P2101, P2176

Circuit/System Description

For an overview of the component/system, refer to **Throttle Actuator Control (TAC) System Description**

Circuit	Description
Control - Terminal 1/A	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.
Control - Terminal 2/B	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.

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.

Conditions for Running the DTC

P1516

- DTC P1682 = Not set
- Ignition Voltage = Greater than 6.4 V
- Throttle Position Learn = Not Activated

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

P2101 Condition 1

- DTC P1682 = Not set
- Ignition Voltage = Greater than 6.4 V
- Throttle Position Learn = Not Activated
- Engine = Running

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Condition 2

- Ignition Voltage = Greater than 6.4 V
- Throttle Position Learn = Active

Condition 3

- Ignition Voltage = Greater than 6.4 V
- Reduced Engine Power = Active

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

P2119

- DTC P0122, P0123, P0222, P0223, P06A3 = Not set
- Ignition Voltage = Greater than 6.4 V
- Engine = Not Running

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

P2176

- Ignition Voltage = Greater than 6.4 V
- Throttle Position Learn = Active

Frequency the DTC runs = Continuously - After the running 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

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 38%

Condition 3

- Throttle Position Learn = Active
- Throttle Position = Greater than 50%

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

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DTC P1516 = Type B DTC

DTC P2101, P2176 = Type A DTC

DTC P2119 = 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 = Type B DTC
- DTC P2101, P2176 = Type A DTC
- DTC P2119 = 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.
- 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

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 DTC P0121, P0122, P0123, P0222, P0223, P0562, P0621, P0622, P16A0-P16A2, P2135 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. Verify the scan tool parameter:Throttle Body Idle Air Flow Compensation = Less than 90%
   - **If 90% or greater**

     Refer to:**Throttle Body 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 - Start

   Verify the scan tool parameter:TAC Motor = Enabled

   - **If not the specified state**

     Refer to Circuit/System Testing below

   - **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:X2@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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing below

   - **Go to next step: If the DTC does not set**
10. 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**

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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 5 to 8 V between the test points:
    - Control circuit terminal 1/A & Ground
    - Control circuit terminal 2/B & Ground
    - **If less than 5 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/A @ Component harness & Ground
        - Control 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 Ω between the test points:
        - Control circuit terminal 1/A @ Component harness & The other end of the circuit @ Control module harness
        - Control circuit terminal 2/B @ Component harness & The other end of the circuit @ Control module harness
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - Replace the component:K20 Engine Control Module
    - **If greater than 8 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/A @ Component harness & Ground
        - Control 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 5 and 8 V**
6. Ignition/Vehicle - Off
7. Disconnect the electrical connector: X2 @ K20 Engine Control Module
8. Test for less than 2 Ω between the test points:
    - Control circuit terminal 1/A @ Component harness & The other end of the circuit@Control module harness
    - Control circuit terminal 2/B @ Component harness & The other end of the circuit@Control module harness
    - **If 2 Ω or greater**

      Repair the open/high resistance in the circuit.

    - **Go to next step: If less than 2 Ω**
9. Ignition OFF, Set the DMM to the 40 V scale, select the Min/Max Recording Mode, and set the Peak Min/Max response time to 1 ms.

NOTE:

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- **The ignition must be OFF and the ECM completely powered down before testing each circuit or a lower voltage will be recorded. It may take up to 2 min for all vehicle systems to power down.**
- **The DMM Min/Max Recording Mode and the response time of 1 ms must be reset after testing each circuit or a lower voltage will be recorded.**

10. Verify the Max voltage is within 3 V of B+ while using DMM Min/Max Recording Mode function on each control circuit listed below as the ignition is turned ON.
    - Control circuit terminal 1/A @ Component harness & Ground
    - Control circuit terminal 2/B @ Component harness & Ground
    - **If not within 3 V of the battery voltage**

      Test or replace the component: K20 Engine Control Module

    - **Go to next step: If within 3 V of the battery voltage**
11. 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 the system learn/reset procedure, refer to **Throttle Body Idle Air Flow Compensation Reset**
- 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) or an out of range high pressure fuel pump actuator current.

Conditions for Running the DTC

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0191, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0628 or P1682 is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The low side fuel pressure is greater than 250 kPa (36 psi).
- The barometric (BARO) pressure is greater than 70 kPa.
- The intake air temperature (IAT) is warmer than -20Ã‚Â°C (-4Ã‚Â°F).
- DTC P163A runs continuously when the conditions are met for greater than 500 mS.

Conditions for Setting the DTC

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The ECM detects a condition with the integrated circuits of the high pressure fuel pump actuator driver module or the ECM detects that the current used to drive the high pressure fuel pump actuator is greater than 11 A or less than 0.1 A for greater than 4 s.

Action Taken When the DTC Sets

DTC P163A is a Type B DTC.

Conditions for Clearing the DTC

DTC P163A is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

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

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

2. Test for 0.3 - 0.7 Ω at 20Ã‚Â°C (68Ã‚Â°F) between the high control circuit terminal 1 and the low control circuit terminal 2 on the G18 High Pressure Fuel Pump.
   - **If not between 0.3 - 0.7 Ω**

     Replace the G18 High Pressure Fuel Pump.

   - **Go to next step: If between 0.3 - 0.7 Ω**
3. Test for infinite resistance between each terminal on the G18 High Pressure Fuel Pump and the G18 High Pressure Fuel Pump housing.
   - **If less than infinite resistance**

     Replace the G18 High Pressure Fuel Pump.

   - **Go to next step: If infinite resistance**

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

    Replace the K20 Engine Control Module.

Repair Instructions

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

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

DTC P16A7, P16AF OR P16B3: ENGINE CONTROLS IGNITION RELAY FEEDBACK CIRCUIT 2

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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 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, P16BC	P0685, P0689, P1682, P16A7, P16AF, P16BC	-
Relay Control Circuit	P0686, P0690, P16B3, P16BF	P0685, P0689, P1682, P16A7, P16AF, P16BC	P0685, P0687, P0689, P1682, P16A7, P16AF, P16BC
Relay Feedback Circuit	P0689, P1682, P16A7, P16AF, P16BC	P0689, P1682, P16A7, P16AF, P16BC	P0690, P16B3, P16BF

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

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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 engine controls ignition relay feedback circuit 2 and the ignition 1 signal circuit 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.

Action Taken When the DTC Sets

- DTC P16A7 is a Type A DTC.
- DTC P16AF is a Type C DTC.
- DTC P16B3 is a Type B DTC.

Conditions for Clearing the DTC

- DTC P16A7 is a Type A DTC.

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- DTC P16AF is a Type C DTC.
- DTC P16B3 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

- **Engine Controls Wiring Schematics**
- 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 below.

   - **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 below.

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

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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.

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

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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.
        - 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.

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

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DTC P2096 OR P2097: POST CATALYST FUEL TRIM SYSTEM

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **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 - 20Ã‚Â°C and +200Ã‚Â°C (-4 and +392Ã‚Â°F).
- The start up engine coolant temperature is warmer than - 20Ã‚Â°C (- 4Ã‚Â°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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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Circuit/System Verification

1. Ignition ON.
2. Verify no other 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 below.

   - **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 below.

   - **Go to next step: If no DTC is set**
6. All OK.

Circuit/System Testing

Inspect for the conditions listed below:

P2096

- Air intake duct collapsed or restricted.
- Air filter dirty or restricted.
- Objects blocking the throttle body.
- Excessive fuel in the crankcase. Change engine oil as necessary.
- Rich fuel injectors. Refer to **Fuel Injector Diagnosis**.
- Excessive fuel system pressure. Refer to **Fuel System Diagnosis**.
- Fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Fuel saturation of the evaporative emissions (EVAP) canister
- Stuck open or leaking EVAP purge valve
- Restricted exhaust. Refer to **Symptoms - Engine Exhaust** .
- Improperly operating crankcase ventilation system. Refer to **Crankcase Ventilation System Inspection/Diagnosis** .

P2097

- Exhaust system leaks. Refer to **Symptoms - Engine Exhaust** .
- Split, kinked, or improperly connected vacuum hoses
- Insufficient fuel in the tank
- Leaks in the air induction system and air intake ducts
- Missing air filter element
- Cracked evaporative canister
- Evaporative pipes plugged, obstructed, or leaking
- Crankcase ventilation system leaking. Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
- Engine vacuum leaks
- Low fuel system pressure. Refer to **Fuel System Diagnosis**.
- Contaminated fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Lean fuel injectors. Refer to **Fuel Injector Diagnosis**.

- If a condition is found

  Repair as necessary.

Repair Instructions

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

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

DTC P2122, P2123, P2127, P2128 OR P2138: ACCELERATOR PEDAL POSITION (APP) SENSOR

Diagnostic 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 P2122

Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

DTC P2123

Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage

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DTC P2127

Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage

DTC P2128

Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

DTC P2138

Accelerator Pedal Position (APP) Sensors 1-2 Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
APP Sensor 1 5 V Reference	P06A3	P2138	P2122	P06A3	P2138
APP Sensor 2 5 V Reference	P0108, P0697	P2138	P2127	P0107, P0522, P0532, P0697	P2138
APP Sensor 1 Signal	P2122	P2138	P2122	P2123	P2138
APP Sensor 2 Signal	P2127	P2138	P2127	P2128	P2138
APP Sensor 1 Low Reference	-	P2138	P2123	-	P2138
APP Sensor 2 Low Reference	-	P2138	P2128	-	P2138

Typical Scan Tool Data

APP Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating at idle. **Parameter Normal Range:** APP Sensor 1 0.88 - 1.08 V			
APP Sensor 1 5 V Reference	0.00 V	0.00 V	2 - 4 V
APP Sensor 1 Signal	0.00 V	0.00 V	4 - 5 V
APP Sensor 1 Low Reference	-	4 - 5 V	-

APP Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating at idle. **Parameter Normal Range:** APP Sensor 2 0.39 - 0.59 V			
APP Sensor 2 5 V Reference	0.00 V	0.00 V	1 - 3 V
APP Sensor 2 Signal	0.00 V	0.00 V	2 - 5 V
APP Sensor 2 Low Reference	-	4 - 5 V	-

Circuit/System Description

The accelerator pedal assembly contains 2 accelerator pedal position (APP) sensors. The APP sensors are mounted to the accelerator pedal assembly and are not serviceable. The APP sensors provide a signal voltage that changes relative to pedal position. The engine control module (ECM) supplies each APP sensor with a 5 V reference circuit, a low reference circuit and a signal circuit.

Conditions for Running the DTC

P2122, P2123, P2127, P2128

- DTC P0697 or P06A3 is not set.

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- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.0 V and reduced power is not active.
- DTC P2122, P2123, P2127, P2128 run continuously when the above conditions are met.

P2138

- DTC P0697, P06A3, P2122, P2123, P2127 and P2128 are not set.
- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.0 V and reduced power is not active.
- DTC P2138 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2122

The ECM detects the APP sensor 1 voltage is less than 0.46 V for greater than 1 s.

P2123

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

P2127

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

P2128

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

P2138

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

Action Taken When the DTC Sets

- DTCs P2122, P2123, P2127, P2128 and P2138 are Type A DTCs.
- The control module commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions the control module commands the engine OFF.

Conditions for Clearing the MIL/DTC

DTCs P2122, P2123, P2127, P2128 and P2138 are Type A DTCs.

Diagnostic Aids

A high resistance condition on the accelerator pedal sensor circuits could cause a DTC to set.

Ensure that the in-line harness connector seals are installed correctly. Improper installation could result in water intrusion into the connector and cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

     Refer to **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 APP Sensor 1 Circuit Status and APP Sensor 2 Circuit Status parameters display OK.
   - **If OK is not displayed**

     Refer to Circuit/System Testing below.

   - **Go to next step: If OK is displayed**
4. Verify the scan tool APP Sensor 1 and 2 Agree/Disagree parameter displays Agree while performing the tests listed below:
   - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.
   - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.
   - **If Disagree**

     Refer to Circuit/System Testing below

   - **Go to next step: If Agree**
5. Verify that DTC P2122, P2123, P2127, P2128 or P2138 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing below

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

     Refer to Circuit/System Testing below

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

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Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B107 Accelerator Pedal Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the appropriate low reference circuit terminal listed below and ground.
    - APP sensor 1 low reference circuit terminal 4
    - APP sensor 2 low reference circuit terminal 3
    - **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 appropriate 5 V reference circuit terminal listed below and ground.
    - APP sensor 1 5 V reference circuit terminal 6
    - APP sensor 2 5 V reference circuit terminal 1
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If between 4.8 - 5.2 V**
5. Verify the scan tool APP sensor 1 and APP sensor 2 voltage parameters are less than 0.3 V.
    - **If 0.3 V or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit terminal listed below and ground.
    - APP sensor 1 signal circuit terminal 5
    - APP sensor 2 signal circuit terminal 2
    - 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 0.3 V**
6. Install a 3 A fused jumper wire between the appropriate signal circuit terminal listed below and the 5 V reference circuit terminal 1.
    - APP sensor 1 signal circuit terminal 5
    - APP sensor 2 signal circuit terminal 2
7. Verify the scan tool APP sensor 1 or APP sensor 2 voltage parameter is greater than 4.8 V.
    - **If 4.8 V or less**

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1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal 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. Test or replace the B107 Accelerator Pedal Position Sensor.

Repair Instructions

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

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

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	-	P0113, P2199, P2227, P2229	P0113*, P0114	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

IAT Sensor 2 and Intake Air Humidity

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 1

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

IAT Sensor 2 and Intake Air Humidity

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient humidity, temperature, and engine bay conditions			
Ignition Voltage	-40Ã‚Â°C (-40Ã‚Â°F) 10 Hz 0%	-40Ã‚Â°C (-40Ã‚Â°F) 10 Hz 0%	-
Signal	-40Ã‚Â°C (-40Ã‚Â°F) 10 Hz 100%	-40Ã‚Â°C (-40Ã‚Â°F) 10 Hz 0%	-40Ã‚Â°C (-40Ã‚Â°F) 10 Hz* 0%
Ground	-	-40Ã‚Â°C (-40Ã‚Â°F) 10 Hz 0%	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

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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 Ã‚Â°C (Ã‚Â°F).

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 Ã‚Â°C (Ã‚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
- 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	-40Ã‚Â°C (-40Ã‚Â°F)
Warm	302 Hz	104Ã‚Â°C (219Ã‚Â°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 55Ã‚Â°C (99Ã‚Â°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; -40Ã‚Â°C (-40Ã‚Â°F), and there are Humidity Sensor DTCs, check for a circuit problem.

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Reference Information

Schematic Reference

Engine Controls 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**

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 P0097, P0098, P0099, P00F4, P00F5, P00F6, P0102, P0103, 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** for further diagnosis.

   - **Go to next step: If none of the DTCs are set**
3. Ignition ON.
4. Verify the following scan tool parameters are within 30Ã‚Â°C (54Ã‚Â°F) of each other.
   - Start-Up IAT Sensor 1
   - IAT Sensor 2
   - **If not within 30Ã‚Â°C (54Ã‚Â°F)**

     Refer to Circuit/System Testing below.

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

     Refer to Circuit/System Testing below.

   - **Go to next step: If between: -38 and +149Ã‚Â°C (-36 and +300Ã‚Â°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 below.

   - **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. Check the integrity of the entire air induction system and verify that none of the following conditions exist:
   - A restricted or collapsed air intake duct
   - An intake manifold leak
   - A misaligned or damaged air intake duct
   - Any water intrusion in the induction system
   - **If a condition exists**

     Repair or replace component as appropriate.

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- **Go to next step: If no condition exists**

2. Ignition Off, and all vehicle systems Off, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
3. Test for less than 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**
4. 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**
5. Ignition On.
6. Verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition Off, remove the test lamp, the fuse for the ignition voltage circuit, and disconnect all components on the 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**
7. Verify the scan tool Intake Air Temperature Sensor 1 parameter is colder than -39Ã‚Â°C (-38Ã‚Â°F).
    - **If warmer than -39Ã‚Â°C (-38Ã‚Â°F).**
    1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If colder than -39Ã‚Â°C (-38Ã‚Â°F).**
8. Ignition Off, install a 3 A fused jumper wire between the IAT 1 signal circuit terminal 1 and the low reference circuit terminal 3.
9. Ignition On.
10. Verify the scan tool Intake Air Temperature Sensor 1 parameter is warmer than 148Ã‚Â°C (298Ã‚Â°F).
    - **If colder than 148Ã‚Â°C (298Ã‚Â°F).**
    1. Ignition Off, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition On.
    3. Test for less than 1 V between the signal circuit and ground.

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- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V

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 warmer than 148Ã‚Â°C (298Ã‚Â°F).**

11. Ignition On.

NOTE: **The intake air temperature sensor 2 signal circuit is pulled up with low current voltage within the controller. Normally, a voltage near B+ can be measured on the circuit with a DMM, but the current will not be high enough to illuminate a test lamp.**

12. 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%**
13. Ignition Off, install a 3 A fused jumper wire between the IAT 2 signal circuit terminal 8 and the low reference circuit terminal 3.
14. Ignition On.
15. 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%**
16. 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.
2. Connect a DMM between the IAT sensor 1 signal terminal 1 and the low reference terminal 3

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

3. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor** table for Hitachi Sensors. The resistance values should be in range of the table values.

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- **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.

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.

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:
   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.
5. 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 - 76Ã‚Â°C (160 - 166Ã‚Â°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**
6. All OK.

Repair Instructions

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

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- **Intake Air Pressure and Temperature 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 -20Ã‚Â°C (-4Ã‚Â°F).
- The engine speed is between 1, 200 - 4, 000 RPM.
- The mass air flow is between 0 - 100 g/s.
- The secondary air injection pump (if equipped) is not ON.
- The Exhaust Camshaft Position and Intake Camshaft Position are between 0 - 35 degrees.
- Engine run time is greater than 30 s.
- Fuel level is greater than 10% and no fuel level sensor fault is present.
- The DTC runs continuously when the above conditions have been met.

Conditions for Setting the DTC

Multiple samples of the pre-catalyst HO2S accumulated voltage are consistently greater than the desired value.

Action Taken When the DTC Sets

DTC P219A is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P219A is a Type A DTC.

Diagnostic Aids

- The fuel trim cylinder balance diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may cause a DTC to set.
- Monitoring the misfire current counters, or misfire graph, may help to isolate the cylinder that is causing the condition.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

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.
    - **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 below.

    - **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**

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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 Injector Diagnosis**.
   - Fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
   - Excessive fuel in the crankcase due to leaking injectors. Change engine oil as necessary.
   - Improperly operating ignition system. Refer to **Electronic Ignition System Diagnosis**.
   - **If a condition is found**

     Repair as necessary.

   - **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

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.**

DTC P2227

Barometric Pressure (BARO) Sensor Performance

DTC P2228

Barometric Pressure (BARO) Sensor Circuit Low Voltage

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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

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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 Ω @ 0Ã‚Â°C (32Ã‚Â°F)
	  • High temperature produces a low resistance: 187 Ω @ 100Ã‚Â°C (212Ã‚Â°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, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0121, P0122, P0123, P0222, P0223, P0236, P0237, P0238, P0502, P0503, P0722, P0723, P1104, P2100, P2101, P2102, P2103, P2135, P2228, P2229, P16A0, P16A1, P16A2 = Not set
- Engine Running = For greater than 5 s

Condition 2

- DTC P0107, P0108, P0237, P0238, P2228, P2229, P2610 = Not set
- Engine = Off - For greater than 10 s
- Ignition = On

DTC runs continuously when the above conditions are met.

P2228, P2229

Engine Running = For greater than 5 s

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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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Control Module References

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: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 below

   - **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 10 Ω between the test points:Low Reference circuit terminal 3 & Ground
   - **If 10 Ω or greater**
   1. Disconnect the electrical connector:K20 Engine Control Module

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2. Test for less than 2 Ω between the test points:Low Reference circuit terminal 3 @ Component harness & The other end of the circuit @ Control module harness
    - If 2 Ω or greater - Repair the open/high resistance in the circuit.
    - If less than 2 Ω - Replace the component:K20 Engine Control Module
- **Go to next step: If less than 10 Ω**

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: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 Ω between the test points:5 V Reference circuit terminal 2 @ Component harness & The other end of the circuit @ Control module harness
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - 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
        - 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: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: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
    5. Ignition/Vehicle - Off

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6. Test for less than 2 Ω between the test points:Signal circuit terminal 4 @ Component harness & The other end of the circuit @ Control module harness
    - If 2 Ω or greater - Repair the open/high resistance in the circuit.
    - If less than 2 Ω - 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.

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
- The boost pressure versus the BARO pressure ratio is between 1.1 - 3.3.
- The turbocharger bypass valve has been commanded Open greater than 6% for greater than 1 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

- P2261 is a Type B DTC with emission package RPOs NT7, NU5, and NQL.
- P2261 is a Type C DTC with emission package RPOs NE4 and NE9.

Conditions for Clearing the MIL/DTC

- P2261 is a Type B DTC with emission package RPOs NT7, NU5, and NQL.
- P2261 is a Type C DTC with emission package RPOs NE4 and NE9.

Reference Information

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Schematic Reference

Engine Controls Wiring Schematics

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, P2228, P2229, 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 below

   - **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.

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- **If a DTC sets**

  Refer to Circuit/System Testing below

- **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, remove the Q40 Turbocharger Bypass Solenoid Valve from the turbocharger, 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 **Camshaft Cover and Compressor Air Intake 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 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

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

Turbocharger Bypass Valve Solenoid 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.**

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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 P2618 OR P2619: CRANKSHAFT POSITION SIGNAL OUTPUT 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 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

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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

Circuit/System Verification

1. Engine - Running
2. Verify there are no DTCs/symptoms related to the following system/component, if equipped:
    - K71 Transmission Control Module
    - K103 Fuel Injector Control Module
    - T3 Audio Amplifier
    - T6 Power Inverter Module
    - **If a DTC or symptom exists**

      Refer to:

    - **Diagnostic Trouble Code (DTC) List - Vehicle**
    - **Symptoms - Vehicle**
    - **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 seconds, 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 Modulation (PWM) controlled current to the fuel pump.

Conditions for Running the DTC

- DTC P018B, P018C, P018D, P0231, P0232, P023F, P0641, P064A, P0606, P1255, P129E, or P12A6 are not active.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The ignition voltage is between 11 - 32 V.
- The engine has been running for more than 30 seconds.
- The engine fuel flow is not 0.
- Low fuel level warning not present.
- The DTC runs continuously when the conditions above are met.

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Conditions for Setting the DTC

The fuel pump driver control module detects a difference of Ã‚Â± 60 kPa at 400 kPa request or Ã‚Â± 45 kPa at 300 kPa request between the desired fuel pressure and the actual fuel pressure for approximately 10 s.

Action Taken When the DTC Sets

DTC P2635 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2635 is a Type B DTC.

Diagnostic Aids

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

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC 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.

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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**

4. Verify the scan tool Short Term Fuel Pump Trim and the Long Term Fuel Pump Trim when multiplied together are less than 1.5.
   - **If greater than 1.5**

     Refer to Circuit/System Testing below.

   - **Go to next step: If less than 1.5**
5. Command the Fuel Pressure to 300 kPa (43.5 psi) using the scan tool Control Function: Fuel Pressure Increase/Decrease.
6. 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 below.

   - **Go to next step: If less than 45 kPa (6.5 psi)**
7. Command the Fuel Pressure to 400 kPa (58 psi) using the scan tool Control Function: Fuel Pressure Increase/Decrease.
8. 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 below.

   - **Go to next step: If less than 60 kPa (8.7 psi)**
9. 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.
10. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing below.

    - **Go to next step: If the DTC does not set**
11. 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.

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- Fuel Feed Pipe Replacement (AWD) Fuel Feed Pipe Replacement (FWD)
- Fuel Injector Replacement
- Fuel Tank Fuel Pump Module Replacement (FWD) Fuel Tank Fuel Pump Module Replacement (AWD)
- Perform the Fuel Pump Trim Reset procedure with a scan tool after the repair.

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Turn OFF the ignition for 60 s.
5. Operate the vehicle within the Conditions for Running the DTC.
6. Verify the scan tool Short Term Fuel Pump Trim and the Long Term Fuel Pump Trim when multiplied together are less than 1.5.
    - **If greater than 1.5**

      Refer to Circuit/System Testing below.

    - **Go to next step: If less than 1.5**
7. Command the Fuel Pressure to 300 kPa (43.5 psi) using the scan tool Control Function: Fuel Pressure Increase/Decrease.
8. 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 below.

    - **Go to next step: If less than 45 kPa (6.5 psi)**
9. Command the Fuel Pressure to 400 kPa (58 psi) using the scan tool Control Function: Fuel Pressure Increase/Decrease.
10. 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 below.

    - **Go to next step: If less than 60 kPa (8.7 psi)**
11. 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

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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.

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

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

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.**

   - **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**

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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 **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** provide an overview of each diagnostic category.

Symptoms Description

Symptoms covers conditions that are not covered by DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause specific symptoms are listed separately under Additional Symptoms Testing. Perform the Symptoms Testing before using the Additional Symptoms Testing.

Symptoms Definition

Backfire

The Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Cuts Out, Misses

A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1, 500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

Detonation/Spark Knock

A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

Dieseling, Run-On

The engine continues to run after the key is turned OFF, but runs very rough.

Engine Control Module (ECM) Commanded Reduced Engine Power

The ECM illuminates the Reduced Engine Power lamp and will limit engine power under potential engine/vehicle damaging or emissions related conditions. A DTC may not be set.

Fuel Odor

A noticeable smell of unburned fuel.

Hard Start

The engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stall.

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Hesitation, Sag, Stumble

A momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

Lack of Power, Sluggishness, or Sponginess

The engine delivers less than expected power. Little or no increase in vehicle speed when the accelerator pedal is pushed down part way.

Poor Fuel Economy

Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

Rough, Unstable, or Incorrect Idle and Stalling

The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle speed may vary. Either condition may be severe enough to stall the engine.

Surges/Chuggles

An engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

Symptoms Verification

Before using the Symptom tables, perform the following inspections:

- Verify the malfunction indicator lamp (MIL) is operating correctly. Use the scan tool to command the lamp ON and OFF.
- Verify there are no DTCs that are stored.
- Verify the scan tool data is within a normal operating range. Refer to **Control Module References** for scan tool information.
- Verify the customer concern.
- Perform the Visual/Physical Inspection. 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

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- High vehicle load conditions
- Rough road surfaces
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of aftermarket, add on accessories

Visual/Physical Check

- Verify the control module grounds are clean, tight, and correctly located.
- Verify the vacuum hoses are not split or kinked, and are properly connected.
- Verify the air filter is clean and free from restrictions.
- Verify there is no water intrusion in connectors terminals and components.
- Inspect the air intake ducts for the conditions listed below:
    - Collapsed
    - Damaged areas
    - Looseness
    - Incorrect installation
    - Leaking

      If any condition listed above has allowed non-metered air to enter the air induction system, the **Throttle 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

- Test/inspect the fuel system for the conditions listed below:
    - Incorrect system operation or fuel pressure - Refer to **Fuel System Diagnosis**.
    - Leaking or incorrectly operating fuel injectors - Refer to **Fuel Injector Diagnosis**.
    - Contaminated or poor quality fuel - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Test/inspect the ignition system for the conditions listed below:
    - Spark plugs with incorrect heat range or an abnormal condition - Refer to **Spark Plug Inspection** and **Ignition System Specifications** .
    - Coolant or oil fouled spark plugs - For diagnosis, refer to **Coolant in Combustion Chamber** or **Oil Consumption Diagnosis** .
    - Secondary ignition system susceptible to moisture. Engine running, wet down the secondary ignition system with water from a spray bottle to help locate damaged or deteriorated components. Look/listen for arcing or misfiring as the water is applied.
    - Weak spark using the **J-26792** Spark Tester - Refer to **Electronic Ignition System Diagnosis**.
- Test/inspect for the conditions listed below:
    - Non-metered air flow into the air induction system. If a leak is found, repair as necessary. The **Throttle Body Idle Air Flow Compensation Reset** procedure must be performed when the repair is complete.

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- Incorrectly operating transmission torque converter clutch (TCC) - The scan tool should indicate an engine speed drop when the TCC is commanded ON. Refer to **Torque Converter Diagnosis** .
- Incorrectly operating A/C compressor.
- An engine that runs lean or rich. Observe the Fuel Trim parameters with a scan tool - Refer to **DTC P0171 or P0172** for more information.
- Slow responding heated oxygen sensors (HO2S) - The HO2S should respond quickly to different throttle positions - Refer to **DTC P0131, P0132, P015A, P015B, P223C, or P223E** or **DTC P0137, P0138, P013A, P013B, P013E, P013F, P2270 or P2271** for more information.

  CAUTION: **Refer to Heated Oxygen and Oxygen Sensor Caution .**

- Water intrusion in the HO2S connector

  NOTE: **The embossed arrows on the mass air flow (MAF) sensor indicate the direction of the intake air flow. The arrows must point toward the engine.**

- Incorrect mass air flow sensor installation. A mass air flow sensor that is incorrectly installed may cause a hard start. Install the mass air flow in the proper direction. Refer to **Mass Airflow Sensor Replacement** .
- Incorrect mass air flow sensor connections.
- Engine oil contaminated by fuel
- Split or kinked vacuum hoses - Verify that the routing and connections are correct.
- Excessive knock sensor system spark retard activity - Observe the Knock Retard parameter on the scan tool for activity more than 0Ã‚Â°.
- Electromagnetic interference (EMI) on the reference circuit, which can cause a misfire condition. You can usually detect electromagnetic interference with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that electromagnetic interference is present. Inspect the high voltage components near the ignition control circuit if a condition exists.
- A crankshaft position sensor with an intermittent condition - Observe the scan tool Crankshaft Position Resync Counter parameter. The Resync Counter parameter should remain at 0 during all operating conditions, and when moving the related harnesses and connectors between the crankshaft position sensor and the ECM.
- A stuck open evaporative emission (EVAP) canister purge solenoid.
- Incorrectly operating crankcase ventilation valve - Refer to **Crankcase Ventilation System Inspection/Diagnosis** .

- Test/inspect the engine cooling system for the conditions listed below:
  - A thermostat with incorrect heat range. Refer to **Thermostat Diagnosis** .
  - Incorrect engine coolant level - If the level is low, refer to **Loss of Coolant** .

  For additional information, refer to **Symptoms - Engine Cooling** .

- Test/inspect the exhaust system components for the conditions listed below:
  - Physical damage or possible internal failure
  - Restricted three-way catalytic converters

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

- Test/inspect the engine for the mechanical conditions listed below:
  - Excessive oil in the combustion chamber or leaking valve seals
  - Oil consumption
  - Incorrect cylinder compression
  - Sticking or leaking valves

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- Worn camshaft lobes
- Incorrect valve timing
- Worn rocker arms
- Broken valve springs
- Excessive carbon buildup in the combustion chambers - Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.
- Incorrect engine parts

  For additional information, refer to **Symptoms - Engine Mechanical** .

- If the above conditions do not address the symptom, refer to the Additional Symptoms Tests.

Additional Symptoms Tests

Detonation/Spark Knock

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

ECM Commanded Reduced Engine Power

Under certain conditions the 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 engine control module to reduce engine power. Refer to **Cooling Fan Description and Operation** , and **Cooling System Description and Operation** to verify correct operation of the cooling fan.
- Temporarily reduced engine power. Under extremely cold ambient temperatures some SIDI equipped vehicles may experience ECM commanded reduced engine power for a few minutes during engine warm-up. This would be a normal condition, noticeable only at wide open throttle, and the reduced engine power lamp would not be illuminated.
- Reduced engine power due to OnStarÃ‚Â® remote command. Verify the vehicle is not in the OnStarÃ‚Â® initiated Stolen Vehicle Slowdown mode. Refer to **OnStar Stolen Vehicle**

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Slowdown Active and Remote Vehicle Speed Limiting Description and Operation for additional information.

- Turbocharger boost pressure out of range, if equipped. Refer to DTC P0234 or P0299 .
- High pressure fuel system condition. Refer to Fuel System Diagnosis, and Fuel System Description to verify high pressure fuel system operation.
- Intake air temperature out of range too high. Observe the scan tool IAT Sensor 1 and IAT Sensor 2 parameters. The readings should be within 9Ã‚Â°C (16Ã‚Â°F) of a each other.
- Fuel temperature out of range too high. Observe the scan tool Fuel Temperature Sensor parameter.
- If equipped with automatic transmission, an incorrect learned brake pedal position (BPP) sensor. Verify the following actions have not occurred:
  - An engine control module has been replaced
  - The BPP sensor has been replaced
  - Thet 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.
- Inspect for a saturated EVAP canister - Refer to Evaporative Emission Control System Description .
- Inspect for a condition with the internal components of the fuel tank assembly - Refer to Fuel System Description .

Hard Start

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

Hesitation, Sag, Stumble

- Test the fuel pressure. Refer to Fuel System Diagnosis.
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to Intake Air Pressure and Temperature Sensor Replacement .
- Test the generator. Refer to Symptoms - Engine Electrical . Repair the charging system if the generator output voltage is less than 9 V or more than 16 V.
- Test the manifold absolute pressure (MAP) sensor. Refer to DTC P0106 .
- Inspect for excessive crankshaft endplay that will cause the crankshaft position sensor reluctor wheel to move out of alignment with the crankshaft position sensor. Refer to Crankshaft and Bearing Cleaning and Inspection and Engine Mechanical Specifications .

NOTE: **The following actions may need to be repeated in order to verify an**

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intermittent intake or exhaust camshaft actuator condition.

- Engine warm and idling, verify the correct operation of the camshaft actuator system. Command the intake and exhaust camshaft actuators from 0 degrees to 20 degrees and back to zero while observing the scan tool Intake Camshaft Position Variance and Exhaust Camshaft Position Variance parameters. Each parameter should be less than 2 degrees in each of the commanded states.
    - If any of the parameters is greater than 2 degrees, inspect the suspect camshaft actuator and camshaft actuator solenoid valve and valve bore for contamination, obstruction, and damage. Refer to **Camshaft Position Actuator Exhaust Solenoid Valve Replacement** , **Camshaft Position Actuator Intake Solenoid Valve Replacement** and **Camshaft Actuator System Description** .

Lack of Power, Sluggishness, or Sponginess (LCV)

- Inspect the engine electrical system for incorrect operation. Refer to **Symptoms - Engine Electrical** .
- Verify that each injector harness is connected to the correct injector.
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Intake Air Pressure and Temperature Sensor Replacement** .

NOTE: **The following actions may need to be repeated in order to verify an intermittent intake or exhaust camshaft actuator condition.**

- Engine warm and idling, verify the correct operation of the camshaft actuator system. Command the intake and exhaust camshaft actuators from 0 degrees to 20 degrees and back to zero while observing the scan tool Intake Camshaft Position Variance and Exhaust Camshaft Position Variance parameters. Each parameter should be less than 2 degrees in each of the commanded states.
    - If any of the parameters is greater than 2 degrees, inspect the suspect camshaft actuator and camshaft actuator solenoid valve and valve bore for contamination, obstruction, and damage. Refer to **Camshaft Position Actuator Exhaust Solenoid Valve Replacement** , **Camshaft Position Actuator Intake Solenoid Valve Replacement** and **Camshaft Actuator System Description** .

Lack of Power, Sluggishness, or Sponginess (LTG)

- Inspect the engine electrical system for incorrect operation. Refer to **Symptoms - Engine Electrical** .
- Verify that each injector harness is connected to the correct injector.
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Intake Air Pressure and Temperature Sensor Replacement** .

NOTE: **The following actions may need to be repeated in order to verify an intermittent intake or exhaust camshaft actuator condition.**

- Engine warm and idling, verify the correct operation of the camshaft actuator system. Command the intake and exhaust camshaft actuators from 0 degrees to 20 degrees and back to zero while observing the scan tool Intake Camshaft Position Variance and Exhaust Camshaft Position Variance parameters. Each parameter should be less than 2 degrees in each of the commanded states.
    - If any of the parameters is greater than 2 degrees, inspect the suspect camshaft actuator and camshaft actuator solenoid valve and valve bore for contamination, obstruction, and damage. Refer to **Camshaft Position Actuator Exhaust Solenoid Valve Replacement** , **Camshaft Position Actuator Intake Solenoid Valve Replacement** , and **Camshaft Actuator System Description** .
- Verify the correct operation of the turbocharger system. Perform the following:
    - Inspect the turbocharger moving components for looseness, binding, wear and damage.

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- 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 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. Refer to **Turbocharger Leaking Fluids Externally** and **Turbocharger Smoke or Smell** .
- Inspect for excessive turbocharger system noise. Refer to **Turbocharger Noise** .
- Inspect for a loss of turbocharger pressure. Refer to **Turbocharger Loss of Boost Pressure** .
- For additional information, refer to **Turbocharger System Description** and **Camshaft Cover and Compressor Air Intake Turbocharger Cleaning and Inspection** .

Poor Fuel Economy

- Observe the Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 90 % may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and clean, if necessary. Refer to **Throttle Body Cleaning** .
- Inspect for heavy loads being carried or towed
- Inspect for acceleration rate too much or too often
- Inspect for incorrect operation of the speedometer.
- Verify that the engine coolant temperature (ECT) has not shifted in value. Allow the engine to run and reach operating temperature. Observe the ECT Sensor parameter with a scan tool and compare the reading to that parameter listed on the **K20 Engine Control Module: Scan Tool Information** , list. If the reading is not in the range specified in the list, test the resistance of the engine coolant temperature sensor. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** , for resistance specifications. Replace the engine coolant temperature sensor if the resistance is not within specification. Refer to **Engine Coolant Temperature Sensor Replacement** . If the sensor is within the specification, test the engine coolant temperature sensor circuits for high resistance.
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Intake Air Pressure and Temperature Sensor Replacement** .
- Inspect the brake system for brake drag.

Rough, Unstable or Incorrect Idle and Stalling

- An excessively high idle may be due to the floor mat interfering with the accelerator pedal. With this condition present, it may not be possible to shift the transmission into gear. Inspect the accelerator pedal for binding and verify that the floor mat is not interfering with the aceclerator pedal movement.
- Engine idle speed may be unstable or the engine may stall if the ECM has learned an incorrect idle/airflow compensation value. A DTC may also set. Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. If the throttle body needs cleaning, refer to **Throttle Body Cleaning** .

  The actions listed below may also cause the ECM to learn an incorrect idle value.

  - The engine control module has been replaced
  - The throttle body has been replaced
  - The throttle body has been cleaned but the idle learn procedure was not performed after completing the cleaning
  - The air induction system was leaking, allowing non-metered air to enter the combustion chamber. The leak was repaired but the idle learn procedure was not performed after repairing the leak

  If any of the actions listed above have occurred, the **Throttle Body Idle Air Flow Compensation Reset** procedure must be performed.

- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Intake Air Pressure and Temperature Sensor Replacement** .
- Inspect the engine mounts. Refer to **Engine Mount Inspection** .
- Inspect the intake and exhaust manifolds for casting flash.

Surges/Chuggles

- Verify that each injector harness is connected to the correct injector.
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Intake Air Pressure and Temperature Sensor Replacement** .
- Inspect for slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The PCM reduces the amount of fuel delivered to the engine, causing a driveability condition. Refer to **DTC P0137, P0138, P013A, P013B, P013E, P013F, P2270 or P2271** for more information.

MALFUNCTION INDICATOR LAMP (MIL) DIAGNOSIS

Diagnostic Instructions

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

Circuit/System Description

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

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors while monitoring the scan tool MIL control circuit status parameters. Perform this test with the ignition ON and the engine OFF, and with the engine running. The MIL control circuit status parameters change from OK or Not Run to Malfunction if there is a condition with a circuit or a connection.

Reference Information

Schematic Reference

- **Engine Controls 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**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
   - The MIL Control Circuit Low Voltage Test Status
   - The MIL Control Circuit Open Test Status
   - The MIL Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing below

   - **Go to next step: If Malfunction is not displayed**
3. Engine running.
4. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
   - The MIL Control Circuit Low Voltage Test Status
   - The MIL Control Circuit Open Test Status
   - The MIL Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing

   - **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 below

   - **Go to next step: If the malfunction indicator lamp turns ON and OFF**
6. All OK.

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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 X1 harness connector at the instrument cluster.
7. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal 8 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the ignition voltage circuit and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ignition voltage circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - **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

ENGINE CRANKS BUT DOES NOT RUN

Diagnostic Instructions

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

Circuit/System Description

This Engine Cranks but Does Not Run 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:

- On vehicles equipped with a key type starting system, the key fob must be in the correct position when attempting to start the engine. The mechanical portion of the 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 attempting to start the engine 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.
- 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.
- The engine control module (ECM) uses the camshaft position sensors to determine engine speed and position when there is a crankshaft position sensor condition. If a crankshaft position sensor condition exists, the engine will operate only if the ECM has stored the learned reference position of the camshafts in ECM memory. With a crankshaft position sensor condition in the signal

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circuit, the engine will go into a limp home mode after a hard restart. The ECM then calculates engine speed from the camshaft position sensor.

- The chassis control module controls and monitors the operation of the in-tank fuel pump. If the chassis control module detects a fault, a DTC sets in the chassis control module. The chassis control module will then send a serial data message to the engine control module (ECM) requesting the illumination of the malfunction indicator lamp (MIL).
- Insufficient fuel can cause a no start condition. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.
- Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition. Refer to **Fuel Injector Diagnosis**.
- There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK, and fuel spray is detected, the fuel injector ON time may be inadequate. If the 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.
- Inspect the engine for good secure electrical grounds.
- Water or foreign material in the fuel can cause a no start or engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 min in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.
- An engine that starts and runs after being brought to the repair shop for a no start condition, may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring in order to check for an engine starting or will not stay running concern.

Reference Information

Schematic Reference

Engine Controls 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**
- **Starting System Description and Operation**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 26792 HEI Spark Tester

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

Circuit/System Verification

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

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

1. Crank the engine for up to 15 s.
2. Verify that P0201 - P0204, P0230, P0231, P0232, P023F, P025A, P0335, P0336, P0351 - P0354, P0601, P0602, P0603, P0604, P0606, P0607, P060E, P062F, P0685, P0689, P0690, P069E, P1516, P1682, P2610 or P2635 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 panel cluster illuminates momentarily.
   - **If the indicator stays ON or is flashing**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** and **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 is greater than 0 RPM while cranking the engine.
   - **If 0 RPM**

     Refer to **DTC P0335 or P0336** for further diagnosis.

   - **Go to next step: If greater than 0 RPM**
6. Ignition OFF.
7. Disconnect the T8 ignition coil from a cylinder and spark plug.
8. Connect a **J 26792** HEI Spark Tester between the boot of the ignition coil and ground.

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

9. Verify that the spark tester sparks while cranking the engine.
   - **If the spark tester does not spark**

     Refer to **Electronic Ignition System Diagnosis** for further diagnosis.

   - **Go to next step: If the spark tester sparks**
10. 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 60Ã‚Â° C (150Ã‚Â° 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.**

11. Command the Fuel Pump Enable On several times with a scan tool.
12. Verify that the scan tool Fuel Pressure Sensor parameter is between 345 - 650 kPa (50 - 94 psi) while the fuel pump is running.
    - **If not within the specified range**

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Refer to **Fuel System Diagnosis**.

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

13. Verify that the scan tool Fuel Pressure Sensor parameter, after the 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.
    - **If not within the specified range**

      Refer to **Fuel System Diagnosis**.

    - **Go to next step: If within the specified range**
14. Ignition OFF, disconnect the harness connector of a fuel injector.
15. Connect a test lamp between the control circuit and the ignition voltage circuit of the harness connector.

NOTE: **Perform the fuel injector test on at least 3 fuel injectors**

16. Verify the test lamp flashes while cranking the engine.
    - **If the test lamp does not flash**

      Refer to **Fuel Injector Circuit Diagnosis**.

    - **Go to next step: If the test lamp flashes**
17. Verify that the conditions listed below do not exist:
    - Collapsed or restricted air intake duct to the throttle body
    - Restricted air filter
    - Gas or coolant fouled spark plugs
    - A skewed manifold absolute pressure (MAP) sensor. Refer to **DTC P0106** .
    - A skewed engine coolant temperature (ECT) sensor. Refer to **DTC P0117, P0118, or P0119** .
    - A restricted exhaust system. Refer to **Restricted Exhaust** .
    - Contaminated fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
    - An engine mechanical condition, for example, worn timing chain and gears or low compression. Refer to **Symptoms - Engine Mechanical** , or **Engine Compression Test** .
        - **If a condition exists**

          Repair as necessary.

        - **Go to next step: If no conditions exist**
18. All OK

Repair Instructions

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

Spark Plug Replacement

FUEL SYSTEM DIAGNOSIS

Diagnostic Instructions

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

Circuit/System Description

The engine control module (ECM) supplies voltage to the fuel pump 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,

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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 valve maintains 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.**
- **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 60Ã‚Â°C (150Ã‚Â°F). High fuel pressure**

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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) Ã‚Â± 5%.

1. Ignition ON, engine OFF, command the Fuel Pump Enable On several times with a scan tool.
2. Verify the scan tool Fuel Pressure Sensor parameter is between 345 - 650 kPa (50 - 94 PSI) with the fuel pump running.
   - **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 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 the scan tool Short Term Fuel Pump Trim and the Long Term Fuel Pump Trim when multiplied together are less than 1.5.
   - **If greater than 1.5**

     Refer to Circuit/System Testing - Fuel Pressure Low.
   - **Go to next step: If less than 1.5**
8. Verify the scan tool 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)**
9. If the fuel system components test normal, refer to **Symptoms - Engine Controls** and **Fuel Injector Diagnosis** for further diagnosis.

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Circuit/System Testing

Fuel Pressure Low

1. Verify none of the conditions listed below exist:
   - Restricted or dislocated fuel feed front pipe check valve
   - Restricted fuel feed pipe
   - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
   - **If a condition exists**

     Repair as necessary.

   - **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 high pressure fuel pump.
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 greater 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.

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Repair Instructions

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

- **Fuel Feed Pipe Replacement (AWD)** **Fuel Feed Pipe Replacement (FWD)**
- **Fuel Pump Replacement** for G18 High Pressure Fuel Pump replacement
- **Fuel Injector 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

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

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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

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)**

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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 20Ã‚Â°C (68Ã‚Â°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.

   - **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 60Ã‚Â°C (140Ã‚Â°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.
4. Select and test an injector. Repeat for each injector.

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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	P2148	P1248
Fuel Injector 2 Control +	P2150	P0202	P2151	P1249
Fuel Injector 2 Control -	P0264	P0202	P2151	P1249
Fuel Injector 3 Control +	P2153	P0203	P2154	P124A
Fuel Injector 3 Control -	P0267	P0203	P2154	P124A
Fuel Injector 4 Control +	P2156	P0204	P2157	P124B
Fuel Injector 4 Control -	P0270	P0204	P2157	P124B

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the injector high voltage supply circuits. The ECM energizes each fuel injector by grounding the high voltage control circuit of the fuel injector. The ECM monitors the status of the injector high voltage supply circuits and the injector high voltage control circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Diagnosis**.
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Do Not perform this procedure unless directed here from the Fuel Injector Balance Test.**

1. Engine idling.
2. Verify the scan tool Cylinder 1 - 4 Current Misfire Counter parameters do not increment.
   - **If the Cylinder 1 - 4 Current Misfire Counters increment**

     Refer to Circuit/System Testing below.

   - **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 below.

   - **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 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.

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- **If less than infinite resistance**

1. Disconnect the harness connector of the Q17 Fuel Injector.
2. Test for infinite resistance between the Q17 Fuel Injector control + circuit and ground.
    - If less than infinite, repair the short to ground in the circuit.
    - If infinite resistance
3. Test for infinite resistance between the Q17 Fuel Injector control - circuit and ground.
    - If less than infinite, repair the short to ground in the circuit.
    - If infinite, replace the Q17 Fuel Injector.

- **Go to next step: If infinite resistance**

3. Ignition ON.
4. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
    - **If 1 V or greater**

    1. Disconnect the harness connector of the Q17 Fuel Injector, ignition ON.
    2. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, repair the short to voltage on the control - circuit.

    - **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 repair.

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

ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS

Diagnostic Instructions

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

Test Description

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10 percent can cause driveability conditions and fuel system deterioration. Fuel with more than 10 percent ethanol could result in driveability conditions such as hesitation, lack of power, stalling, or no start. Excessive concentrations of ethanol used in vehicles not

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designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

Reference Information

Special Tool

CH 44175-A Fuel Composition Tester, if available

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

System Verification

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear.

- If the sample appears cloudy, or contaminated with water, as indicated by a water layer at the bottom of the sample, perform the **Particulate Contaminants in Fuel Testing Procedure**.
- If alcohol contamination is suspected, perform the Alcohol in Fuel Testing procedure.

Alcohol in Fuel Testing with Special Tool, If Available

1. Test the fuel composition using the **CH 44175-A** Fuel Composition Tester and the Instruction Manual.
2. If water appears in the fuel sample, clean the fuel system.
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.
4. If the fuel sample contains more than 15 percent ethanol, add fresh, regular gasoline to the vehicle's fuel tank.
5. Test the fuel composition.
6. If testing shows the ethanol percentage is still more than 15 percent, replace the fuel in the vehicle.

Alcohol in Fuel Testing without Special Tool

1. Using a 100 ml (3.38 oz) specified cylinder with 1 ml (0.034 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.
2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.38 oz) and install a stopper.
3. Shake the cylinder vigorously for 10 - 15 seconds.
4. Carefully loosen the stopper in order to release the pressure.
5. Re-install the stopper and shake the cylinder vigorously again for 10 - 15 seconds.
6. Put the cylinder on a level surface for approximately 5 min in order to allow adequate liquid separation. If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be more than 10 ml (0.34 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5 percent alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.

Particulate Contaminants in Fuel Testing Procedure

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel.
2. Place the container on a level surface for approximately 5 min in order to allow settling of the particulate contamination. Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles.
3. Observe the fuel sample. If any physical contaminants or water are present, clean the fuel system.

Repair Instructions

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Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Fuel System Cleaning
- Fuel Tank Draining

EVAPORATIVE EMISSION 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

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.
   - **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.**

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- **Inject smoke in less than 2 min cycles for optimum tester performance.**

6. Press and release the remote switch to deactivate the tester.

NOTE: **For optimum visual smoke performance, deactivate the smoke flow and allow the system pressure to drop. Allowing the smoke to exit small holes at a low flow rate greatly enhances visibility.**

7. Introduce smoke into the system for an additional 60 s. Continue introducing smoke at 15 s intervals, as necessary until leak source is identified.
8. Using a high-intensity white light, inspect the entire EVAP system path, and look for the source of the leak indicated by the exiting smoke.
    - **Smoke seen leaking**

      Repair or replace the affected component.

    - **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 21Ã‚Â°C (70Ã‚Â°F). Vehicles brought in for diagnosis may have an EVAP system at significantly different temperatures.

For Example

NOTE: **With no temperature difference between the Nitrogen gas and EVAP system, the resulting vehicle EVAP system pressure will remain stable at 13 in. H2O (0.5 PSI) once pressurized, providing no leaks are present.**

When the EVAP flow meter tests are performed with significant differences in temperature between the Nitrogen gas and the vehicle EVAP system, the following results can occur:

- An increase in flow during the flow meter test can be caused by a vehicle's warm EVAP system cooling down.
- A decrease in flow during the flow meter test can be caused by a vehicle's cool EVAP system warming up.

The Solution

When working on a vehicle with significant temperature differences between the vehicle EVAP system and the Nitrogen gas, allow the vehicle EVAP system temperature to stabilize as close as possible to the temperature of the Nitrogen gas before conducting the flow meter test.

ELECTRONIC IGNITION SYSTEM DIAGNOSIS

Diagnostic Instructions

- Perform the Diagnostic System Check 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**

Circuit/System Description

For an overview of the component/system, refer to **Electronic Ignition System Description**

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The ECM controls the spark event for each cylinder through individual ignition coil control circuits. When the ECM commands the ignition control circuit On, electrical current flows through the primary winding of the ignition coil, creating a magnetic field. When a spark event is requested, the ECM commands the ignition control circuit Off, interrupting current flow through the primary winding. The collapsing magnetic field created by the primary winding induces a high voltage in the secondary winding, which is connected to the spark plugs.The ignition system on this engine uses ignition coils with integrated power transistors.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

Scan Tool Reference

Control Module References

Special Tools

J-26792 Ignition Spark Tester

Equivalent regional tools: **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

Circuit/System Testing

NOTE: **Do NOT perform this procedure unless directed here from the following diagnostic:**

- **DTC P0300-P0304**
- **Engine Cranks But Does Not Run**

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:T8 Ignition Coil
3. Test for less than 10 Ω between the test points: Ground circuit terminal 1/A & Ground
   - **If 10 Ω or greater**
   1. Disconnect the ground connection:Ground terminal
   2. Test for less than 2 Ω between the test points: Ground circuit terminal 1/A @ Component harness & The other end of the circuit
      - If 2 Ω or greater - Repair the open/high resistance in the circuit.
      - If less than 2 Ω - Repair the open/high resistance in the ground connection.

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- **Go to next step: If less than 10 Ω**

4. Test for less than 10 Ω between the test points: Low Reference circuit terminal 2/B & Ground
    - **If 10 Ω or greater**
    1. Disconnect the electrical connector:K20 Engine Control Module
    2. Test for less than 2 Ω between the test points: Low Reference circuit terminal 2/B @ Component harness & The other end of the circuit
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - Replace the component:K20 Engine Control Module
    - **Go to next step: If less than 10 Ω**
5. Ignition - On / Vehicle - In Service Mode
6. Verify a test lamp turns On between the test points:Ignition circuit terminal 4/D & Ground
    - **If the test lamp does not turn On**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Test for less than 2 Ω between the test points: Ignition circuit terminal 4/D @ Component harness & Output terminal @ Fuse
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - Verify the fuse is OK and there is voltage at the fuse.
    - **Go to next step: If the test lamp turns On**
7. Test or replace the component:T8 Ignition Coil

Component Testing

With Special Tool

NOTE: **Circuit/System Testing must be performed before proceeding with Component Testing.**

1. Ignition/Vehicle - Off
2. Remove the appropriate component:T8 Ignition Coil - Leave the electrical connector connected.
3. Install the special tool: **J-26792** Ignition Spark Tester
4. Engine - Running

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

5. Verify there is spark at the special tool.
    - **If there is no spark**

      Test or replace the component:T8 Ignition Coil

    - **Go to next step: If there is spark**
6. All OK.

Without Special Tool

1. Ignition/Vehicle - Off
2. Swap the two components:T8 Ignition Coil - The original component that set the DTC & Another known good component from the vehicle
3. Engine - Running
4. Verify the scan tool parameter:Cylinder 1-4 Current Misfire Counter = Increments - At the original component location the DTC set.
    - **If the parameter value does not increment**

      Replace the component:T8 Ignition Coil - The original component that set the DTC

    - **Go to next step: If the parameter value increments**
5. Refer to Circuit/System Testing below

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Repair Instructions

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

- **Ignition Coil Replacement**
- For control module replacement, programming and setup, refer to **Control Module References**

INSPECTION/MAINTENANCE SYSTEM CHECK

Diagnostic Instructions

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

Description

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and inspection/maintenance (I/M) emission inspections in order to renew license plates. This is accomplished by viewing the Inspection/Maintenance System Status or Data display on a scan tool. Using a scan tool, the technician can observe the I/M status in order to verify that the vehicle meets the criteria that complies with the local area requirements.

While testing in the I/M System Status mode, some DTCs may occur that are called I/M Test DTCs. An I/M Test DTC is defined as a fault code that is currently commanding the malfunction indicator lamp (MIL) ON, and is stored in non-volatile memory. The intended use of this data is to prevent vehicles from passing I/M inspection without proper repair to the vehicle. These fault codes are not erasable from any scan tool command or by disconnecting power to the controller. I/M Test DTCs are supported by all emissions related electronic control units (ECUs), such as engine control modules (ECMs), transmission control modules (TCMs), fuel pump control modules (FPCMs), etc. An I/M Test DTC will not be stored or erased from the ECU except at the end of trip processing which occurs 5 s after ignition OFF.

Conditions for Updating the I/M System Status

NOTE: **New vehicles may not report an Inspection/Maintenance System Check pass or fail status for certain post catalyst oxygen sensor or heated oxygen sensor 2 diagnostics prior to 700 miles. After replacing a catalytic converter on a vehicle with greater than 700 miles, it may require up to an additional 700 miles to prevent a false failure status.**

Each system requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a DTC. A system monitor is complete when either all of the DTCs comprising the monitor have Run and Passed, or any one of the DTCs comprising the monitor have illuminated the MIL. Once all of the tests are completed, the Inspection/Maintenance System Status or Data will indicate YES in the Completed or Value column.

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

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the tests.
- The battery has been disconnected or discharged below operating voltage.
- The control module power or ground has been interrupted.
- The control module has been reprogrammed.
- The control module DTCs have been cleared as part of a service procedure.

Conditions for Clearing I/M Test DTCs

1. Only the OBD II System can erase I/M Test DTCs. The OBD II system must determine that the malfunction that caused the I/M Test DTC to be stored is no longer present and is not commanding the MIL. Each of the following represents ways to clear an I/M Test DTC:
    - If the MIL goes off due to 3 passing drive cycles, and the scan tool code clear is not used, the I/M Test DTC is erased at power down of the last drive cycle.
    - If a scan tool code clear is used to turn OFF the MIL, the I/M Test DTC is not erased, therefore the DTC must PASS and not FAIL during the drive cycle. The I/M Test DTC is erased at power down of the drive cycle.
    - If the controller is reflashed/reprogrammed, all I/M Test DTCs are erased.
2. For the OBD II System to run a single drive cycle for clearing an I/M Test DTC, all of the following conditions must occur:
    - Cumulative time of engine run time greater than 600 s.
    - Cumulative vehicle operation above 40 km/h (25 mph) over 300 s.
    - Continuous vehicle idle greater than 30 s.
    - Ignition OFF for 5 s to allow the code to clear.

Monitored Emission Control Systems

The OBD II system monitors all emission control systems that are on-board, but not all vehicles need every possible emission control system. For example, a vehicle may not be equipped with secondary air injection (AIR) or exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following; if equipped:

- The air conditioning system
- The catalytic converter efficiency
- Comprehensive component monitoring - Emission related inputs and outputs
- The evaporative emission (EVAP) system
- The fuel delivery system
- Heated catalyst monitoring
- Misfire monitoring
- The oxygen sensor system (O2S or HO2S)
- The oxygen sensor heater system (HO2S heater)

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For the specific DTCs required for each system, refer to **Inspection/Maintenance (I/M) System DTC Table**. Systems such as misfire and comprehensive components may not be listed in a system status list. These tests run continuously and do not require an I/M System Status indicator.

Diagnostic Aids

The Inspection/Maintenance System Status or Data display provides an indication of when the control module has completed the required tests. This does not necessarily mean that the test has passed, only that a decision was made. If the diagnostic fails, a DTC will indicate the failure. If a failure indication is present for a DTC associated with one of the I/M regulated systems, it may prevent other required tests from running. For example, a DTC for the control circuit of the EVAP purge solenoid may not be listed in the Inspection/Maintenance System DTC Table because it is a continuous test. If this DTC is set, the Active Tests for the EVAP system may not run.

The Inspection/Maintenance System Status or Data information may be useful for a technician to determine if diagnostics have run when verifying repairs.

Circuit/System Verification

Review the Inspection/Maintenance System Status or Data indicators. All Inspection/Maintenance System Status or Data indicators should report YES, and no I/M Test DTCs should be present.

Circuit/System Testing

NOTE: **Many DTC related repairs will instruct the technician to clear the DTC information. Clearing the DTC will reset the**

Inspection/Maintenance System Status or Data indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.

1. Observe the Engine DTC information with a scan tool. Verify no DTCs are present.
    - If a DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.
    - If a control module re-program or other repair is required, perform the **Inspection/Maintenance Complete System Set Procedure**.
3. Observe the Inspection/Maintenance System Status or Data indicators.
    - If any Inspection/Maintenance System Status or Data indicators report NO, perform the **Inspection/Maintenance Complete System Set Procedure**.
4. Observe the I/M Test DTC information with a scan tool. Verify there are no I/M Test DTCs present.
    - If an I/M Test DTC is set and all of the Inspection/Maintenance System Status or Data indicators are Yes, there is no need to perform the Complete System Set Procedure. Diagnose the DTC using the **Diagnostic Trouble Code (DTC) List - Vehicle** and refer to Conditions for Clearing the I/M Test DTCs.
    - If an I/M Test DTC is set and the Inspection/Maintenance System Status or Data indicators are NO, diagnosis the DTC and perform the **Inspection/Maintenance Complete System Set Procedure**.

INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE

Diagnostic Instructions

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

Description

The purpose of the Inspection/Maintenance Complete System Set Procedure is to satisfy the enable criteria necessary to execute all of the I/M readiness diagnostics and complete the drive cycles for those particular diagnostics. When all I/M monitored diagnostic tests are completed, the I/M System Status indicators are set to YES. Perform the Inspection/Maintenance Complete System Set Procedure if any I/M System Status indicators are set to NO.

Conditions for Meeting a Cold Start

- The ignition voltage between 11 - 18 V.
- The barometric pressure is more than 75 kPa (10.9 psi).
- The start-up engine coolant temperature (ECT) is between 4 - 30Ã‚Â°C (39 - 86Ã‚Â°F).
- The start-up intake air temperature (IAT) is between 4 - 30Ã‚Â°C (39 - 86Ã‚Â°F).
- The difference between the IAT and the ECT is less than or equal to 6Ã‚Â°C (43Ã‚Â°F).
- The ambient air temperature is between 4 - 30Ã‚Â°C (39 - 86Ã‚Â°F).
- The fuel level is between 15 - 85%.

Circuit/System Verification

1. Verify that all I/M System Status indicators report YES, and that no I/M Test DTCs are present.
    - **If any I/M Test DTCs are set**

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

    - **Go to next step: If no I/M Test DTCs are set**
2. All OK.

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

1. Ensure that the vehicle meets the conditions for a cold start listed above.
2. The evaporative emission inspection/maintenance system status indicator should display YES.
   - If the inspection/maintenance system status indicator displays NO, perform the Service Bay Test, if applicable. If the Service Bay Test is NOT available, it may take up to 6 drive cycles, with up to 17 h between drive cycles, for the inspection/maintenance system status indicator to transition to YES.
3. The O2S Heater inspection/maintenance system status indicator should display YES.
   - If the O2S Heater inspection/maintenance system status indicator displays NO, ensure that the ignition has been turned OFF for at least 10 h.
4. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc.
5. Set the vehicle parking brake and ensure the vehicle is in Park for automatic transmission or Neutral for manual transmission.
6. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc.
7. Start and idle the engine for at least 2 min and until 65Ã‚Â°C (149Ã‚Â°F) is achieved.
8. Run the engine for 6.5 min within the following conditions:
   - MAF parameter between 4 - 30 g/s
   - Engine speed steady between 1, 000 - 3, 000 RPM
9. Return the engine to idle for 1 minute.
10. Apply and hold the brake pedal, and shift to Drive for automatic transmission, or apply the clutch pedal for manual transmission and operate the vehicle within the following conditions for 2 min:
    - Depress the accelerator pedal until throttle position sensor angle is more than 2 %.
    - Mass air flow signal between 15 - 30 g/s
    - RPM steady between 1, 200 - 2, 000 RPM

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

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

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

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

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19. Shift to Park for automatic and apply the parking brake, or neutral and release clutch pedal for manual.

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

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

NOTE: **An I/M Test DTC will not be stored or erased from the ECU except at the end of trip processing which occurs 5 s after ignition OFF.**

22. Observe the I/M Test DTC information with a scan tool. Verify there are no I/M Test DTCs present.
    - If an I/M Test DTC is set, diagnose the DTC using the **Diagnostic Trouble Code (DTC) List - Vehicle** , and refer to **Inspection/Maintenance System Check** for clearing I/M Test DTCs.
    - If an I/M Test DTC is set and the I/M System Status indicators are NO, diagnosis the DTC and perform the **Inspection/Maintenance Complete System Set Procedure**.
23. Observe the engine DTC information with a scan tool. Verify no DTCs are present.
    - If a DTC is set, diagnose using the **Diagnostic Trouble Code (DTC) List - Vehicle** . After repairs, perform the **Inspection/Maintenance Complete System Set Procedure** to verify no further DTCs are set.

POOR FUEL FILL QUALITY

Problem	Causes
DEFINITION: During the fueling process a continual, occasional, or no-fuel nozzle shut-off condition has occurred.	
Difficult to fill	• Fuel fill limiter vent valve stuck closed • Evaporative emission (EVAP) canister restricted • EVAP vent valve stuck closed • Hose between canister and canister vent solenoid twisted or kinked if applicable • High fuel temperature • Fuel filler hose is kinked • Faulty dispensing nozzle • Ignition switch ON, vent valve closed
Over fill	• Fill limiter vent valve stuck open or leaking • Fuel inlet check valve stuck open

Problem	Causes
Pre-mature shut-off of the fuel dispensing nozzle occurs immediately after engaging dispensing nozzle, tank empty	• Restricted vapor lines or fuel fill pipe • High fuel temperature • Inlet check valve at tank stuck closed, fill pipe full of fuel • Fuel tank full, gauge not accurate
Pre-mature shut-off of the fuel dispensing nozzle, more than 1/8 of tank capacity dispensed	• Kinked, pinched or plugged lines in fuel tank vent system • EVAP vent valve stuck closed or restricted • EVAP canister restricted • Fuel limiting vent valve stuck closed or obstruction at top of fuel tank
Fuel Spitback	• Restricted EVAP canister • High fuel temperature • Ignition switch ON, EVAP vent valve closed

INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE

System	DTCs Required to Set System Status to YES
If an I/M System Status indicator did NOT update to YES during the **Inspection/Maintenance Complete System Set Procedure**, review each indicator and reference this table to determine each DTC associated with the I/M System Status Indicator. Each DTC listed below has specific conditions that must be met for the diagnostic to run. Included within the conditions are additional DTCs, which if set, may inhibit the DTCs listed below from running. Reviewing and operating the vehicle within the Conditions for Running for each DTC listed below will allow the I/M System Status Indicators to transition to YES.	
Boost	**DTC P0234 or P0299**
Catalyst	**DTC P0420**
EGR/CMP	• **DTC P0011 or P0014** • **DTC P05CC or P05CE**
EVAP	• **DTC P0442** • **DTC P0446** • **DTC P0455**
Fuel System	• **DTC P219A** • **DTC P0089, P00C6, P228C, or P228D**
HO2S	• **DTC P0030-P0032, P0036-P0038, P0054, P0135, P0141, P103B, or P103C** • **DTC P0131, P0132, P015A, P015B, P223C, or P223E**
H02S/02S	**DTC P0137, P0138, P013A, P013B, P013E, P013F, P2270, or P2271**

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 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 35Ã‚Â°C (95Ã‚Â°F) at start-up.
- The intake air temperature (IAT) is less than 34Ã‚Â°C (93Ã‚Â°F) at start-up.
- The ambient air temperature is between 0 - 40Ã‚Â°C (32 - 104Ã‚Â°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.

   - **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.

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2018 ENGINE PERFORMANCE

Engine Controls And Fuel - 2.0L (LTG) - 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 0 km/h (0 MPH)

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.

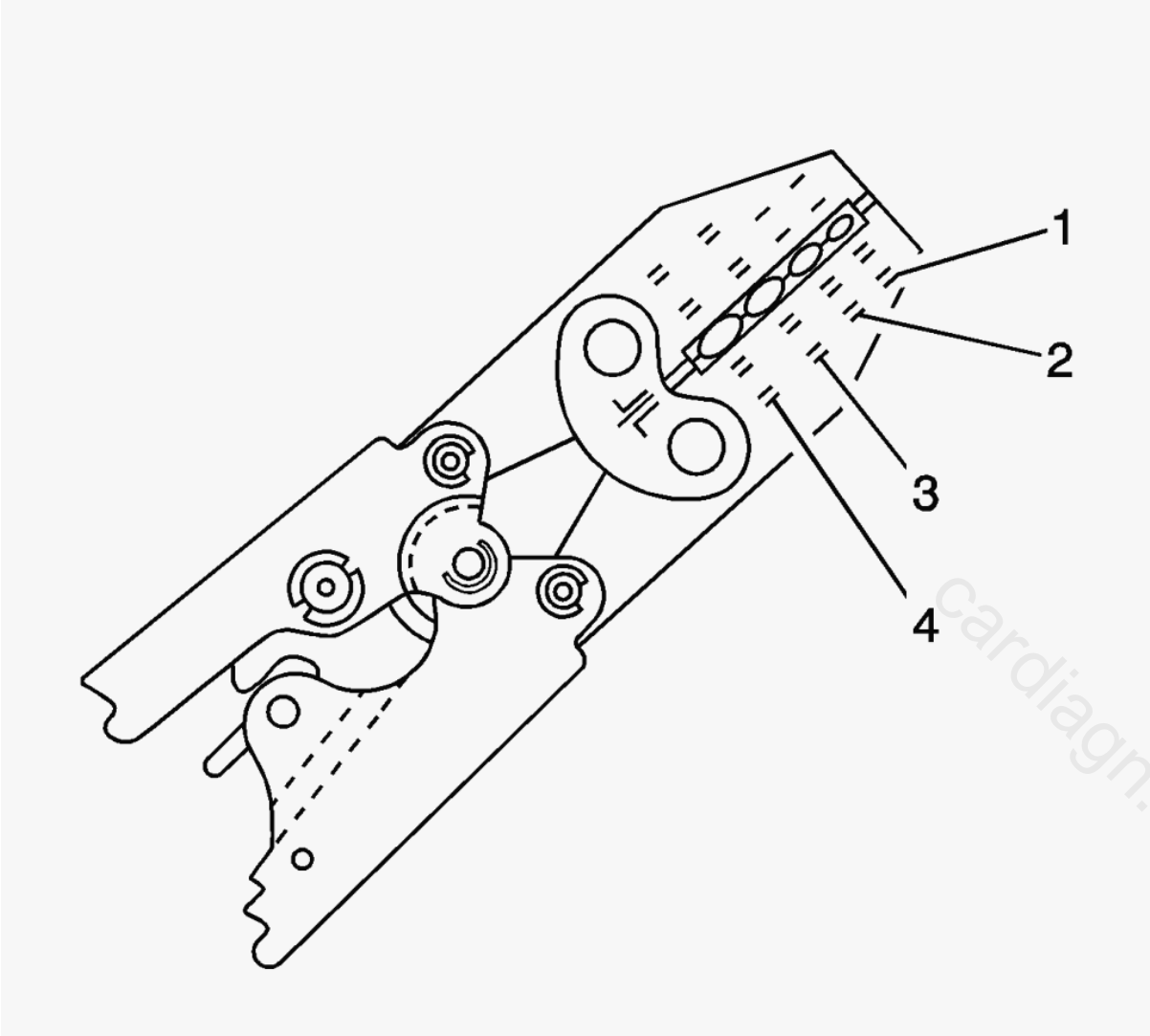

Fig. 1: Splice Sleeve Crimping Tool With 4 Crimp Nests
Courtesy of GENERAL MOTORS COMPANY

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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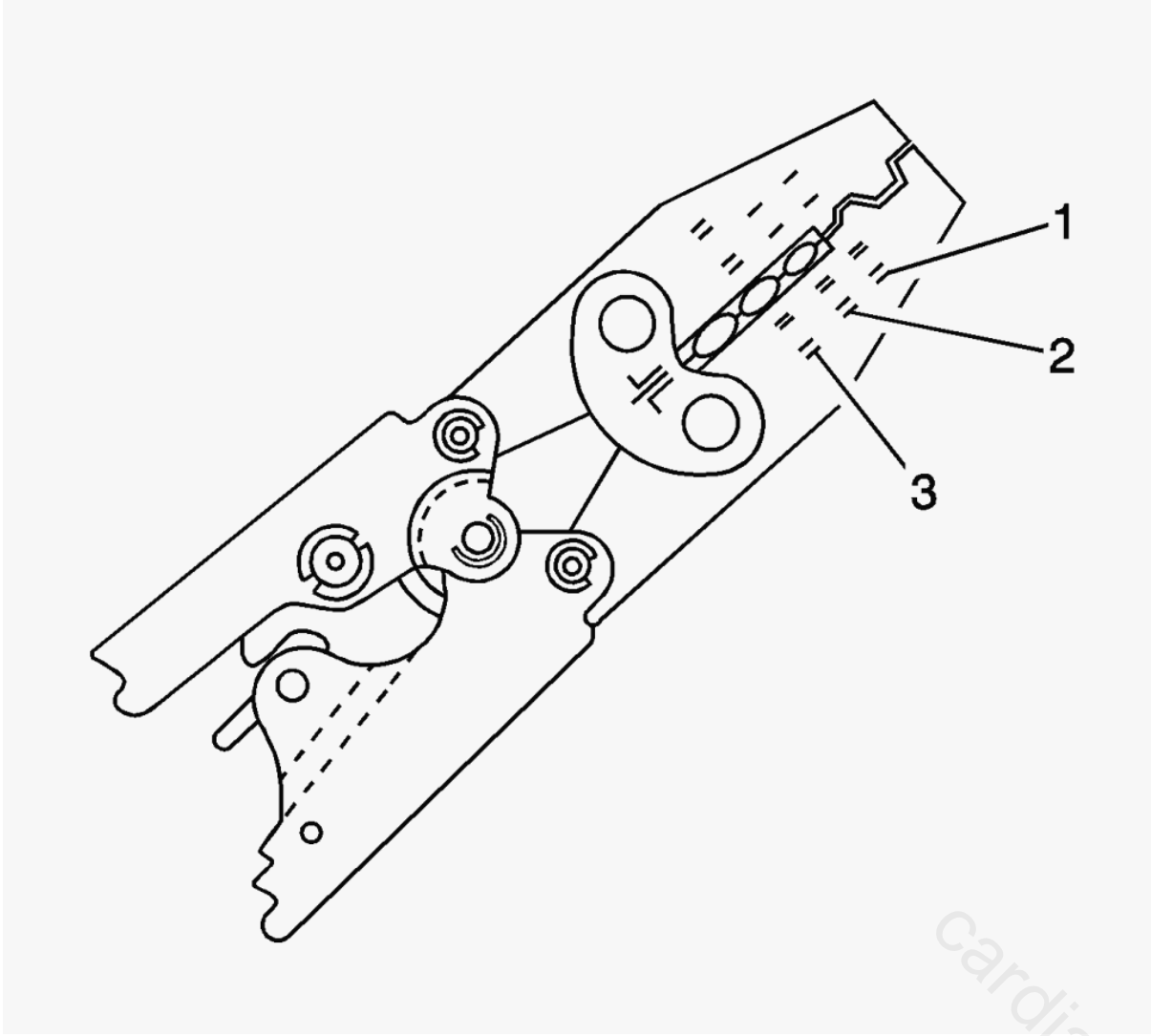

Fig. 2: Splice Sleeve Crimping Tool With 3 Crimp Nests
Courtesy of GENERAL MOTORS COMPANY

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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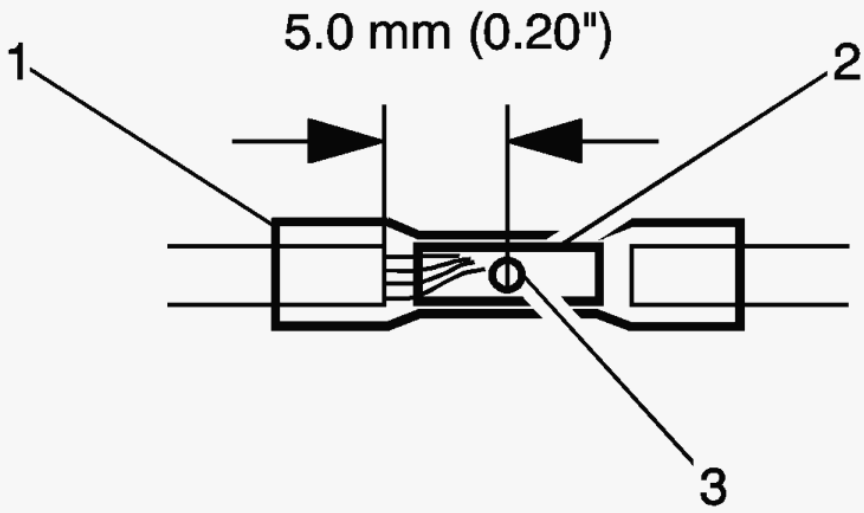

Fig. 3: Identifying DuraSeal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

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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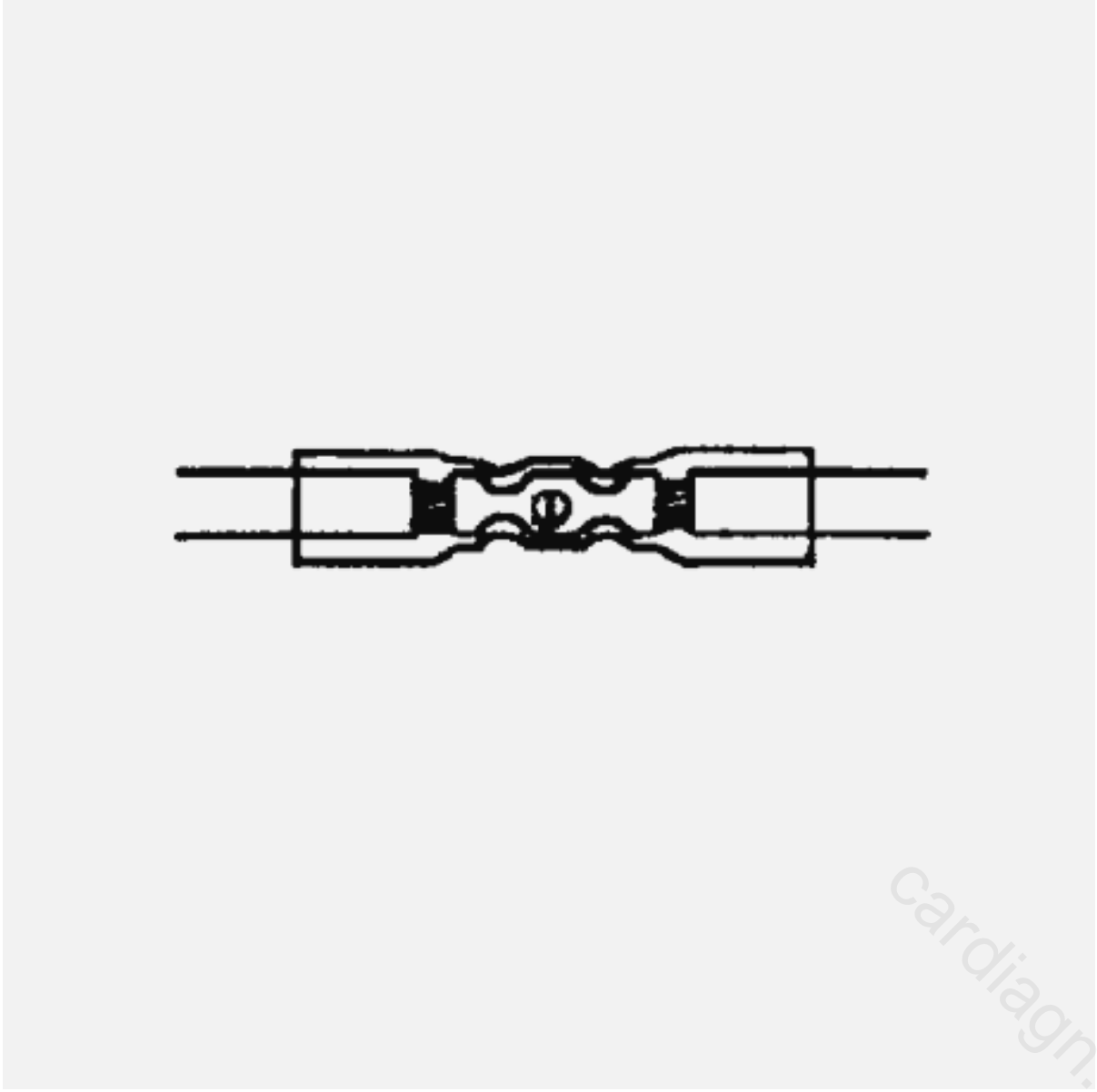

Fig. 4: Identifying Crimped Duraseal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

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: Crimped Duraseal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

12. Using the heat torch, apply heat to the crimped area of the barrel.
13. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
    - The tubing will shrink completely as the heat is moved along the insulation.
    - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

Weatherpack™ Wiring Repair

NOTE: **Some replacement pigtail connectors may be delivered without the terminated leads installed into the connector. For Weatherpack™ connectors, all terminated leads included in the package should to be installed into the connector. If the connector end view shows that a terminal is not occupied, the extra terminated lead (s) need to be installed and the end (s) sealed using a DuraSeal splice sleeve and taped back into the harness.**

1. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different gauges.

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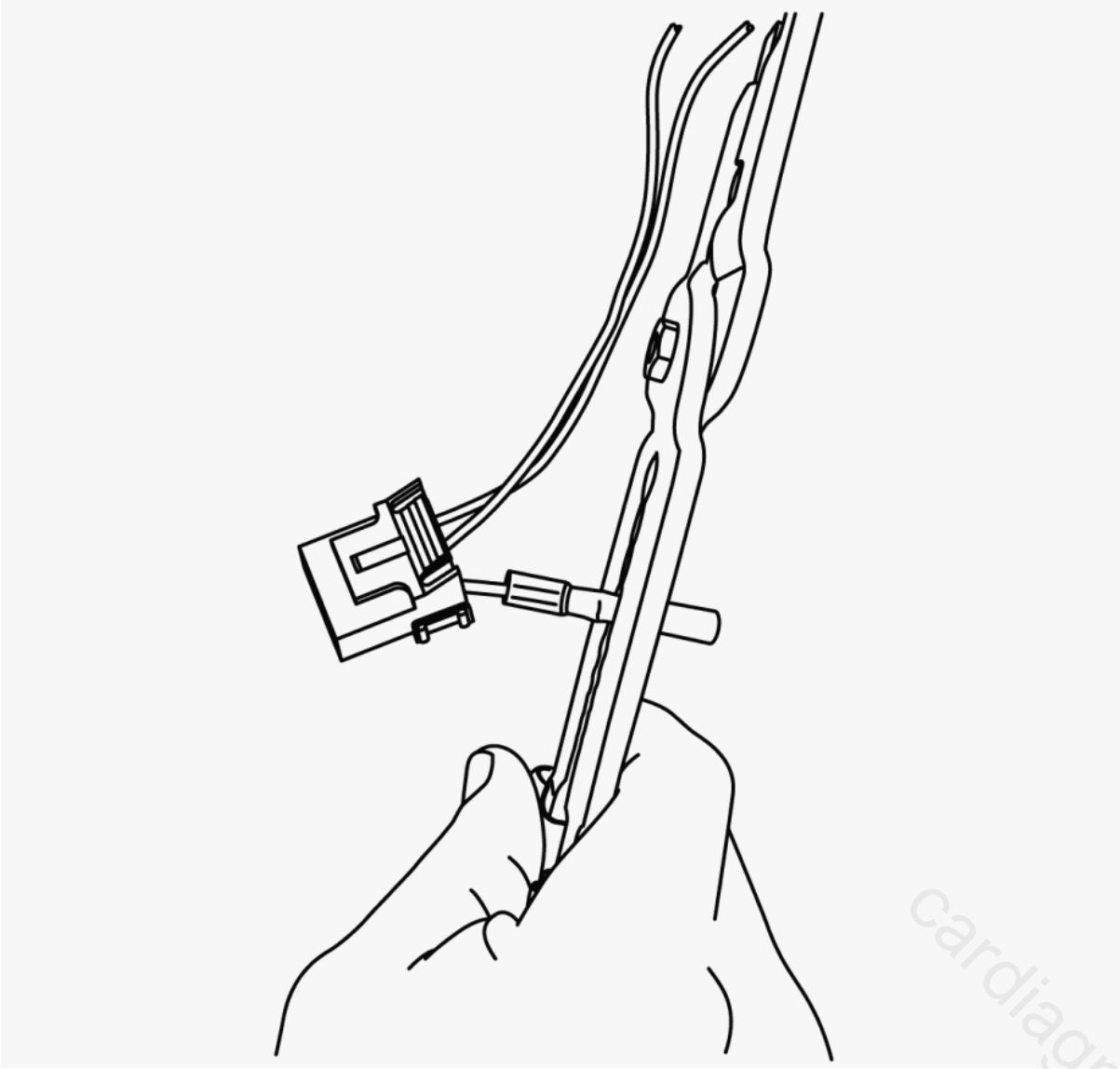

Fig. 6: Tightly Close Handles Of Crimp Tool
Courtesy of GENERAL MOTORS COMPANY

2. Tightly close the handles of the crimp tool until the crimper handles open when released.

   The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Holding the DuraSEAL with 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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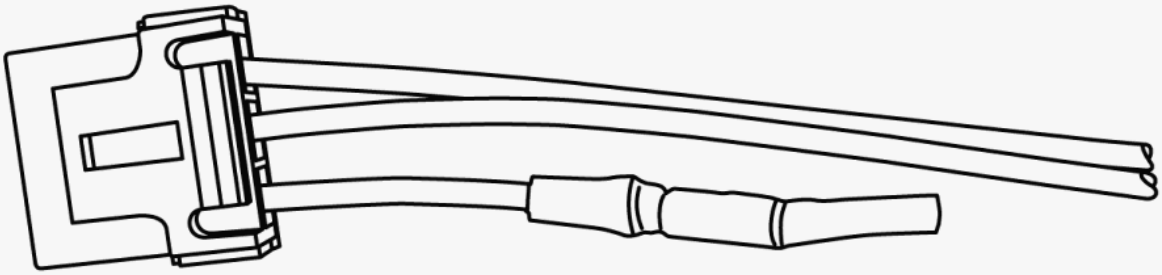

Fig. 7: Heat To Crimped Area Of Barrel
Courtesy of GENERAL MOTORS COMPANY

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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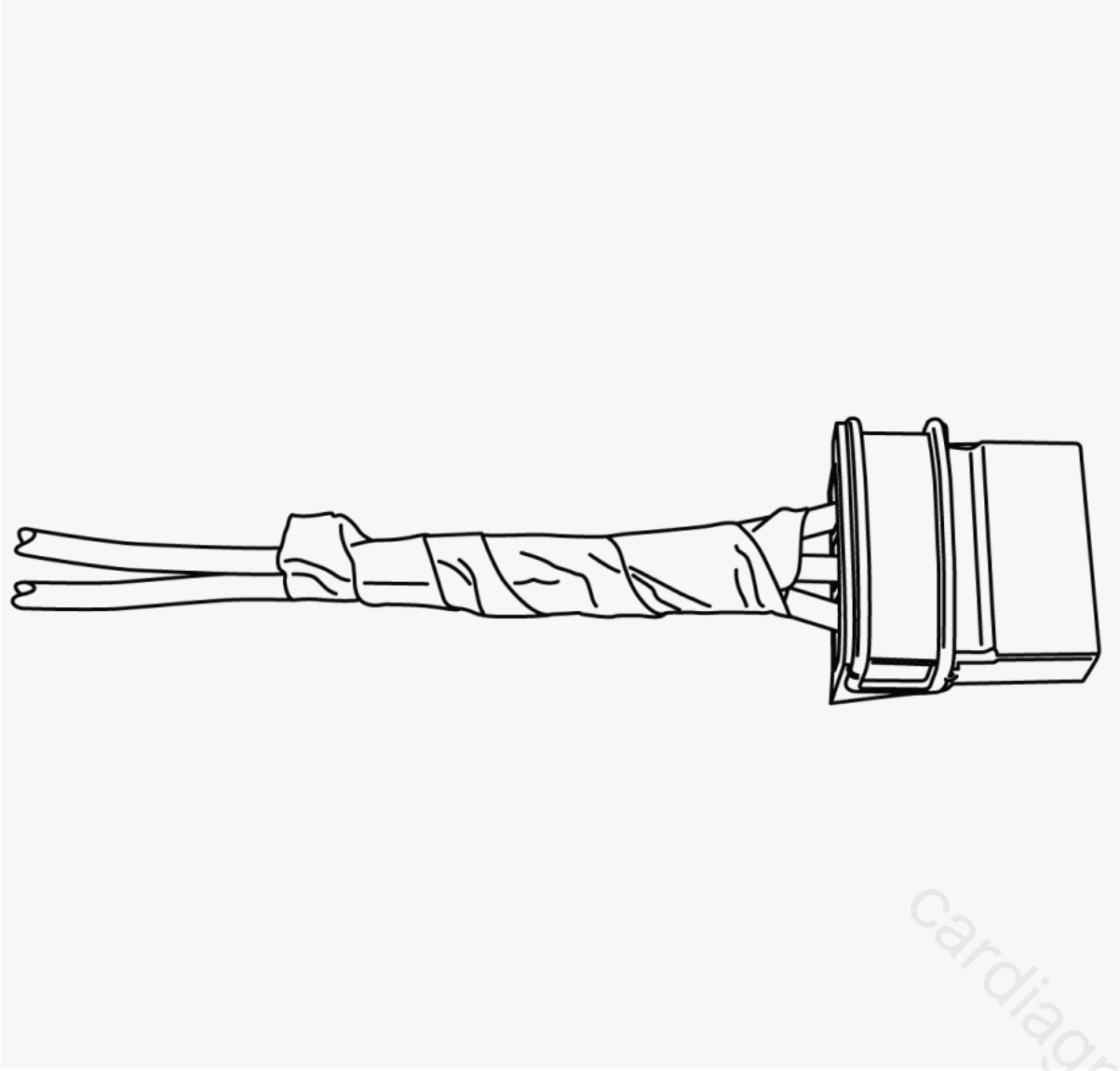

Fig. 8: Taping Extra Terminated Leads Back Into Harness
Courtesy of GENERAL MOTORS COMPANY

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.

ENGINE CONTROL MODULE REPLACEMENT

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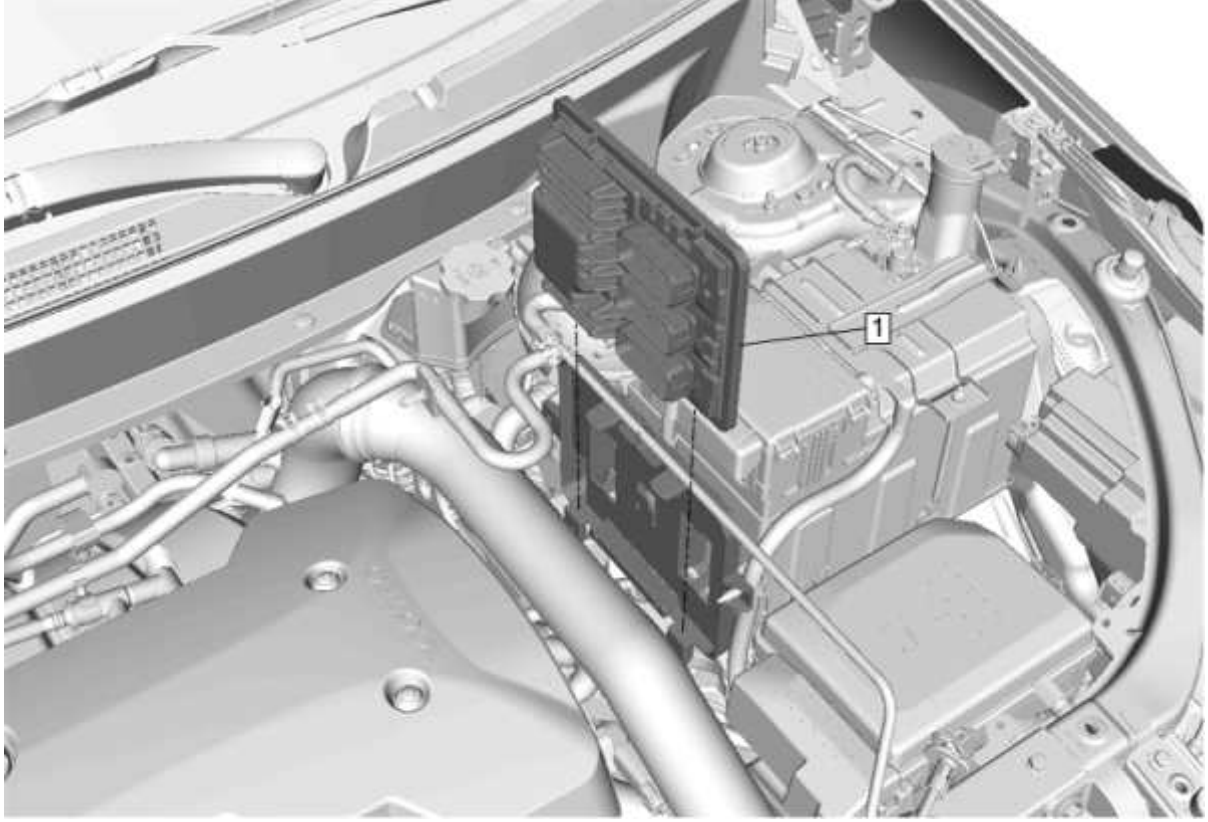

Fig. 9: Engine Control Module
Courtesy of GENERAL MOTORS COMPANY

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

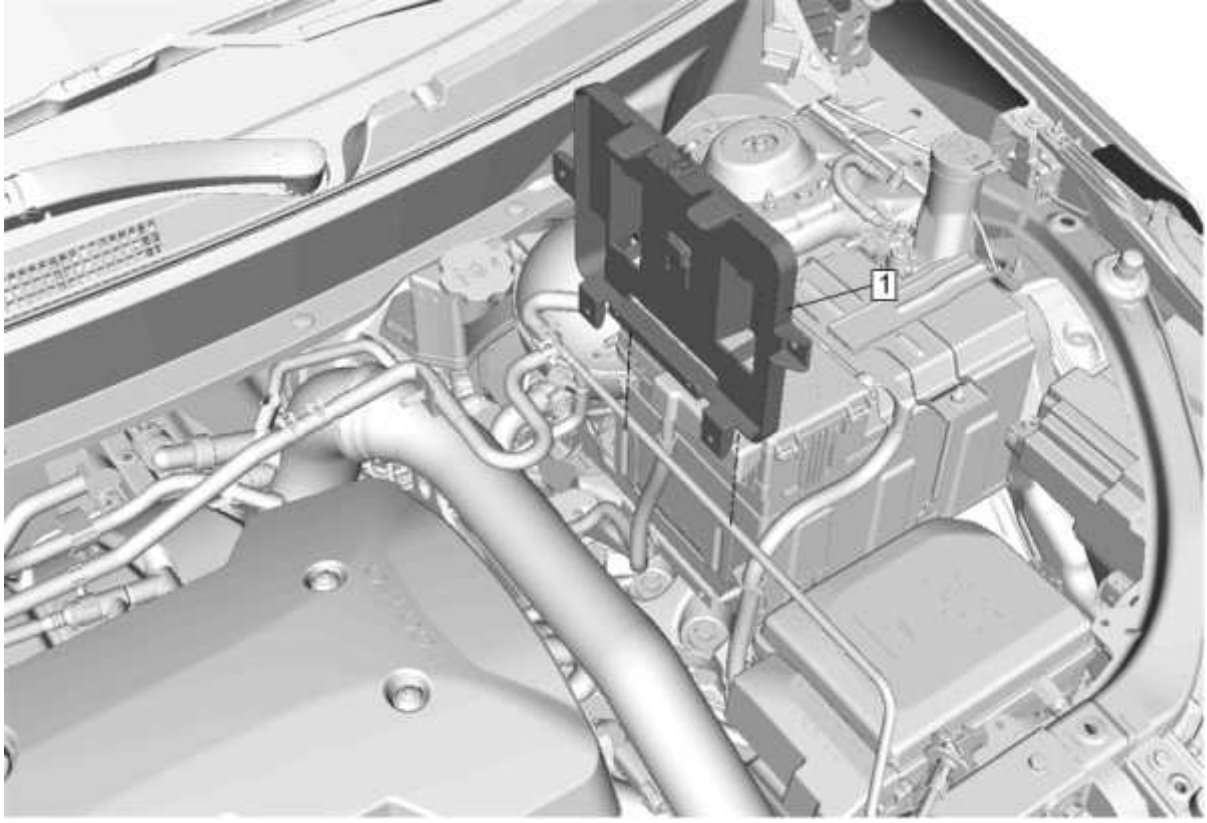

Fig. 10: Engine Control Module Bracket
Courtesy of GENERAL MOTORS COMPANY

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 (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)** 3. Remove wiring harness from engine control module bracket.	
1	Engine Control Module Bracket **Procedure** Release retaining tab to remove bracket from battery tray.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

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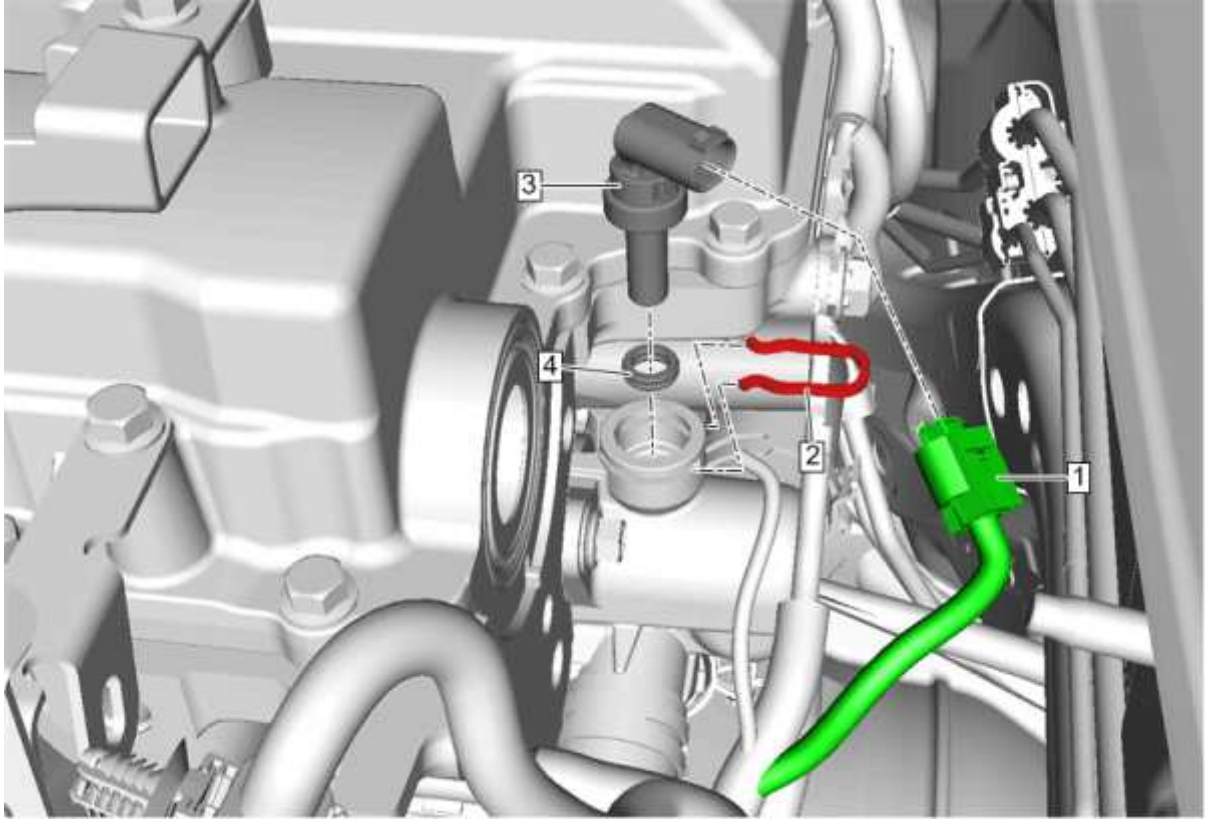

Fig. 11: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Cooling System Draining and Filling (GE 47716) Cooling System Draining and Filling (Static) 2. Vacuum Pump Replacement	
1	Electrical Connector
2	Engine Coolant Temperature Sensor Retainer
3	Engine Coolant Temperature Sensor
4	Engine Coolant Temperature Sensor Seal **Procedure** The seal is reusable, inspect the seal and replace if damaged.

ENGINE OIL PRESSURE SENSOR REPLACEMENT

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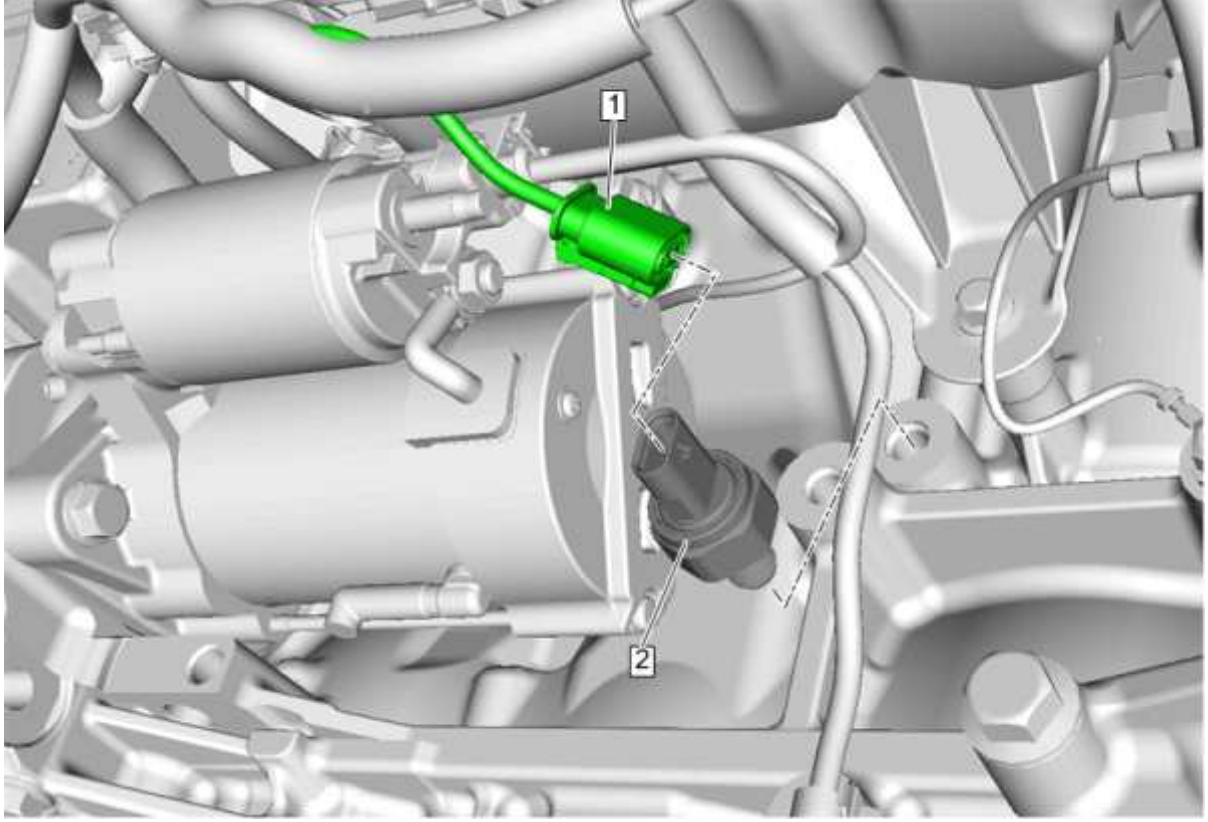

Fig. 12: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Power Transfer Unit Case Replacement (M3D Transmission with LTG Engine)	
1	Electrical Connector
2	Engine Oil Pressure Sensor **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten** 35 N.m (26 lb ft)

INTAKE AIR PRESSURE AND TEMPERATURE SENSOR REPLACEMENT

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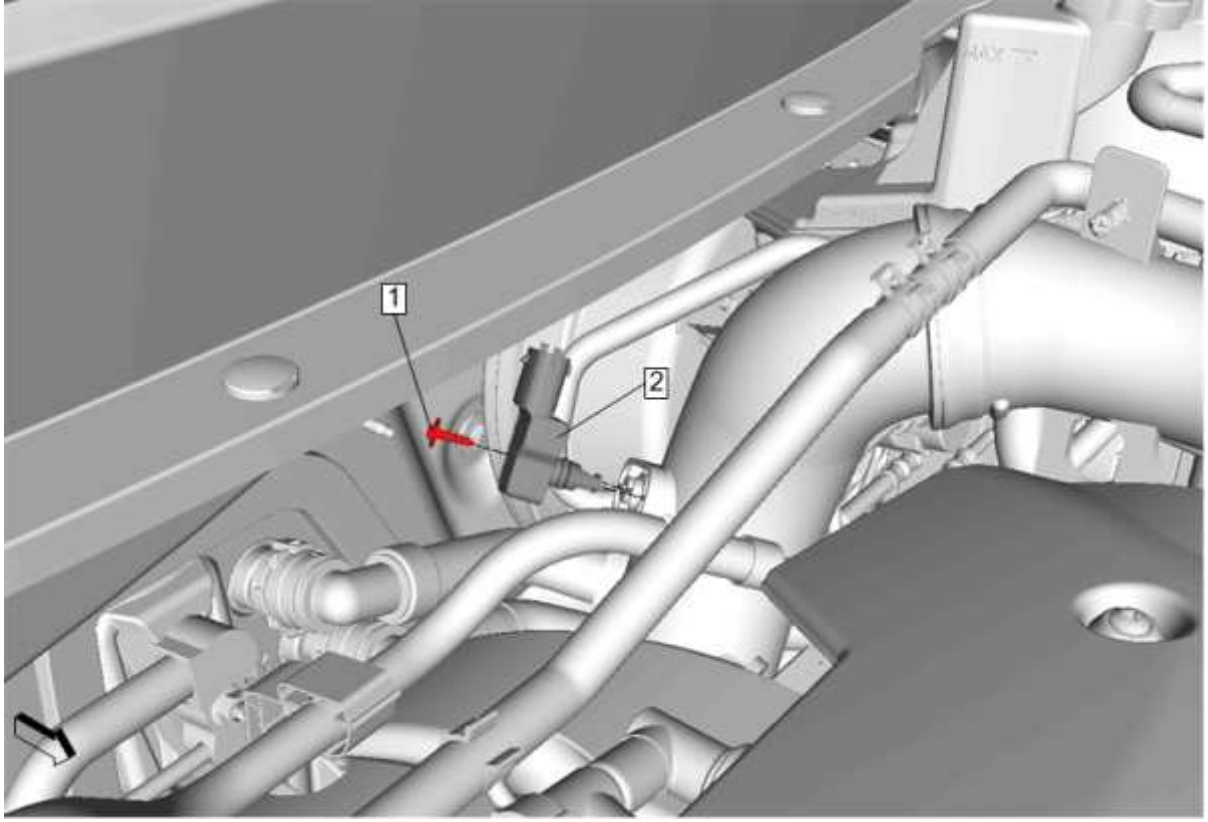

Fig. 13: Intake Air Pressure and Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

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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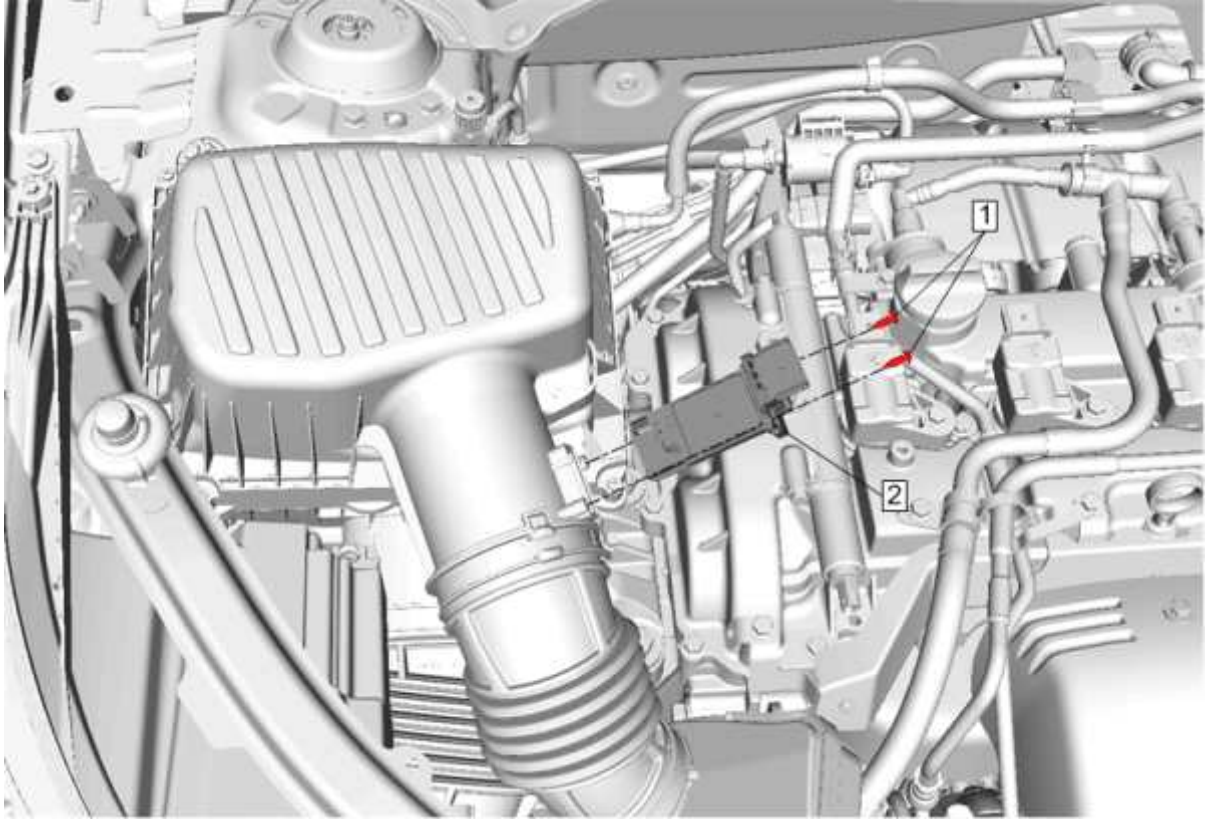

Fig. 14: Mass Airflow Sensor
Courtesy of GENERAL MOTORS COMPANY

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**

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

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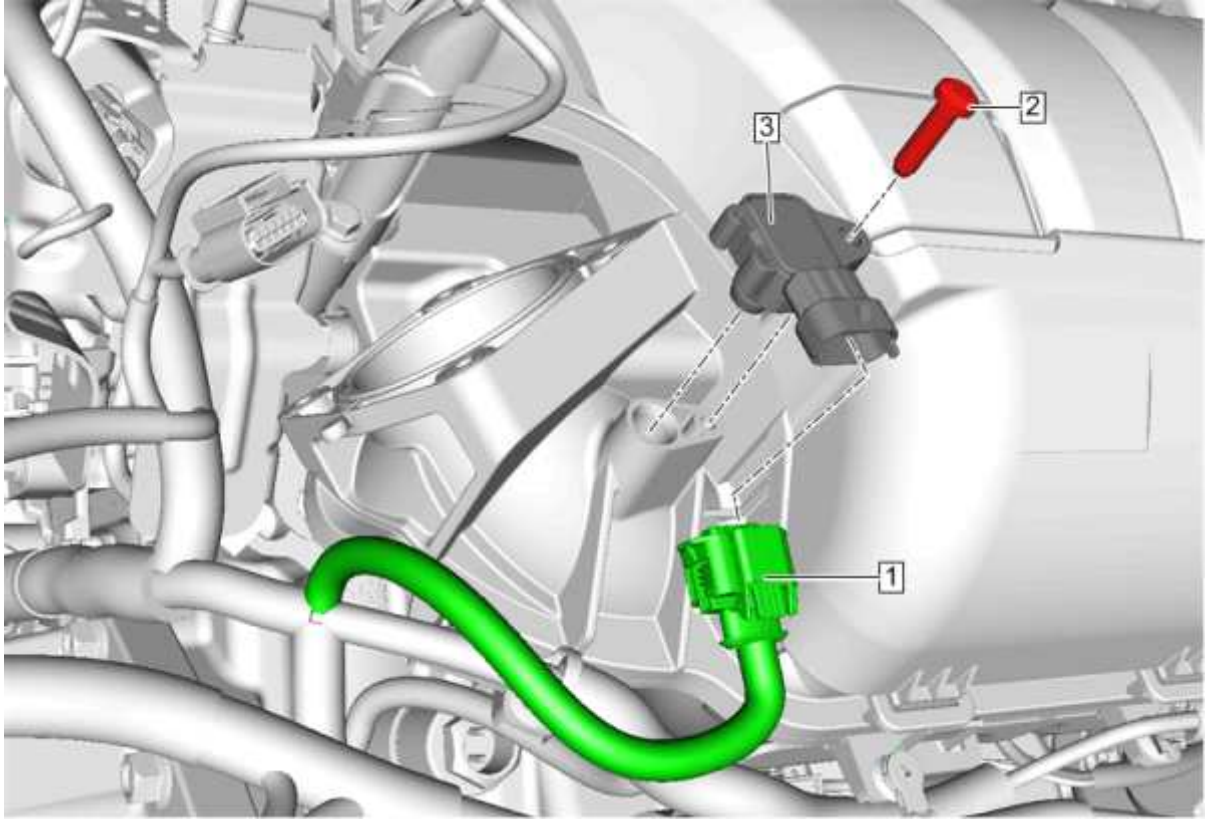

Fig. 15: Manifold Absolute Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Throttle Body Assembly Replacement	
1	Electrical Connector
2	Manifold Absolute Pressure Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 5 N.m (44 lb in)
3	Manifold Absolute Pressure Sensor **Procedure** 1. The seal is reusable, inspect the seal and replace if damaged. 2. Perform the intake system learned values reset. Intake System Learned Values Reset

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 1

Special Tools

J-39194 Oxygen Sensor Wrench

Equivalent regional tools:Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools)

Removal Procedure

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**

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gloves to avoid personal injury.

CAUTION: **Refer to Heated Oxygen and Oxygen Sensor Caution .**

CAUTION: **The use of excessive force may damage the threads in the exhaust manifold/pipe.**

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**

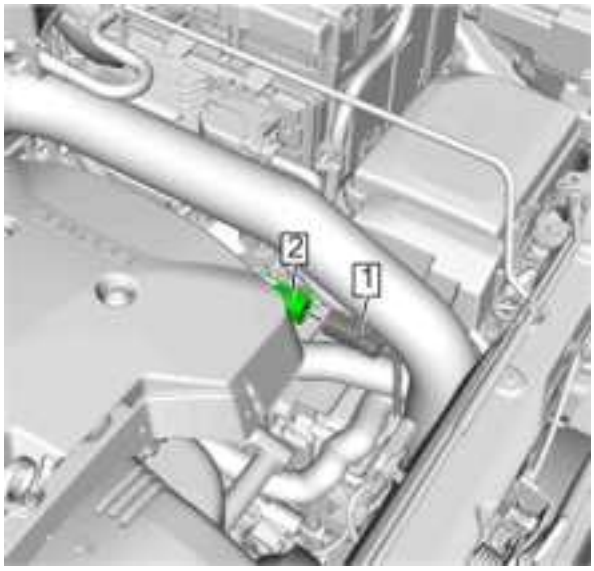

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Fig. 16: Heated Oxygen Sensor Wiring Connector
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the heated oxygen sensor wiring connector (1) from the engine wiring harness connector (2).

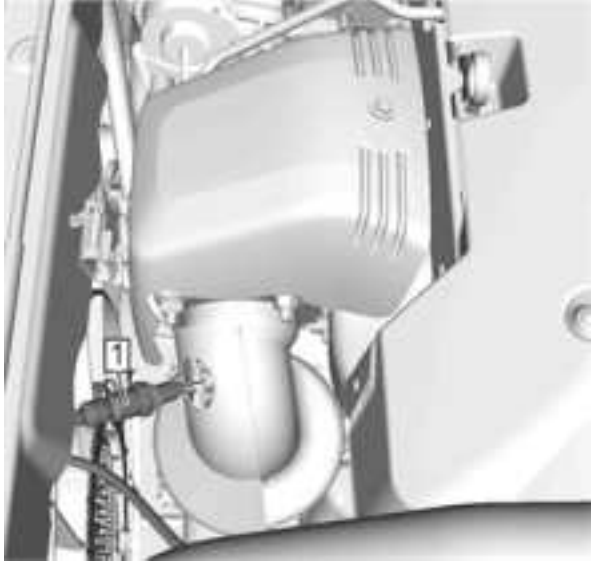

Fig. 17: Heated Oxygen Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Use the **J-39194** wrench to remove the heated oxygen sensor (1).

Installation Procedure

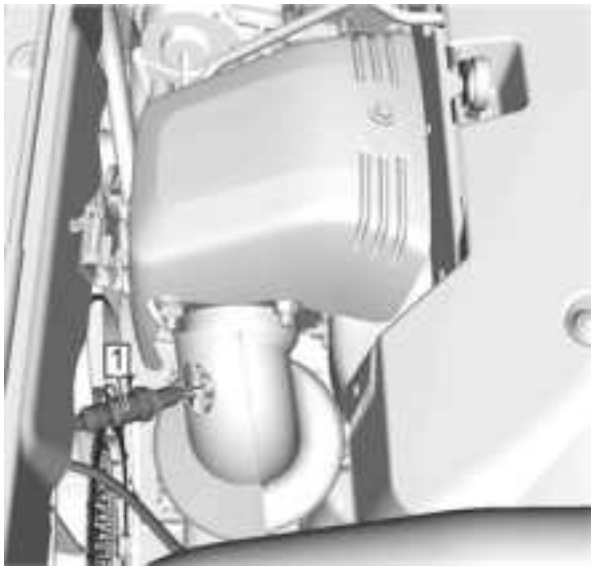

Fig. 18: Heated Oxygen Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener Tightening Caution .**

1. Use the **J-39194** wrench to install the heated oxygen sensor (1) and tighten to 42 N.m (31 lb ft).

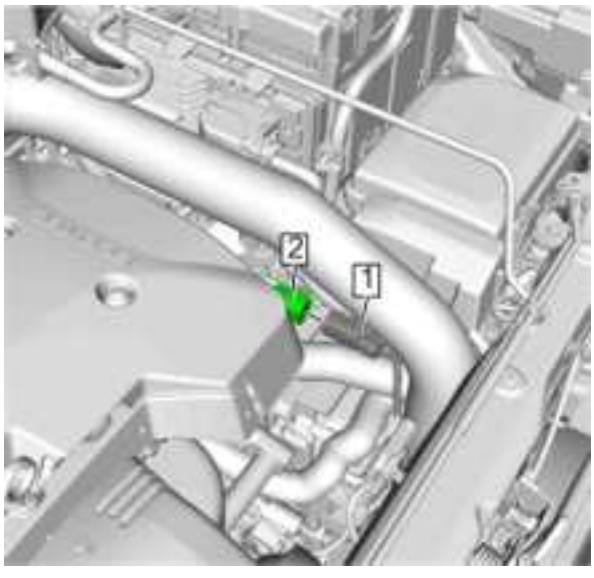

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Fig. 19: Heated Oxygen Sensor Wiring Connector
Courtesy of GENERAL MOTORS COMPANY

2. Connect the heated oxygen sensor wiring connector (1) to the engine wiring harness connector (2).

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

3. If replacing, perform the HO2S heater resistance learned values reset. HO2S Heater Resistance Learned Values Reset

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 2

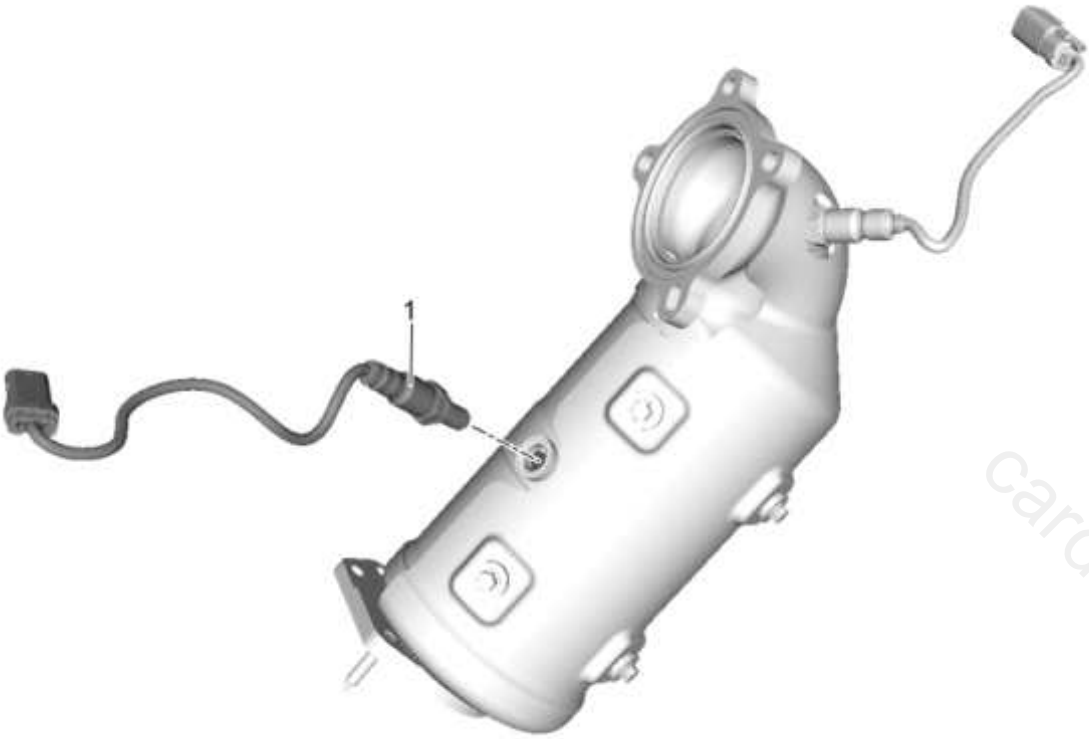

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Fig. 20: Heated Oxygen Sensor - Sensor 2
Courtesy of GENERAL MOTORS COMPANY

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 Warm Up Three-Way Catalytic Converter Replacement (LTG)	

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** 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** **J-39194** Oxygen Sensor Wrench Equivalent regional tools:**Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools)**

ACCELERATOR PEDAL WITH POSITION SENSOR ASSEMBLY REPLACEMENT

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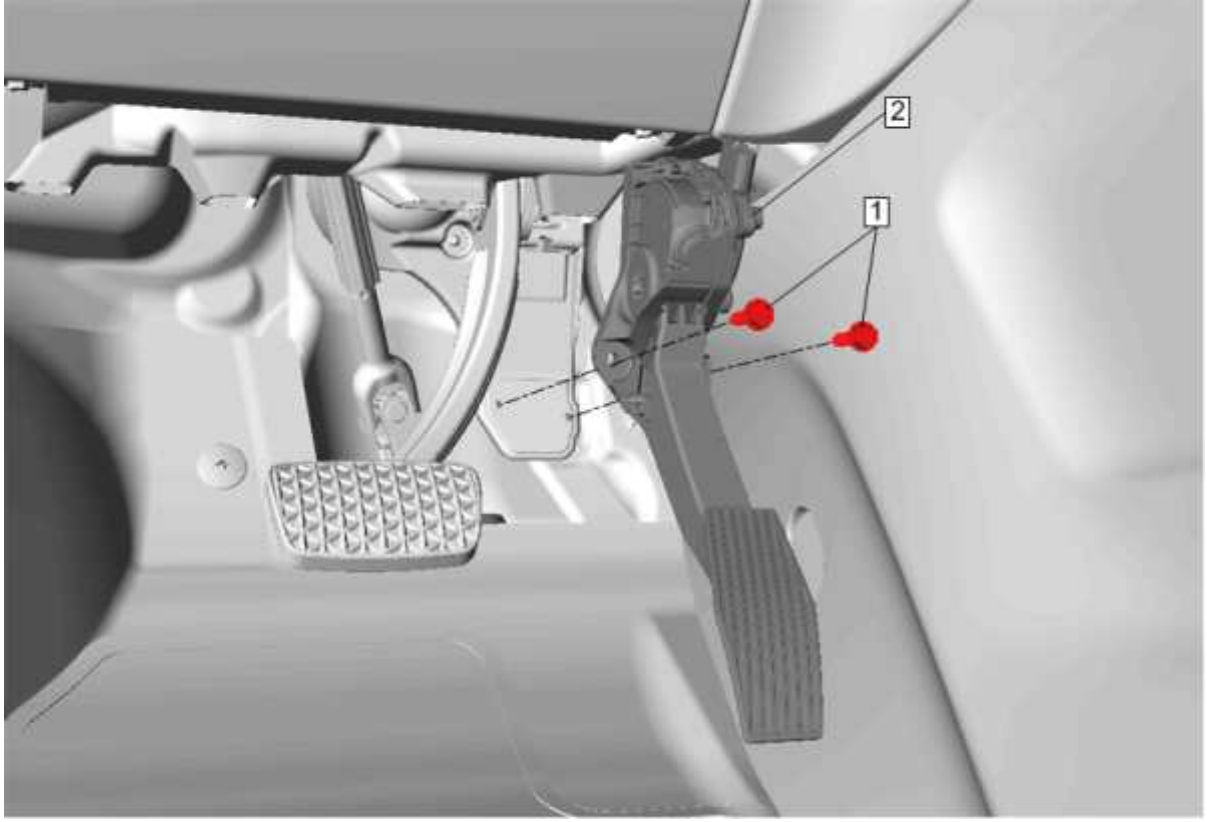

Fig. 21: Accelerator Pedal With Position Sensor Assembly
Courtesy of GENERAL MOTORS COMPANY

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.

THROTTLE BODY ASSEMBLY REPLACEMENT

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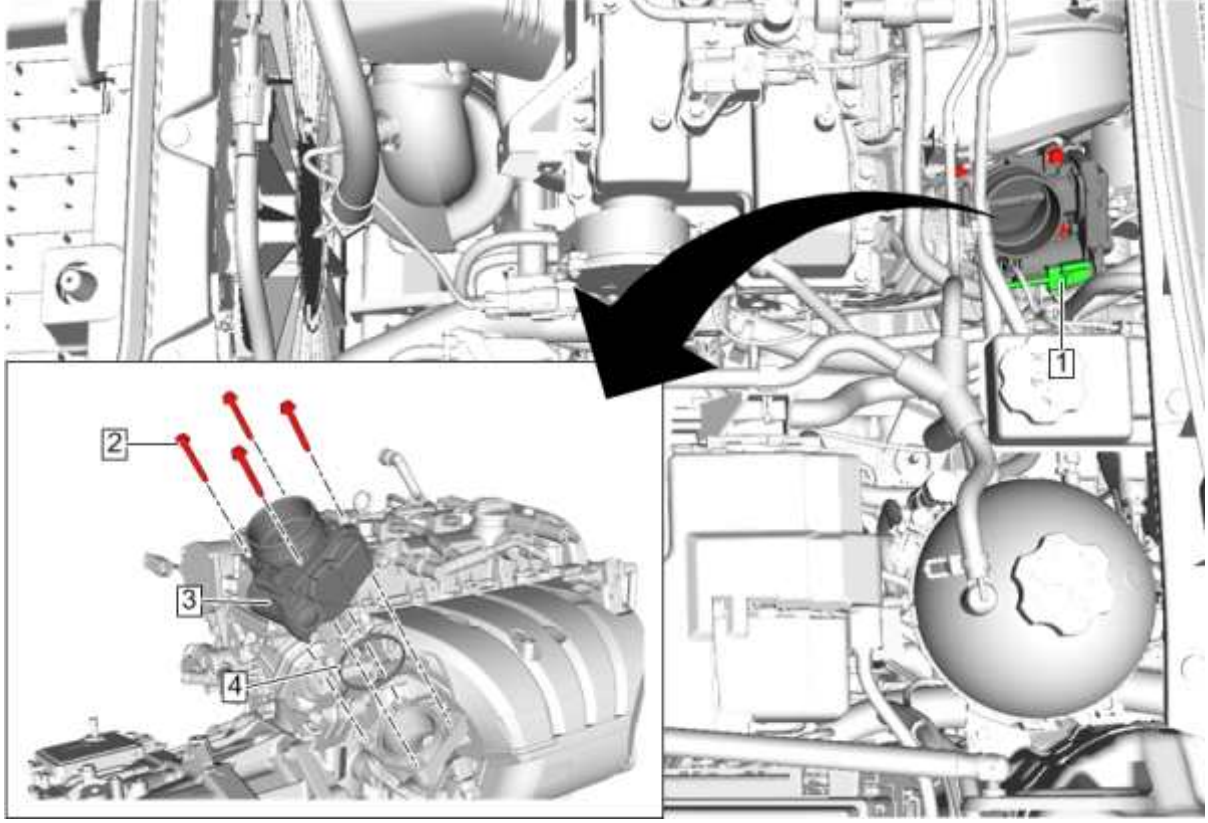

Fig. 22: Throttle Body Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	CAUTION: **Do not use solvent of any type when cleaning the gasket surfaces on the intake manifold and the throttle body assembly, as damage to the gasket surfaces and throttle body assembly may result.** **Use care in cleaning the gasket surfaces on the intake manifold and the throttle body assembly, as sharp tools may damage the gasket surfaces.** **CAUTION:** **Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.** **NOTE:** **Do NOT prop open the throttle blade with the ignition key in the ON position as it MAY set a diagnostic trouble code (DTC).** **Preliminary Procedures** 1. Charge Air Cooler Outlet Air Tube Replacement 2. Intake Manifold Cover Replacement
1	Electrical Connector
2	Throttle Body Bolt [4x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)

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Callout	Component Name
3	Throttle Body **Procedure** 1. Perform the intake system learned values reset. **Intake System Learned Values Reset** 2. Perform the throttle body idle air flow compensation reset. **Throttle Body Idle Air Flow Compensation Reset**
4	Throttle Body Seal **Procedure** The seal is reusable, inspect the seal and replace if damaged.

THROTTLE BODY CLEANING

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

CAUTION: **Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.**

CAUTION: **Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.**

1. Remove the charge air cooler outlet air tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement**.

   NOTE: **DO NOT prop open the throttle blade with the ignition key in the ON position as it may set a diagnostic trouble code (DTC).**

2. Inspect the throttle body bore and the throttle valve plate for deposits. You must open the throttle valve in order to inspect all of the surfaces.
3. Clean the throttle body bore and the throttle valve plate using a clean shop towel and approved cleaner.
4. Install the charge air cooler outlet air tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement**.
5. Perform the Throttle/Idle Learn procedure. Refer to **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.

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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 PRESSURE GAUGE INSTALLATION AND REMOVAL

Special Tools

- **CH-37287-1A** Fuel Pressure Gauge Adapter
- **J-34730 - 1A** Fuel Pressure Gauge

Equivalent regional tools:**Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

Installation Procedure

WARNING: **Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.**

WARNING: **Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.**

CAUTION: **Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:**

- **The fuel pipe connections**
- **The hose connections**
- **The areas surrounding the connections**

1. Relieve the fuel system pressure. **Fuel Pressure Relief**
2. Disconnect the quick connect coupling of the fuel feed hose from the fuel feed pipe of the fuel pump. Use a shop towel in order to catch any remaining fuel that may leak. **Metal Collar Quick Connect Fitting Service**
3. Install the **CH-37287-1A** adapter (2) between the fuel feed pipe of the fuel pump and of the fuel feed hose.

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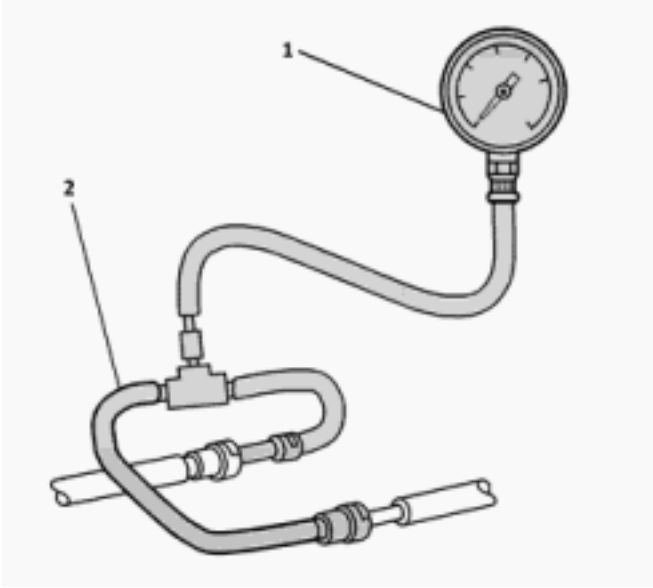

Fig. 23: Gauge And Adapter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener Tightening Caution .**

4. Install the **J-34730 - 1A** gauge (1) to the **CH-37287-1A** adapter (2), and tighten securely.
5. Turn ON the ignition in order to pressurize the fuel system.
6. Turn OFF the ignition.
7. Check for any fuel leaks.

Removal Procedure

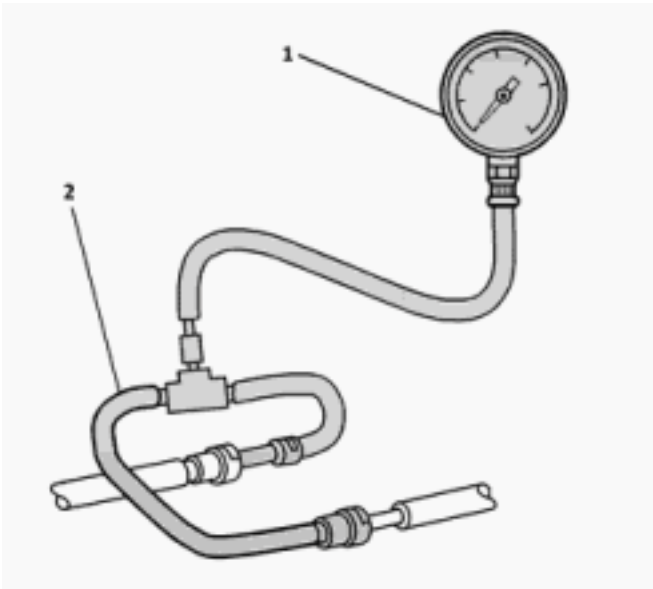

Fig. 24: Gauge And Adapter
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure. **Fuel Pressure Relief**
2. Remove the **J-34730 - 1A** gauge (1).
3. Disconnect the quick connect coupling of the **CH-37287-1A** adapter from the fuel feed hose and from the fuel feed pipe on the fuel pump. Use a shop towel in order to catch any remaining fuel that may leak. **Metal Collar Quick Connect Fitting Service**
4. Connect the quick-connect fitting of the fuel feed hose to the fuel feed pipe of the fuel pump. **Metal Collar Quick Connect Fitting Service**
5. Turn ON the ignition in order to pressurize the fuel system.
6. Turn OFF the ignition.
7. Check for any fuel leaks.

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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 .**

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

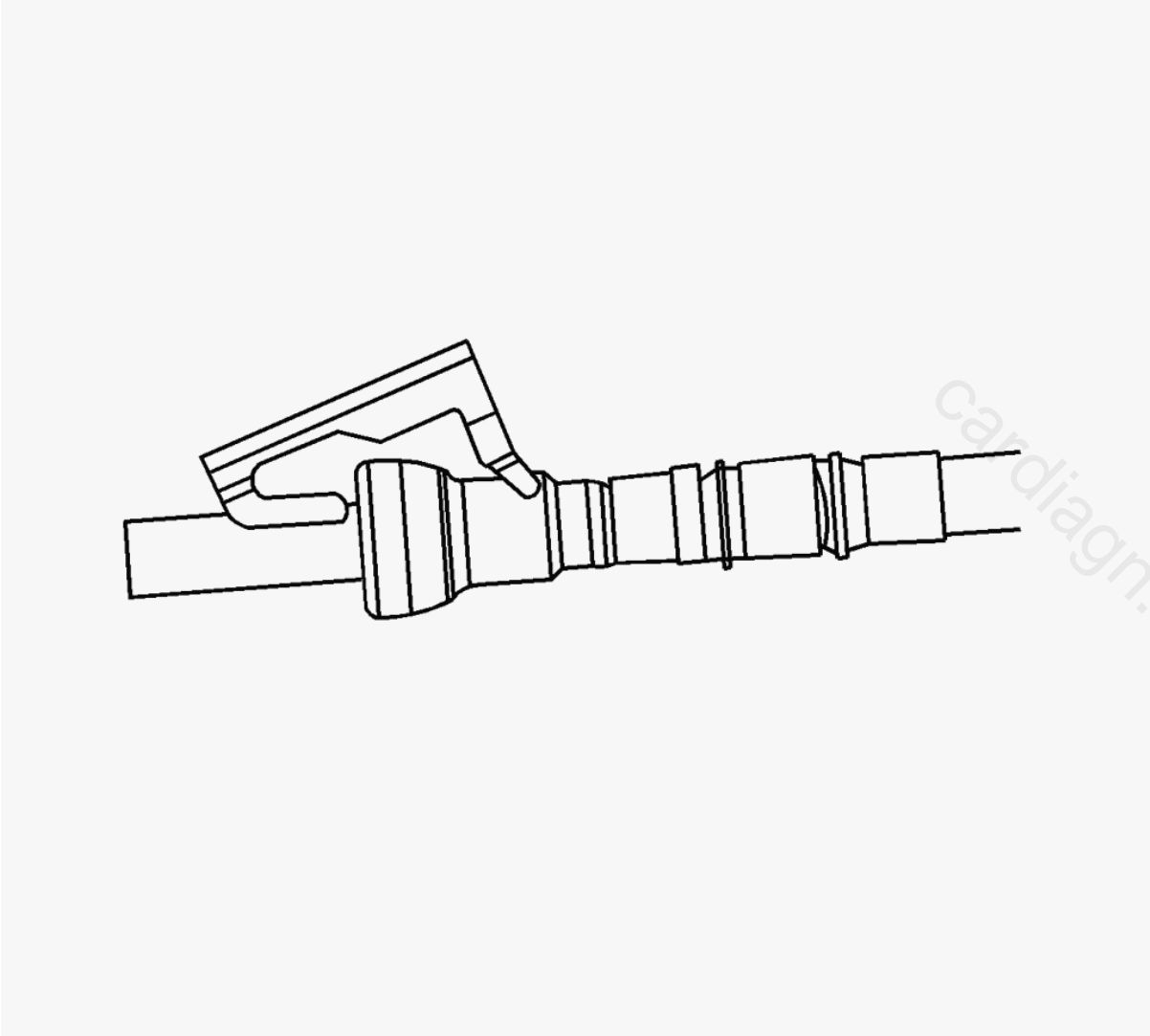
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Fig. 25: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Remove the retainer from the quick-connect fitting.

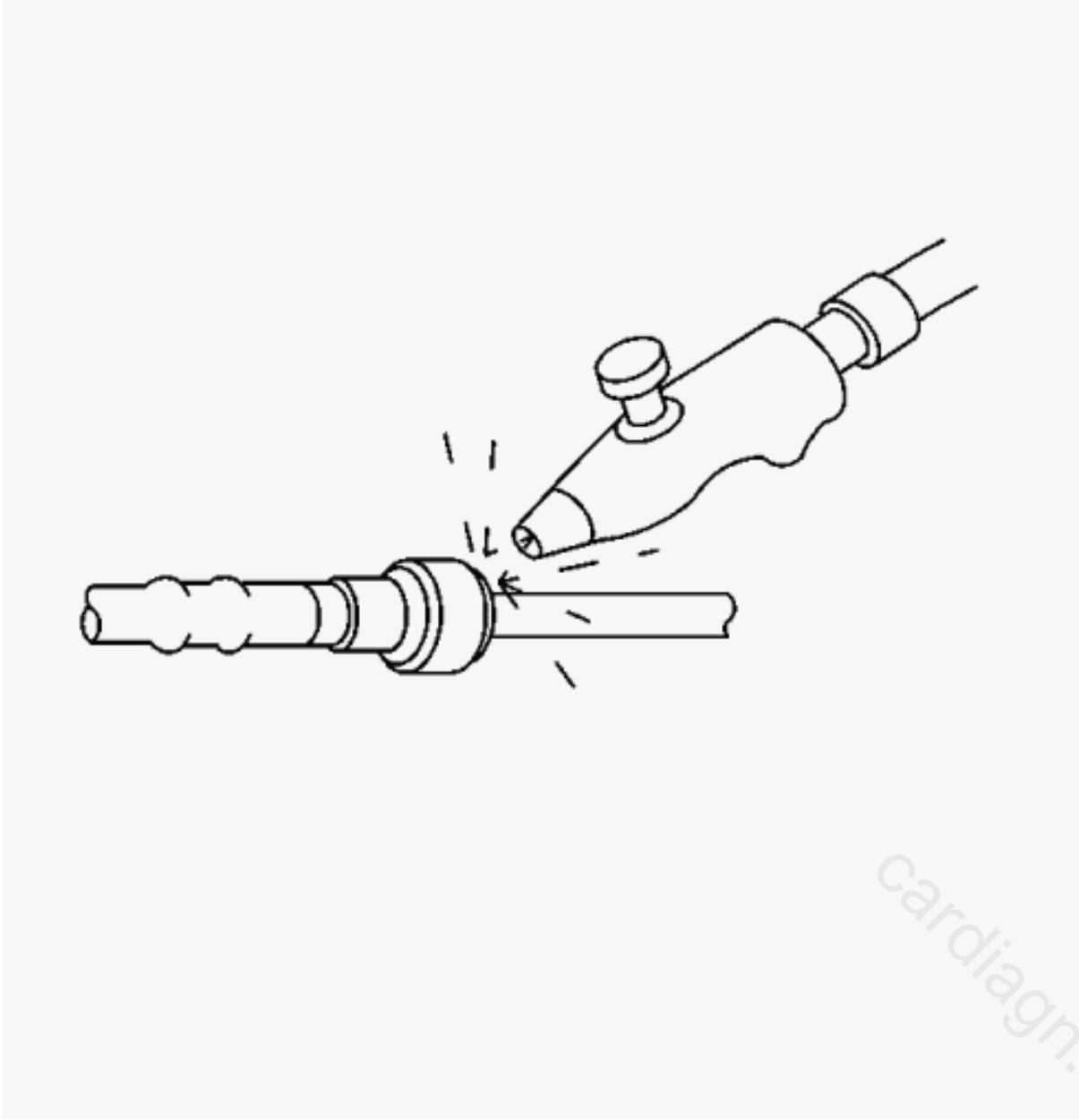

Fig. 26: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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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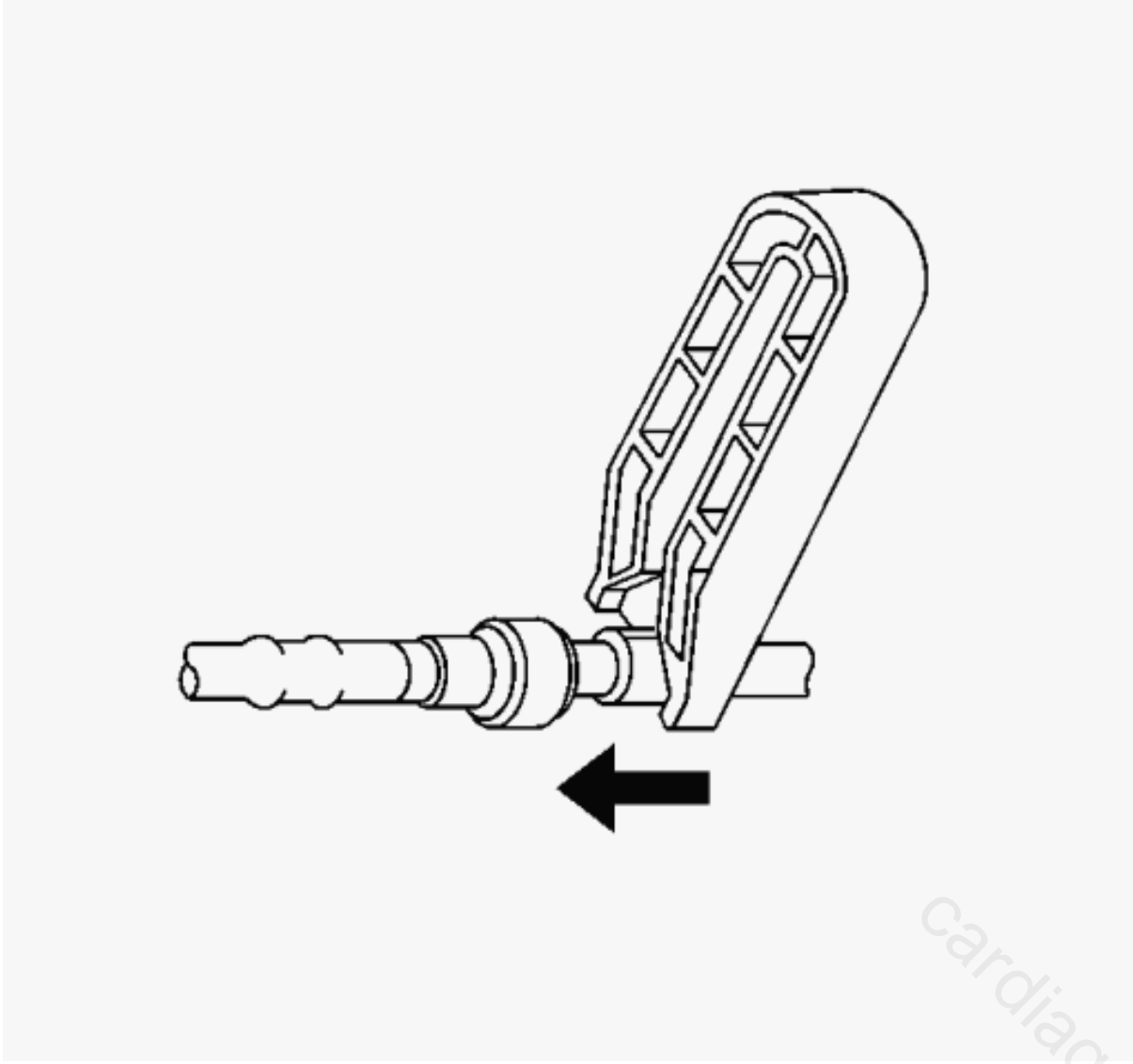

Fig. 27: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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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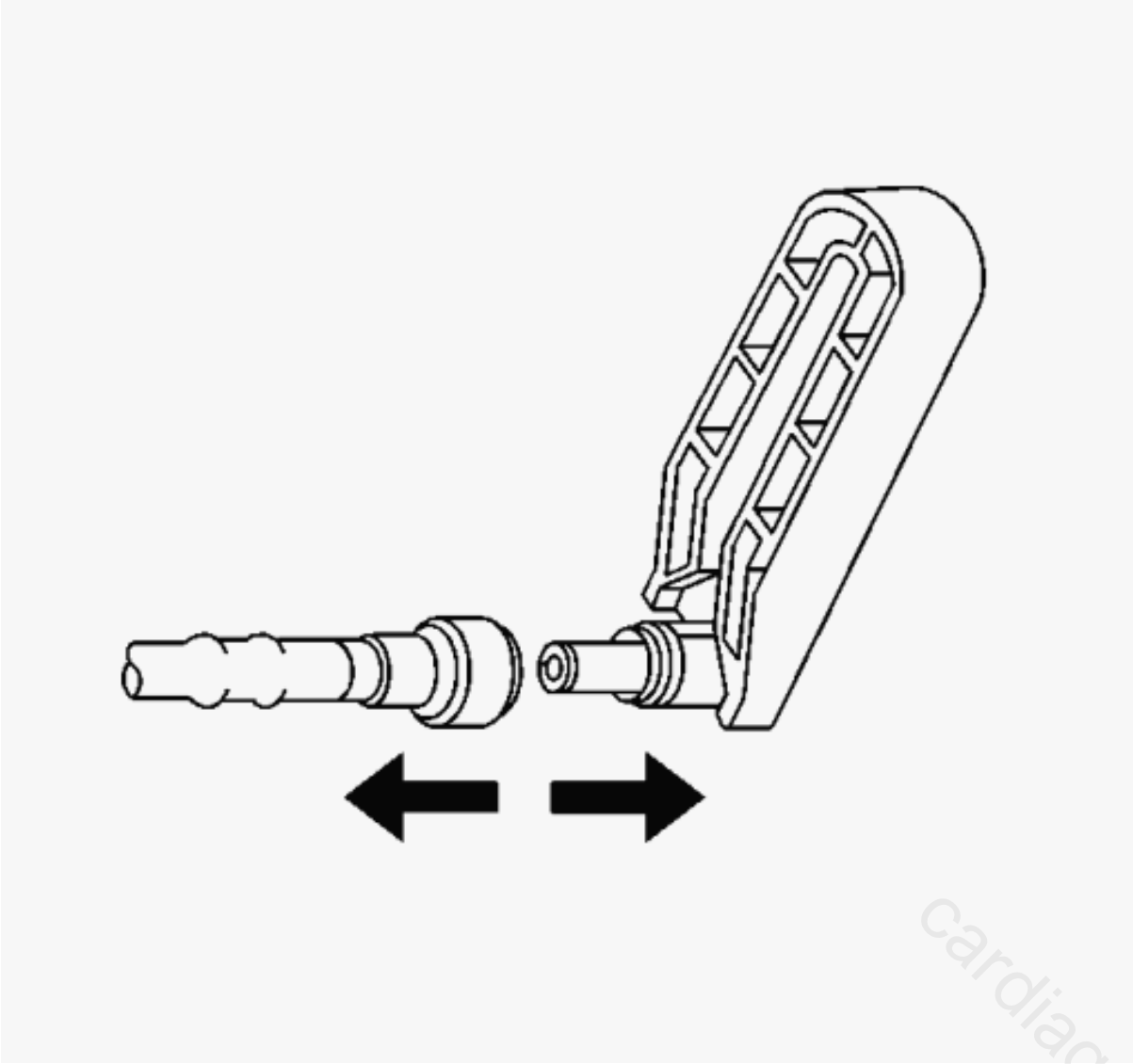

Fig. 28: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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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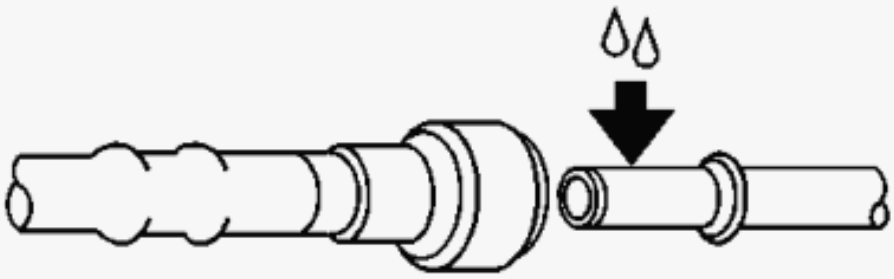

Fig. 29: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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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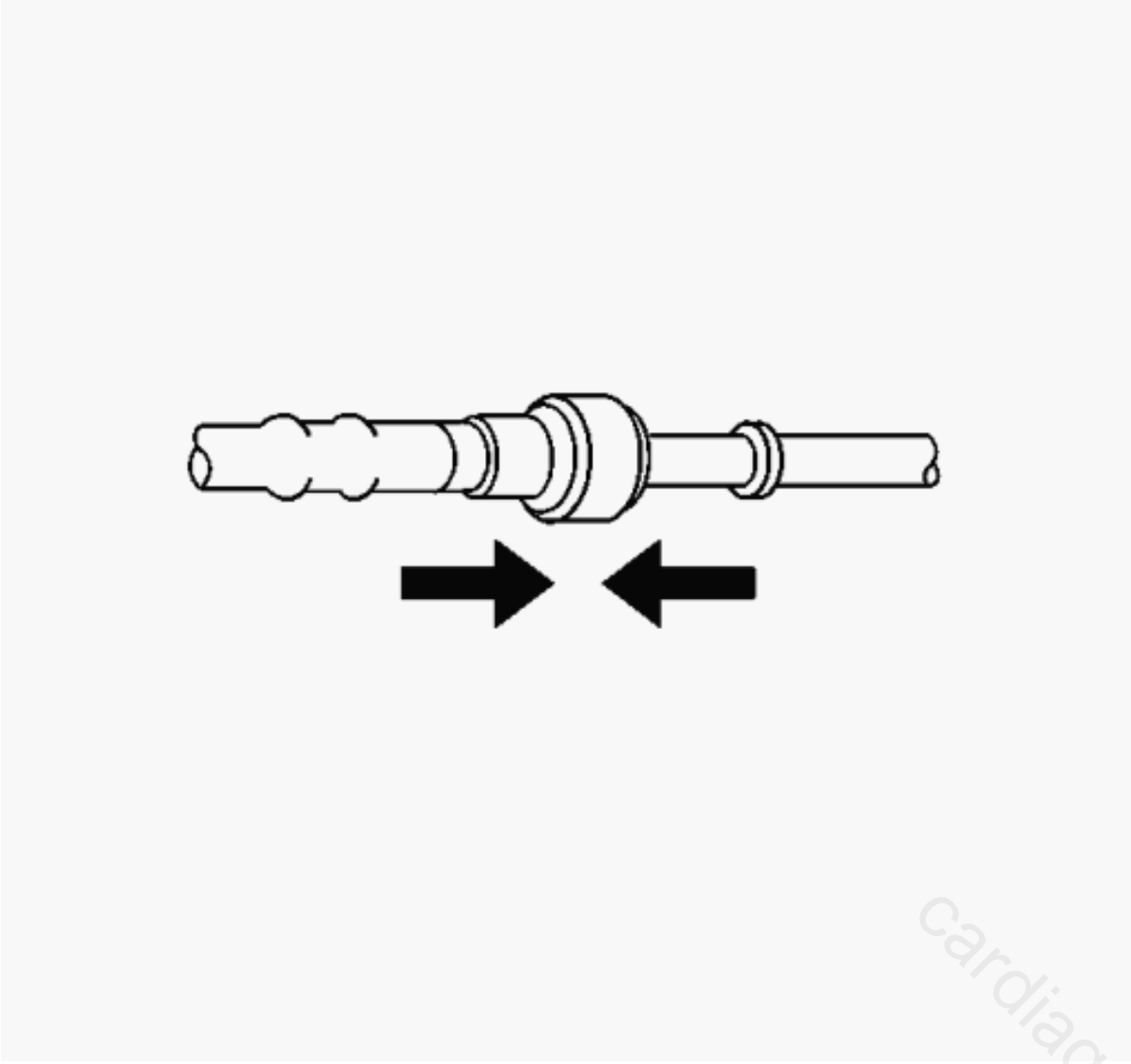

Fig. 30: View Of Connectors (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the quick-connect fitting together to cause the retaining tabs to snap into place.

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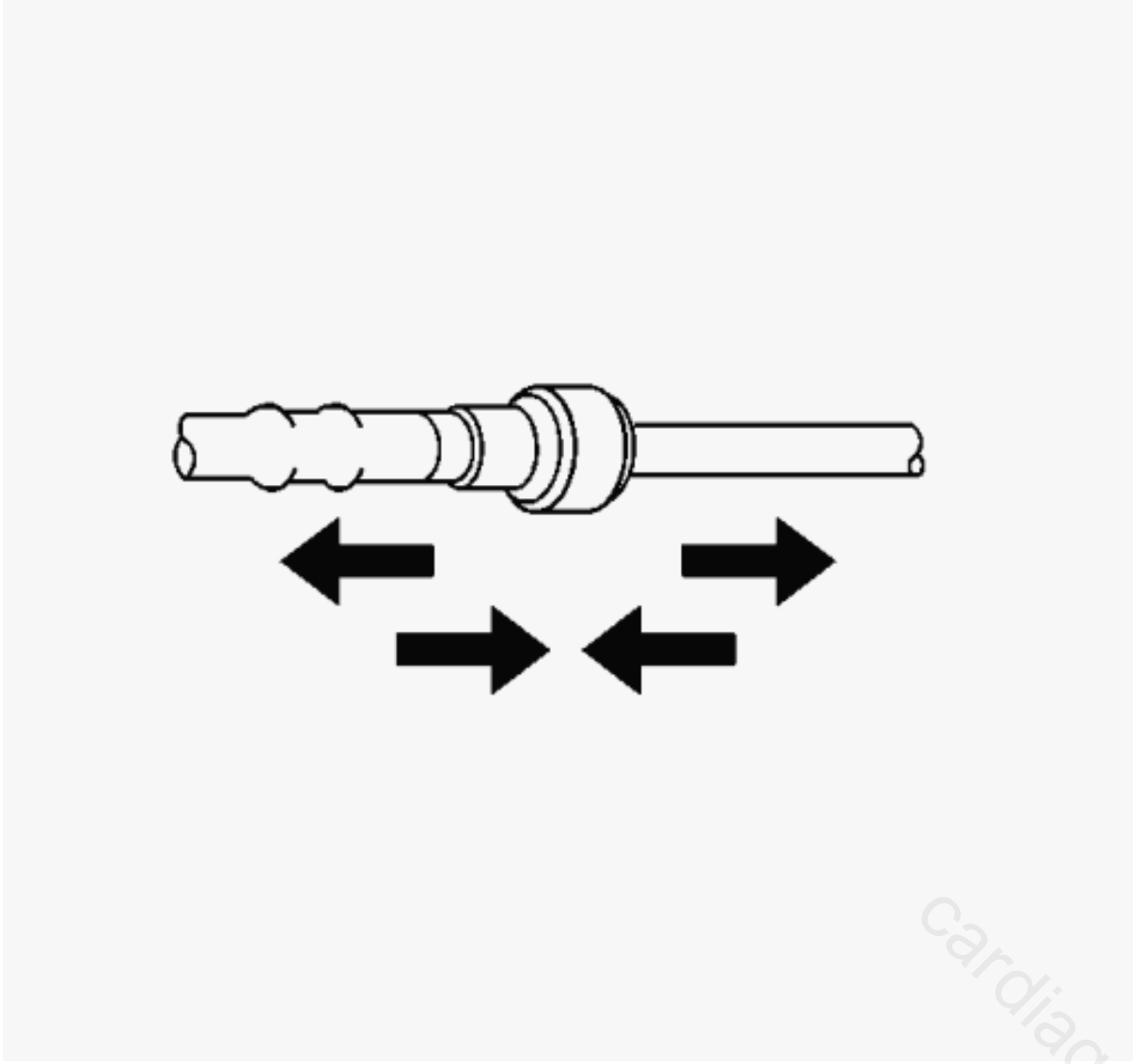

Fig. 31: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

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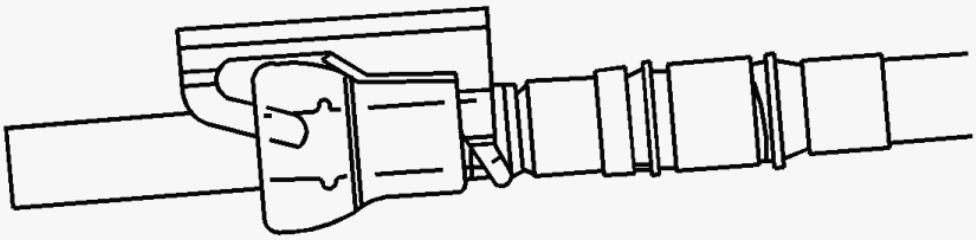

Fig. 32: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS COMPANY

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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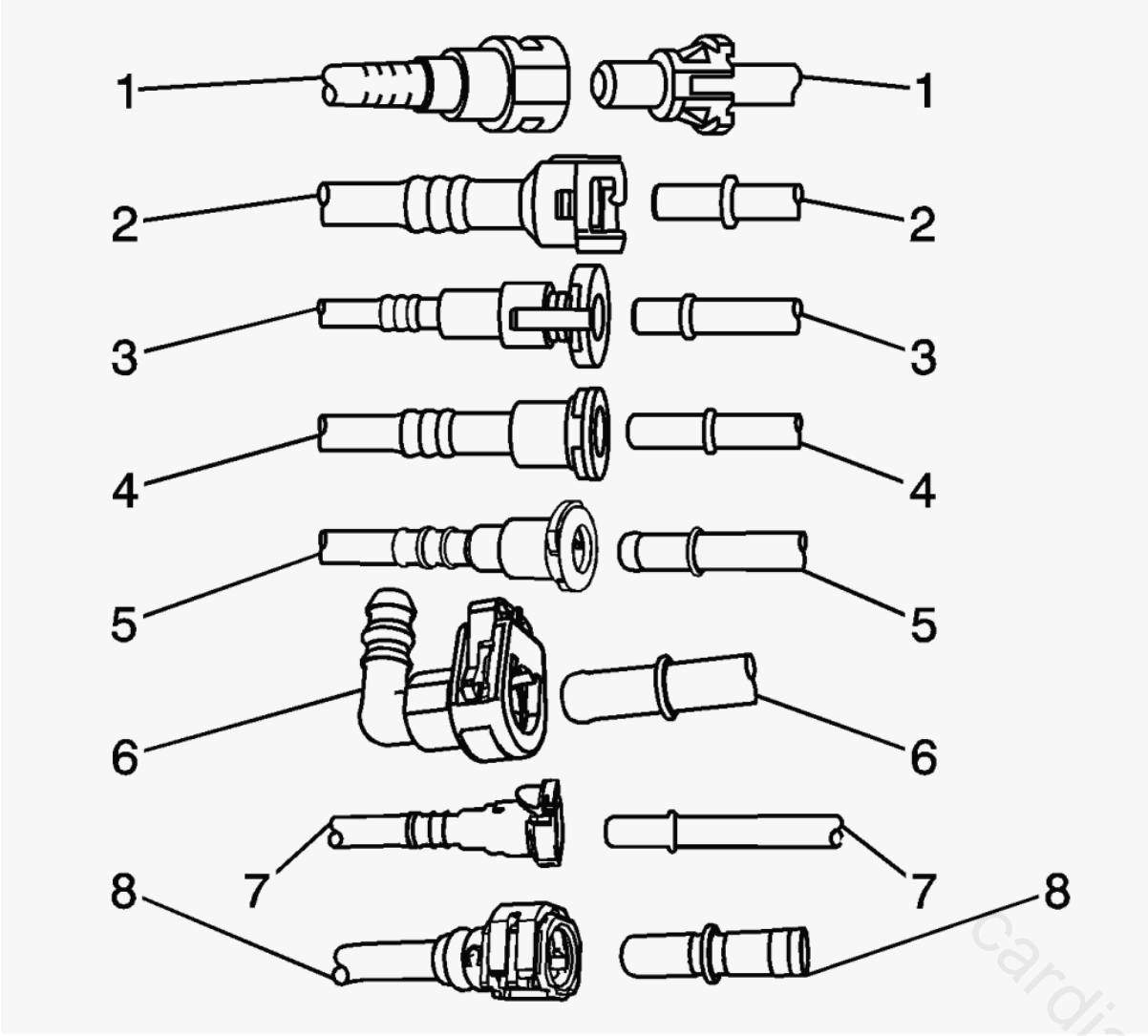

Fig. 33: Plastic Collar Quick Connect Fitting Service
Courtesy of GENERAL MOTORS COMPANY

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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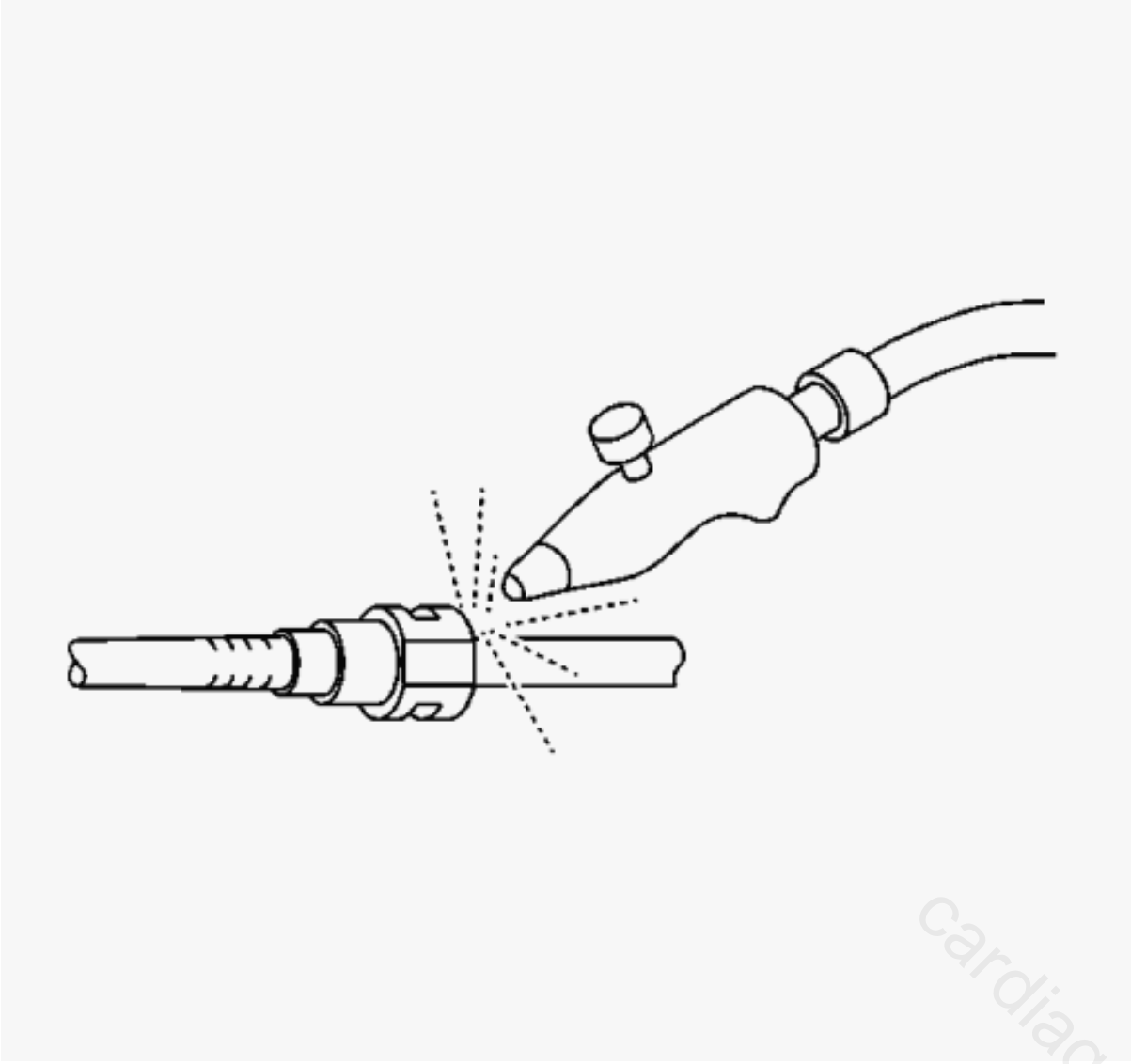

Fig. 34: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

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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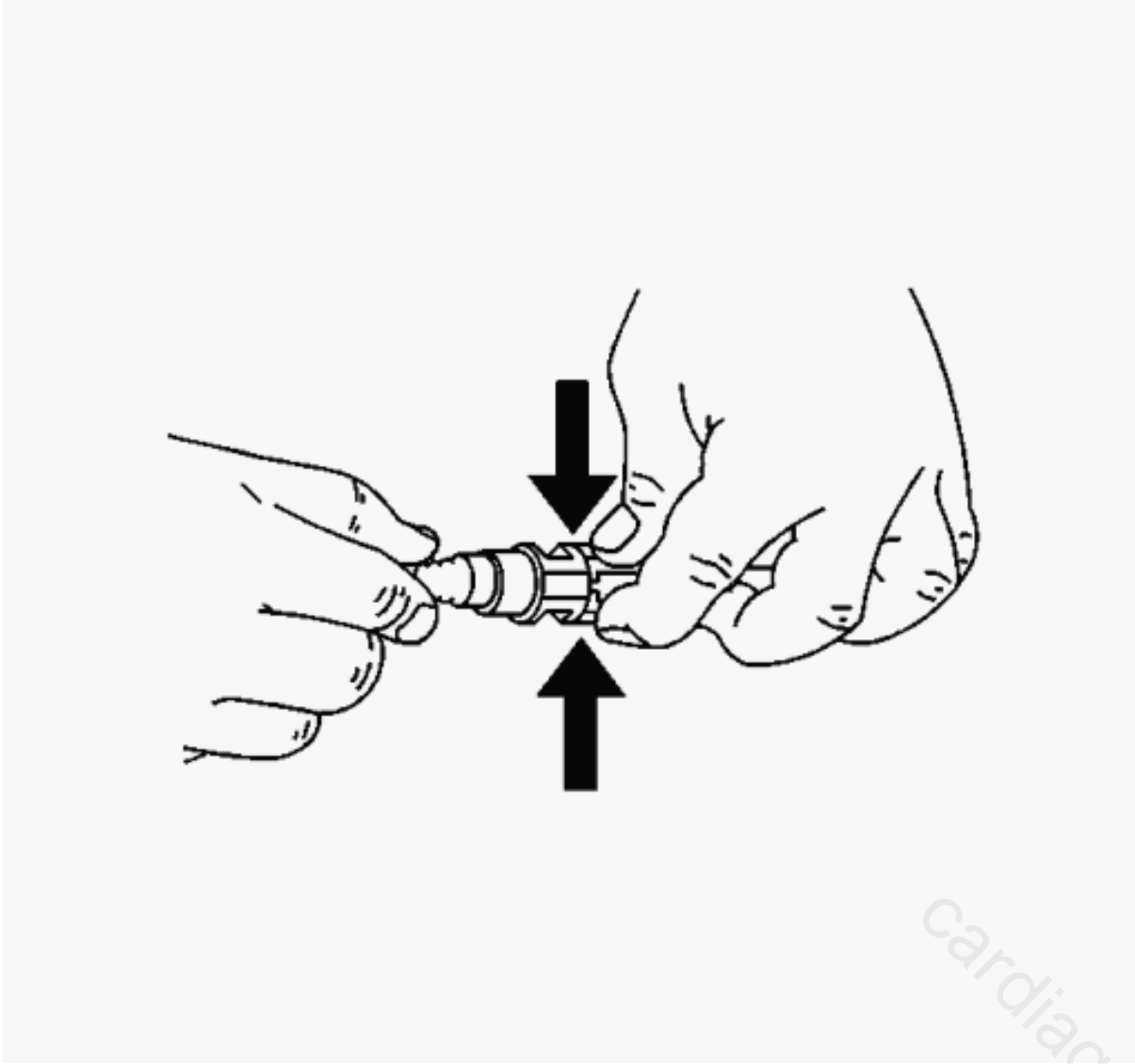

Fig. 35: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

2. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick-connect fitting release tabs.

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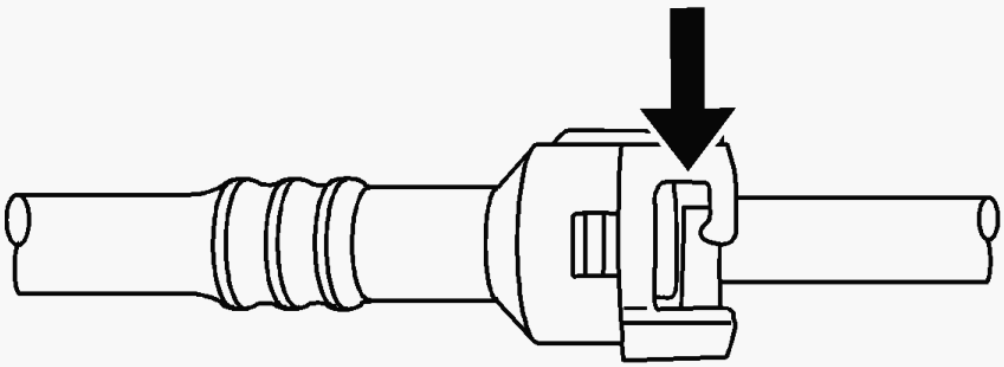

Fig. 36: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

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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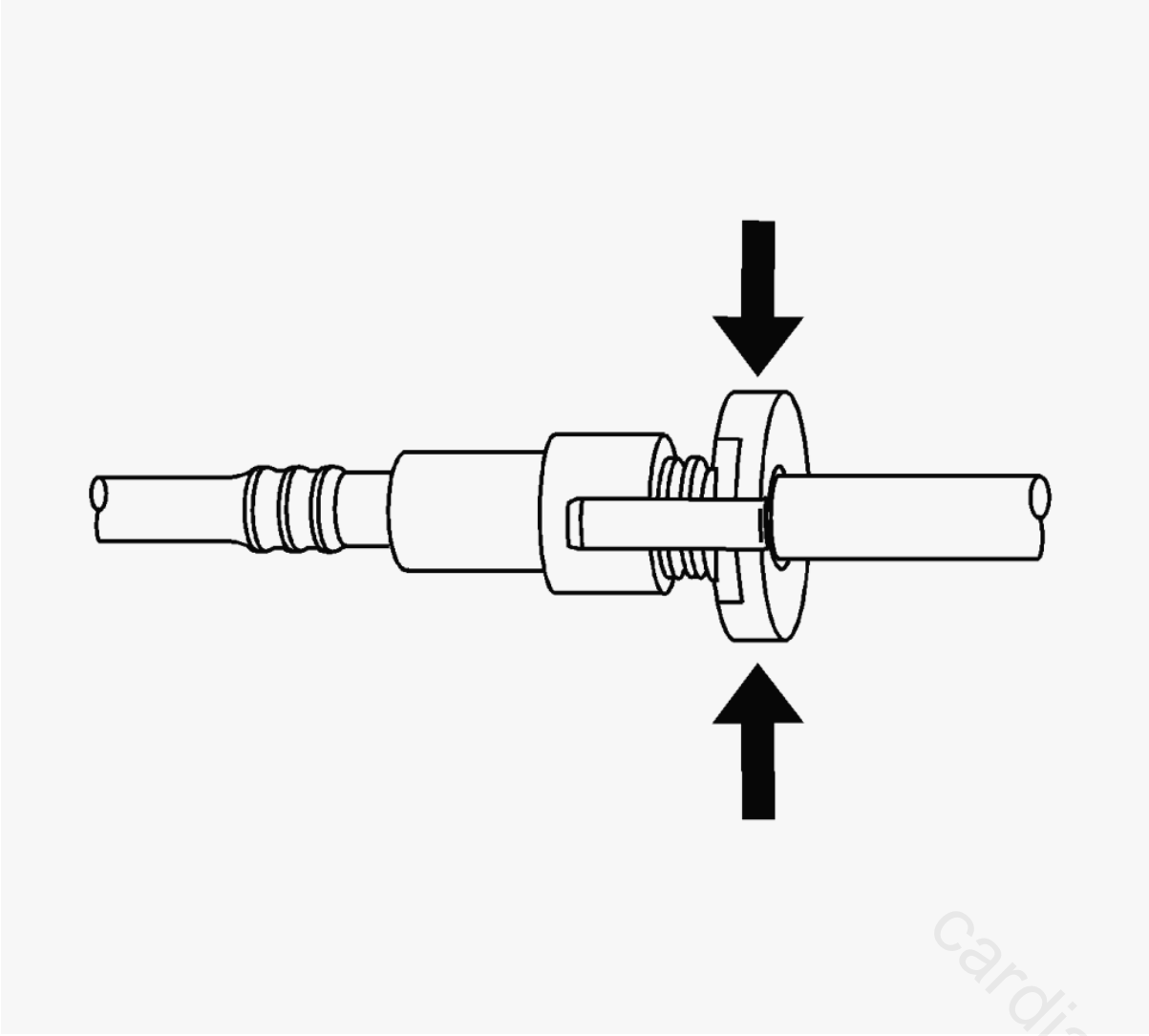

Fig. 37: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

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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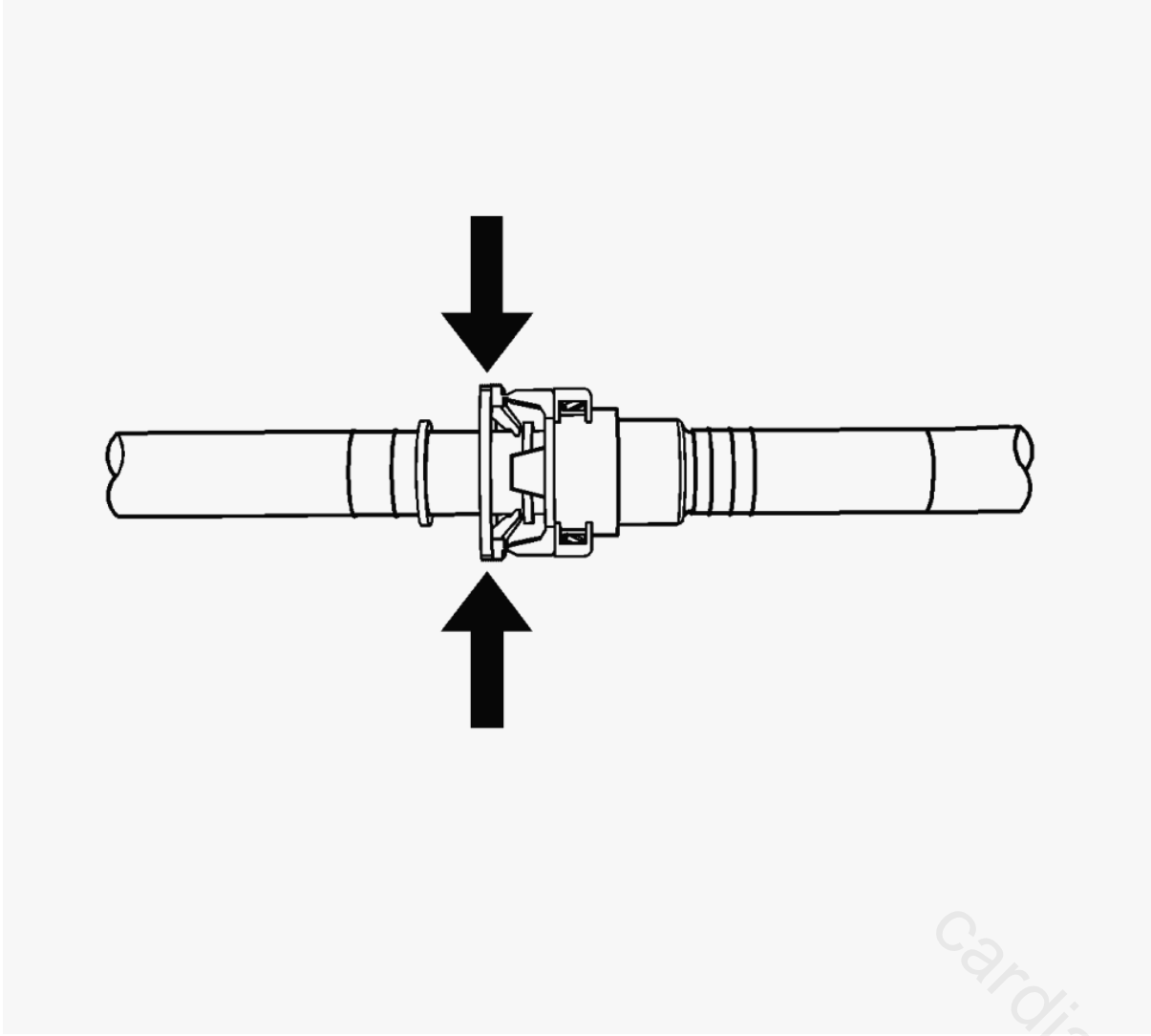

Fig. 38: Pushing In Male Side Of Connector
Courtesy of GENERAL MOTORS COMPANY

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.

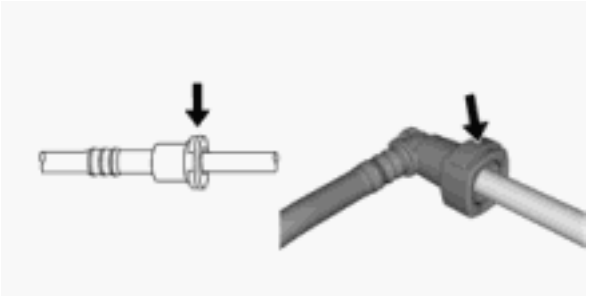

Fig. 39: Variants Of Sliding Retainer Style Connectors
Courtesy of GENERAL MOTORS COMPANY

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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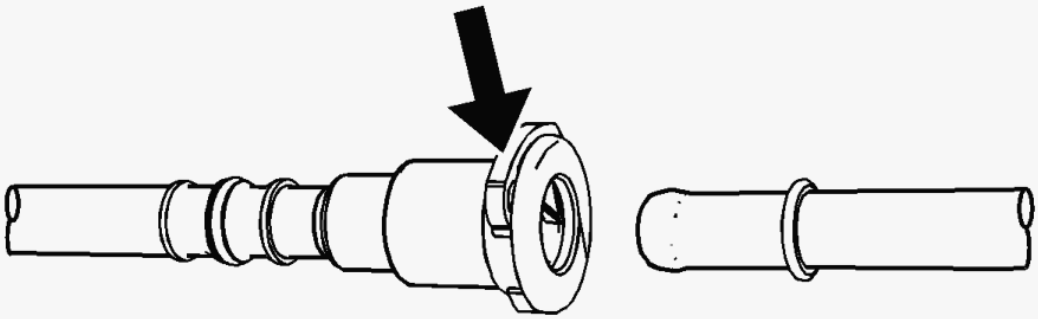

Fig. 40: Global Connector Style
Courtesy of GENERAL MOTORS COMPANY

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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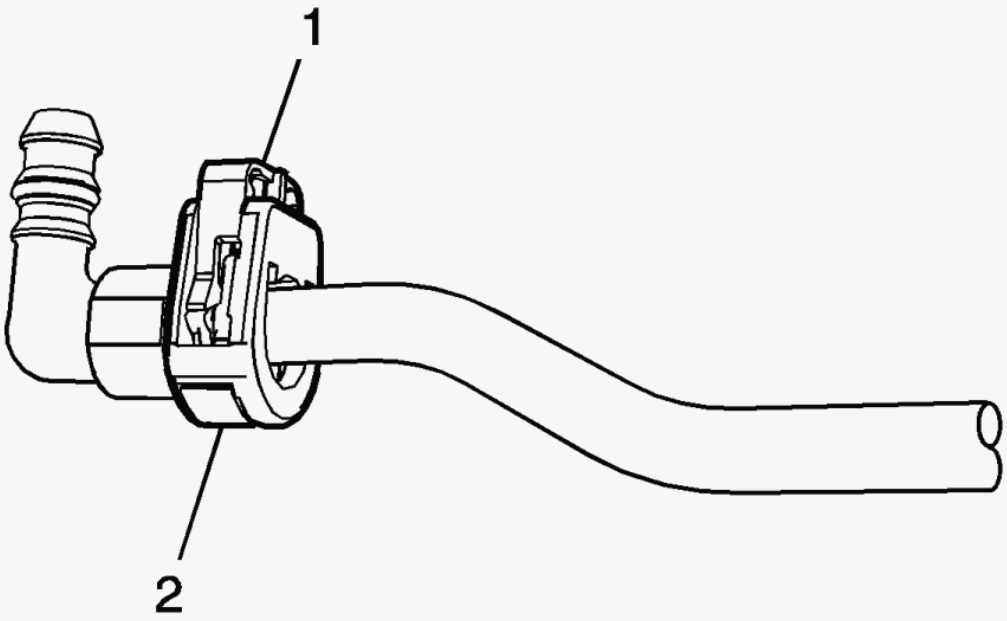

Fig. 41: TI Loc style
Courtesy of GENERAL MOTORS COMPANY

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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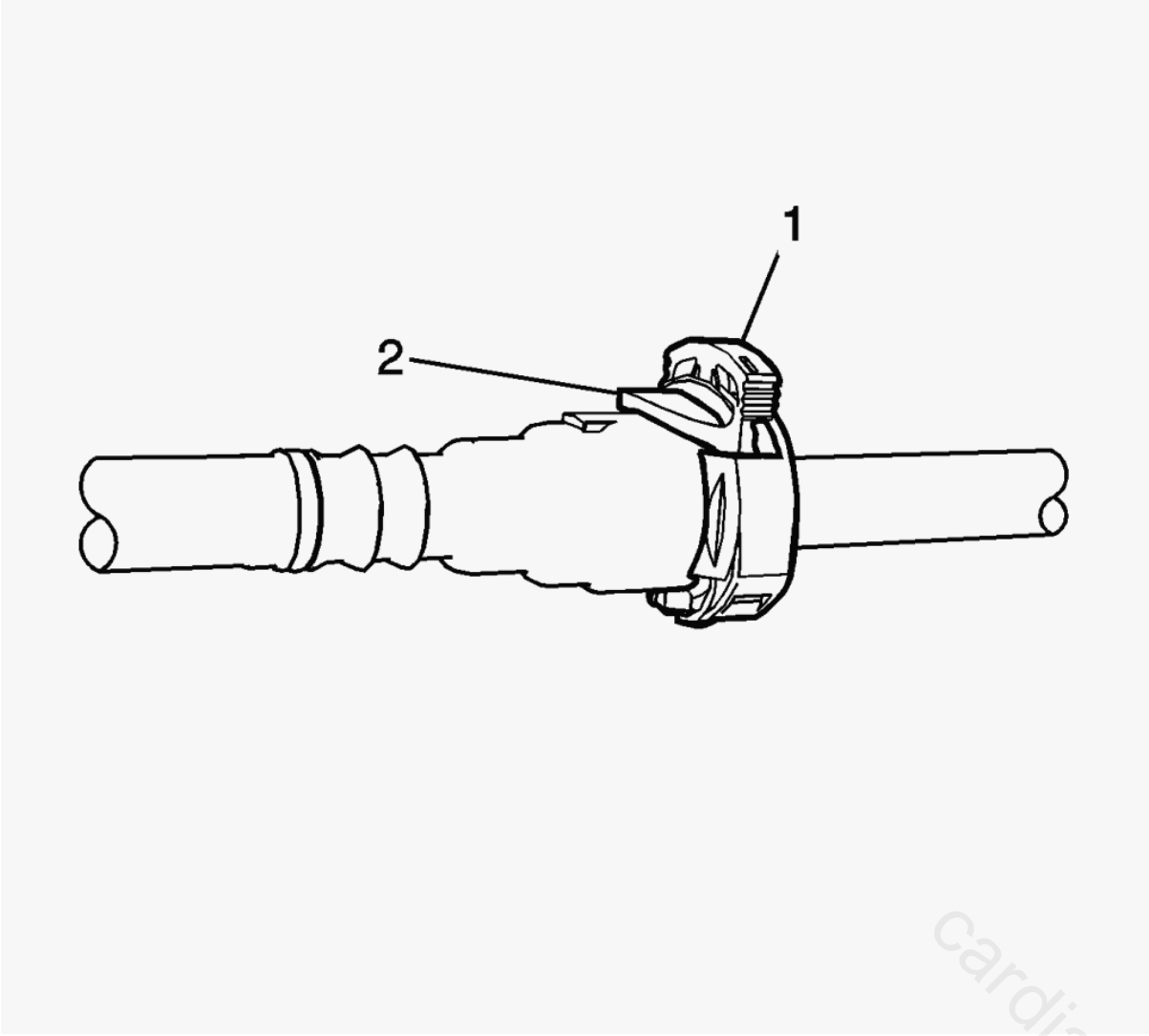

Fig. 42: Safe Lock Style
Courtesy of GENERAL MOTORS COMPANY

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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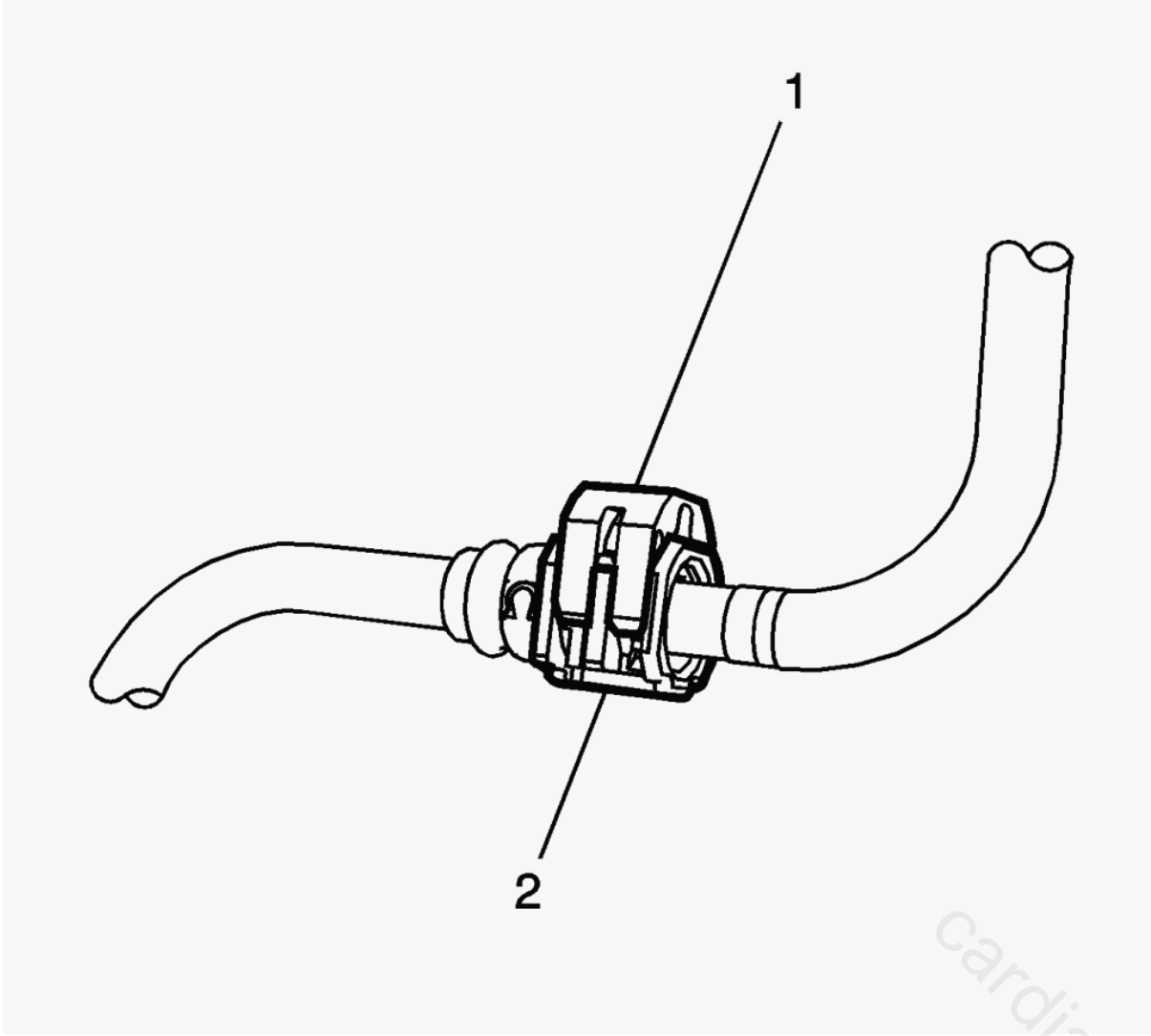

Fig. 43: Latch And Connector Straight Out
Courtesy of GENERAL MOTORS COMPANY

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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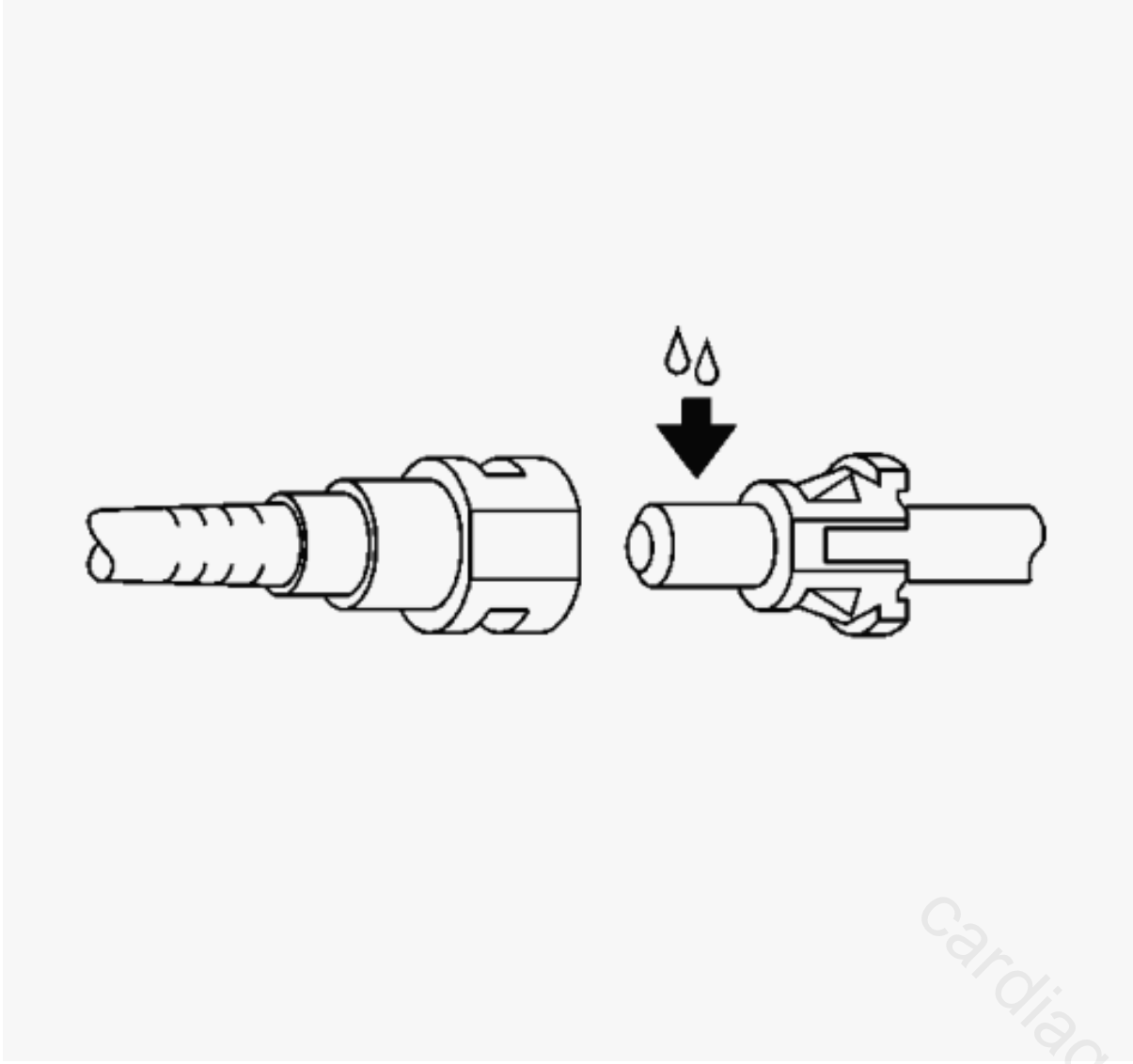

Fig. 44: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS COMPANY

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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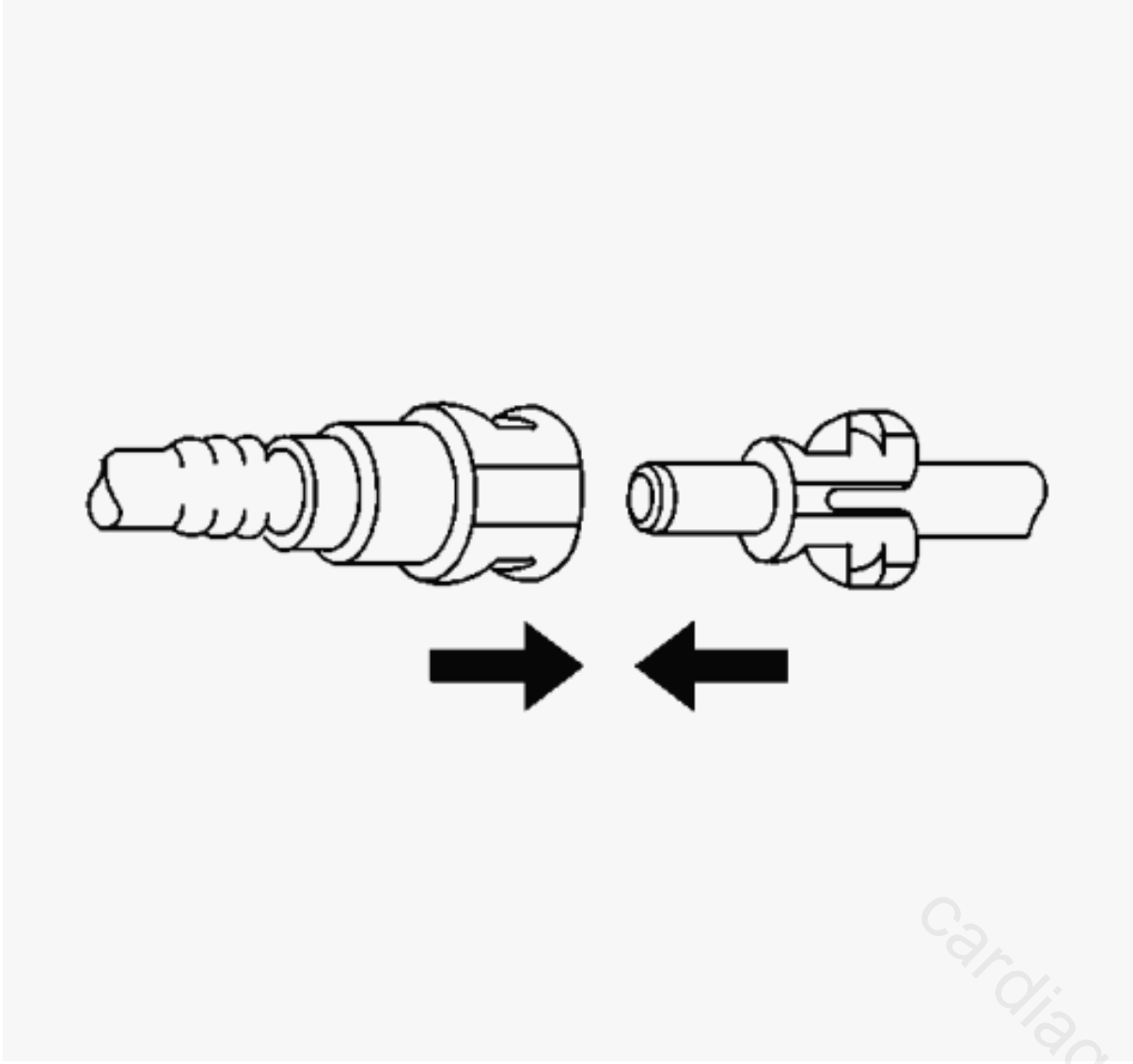

Fig. 45: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

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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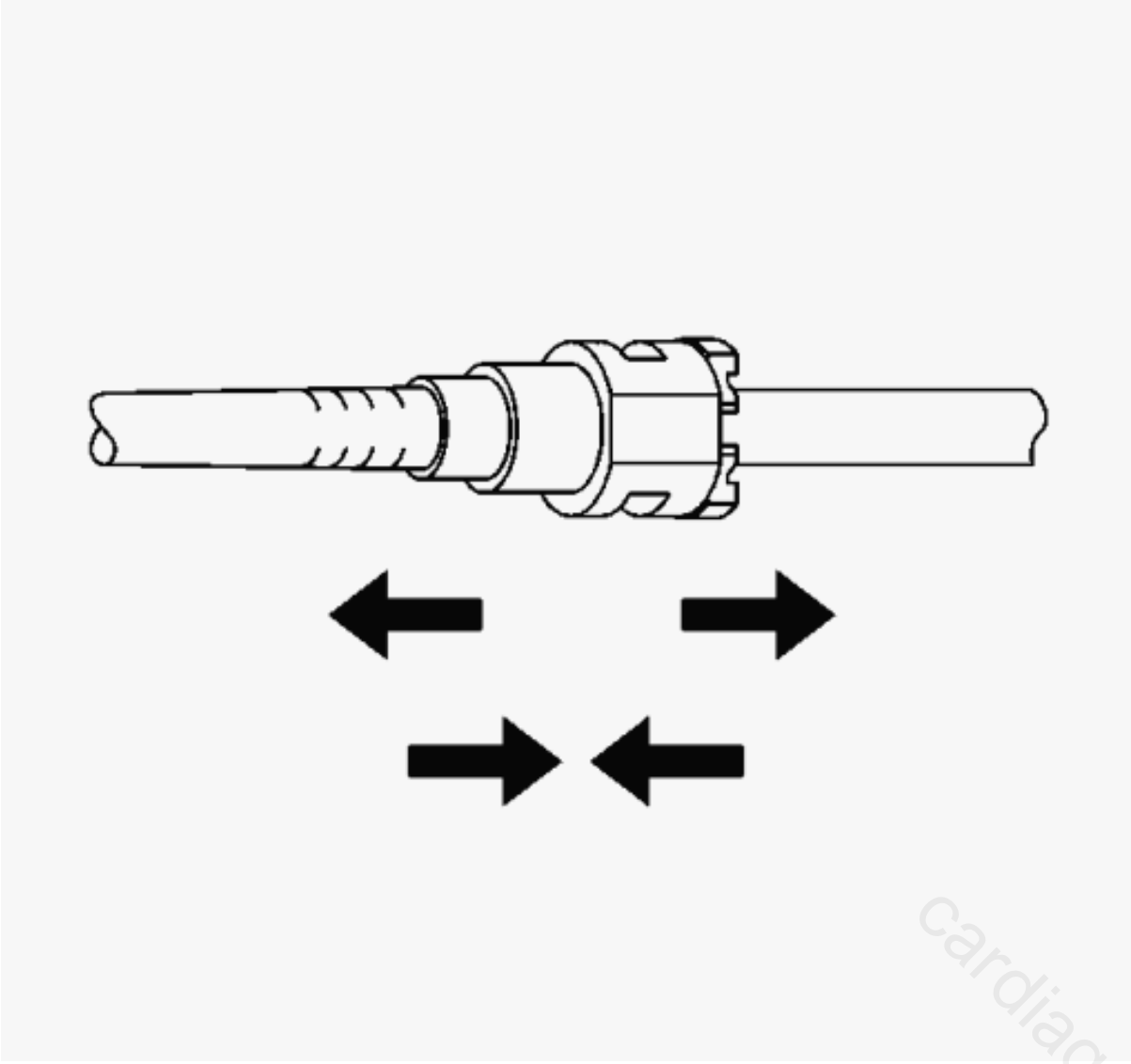

Fig. 46: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

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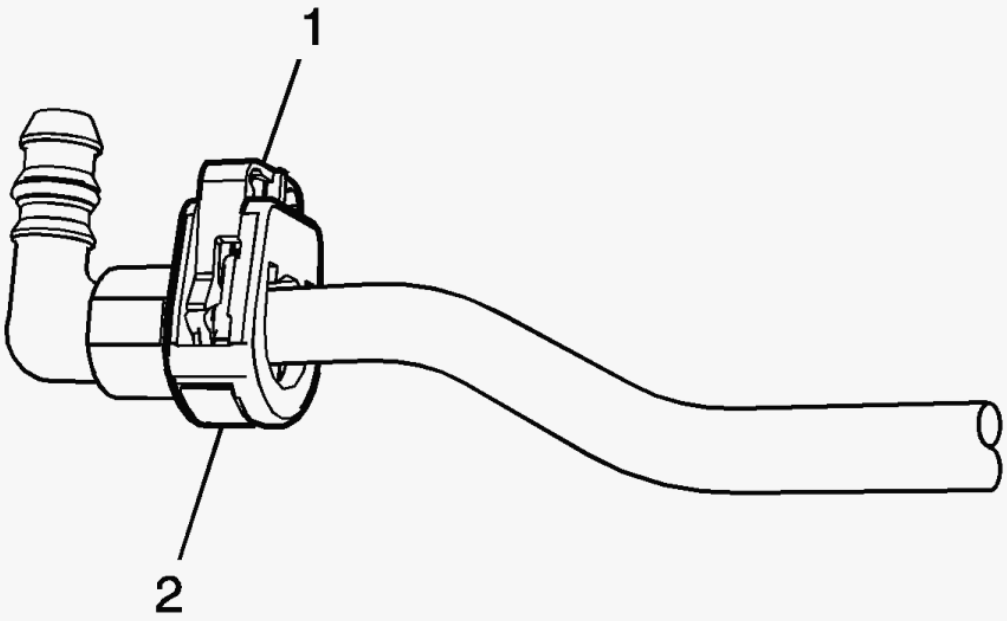

Fig. 47: TI Loc style
Courtesy of GENERAL MOTORS COMPANY

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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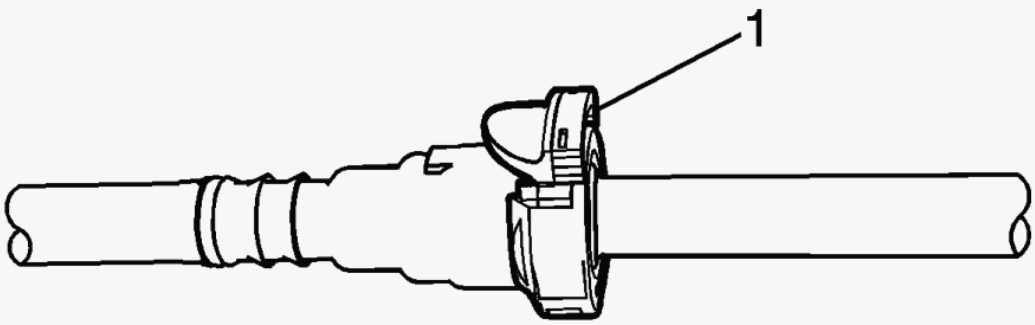

Fig. 48: Redundant Latch
Courtesy of GENERAL MOTORS COMPANY

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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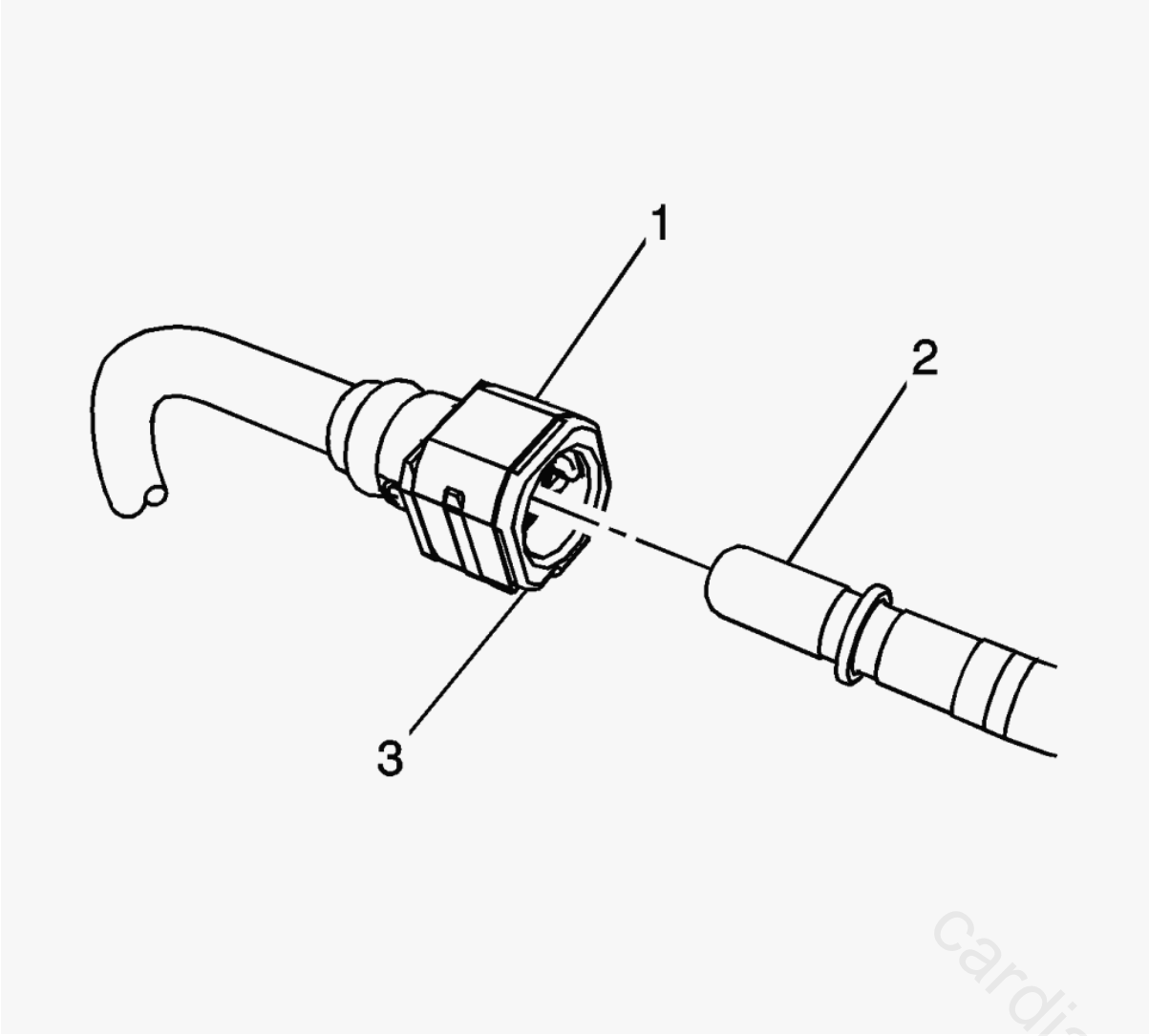

Fig. 49: Latch And Connector
Courtesy of GENERAL MOTORS COMPANY

8. For the plastic connector type 8, depress the latch (1) while inserting the connector (3) on to the pipe (2).
9. Move the latch (1) upward in order to secure the connection.
10. Inspect for leaks using the following procedure:
    1. Turn the ignition ON, with the engine OFF for 2 seconds.
    2. Turn the ignition OFF, for 10 seconds.
    3. Turn the ignition ON, with the engine OFF for 2 seconds.
    4. Turn the ignition OFF.
    5. Inspect for leaks.

FUEL TANK DRAINING

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.

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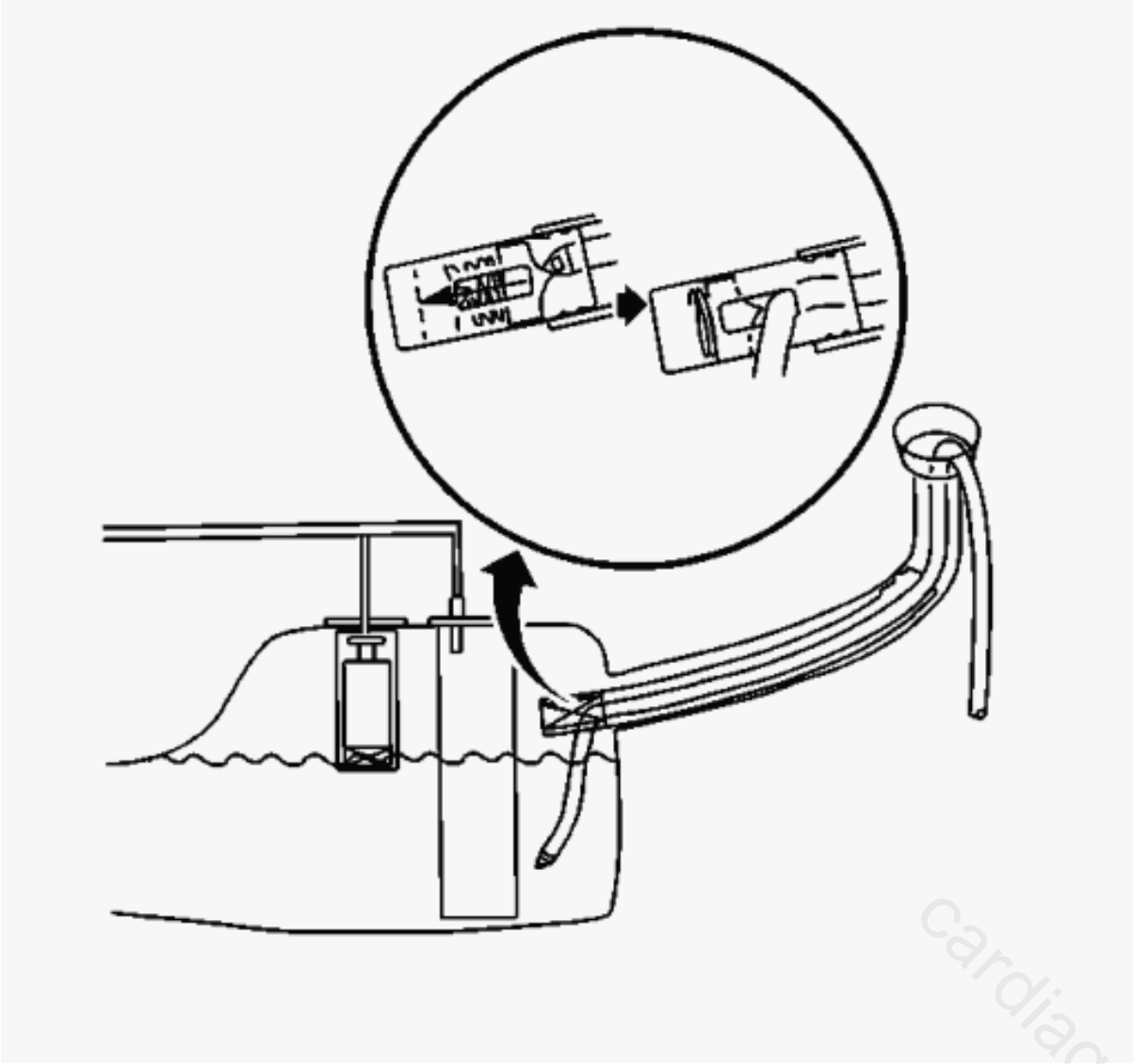

Fig. 50: Draining Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

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 SHIELD REPLACEMENT (AWD)

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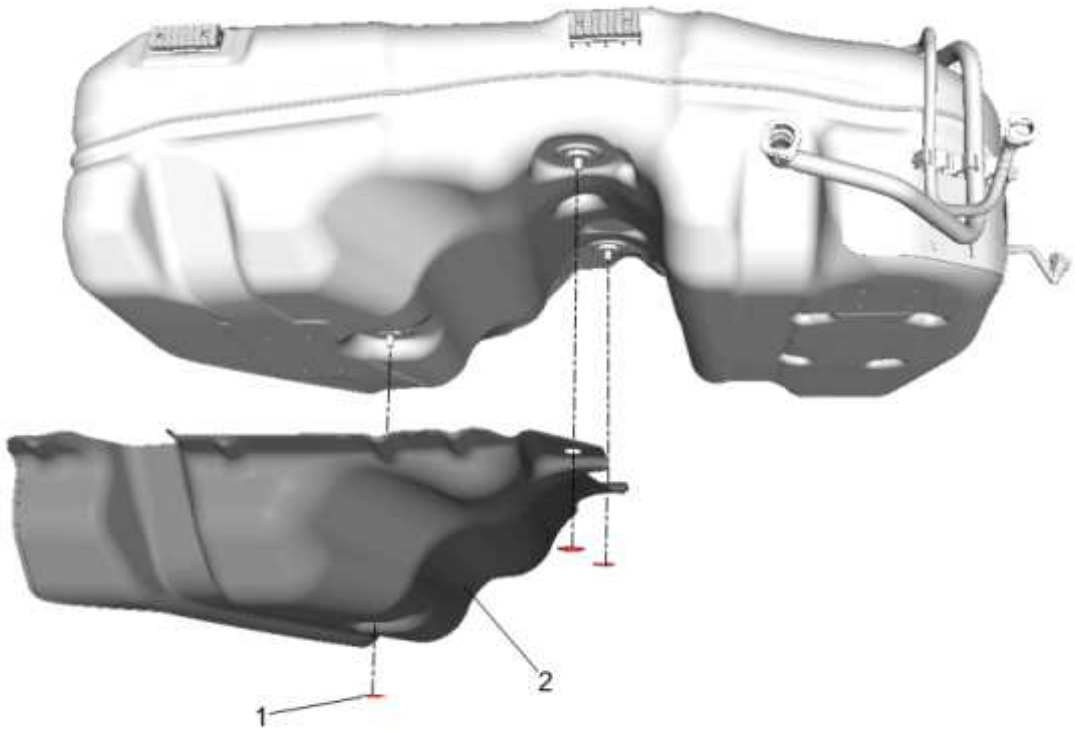

Fig. 51: Fuel Tank Shield (AWD)
Courtesy of GENERAL MOTORS COMPANY

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 SHIELD REPLACEMENT (FWD)

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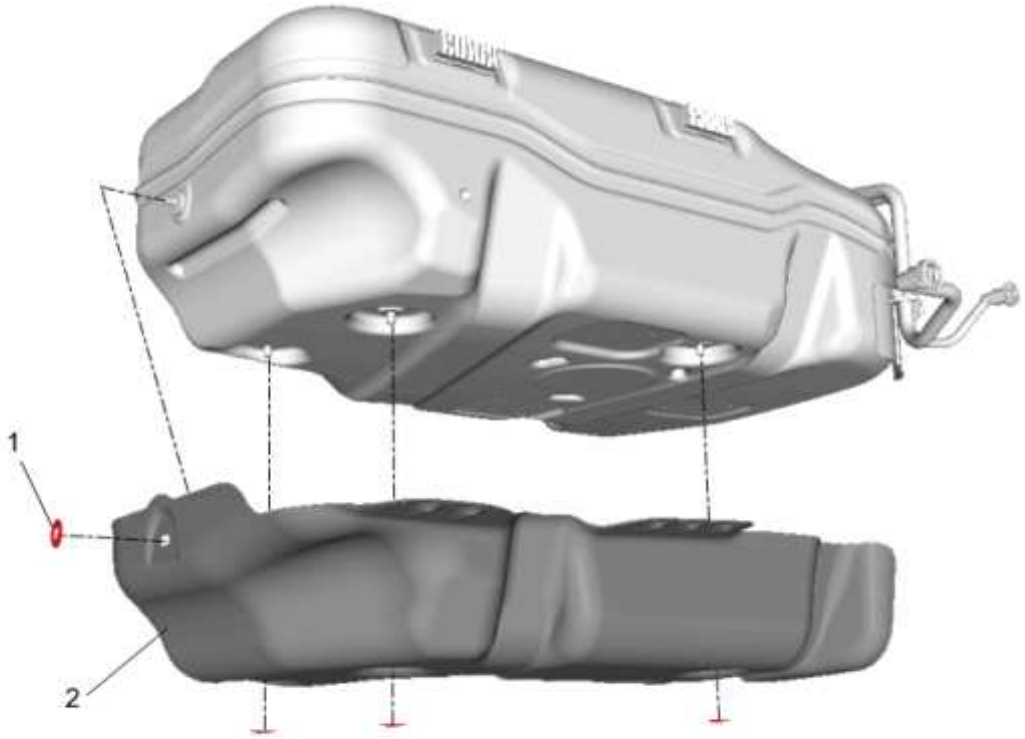

Fig. 52: Fuel Tank Shield (FWD)
Courtesy of GENERAL MOTORS COMPANY

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 Shield Retainer [4x]
2	Fuel Tank Shield

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) Underbody Rear Air Deflector Replacement (Diesel)

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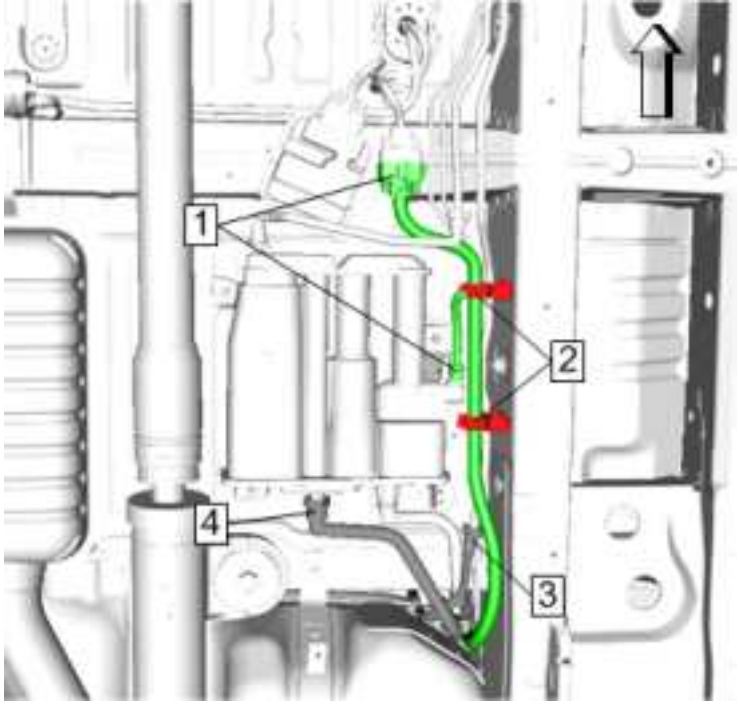

Fig. 53: Fuel Tank Fuel Pump Module Wiring Harness, Fuel Pump Fuel Feed Hose And Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

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**

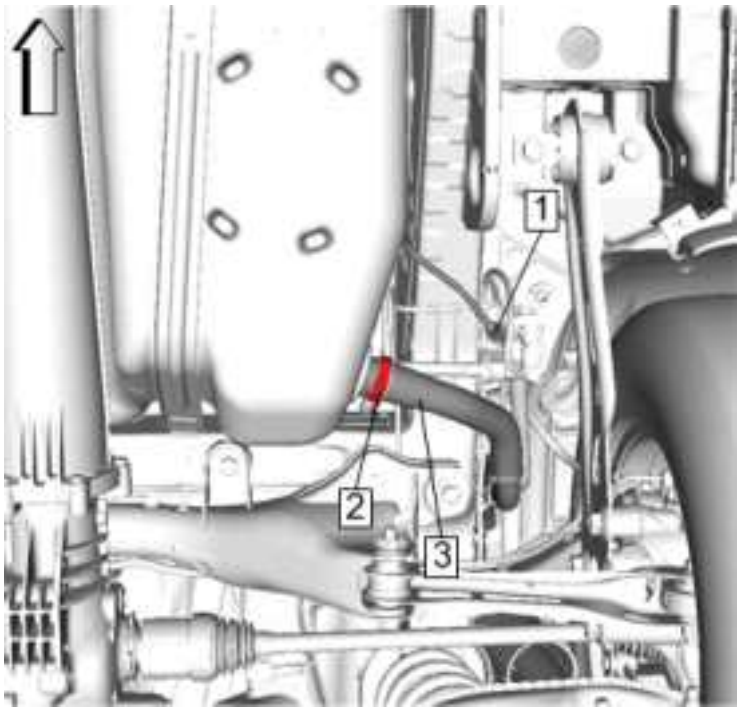

Fig. 54: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

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).

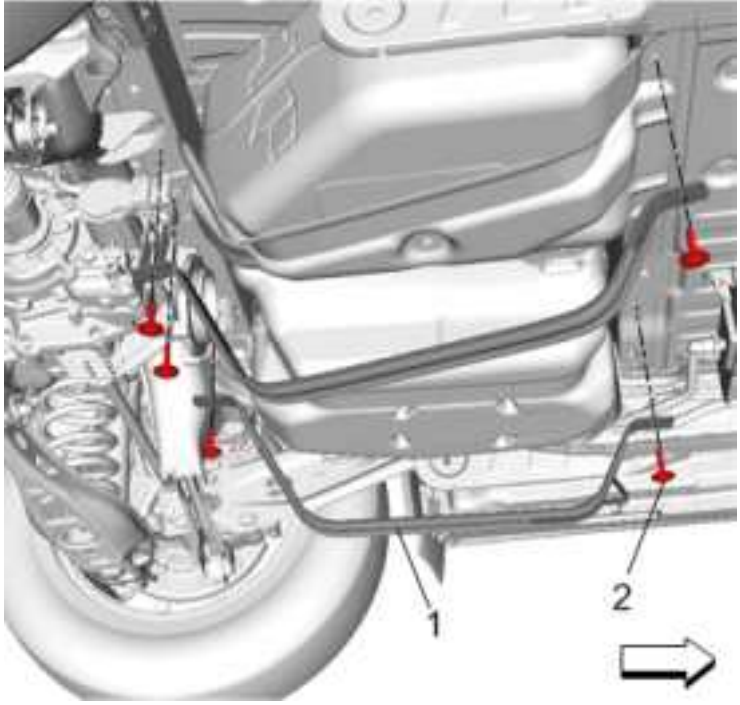

Fig. 55: Fuel Tank Strap And Bolt
Courtesy of GENERAL MOTORS COMPANY

14. Place a suitable adjustable jack under the fuel tank.
15. Remove Fuel Tank Strap Bolt (1) - [5x]
16. Remove Fuel Tank Strap (2) - [2x]

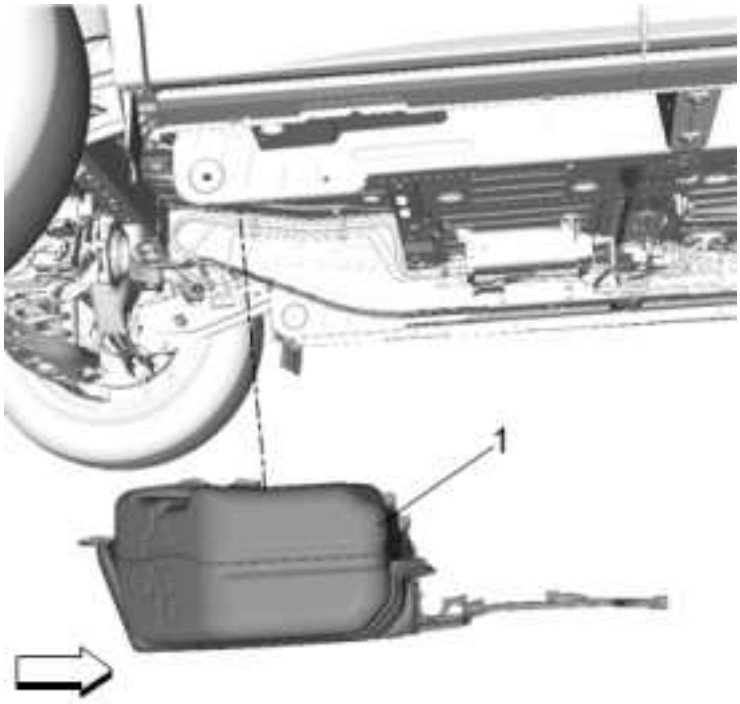

Fig. 56: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

17. Remove Fuel Tank (1)
18. If replacing fuel tank transfer parts as necessary.

Installation Procedure

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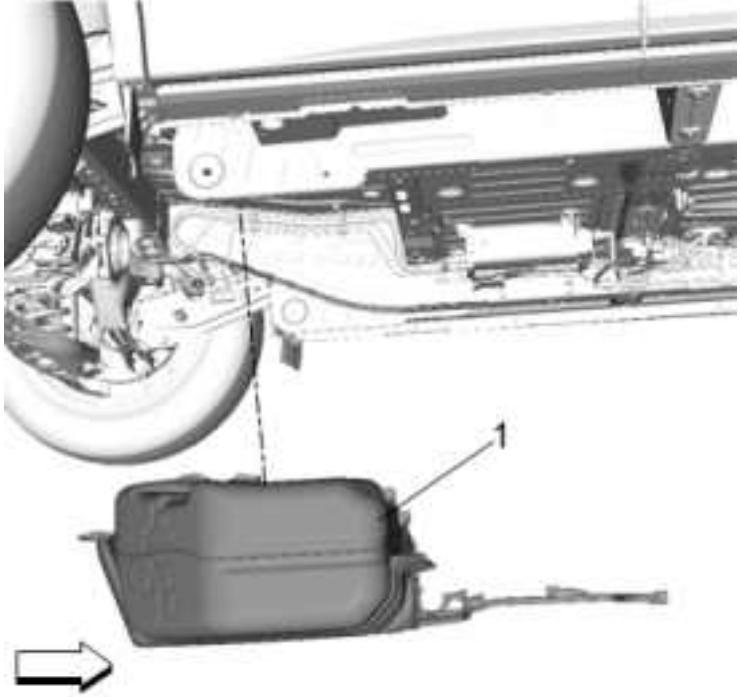

Fig. 57: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

1. Place a suitable adjustable jack under the fuel tank.
2. Install Fuel Tank (1)

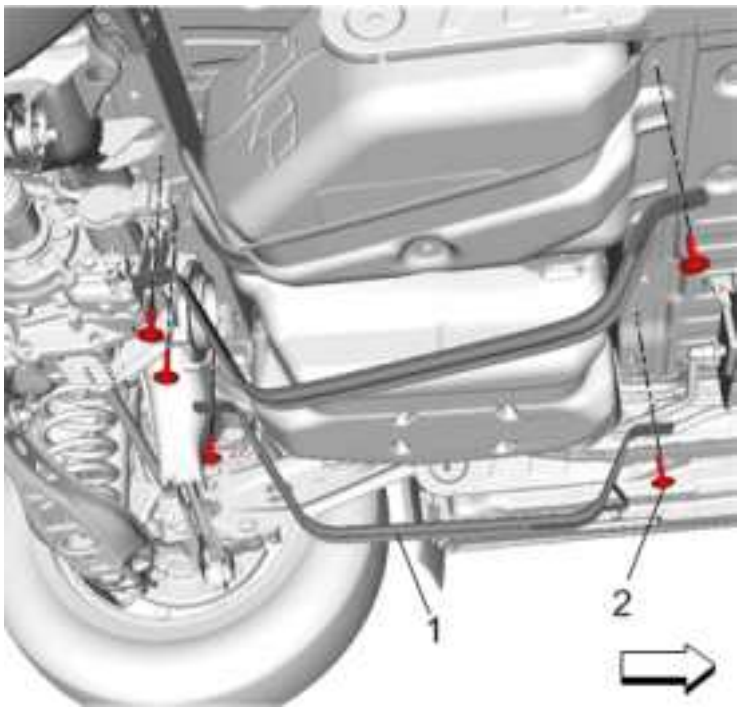

Fig. 58: Fuel Tank Strap And Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install Fuel Tank Strap (2) - [2x]

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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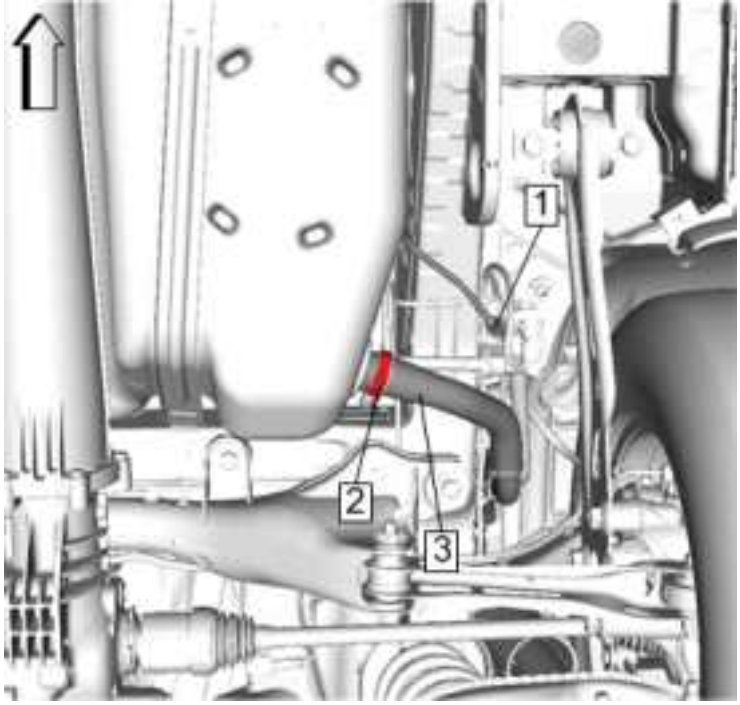

Fig. 59: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

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**

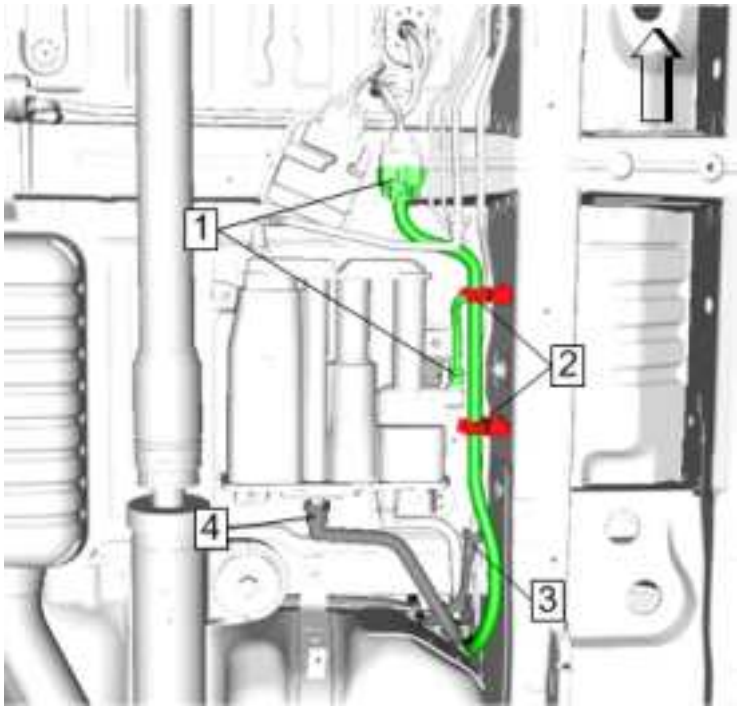

Fig. 60: Fuel Tank Fuel Pump Module Wiring Harness, Fuel Pump Fuel Feed Hose And Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

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)** **Underbody Rear Air Deflector Replacement (Diesel)**
13. Install Driveline Torque Tube -**Driveline Torque Tube Replacement**

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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 REPLACEMENT (FWD)

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. Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (Front Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

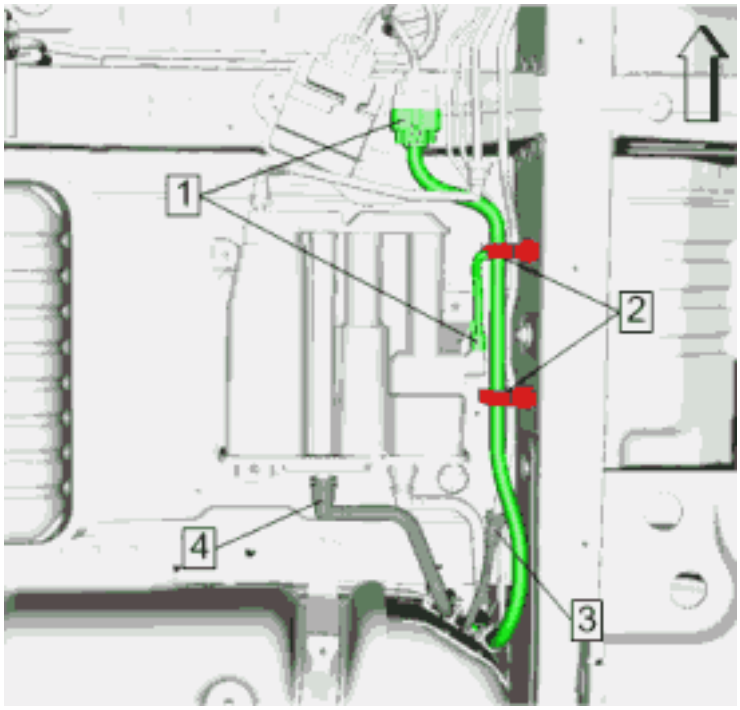

Fig. 61: Fuel Tank Fuel Pump Module Wiring Harness And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

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**

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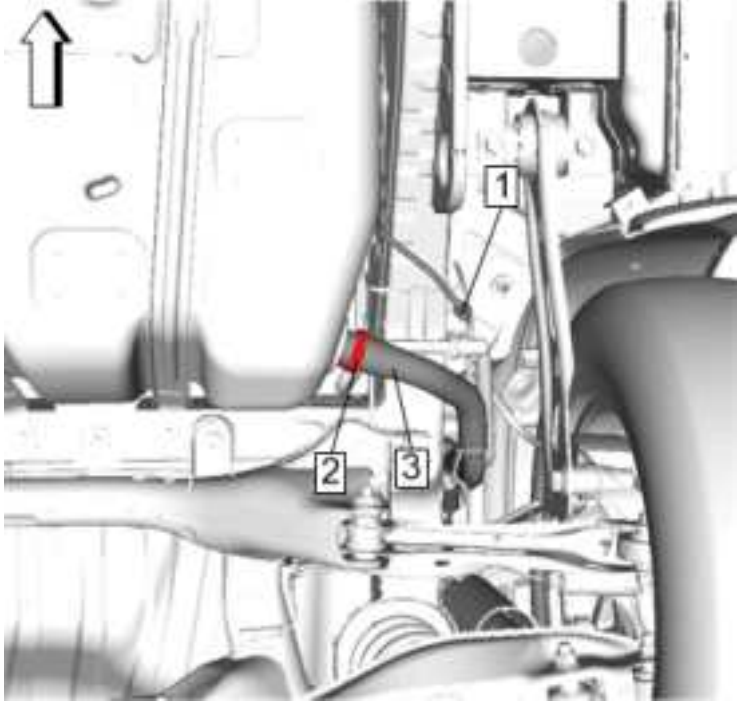

Fig. 62: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect Fuel Tank Vent Hose (1) - **Plastic Collar Quick Connect Fitting Service**
11. Remove Fuel Tank Filler Hose Clamp (2)
12. Remove Fuel Tank Filler Hose (3)

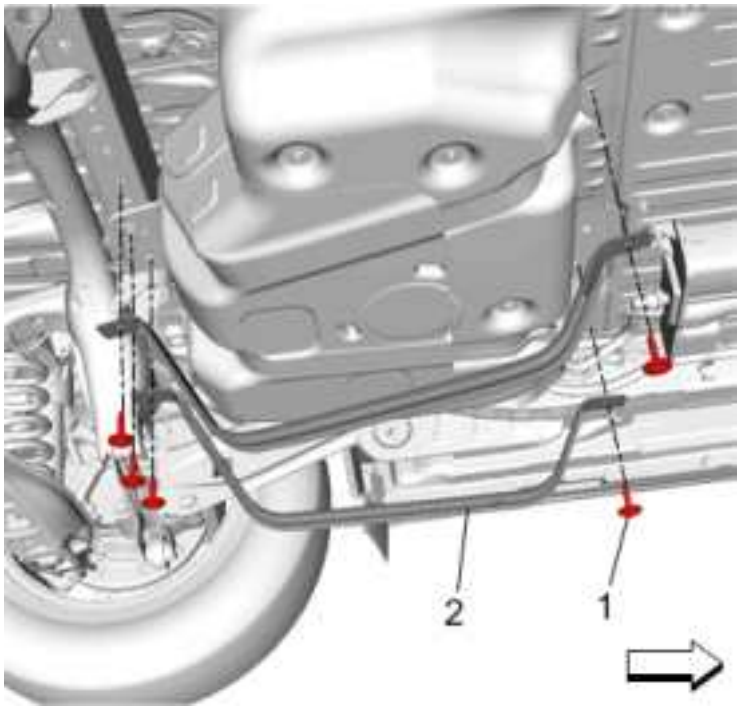

Fig. 63: Fuel Tank Strap And Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Place a suitable adjustable jack under the fuel tank.
14. Remove Fuel Tank Strap Bolt (1) - [5x]
15. Remove Fuel Tank Strap (2) - [2x]

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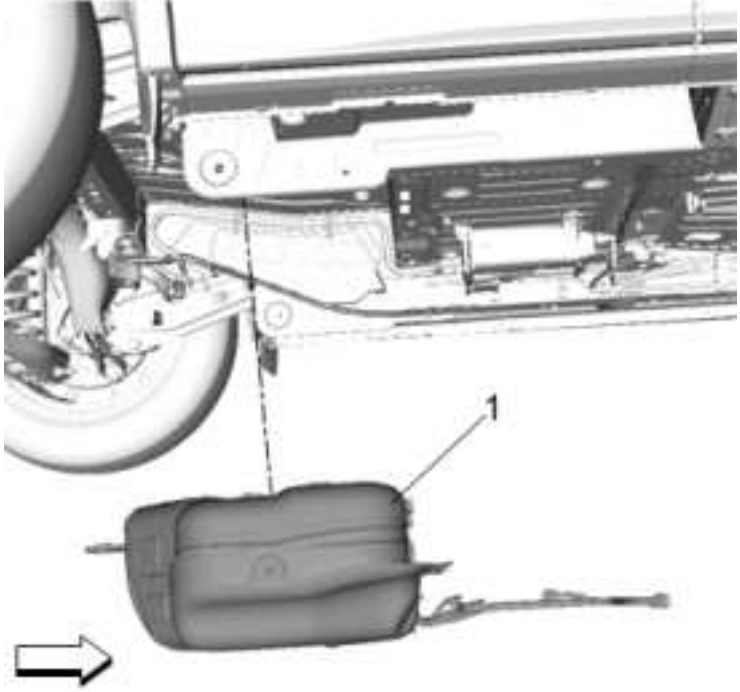

Fig. 64: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

16. Remove Fuel Tank (1).
17. If replacing fuel tank transfer parts as necessary.

Installation Procedure

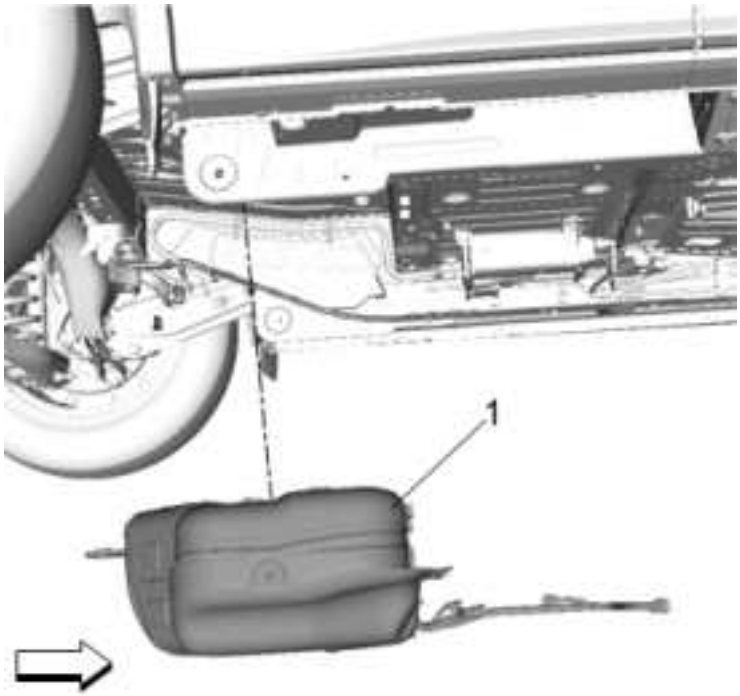

Fig. 65: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

1. Place a suitable adjustable jack under the fuel tank.
2. Install Fuel Tank (1).

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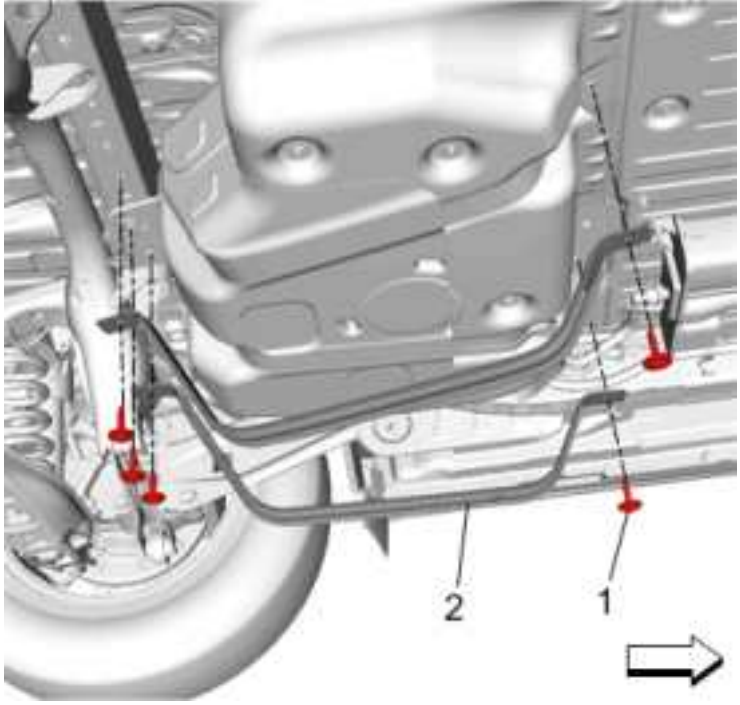

Fig. 66: Fuel Tank Strap And Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install Fuel Tank Strap (2) [2x]

CAUTION: **Refer to Fastener Caution .**

4. Install Fuel Tank Strap Bolt (1) - and tighten [5x] 22 N.m (16 lb ft)

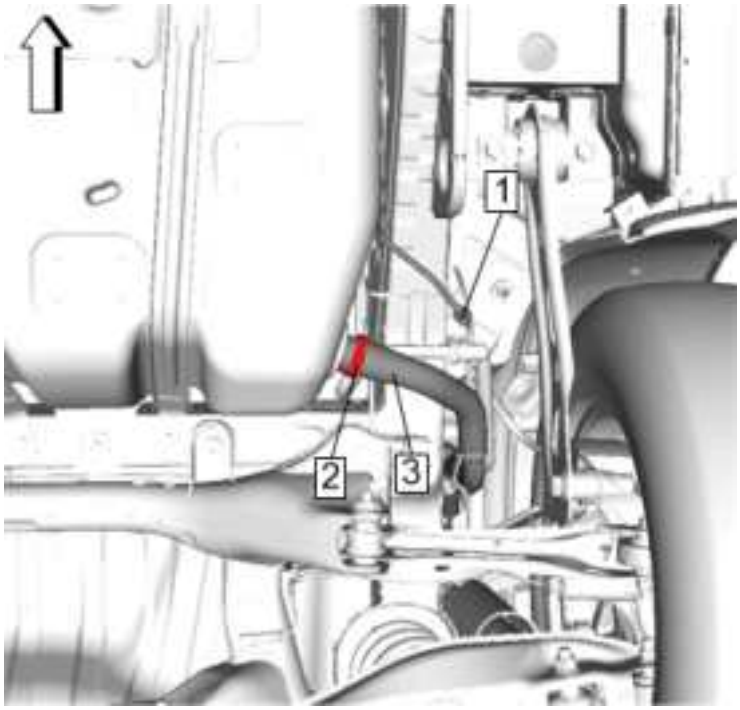

Fig. 67: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Install Fuel Tank Filler Hose (3)
6. Install Fuel Tank Filler Hose Clamp (2) and tighten 4 N.m (35 lb in)
7. Correct Fuel Tank Vent Hose (1) - **Plastic Collar Quick Connect Fitting Service**

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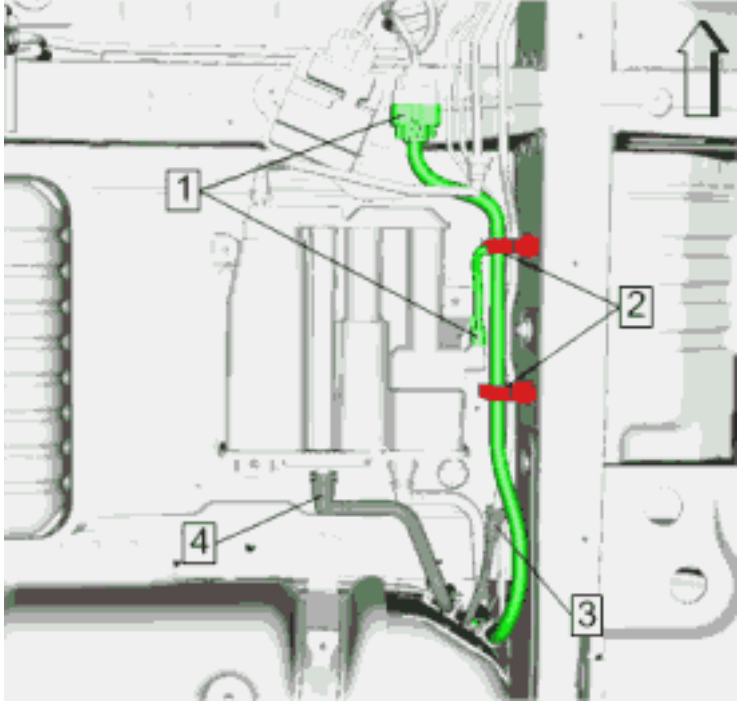

Fig. 68: Fuel Tank Fuel Pump Module Wiring Harness And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

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)** **Underbody Rear Air Deflector Replacement (Diesel)**
13. Install Exhaust Muffler Assembly - **Exhaust Muffler Replacement (LTG, LYX)**
14. Lower the vehicle.
15. Refill the fuel tank.
16. Inspect for fuel leaks.

FUEL TANK FILLER HOSE REPLACEMENT (AWD)

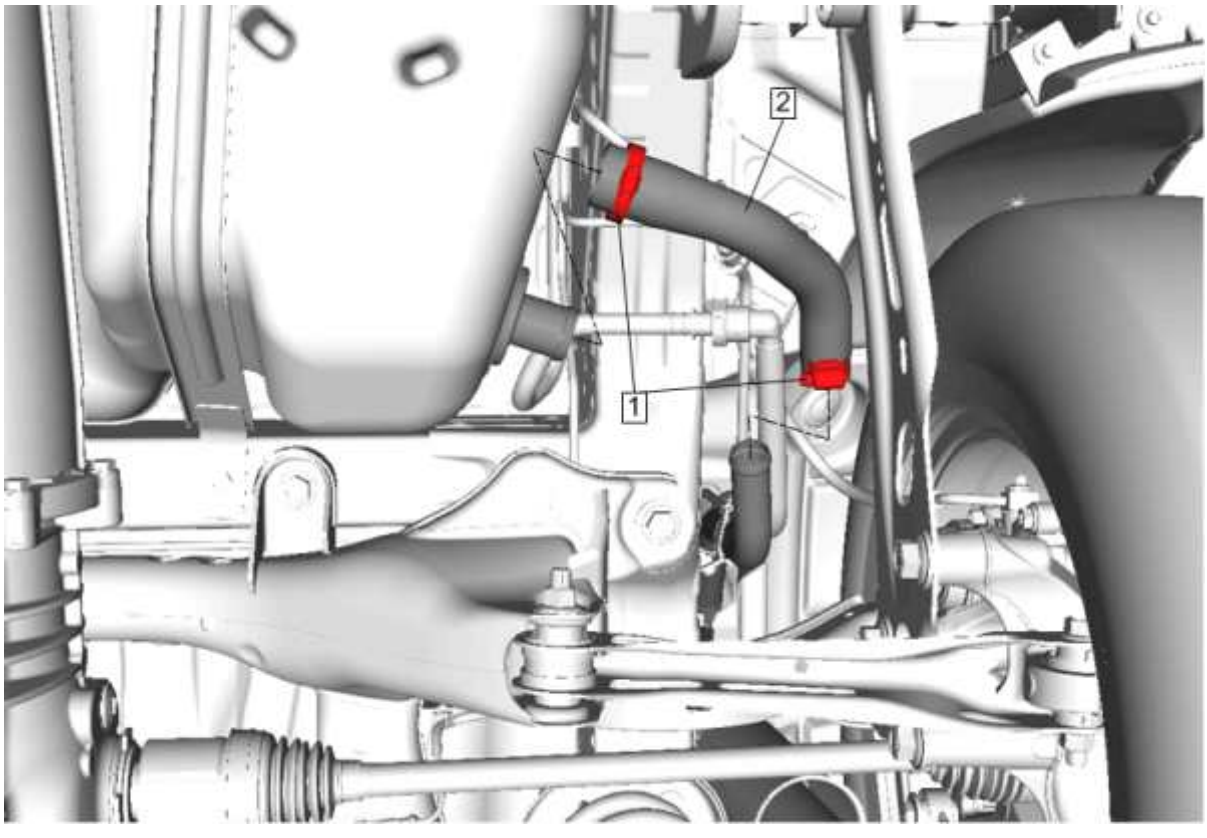

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Fig. 69: Fuel Tank Filler Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Fuel Tank Draining 2. Lifting and Jacking the Vehicle	
1	Fuel Tank Filler Hose Clamp [2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 4 N.m (35 lb in)
2	Fuel Tank Filler Hose

FUEL TANK FILLER HOSE REPLACEMENT (FWD)

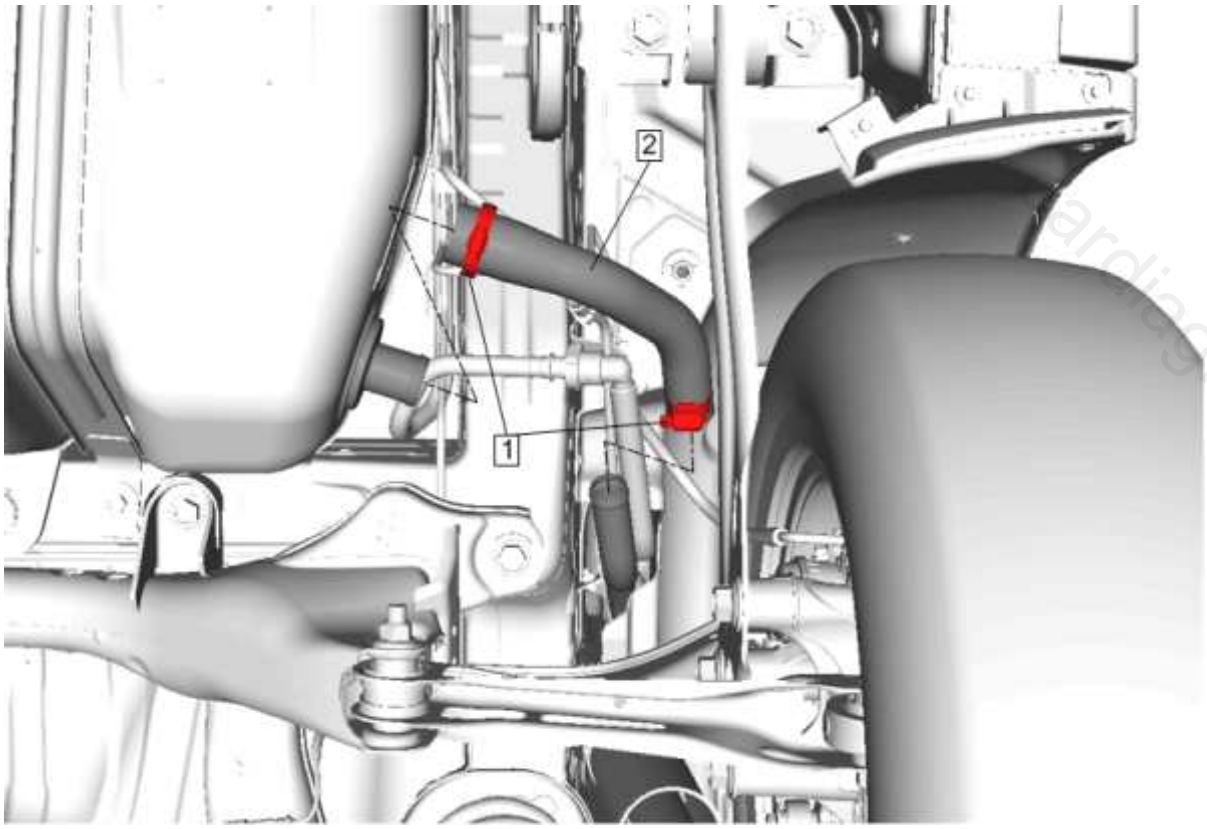

Fig. 70: Fuel Tank Filler Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Fuel Tank Draining 2. Lifting and Jacking the Vehicle	

Callout	Component Name
1	Fuel Tank Filler Hose Clamp [2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 4 N.m (35 lb in)
2	Fuel Tank Filler Hose

FUEL SYSTEM CLEANING

NOTE: **When flushing the fuel tank, treat the fuel and water mixture as a hazardous material. Handle the material in accordance with all local, state and federal laws and regulations.**

NOTE: **Whenever the fuel tank is cleaned, inspect the fuel pump fuel strainer. If the fuel pump fuel strainer is contaminated, replace the fuel pump fuel strainer and inspect the fuel pump.**

NOTE: **Always maintain cleanliness when servicing fuel system components.**

1. Remove the fuel tank fuel pump module. 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).

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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)

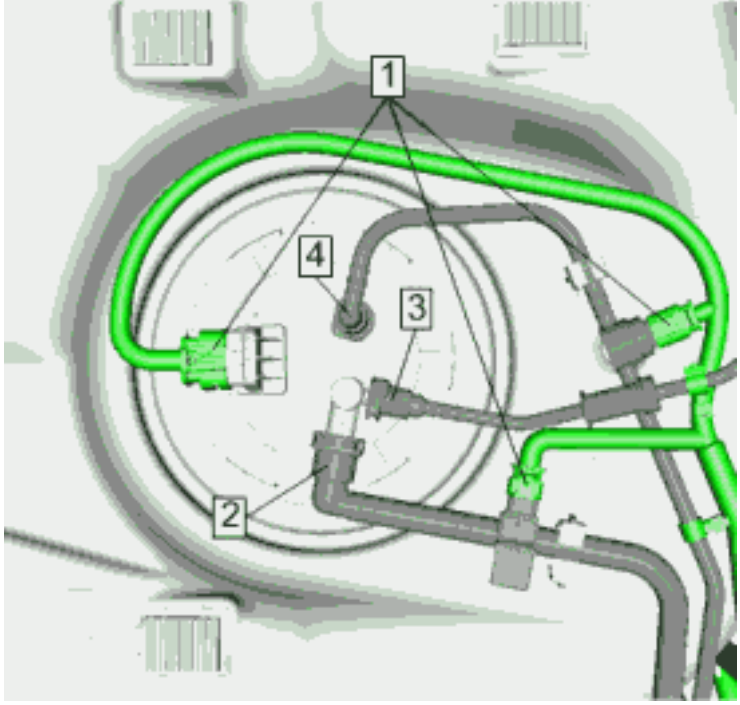

Fig. 71: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Electrical Connector (1) - [3x]
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**

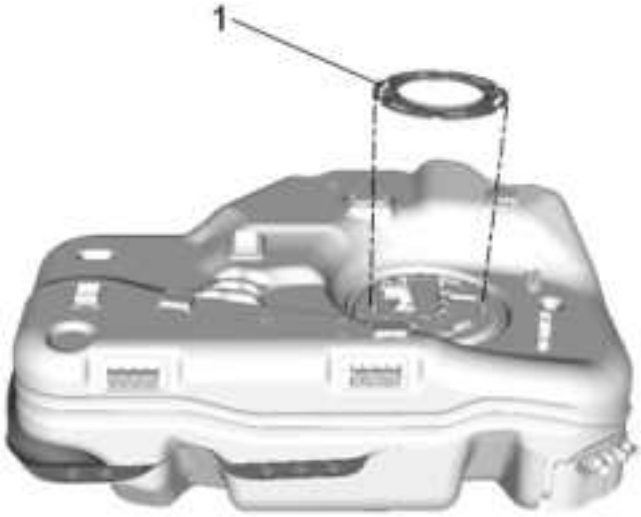

Fig. 72: Fuel Pump Lock Ring
Courtesy of GENERAL MOTORS COMPANY

6. Remove Fuel Pump Lock Ring (1) - **CH 52075** Fuel Sender Lock Ring Wrench

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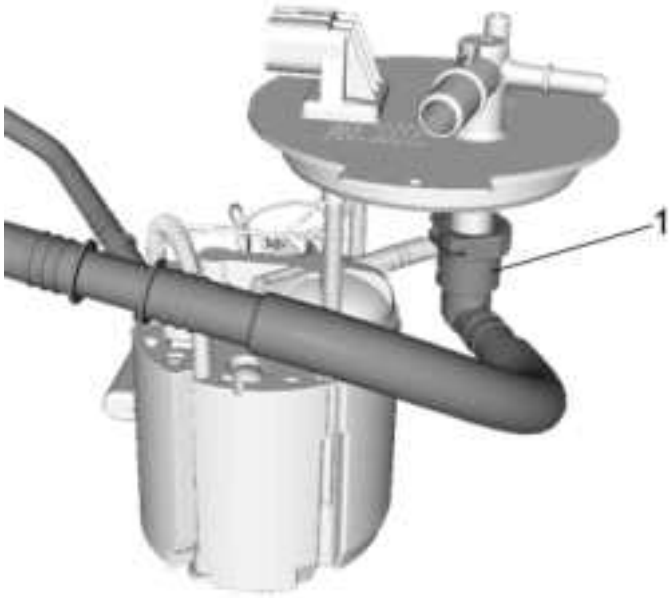

Fig. 73: Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Fuel Tank Vent Hose (1) - **Plastic Collar Quick Connect Fitting Service**

Fig. 74: Fuel Tank Fuel Pump Module And O-Ring
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. 75: Fuel Tank Fuel Pump Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW O-Ring (2)
2. Install Fuel Tank Fuel Pump Module (1)

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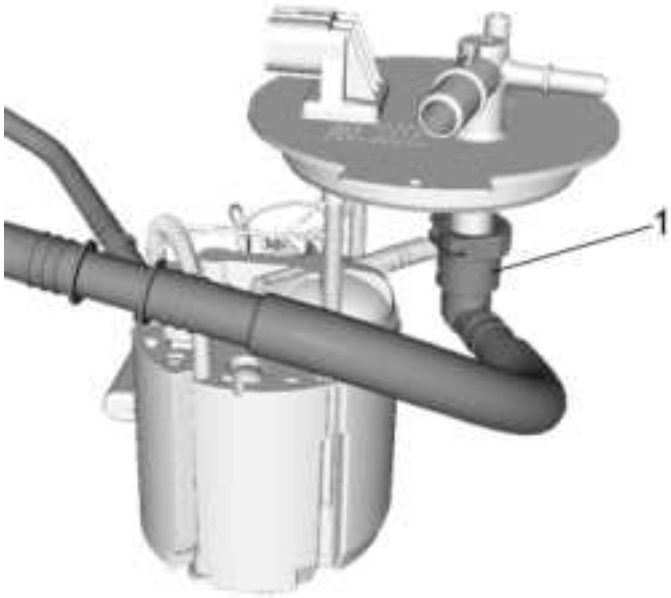

Fig. 76: Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

3. Connect Fuel Tank Vent Hose (1) - **Plastic Collar Quick Connect Fitting Service**

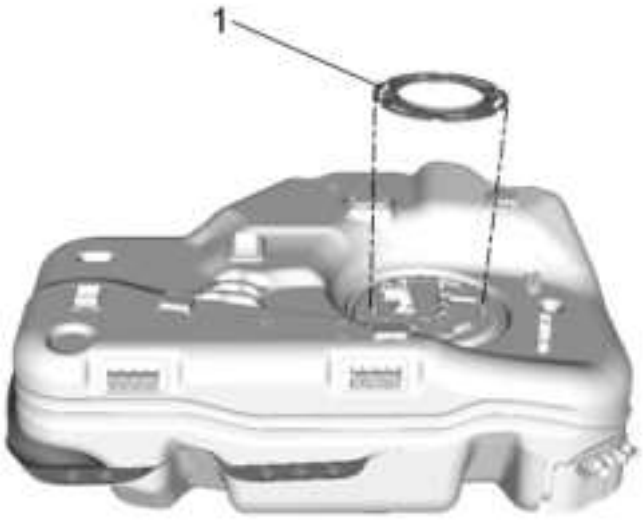

Fig. 77: Fuel Pump Lock Ring
Courtesy of GENERAL MOTORS COMPANY

4. Install Fuel Pump Lock Ring (1) - **CH 52075** Fuel Sender Lock Ring Wrench

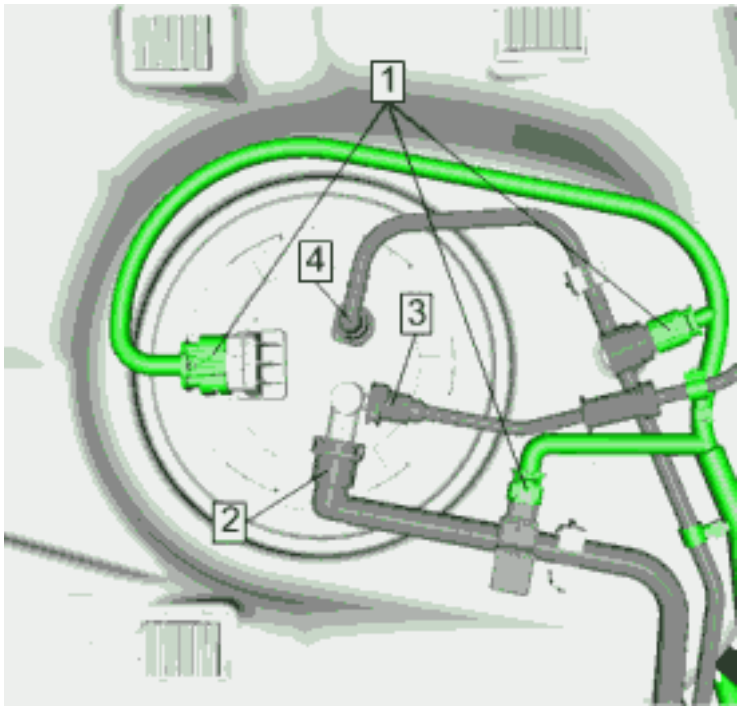

Fig. 78: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

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. Evaporative Emission Canister Vent Hose (2) - **Plastic Collar Quick Connect Fitting Service**
8. Connect Electrical Connector (1) - [3x]
9. Install Fuel Tank - **Fuel Tank Replacement (FWD)**

FUEL TANK FUEL PUMP MODULE REPLACEMENT (AWD)

Special Tools

CH 52075 Fuel Sender Lock Ring Wrench

Equivalent regional tools:**Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

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Removal Procedure

WARNING: Refer to Diesel/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Remove Fuel Tank -Fuel Tank Replacement (AWD)

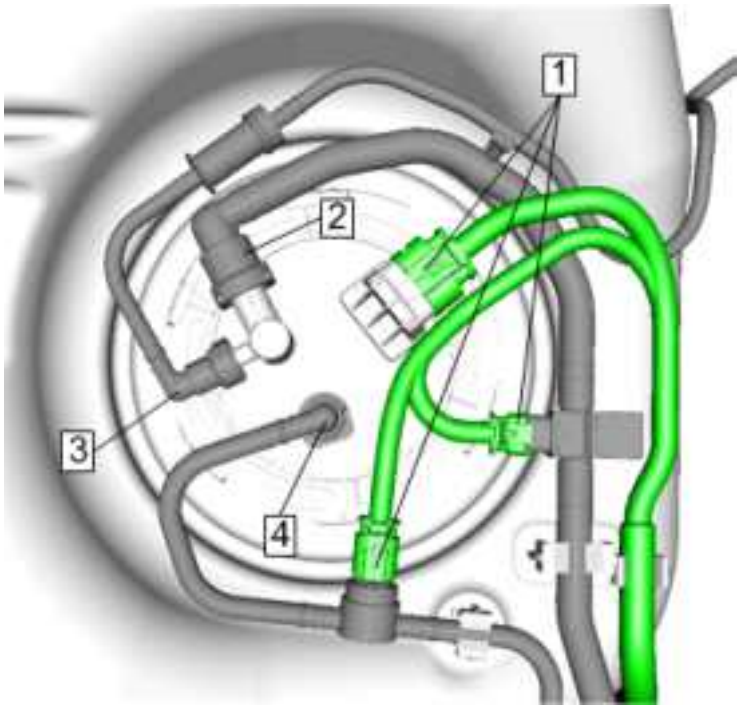

Fig. 79: Electrical Connector And Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Electrical Connector (1) - [3x]
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

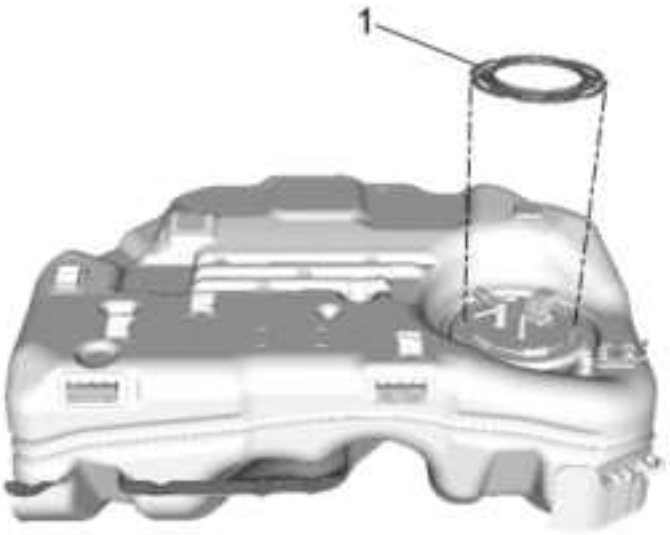

Fig. 80: Fuel Pump Lock Ring
Courtesy of GENERAL MOTORS COMPANY

6. Remove Fuel Pump Lock Ring (1) - **CH 52075** Fuel Sender Lock Ring Wrench

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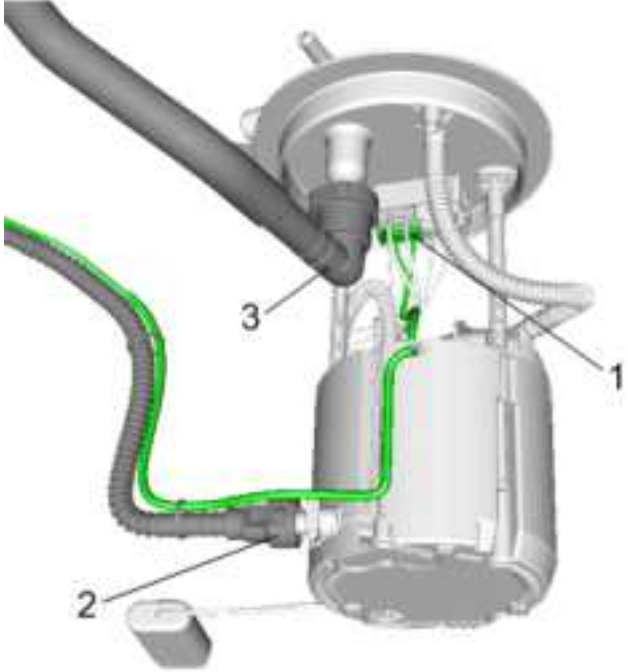

Fig. 81: Electrical Connector, Electrical Connector And Transfer Hose
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Electrical Connector (1).
8. Disconnect Transfer Hose (2) -**Plastic Collar Quick Connect Fitting Service**
9. Disconnect Electrical Connector (3) - **Plastic Collar Quick Connect Fitting Service**

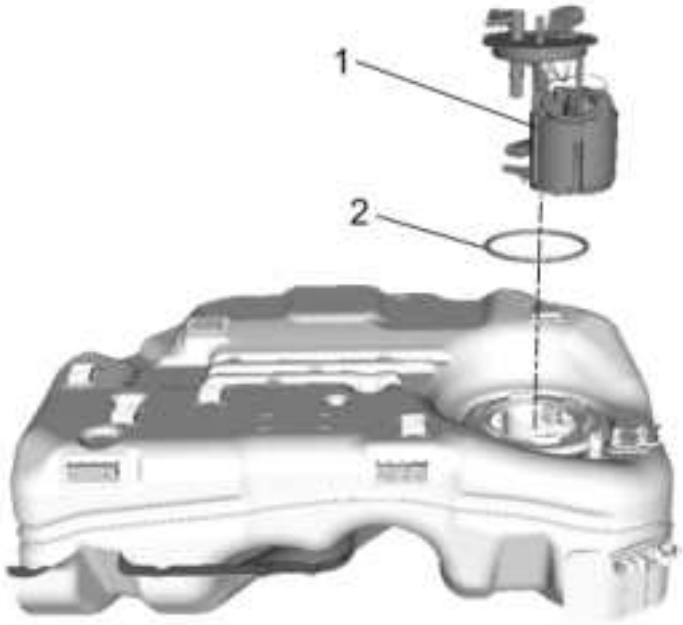

Fig. 82: Fuel Tank Fuel Pump Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

10. Remove Fuel Tank Fuel Pump Module (1)
11. Remove O-Ring (2) and DISCARD

Installation Procedure

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Fig. 83: 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.

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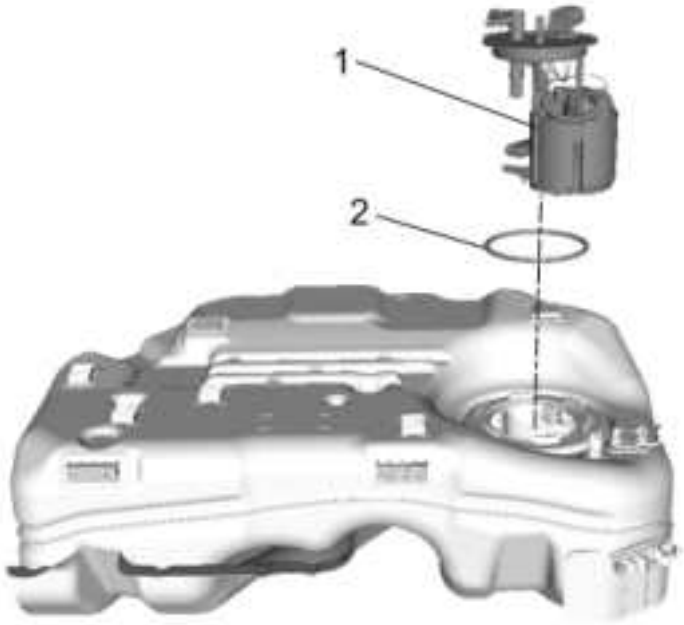

Fig. 84: Fuel Tank Fuel Pump Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW O-Ring (2)
3. Install Install Fuel Tank Fuel Pump Module (1)

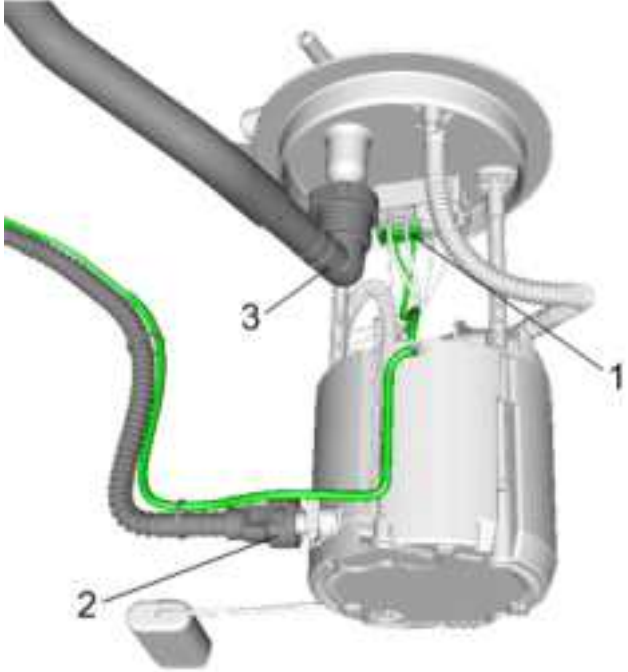

Fig. 85: Electrical Connector, Electrical Connector And Transfer Hose
Courtesy of GENERAL MOTORS COMPANY

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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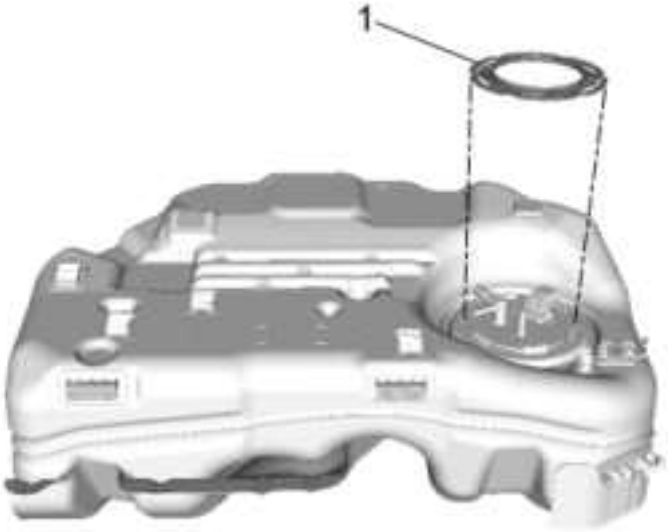

Fig. 86: Fuel Pump Lock Ring
Courtesy of GENERAL MOTORS COMPANY

7. Install Fuel Pump Lock Ring (1) - **CH 52075** Fuel Sender Lock Ring Wrench

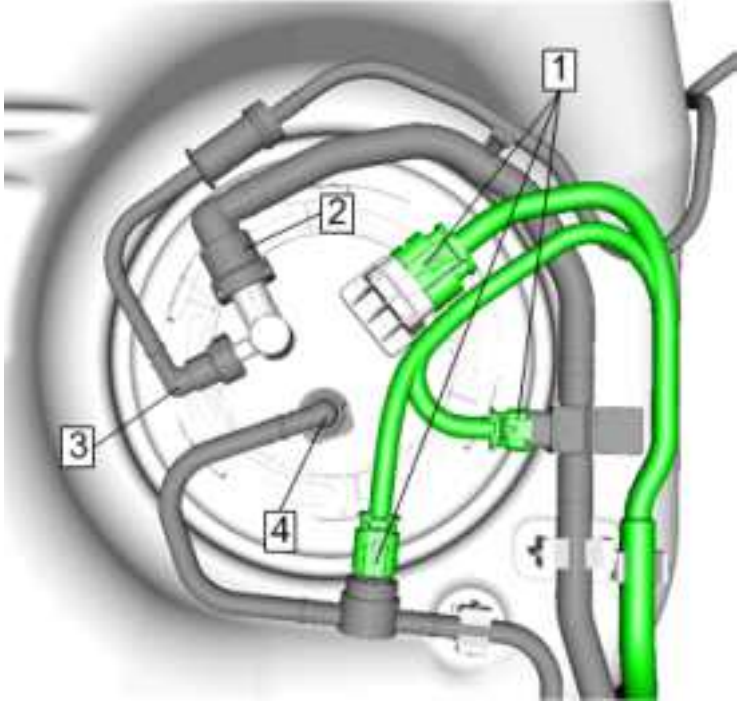

Fig. 87: Electrical Connector And Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

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) - [3x]
12. Install Fuel Tank - **Fuel Tank Replacement (AWD)**

FUEL PUMP POWER CONTROL MODULE REPLACEMENT (AWD)

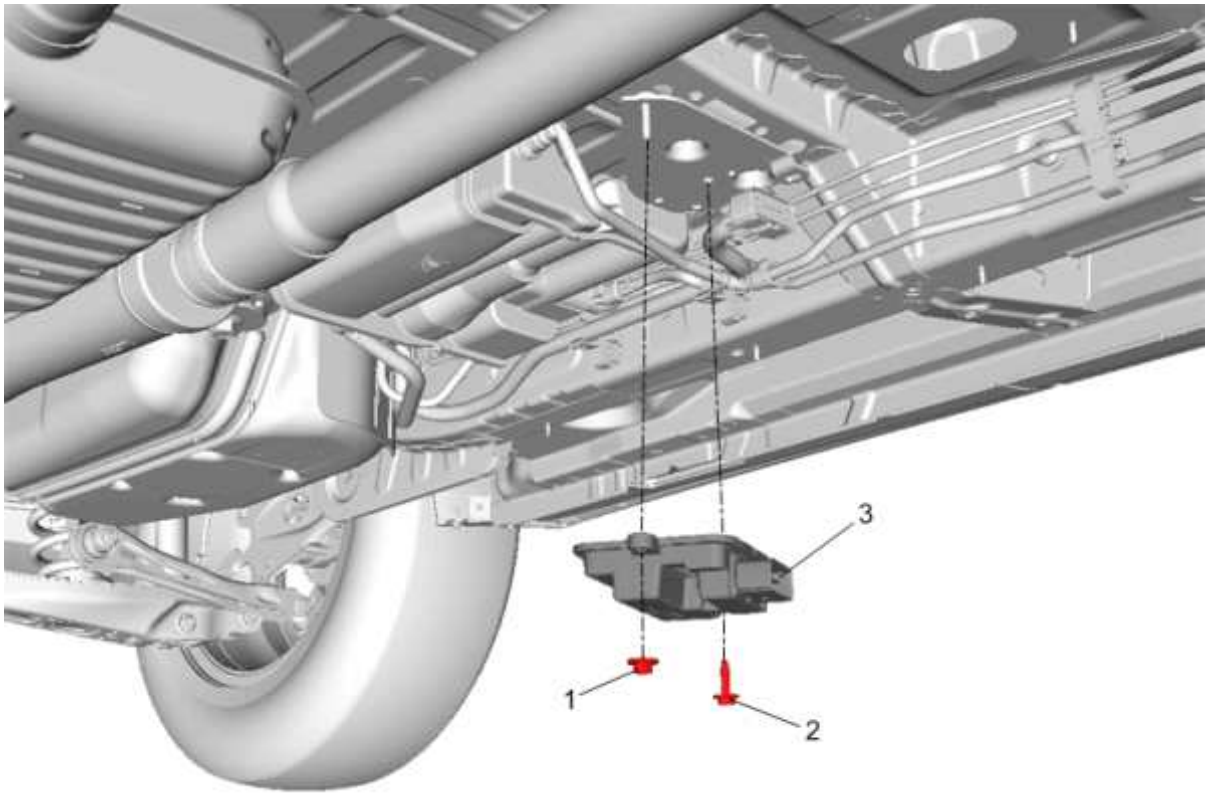

Fig. 88: Fuel Pump Power Control Module (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

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Callout	Component Name
Preliminary Procedure Underbody Rear Air Deflector Replacement (All Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel)	
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 (FWD)

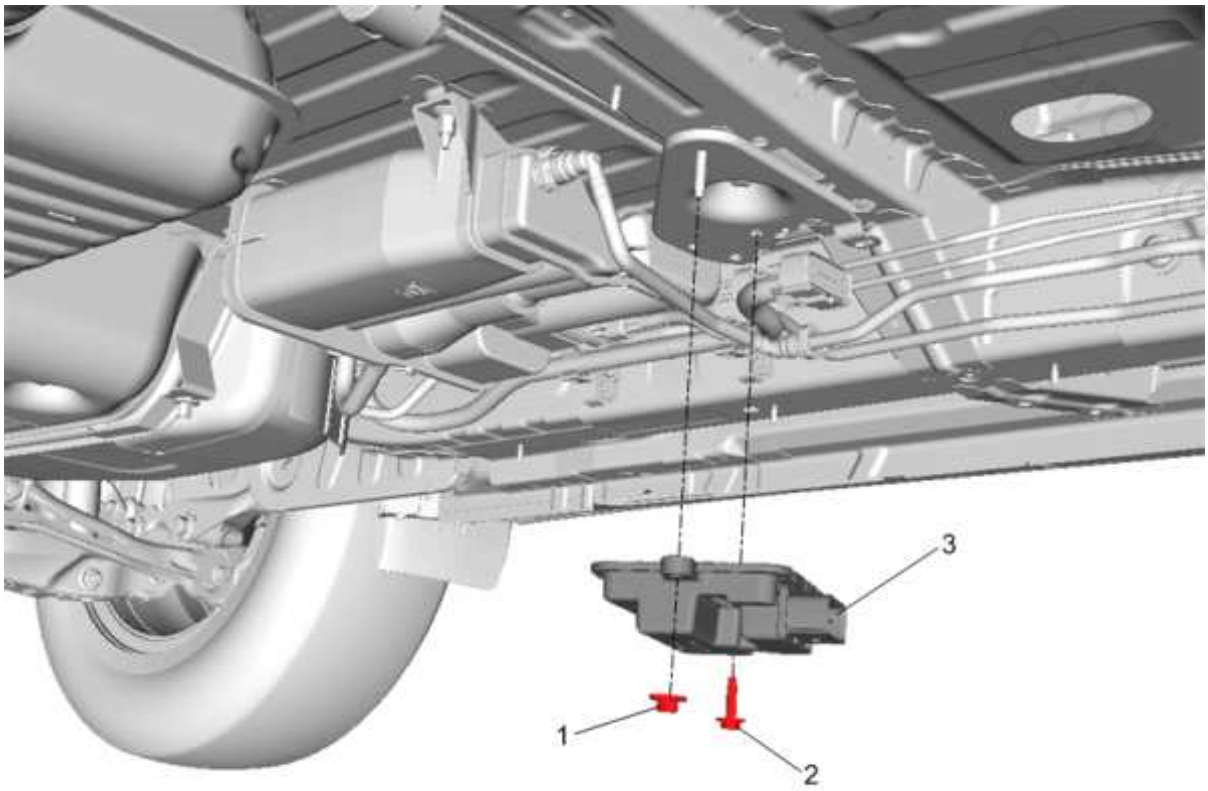

Fig. 89: Fuel Pump Power Control Module (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Underbody Rear Air Deflector Replacement (Front Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel)	

Callout	Component Name
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 TANK PRESSURE SENSOR REPLACEMENT (AWD)

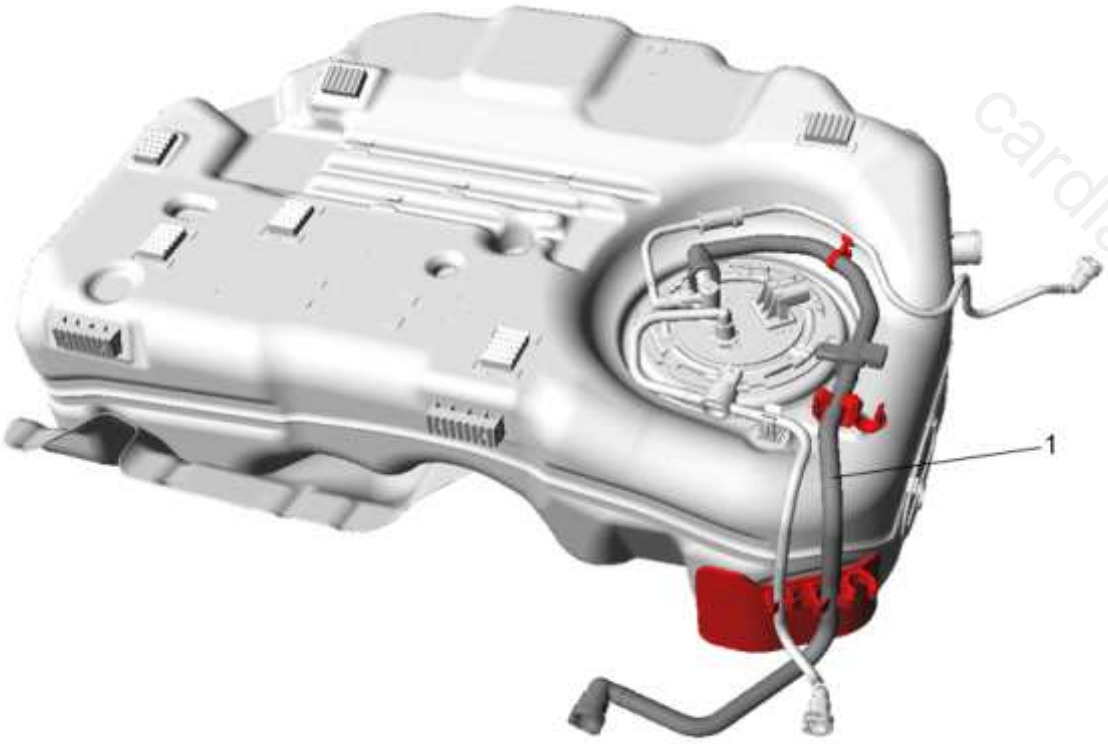

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Fig. 90: Fuel Tank Pressure Sensor (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedure Fuel Tank Replacement (AWD)**	

Callout	Component Name
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 (FWD)

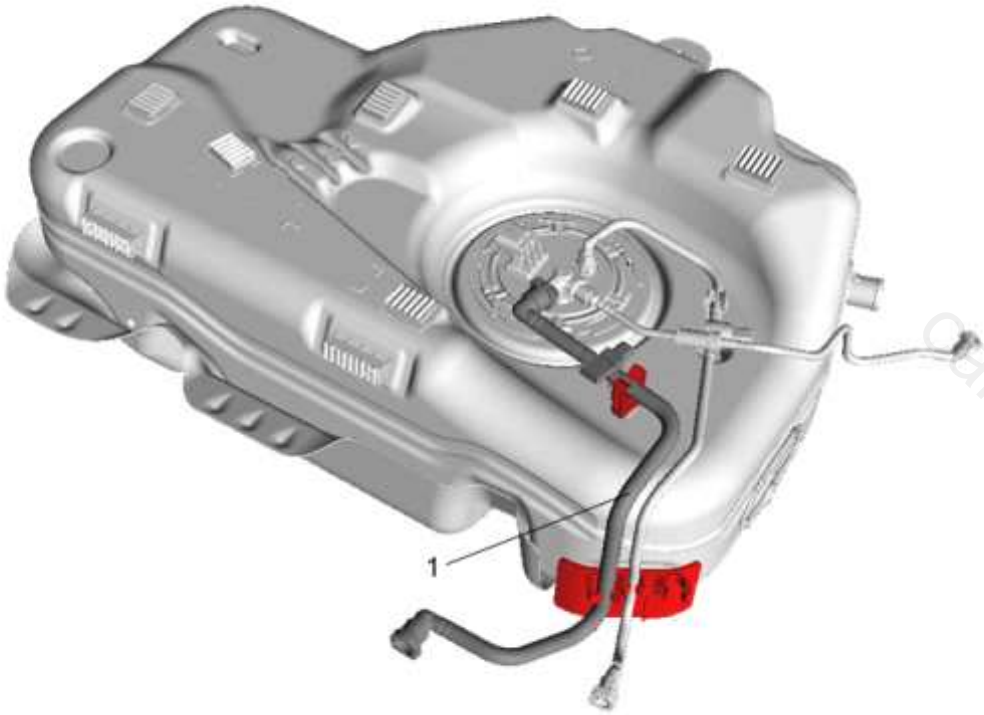

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Fig. 91: Fuel Tank Pressure Sensor (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedure Fuel Tank Replacement (FWD)**

Callout	Component Name
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 LEVEL SENSOR REPLACEMENT (AWD)

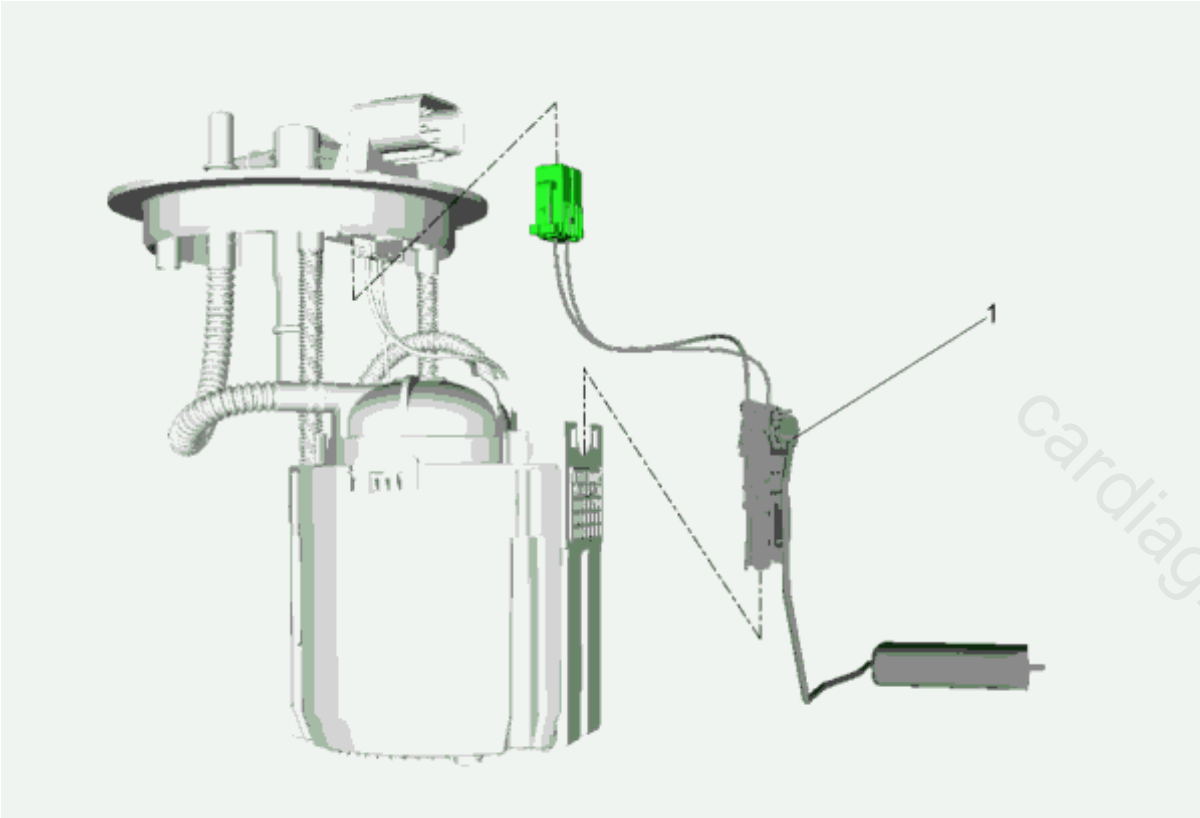

Fig. 92: Fuel Level Sensor (AWD)
Courtesy of GENERAL MOTORS COMPANY

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 LEVEL SENSOR REPLACEMENT (FWD)

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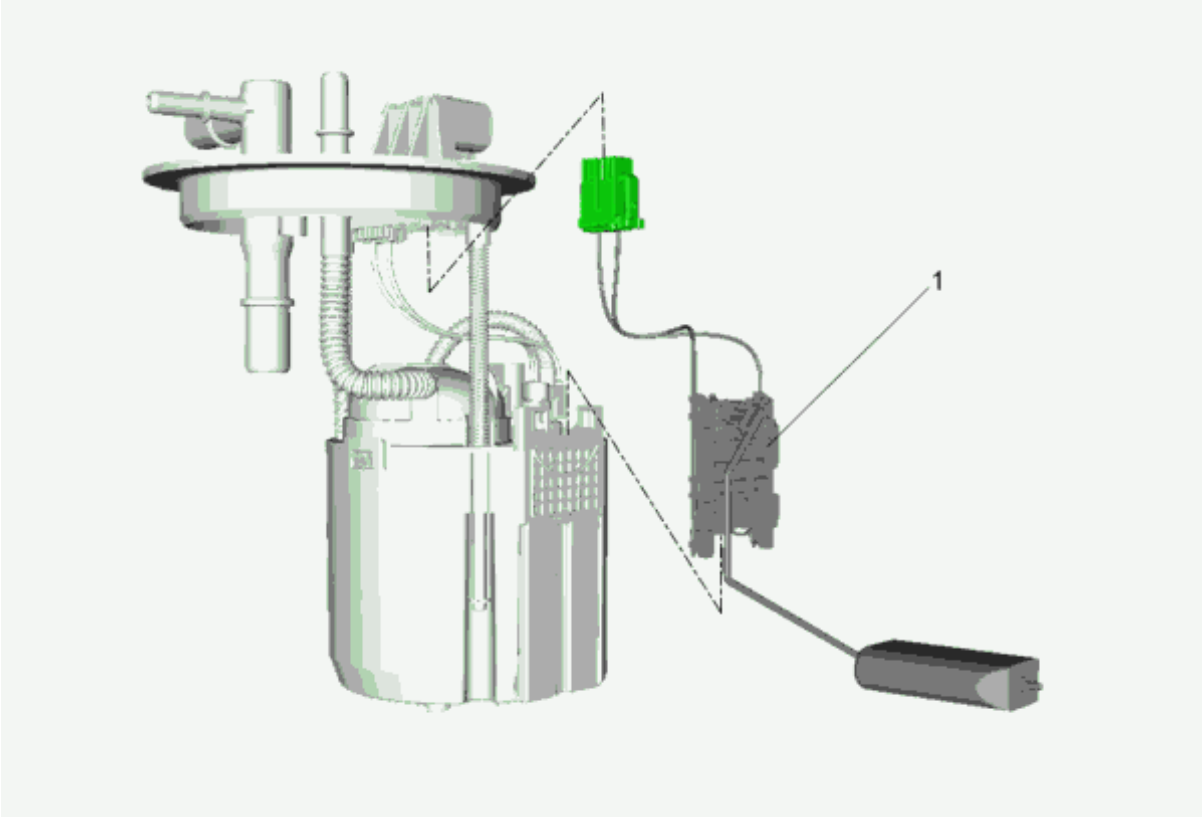

Fig. 93: Fuel Level Sensor (FWD)
Courtesy of GENERAL MOTORS COMPANY

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 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)

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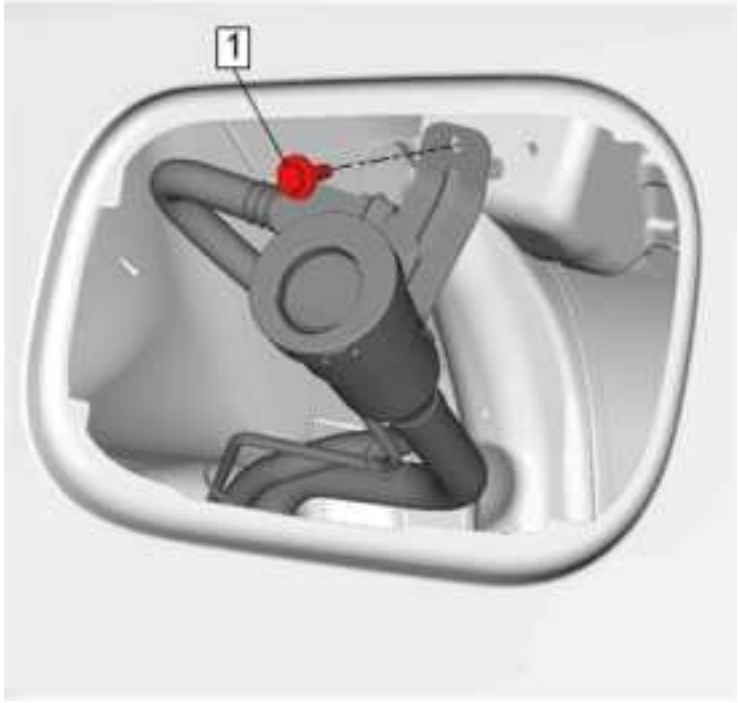

Fig. 94: Fuel Tank Filler Pipe Ground Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove Fuel Tank Filler Pipe Ground Bolt (1)

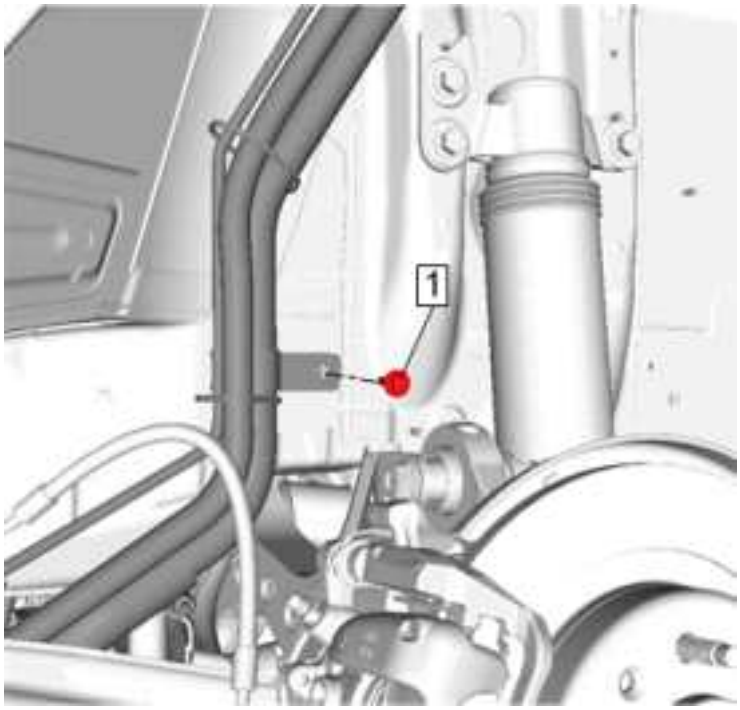

Fig. 95: Fuel Tank Filler Pipe Ground Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove Fuel Tank Filler Pipe Ground Bolt (1)

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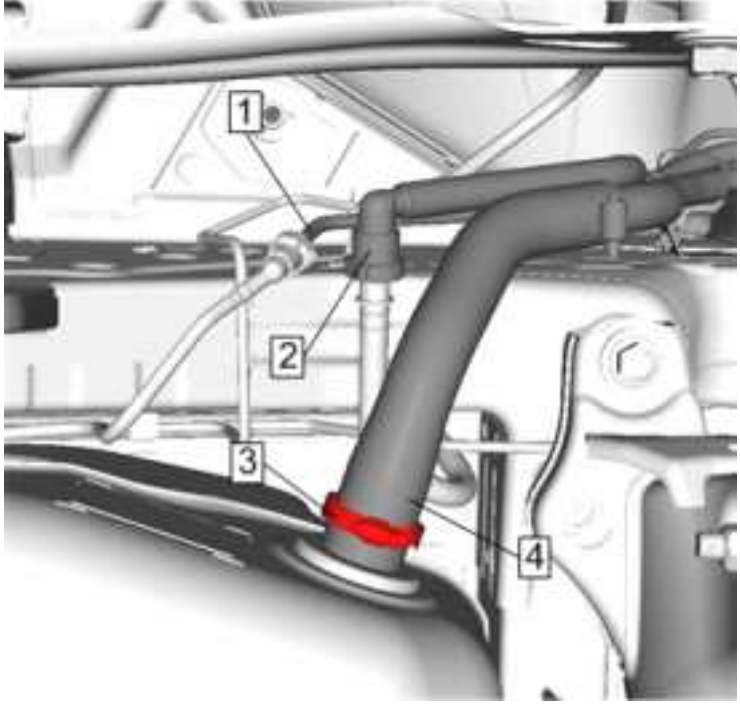

Fig. 96: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

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)

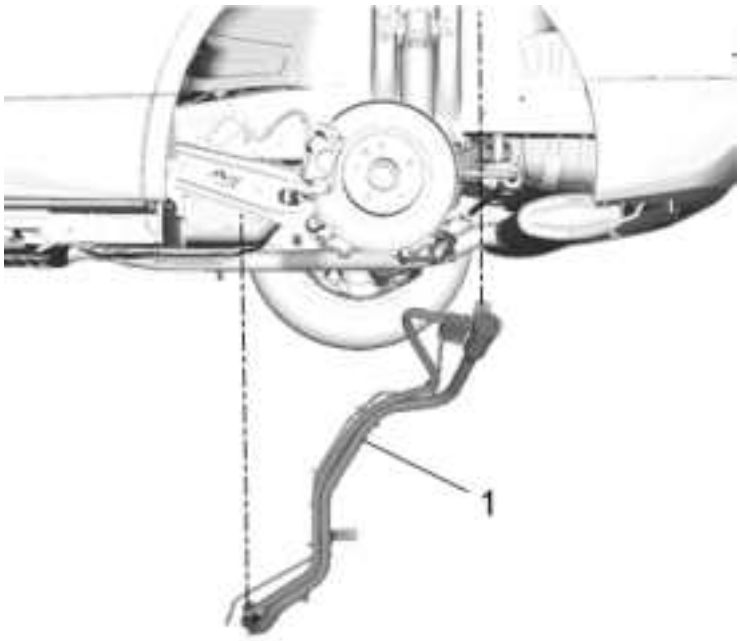

Fig. 97: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

10. Remove Fuel Tank Filler Pipe (1)

Installation Procedure

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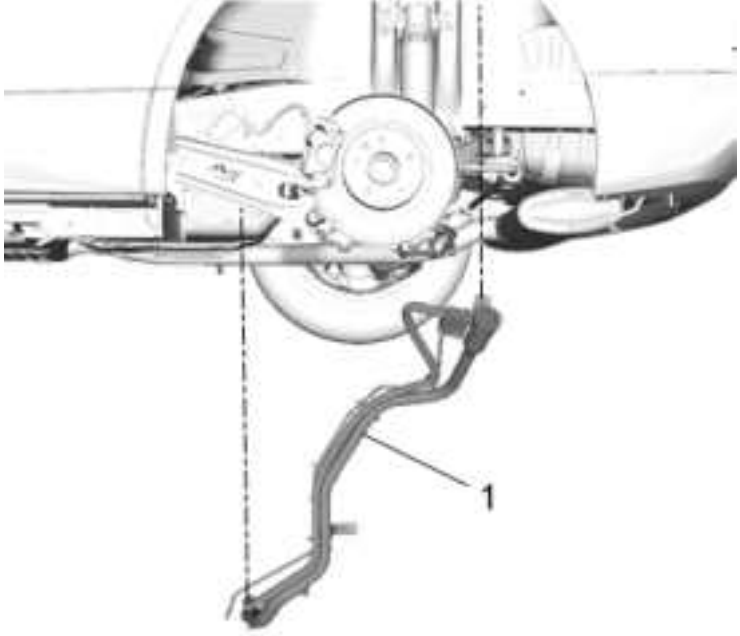

Fig. 98: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Install Fuel Tank Filler Pipe (1)

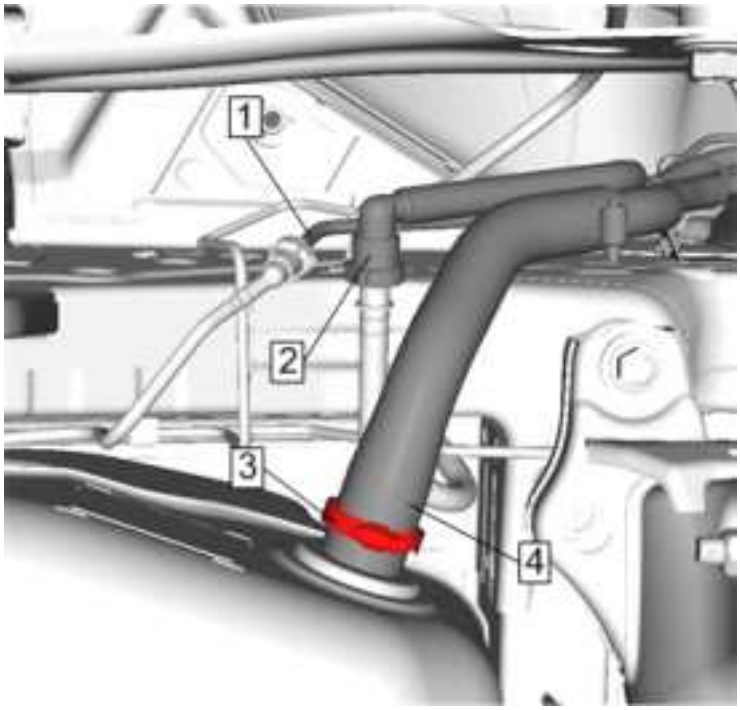

Fig. 99: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

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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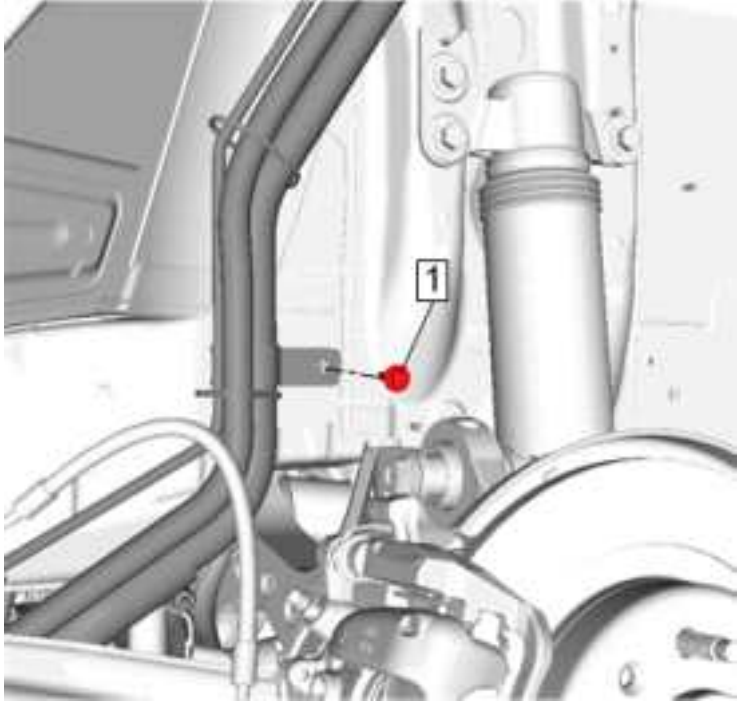

Fig. 100: Fuel Tank Filler Pipe Ground Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Install Fuel Tank Filler Pipe Ground Bolt (1) and tighten 9 N.m (80 lb in)

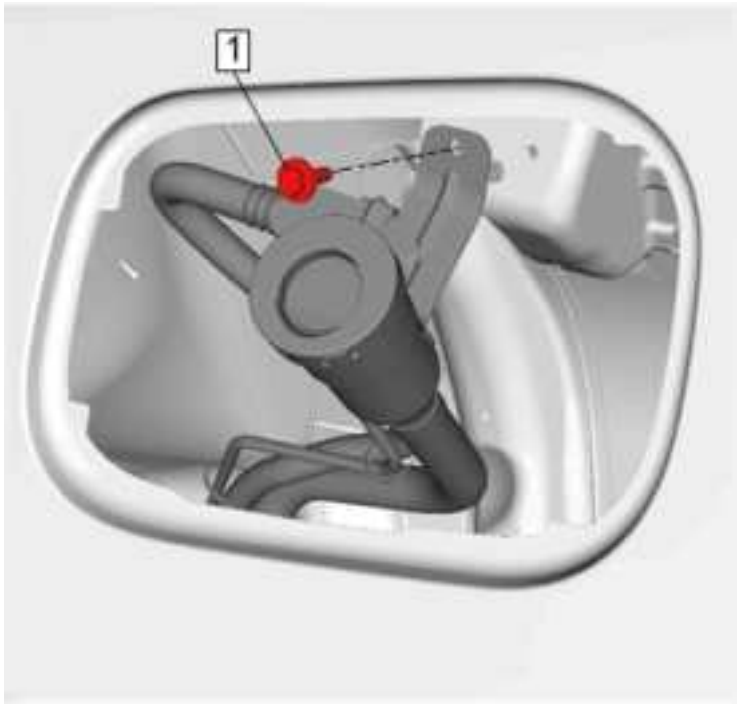

Fig. 101: Fuel Tank Filler Pipe Ground Bolt
Courtesy of GENERAL MOTORS COMPANY

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 PUMP COVER REPLACEMENT

Removal Procedure

1. Remove Charge Air Cooler Outlet Air Tube - **Charge Air Cooler Outlet Air Tube Replacement**
2. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**

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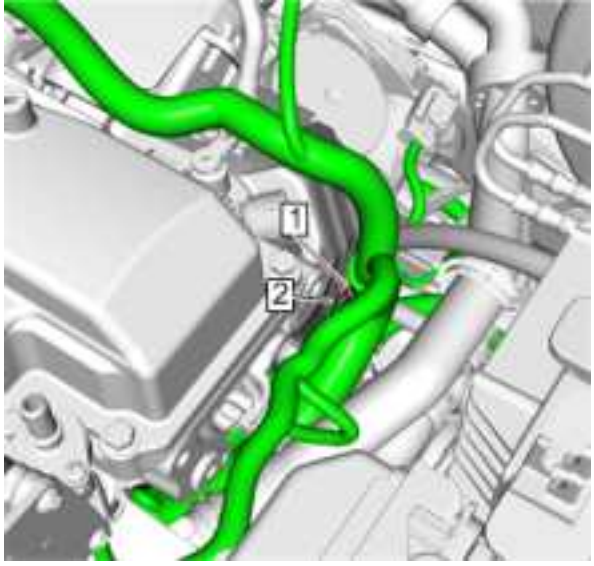

Fig. 102: Engine Wiring Harness Retainer And Fuel Pump Cover
Courtesy of GENERAL MOTORS COMPANY

3. Remove Engine Wiring Harness Retainer (1) @ Fuel Pump Cover (2).

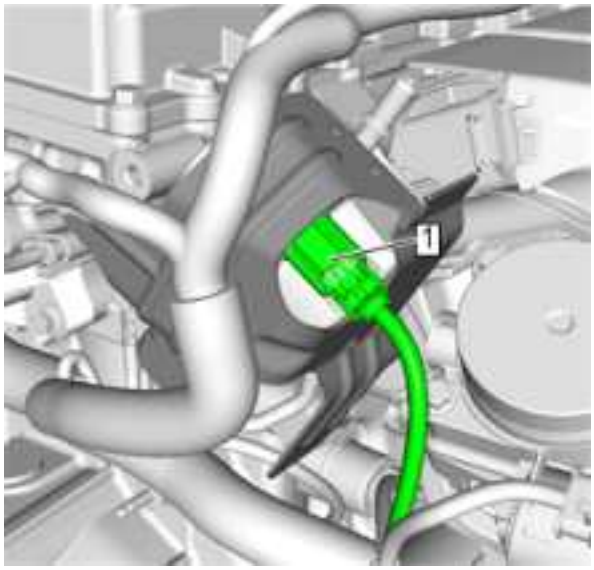

Fig. 103: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Electrical Connector (1) @ Fuel Pump

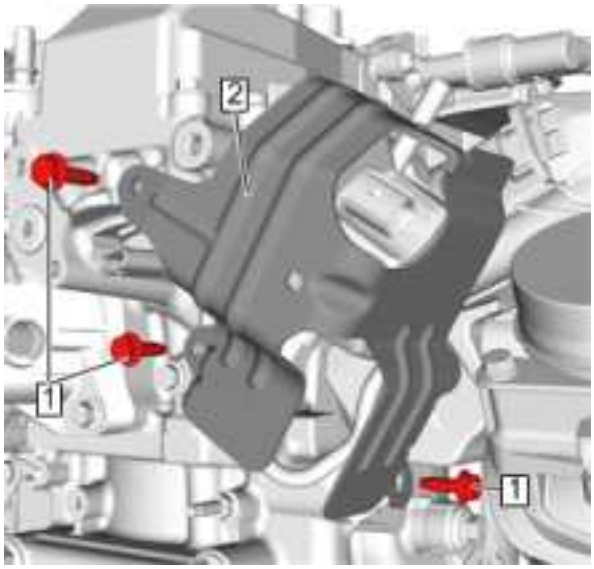

Fig. 104: Fuel Pump Shield Bolt
Courtesy of GENERAL MOTORS COMPANY

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5. Remove Fuel Pump Shield Bolt (1) - [3x]
6. Remove Fuel Pump Cover (2).

Installation Procedure

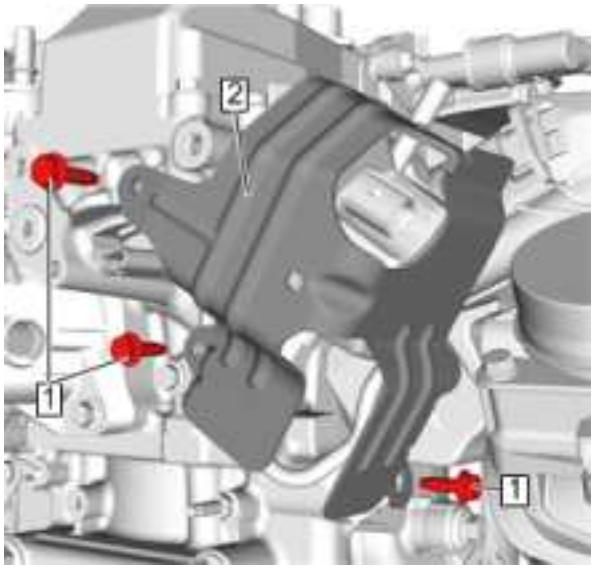

Fig. 105: Fuel Pump Shield Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install Fuel Pump Cover (2)

CAUTION: **Refer to Fastener Caution .**

2. Install Fuel Pump Shield Bolt (1) and tighten [3x] 10 N.m (89 lb in)

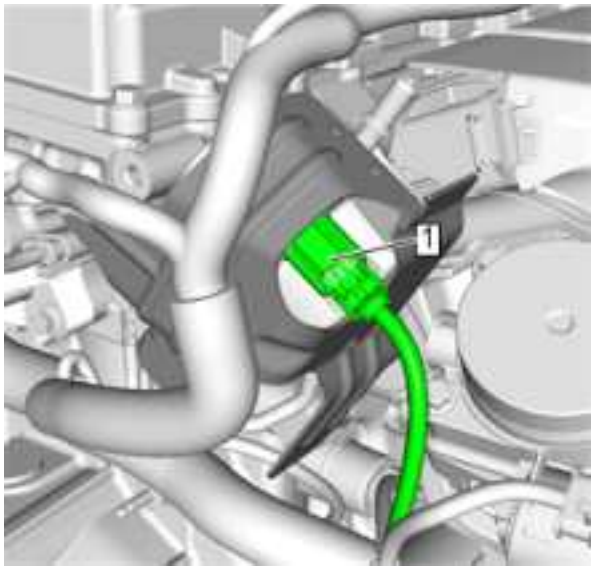

Fig. 106: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect Electrical Connector (1) @ Fuel Pump.

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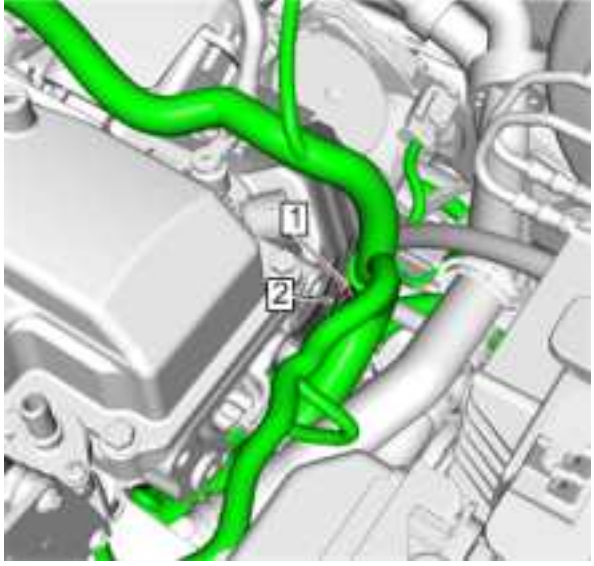

Fig. 107: Engine Wiring Harness Retainer And Fuel Pump Cover
Courtesy of GENERAL MOTORS COMPANY

4. Install Engine Wiring Harness Retainer (1) @ Fuel Pump Cover (2)
5. Install Intake Manifold Cover **Intake Manifold Cover Replacement**
6. Install Install Charge Air Cooler Outlet Air Tube - **Charge Air Cooler Outlet Air Tube Replacement**

FUEL PUMP INSULATOR REPLACEMENT

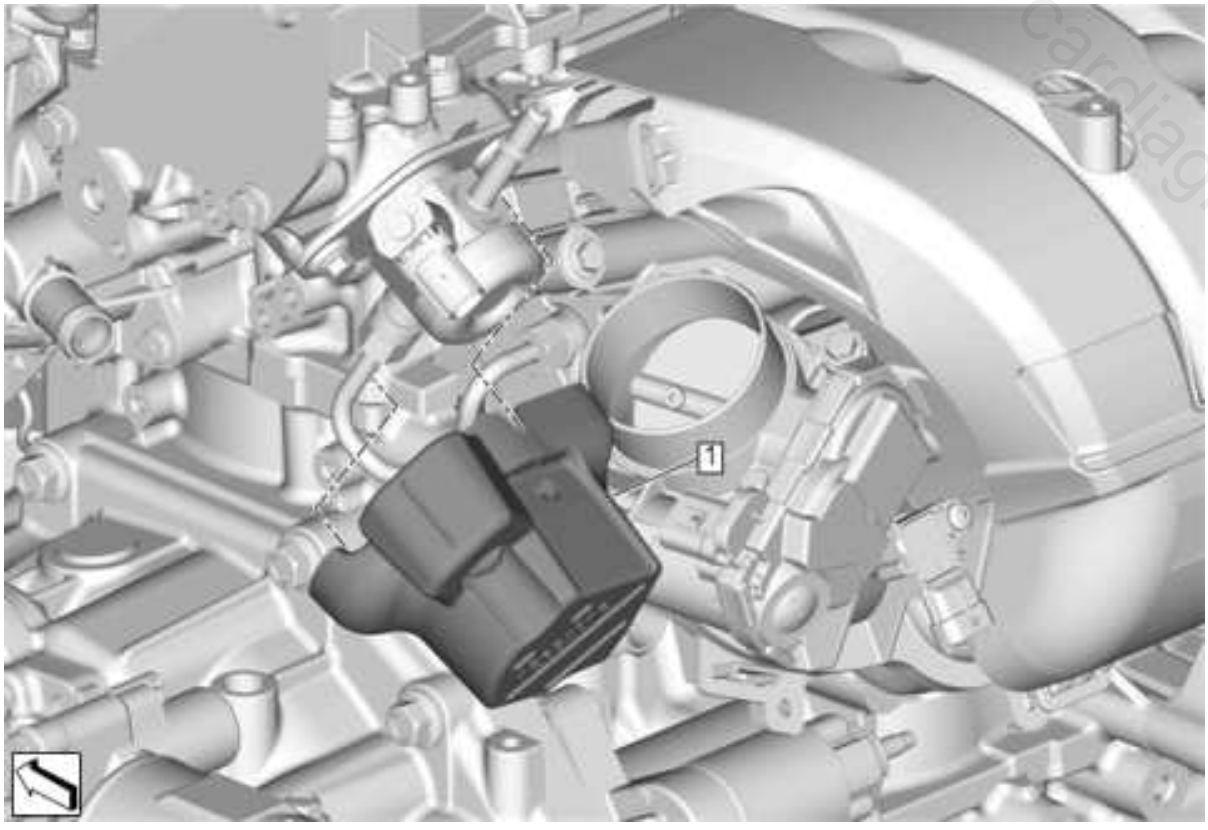

Fig. 108: Fuel Pump Insulator
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
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.** **Preliminary Procedure** Fuel Pump Cover Replacement	

Callout	Component Name
1	Fuel Pump Insulator **NOTE:** **The fuel pump insulator snaps into place.**

FUEL FEED PIPE 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. Disconnect Fuel Feed Front Pipe - **Fuel Feed Front Pipe Replacement**

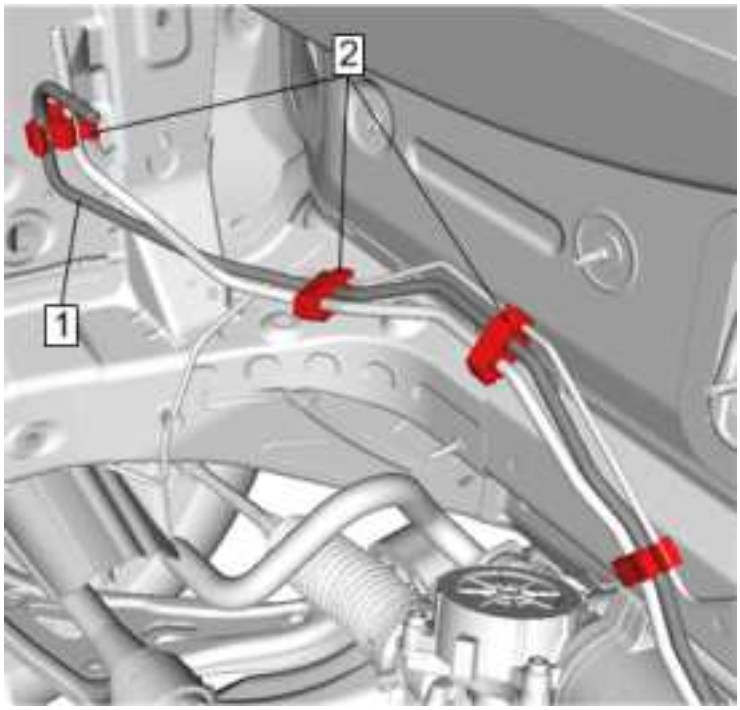

Fig. 109: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Remove Fuel Feed Pipe (1) @ Retainer (2) -[4x]
4. Raise and support the vehicle. **Lifting and Jacking the Vehicle** .

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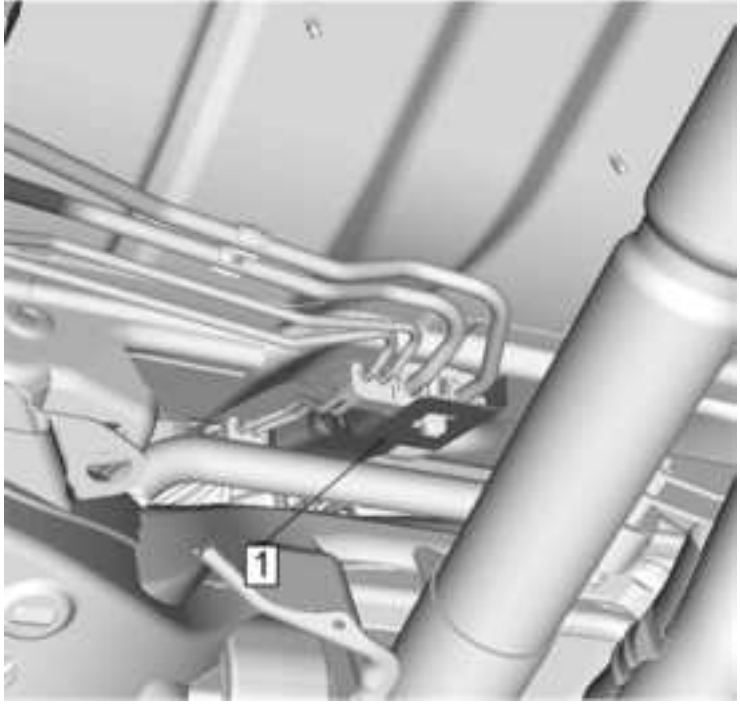

Fig. 110: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Remove Shield (1).

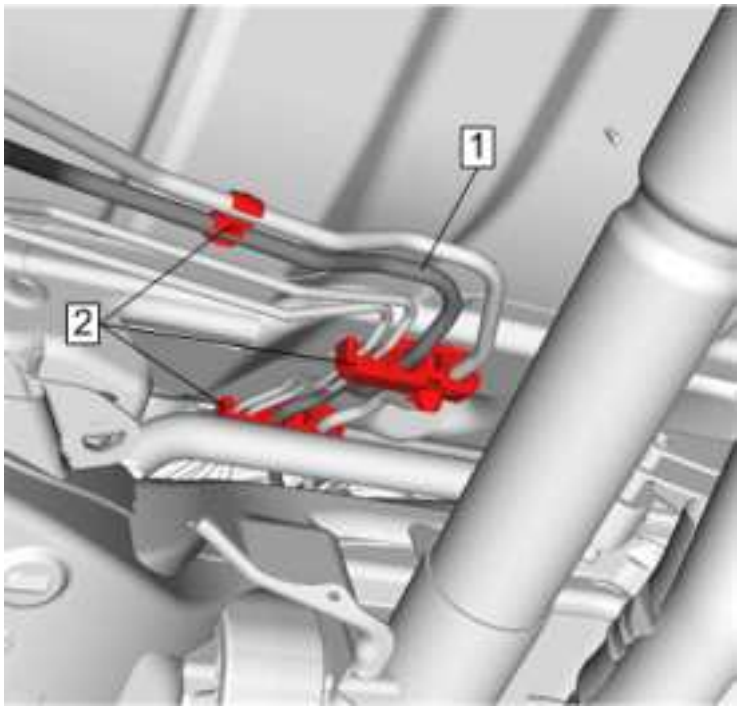

Fig. 111: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Remove Fuel Feed Pipe (1) @ Retainer (2) - [3x]
7. Remove Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (All Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

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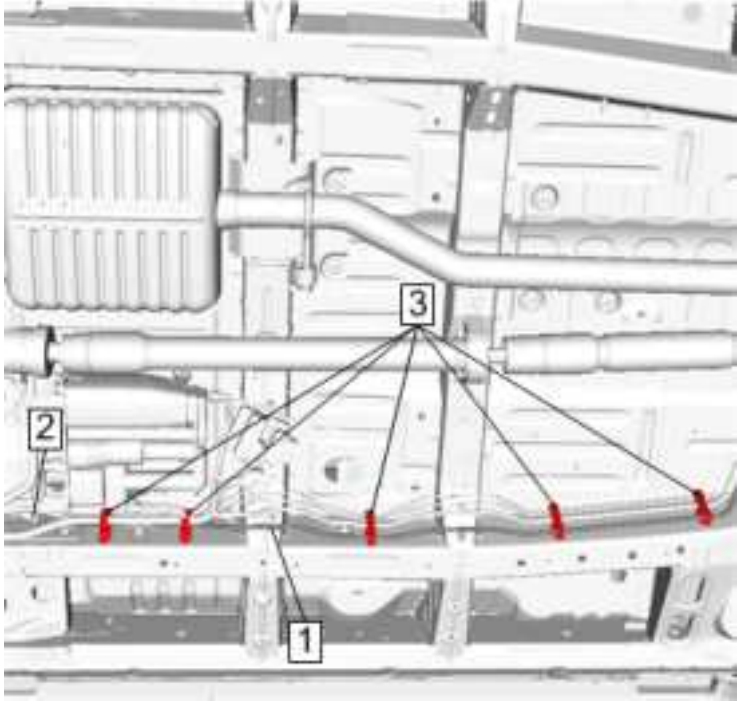

Fig. 112: Fuel Feed Pipe And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

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 (2) - [5x]

Installation Procedure

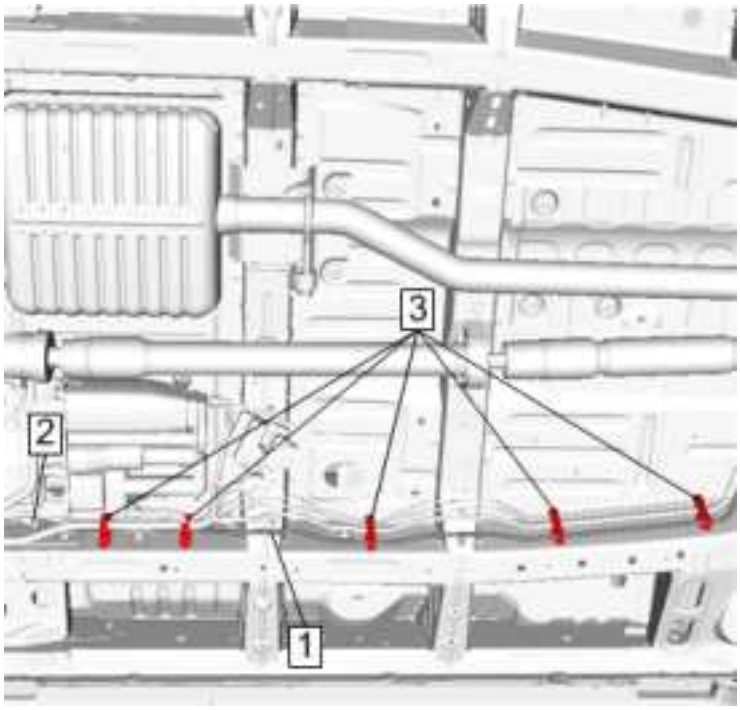

Fig. 113: Fuel Feed Pipe And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

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)** **Underbody Rear Air Deflector Replacement (Diesel)**

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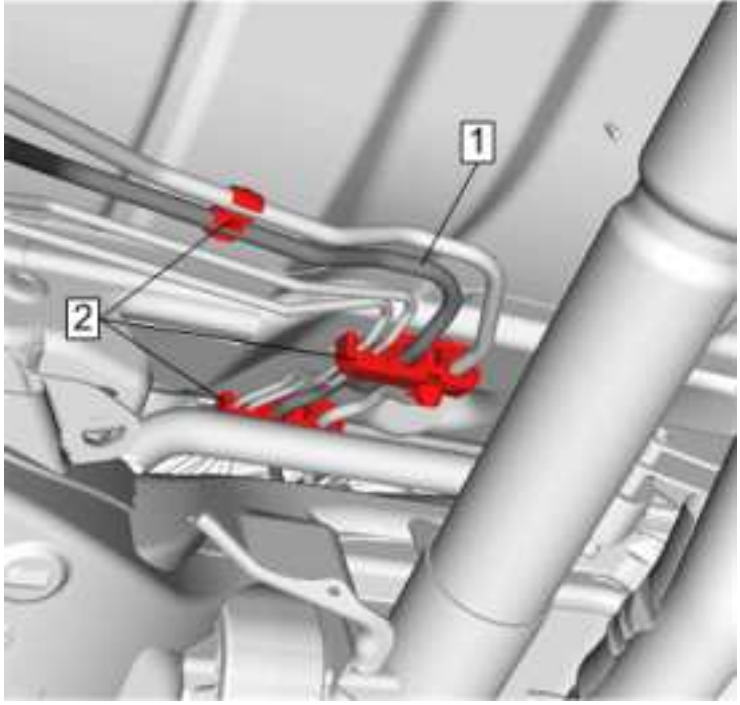

Fig. 114: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Fuel Feed Pipe (1) @ Retainer (2) - [3x]

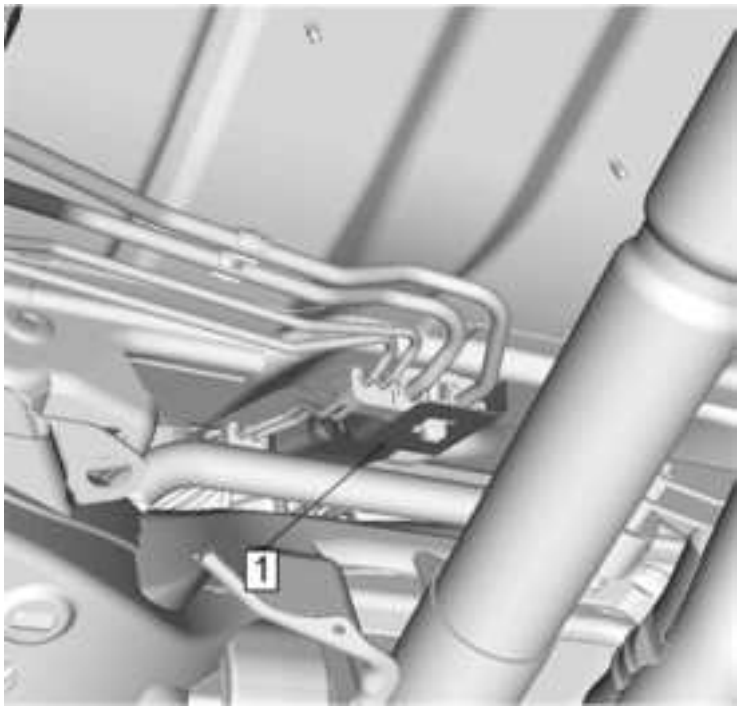

Fig. 115: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Install Shield (1)
6. Lower the vehicle.

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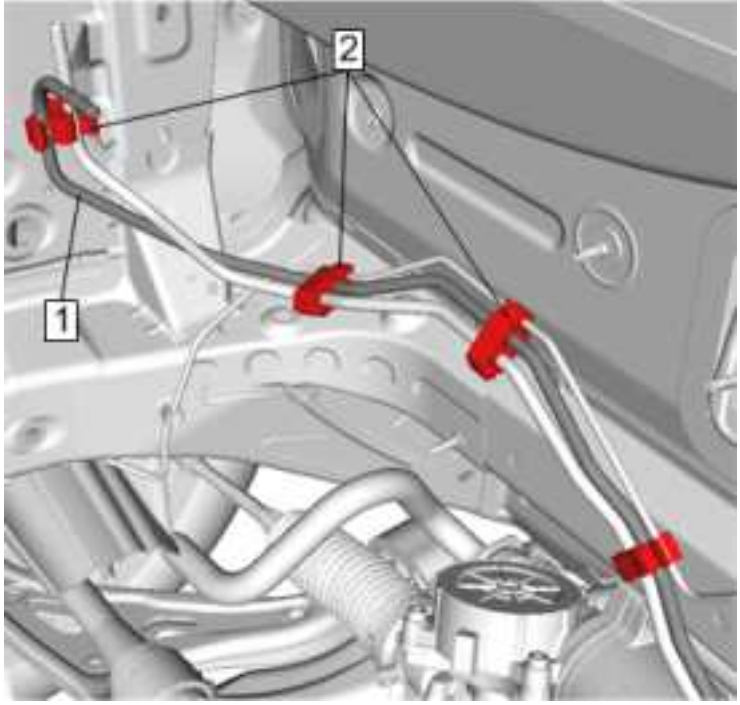

Fig. 116: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

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 FEED PIPE REPLACEMENT (FWD)

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. Disconnect Fuel Feed Front Pipe - **Fuel Feed Front Pipe Replacement**

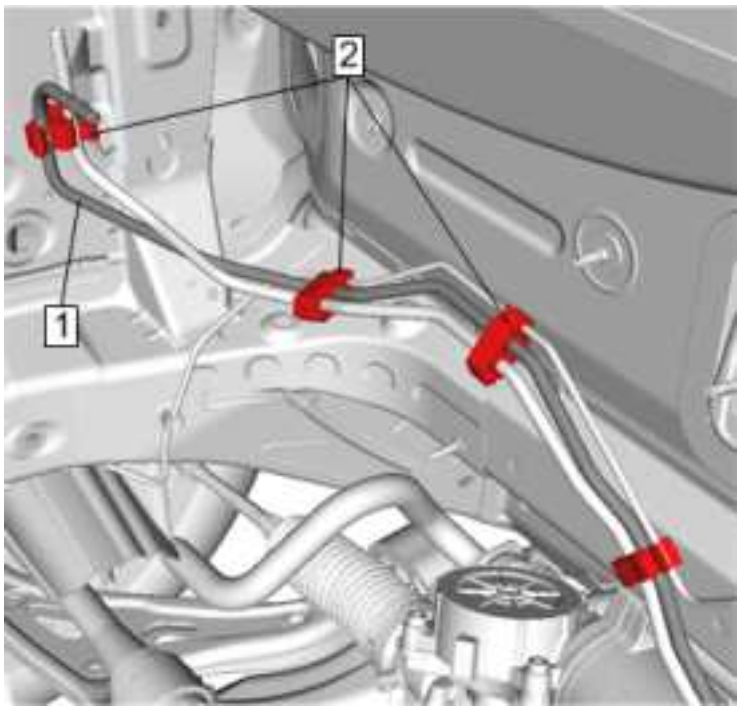

Fig. 117: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

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3. Remove Fuel Feed Pipe (1) @ Retainer (2) - [4x]
4. Raise and support the vehicle. **Lifting and Jacking the Vehicle** .

Fig. 118: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Remove Shield (1)

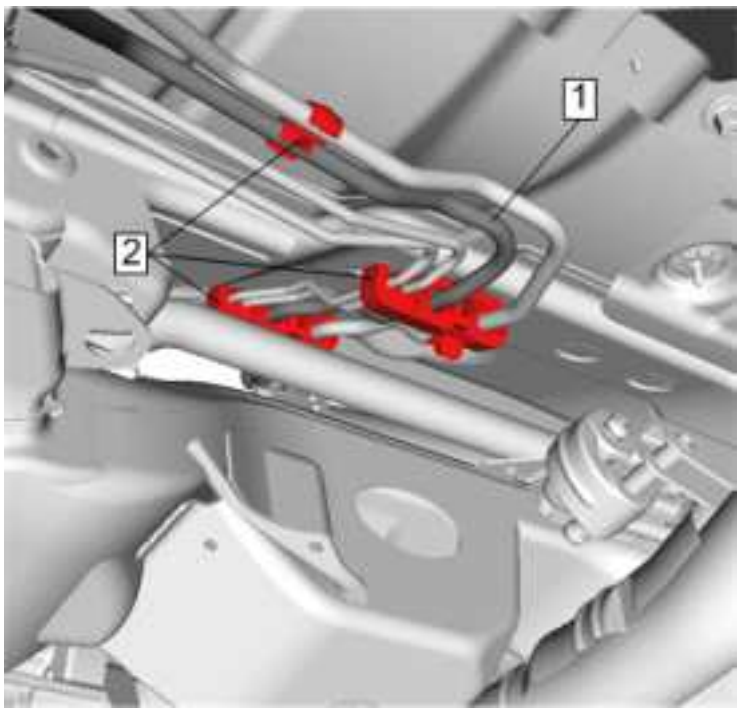

Fig. 119: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Remove Fuel Feed Pipe (1) @ Retainer (2) - [3x]
7. Remove Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (Front Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

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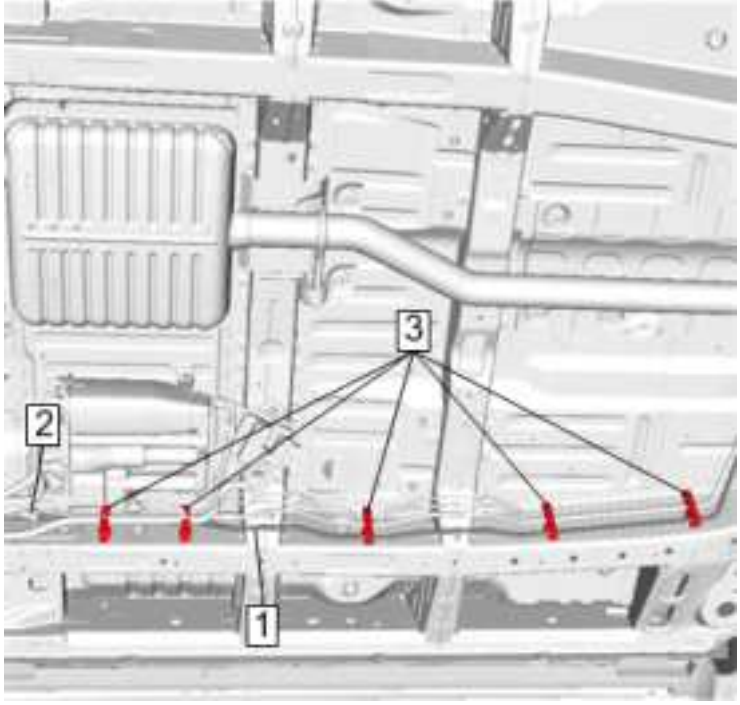

Fig. 120: Fuel Feed Pipe And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

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

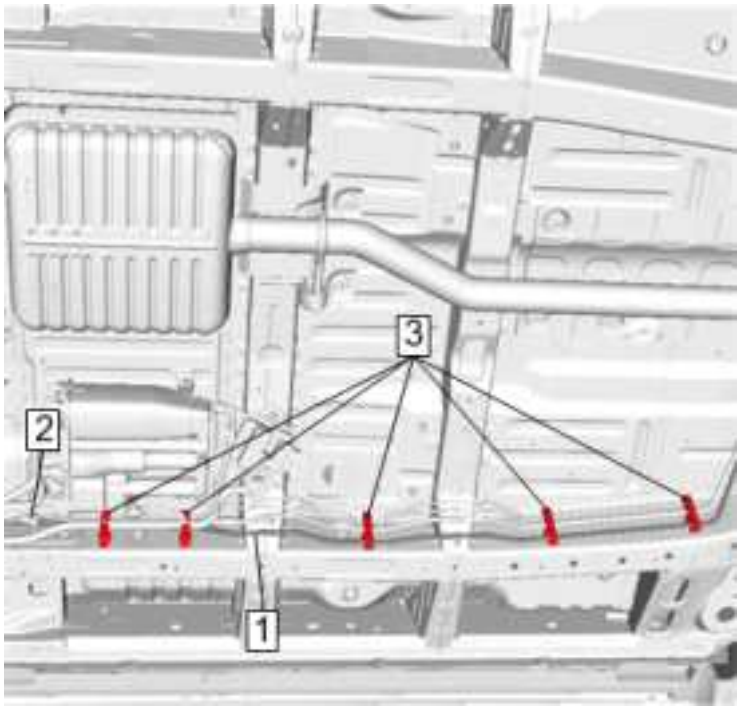

Fig. 121: Fuel Feed Pipe And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install Fuel Feed Pipe (1) @ Retainer (3) - [5x]
2. 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)** **Underbody Rear Air Deflector Replacement (Diesel)**

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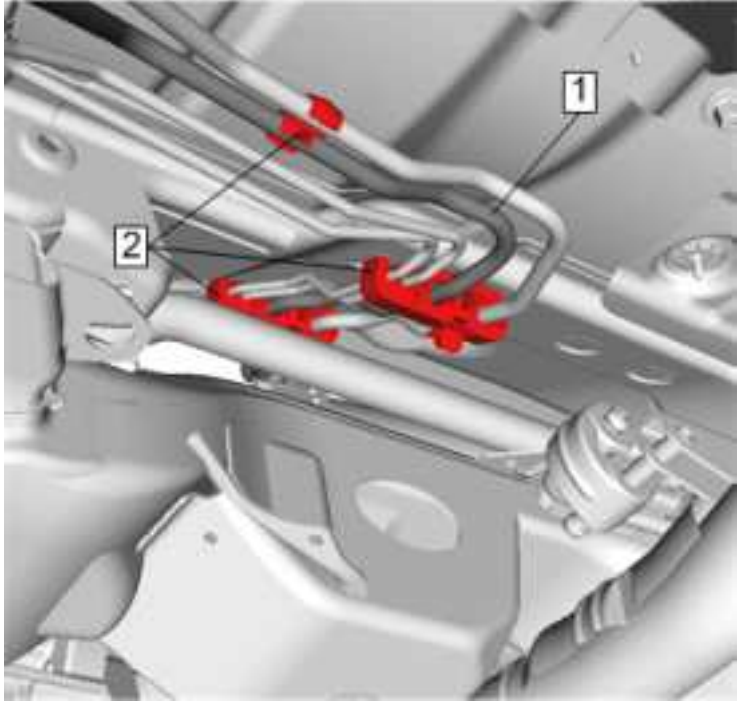

Fig. 122: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Fuel Feed Pipe (1) @ Retainer (2) - [3x]

Fig. 123: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Install Shield (1)
6. Lower the vehicle.

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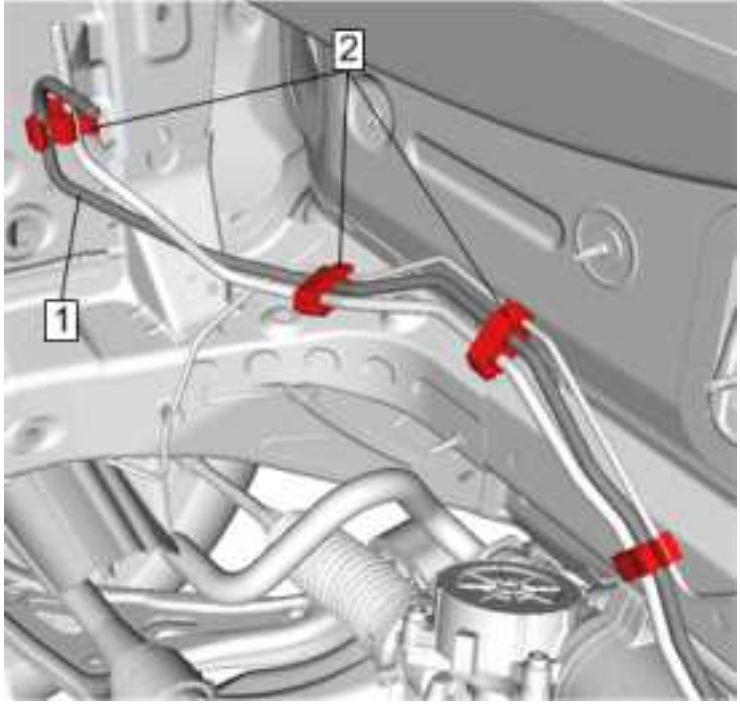

Fig. 124: Fuel Feed Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

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 FEED FRONT PIPE REPLACEMENT

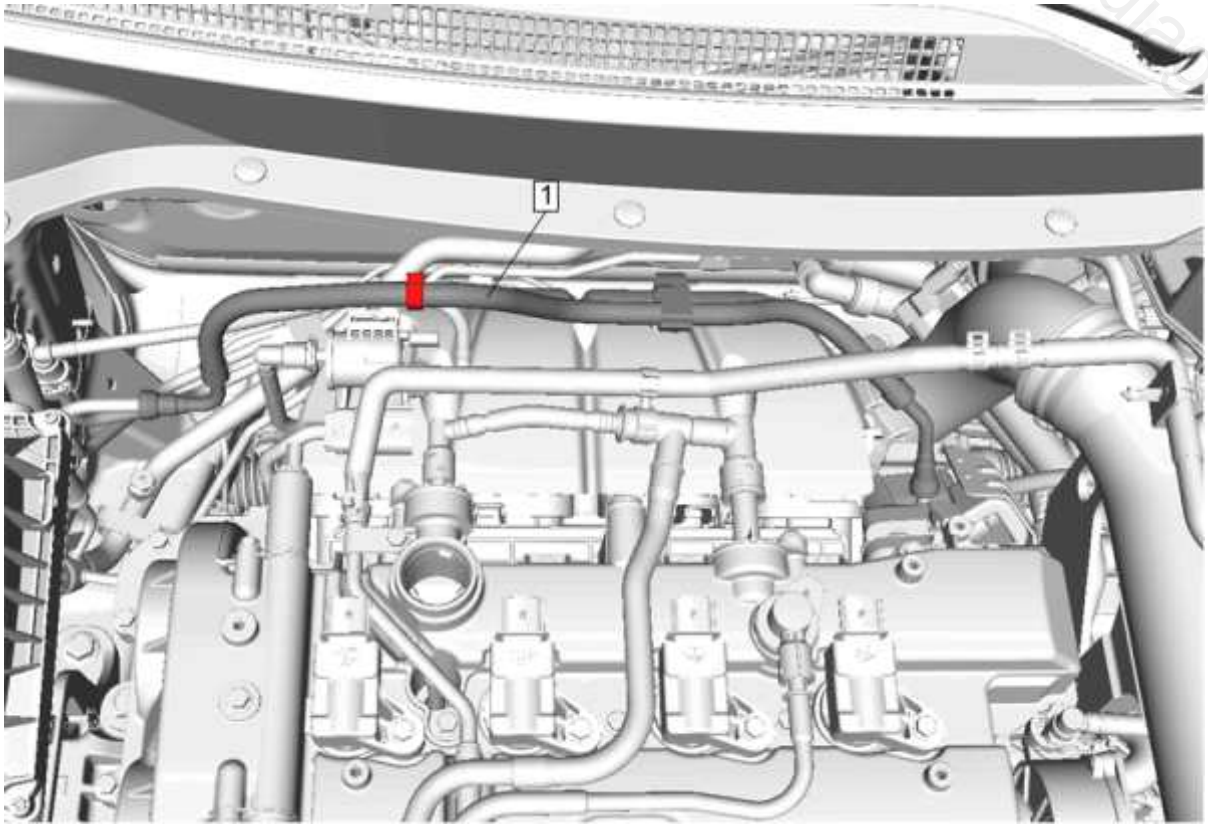

Fig. 125: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

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. Relieve the fuel system pressure. **Fuel Pressure Relief** 2. **Intake Manifold Cover Replacement** 3. Reposition the engine wiring harness as necessary.	
1	Fuel Feed Front Pipe **Procedure** 1. Disconnect the fuel feed front pipe and remove from retainer. **Metal Collar Quick Connect Fitting Service** 2. Pressurize fuel system and check for fuel leaks.

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE (AWD)

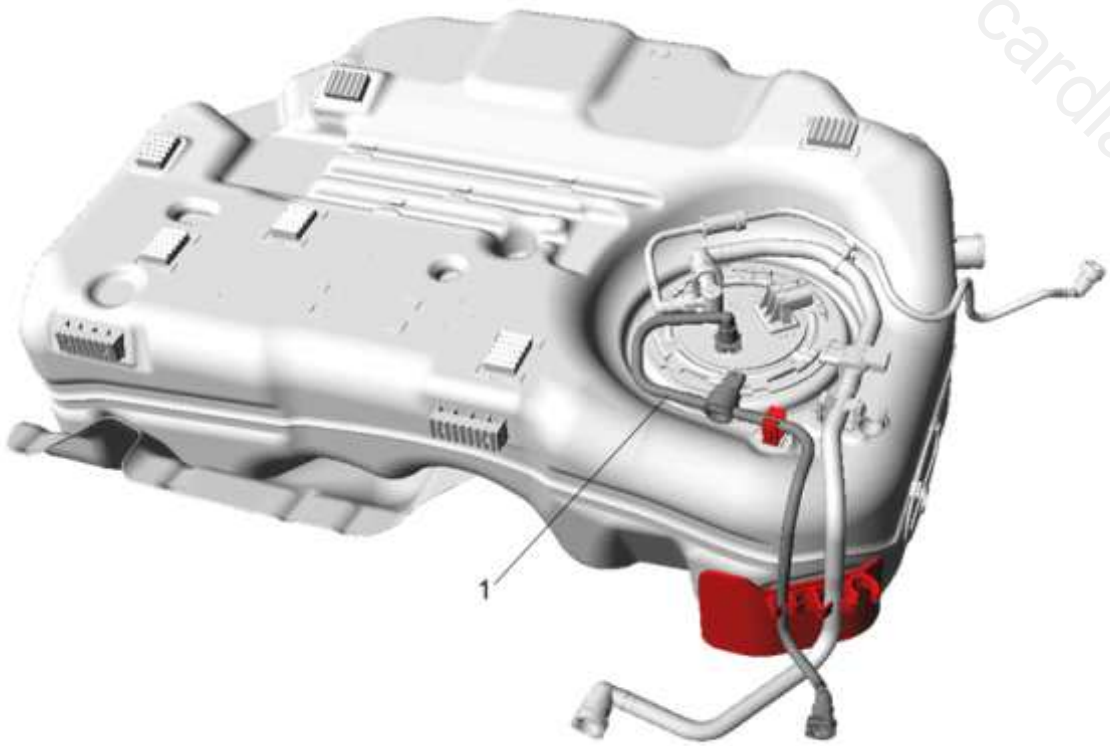

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Fig. 126: Fuel Pressure Sensor - Fuel Feed Pipe (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedure Fuel Tank Replacement (AWD)**	

Callout	Component Name
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 (FWD)

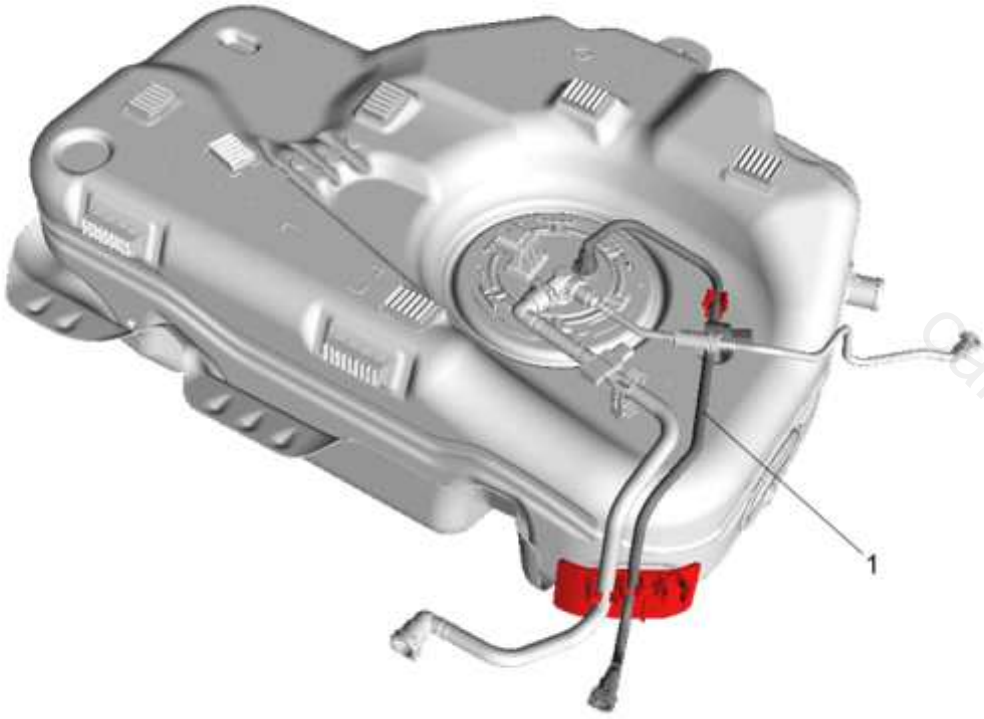

Fig. 127: Fuel Pressure Sensor - Fuel Feed Pipe (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedure Fuel Tank Replacement (FWD)**

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Callout	Component Name
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 FEED INTERMEDIATE PIPE REPLACEMENT

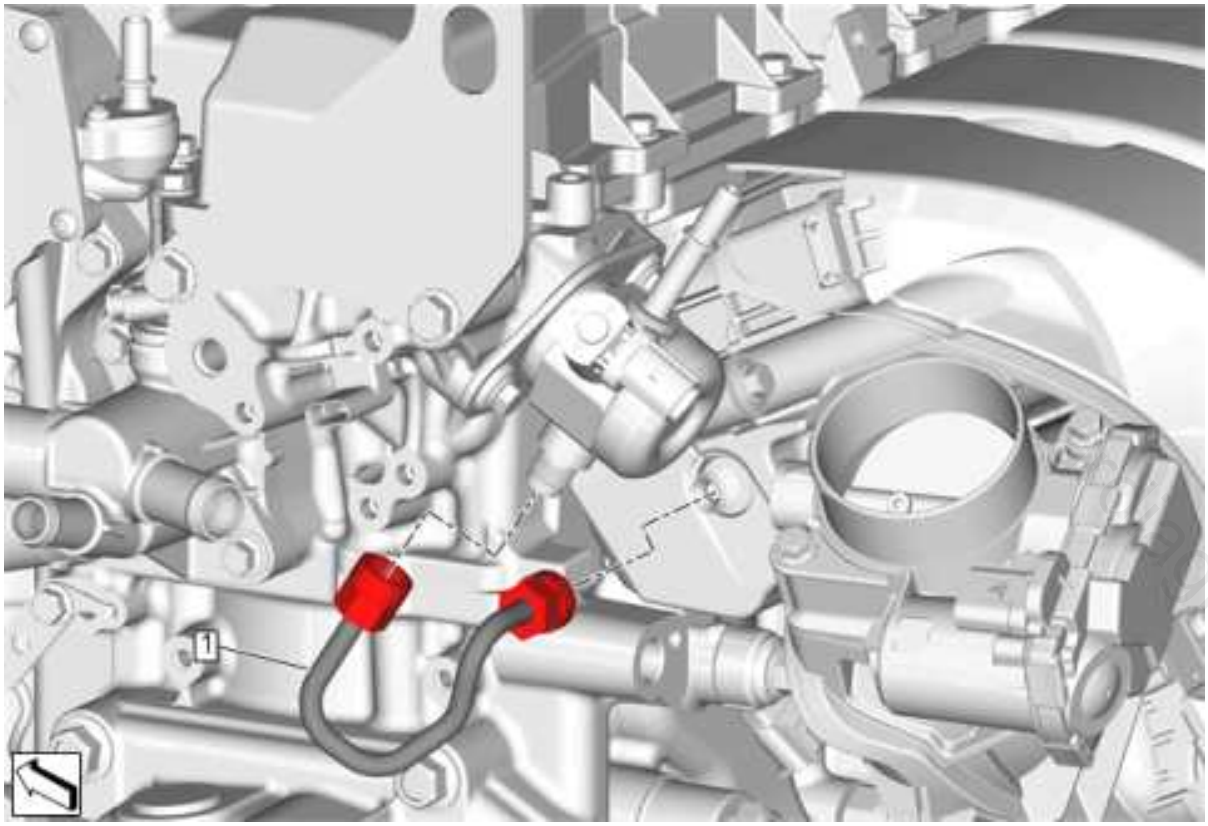

Fig. 128: Fuel Feed Intermediate Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **Preliminary Procedures** 1. **Fuel Pressure Relief** 2. **Fuel Pump Cover Replacement** 3. **Fuel Pump Insulator Replacement**

Callout	Component Name
1	Fuel Feed Intermediate Pipe **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** 1. DISCARD the fuel feed intermediate pipe. 2. Hand start both fuel feed intermediate pipe fittings before tightening to specification. **Tighten** Tighten the fitting to the fuel injection fuel rail to 15 N.m (11 lb ft) Tighten the fitting to the fuel pump to 15 N.m (11 lb ft) Tighten the fitting to the fuel injection fuel rail to 30 N.m (22 lb ft) Tighten the fitting to the fuel pump to 30 N.m (22 lb ft)

FUEL TANK VENT HOSE REPLACEMENT (AWD)

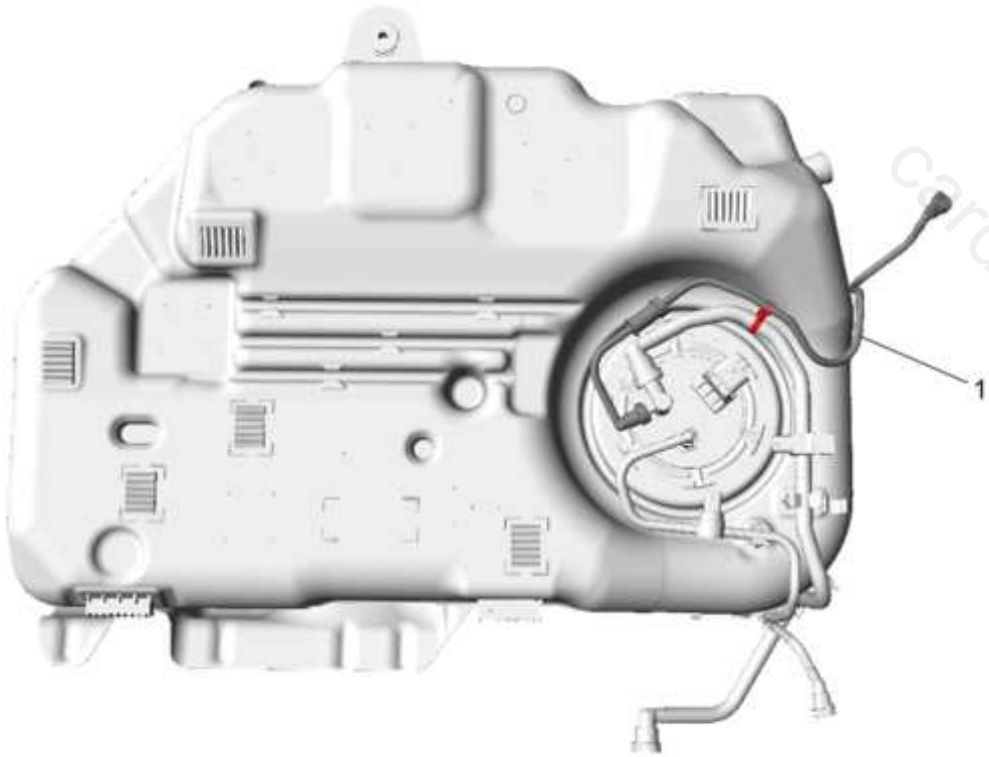

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Fig. 129: Fuel Tank Vent Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

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 VENT HOSE REPLACEMENT (FWD)

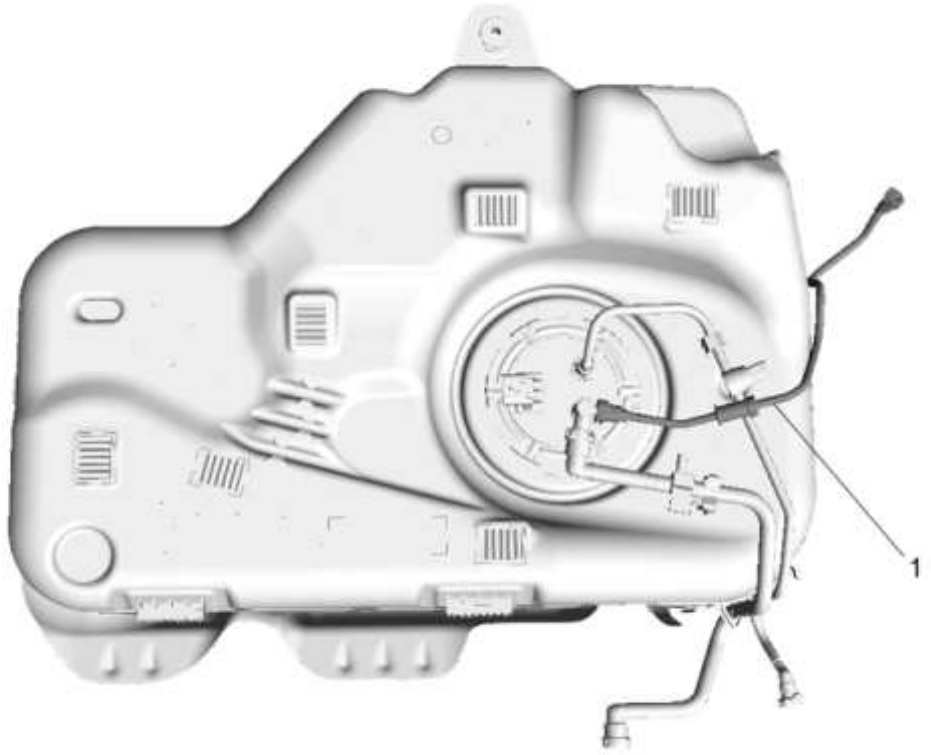

Fig. 130: Fuel Tank Vent Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

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 PUMP REPLACEMENT

Special Tools

EN-50790 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 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.**

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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. Remove Fuel Feed Front Pipe - **Fuel Feed Front Pipe 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.**

3. Remove Fuel Feed Intermediate Pipe and DISCARD - **Fuel Feed Intermediate Pipe Replacement**

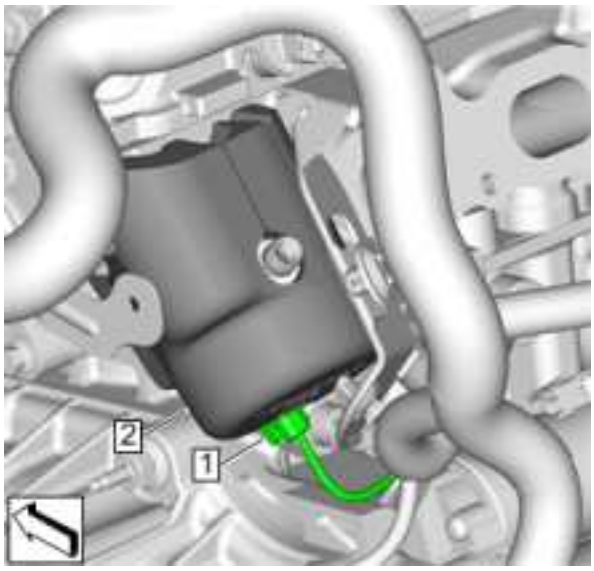

Fig. 131: Fuel Pump Insulator And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connector (1).
5. Remove the fuel pump insulator (2).

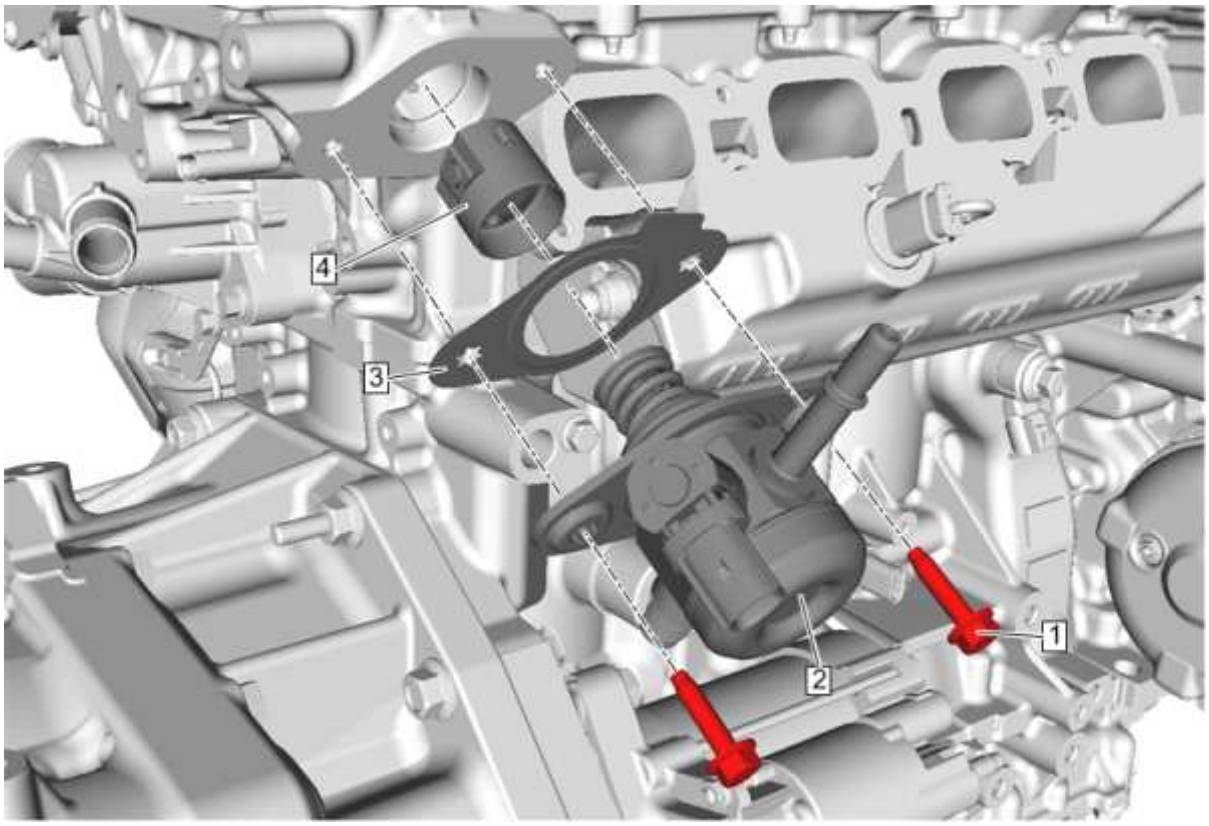

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Fig. 132: Fuel Pump Assembly, Fuel Pump Gasket, Bolts And Valve Lifter Follower
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Alternately loosen the fuel pump bolts one turn at a time until the pump is fully disengaged from fuel pump lifter follower. Trying to remove the pump bolts without even side-to-side loosening may result in pump plunger damage**

6. Remove and DISCARD the 2 fuel pump bolts (1).

NOTE: **Ensure that during removal of the fuel pump that the valve lifter follower does NOT fall apart.**

7. 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.**

8. Remove the valve lifter follower (4).
9. Remove and DISCARD the fuel pump housing gasket (3).

Installation Procedure

1. Lubricate the cylinder head bore with clean engine oil. Adhesives, Fluids, Lubricants, and Sealers

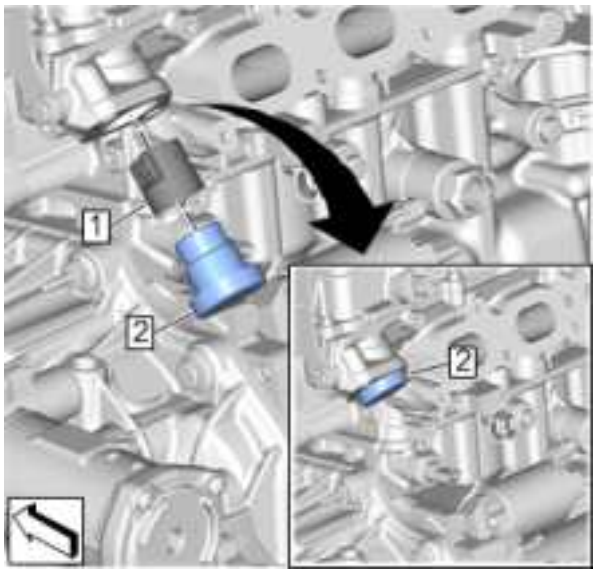

Fig. 133: Valve Lifter Follower
Courtesy of GENERAL MOTORS COMPANY

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-50790 alignment gauge will sit flush with the cylinder head.**

3. Install the **EN-50790** alignment gauge (2) and turn the crankshaft until the camshaft lobe is at the base circle position.
4. Remove the **EN-50790** alignment gauge (2) and valve lifter follower (1).

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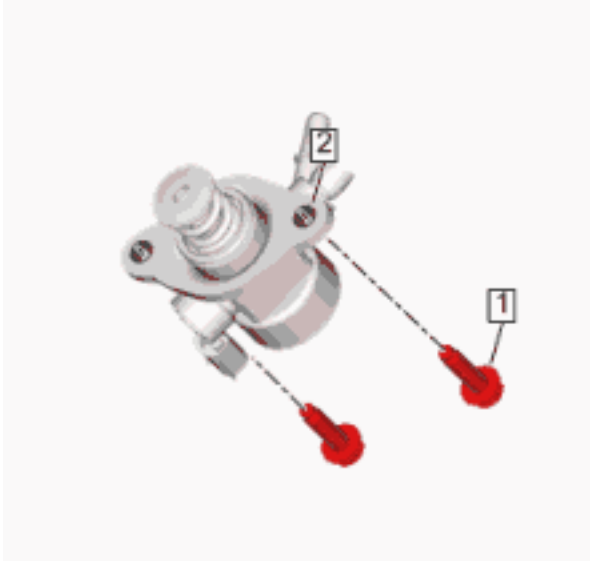

Fig. 134: Fuel Pump Bolts And Fuel Pump Bolt Retainers
Courtesy of GENERAL MOTORS COMPANY

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.**

5. Install the 2 NEW fuel pump bolts (1) through the 2 fuel pump bolt retainers (2).

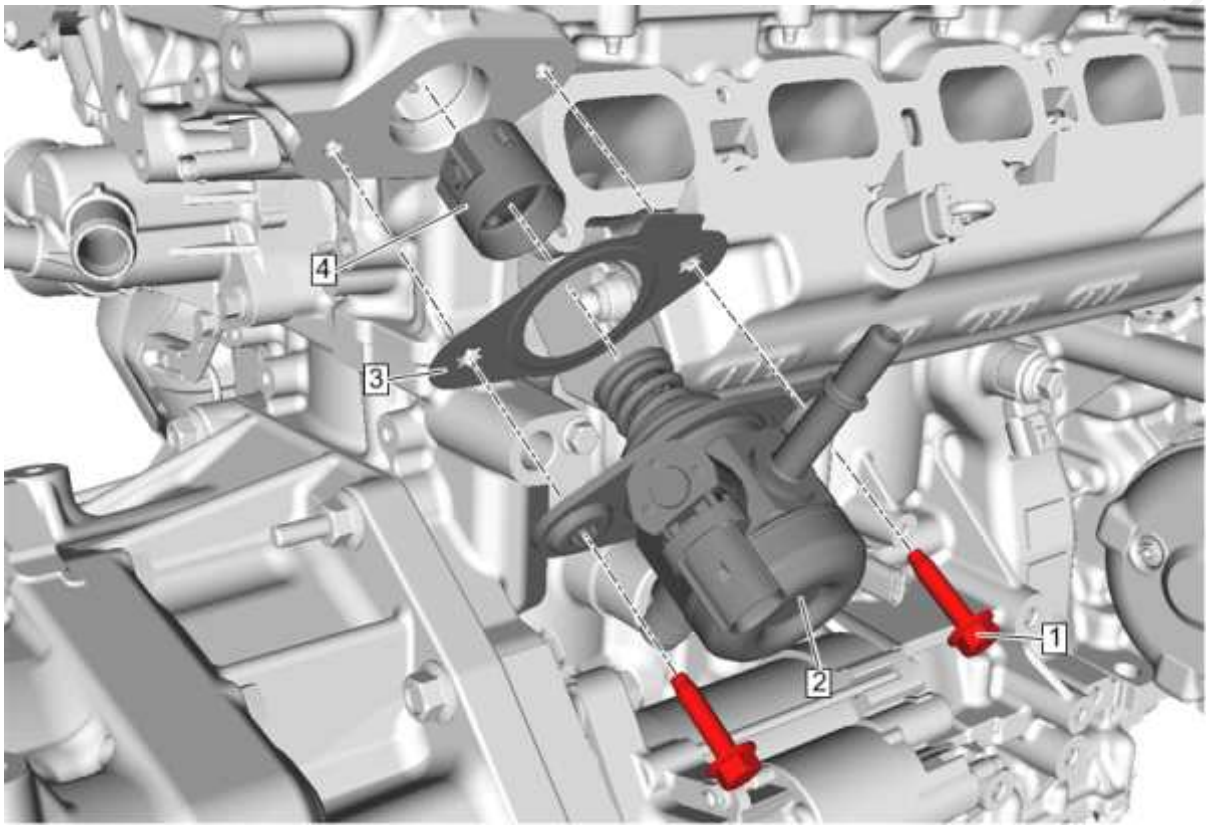

Fig. 135: Fuel Pump Assembly, Fuel Pump Gasket, Bolts And Valve Lifter Follower
Courtesy of GENERAL MOTORS COMPANY

6. Lubricate the valve lifter follower (4) again with clean engine oil, if necessary, and install it into the cylinder head bore. **Adhesives, Fluids, Lubricants, and Sealers**
7. Install a NEW fuel pump gasket (3) with the locating tab pointing upwards.

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8. Install the fuel pump assembly (2) into the cylinder head and start the NEW fuel pump bolts (1) 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 even side-to-side tightening may result in pump plunger damage.**

9. Tighten the NEW fuel pump bolts (3) to:
    1. First Pass: 8 N.m (71 lb in)
    2. Final Pass: 50 degrees

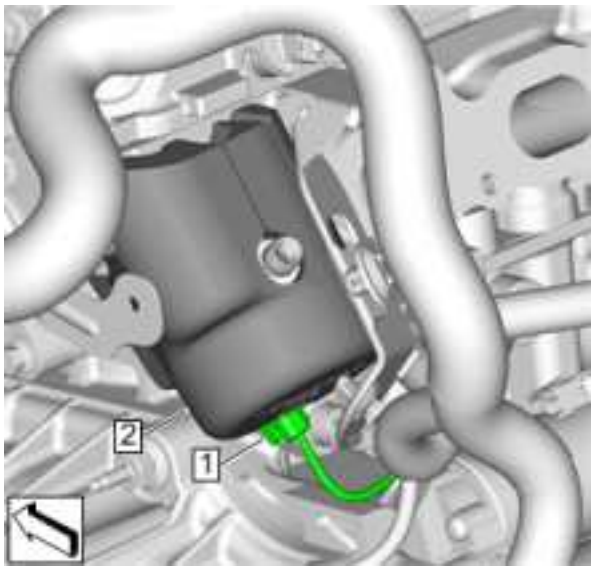

Fig. 136: Fuel Pump Insulator And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

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**
13. Install Fuel Feed Front Pipe - **Fuel Feed Front Pipe Replacement**
14. 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.
15. Perform the fuel rail pressure relief valve learned values reset. **Fuel Rail Pressure Relief Valve Learned Values Reset**

FUEL PUMP FUEL FEED HOSE REPLACEMENT (AWD)

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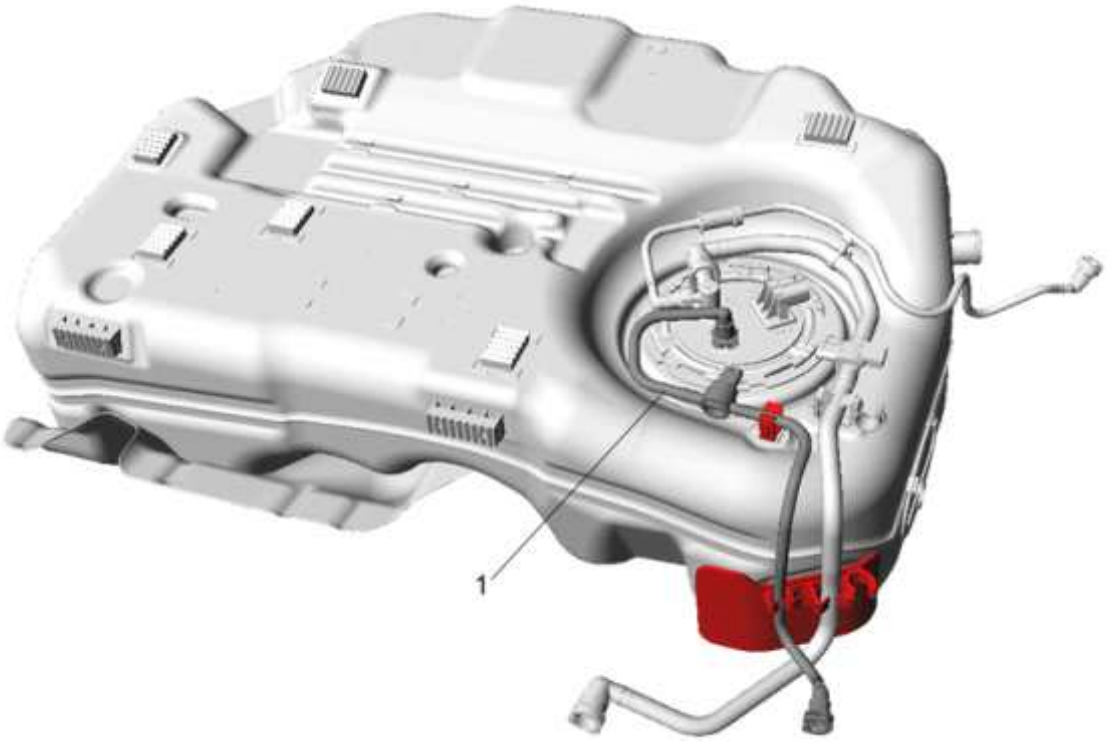

Fig. 137: Fuel Pump Fuel Feed Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

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 PUMP FUEL FEED HOSE REPLACEMENT (FWD)

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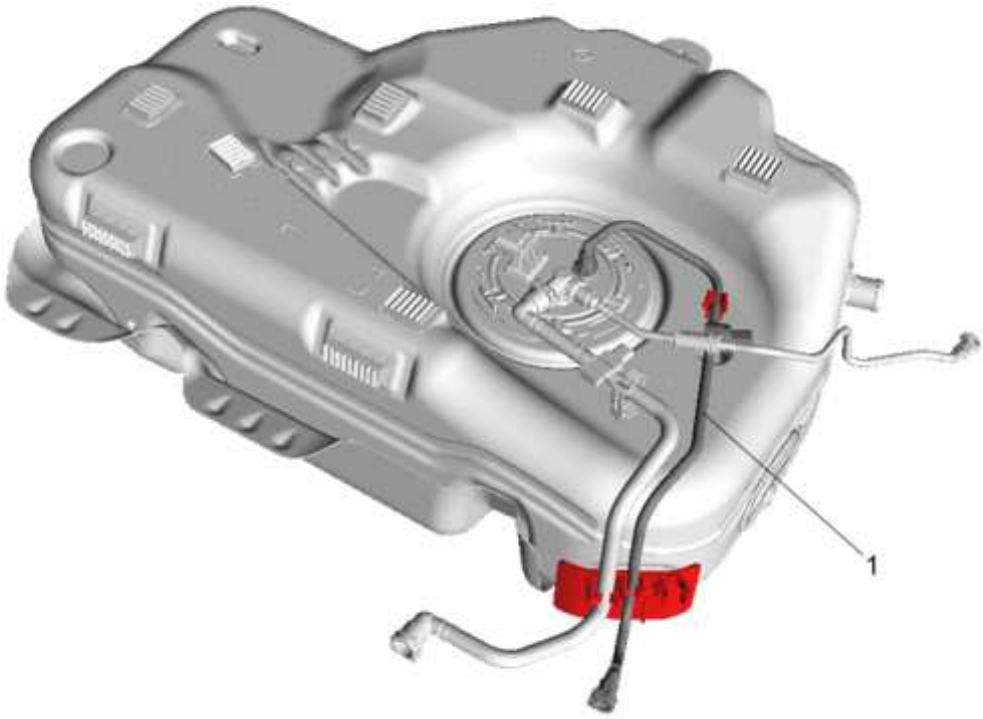

Fig. 138: Fuel Pump Fuel Feed Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

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 INJECTION FUEL RAIL ASSEMBLY REPLACEMENT

Special Tools

- **EN-47909** Injector Bore and Sleeve Cleaning Kit
- **EN-49248** Fuel Rail Assembly Remover

Equivalent regional tools:Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools)

Removal Procedure

1. Remove Fuel Injection Fuel Rail Noise Shield - Fuel Injection Fuel Rail Noise Shield Replacement
2. Remove Fuel Feed Intermediate Pipe - and DISCARD - Fuel Feed Intermediate Pipe Replacement
3. Remove Fuel Injection Fuel Rail Fuel Pressure Sensor - Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement

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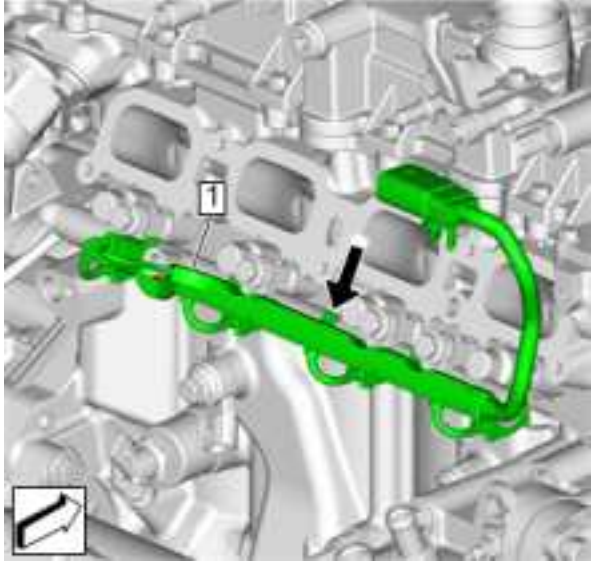

Fig. 139: Fuel Injection Fuel Rail Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The fuel injection fuel rail wiring harness is clipped onto the fuel rail.**

4. Remove the fuel injection fuel rail wiring harness (1).

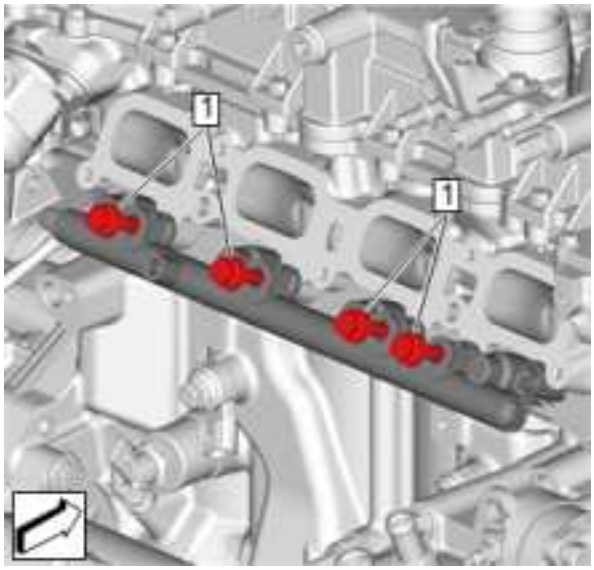

Fig. 140: Fuel Injection Fuel Rail Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Fuel rail bolts are captured in the fuel rail assembly. Ensure the bolt is completely loosened, and the threads are no longer engaged. Use a suitable tool to apply enough force to pull the bolt straight out of the fuel rail.**

5. Remove the fuel injection fuel rail bolts (1) including the upper grommets.

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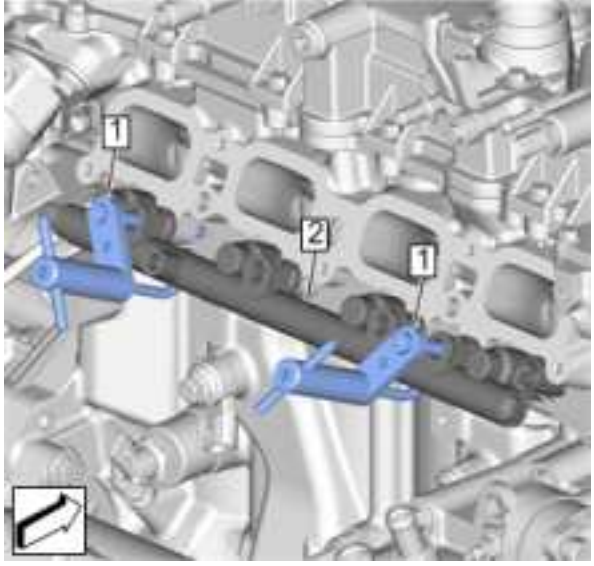

Fig. 141: Fuel Injection Fuel Rail And Remover
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The hook of the portion of the EN-49248 remover MUST be properly seated on the underside of the fuel injection fuel rail.**
- **Turn BOTH handles simultaneously, in small, even increments.**
- **Do NOT twist the fuel injector fuel rail while removing.**

6. Using the **EN-49248** remover (1), slowly work the fuel injection fuel rail (2) upwards, in small, even increments.
7. Once the fuel injection fuel rail (2) is free, remove the **EN-49248** remover (1), and remove the fuel rail from the vehicle.

Installation Procedure

1. Use the **EN-47909** cleaning kit to clean the fuel injector bores and sleeves. **Fuel Rail and Injectors Cleaning and Inspection**
2. If necessary, replace the fuel injection fuel rail insulators. **Fuel Rail and Injectors Cleaning and Inspection**

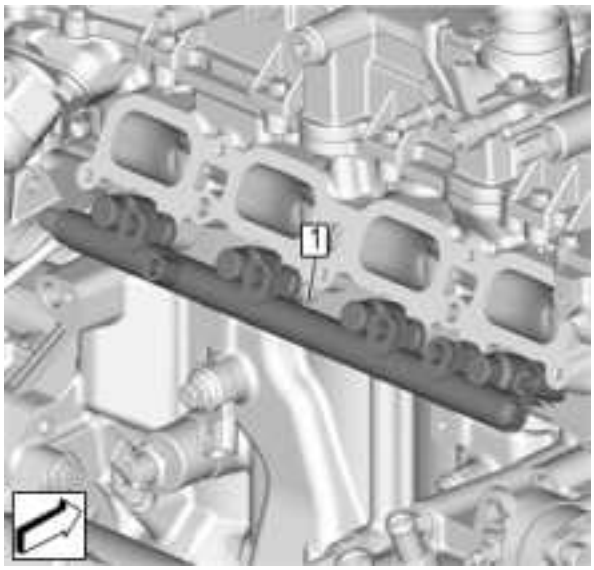

Fig. 142: Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

3. Install the fuel injection fuel rail (1), making sure the fuel injectors seat into the cylinder head evenly.

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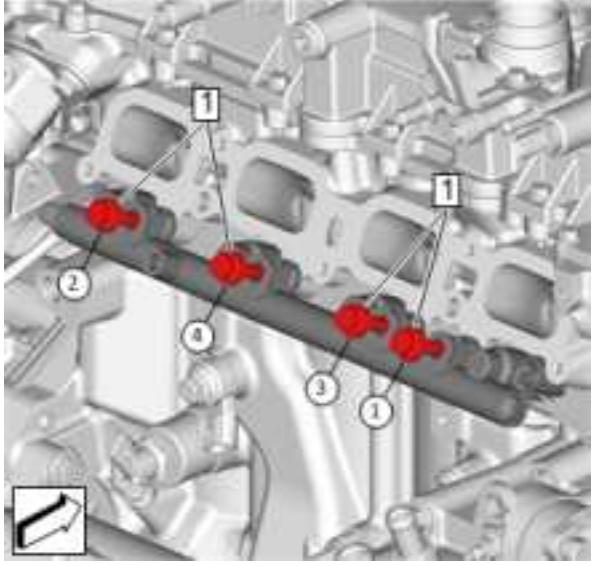

Fig. 143: Fuel Injection Fuel Rail Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

4. To install the fuel injection fuel rail bolts (1), perform the following steps:
    1. First Pass: Start ALL bolts by hand, but do NOT tighten.
    2. Second Pass: Tighten the outer two bolts by hand to seat the fuel injectors.
    3. Third Pass: Tighten the remaining bolts by hand.
    4. Final Pass: Tighten ALL bolts in sequence to 25 N.m (18 lb ft).

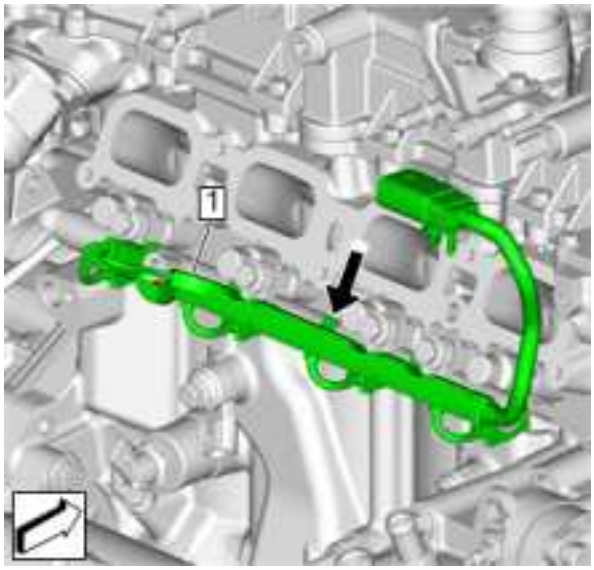

Fig. 144: Fuel Injection Fuel Rail Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The fuel injection fuel rail wiring harness is clipped onto the fuel rail.**

5. Install the fuel injection fuel rail wiring harness (1).
6. Install the fuel injection fuel rail pressure sensor. **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**
7. Install a NEW fuel feed intermediate pipe. **Fuel Feed Intermediate Pipe Replacement**
8. Pressurize the fuel system and inspect for leaks.
9. Install Fuel Injection Fuel Rail Noise Shield - **Fuel Injection Fuel Rail Noise Shield Replacement**

FUEL INJECTION FUEL RAIL NOISE SHIELD REPLACEMENT

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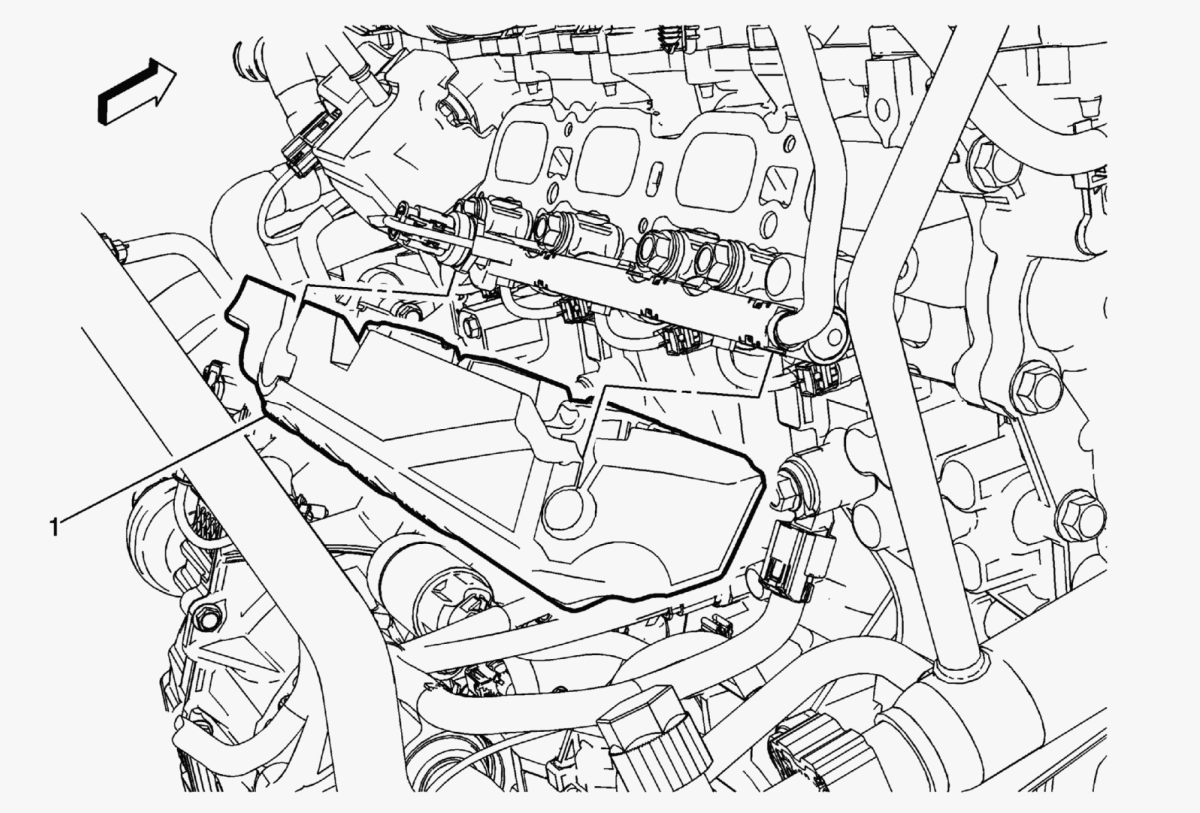

Fig. 145: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Intake Manifold Replacement	
1	Fuel Injection Fuel Rail Noise Shield **WARNING:** **The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.** **NOTE:** **The fuel injection fuel rail noise shield snaps into place.**

FUEL INJECTION FUEL RAIL FUEL PRESSURE SENSOR REPLACEMENT

Removal Procedure

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: **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.**

1. Relieve the fuel system pressure. Fuel Pressure Relief

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NOTE: **It is NOT necessary to completely remove the intake manifold to gain access to the fuel injection fuel rail fuel pressure sensor.**

2. Reposition Intake Manifold - **Intake Manifold Replacement**
3. Reposition Fuel Injection Fuel Rail Noise Shield - **Fuel Injection Fuel Rail Noise Shield Replacement**

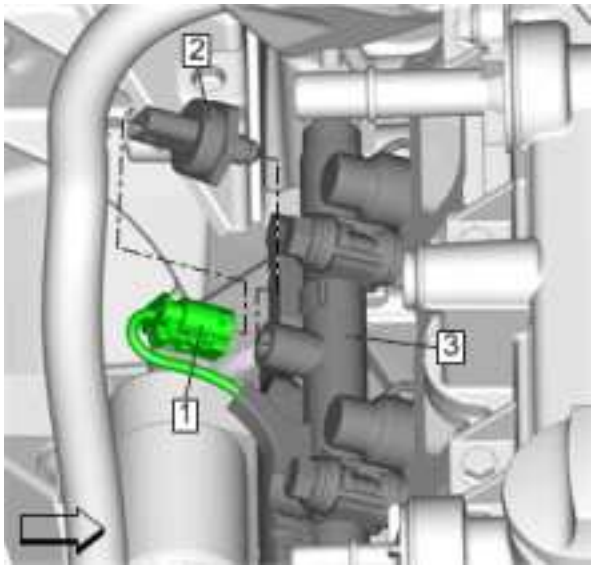

Fig. 146: Fuel Rail Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connector (1).

CAUTION: **Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .**

NOTE:

- **Do NOT apply force to the plastic housing of the fuel injection fuel rail fuel pressure sensor. ONLY apply force to the attached hexagon.**
- **Some fuel may leak from the fuel injection fuel rail orifice after the sensor is removed. Dry the area around the orifice using a lint free cloth.**
- **After removal, the area around the fuel injection fuel rail sealing surface should be inspected. The surface should be free of fuel, dirt, debris, and burrs.**

5. Remove the fuel injection fuel rail fuel pressure sensor (2).

Installation Procedure

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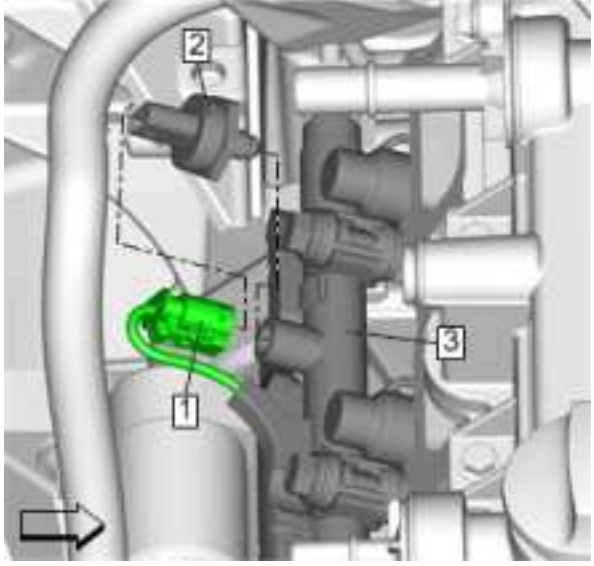

Fig. 147: Fuel Rail Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

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 fuel injection fuel rail fuel pressure sensor (2) properly, perform the following steps:
    1. Lubricate the sensor threads and sealing surface with one drop of clean engine oil.
    2. Install the sensor and hand tighten.
    3. Remove the sensor.
    4. Re-lubricate the sensor threads and sealing surface with one drop of clean engine oil.
    5. Install the sensor and tighten to 33 N.m (24 lb ft).
2. Connect the electrical connector (1).

NOTE: **If a fuel leak occurs at the fuel injection fuel rail, the fuel rail will need to be replaced.**

3. Pressurize the fuel system and inspect for leaks.
4. Install Fuel Injection Fuel Rail Noise Shield - **Fuel Injection Fuel Rail Noise Shield Replacement**
5. Install Intake Manifold - **Intake Manifold Replacement**

FUEL INJECTOR REPLACEMENT

Special Tools

- **EN-47909** Injector Bore and Sleeve Cleaning Kit
- **EN-49245** Fuel Injector Seal Installer and Sizer
- **EN-50791** Fuel Injector Nozzle Installer
- **EN-51105** Fuel Injector Seal Installer

Equivalent regional tools:**Special Tools**

CAUTION: **Use care in removing the fuel injectors in order to prevent damage to the fuel injector electrical connector pins or the fuel injector nozzles. Do not**

immerse the fuel injector in any type of cleaner. The fuel injector is an electrical component and may be damaged by this cleaning method.

1. Remove Fuel Injection Fuel Rail - **Fuel Injection Fuel Rail Assembly Replacement**

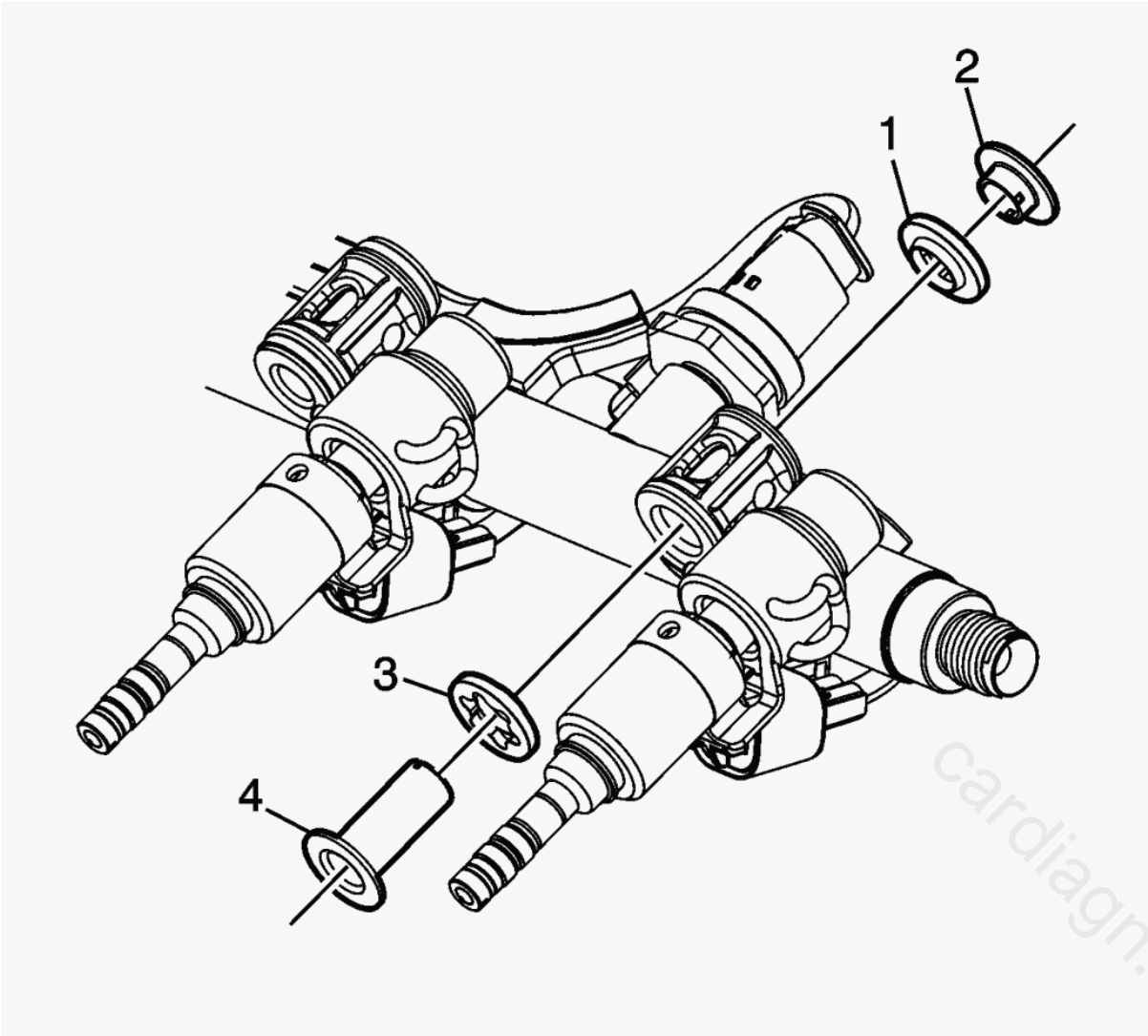

Fig. 148: Fuel Rail Insulator Assemblies
Courtesy of GENERAL MOTORS COMPANY

2. Remove and inspect the fuel rail insulator assemblies (1 - 4). Replace the entire assembly if any components show signs of wear or the insulators (4) show the following conditions:
   - Dry or cracked appearance
   - Flattened or misshapen appearance

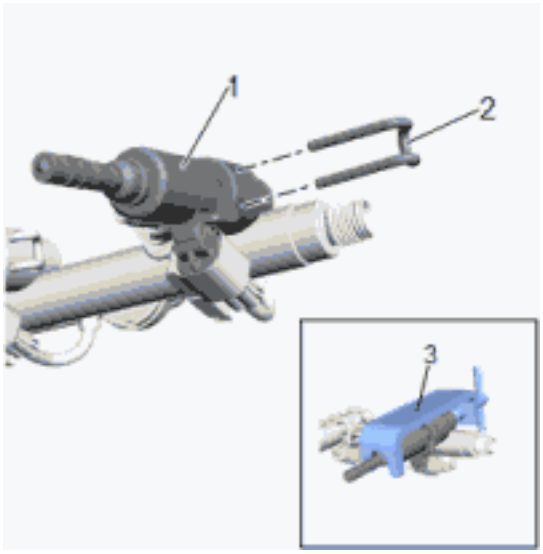

Fig. 149: Fuel Injector And Retaining Pin
Courtesy of GENERAL MOTORS COMPANY

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3. Disconnect the electrical connectors from the fuel injectors.
4. Use the **EN-50791** installer (3) to compress the fuel injector (1) and relieve pressure on the retaining pin (2). Remove the fuel injector retaining pin (2). Remove the **EN-50791** installer once the retaining pin is removed.

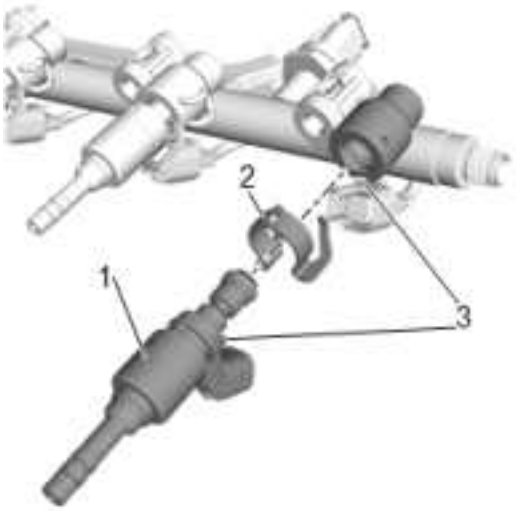

Fig. 150: Injectors And Fuel Rail Slot
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Support the fuel injector at the widest point.**
- **Support the fuel injection fuel rail along the bottom.**
- **Do NOT support or hold the fuel injector by the tip or connector.**
- **Do NOT tilt or excessively twist the fuel injector during removal.**

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5. Remove the fuel injector (1) from the fuel injection fuel rail by pulling it straight out along the fuel injector axis. Slight rotation of the fuel injector is acceptable as long as excessive force is not applied to the fuel injector tab while engaged in the fuel rail slot (3).
6. Remove the fuel injector holding clamp (2) from the rear of the fuel injector.

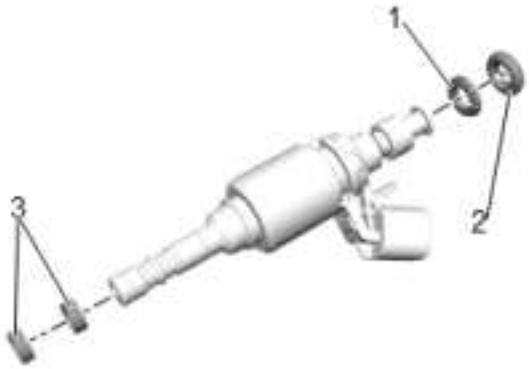

Fig. 151: Fuel Injector O-ring And Plastic Spacer
Courtesy of GENERAL MOTORS COMPANY

7. Remove and DISCARD the fuel injector O-ring (2) and spacer (1).
8. Remove and DISCARD the fuel injector seals (3).

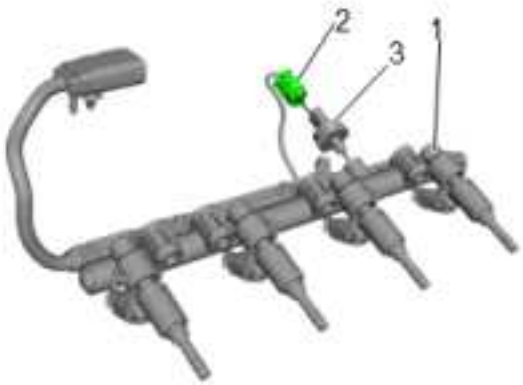

Fig. 152: Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT soak or submerge the fuel injection fuel rail or the fuel injectors in solvent. Do NOT use solvent on the fuel rail label.**

9. Clean the exterior of the fuel injection fuel rail (1) and the fuel injectors in solvent.
10. Use the **EN-47909** cleaning kit to clean the fuel injector bores and sleeves.
11. Inspect the fuel injection fuel rail and components for the following conditions:
    - Damage, debris, or restrictions to the fuel rail
    - Damage, debris, or restrictions to the fuel ports in the fuel rail
    - Damage to the mounting area for the fuel rail
    - Damage to the fuel rail mounting bolts
    - Damage to the threads on the fuel rail fuel feed fitting
12. Replace the fuel injection fuel rail if ANY damage is found. Do NOT attempt to repair a fuel rail.

CAUTION: **Refer to Fastener Caution .**

NOTE: **Remove and inspect the fuel injection fuel rail fuel pressure sensor ONLY if the sensor is suspect.**

13. Remove and inspect the fuel injection fuel rail fuel pressure sensor (3) for damage using the following procedure:
    1. Disconnect the wiring harness connector from the fuel injection fuel rail fuel pressure sensor.
    2. Remove the fuel injection fuel rail fuel pressure sensor. Dry the pressure sensor bore in the fuel rail with a lint free cloth. The bore should be free of fuel, debris, and burrs.
    3. Lubricate the fuel injection fuel rail fuel pressure sensor bore with clean engine oil.
    4. Lubricate the threads and sealing area on the fuel injection fuel rail fuel pressure sensor with clean engine oil.
    5. Install the fuel injection fuel rail fuel pressure sensor hand tight.
    6. Remove the fuel injection fuel rail fuel pressure sensor and re-lubricate the bore, threads, and sealing area.
    7. Install the fuel injection fuel rail fuel pressure sensor and tighten to 33 N.m (24 lb ft).
    8. Connect the wiring harness connector to the fuel injection fuel rail fuel pressure sensor.

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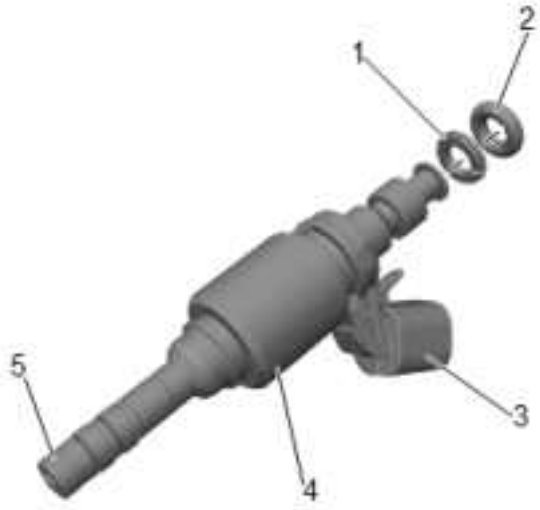

Fig. 153: Fuel Injector Connector
Courtesy of GENERAL MOTORS COMPANY

14. Inspect the fuel injectors for the following conditions:
    - Damage to the fuel injector connector (3)
    - Damage to the fuel injector harness connector
    - Damage to the fuel injector tip (5)
    - Damage to the fuel injector (4)
15. Replace the fuel injector if ANY damage is found. Do NOT attempt to repair a fuel injector.
16. Install the NEW fuel injector spacer (1).

NOTE: **Lubricate the NEW fuel injector O-ring with clean engine oil.**

17. Install the NEW fuel injector O-ring.

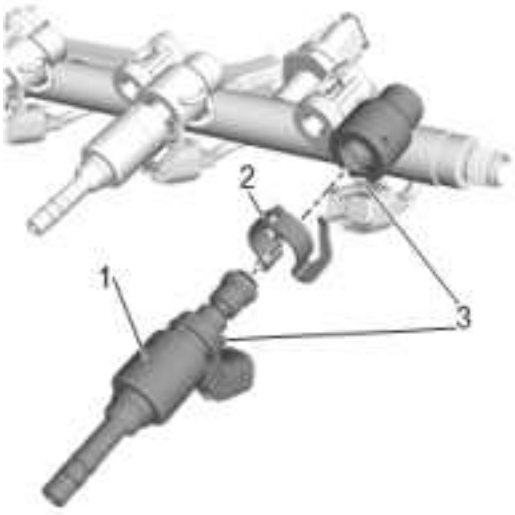

Fig. 154: Injectors And Fuel Rail Slot
Courtesy of GENERAL MOTORS COMPANY

18. Install the fuel injector holding clamp (2) onto the rear of the fuel injector.
19. Hand install the fuel injector (1) to the fuel injection fuel rail, carefully aligning the fuel injector tab to the slot in the fuel rail (3).

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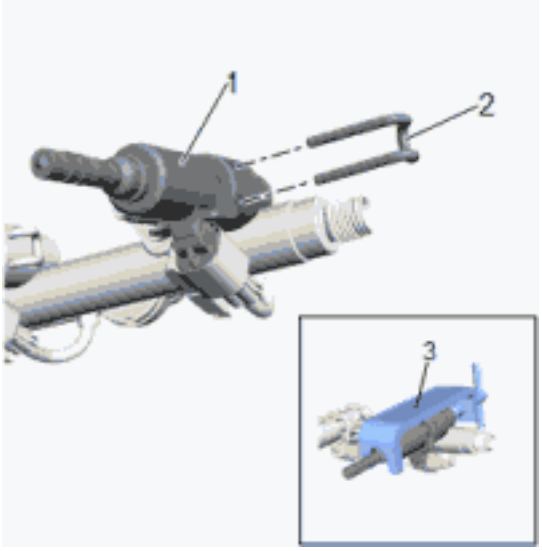

Fig. 155: Fuel Injector And Retaining Pin
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The fuel injector MUST be fully installed and properly aligned with the fuel injection fuel rail before installing the retaining pin.**

20. Use the **EN-50791** installer (3) to compress the fuel injector (1) into the fuel injection fuel rail.
21. Ensure the fuel injector is fully seated in the fuel injection fuel rail and install the fuel injector retaining pin (4).
22. Ensure the fuel injector retaining pin is fully seated in the fuel injector fuel rail and remove **EN-50791** installer.
23. Repeat the process until all fuel injectors are properly installed to the fuel rail.

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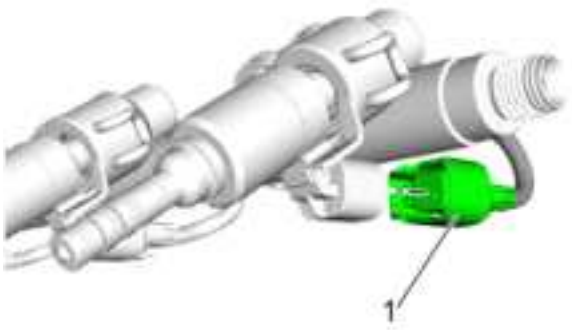

Fig. 156: Fuel Rail Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

24. Connect the electrical connectors (1) to the fuel injectors.

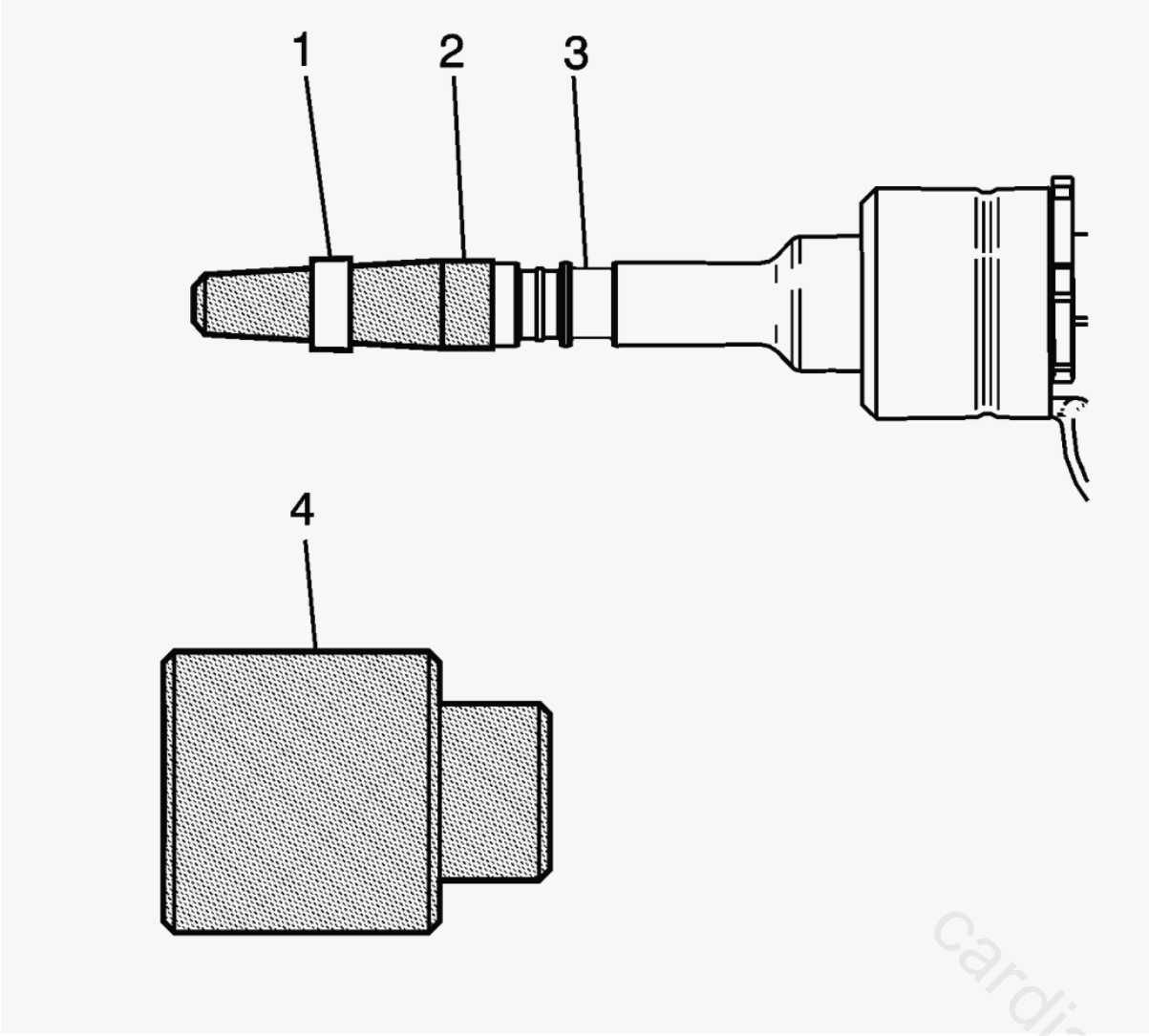

Fig. 157: Second Recessed Area And NEW Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT use any type of lubricant when installing the NEW fuel injector seals on the fuel injector tip.**

25. Install the **EN-51105 - 1** long protector (2) onto the fuel injector tip.
26. Place a NEW fuel injector seal (1) onto the **EN-51105 - 1** long protector.
27. Use the **EN-49245** pusher to install the NEW fuel injector seal into the second recessed area (3) of the fuel injector.
28. Remove the **EN-51105 - 1** long protector.
29. Compress the NEW fuel injector seal with your fingers, then resize the seal using the **EN-49245** pusher (4).

NOTE: **Do NOT use any type of lubricant when installing the NEW fuel injector seals on the fuel injector tip.**

30. Install the **EN-51105 - 2** short protector (2) onto the fuel injector tip.
31. Place a NEW fuel injector seal (1) onto the **EN-51105 - 2** short protector.
32. Use the **EN-49245** pusher to install the NEW fuel injector seal into the remaining recessed area of the fuel injector.
33. Remove the **EN-51105 - 2** short protector.
34. Compress the NEW fuel injector seal with your fingers, then resize the seal using the **EN-49245** pusher (4).
35. Install Fuel Injection Fuel Rail - **Fuel Injection Fuel Rail Assembly Replacement**

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

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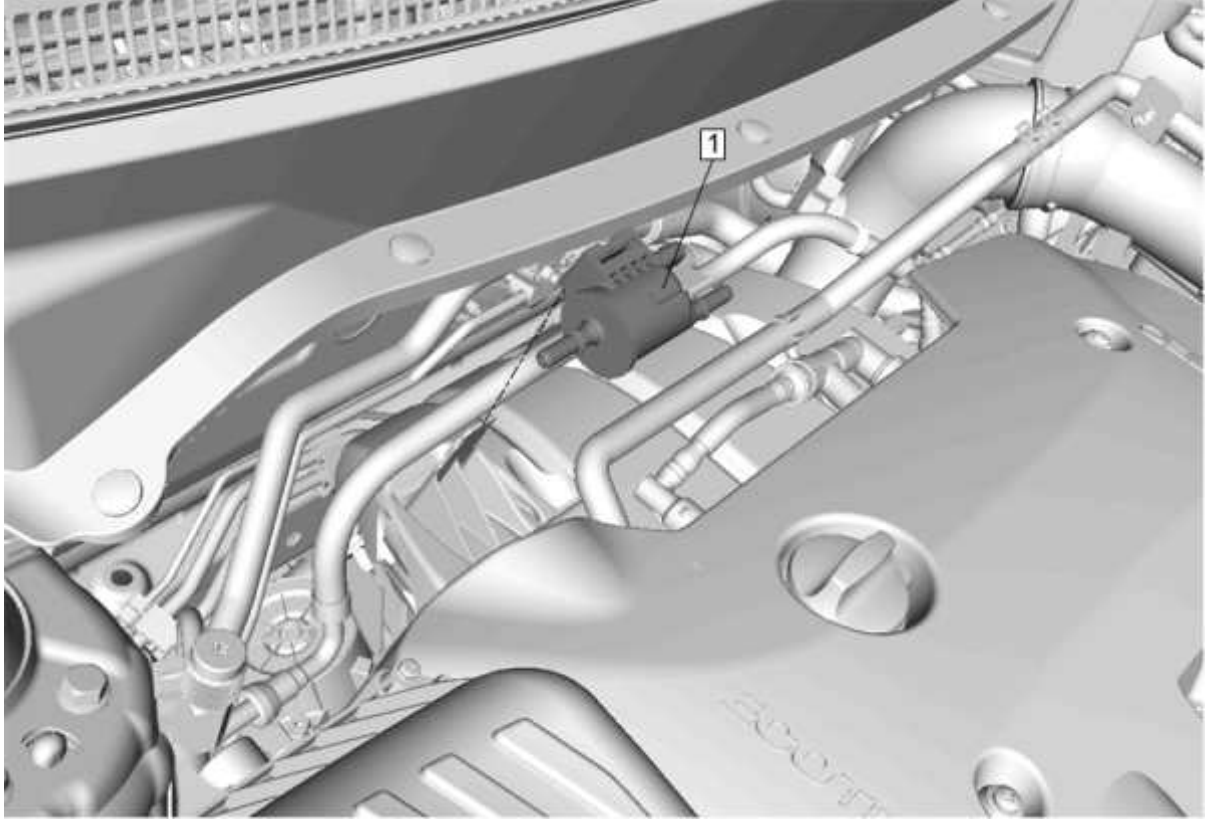

Fig. 158: Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

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 (AWD)

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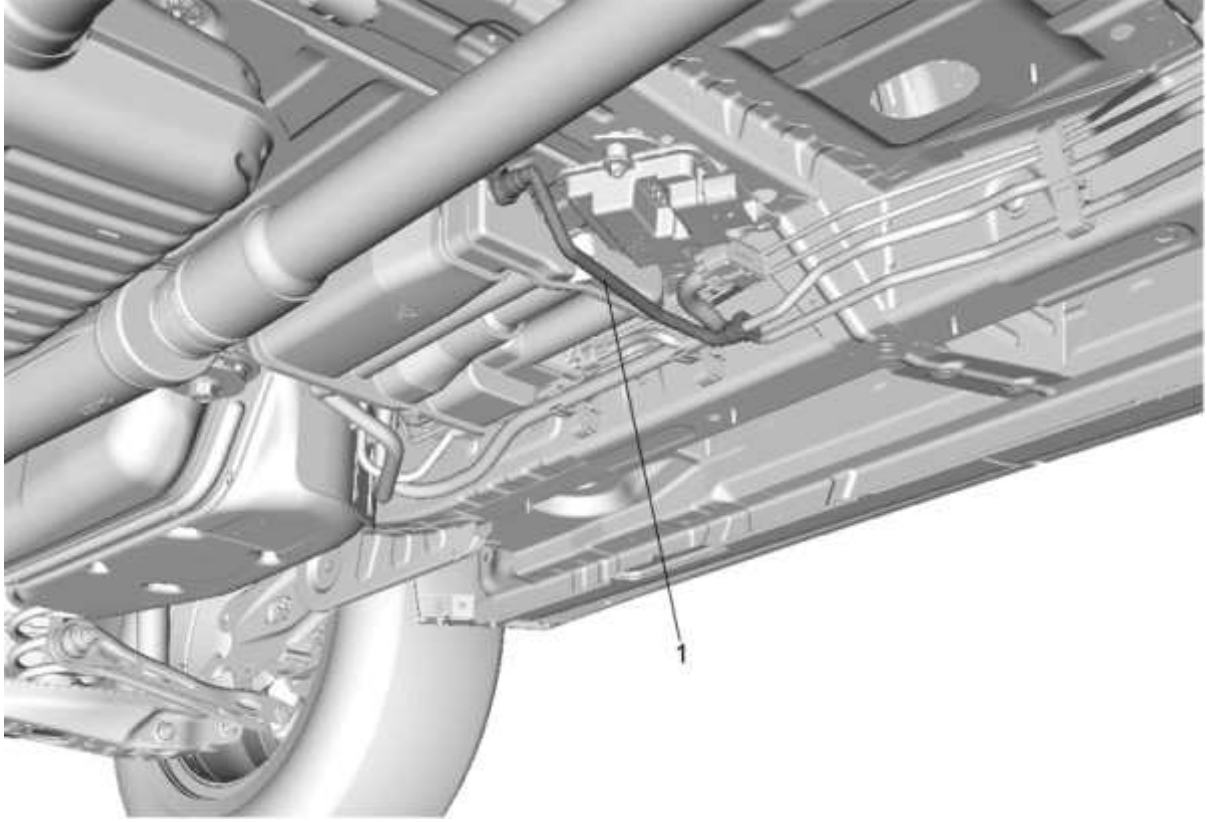

Fig. 159: Evaporative Emission Canister Purge Solenoid Valve Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

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) Underbody Rear Air Deflector Replacement (Diesel)	
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 (FWD)

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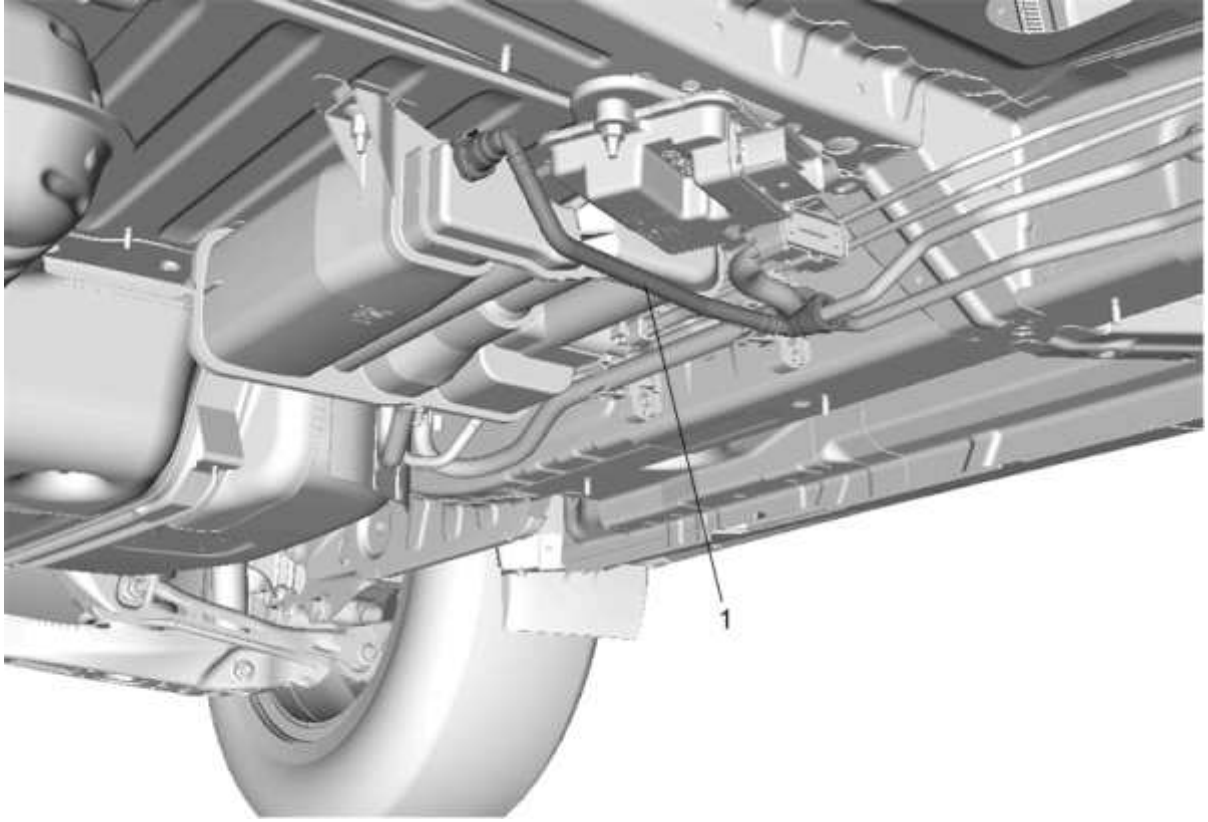

Fig. 160: Evaporative Emission Canister Purge Solenoid Valve Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

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) Underbody Rear Air Deflector Replacement (Diesel)	
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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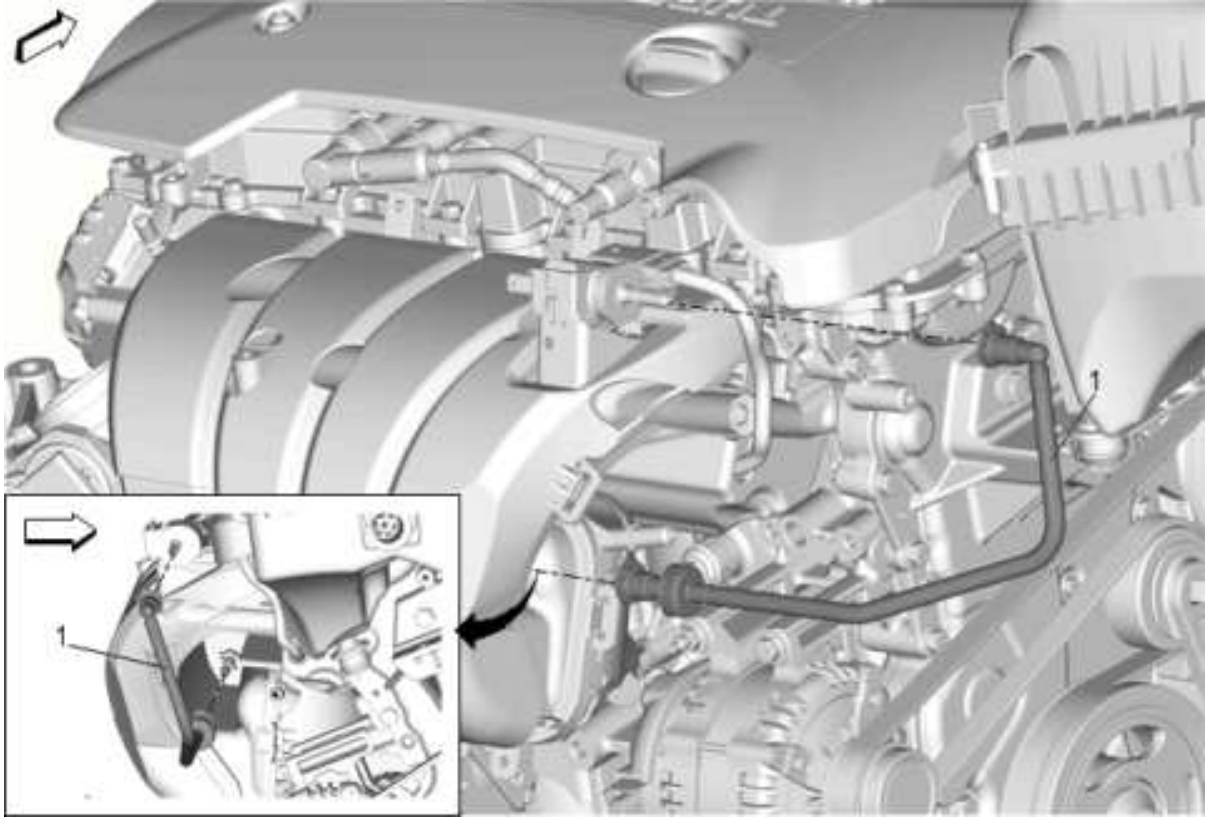
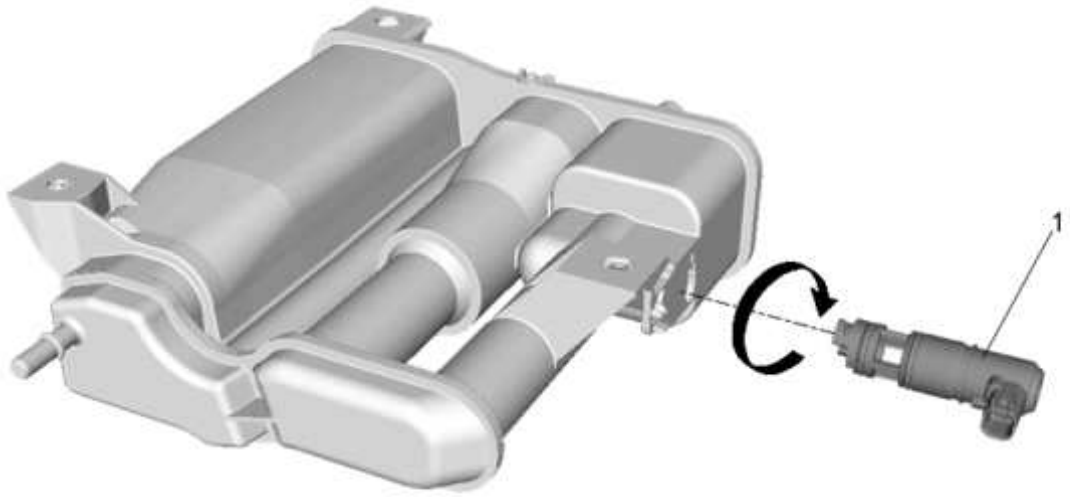


Fig. 161: Evaporative Emission Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure **Throttle Body Assembly Replacement**	
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



Cardiagn.com

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 (AWD)Evaporative Emission Canister Replacement (FWD)	
1	Evaporative Emission Canister Vent Solenoid Valve **NOTE:** Rotate solenoid clockwise 1/4 turn to remove.

EVAPORATIVE EMISSION CANISTER VENT HOSE REPLACEMENT (AWD)

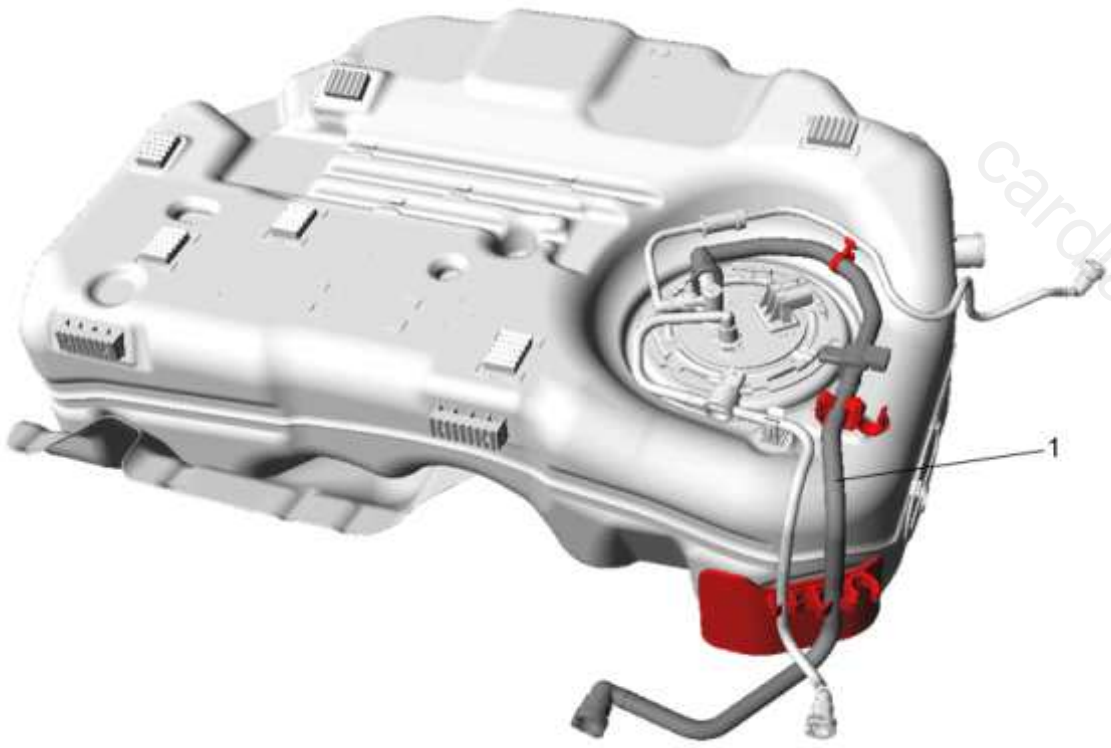


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Fig. 163: Evaporative Emission Canister Vent Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . Preliminary Procedure Fuel Tank Replacement (AWD)	

Callout	Component Name
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 (FWD)

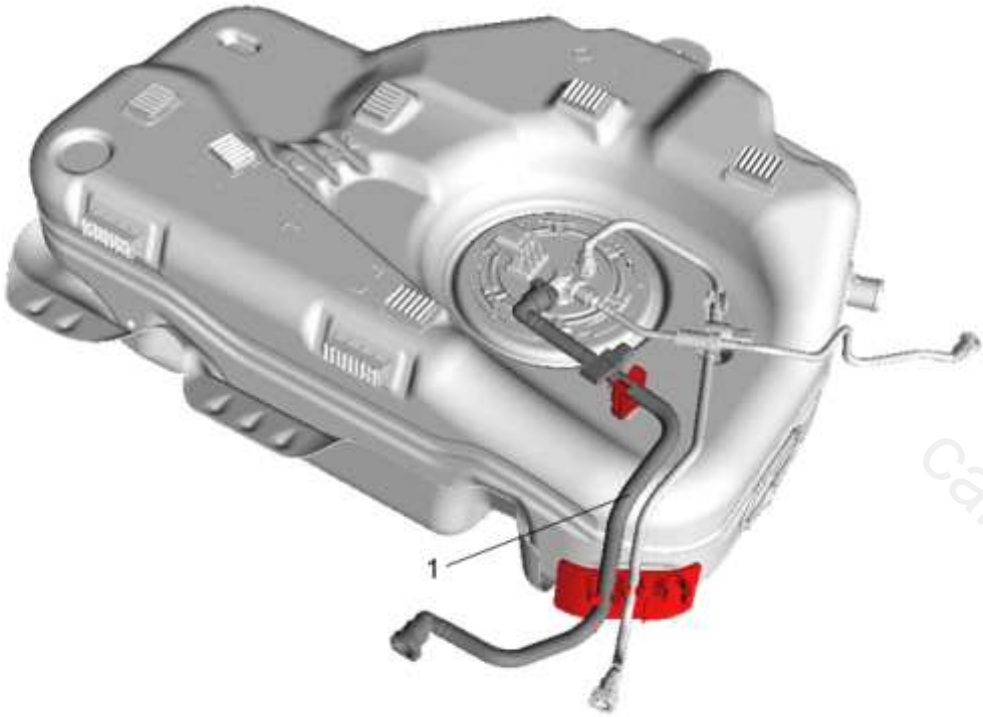

Fig. 164: Evaporative Emission Canister Vent Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

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 FILLER PIPE)

Removal Procedure

WARNING: Refer to Diesel/Gasoline Vapors Warning .

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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)**

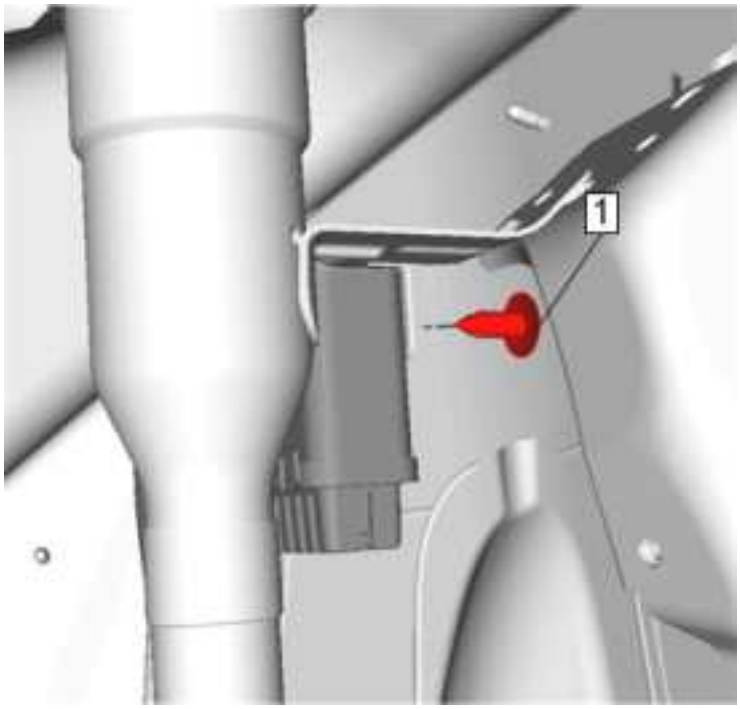

Fig. 165: Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Remove Retainer (1)

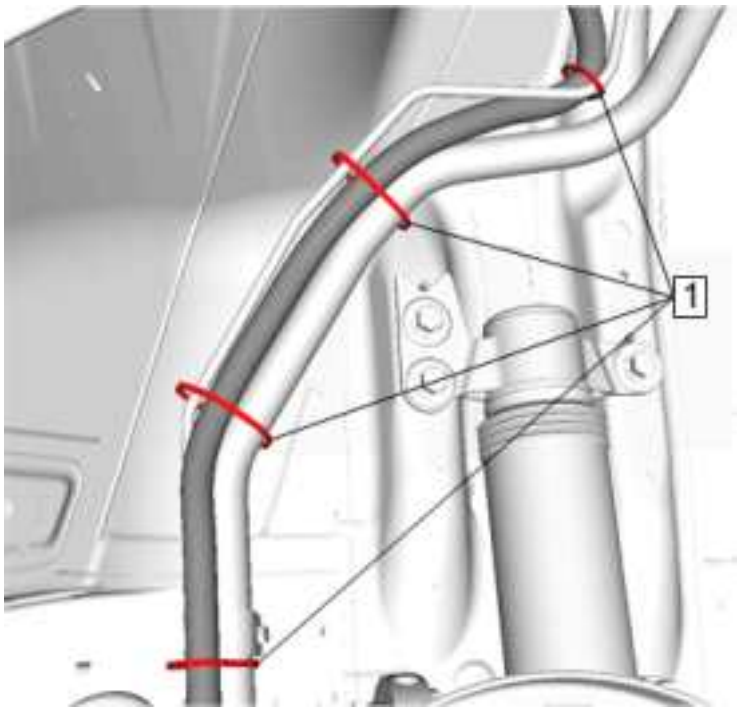

Fig. 166: Tie Strap
Courtesy of GENERAL MOTORS COMPANY

4. Remove Tie Strap (1) and DISCARD [4x]

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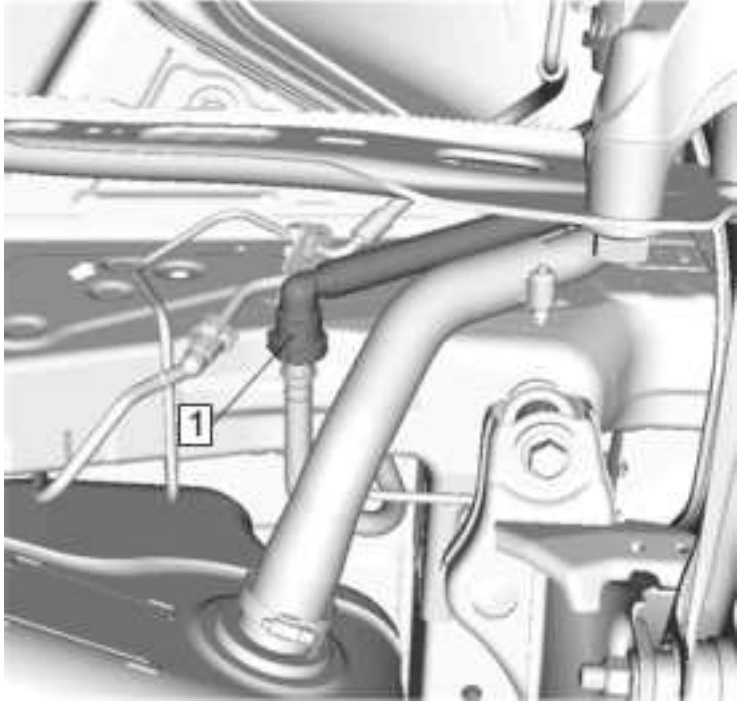

Fig. 167: Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect Evaporative Emission Canister Vent Hose - **Plastic Collar Quick Connect Fitting Service**

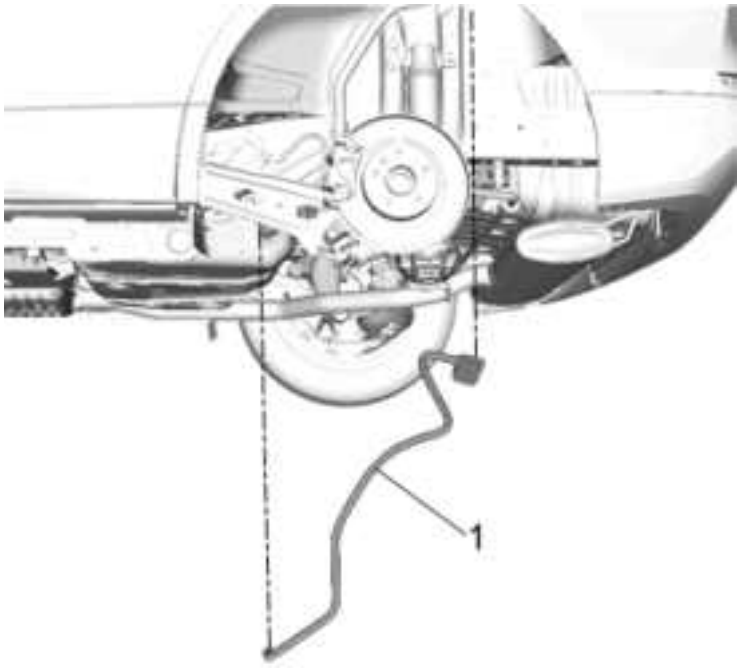

Fig. 168: Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove Evaporative Emission Canister Vent Hose.

Installation Procedure

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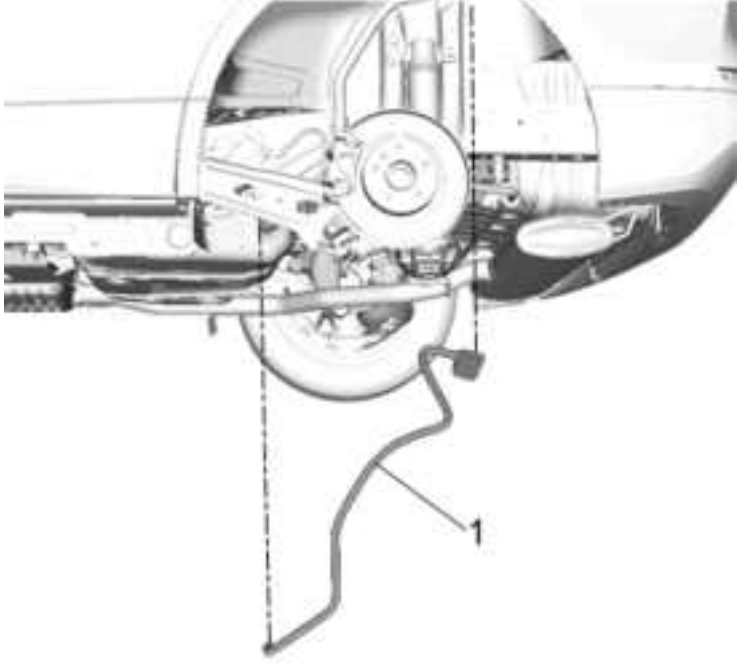

Fig. 169: Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install Evaporative Emission Canister Vent Hose.

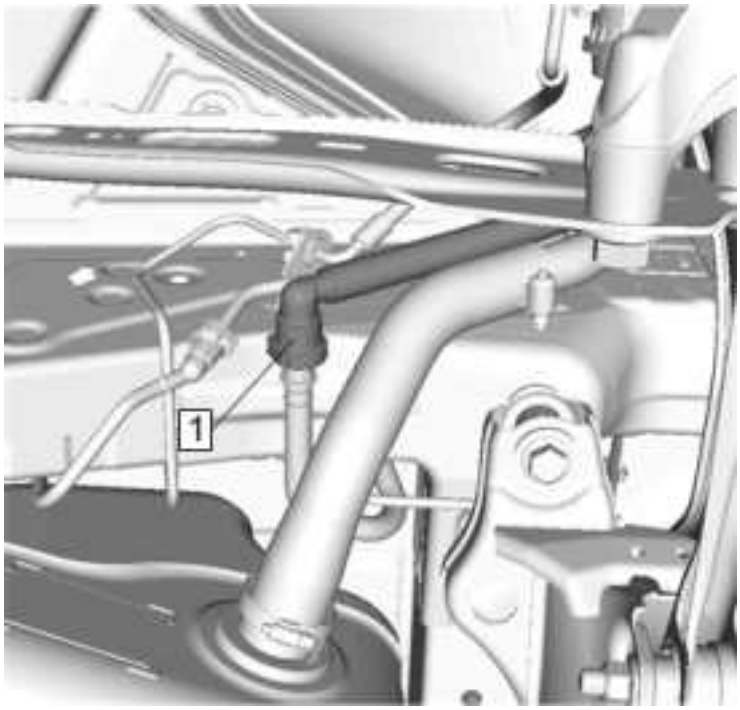

Fig. 170: Evaporative Emission Canister Vent Hose
Courtesy of GENERAL MOTORS COMPANY

2. Connect Evaporative Emission Canister Vent Hose - **Plastic Collar Quick Connect Fitting Service**

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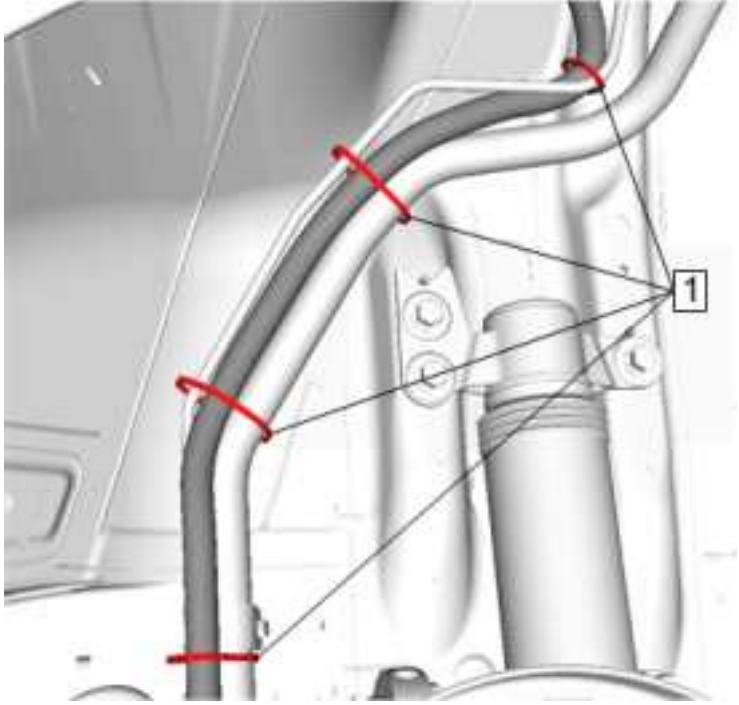

Fig. 171: Tie Strap
Courtesy of GENERAL MOTORS COMPANY

3. Install NEW Tie Strap (1) - [4x]

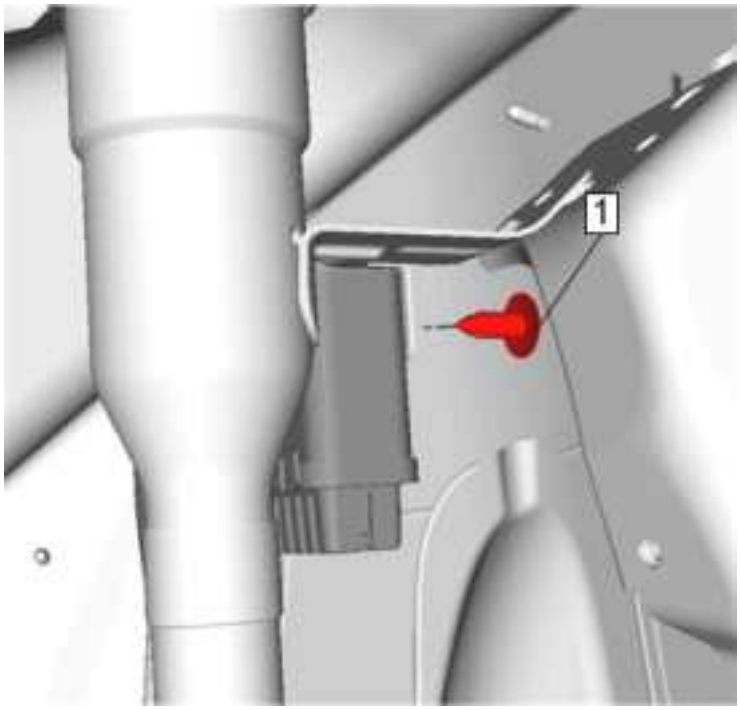

Fig. 172: Retainer
Courtesy of GENERAL MOTORS COMPANY

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 CANISTER FILTER PIPE REPLACEMENT (AWD)

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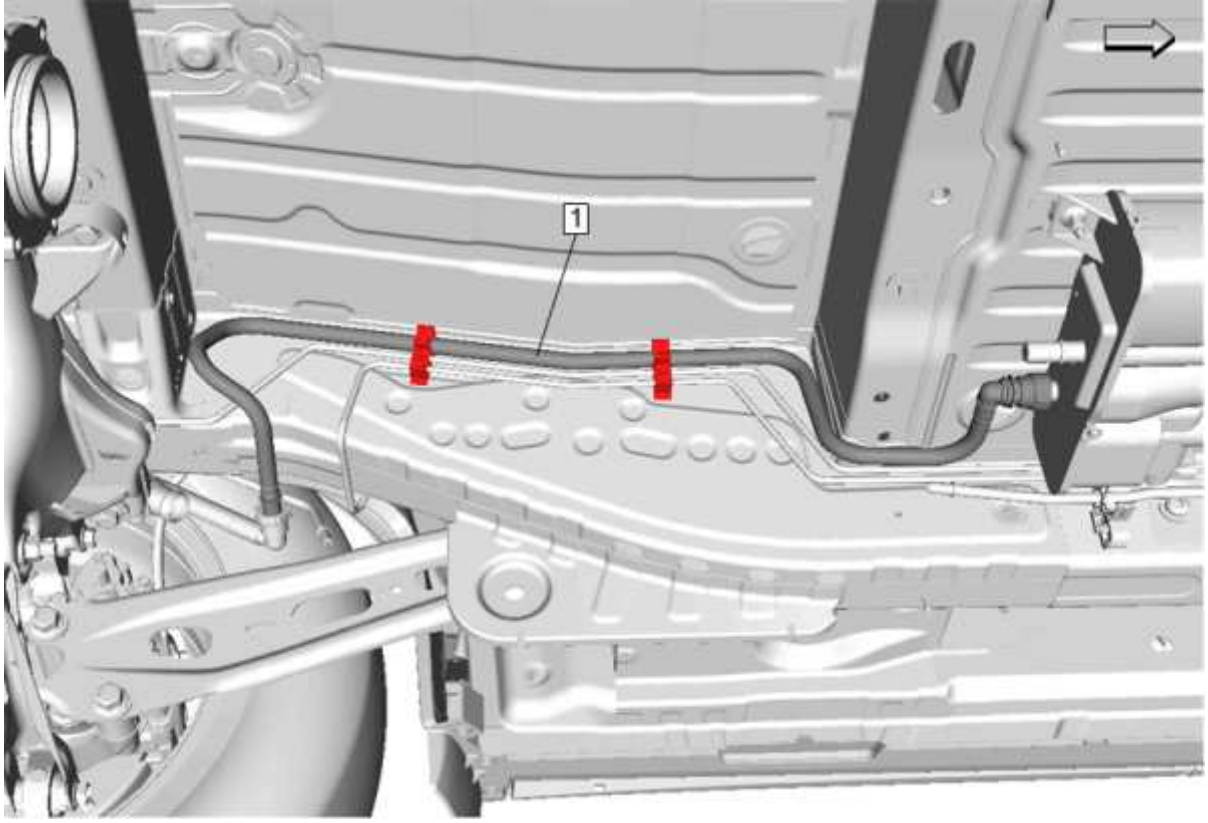

Fig. 173: Evaporative Emission Canister Filter Pipe (AWD)
Courtesy of GENERAL MOTORS COMPANY

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 FILTER PIPE REPLACEMENT (FWD)

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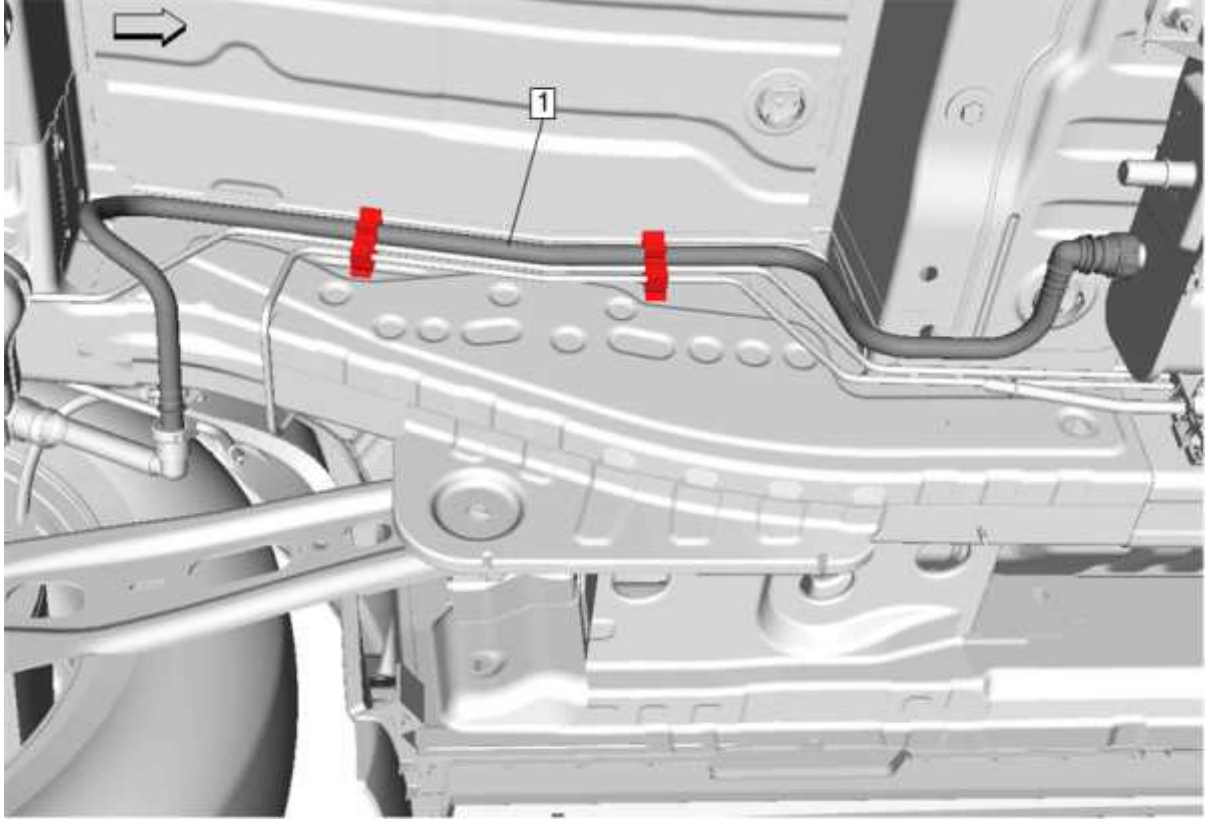

Fig. 174: Evaporative Emission Canister Filter Pipe (FWD)
Courtesy of GENERAL MOTORS COMPANY

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 Filter Pipe **Procedure** Disconnect the evaporative emission canister filter pipe and remove from retainers. Plastic Collar Quick Connect Fitting Service

EVAPORATIVE EMISSION FRONT HOSE REPLACEMENT

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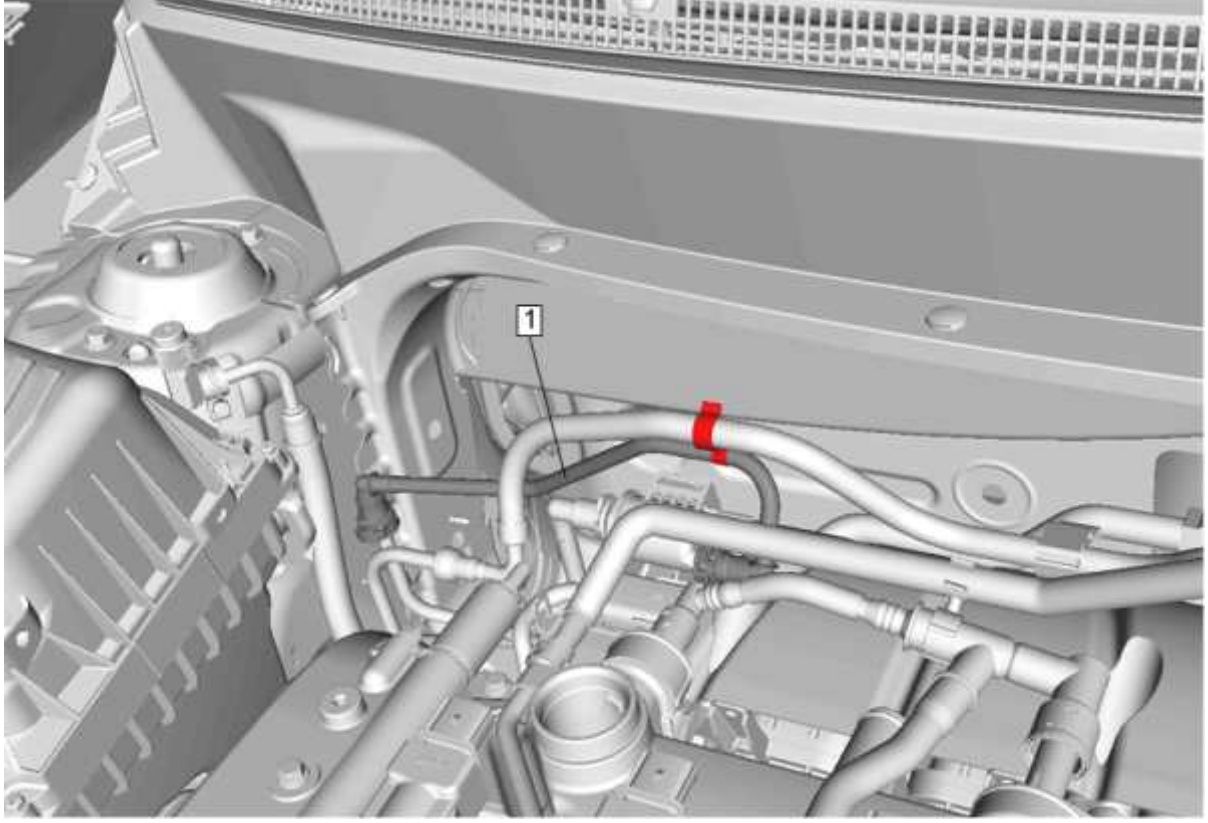

Fig. 175: Evaporative Emission Front Hose
Courtesy of GENERAL MOTORS COMPANY

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 and remove from retainers. Plastic Collar Quick Connect Fitting Service

EVAPORATIVE EMISSION FRONT PIPE REPLACEMENT (AWD)

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

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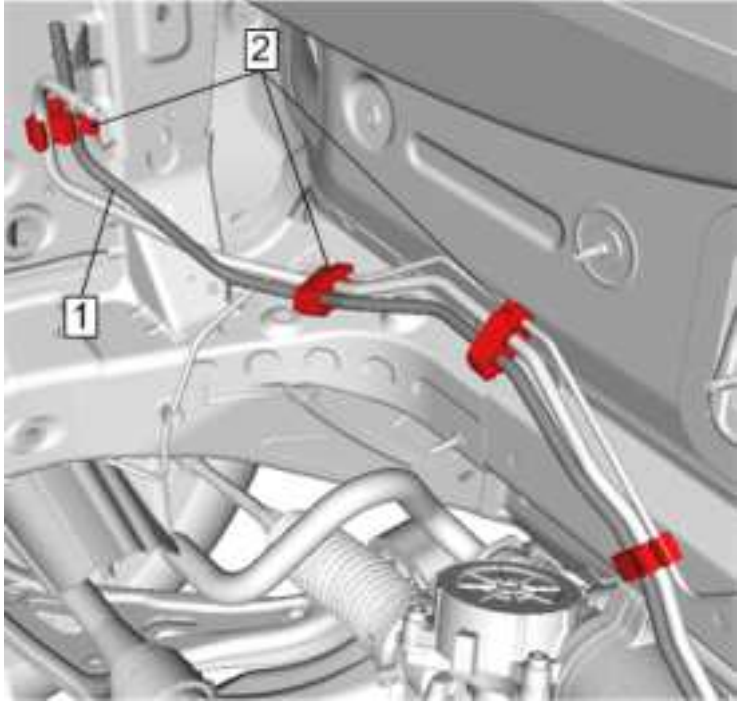

Fig. 176: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Remove Evaporative Emission Front Pipe (1) @ Retainer (2) - [4x]
3. Raise and support the vehicle. **Lifting and Jacking the Vehicle** .

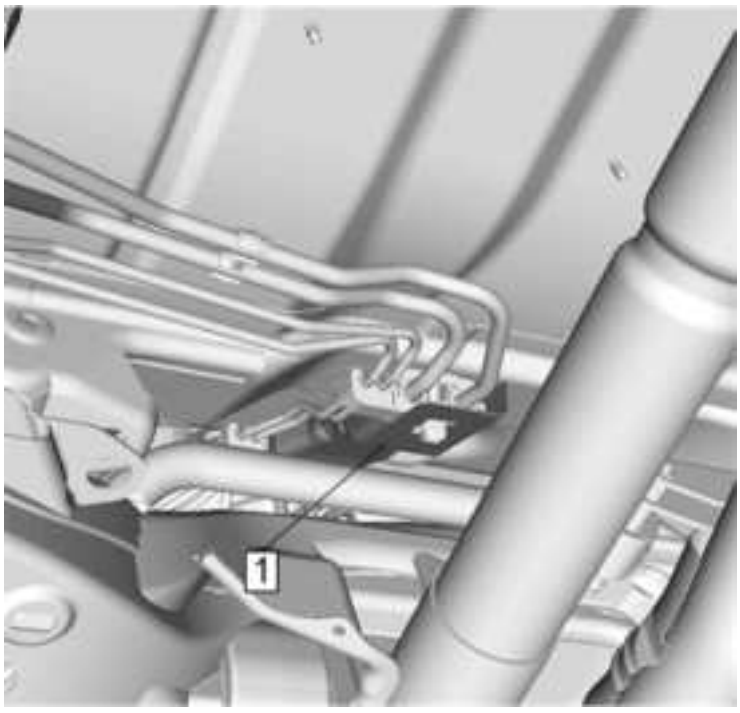

Fig. 177: Shield
Courtesy of GENERAL MOTORS COMPANY

4. Remove Shield (1).

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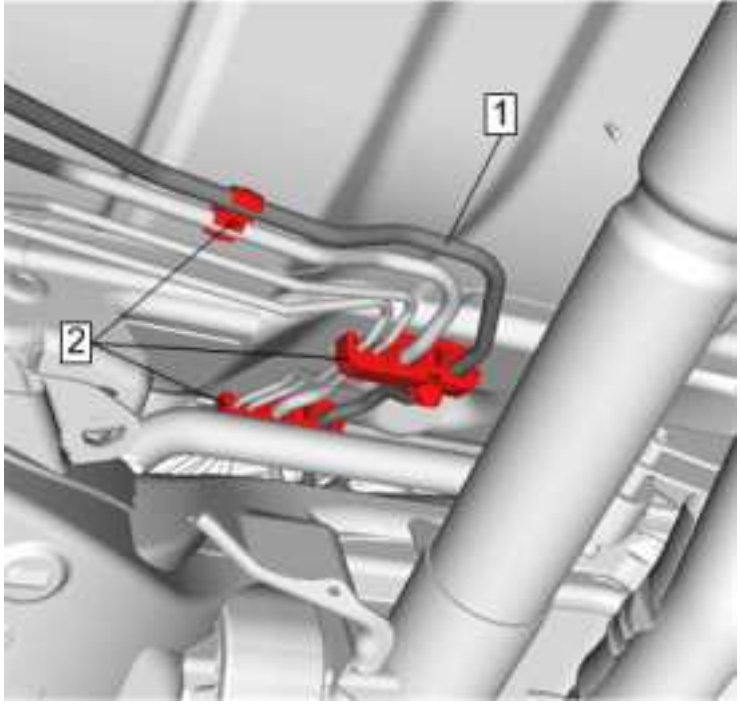

Fig. 178: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove Evaporative Emission Front Pipe (1) @ Retainer (2) - [3x]
6. Remove Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (All Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

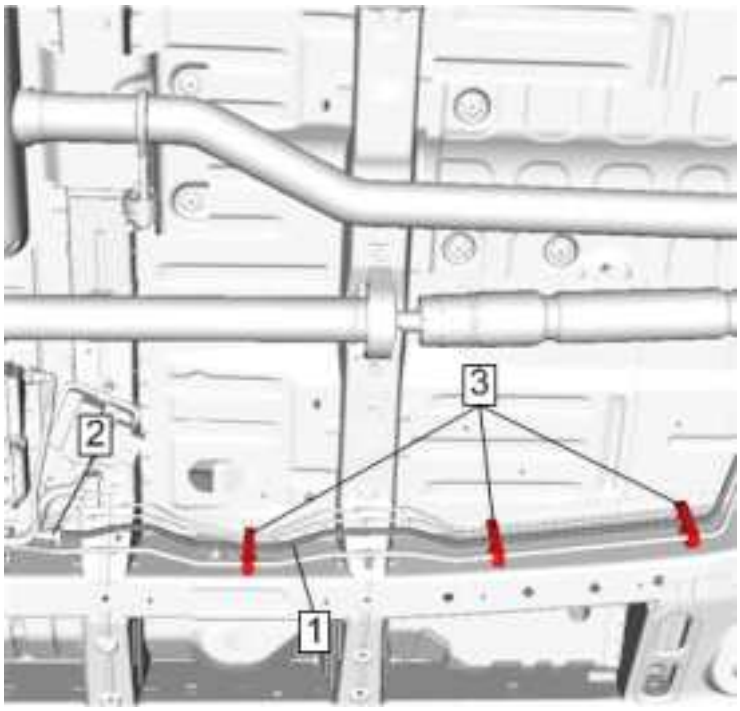

Fig. 179: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

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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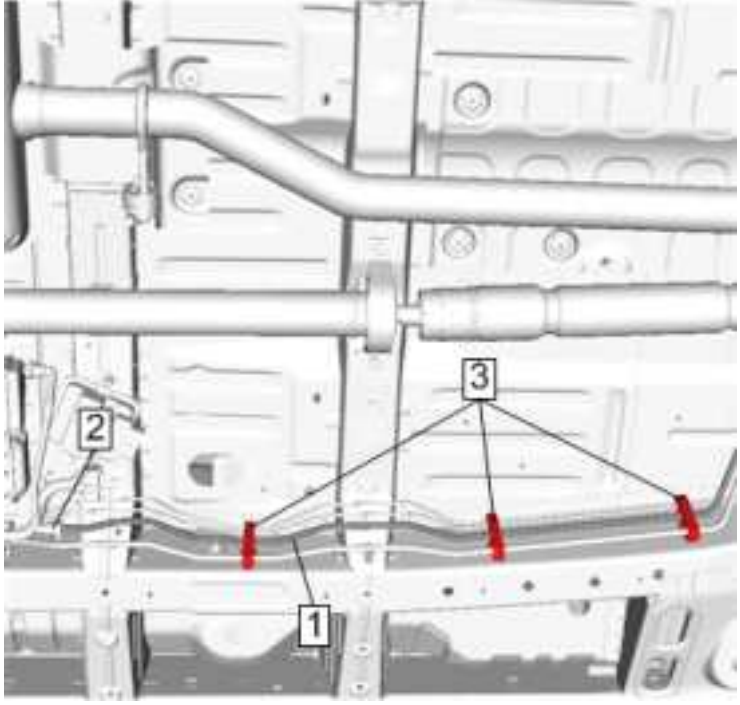

Fig. 180: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

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)** **Underbody Rear Air Deflector Replacement (Diesel)**

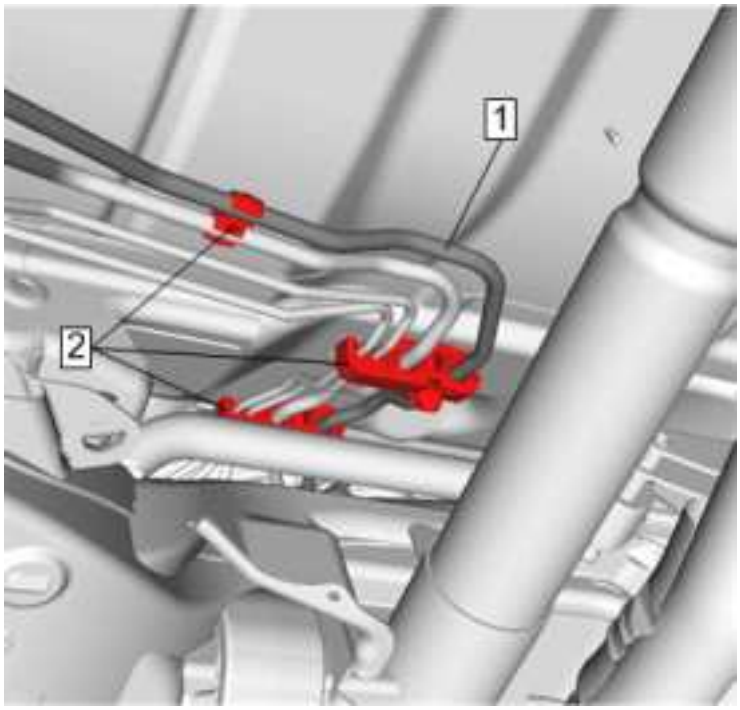

Fig. 181: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Evaporative Emission Front Pipe (1) @ Retainer (2) - [3x]

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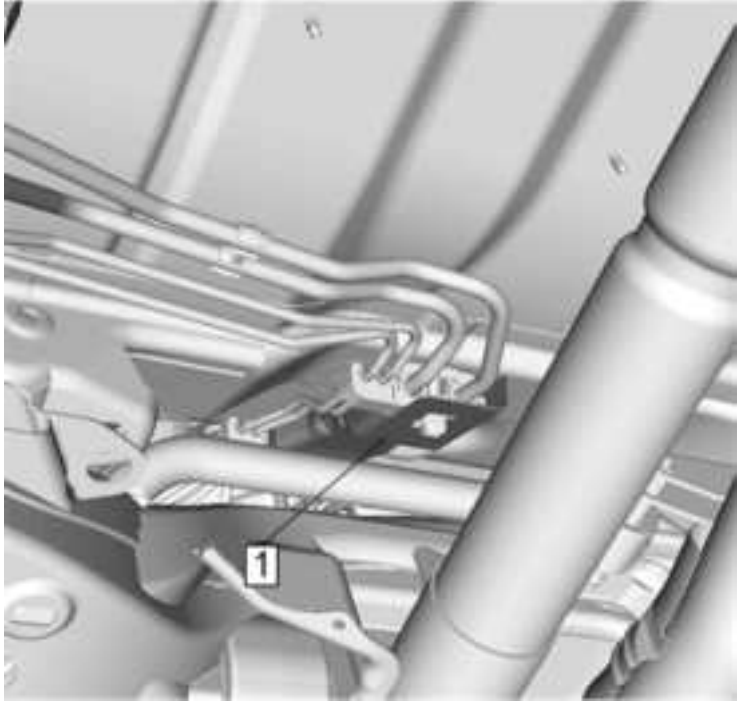

Fig. 182: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Install Shield (1)
6. Lower the vehicle.

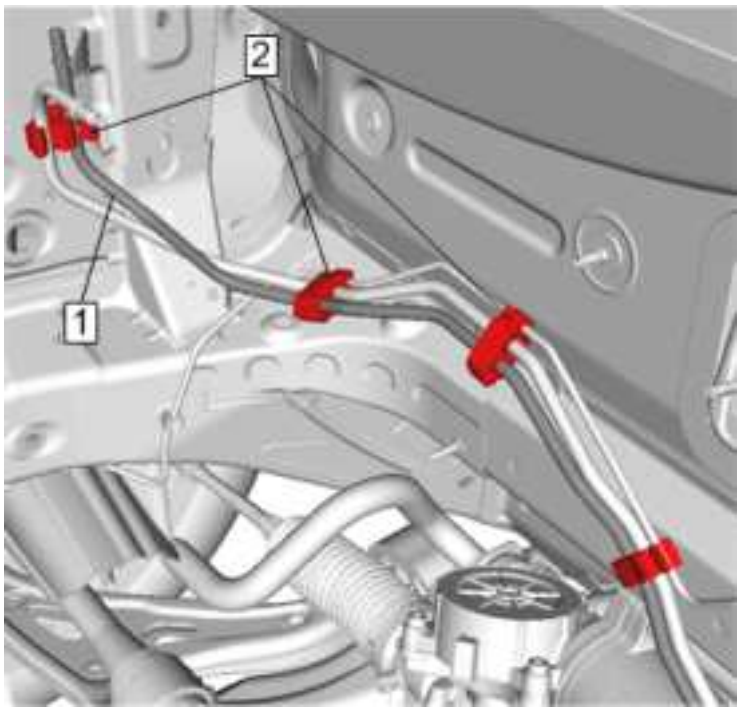

Fig. 183: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Install Evaporative Emission Front Pipe (1) @ Retainer (2) - [4x]
8. Install Evaporative Emission Front Hose - **Evaporative Emission Front Hose Replacement**

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**

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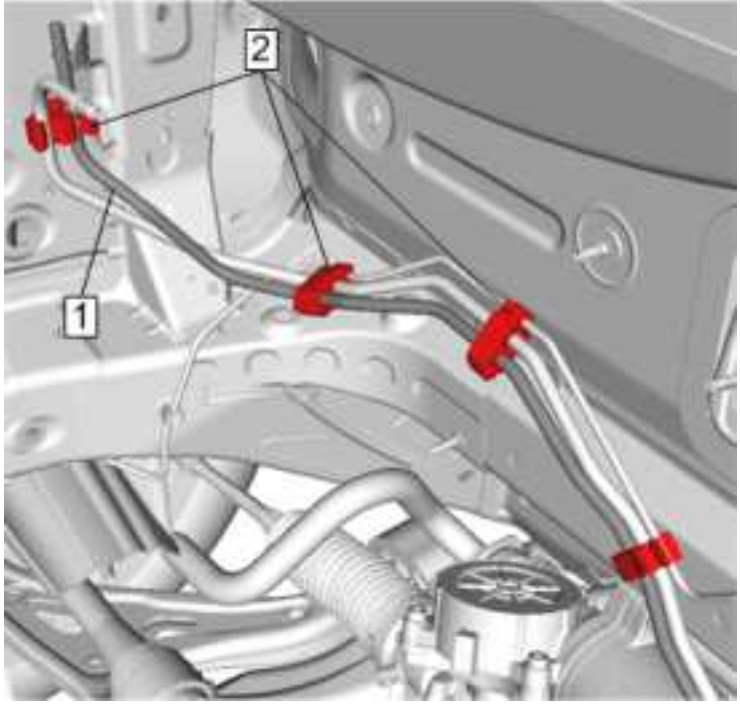

Fig. 184: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Remove Evaporative Emission Front Pipe (1) @ Retainer (2) - [4x]
3. Raise and support the vehicle. **Lifting and Jacking the Vehicle** .

Fig. 185: Shield
Courtesy of GENERAL MOTORS COMPANY

4. Remove Shield (1)

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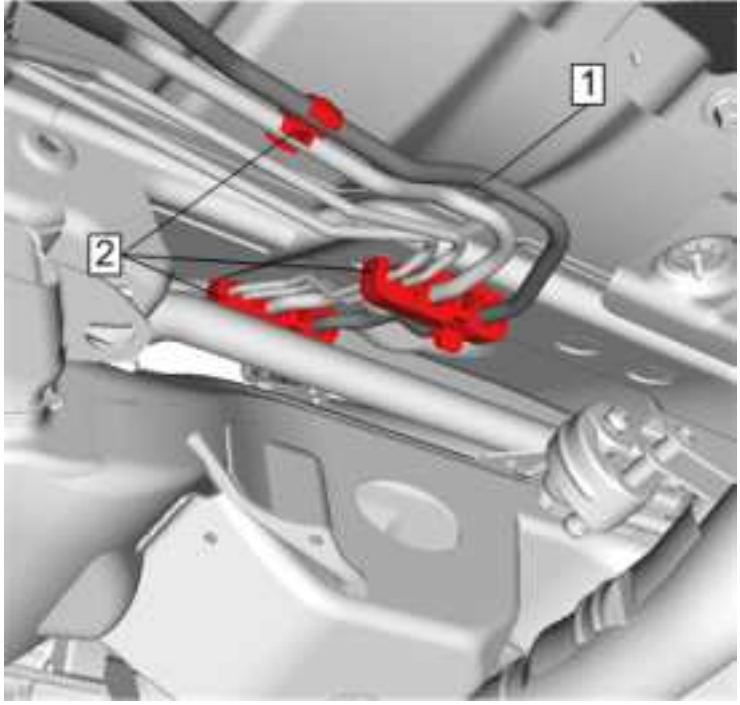

Fig. 186: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove Evaporative Emission Front Pipe (1) @ Retainer (2) - [3x]
6. Remove Underbody Rear Air Deflector - **Underbody Rear Air Deflector Replacement (Front Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

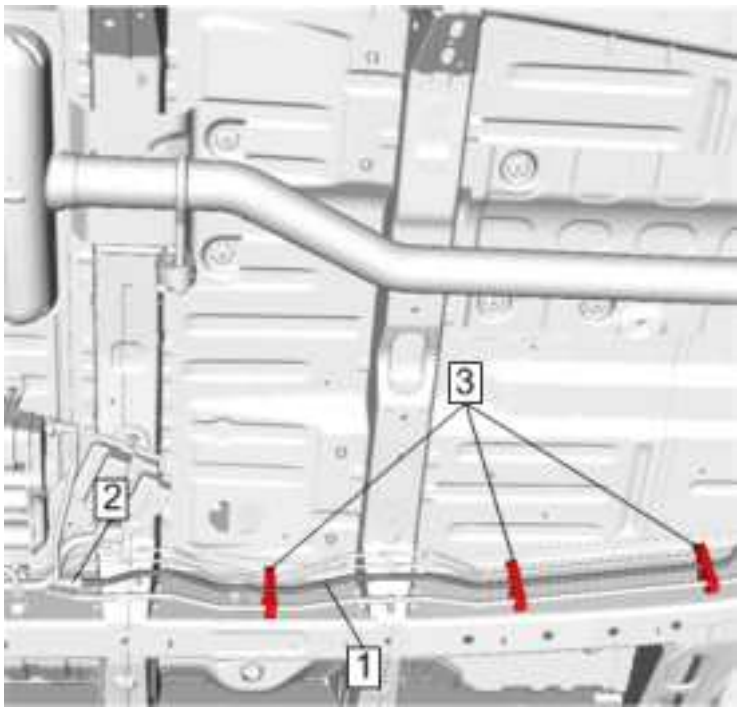

Fig. 187: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

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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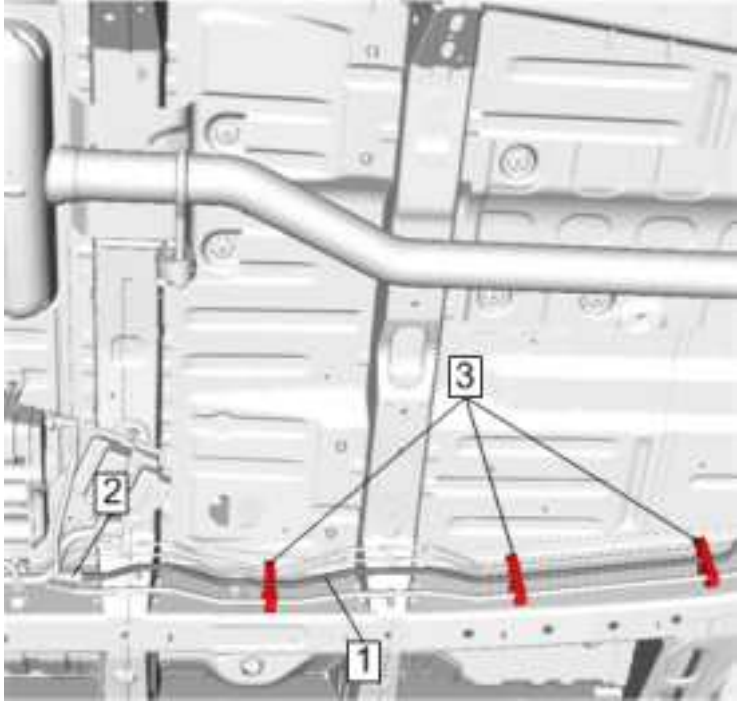

Fig. 188: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

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)** **Underbody Rear Air Deflector Replacement (Diesel)**

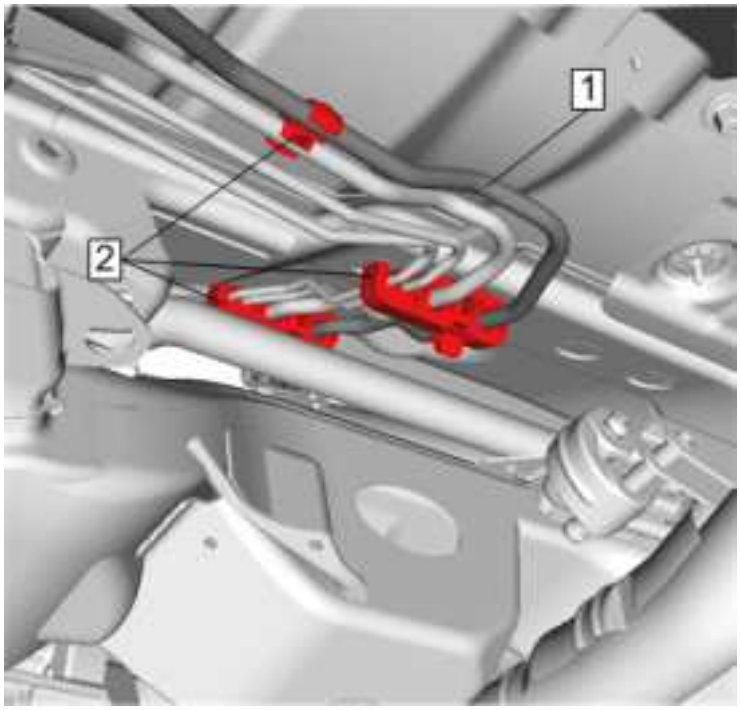

Fig. 189: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Evaporative Emission Front Pipe (1) @ Retainer (2) - [3x]

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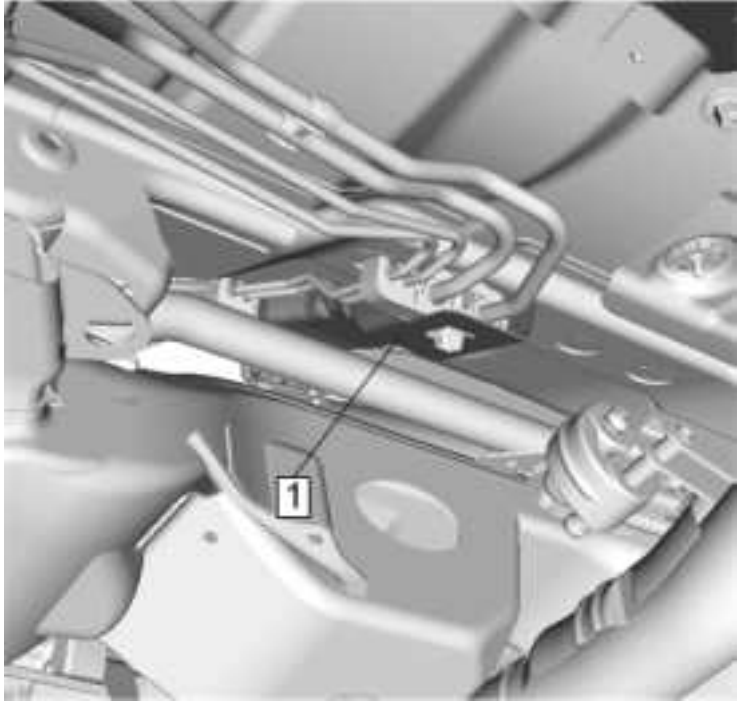

Fig. 190: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Install Shield (1)
6. Lower the vehicle.

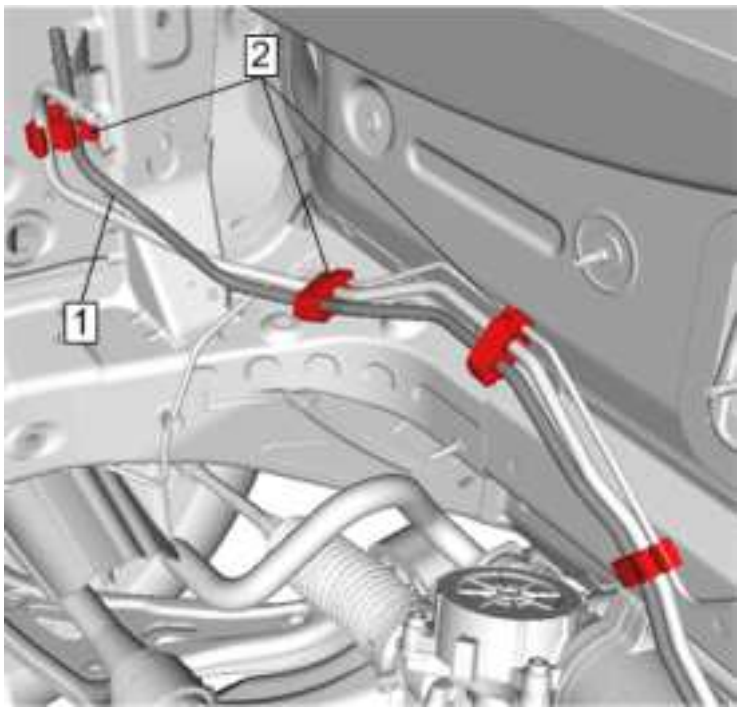

Fig. 191: Evaporative Emission Front Pipe And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Install Evaporative Emission Front Pipe (1) @ Retainer (2) - [4x]
8. Install Evaporative Emission Front Hose - **Evaporative Emission Front Hose Replacement**

EVAPORATIVE EMISSION CANISTER REPLACEMENT (AWD)

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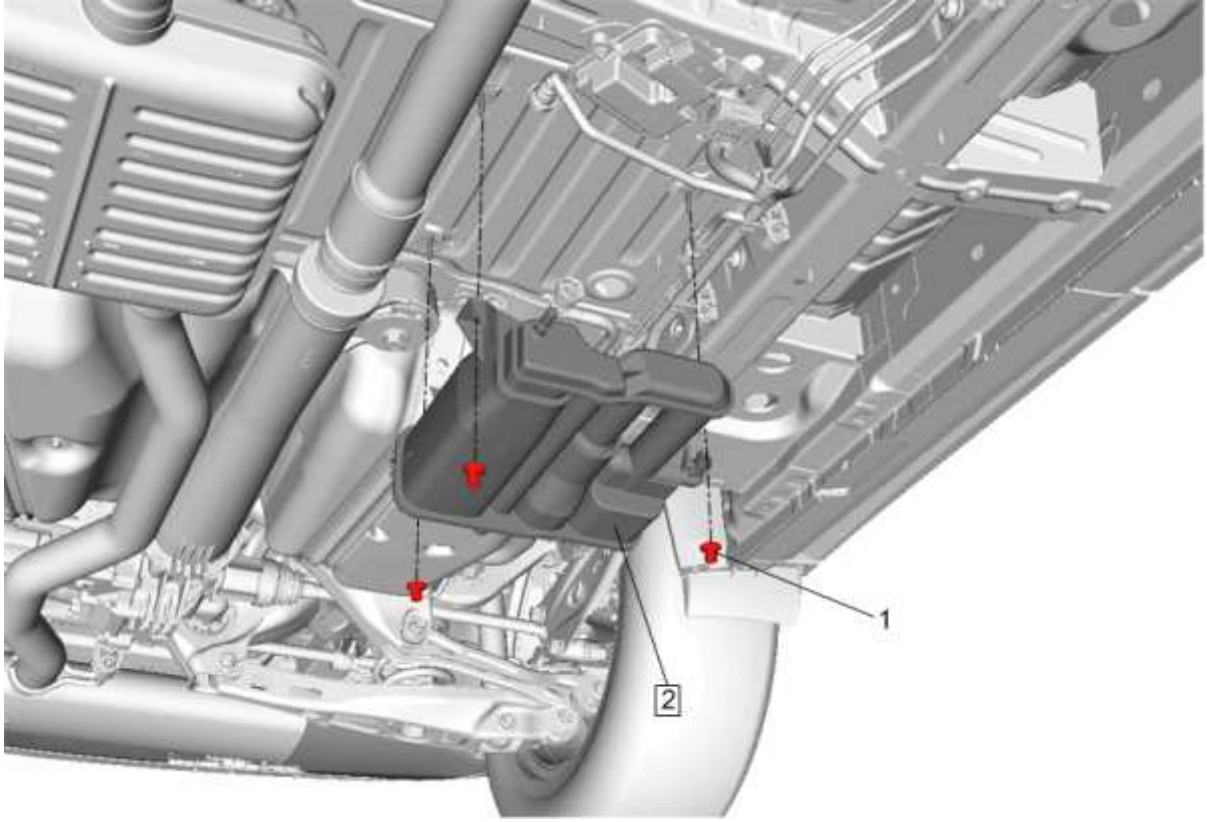

Fig. 192: Evaporative Emission Canister (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedures** 1. Underbody Rear Air Deflector Replacement (All Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel) 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** 9 N.m (80 lb in)
2	Evaporative Emission Canister **Procedure** Disconnect the electrical connector.

EVAPORATIVE EMISSION CANISTER REPLACEMENT (FWD)

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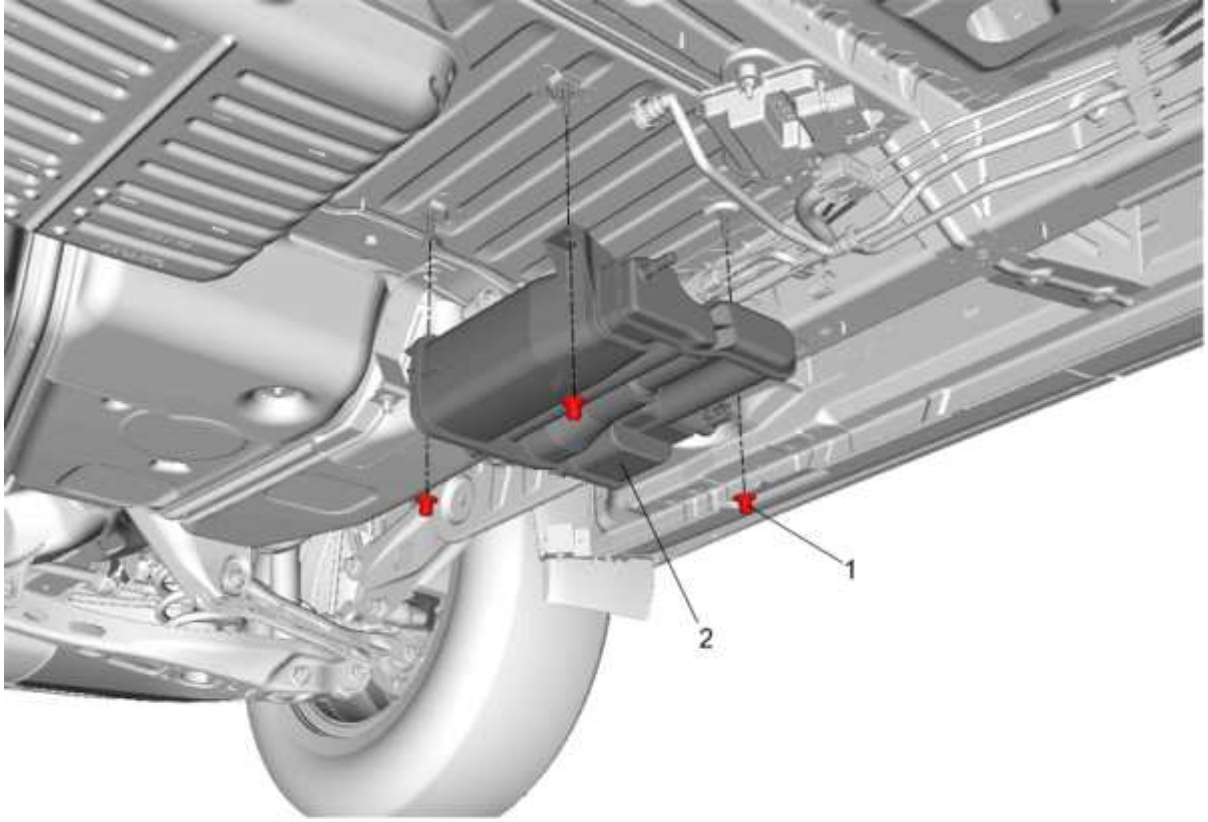

Fig. 193: Evaporative Emission Canister (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedures** 1. Underbody Rear Air Deflector Replacement (All Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel) 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** 9 N.m (80 lb in)
2	Evaporative Emission Canister **Procedure** Disconnect the electrical connector.

EVAPORATIVE EMISSION SYSTEM CLEANING

Special Tools

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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.**

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 (AWD)Evaporative Emission Canister Replacement (FWD)**
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 (AWD)Evaporative Emission Canister Replacement (FWD)**
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.

IGNITION COIL REPLACEMENT

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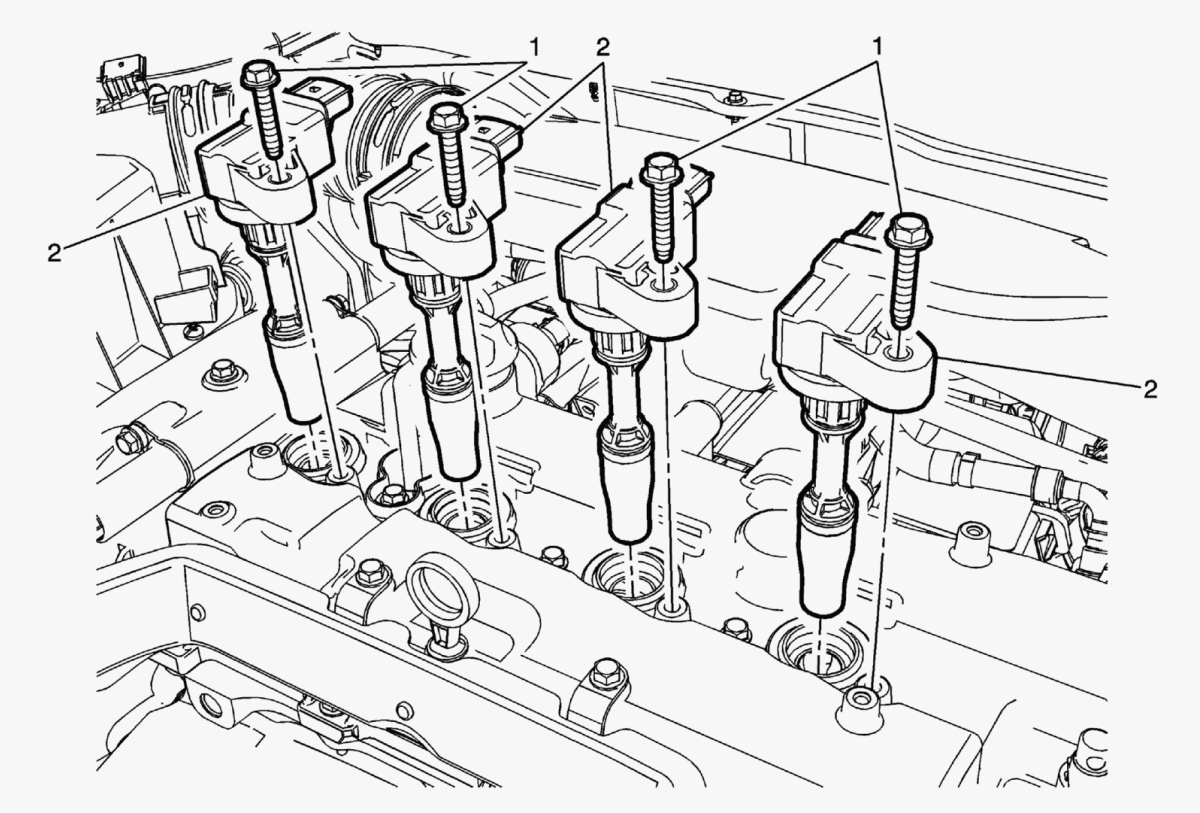

Fig. 194: Ignition Coils And Fasteners
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. **Intake Manifold Cover Replacement** 2. Disconnect the electrical connectors.	
1	Ignition Coil Fastener [4x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Ignition Coil [4x] **Procedure** 1. Inspect the inside of the ignition coil boot for a thin, even coat of dielectric grease. If there is no grease present or additional grease is necessary, continue to the next step. 2. Apply a thin coating of dielectric grease to the inside of the ignition coil boot up to a depth of 15 mm (0.60 in) from the end of the boot. **Adhesives, Fluids, Lubricants, and Sealers** 3. Remove any excess dielectric grease from around the end of the ignition coil boot and ensure there is not an excessive amount within the boot.

SPARK PLUG REPLACEMENT

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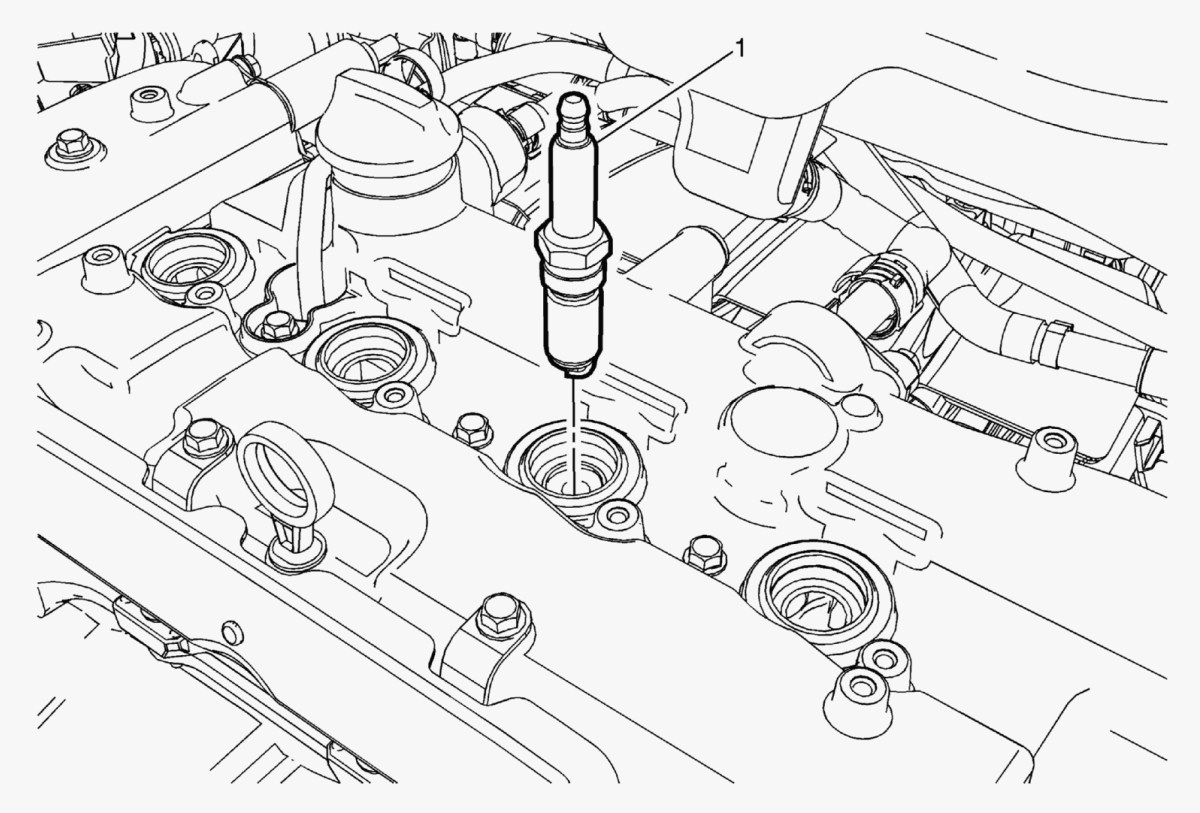

Fig. 195: Spark Plug
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
CAUTION: **This engine has aluminum cylinder heads. Do not remove the spark plugs from a hot engine, allow it to cool first. Removing the spark plugs from a hot engine may cause spark plug thread damage or cylinder head damage.** **Preliminary Procedure** Ignition Coil Replacement	
1	Spark Plug [4x] **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** 1. If reusing the spark plugs, inspect for wear or damage. Spark Plug Inspection 2. If using NEW spark plugs, do NOT attempt to check the spark plug gap. The plugs come pre-gapped. 3. **Tighten** 20 N.m (15 lb ft)

SPARK PLUG INSPECTION

Spark Plug Usage

Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to the Electronic Parts Catalog.

Spark Plug Inspection

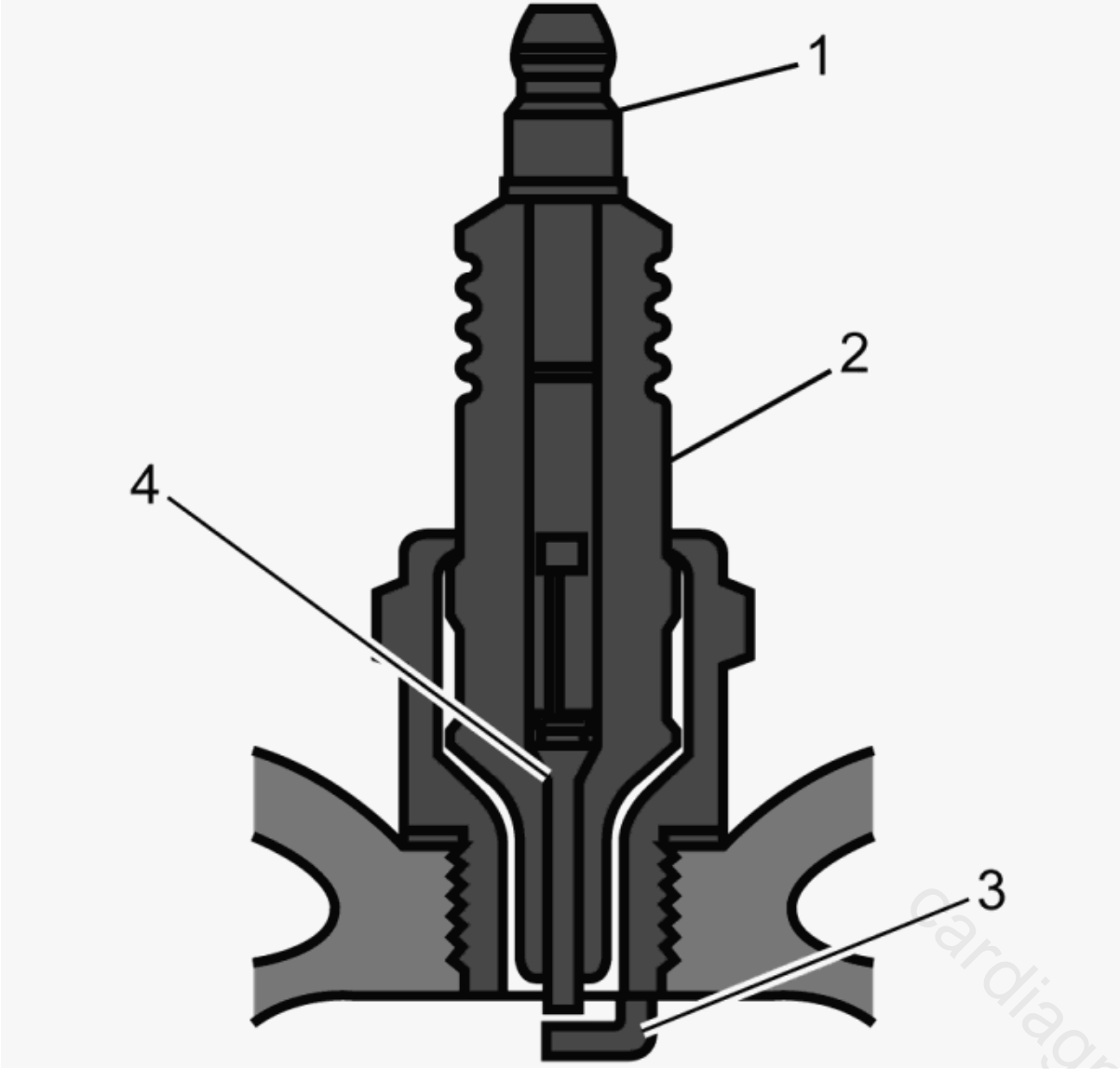

Fig. 196: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

- Inspect the terminal post (1) for damage.
  - Inspect for a bent or broken terminal post (1).
  - Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.
- Inspect the insulator (2) for flashover or carbon tracking, soot. This condition is often mistakenly identified as a cracked insulator. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
  - Inspect the spark plug boot for damage.
  - Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant, or water. A spark plug boot that is saturated causes arcing to ground.
- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).
- Inspect for evidence of improper arcing.
  - Measure the gap between the center electrode (4) and the side electrode (3) terminals. This must be done carefully in order to avoid damaging the small diameter Iridium center electrode. Refer to **Ignition System Specifications** . An excessively wide electrode gap can prevent correct spark plug operation.
  - Inspect for the correct spark plug torque. Refer to **Ignition System Specifications** . Insufficient torque can prevent correct spark plug operation. An over torqued spark plug, causes the insulator (2) to crack.
  - Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
  - Inspect for a broken or worn side electrode (3).

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- Inspect for a broken, worn, or loose center electrode (4) by shaking the spark plug.
  - A rattling sound indicates internal damage.
  - A loose center electrode (4) reduces the spark intensity.
- Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
- Inspect for worn or missing platinum pads on the electrodes (3, 4) If equipped.
- Inspect for excessive fouling.

- Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

- Normal operation - Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives. Reddish orange deposits can indicate MMT fuel additive which is still used in some markets around the world (will cause misfire and cannot be burned off). MMT fuel additive use should be avoided.
- Carbon Fouled - Dry, fluffy black carbon, or soot caused by the following conditions:
  - Rich fuel mixtures
    - Leaking fuel injectors
    - Excessive fuel pressure
    - Restricted air filter element
    - Incorrect combustion
  - Reduced ignition system voltage output
    - Weak coils
    - Worn ignition wires
    - Incorrect spark plug gap
  - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
- Deposit Fouling - Oil, coolant, or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

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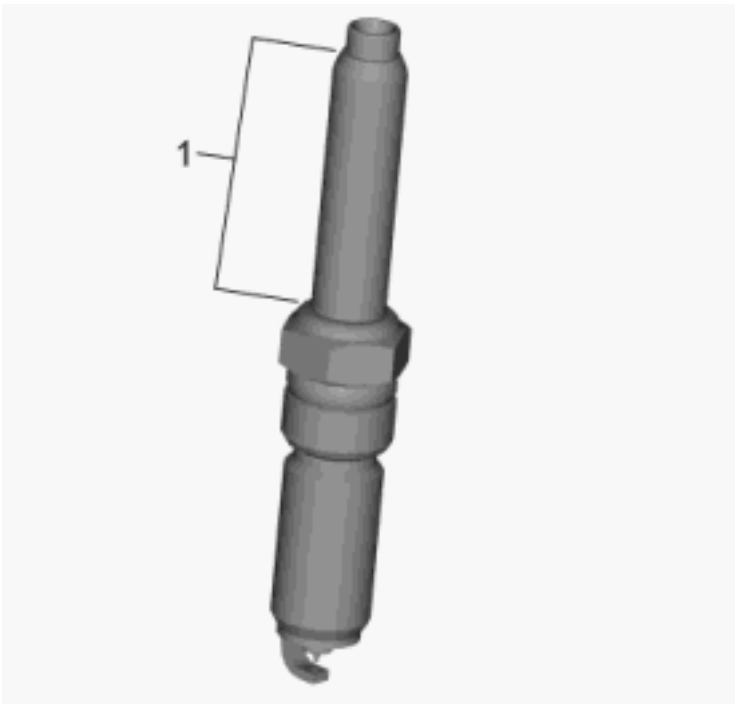

Fig. 197: Inspect For Carbon On Spark Plug Tower
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Carbon on spark plug tower means carbon will also be on inside of spark plug wire boot or coil boot and will cause both new spark plug**

and spark plug wire or coil boot to fail again.

-
- If carbon tracking occurs on spark plug tower (1), replace spark plug and spark plug wire or coil boot.

CRANKSHAFT POSITION SENSOR REPLACEMENT

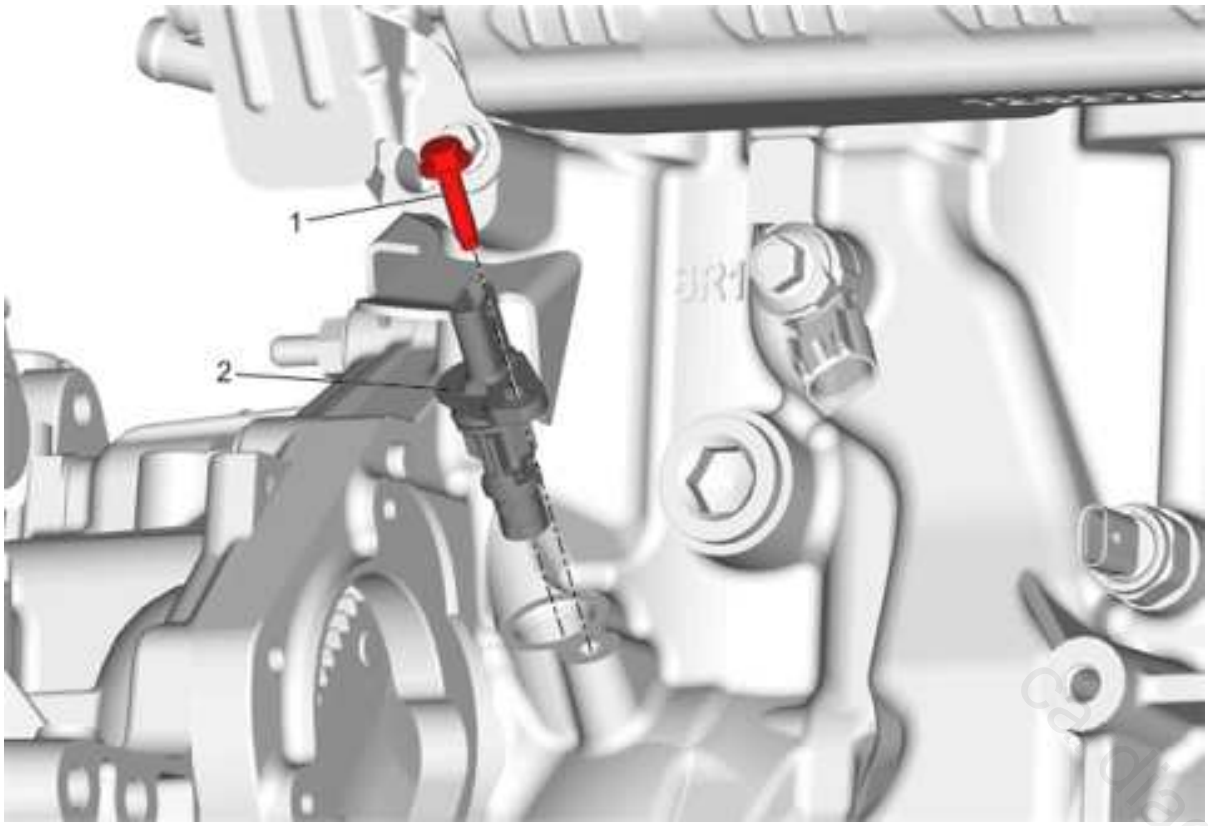

Fig. 198: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Starter Replacement (LTG - All Wheel Drive) Starter Replacement (LTG - Front Wheel Drive) 2. Disconnect the electrical connector.	
1	Crankshaft Position Sensor Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Crankshaft Position Sensor **Procedure** 1. If reusing the OLD sensor, install a NEW seal. 2. Perform the crankshaft position variation learn. Crankshaft Position Variation Learn **NOTE:** **A NEW sensor will come with a NEW seal.**

CAMSHAFT POSITION SENSOR REPLACEMENT - INTAKE

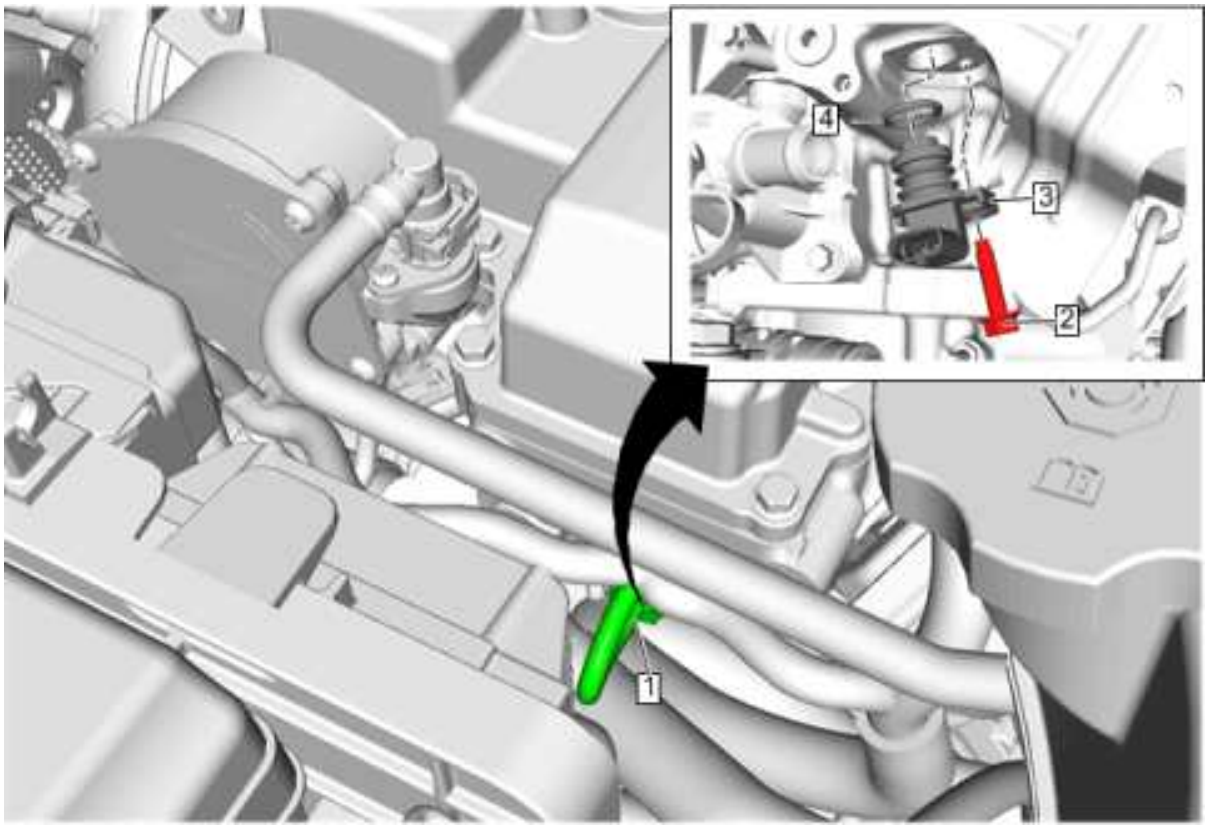

Fig. 199: Camshaft Position Sensor - Intake
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Charge Air Cooler Outlet Air Tube Replacement 2. Reposition Heater Inlet Hose @ Water Outlet - Water Outlet Replacement (LTG)	
1	Electrical Connector
2	Camshaft Position Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
3	Camshaft Position Sensor
4	Camshaft Position Sensor Seal **Procedure** Install a NEW seal.

CAMSHAFT POSITION SENSOR REPLACEMENT - EXHAUST

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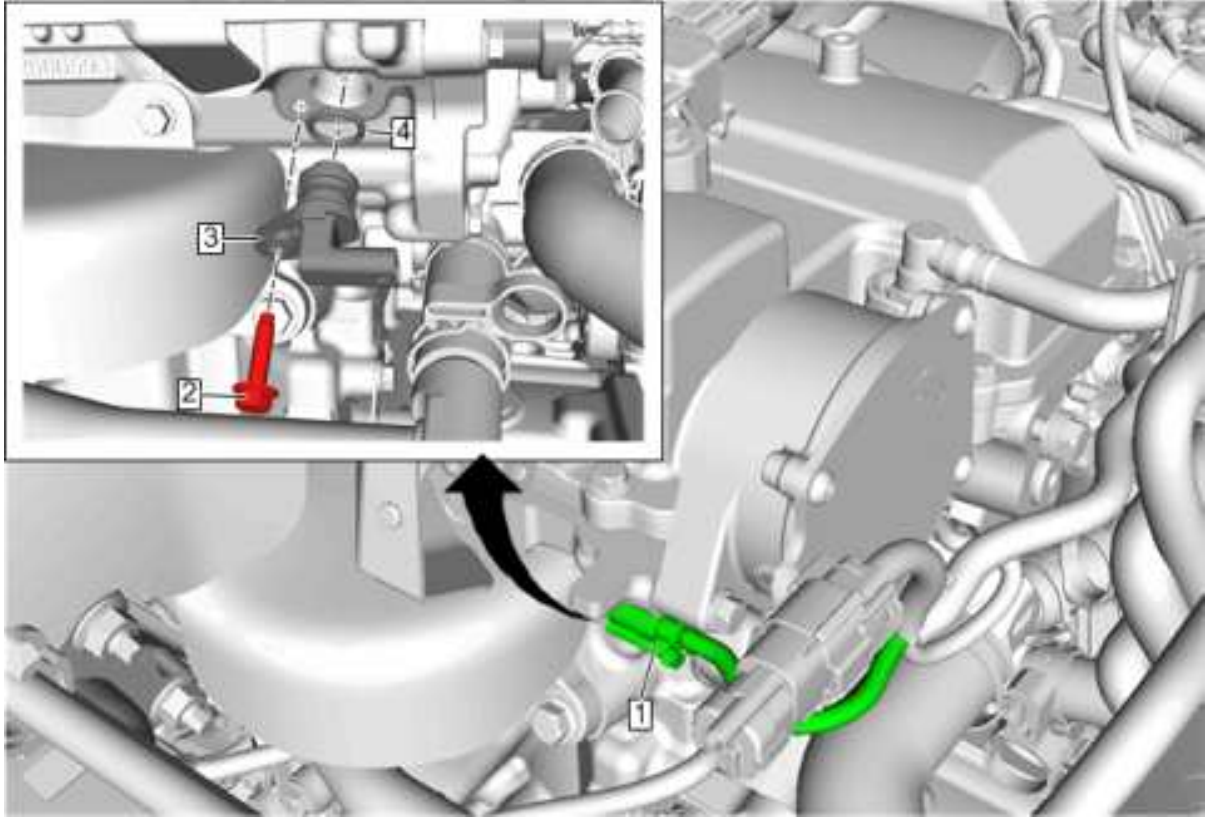

Fig. 200: Camshaft Position Sensor - Exhaust
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Intake Manifold Cover Replacement	
1	Electrical Connector
2	Camshaft Position Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
3	Camshaft Position Sensor
4	Camshaft Position Sensor Seal **Procedure** Install a NEW seal.

CAMSHAFT POSITION ACTUATOR EXHAUST SOLENOID VALVE REPLACEMENT

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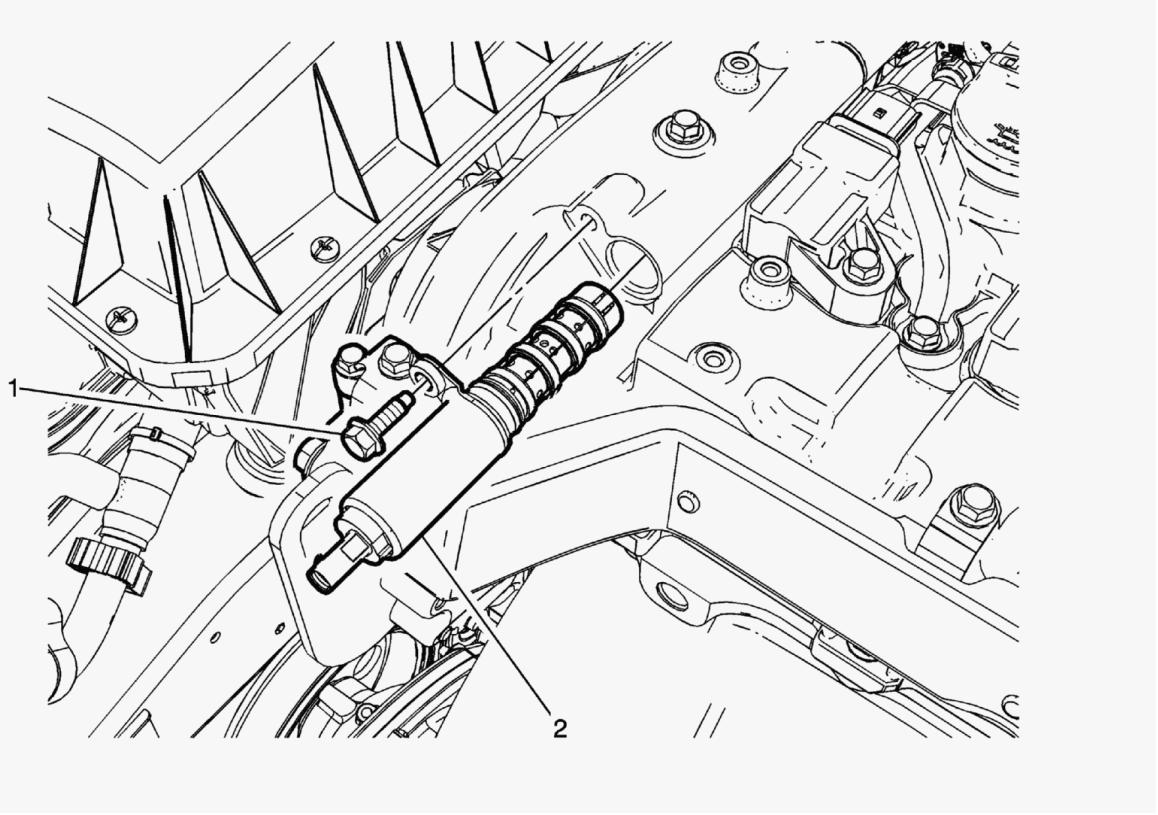

Fig. 201: Camshaft Position Actuator Exhaust Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Intake Manifold Cover Replacement 2. Disconnect the electrical connector.	
1	Camshaft Position Actuator Exhaust Solenoid Valve Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Actuator Exhaust Solenoid Valve **Procedure** If reusing the OLD solenoid valve, install a NEW seal. **NOTE:** **A NEW solenoid valve will come with a NEW seal.**

CAMSHAFT POSITION ACTUATOR INTAKE SOLENOID VALVE REPLACEMENT

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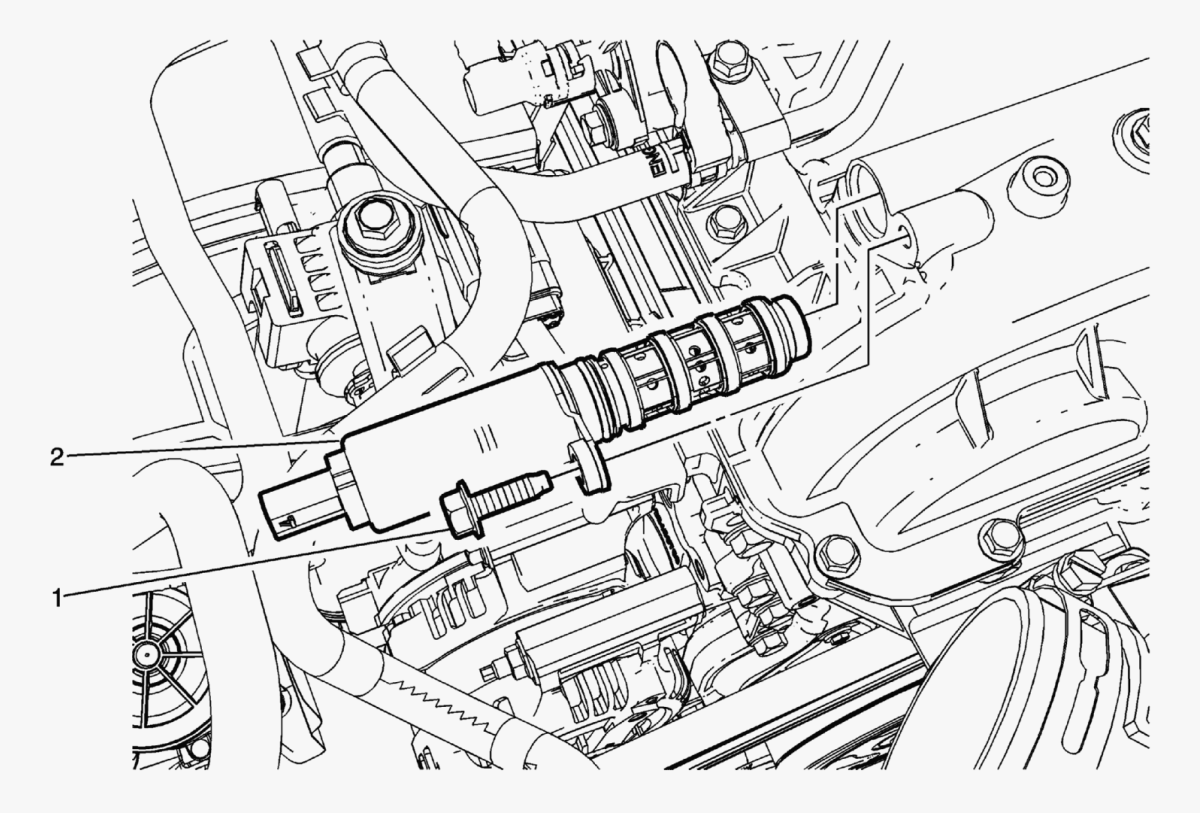

Fig. 202: Camshaft Position Actuator Intake Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Intake Manifold Cover Replacement 2. Disconnect the electrical connector.	
1	Camshaft Position Actuator Intake Solenoid Valve Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Actuator Intake Solenoid Valve **Procedure** If reusing the OLD solenoid valve, install a NEW seal. **NOTE:** **A NEW solenoid valve will come with a NEW seal.**

KNOCK SENSOR REPLACEMENT (POSITION 1)

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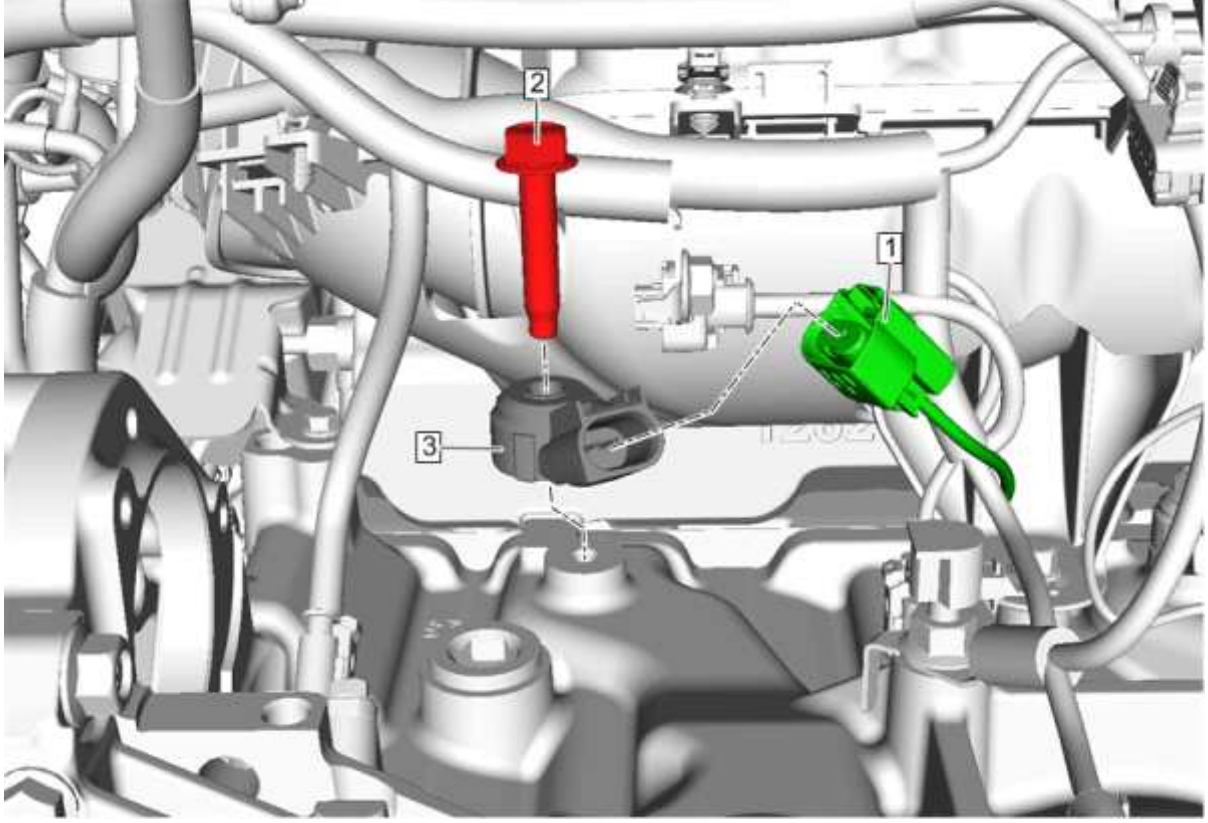

Fig. 203: Knock Sensor (Position 1)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Starter Replacement (LTG - All Wheel Drive) Starter Replacement (LTG - Front Wheel Drive)	
1	Electrical Connector
2	Knock Sensor Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
3	Knock Sensor

KNOCK SENSOR REPLACEMENT (POSITION 2)

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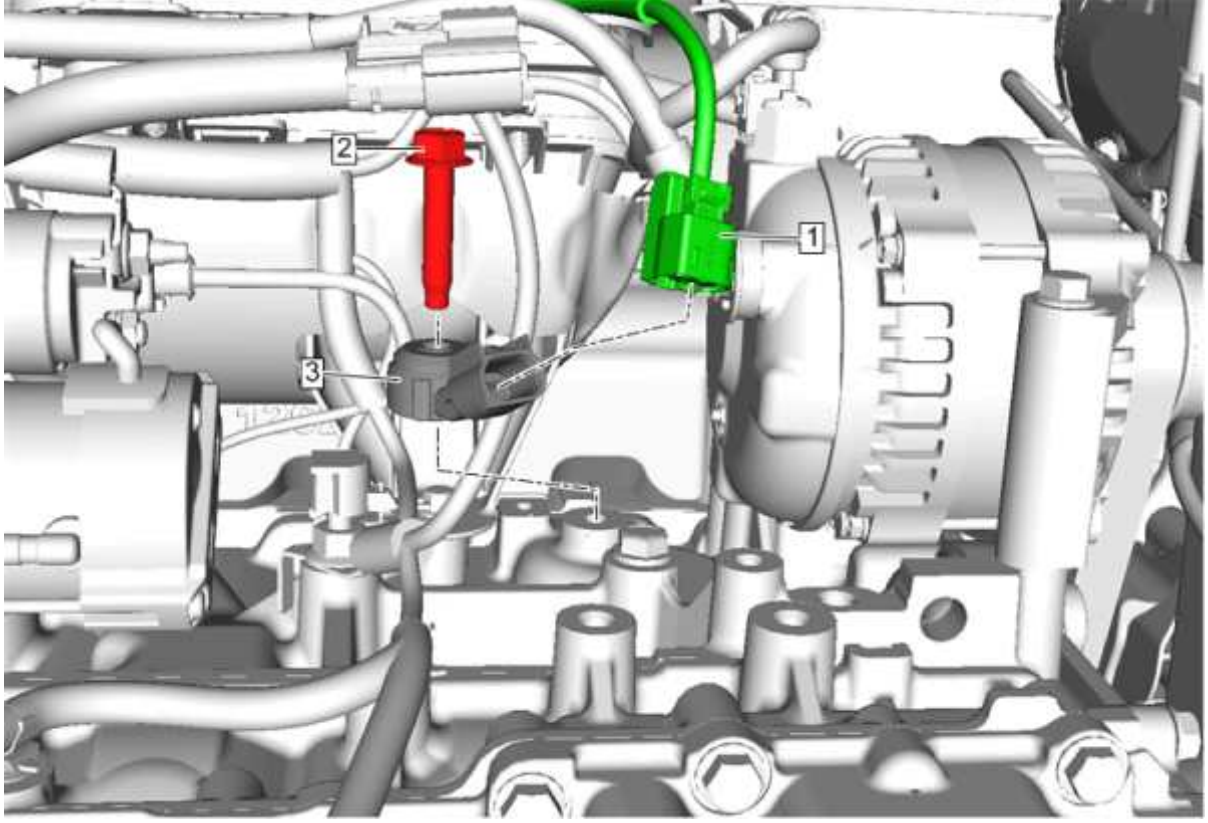

Fig. 204: Knock Sensor (Position 2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure { If equipped } Power Transfer Unit Case Replacement (M3D Transmission with LTG Engine)	
1	Electrical Connector
2	Knock Sensor Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
3	Knock Sensor

OIL PUMP FLOW CONTROL VALVE REPLACEMENT

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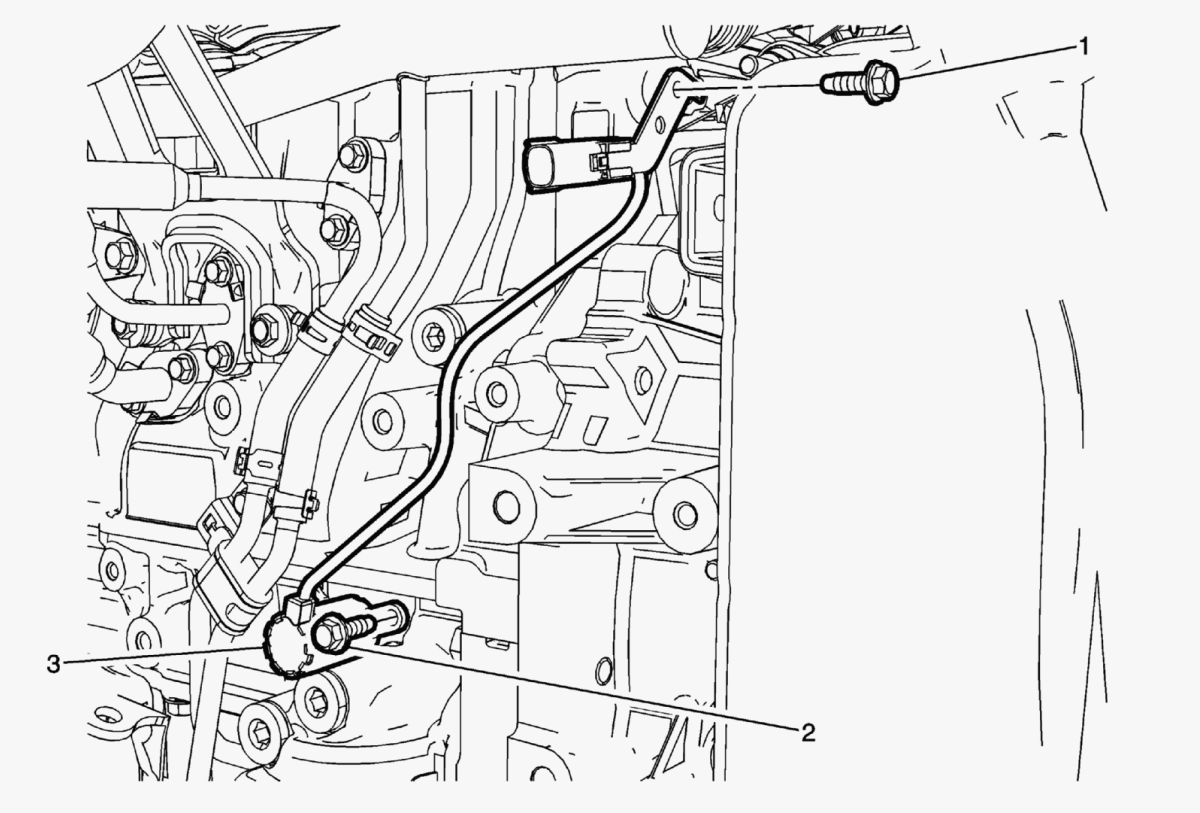

Fig. 205: Oil Pump Flow Control Valve (LTG)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Warm Up Three-Way Catalytic Converter Replacement (LTG) 2. Oil Pump Flow Control Valve Heat Shield Replacement	
1	Oil Pump Flow Control Valve Electrical Wiring Harness Connector Bracket Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Oil Pump Flow Control Valve Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
3	Oil Pump Flow Control Valve **Procedure** Disconnect the electrical wiring harness connector from the oil pump flow control valve.

OIL PUMP FLOW CONTROL VALVE HEAT SHIELD REPLACEMENT

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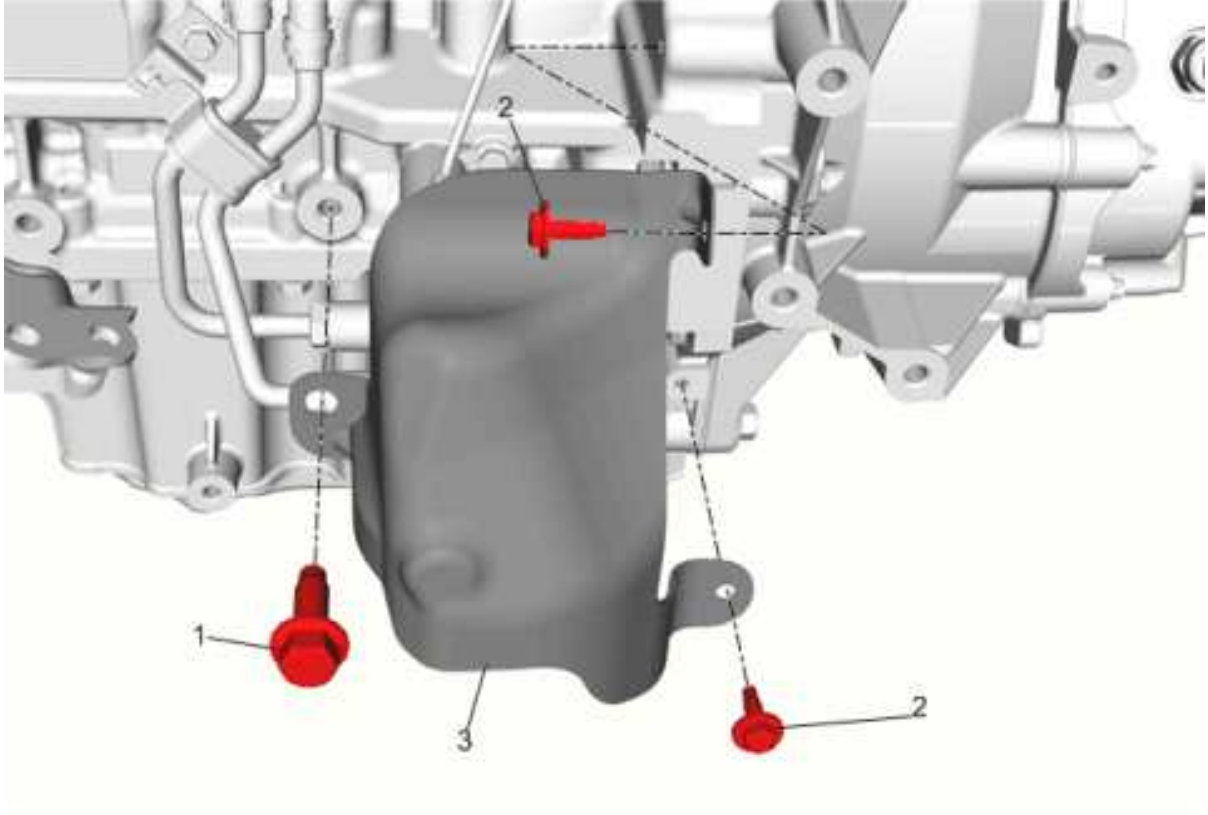

Fig. 206: Oil Pump Flow Control Valve Heat Shield Fasteners
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Warm Up Three-Way Catalytic Converter Replacement (LTG)	
1	Oil Pump Flow Control Valve Heat Shield Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 58 N.m (43 lb ft)
2	Pump and Component Oil Heat Shield Fasteners (Qty 2) **Tighten** 9 N.m (80 lb in)
3	Oil Pump Flow Control Valve Heat Shield

VACUUM PUMP REPLACEMENT

Removal Procedure

1. Remove Charge Air Cooler Outlet Air Tube - Charge Air Cooler Outlet Air Tube Replacement
2. Remove Intake Manifold Cover - Intake Manifold Cover Replacement
3. Disconnect Power Brake Booster Vacuum Pipe @ Vacuum Pump Assembly - Power Brake Booster Vacuum Pipe Replacement (LTG)

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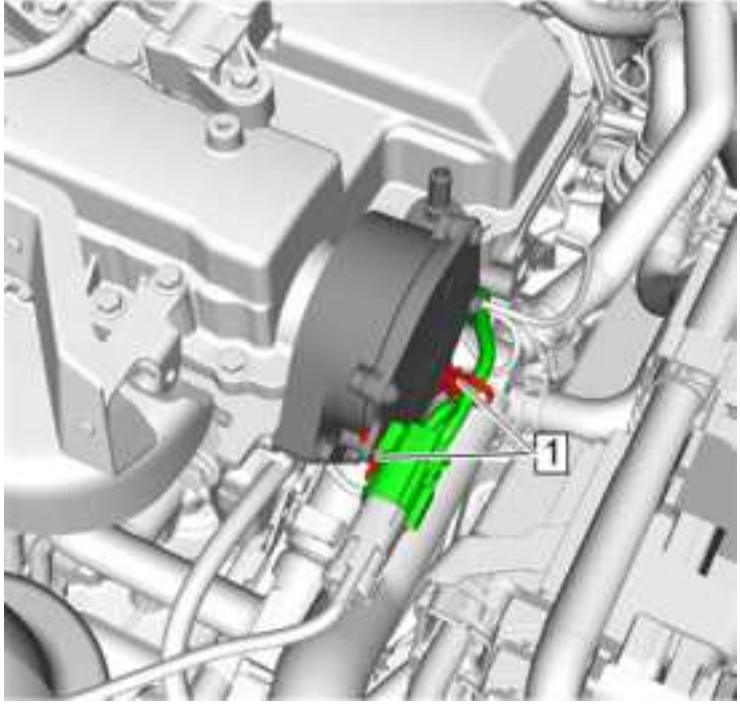

Fig. 207: Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Unclip Retainer (1) - [2x]
5. Disconnect Radiator Inlet Hose @ Water Outlet - **Radiator Inlet Hose Replacement (LTG with KL9)**

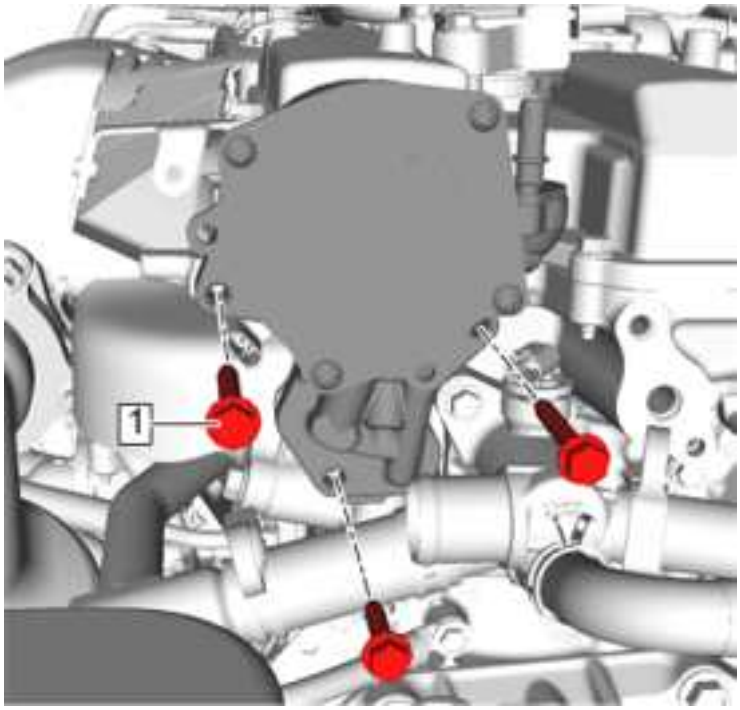

Fig. 208: Vacuum Pump Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove Vacuum Pump Bolt (1) - [3x]

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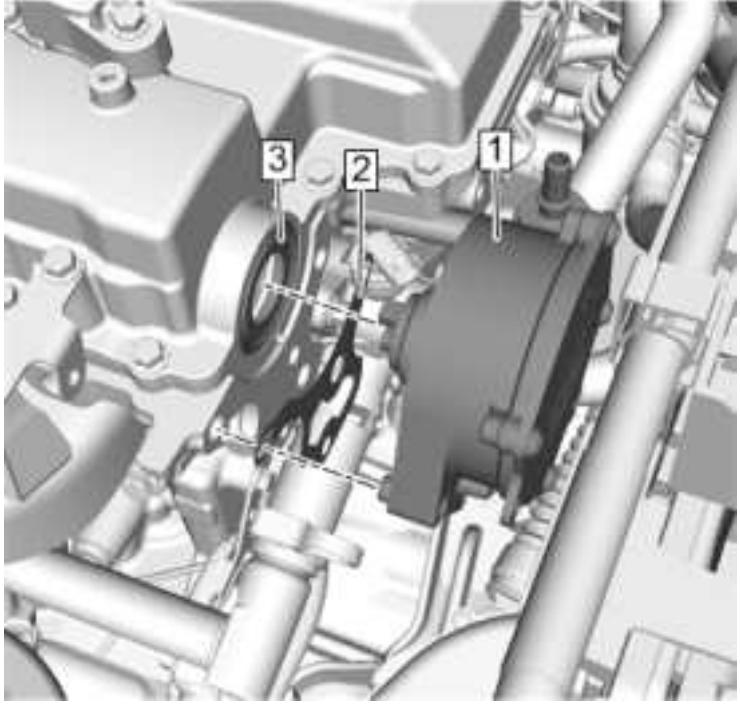

Fig. 209: Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

7. Remove Vacuum Pump (1).

NOTE: **Inspect the vacuum pump gasket and replace as necessary.**

8. Remove Vacuum Pump Gasket (2).

NOTE: **Inspect the vacuum pump seal and replace as necessary.**

9. Vacuum Pump Seal (3) - Lubricate the vacuum pump seal with clean engine oil. **Adhesives, Fluids, Lubricants, and Sealers**

Installation Procedure

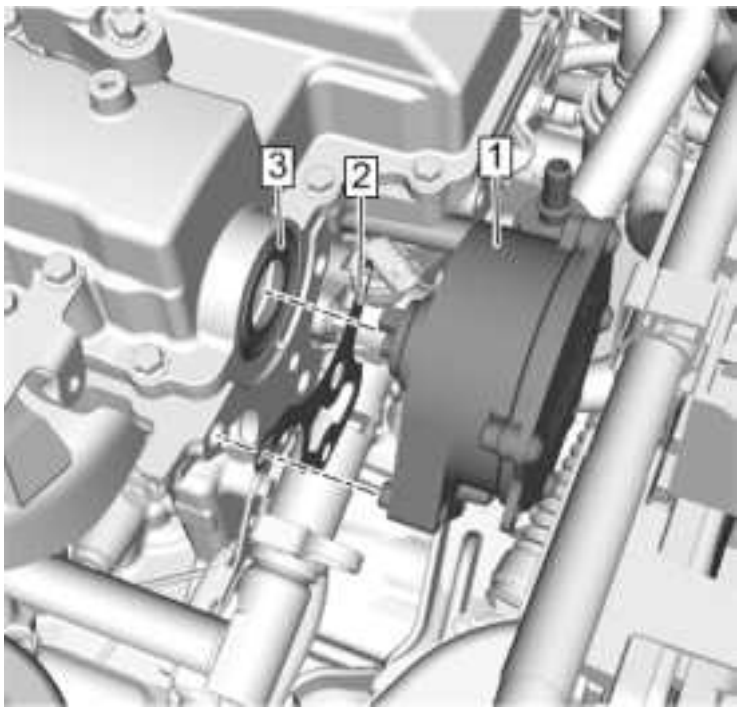

Fig. 210: Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

1. Install Vacuum Pump Gasket (2)
2. Install Vacuum Pump (1).

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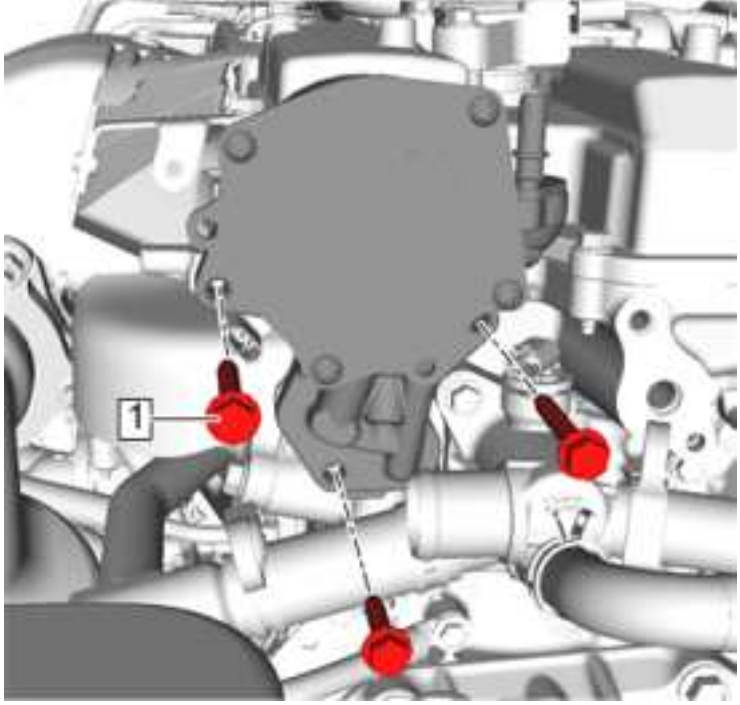

Fig. 211: Vacuum Pump Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install Vacuum Pump Bolt (1) and tighten [3x] 10 N.m (89 lb in)
4. Connect Radiator Inlet Hose @ Water Outlet - **Radiator Inlet Hose Replacement (LTG with KL9)**

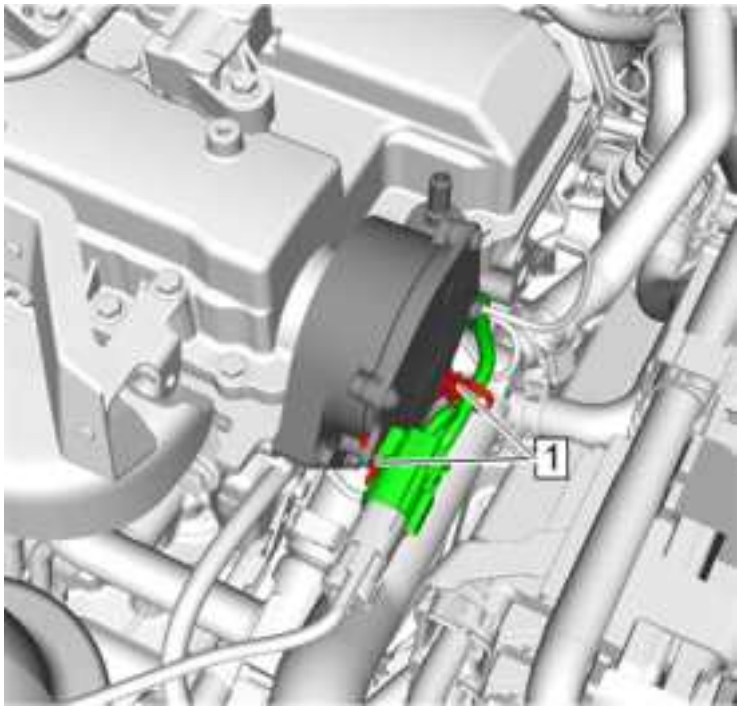

Fig. 212: Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Install Retainer (1) - [2x]
6. Connect Power Brake Booster Vacuum Pipe @ Vacuum Pump Assembly - **Power Brake Booster Vacuum Pipe Replacement (LTG)**
7. Install Intake Manifold Cover - **Intake Manifold Cover Replacement**
8. Install Charge Air Cooler Outlet Air Tube - **Charge Air Cooler Outlet Air Tube Replacement**

TURBOCHARGER WASTEGATE ACTUATOR REPLACEMENT

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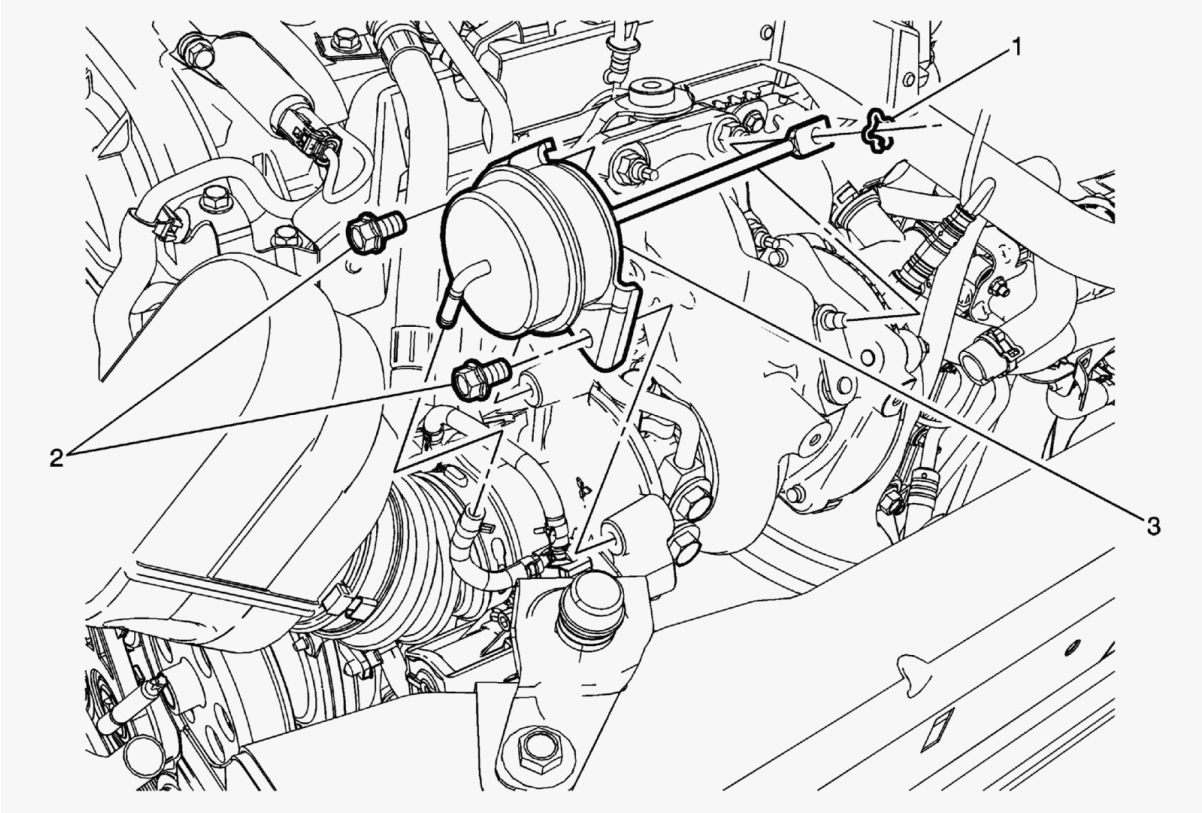

Fig. 213: Turbocharger Wastegate Actuator (LTG)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Air Cleaner Outlet Duct Replacement (Non-Tamperproof)Air Cleaner Outlet Duct Replacement (Tamperproof) 2. Turbocharger Heat Shield Replacement	
1	Turbocharger Wastegate Actuator Arm Retainer
2	Turbocharger Wastegate Actuator Fastener [2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 20 N.m (15 lb ft)
3	Turbocharger Wastegate Actuator **Procedure** Disconnect the vacuum line from the turbocharger wastegate actuator.

TURBOCHARGER WASTEGATE REGULATOR SOLENOID VALVE REPLACEMENT

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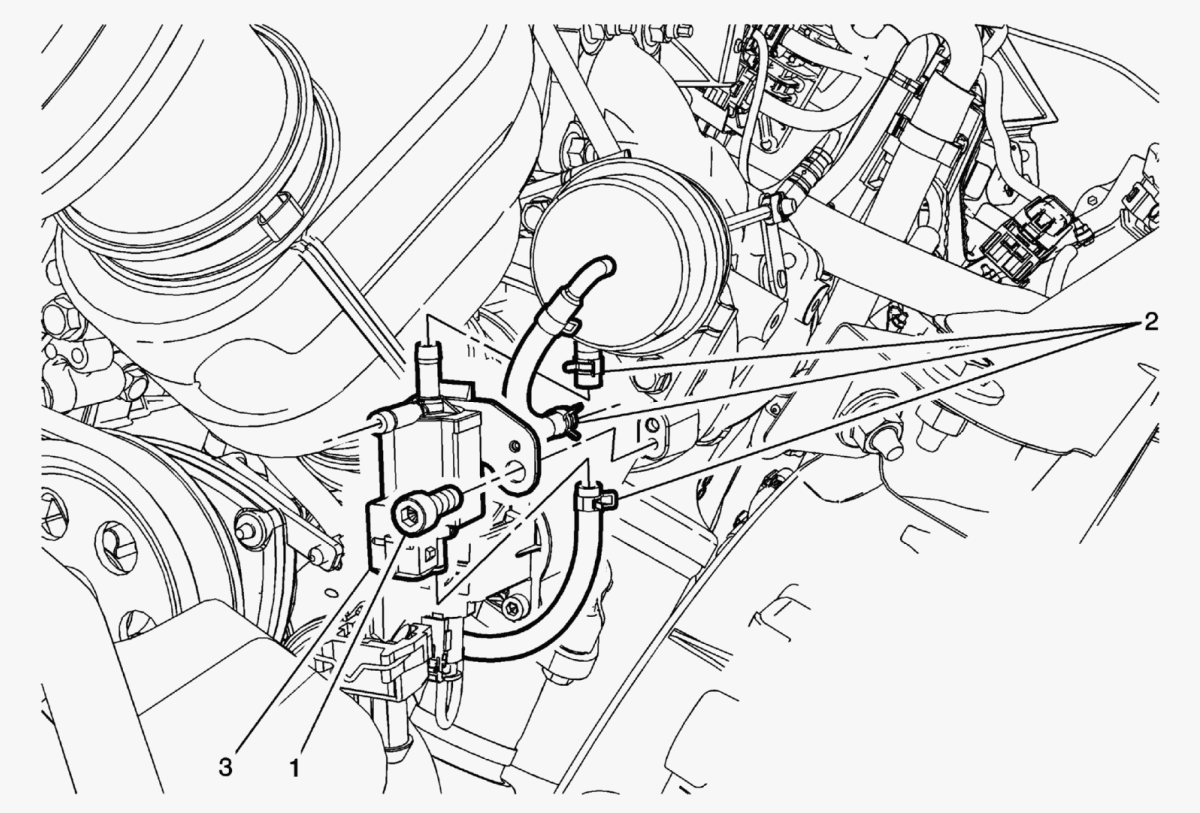

Fig. 214: Turbocharger Wastegate Regulator Solenoid Valve (LTG)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Air Cleaner Outlet Duct Replacement (Non-Tamperproof)Air Cleaner Outlet Duct Replacement (Tamperproof) 2. Disconnect the electrical connector.	
1	Turbocharger Wastegate Regulator Solenoid Valve Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 7.8 N.m (69 lb in)
2	Vacuum Hose [3x] Hose Clamp Replacement Guidelines - Spring Type
3	Turbocharger Wastegate Regulator Solenoid Valve **Procedure** Perform the intake system learned values reset. Intake System Learned Values Reset

TURBOCHARGER BYPASS VALVE SOLENOID REPLACEMENT

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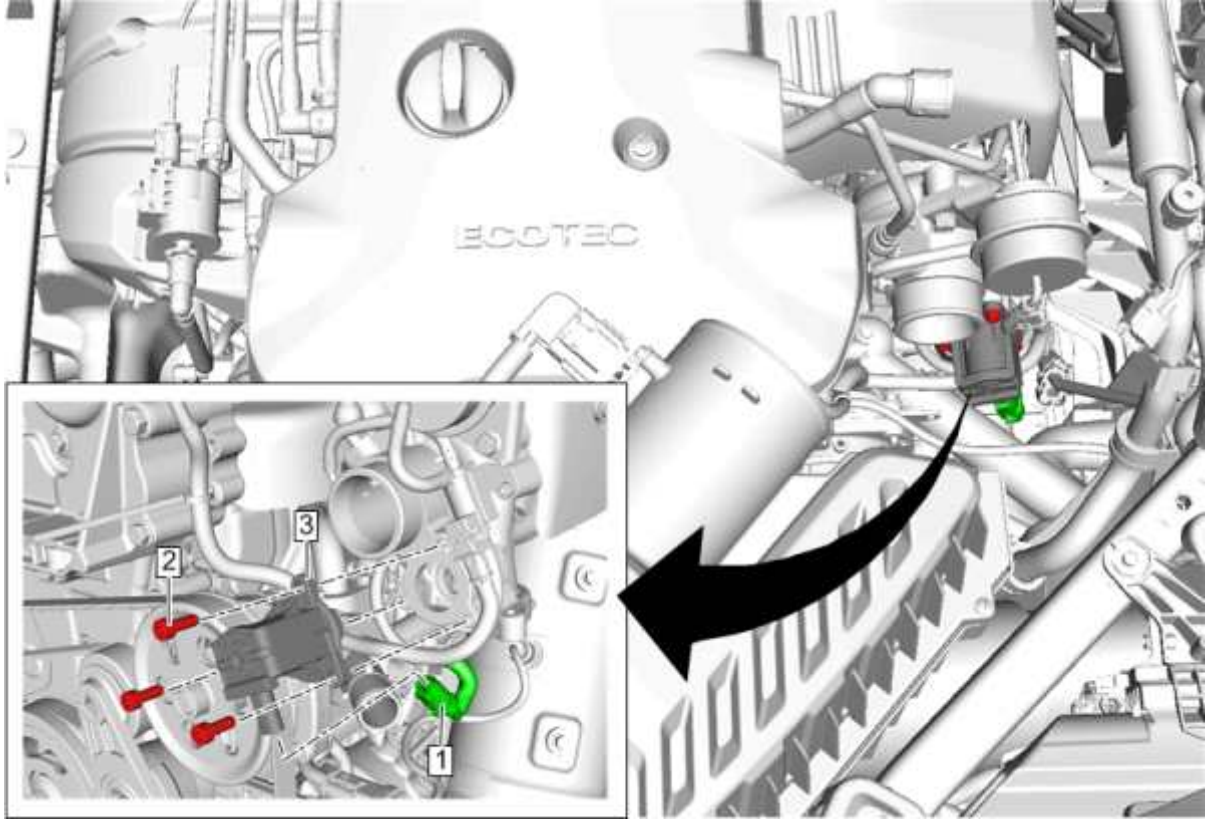

Fig. 215: Turbocharger Bypass Valve Solenoid
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Air Cleaner Outlet Duct Replacement (Non-Tamperproof)Air Cleaner Outlet Duct Replacement (Tamperproof)	
1	Electrical Connector
2	Turbocharger Bypass Valve Solenoid Bolt [3x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 7.8 N.m (69 lb in)
3	Turbocharger Bypass Valve Solenoid **Procedure** 1. The seal is reusable, inspect the seal and replace if damaged. 2. Perform the intake system learned values reset. Intake System Learned Values Reset

AIR CLEANER ELEMENT REPLACEMENT

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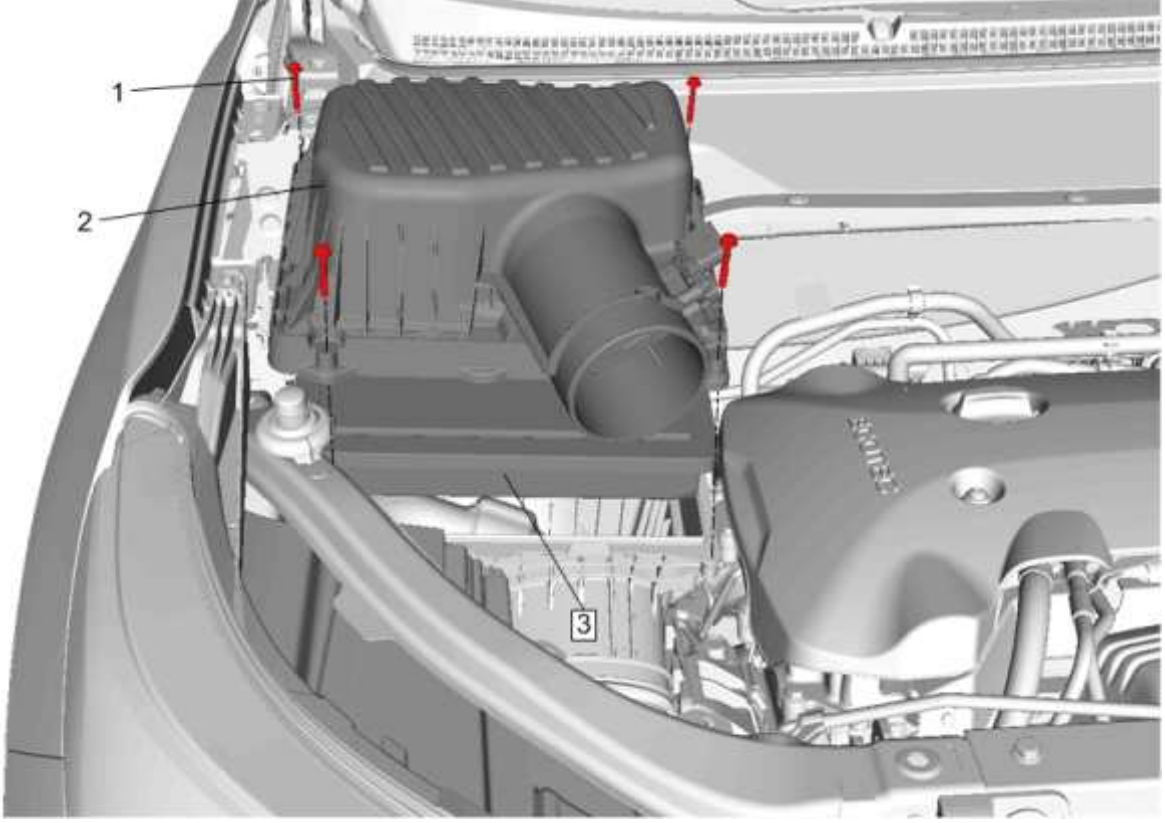

Fig. 216: Air Cleaner Element
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Air Cleaner Outlet Duct Replacement (Non-Tamperproof)Air Cleaner Outlet Duct Replacement (Tamperproof) 2. Disconnect the electrical connector.	
1	Air Cleaner Upper Housing Bolt [4x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 4 N.m (35 lb in)
2	Air Cleaner Upper Housing
3	Air Cleaner Element

AIR CLEANER ASSEMBLY REPLACEMENT

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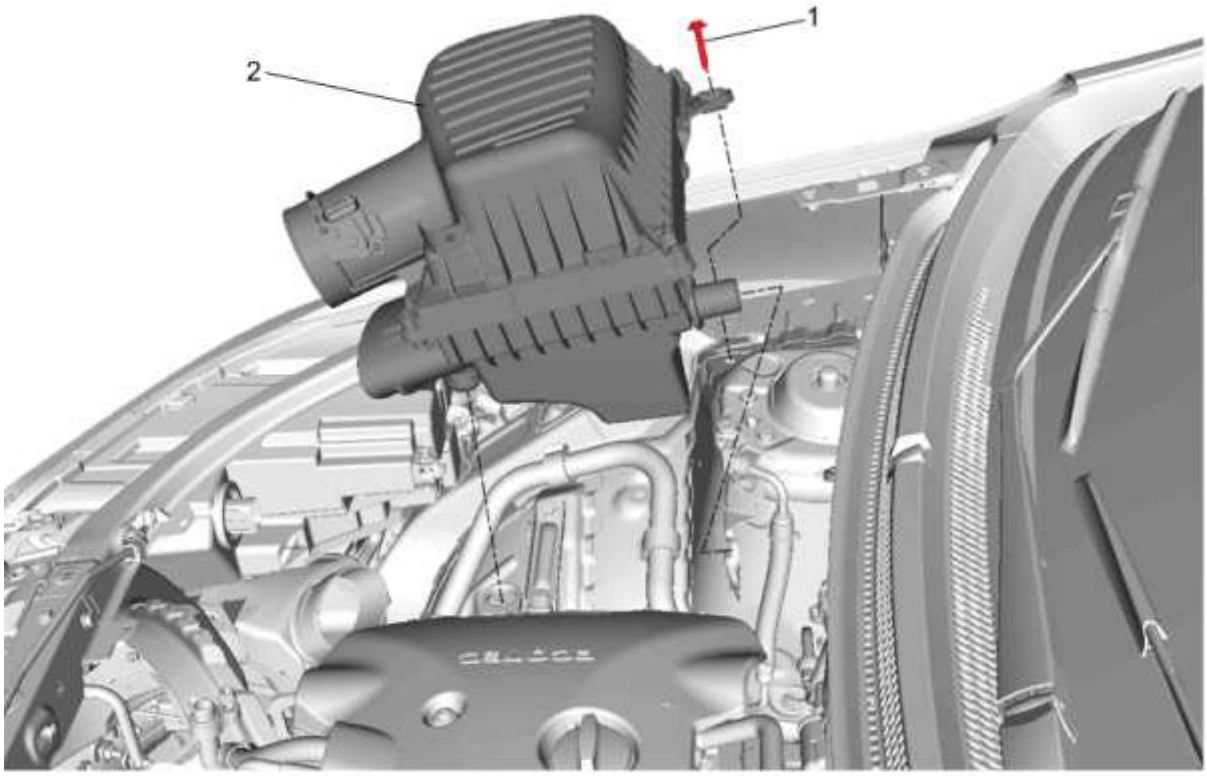

Fig. 217: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Air Cleaner Outlet Duct Replacement (Non-Tamperproof)Air Cleaner Outlet Duct Replacement (Tamperproof) 2. Intake Air Duct Replacement 3. Disconnect the electrical connector. 4. Disconnect the mass airflow sensor 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 OUTLET DUCT REPLACEMENT (NON-TAMPERPROOF)

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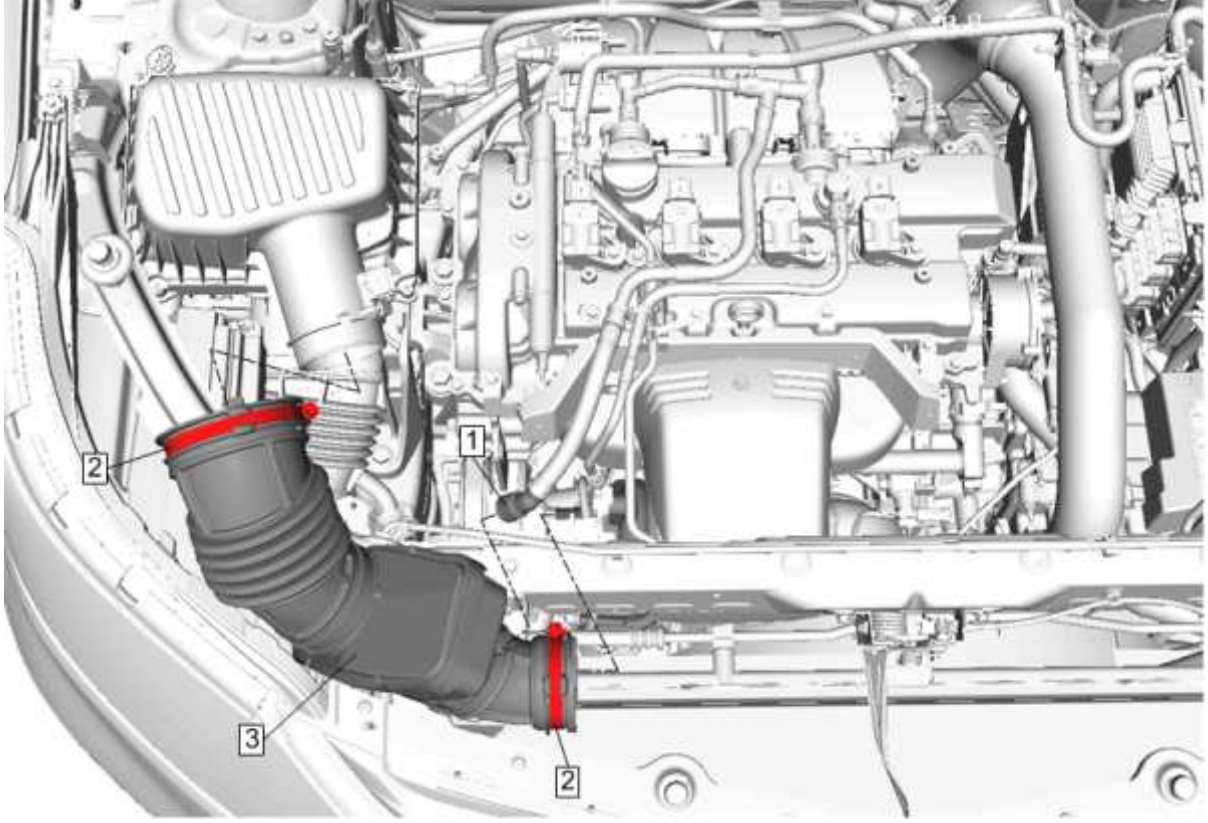

Fig. 218: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Positive Crankcase Ventilation Tube **Procedure** Remove Positive Crankcase Ventilation Tube - **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Inlet)**
2	Air Cleaner Outlet Duct Clamp [2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 3.5 N.m (31 lb in)
3	Air Cleaner Outlet Duct

AIR CLEANER OUTLET DUCT REPLACEMENT (TAMPERPROOF)

Removal Procedure

1. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**

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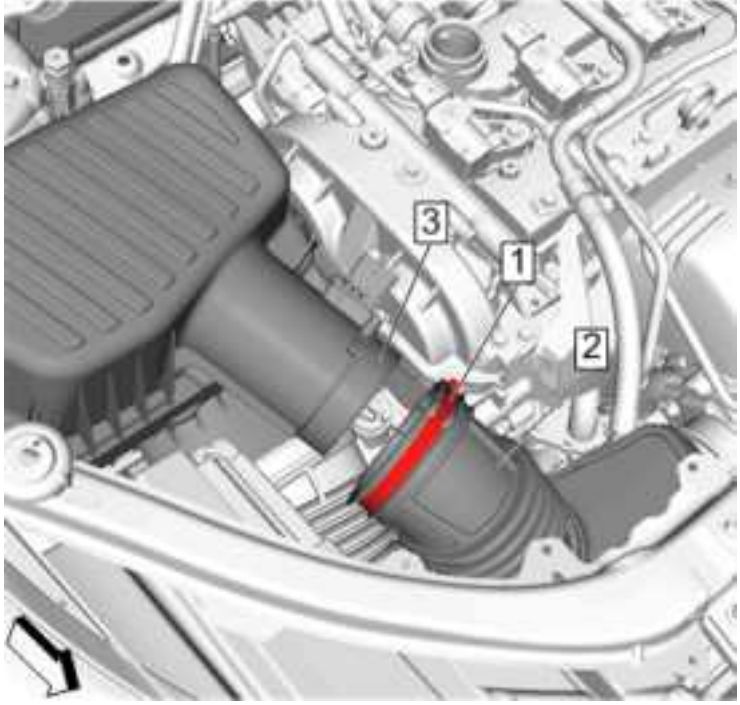

Fig. 219: Air Cleaner Outlet Duct, Clamp And Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Loosen Air Cleaner Outlet Duct Clamp (1)
3. Remove Air Cleaner Outlet Duct (2) @ Air Cleaner Assembly (3)

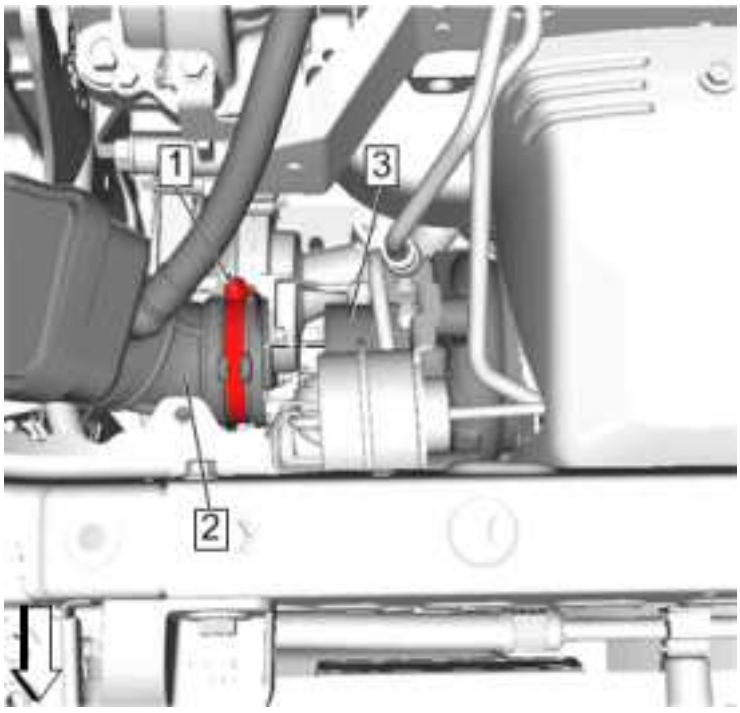

Fig. 220: Air Cleaner Outlet Duct Clamp And Turbocharger Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Loosen Air Cleaner Outlet Duct Clamp (1).
5. Remove Air Cleaner Outlet Duct (2) @ Turbocharger Assembly (3).

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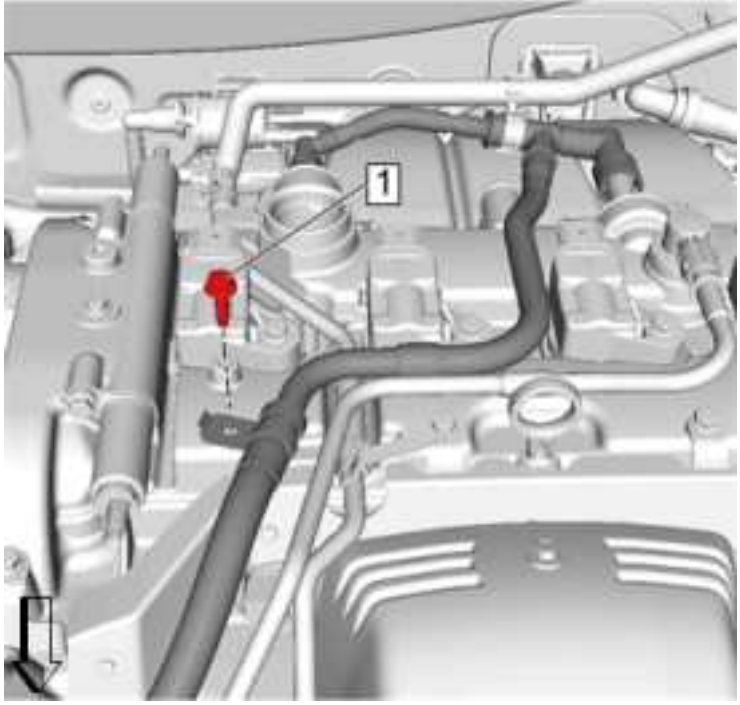

Fig. 221: Positive Crankcase Ventilation Tube Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Due to the PCV tamper-resistant connections, the air cleaner outlet duct must be repositioned during repair. Do NOT damage the tamper-resistant connections.**

6. Remove Positive Crankcase Ventilation Tube Bolt (1) - **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Inlet)**

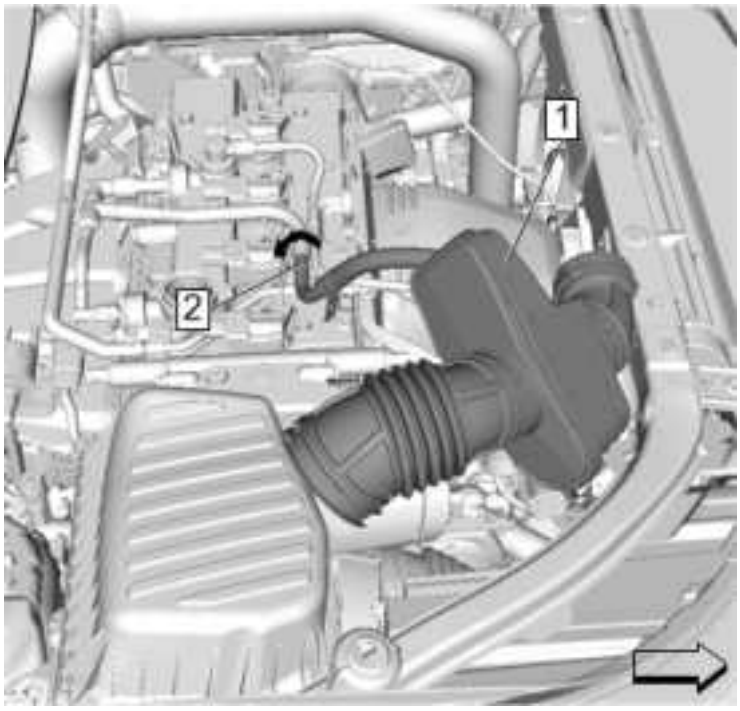

Fig. 222: Air Cleaner Outlet Duct And PCV Tube's Pivot Joint
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The PCV tube's connections are tamperproof and cannot be disconnected.**

7. Rotate the air cleaner outlet duct (1) at the PCV tube's pivot joint (2).

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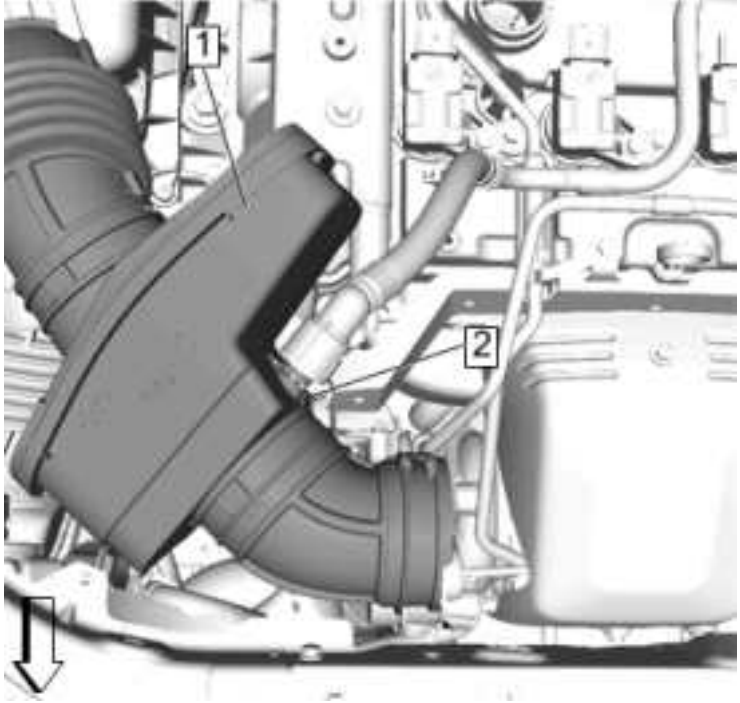

Fig. 223: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

8. Only when replacing the air cleaner outlet duct (1) with NEW can the air cleaner outlet duct nipple be cut. Use a suitable tool to cut the air cleaner outlet duct nipple marked by the dashed line (2). Remove air cleaner outlet duct from vehicle and discard.

Fig. 224: PCV Valve Tangs And PCV Tube
Courtesy of GENERAL MOTORS COMPANY

9. Using suitable tools, release the PCV valve tangs (1) while pulling the remaining PCV tube (2) from the PCV hose and discard.

Installation Procedure

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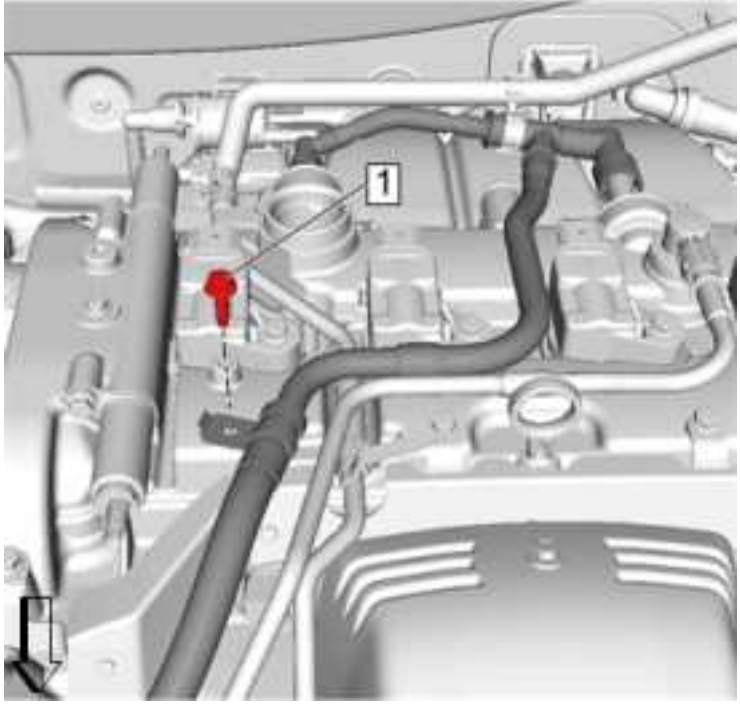

Fig. 225: Positive Crankcase Ventilation Tube Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Reposition PVC tube.

CAUTION: **Refer to Fastener Caution .**

2. Install Positive Crankcase Ventilation Tube Bolt (1) - **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Inlet)**

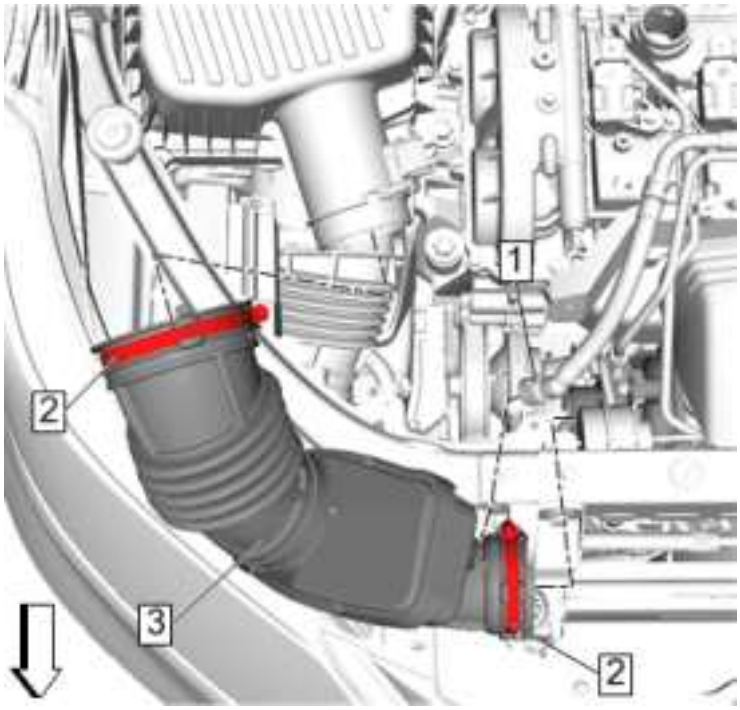

Fig. 226: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the outlet duct is fully seated to the mating surfaces before clamping. Verify that the cuff is not rolled under.**

3. Install Air Cleaner Outlet Duct (3).
4. Install Air Cleaner Outlet Duct Clamp (2) and tighten [2x] 3.5 N.m (31 lb in)
5. Connect Positive Crankcase Ventilation Tube (1) @ Air Cleaner Outlet Duct (3).
6. Install Intake Manifold Cover - **Intake Manifold Cover Replacement**

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INTAKE AIR BAFFLE REPLACEMENT

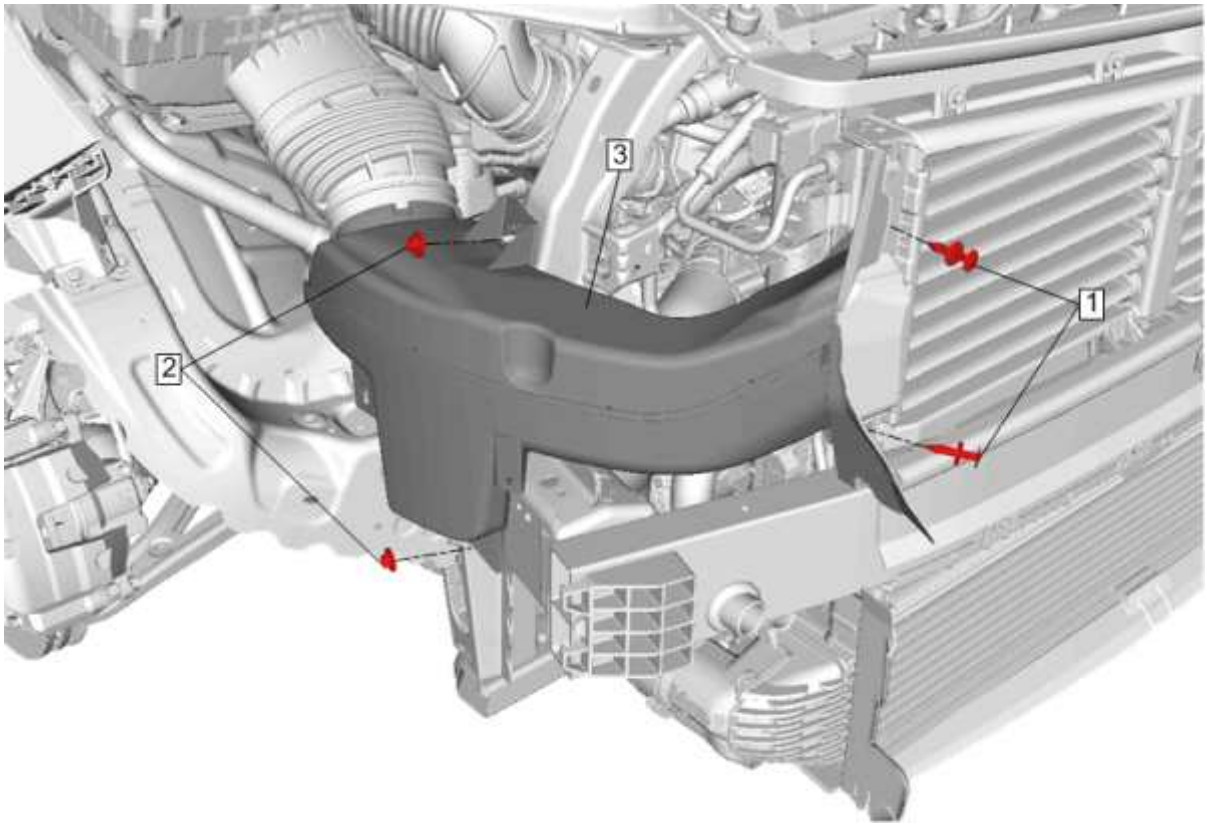

Fig. 227: Intake Air Baffle
Courtesy of GENERAL MOTORS COMPANY

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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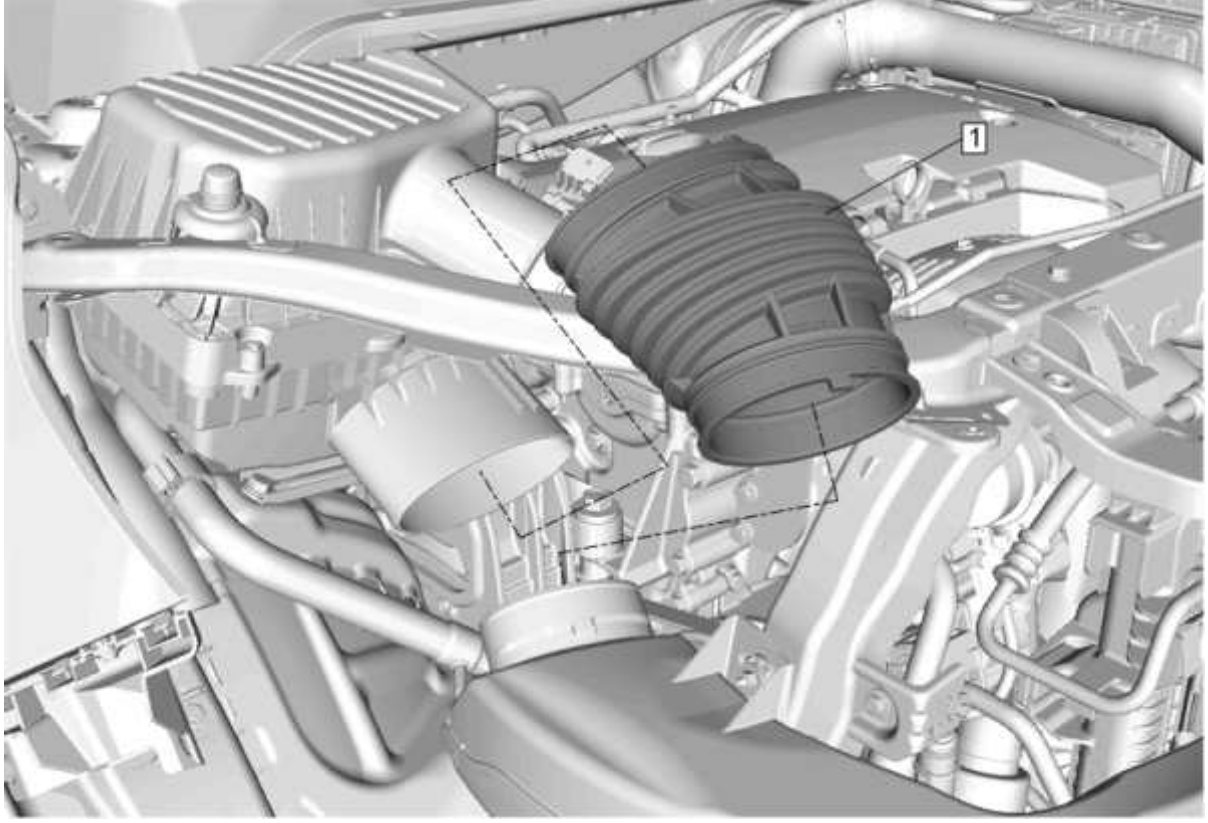

Fig. 228: Intake Air Duct
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Air Cleaner Outlet Duct Replacement (Non-Tamperproof)Air Cleaner Outlet Duct Replacement (Tamperproof)	
1	Intake Air Duct **Procedure** Perform the intake system learned values reset. Intake System Learned Values Reset

CHARGE AIR COOLER OUTLET AIR TUBE REPLACEMENT

Removal Procedure

1. Remove Front Bumper Fascia - Front Bumper Fascia Replacement (Equinox) Front Bumper Fascia Replacement (Terrain)
2. Remove Intake Air Pressure and Temperature Sensor - Intake Air Pressure and Temperature Sensor Replacement
3. Remove Engine Coolant Air Bleed Hose @ Charge Air Cooler Outlet Air Tube - Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)

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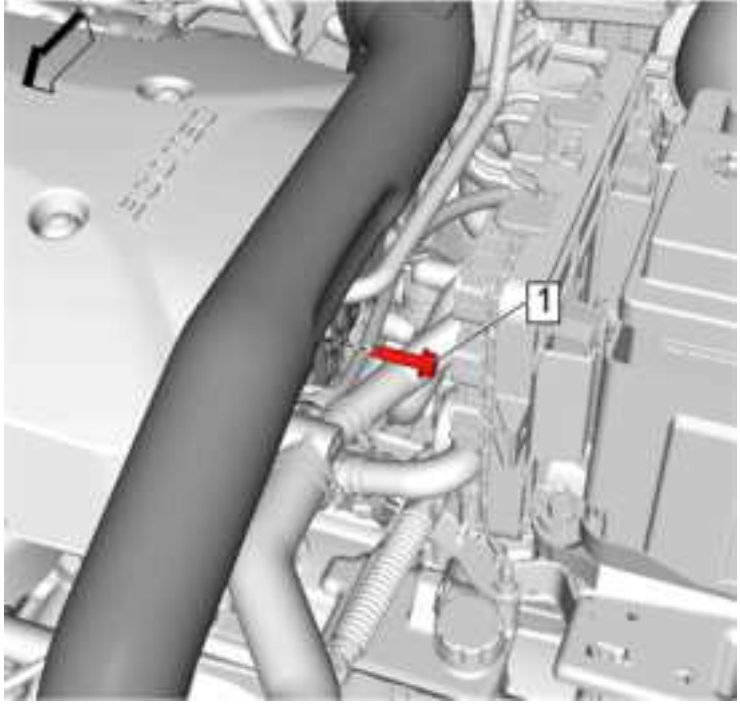

Fig. 229: Charge Air Cooler Outlet Air Tube Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove Charge Air Cooler Outlet Air Tube Bolt (1)

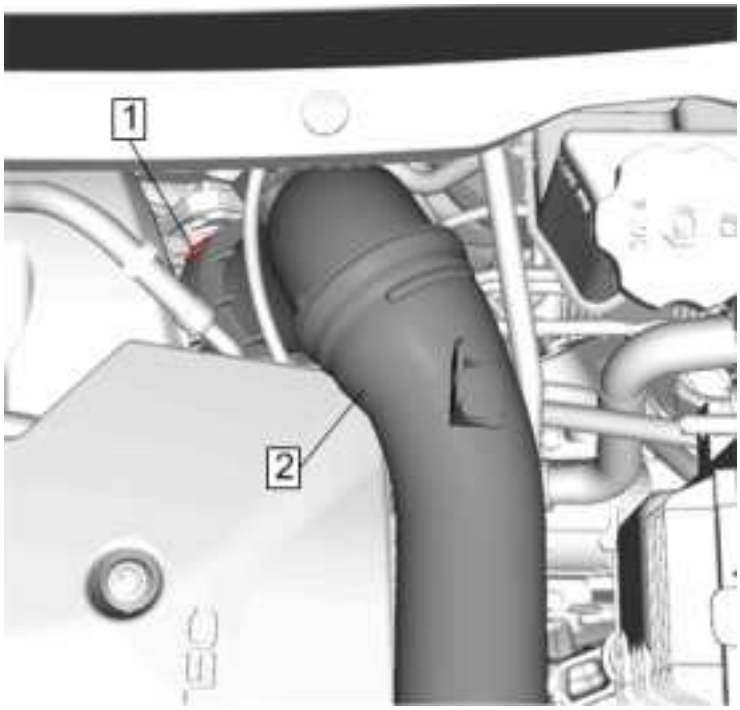

Fig. 230: Retainer Spring And Charge Air Cooler Outlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

5. Release Retainer Spring (1).
6. Remove Charge Air Cooler Outlet Air Tube (2)

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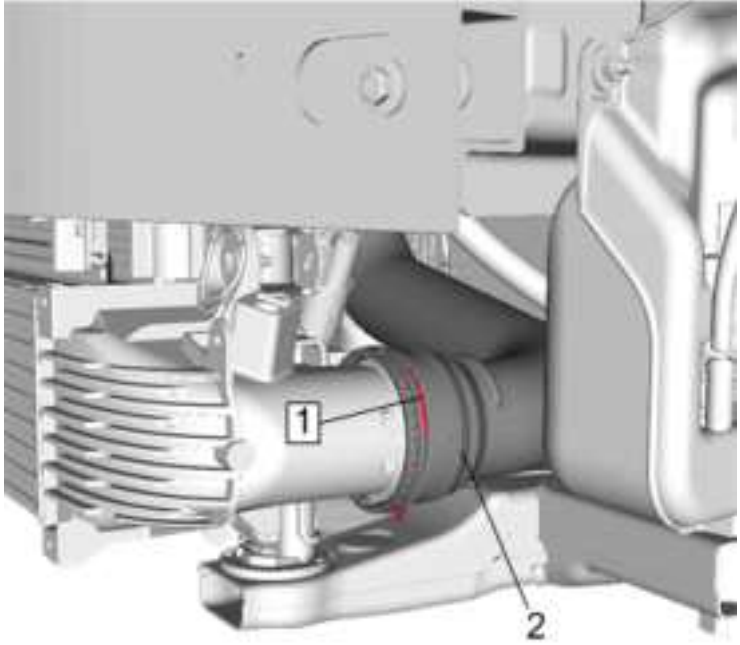

Fig. 231: Retainer Spring And Charge Air Cooler Outlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

7. Release Retainer Spring (1)
8. Remove Charge Air Cooler Outlet Air Tube (2)

Installation Procedure

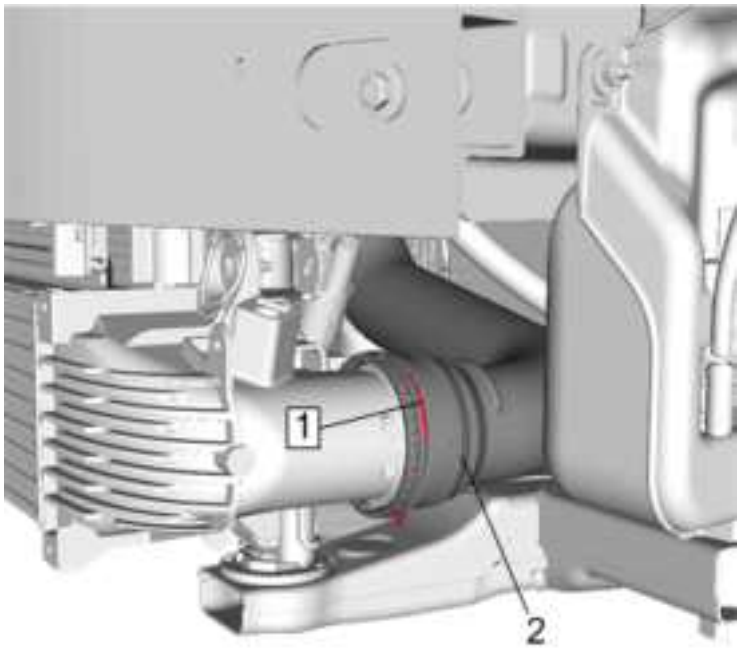

Fig. 232: Retainer Spring And Charge Air Cooler Outlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

1. Install Charge Air Cooler Outlet Air Tube (2).
2. Engage Retainer Spring (1)

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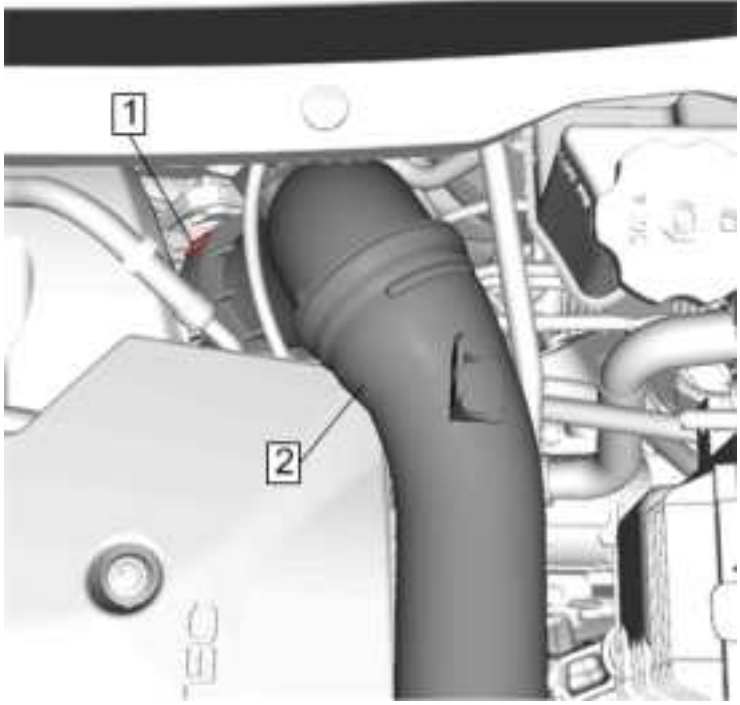

Fig. 233: Retainer Spring And Charge Air Cooler Outlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

3. Install Charge Air Cooler Outlet Air Tube (1).
4. Engage Retainer Spring (1)

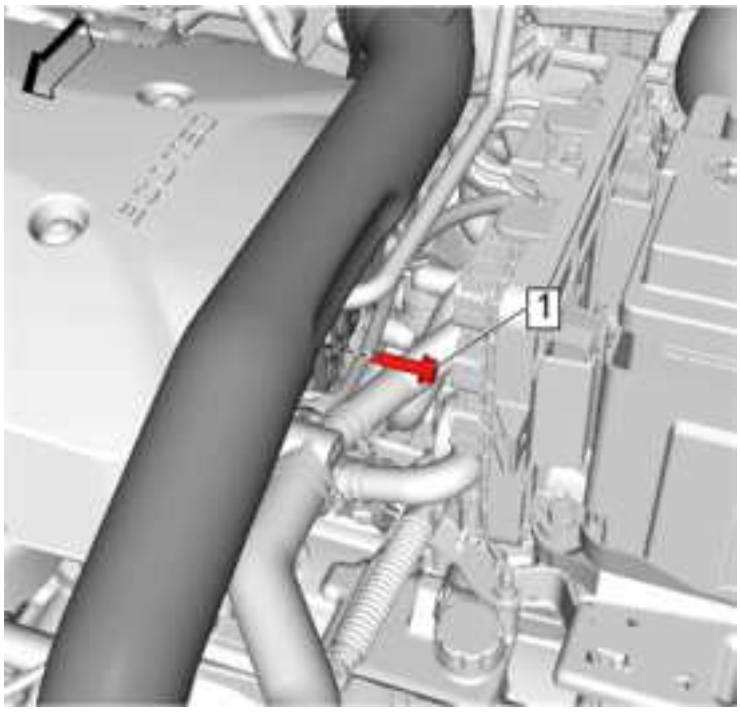

Fig. 234: Charge Air Cooler Outlet Air Tube Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install Charge Air Cooler Outlet Air Tube Bolt (1) and tighten 9 N.m (80 lb in)
6. Install Engine Coolant Air Bleed Hose @ Charge Air Cooler Outlet Air Tube - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)**
7. Install Intake Air Pressure and Temperature Sensor - **Intake Air Pressure and Temperature Sensor Replacement**
8. Install Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

CHARGE AIR COOLER INLET AIR TUBE REPLACEMENT

Removal Procedure

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1. Remove Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

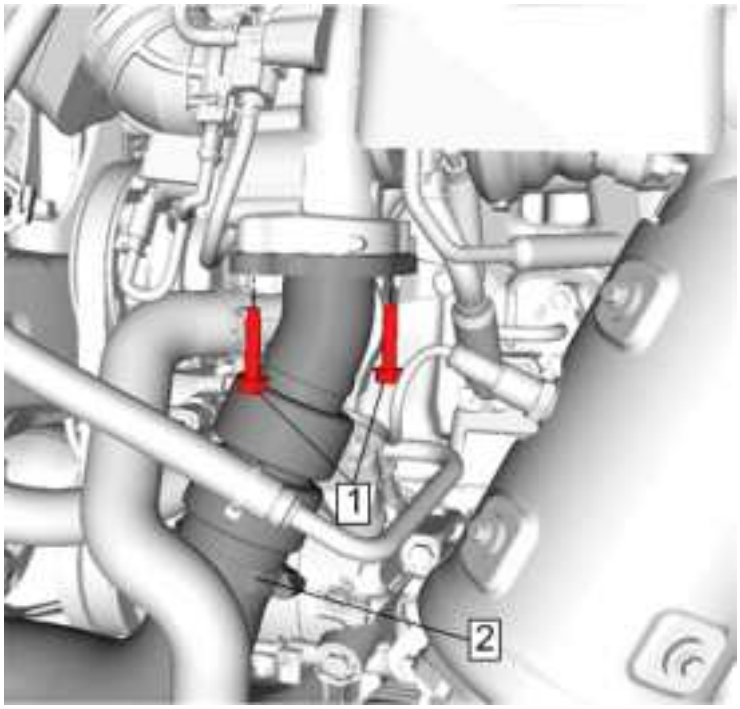

Fig. 235: Charge Air Cooler Inlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

2. Remove Charge Air Cooler Inlet Air Tube Bolt (1) - [2x]
3. Remove Charge Air Cooler Inlet Air Tube (2).

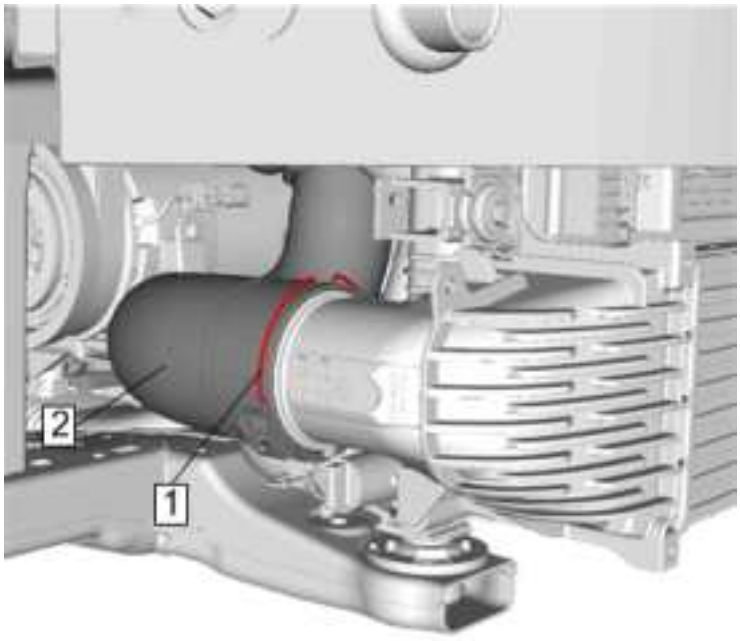

Fig. 236: Retainer Spring And Charge Air Cooler Inlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

4. Release Retainer Spring (1)
5. Remove Charge Air Cooler Inlet Air Tube (2)

Installation Procedure

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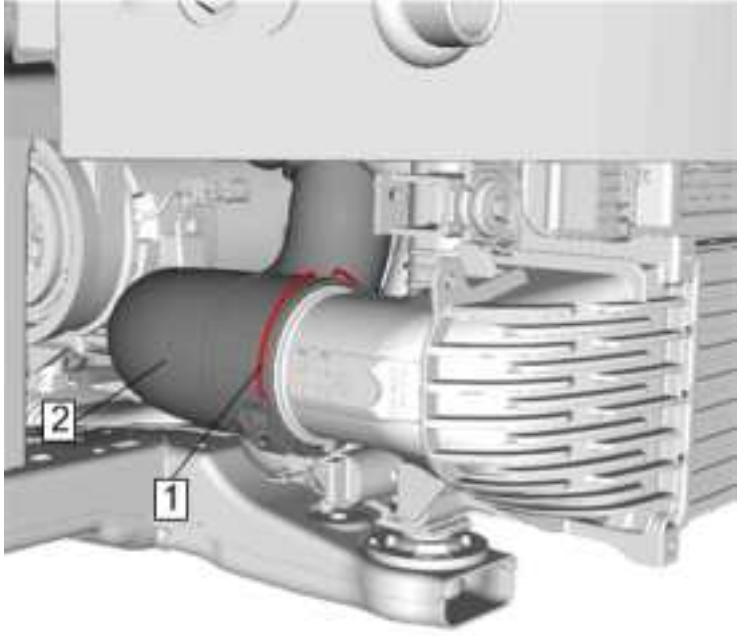

Fig. 237: Retainer Spring And Charge Air Cooler Inlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

1. Install Charge Air Cooler Inlet Air Tube (2)
2. Engage Retainer Spring (1)

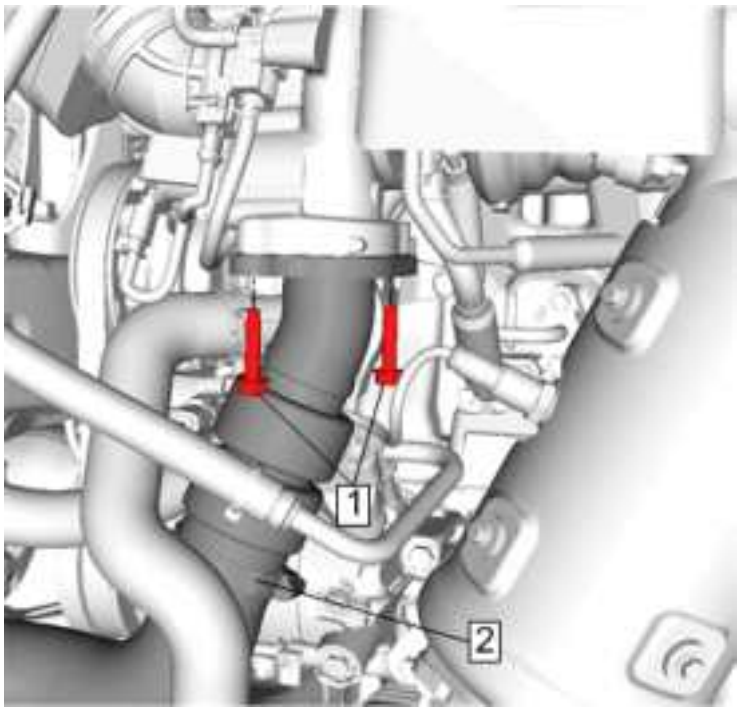

Fig. 238: Charge Air Cooler Inlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

3. Install Charge Air Cooler Inlet Air Tube (2)

CAUTION: **Refer to Fastener Caution .**

4. Install Charge Air Cooler Inlet Air Tube Bolt (1) [2x] 22 N.m (16 lb ft)
5. Install Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

CHARGE AIR COOLER REPLACEMENT

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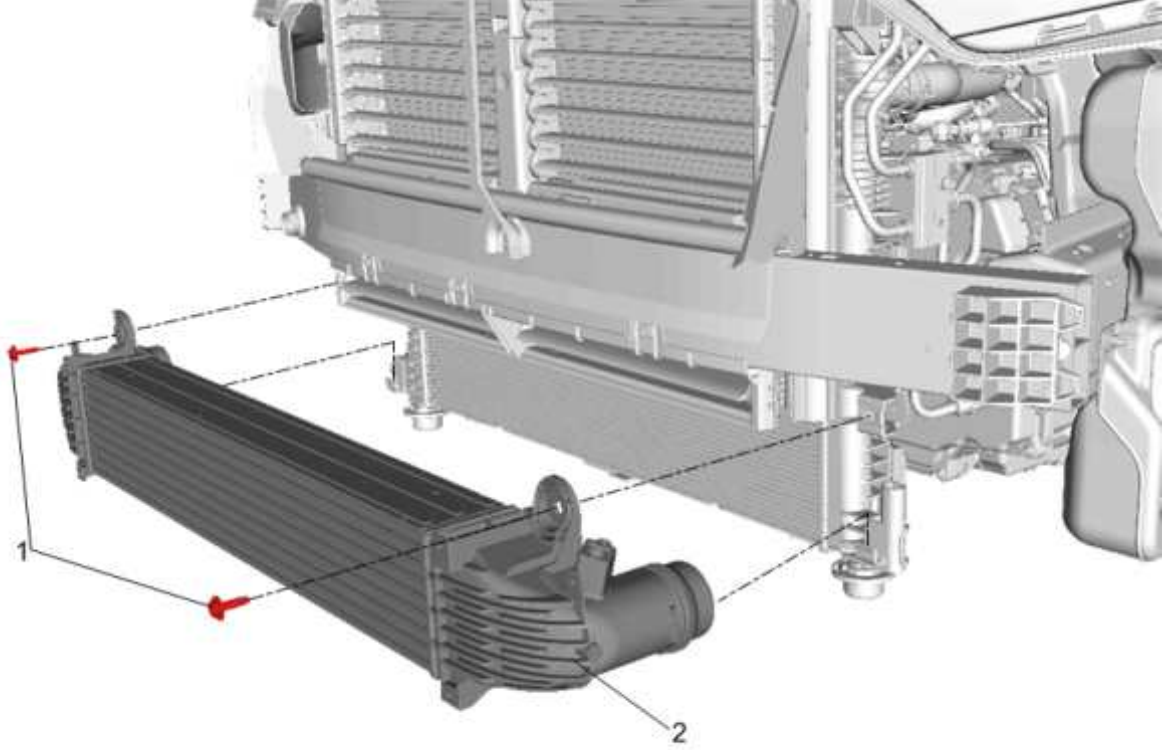

Fig. 239: Charge Air Cooler
Courtesy of GENERAL MOTORS COMPANY

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	
1	Charge Air Cooler Bolt [2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Charge Air Cooler

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Back To Article

2018 ENGINE PERFORMANCE

Engine Controls And Fuel - 2.0L (LTG) - Schematic And Routing Diagrams - Engine Controls Schematics - Equinox & Terrain

SCHEMATIC WIRING DIAGRAMS

ENGINE CONTROLS WIRING SCHEMATICS 2.0L (LTG)

Power, Ground, Serial Data, and MIL

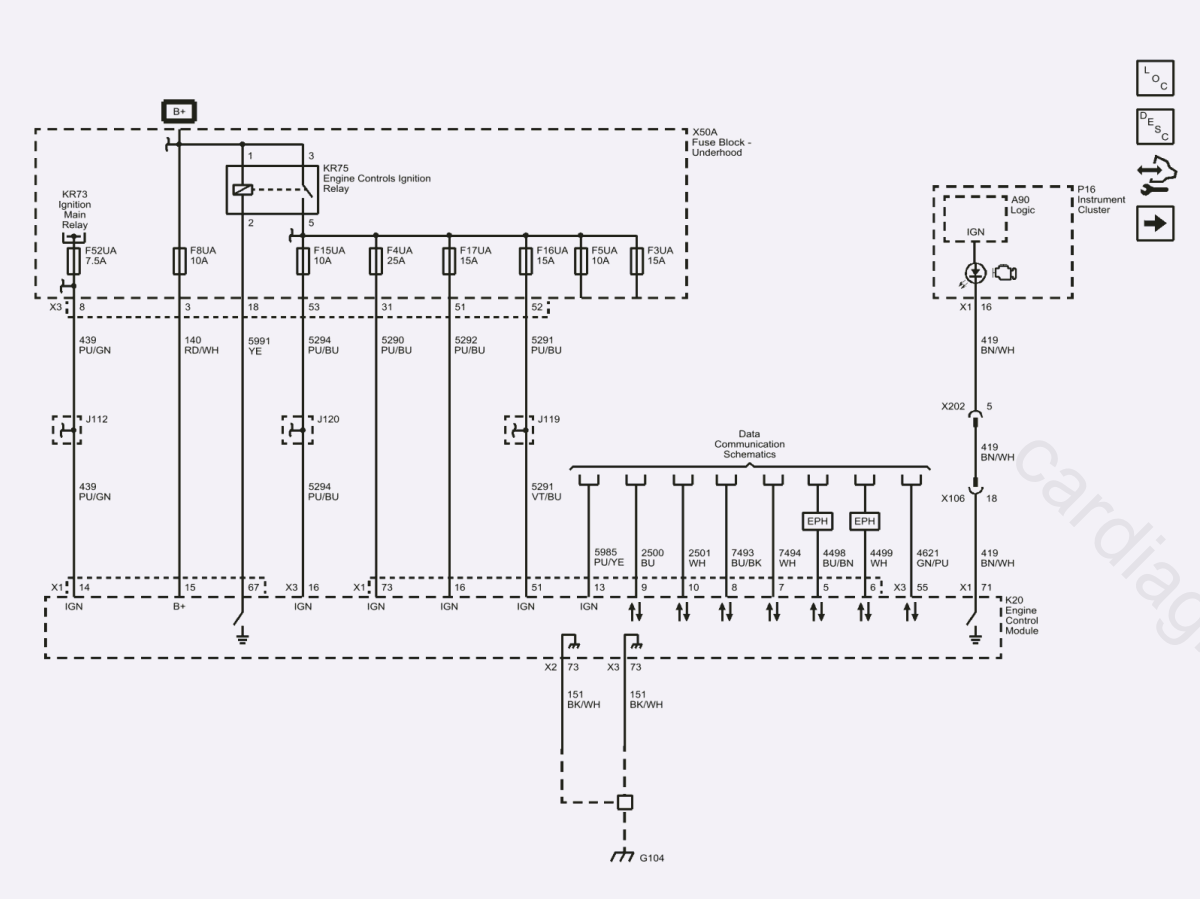

Fig. 1: Power, Ground, Serial Data, and MIL
Courtesy of GENERAL MOTORS COMPANY

5V1, 5V2, and Low Reference Bus (1 of 3)

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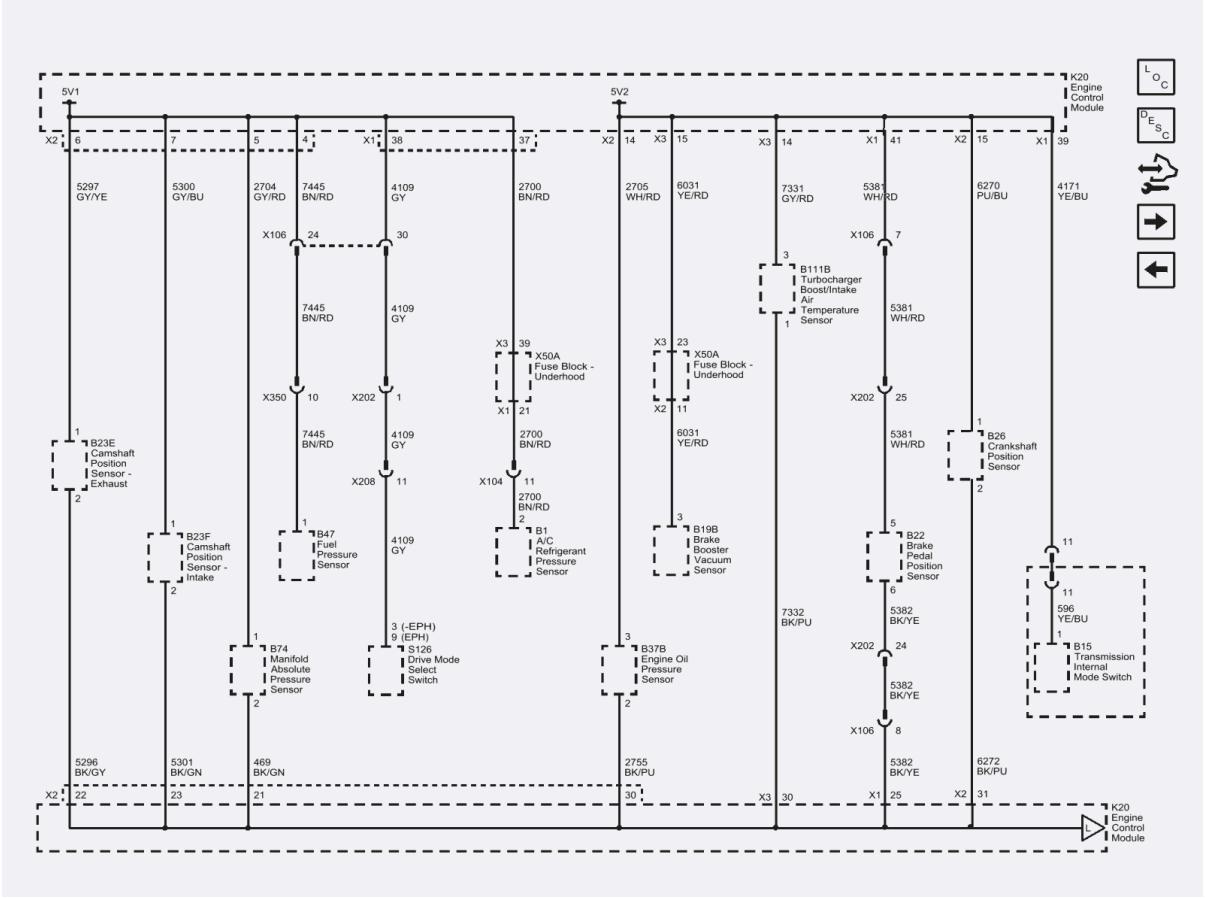

Fig. 2: 5V1, 5V2, and Low Reference Bus (1 of 3)
Courtesy of GENERAL MOTORS COMPANY

5V3, 5V4, 5V5, and Low Reference Bus (2 of 3)

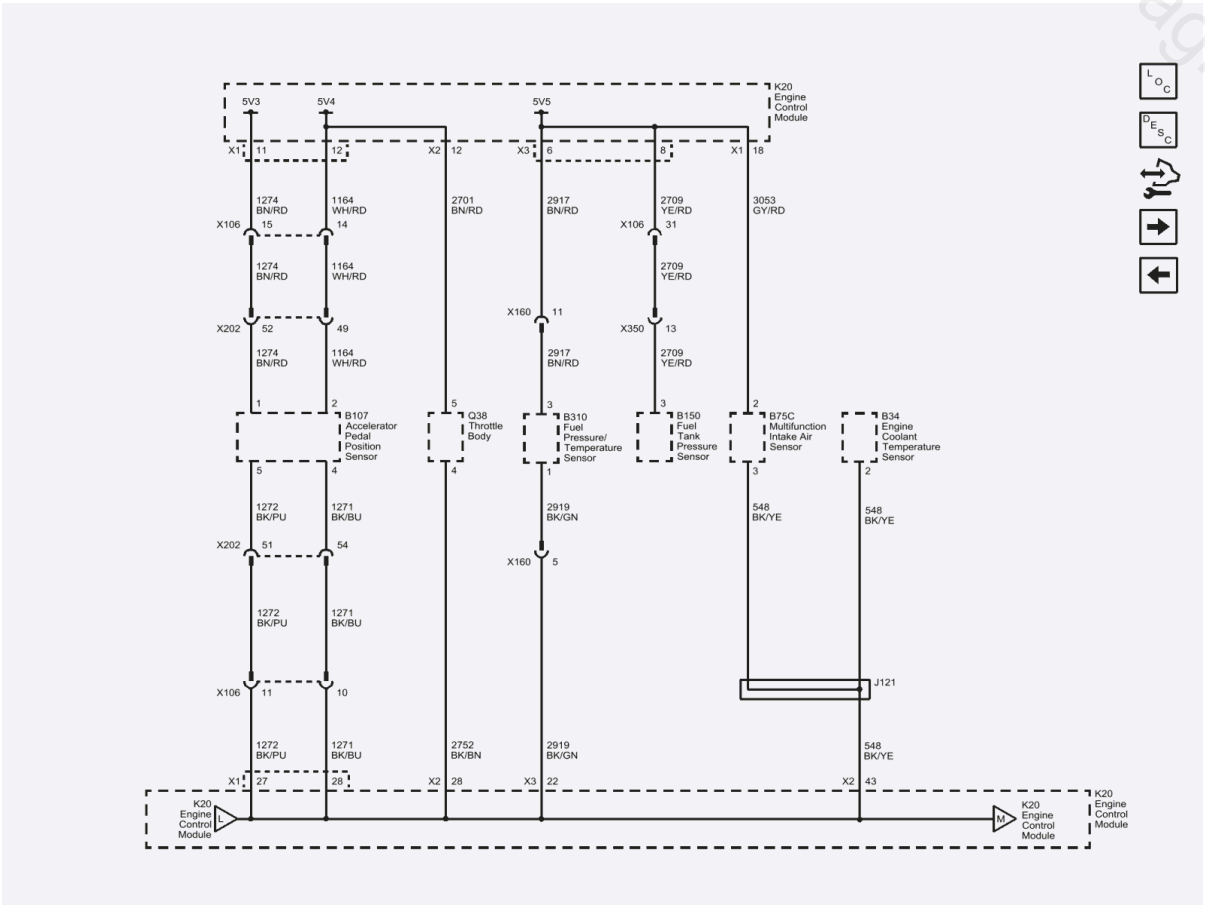

Fig. 3: 5V3, 5V4, 5V5, and Low Reference Bus (2 of 3)
Courtesy of GENERAL MOTORS COMPANY

Low Reference Bus (3 of 3)

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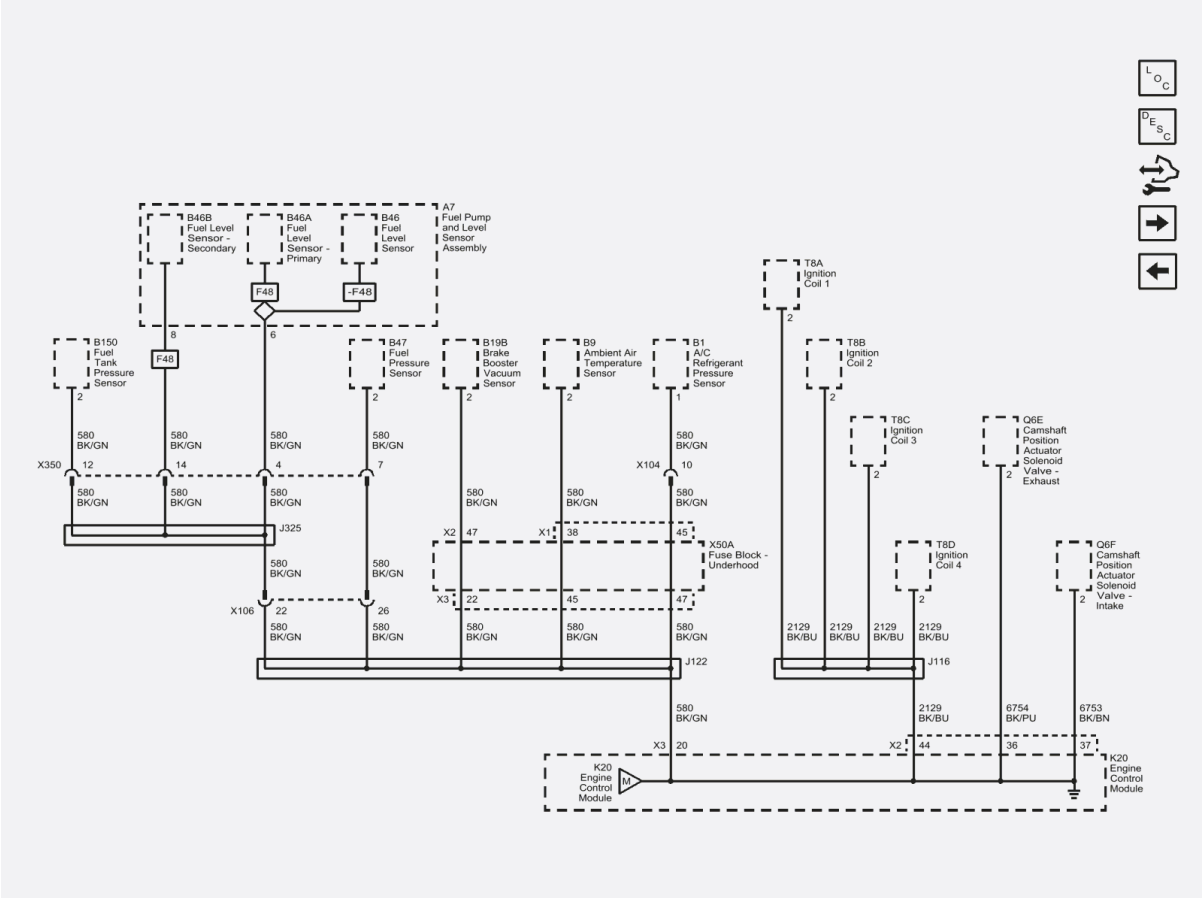

Fig. 4: Low Reference Bus (3 of 3)
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Pressure and Temperature

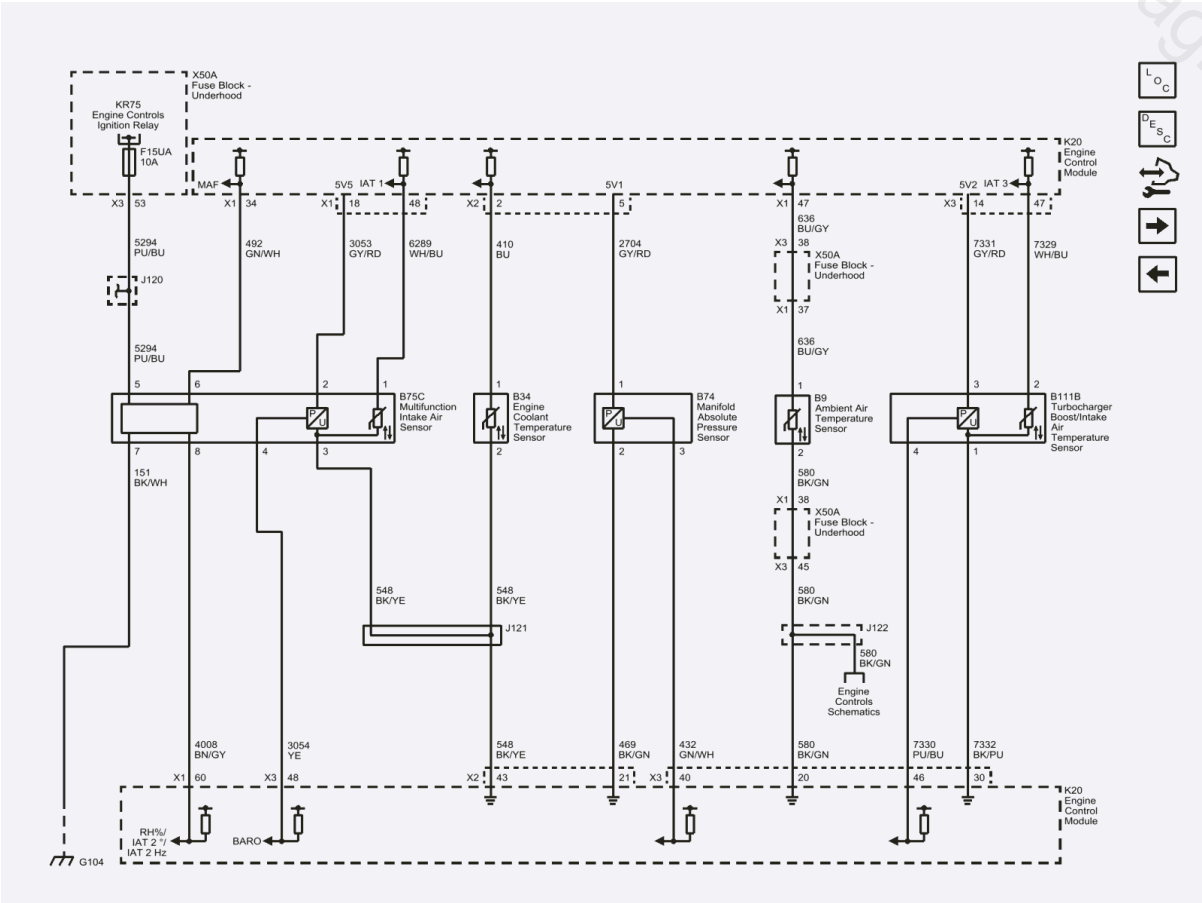

Fig. 5: Engine Data Sensors - Pressure and Temperature
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Throttle and Brake Sensor Controls

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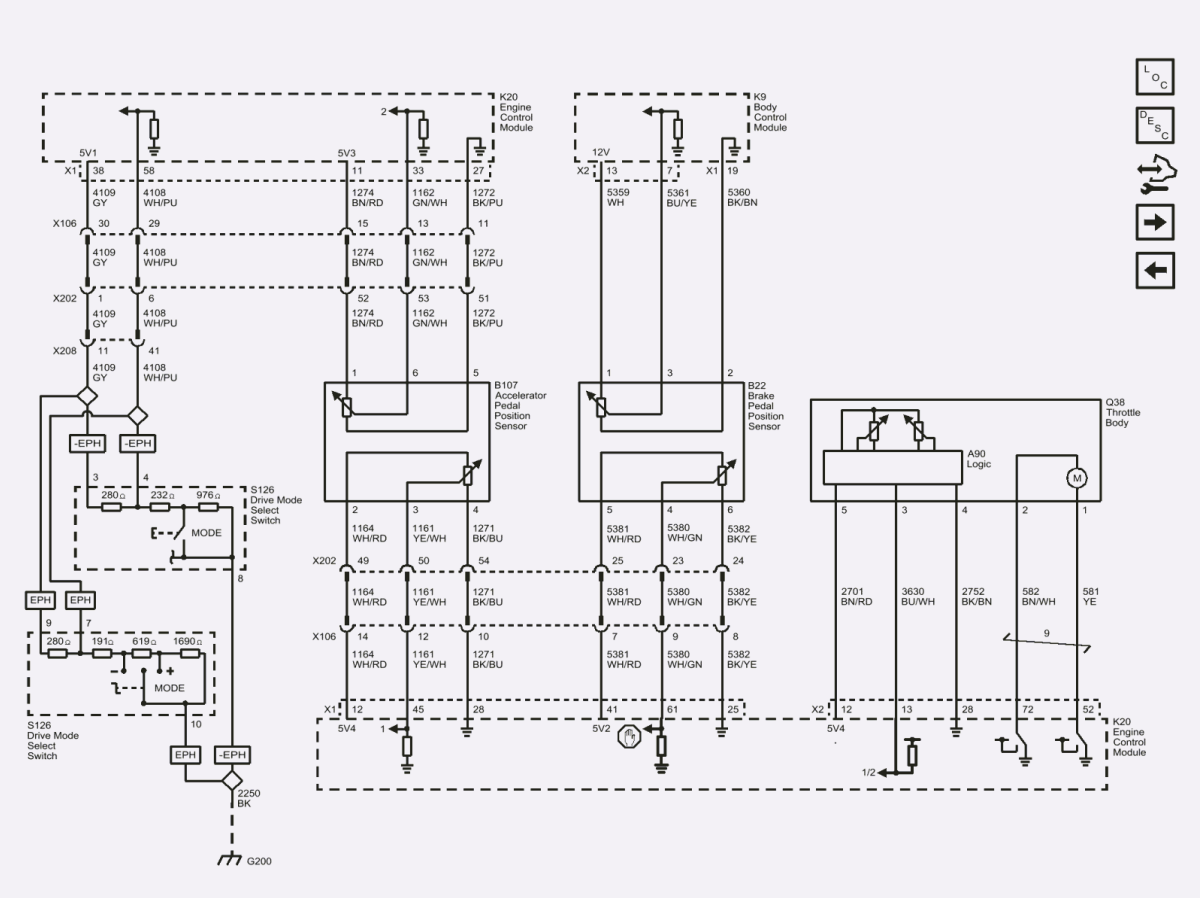

Fig. 6: Engine Data Sensors - Throttle and Brake Sensor Controls
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Oxygen Sensors

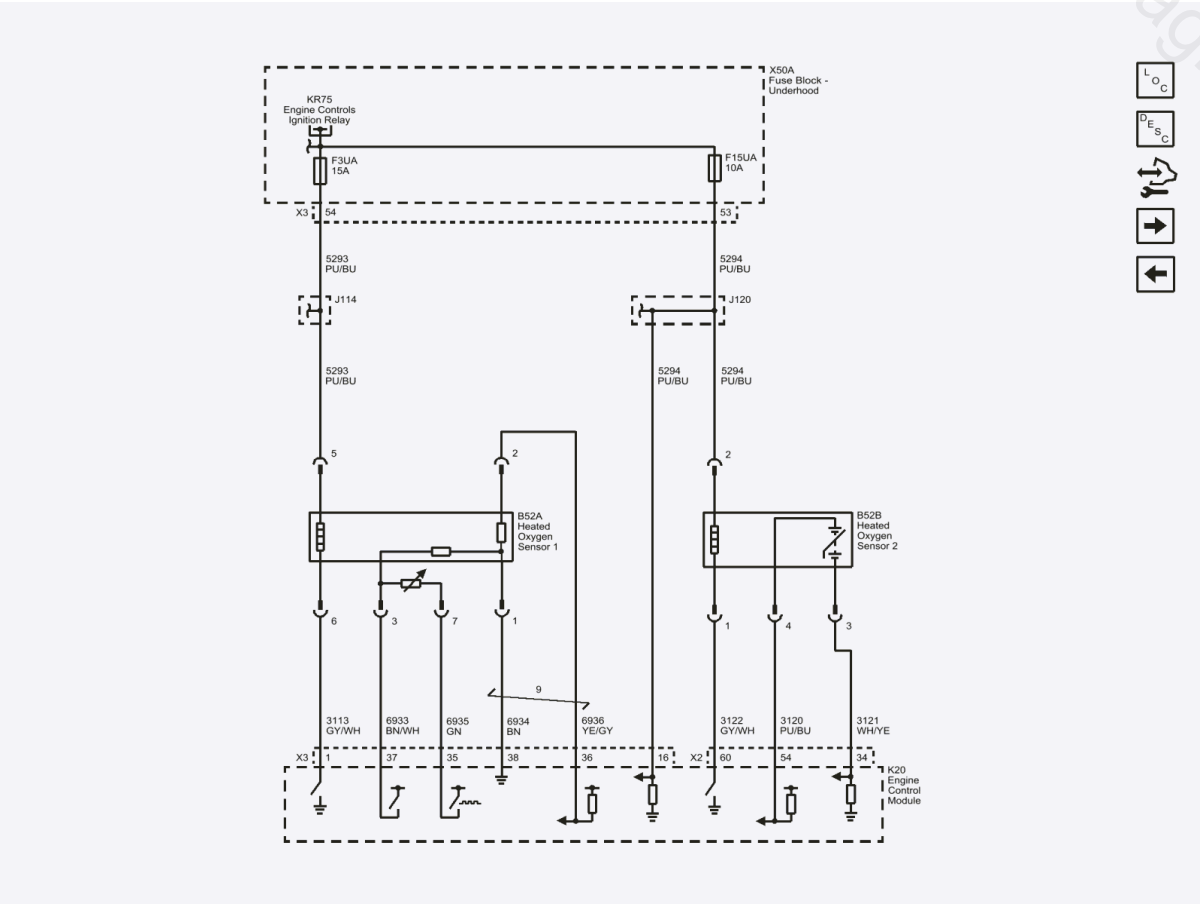

Fig. 7: Engine Data Sensors - Oxygen Sensors
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Ignition System

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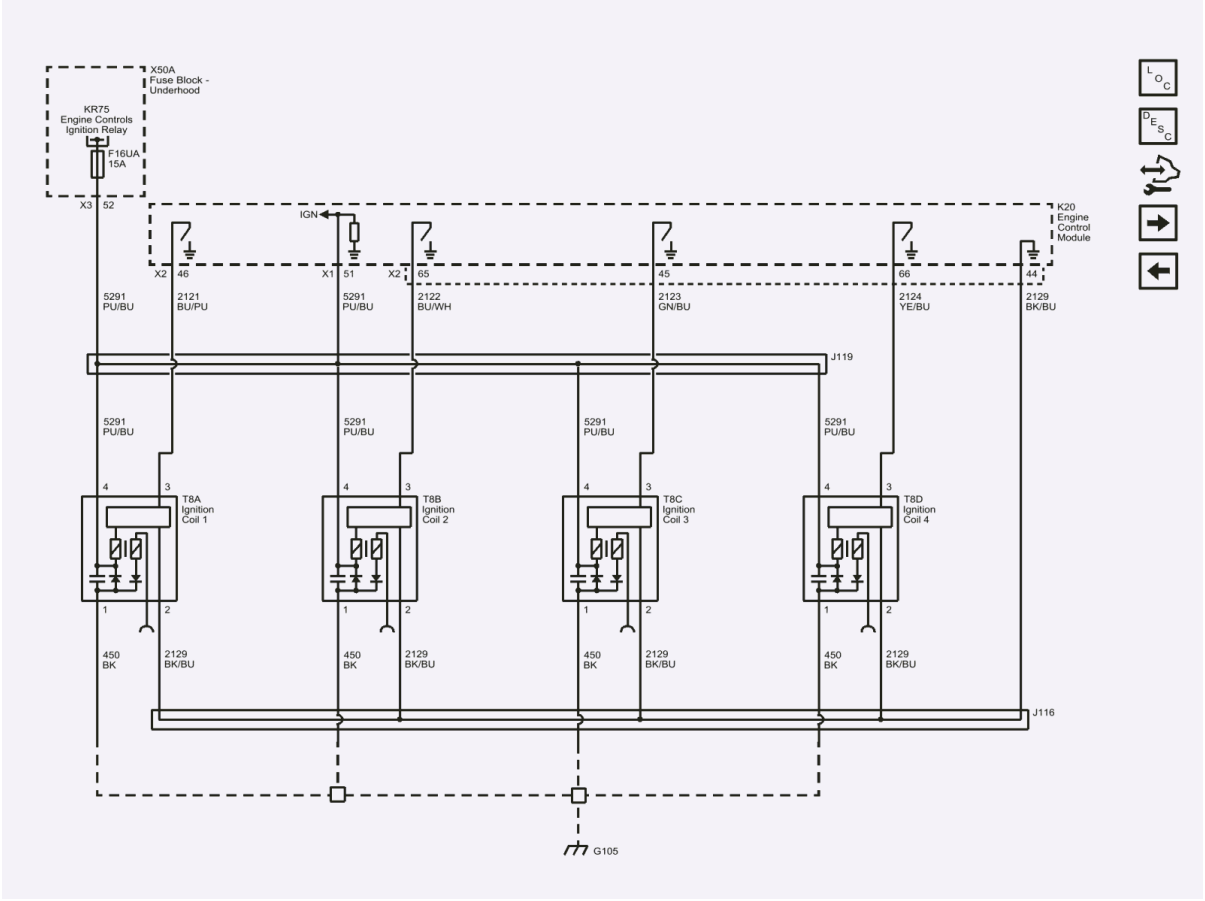

Fig. 8: Ignition Controls - Ignition System
Courtesy of GENERAL MOTORS COMPANY

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Ignition Controls - Camshaft, Crankshaft, Knock Sensors, and Camshaft Position Actuators

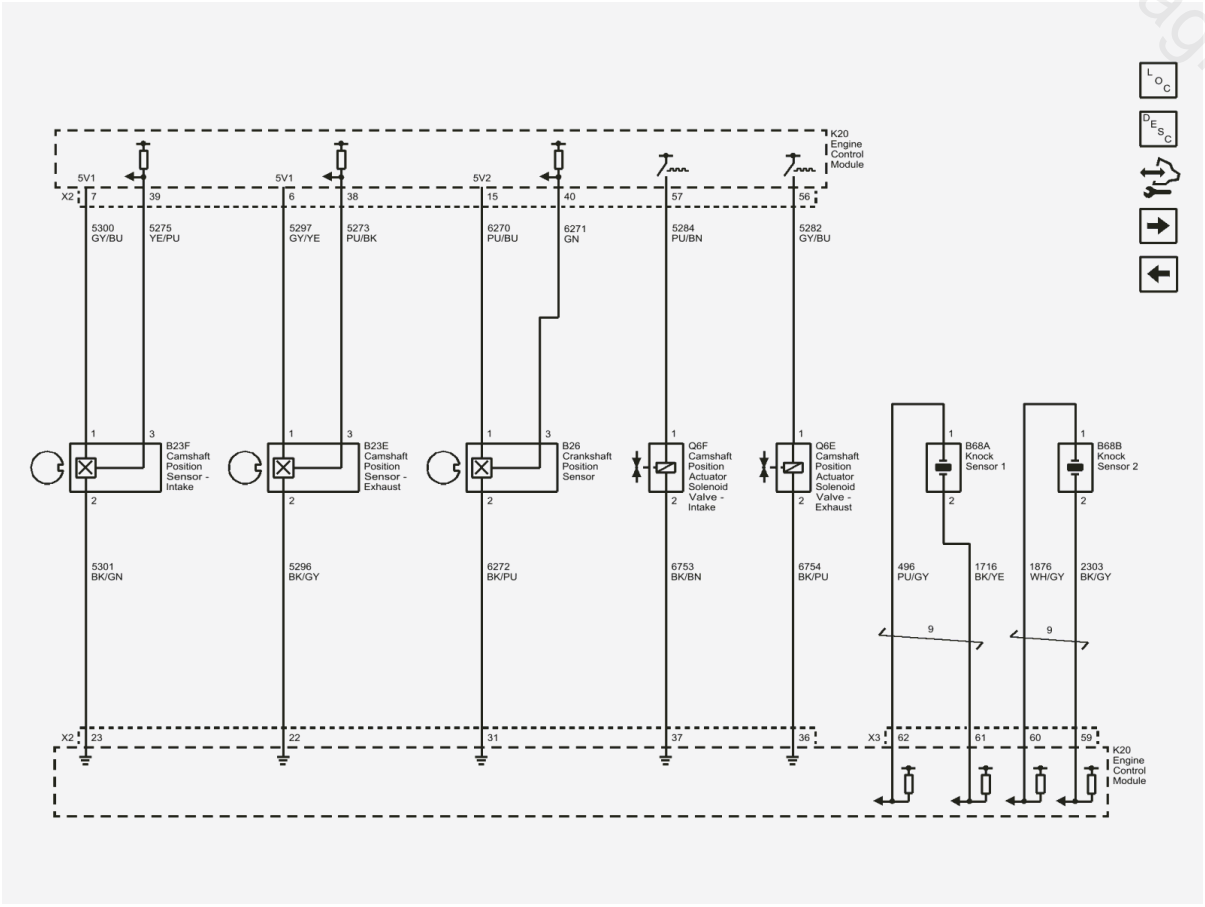

Fig. 9: Ignition Controls - Camshaft, Crankshaft, Knock Sensors, and Camshaft Position Actuators
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Injectors

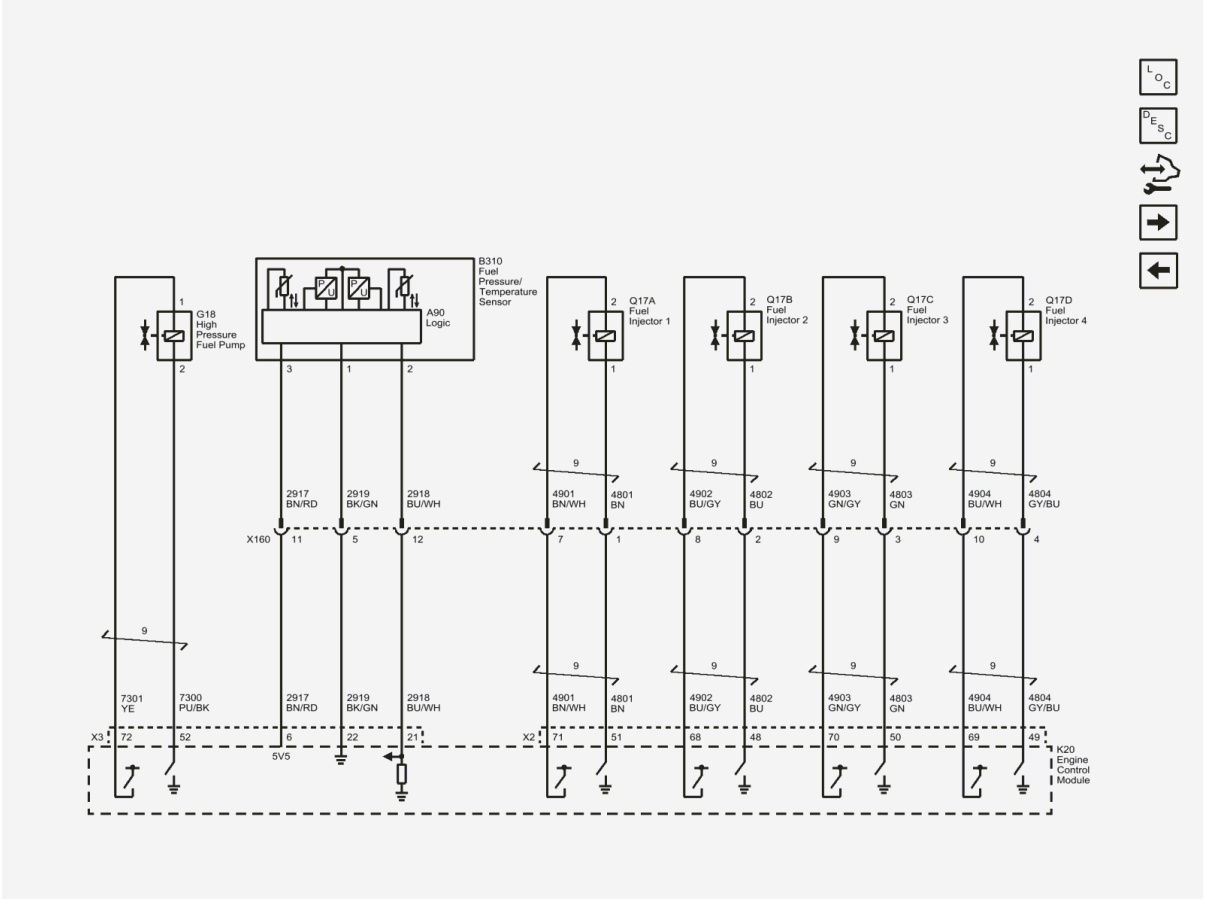

Fig. 10: Fuel Controls - Fuel Injectors
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Pump and Fuel Pump Controls

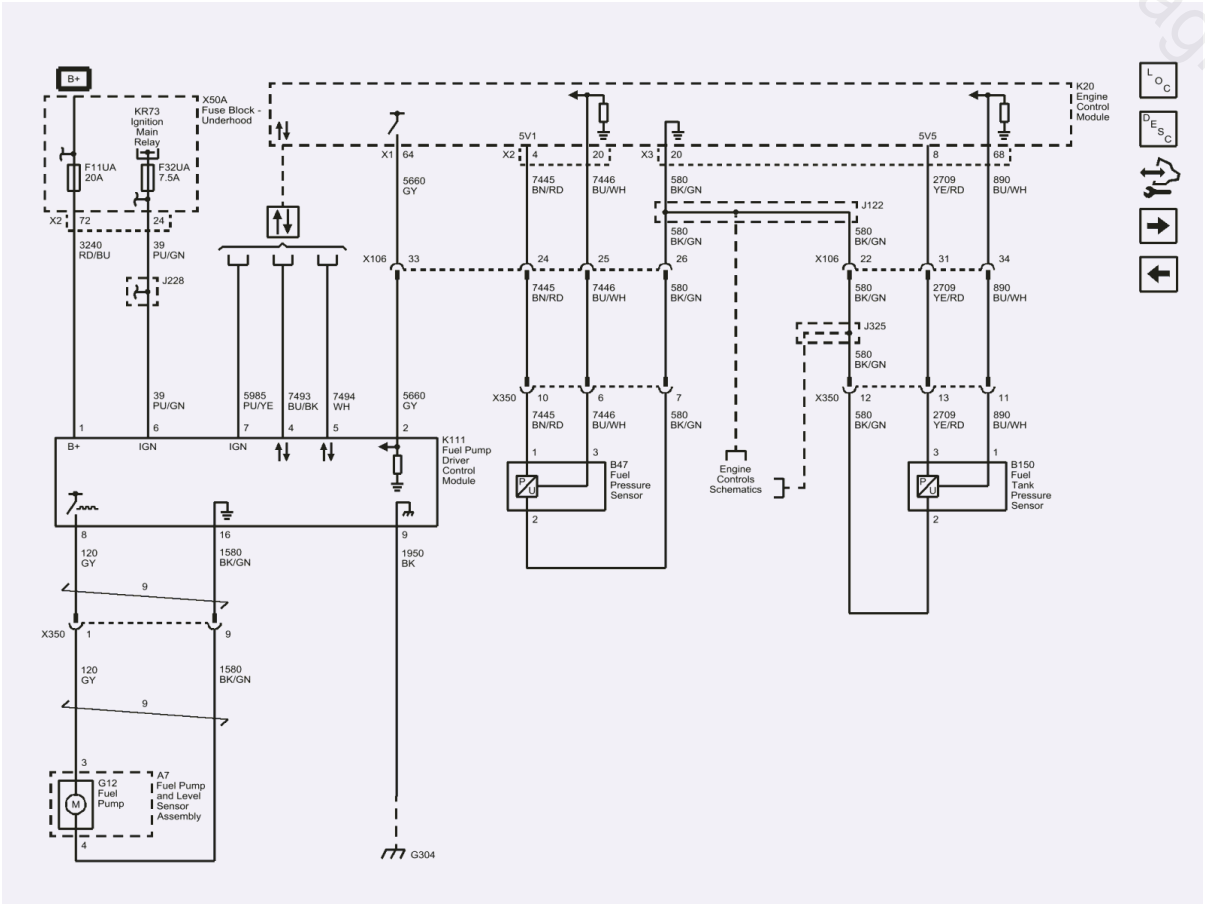

Fig. 11: Fuel Controls - Fuel Pump and Fuel Pump Controls
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Evaporative Emission, and Device Controls

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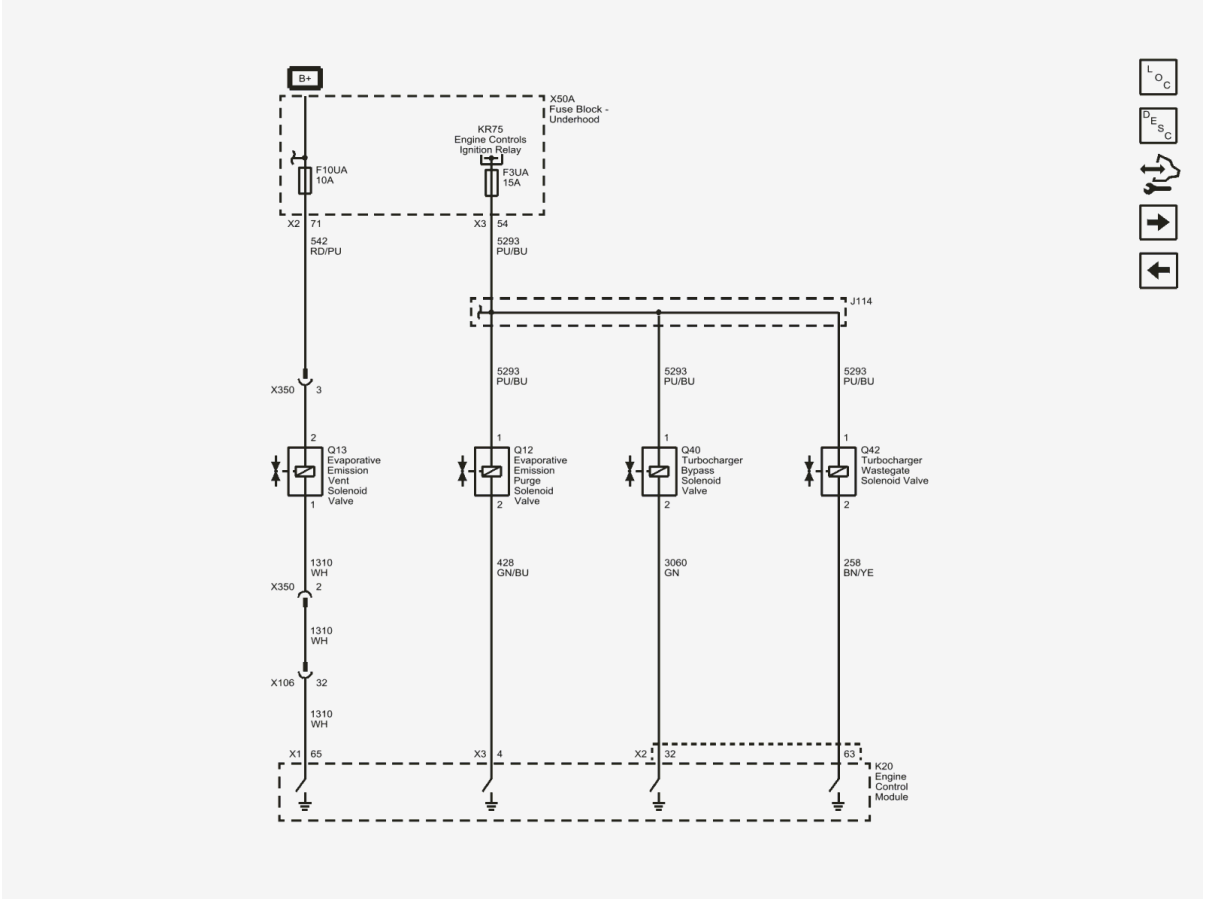

Fig. 12: Fuel Controls - Evaporative Emission, and Device Controls
Courtesy of GENERAL MOTORS COMPANY

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Controlled/Monitored Subsystem References

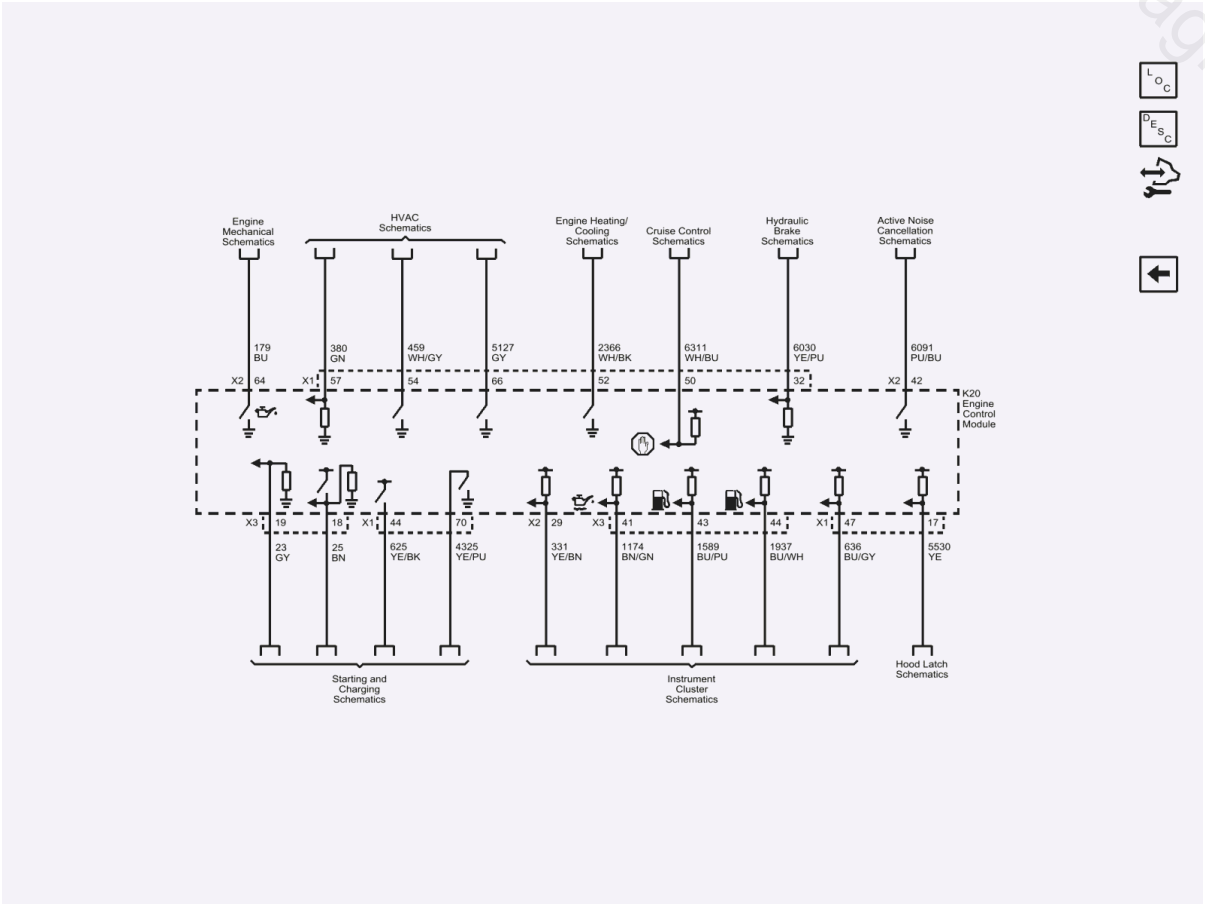

Fig. 13: Controlled/Monitored Subsystem References
Courtesy of GENERAL MOTORS COMPANY

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SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS (DIAGNOSTIC TOOLS)

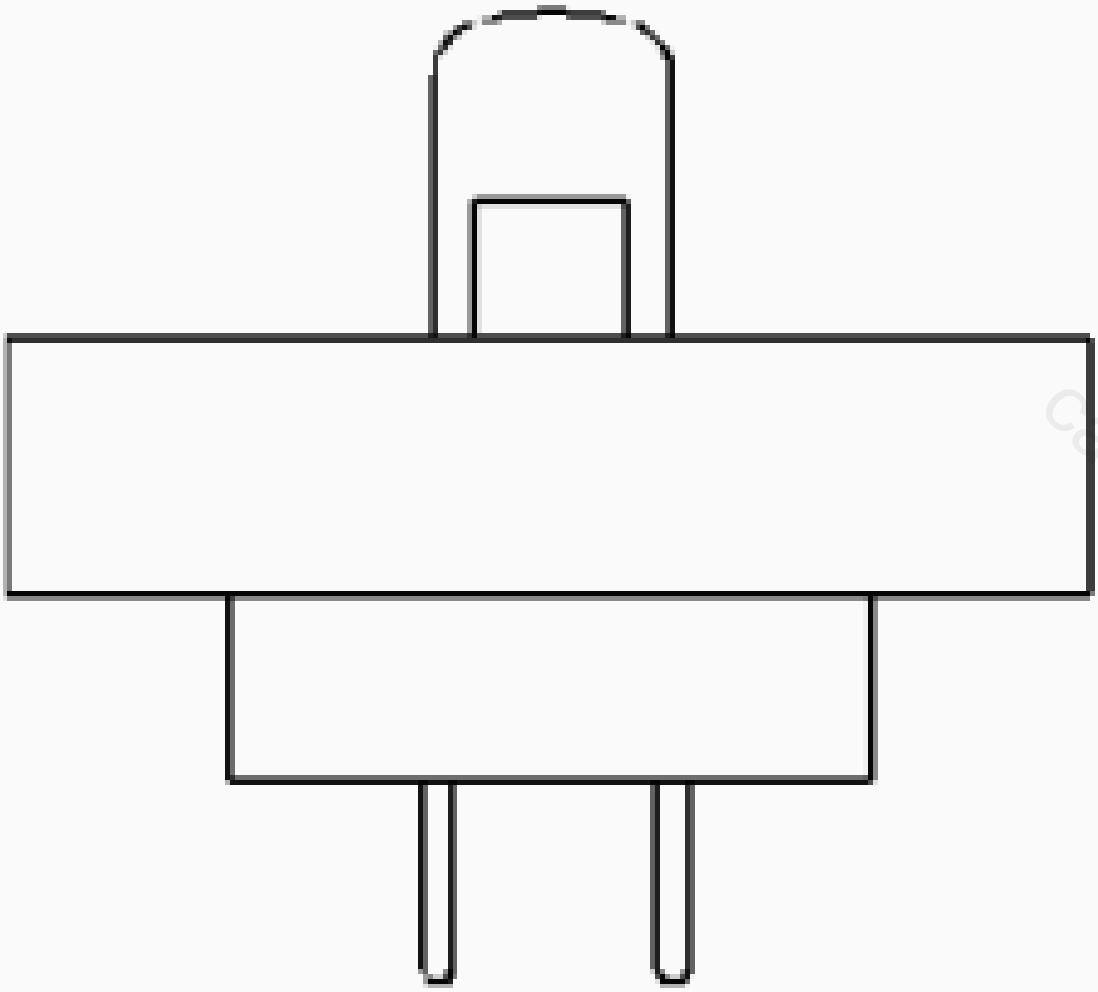
Illustration	Tool Number/Description
	CH-34730-2C J-34730-2C Injector Test Lamp

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Illustration	Tool Number/Description
	CH-37287-1A Fuel Pressure Gauge Adapter 3/8"
	CH-38641-B J-38641-B Diesel Fuel Quality Tester

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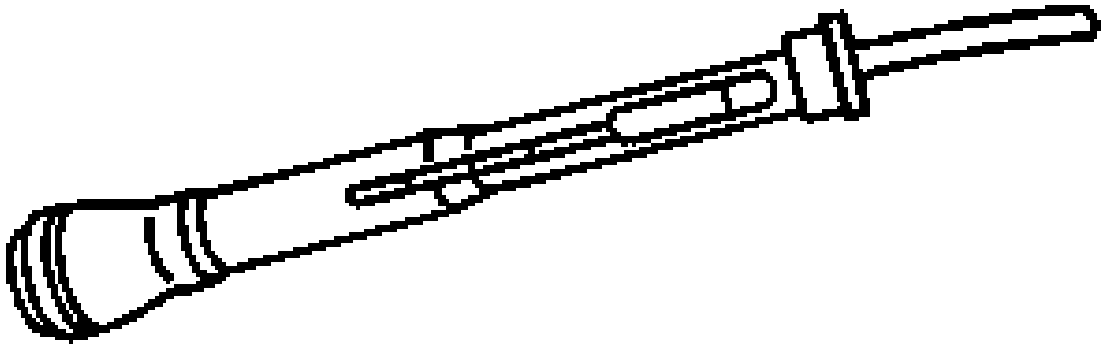
Illustration	Tool Number/Description
	

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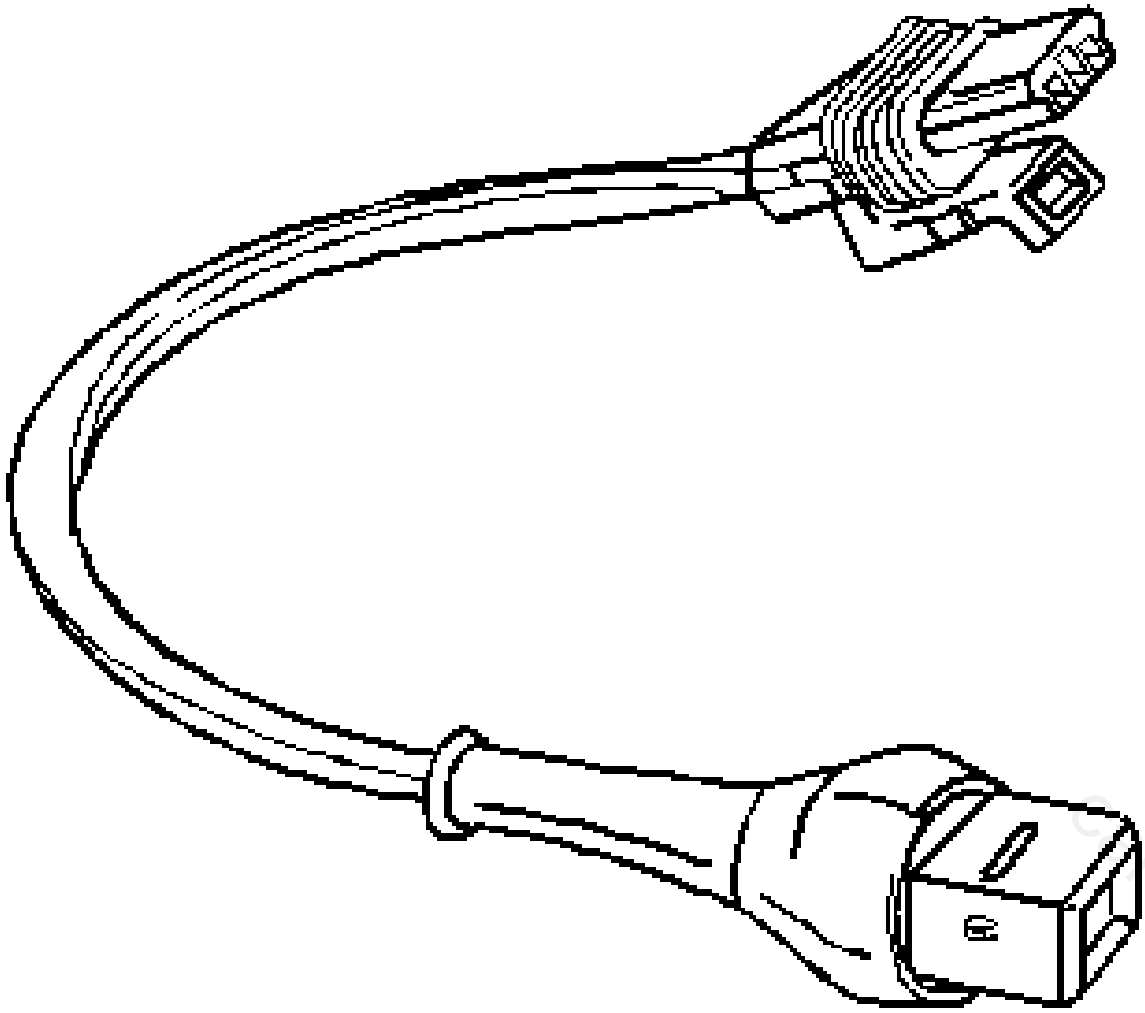
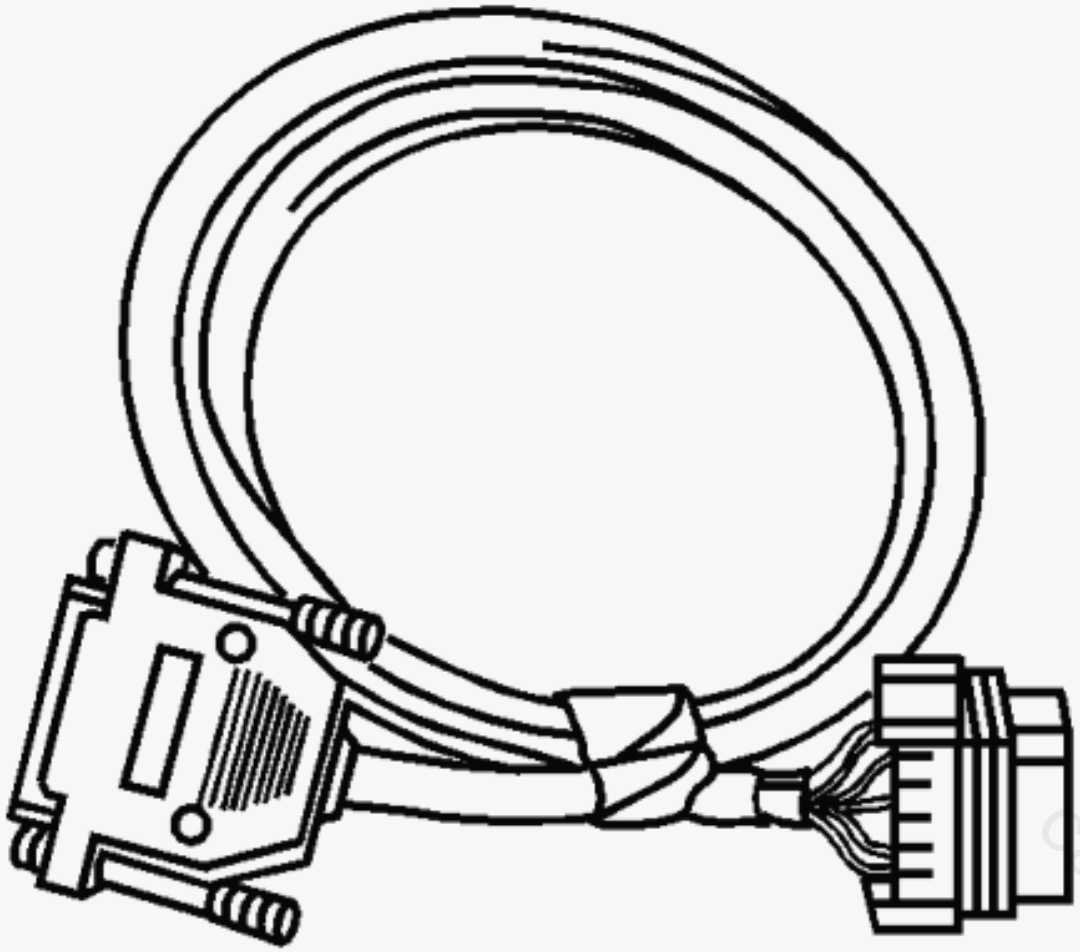
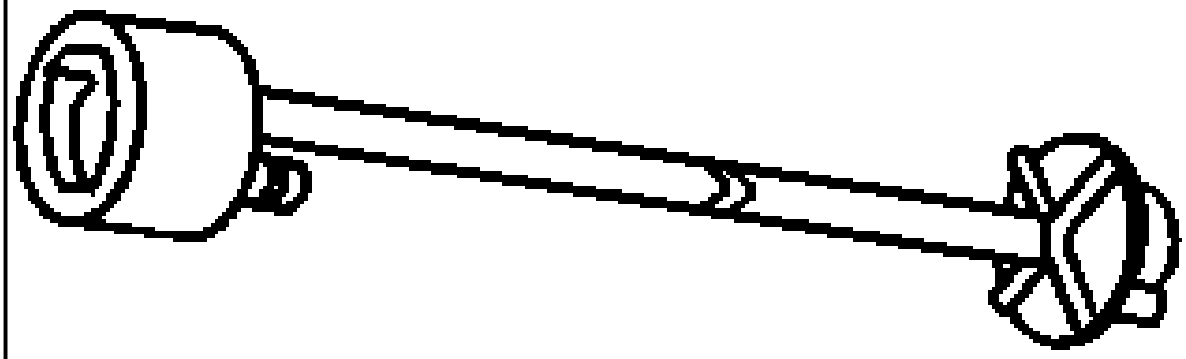
Illustration	Tool Number/Description
	CH-39021-301 J-39021-301 Fuel Injector Harness Adapter

carsdiagn.com

Illustration	Tool Number/Description
	CH-39021-460 J-39021-460 Fuel Injector Test Adapter

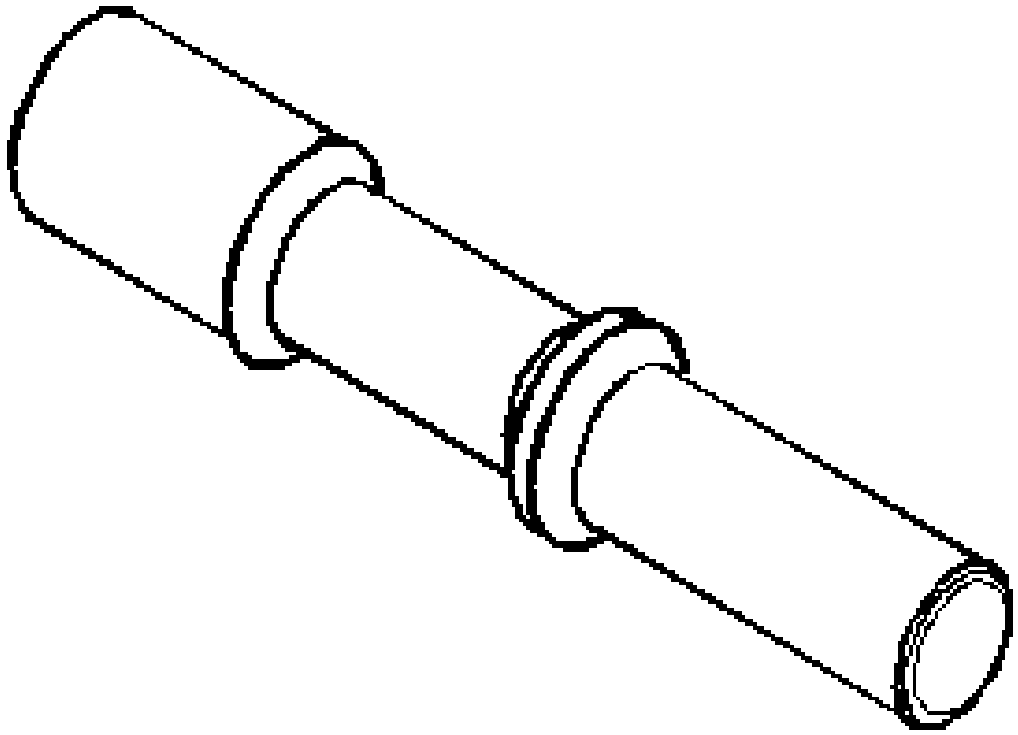
cardiagn.com

Illustration	Tool Number/Description
	CH-41415-30 GE-41415-30 J-41415-30 Fuel Tank Cap Adapter

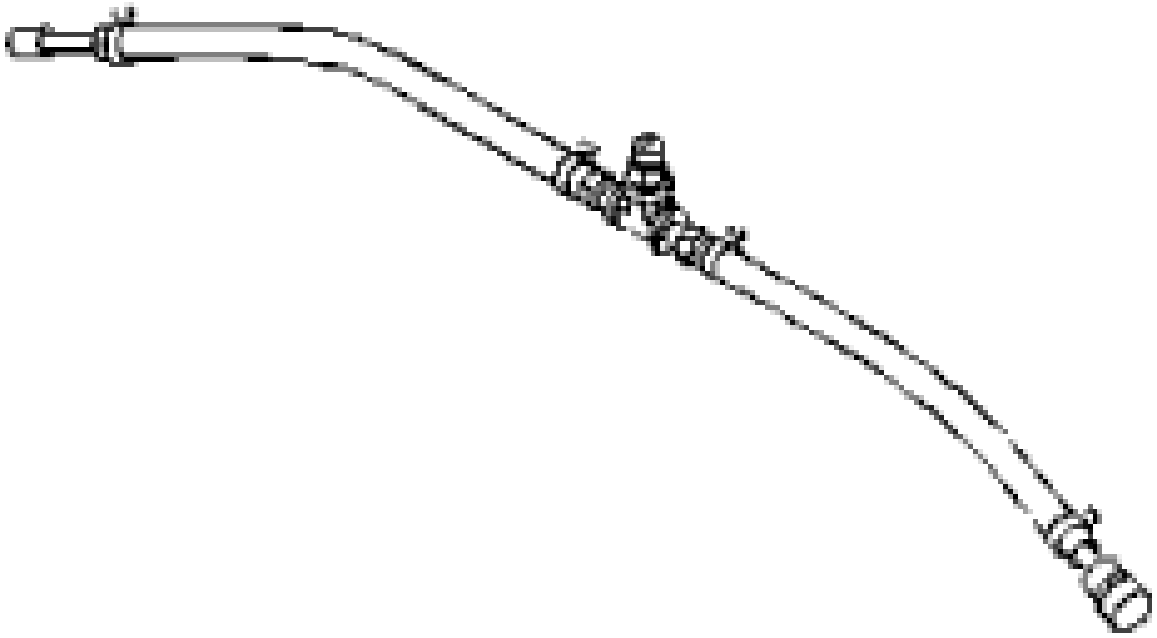
cardiagn.com

Illustration	Tool Number/Description
	CH-41769 J-41769 Fuel Line Quick Disconnect Tool
	CH-44284-2 J-44284-2 Fuel Flapper Door Holder

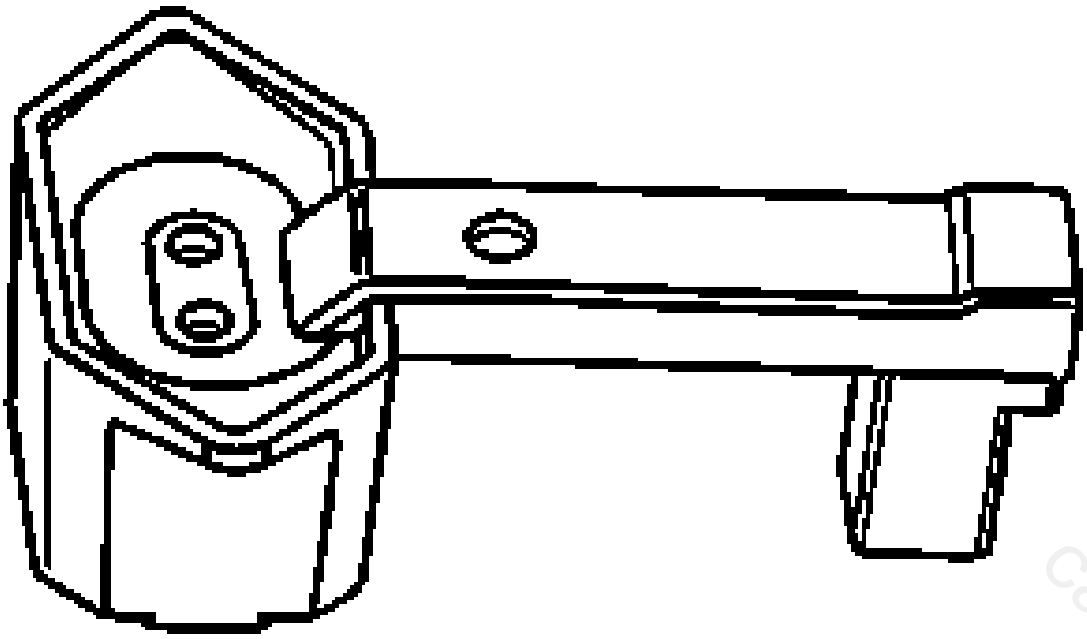
cardiagn.com

Illustration	Tool Number/Description
	

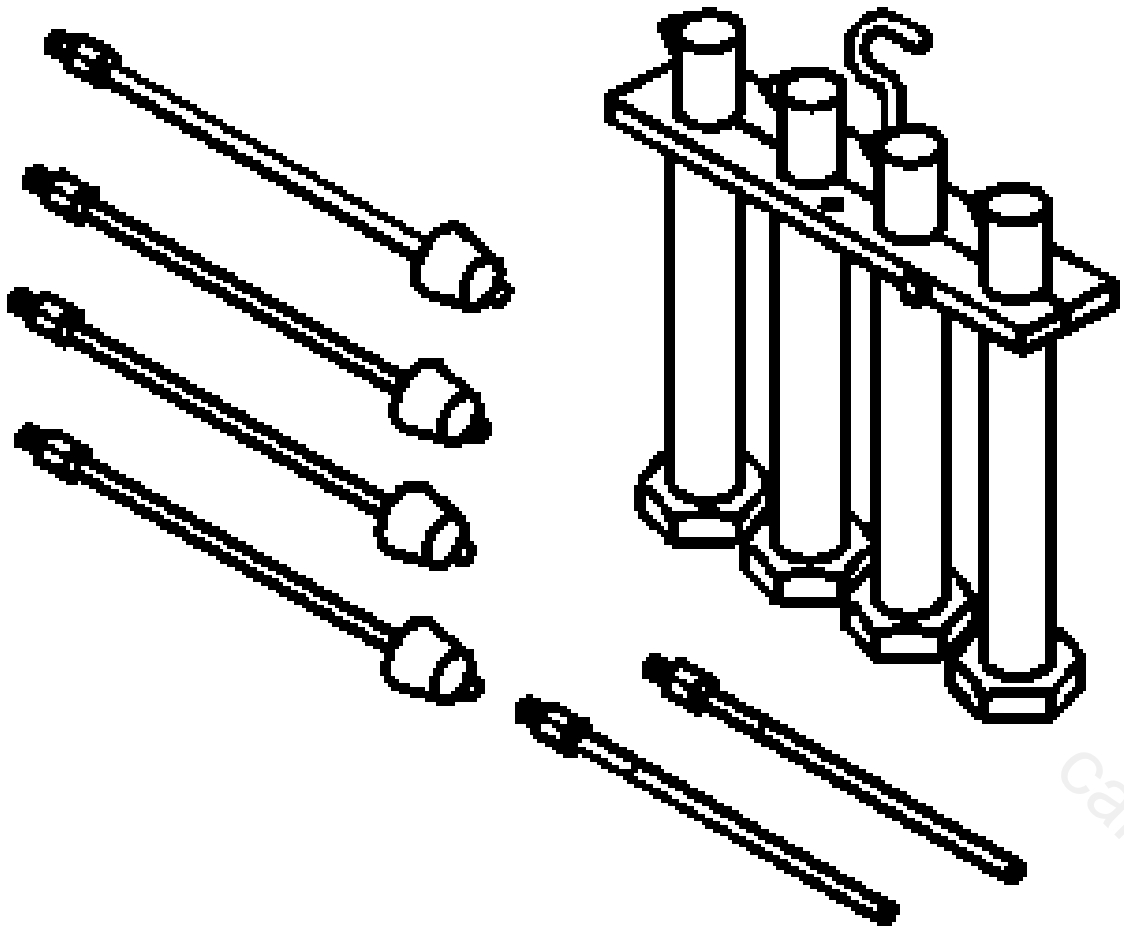
cardiagn.com

Illustration	Tool Number/Description
	CH-42982 J-42982 Fuel Pressure Gauge Adapter

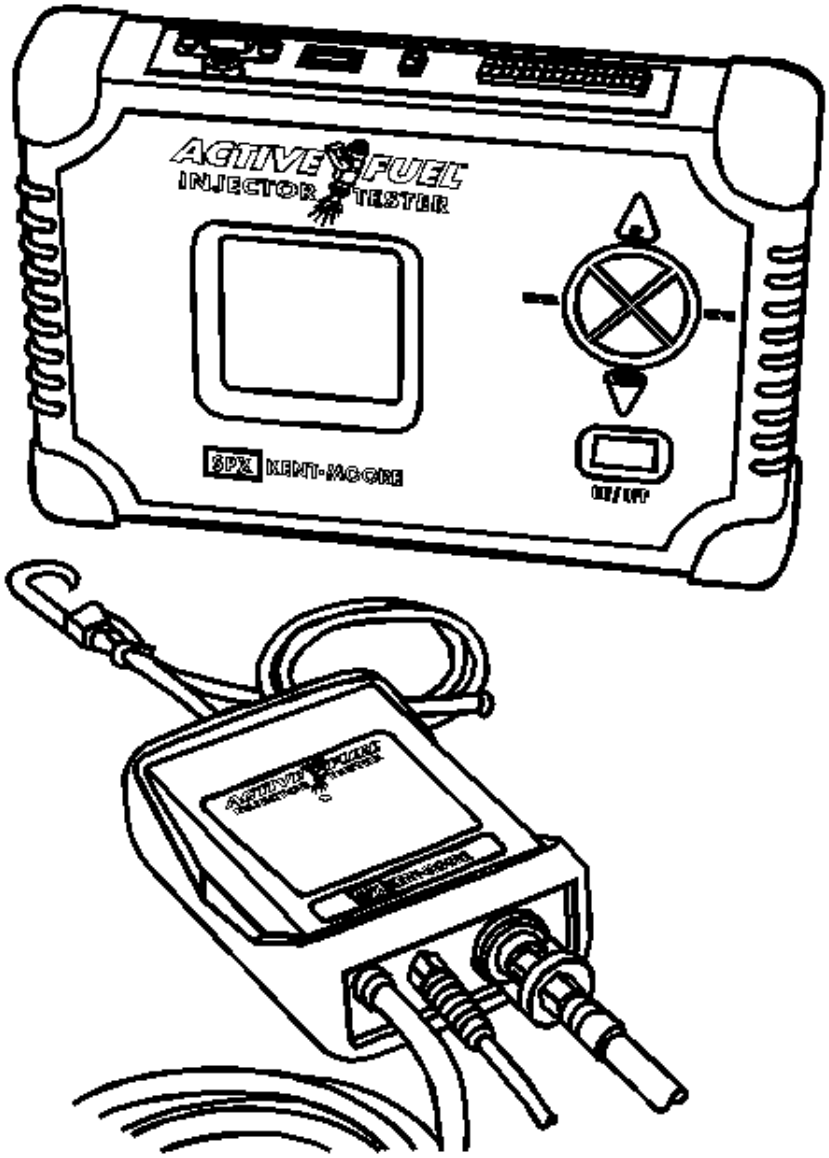
cardiagn.com

Illustration	Tool Number/Description
	CH-44175-A J-44175-A Fuel Composition Tester

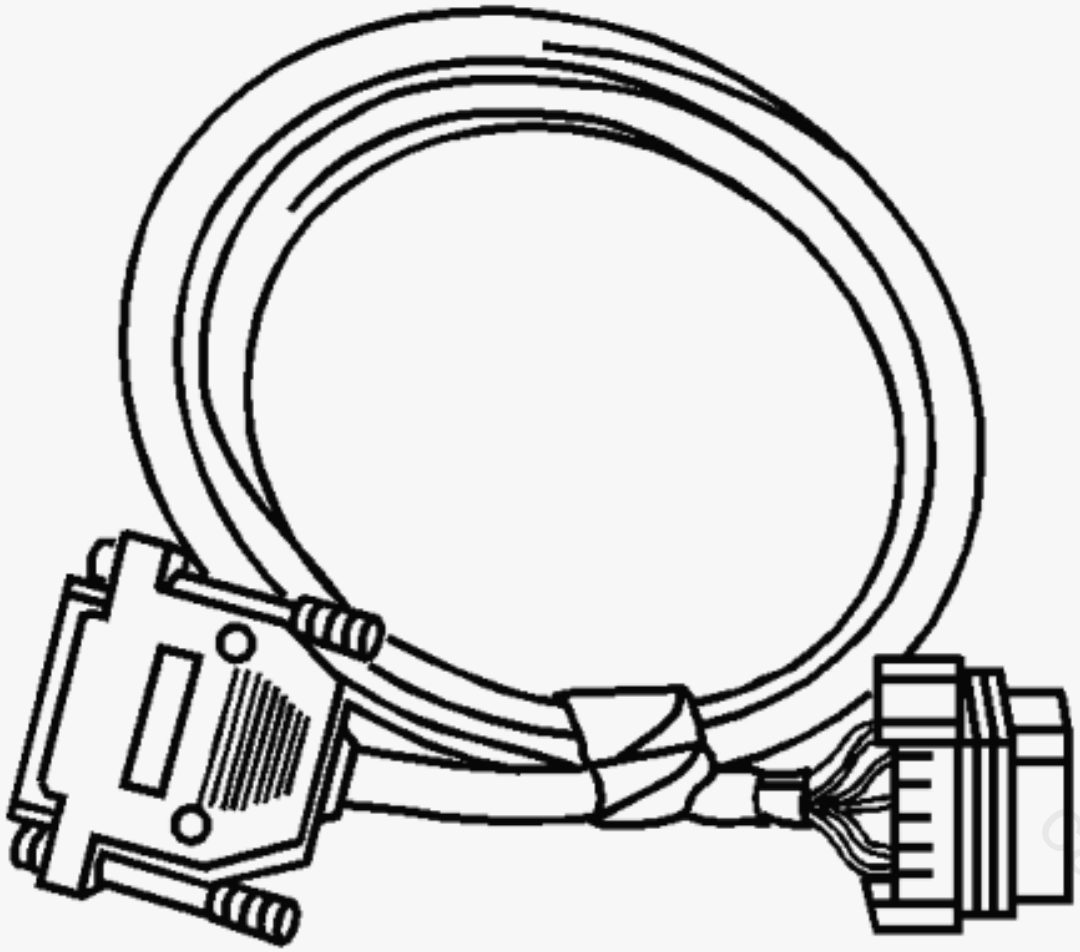
cardiagn.com

Illustration	Tool Number/Description
	CH-45873 J-45873 Fuel Return Volume Test Kit

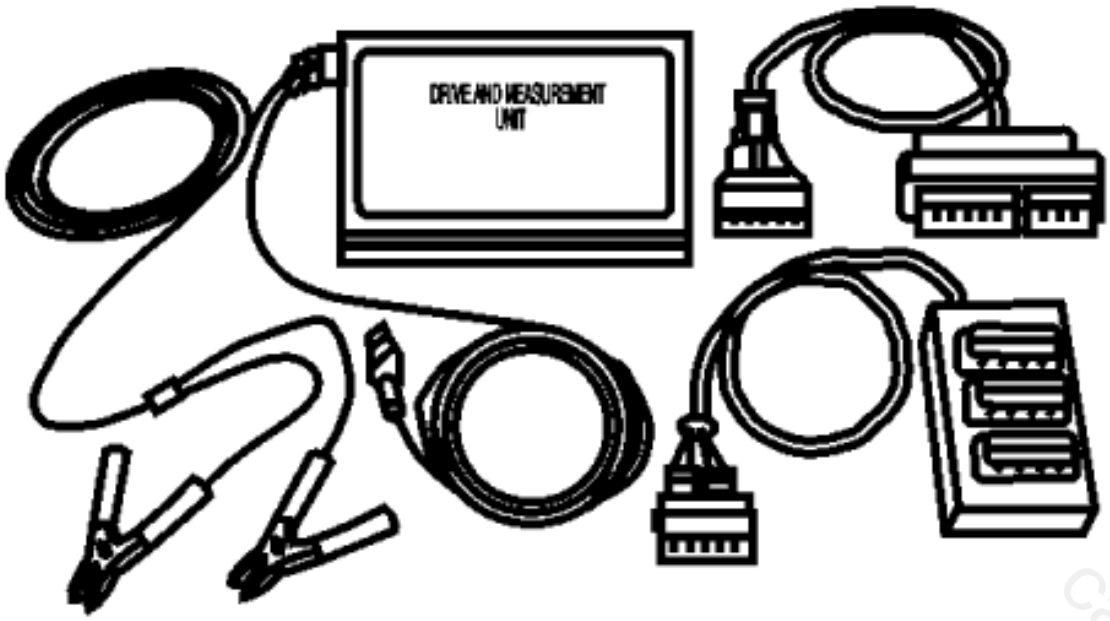
cardiagn.com

Illustration	Tool Number/Description
	CH-47976 Active Fuel Injector Tester (AFIT)

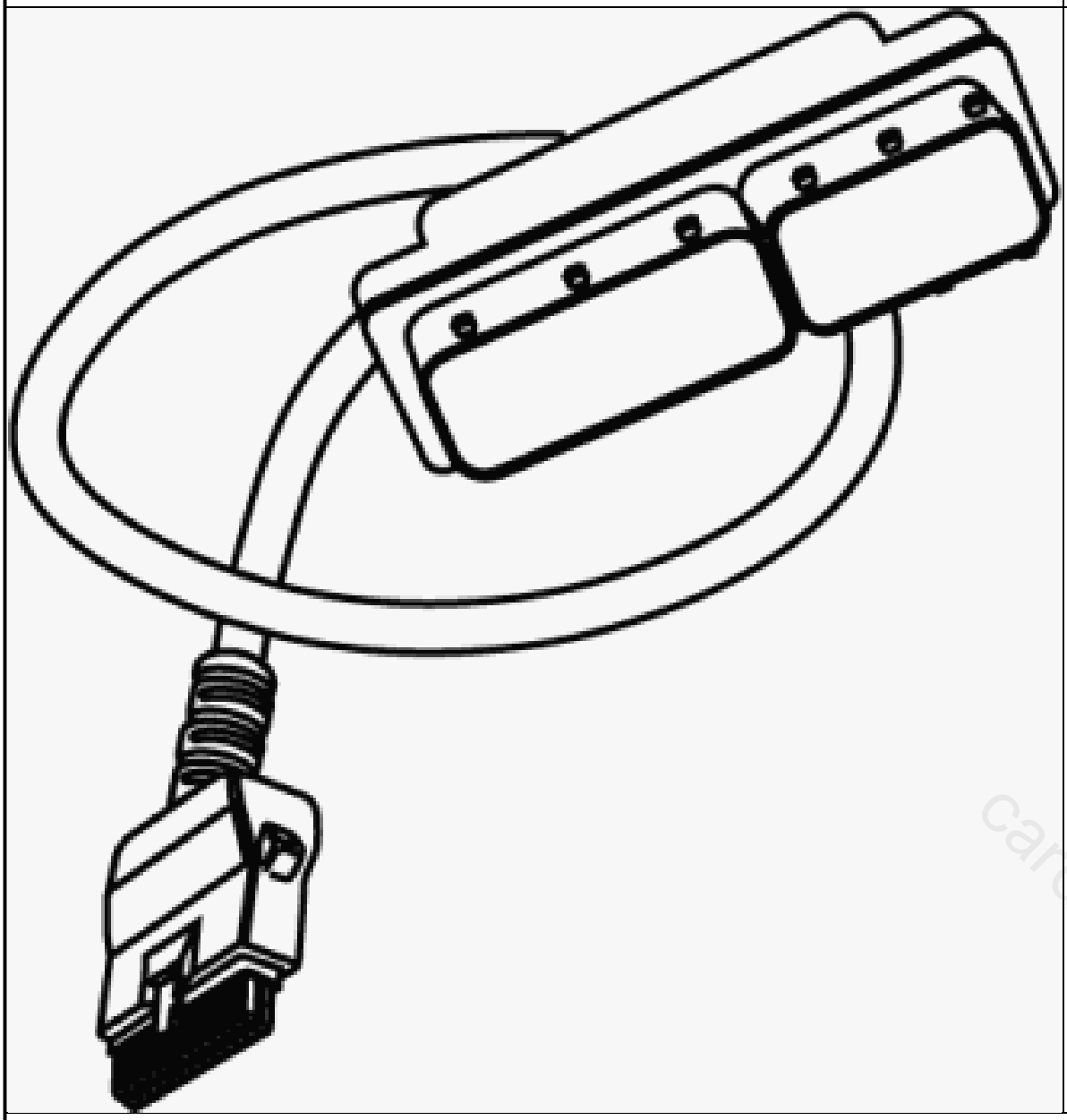
cardiagn.com

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

cardiagn.com

Illustration	Tool Number/Description
	

cardiagn.com

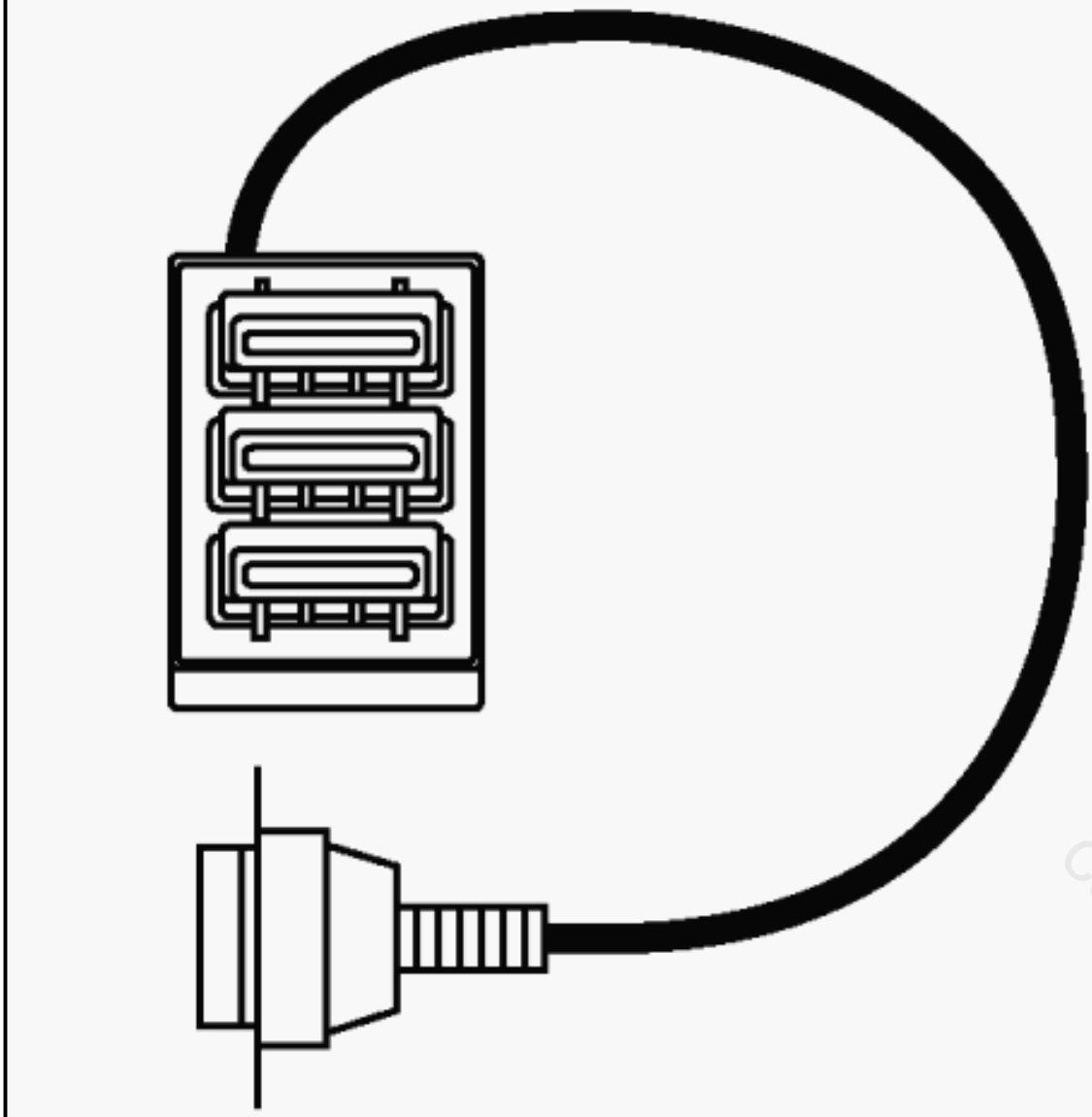
Illustration	Tool Number/Description
	CH-47976-502A AFIT SIDI E92 G2A Adapter Cable

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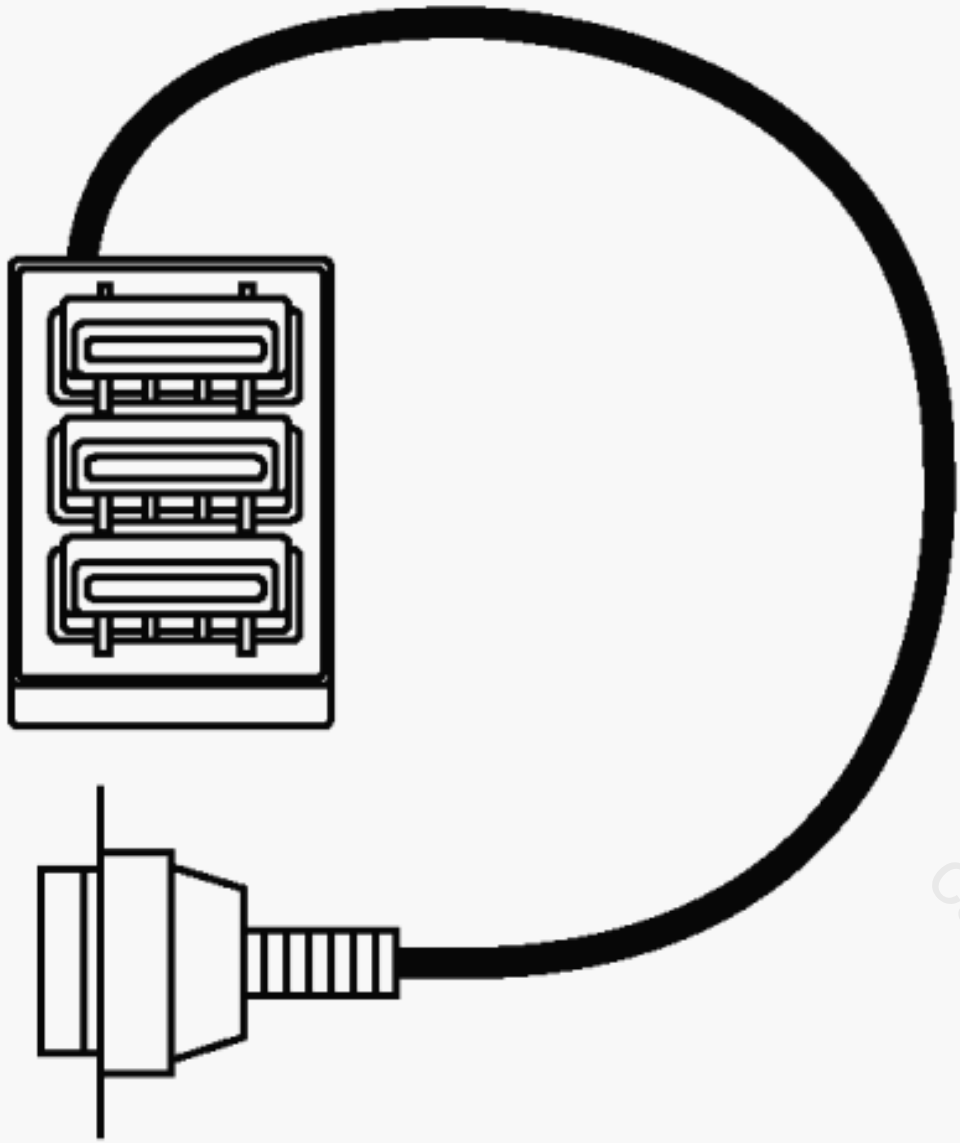
Illustration	Tool Number/Description
	CH-47976-503 AFIT SIDI E80 G3 Adapter Cable

cardiagn.com

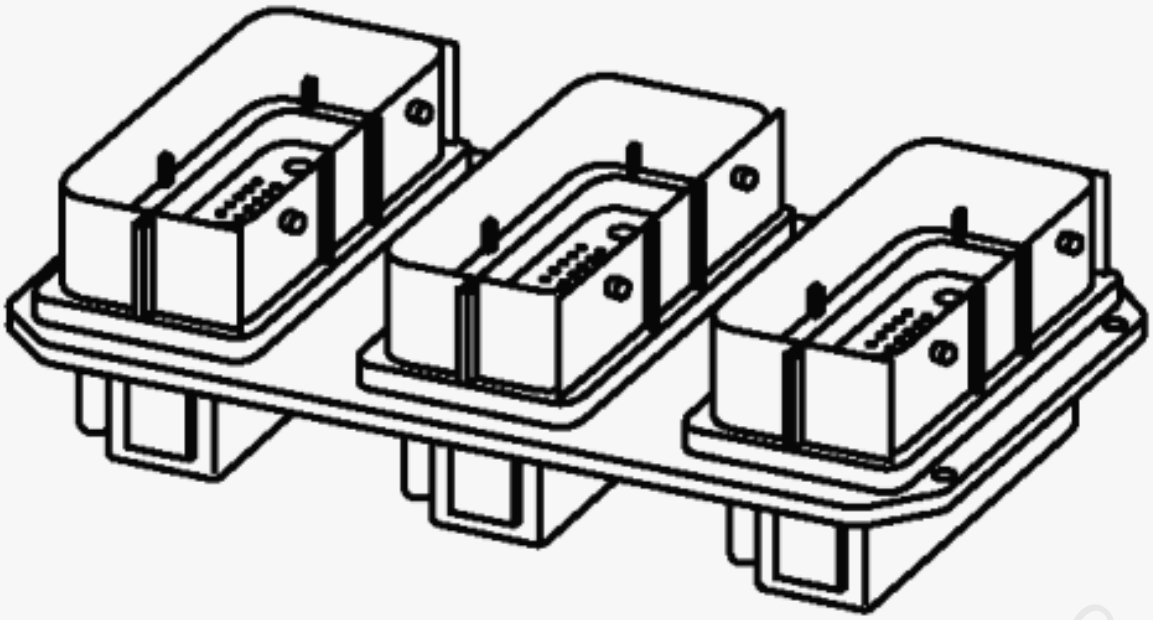
Illustration	Tool Number/Description
	CH-47976-504 E92/E39A G2B Start/Stop Adapter

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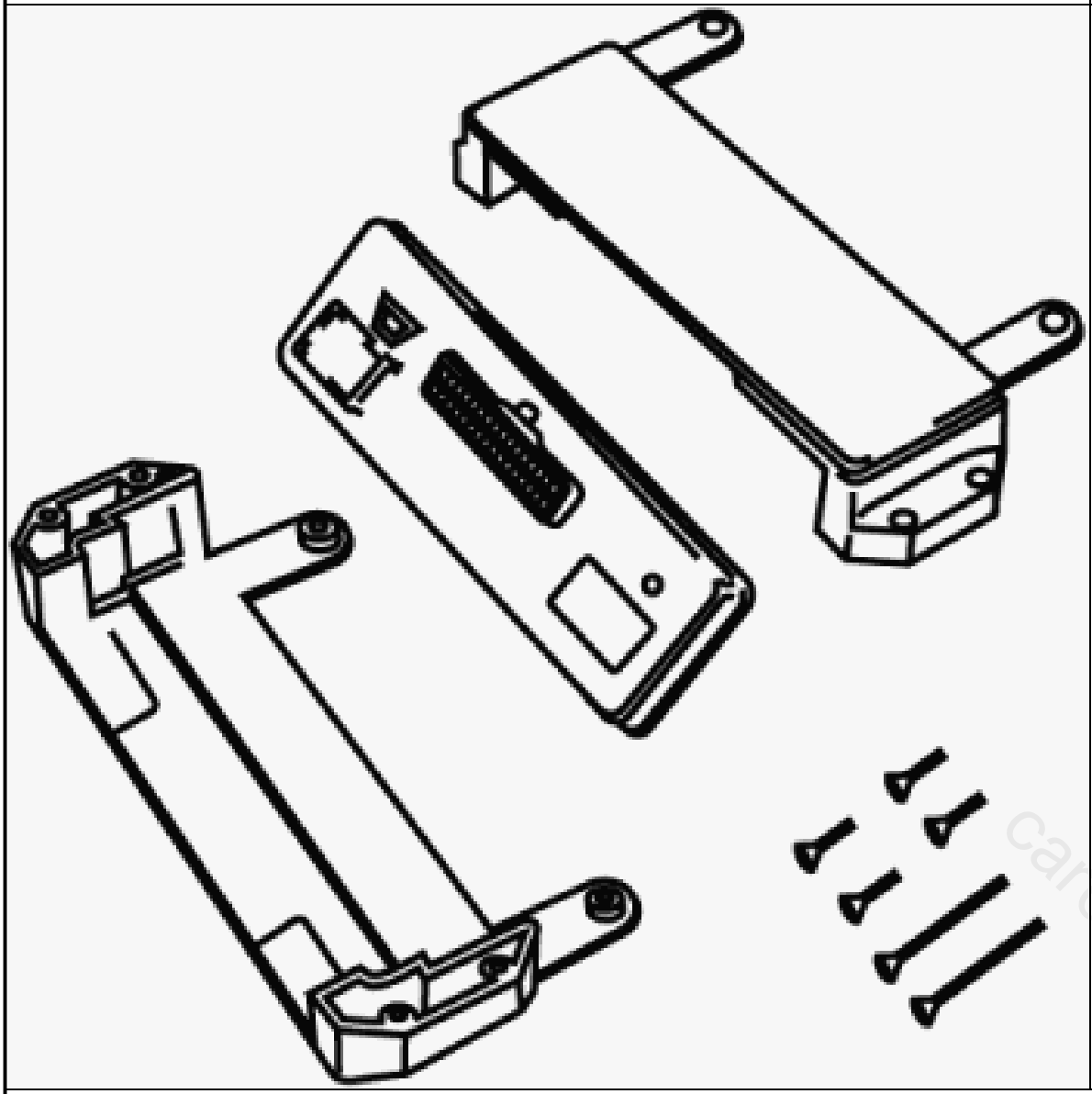
Illustration	Tool Number/Description
	CH-47976-507 AFIT Sent Adapter

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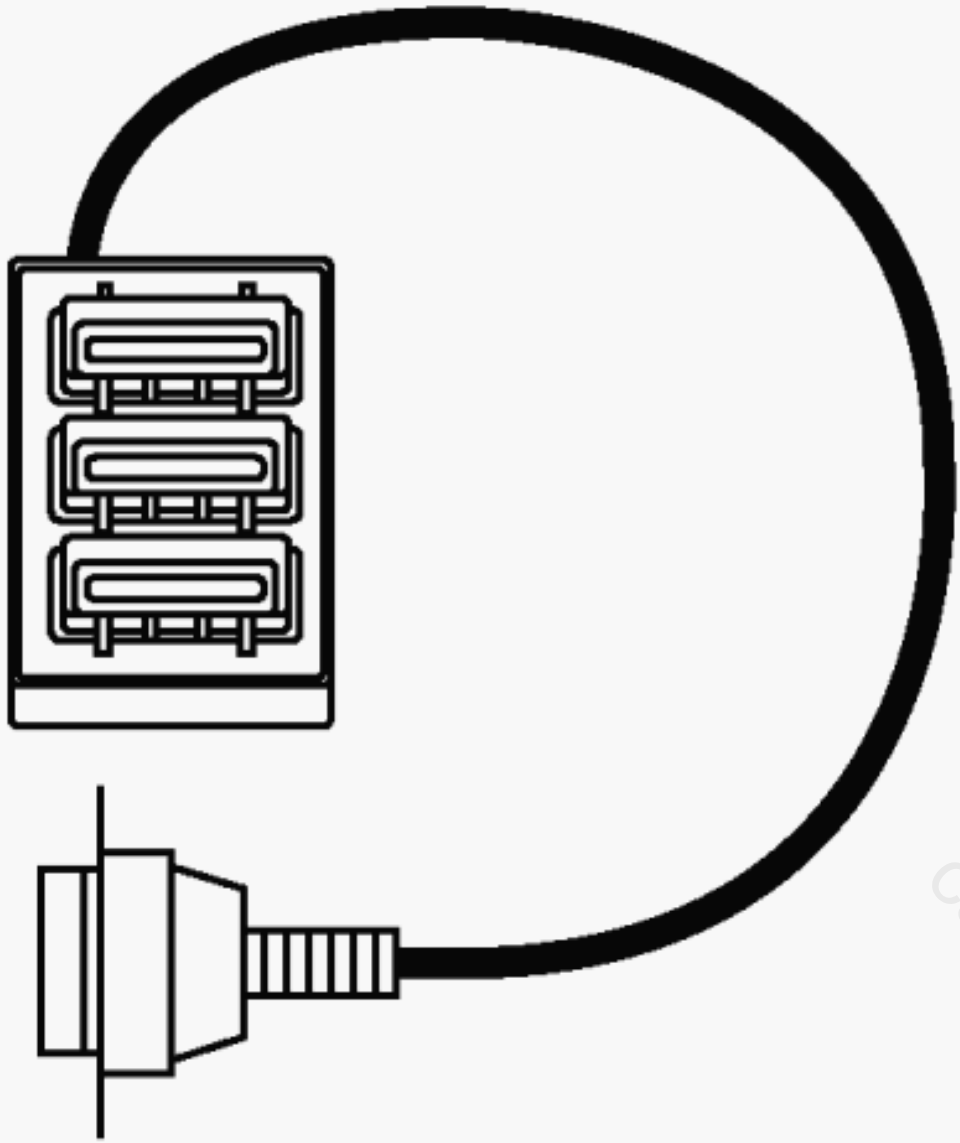
Illustration	Tool Number/Description
	CH-47976-509 AFIT SIDI E81 G4 Adapter Cable

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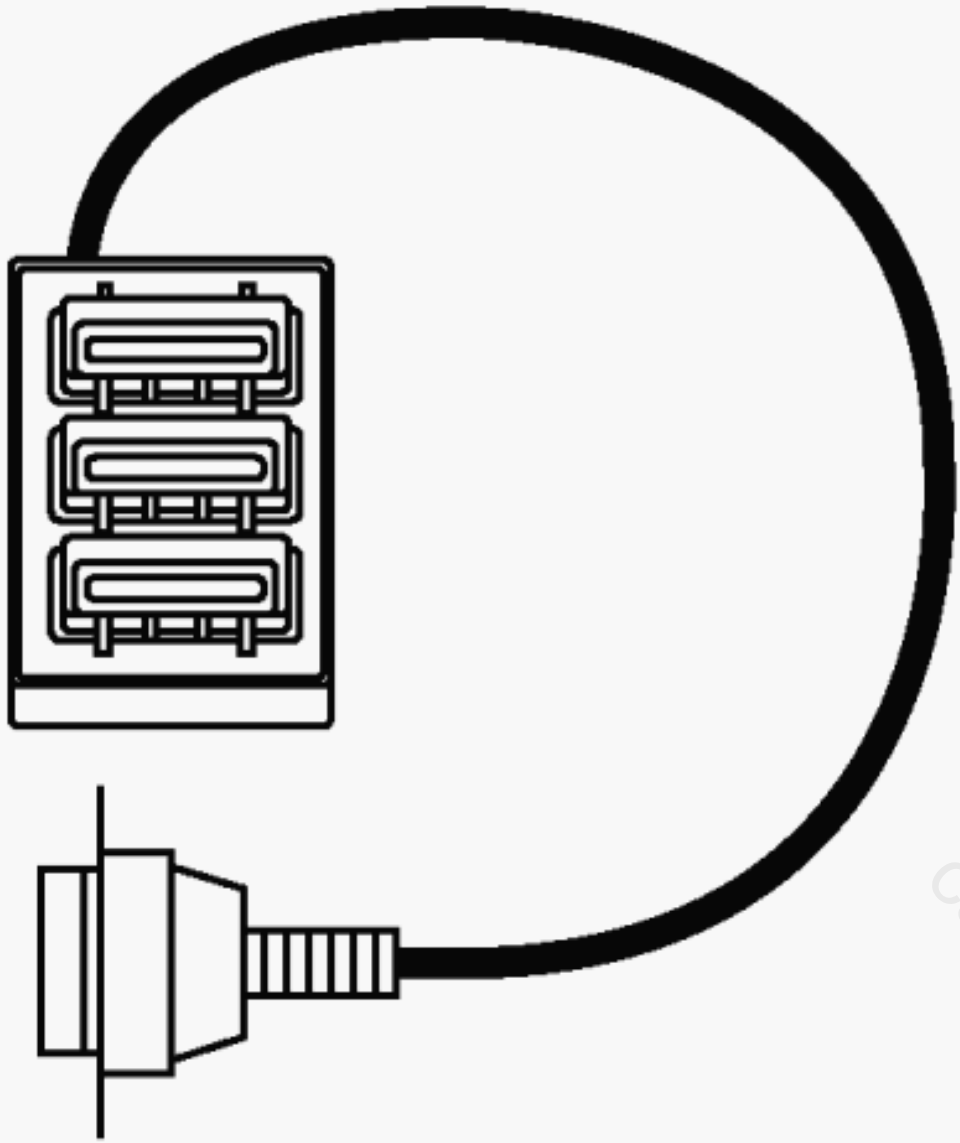
Illustration	Tool Number/Description
	CH-47976-511 AFIT SIDI E82 G5 Adapter Cable

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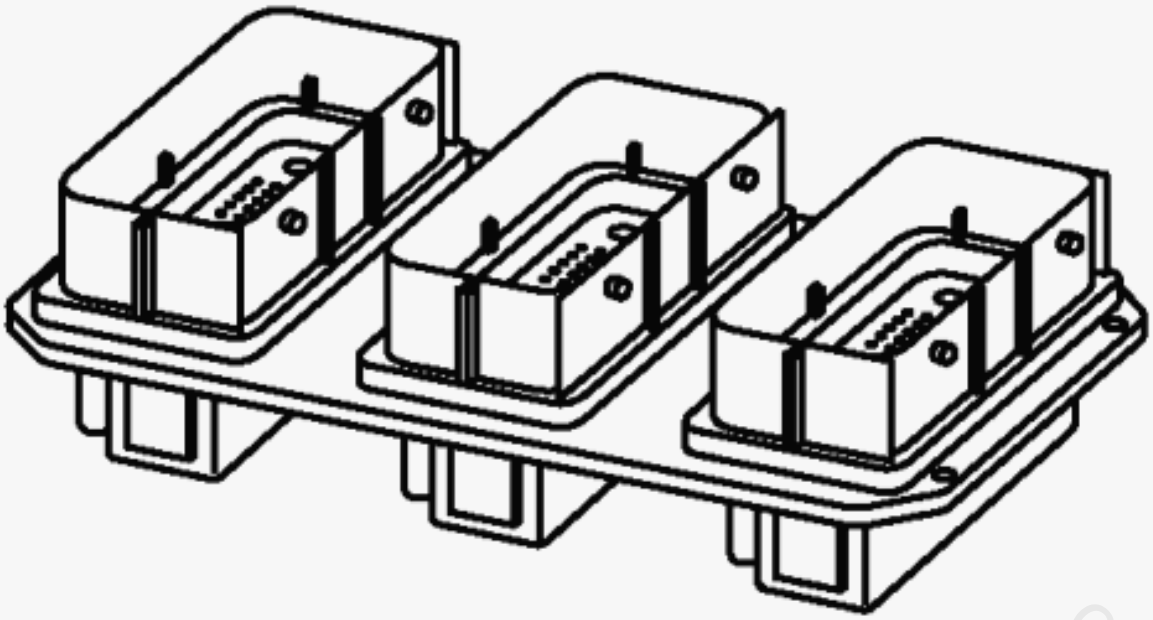
Illustration	Tool Number/Description
	CH-47976-512 E80 G3B Stop/Start Adapter

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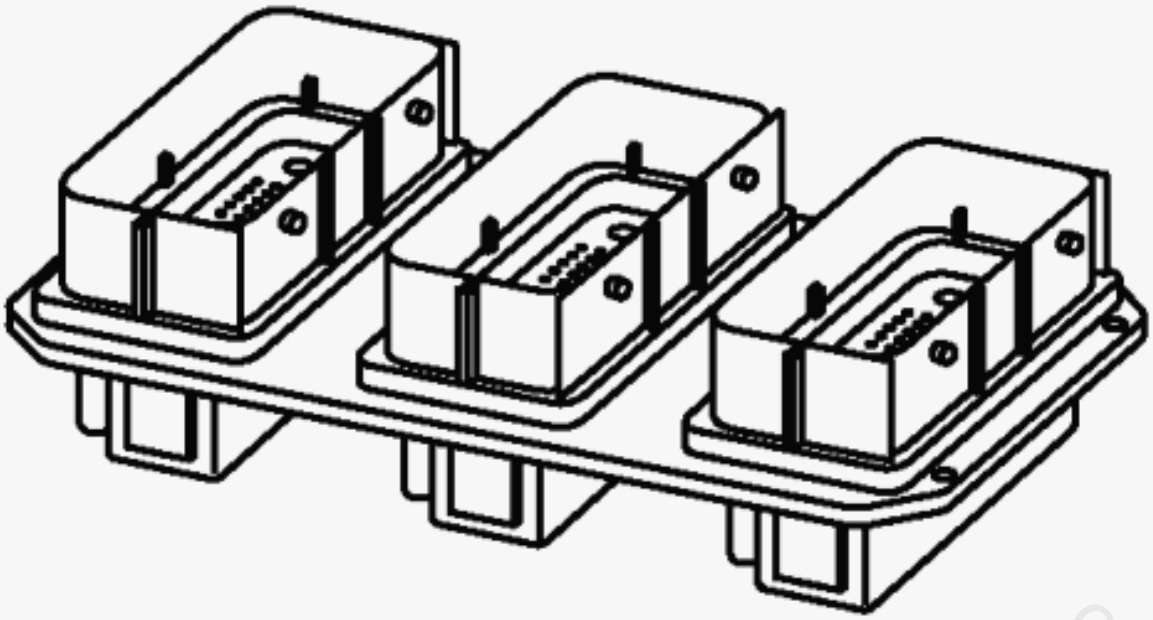
Illustration	Tool Number/Description
	CH-47976-513 E92 G2C Stop/Start and SENT Adapter

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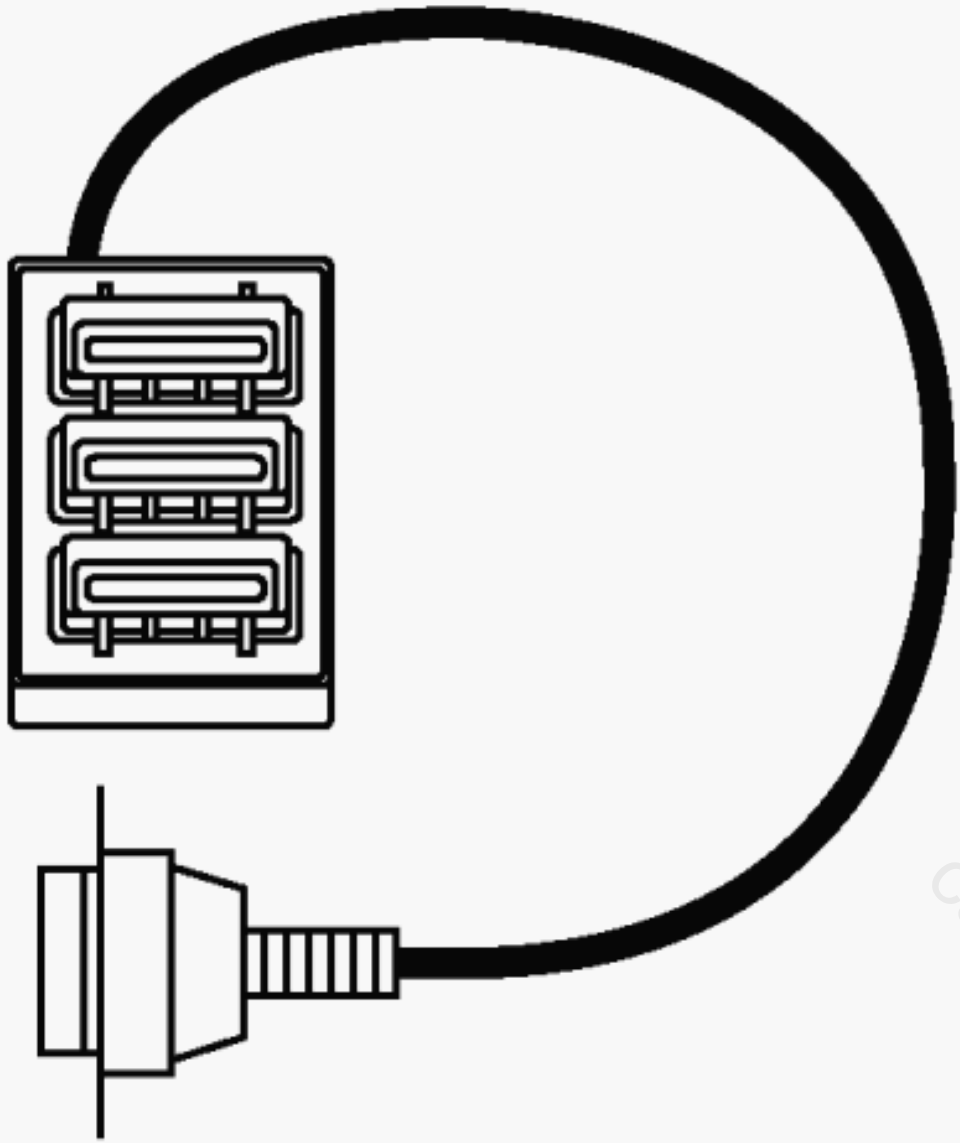
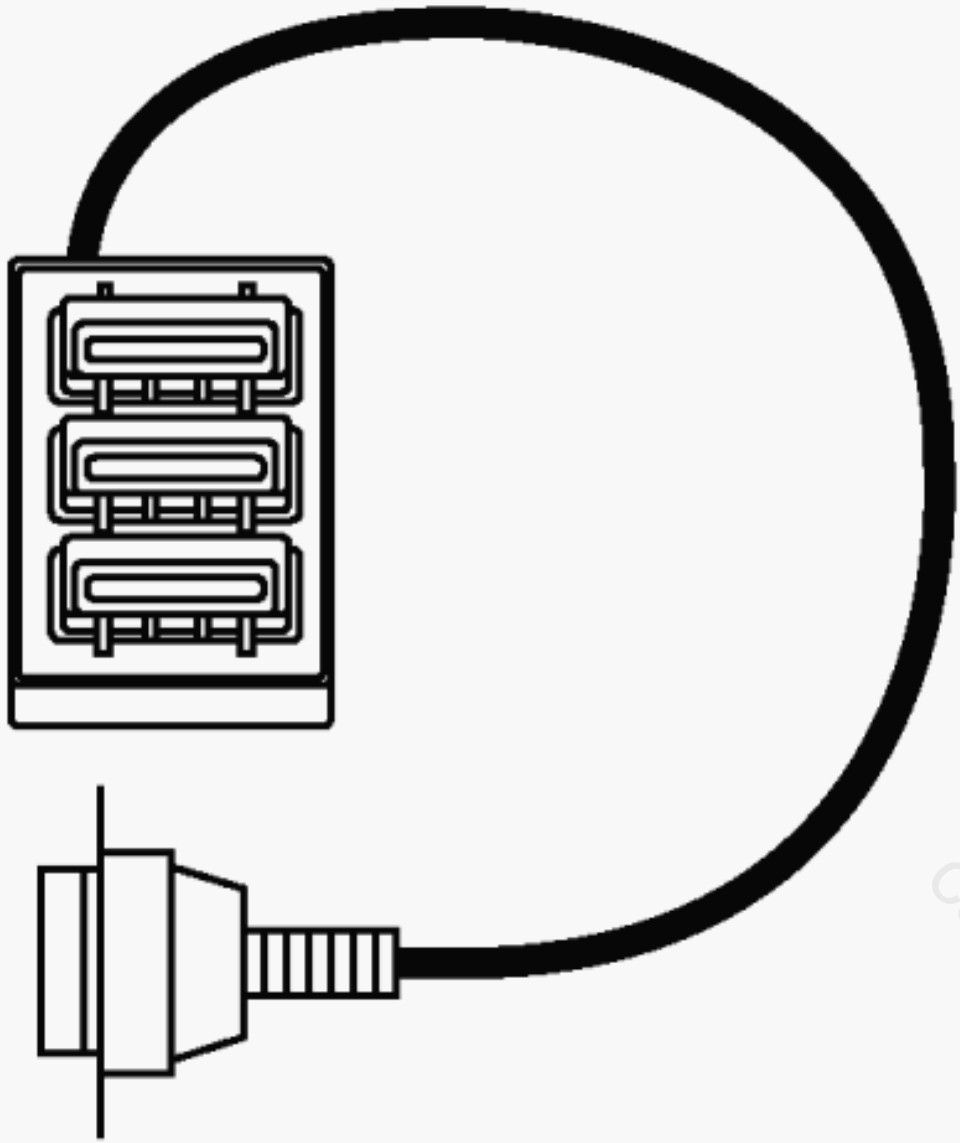
Illustration	Tool Number/Description
	CH-47976-514 AFIT SIDI E88 G6 Adapter Cable

cardiagn.com

Illustration	Tool Number/Description
	CH-47976-515 AFIT Universal Cable

cardiagn.com

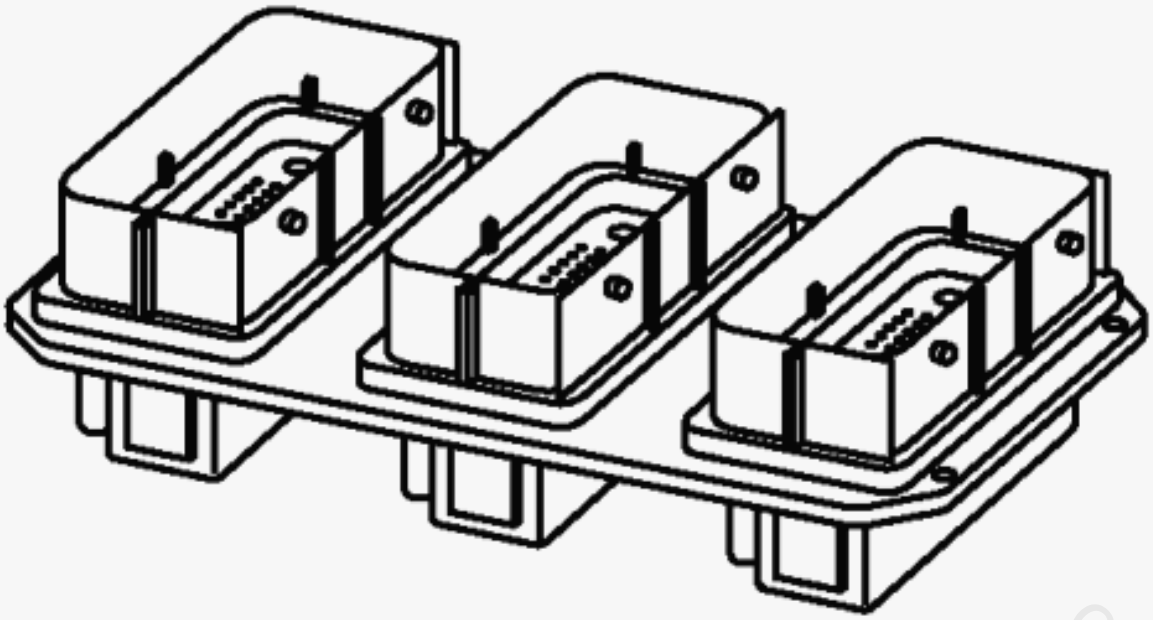
Illustration	Tool Number/Description
	CH-47976-516 AFIT E01 G7 Adapter Cable

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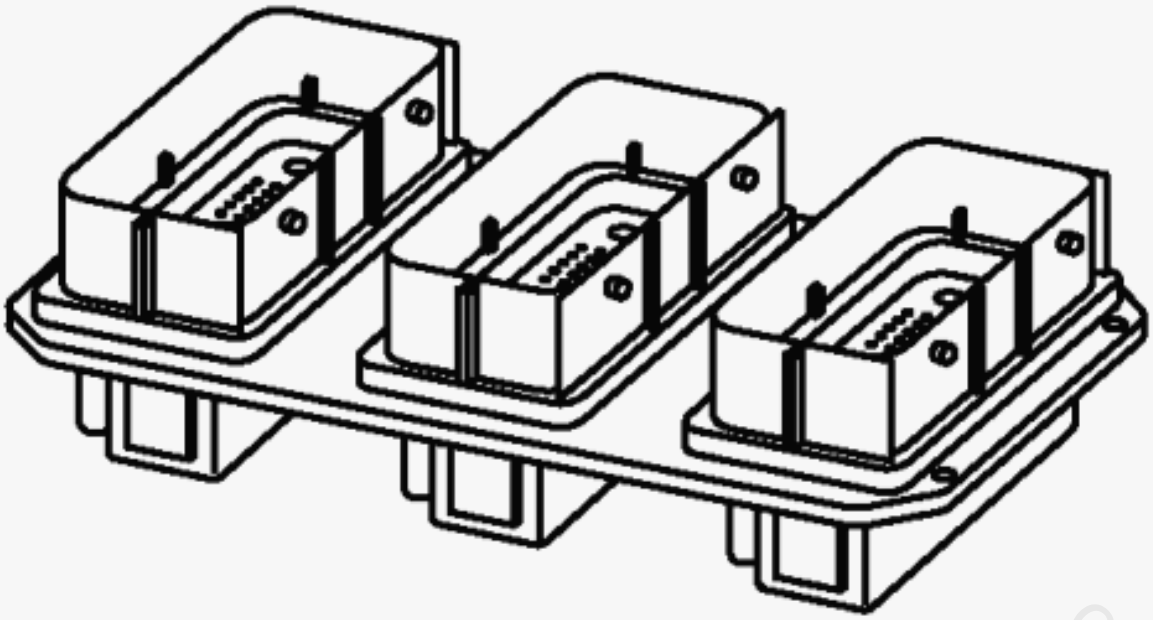
Illustration	Tool Number/Description
	CH-47976-517 AFIT E90 & E93 G8 Adapter Cable

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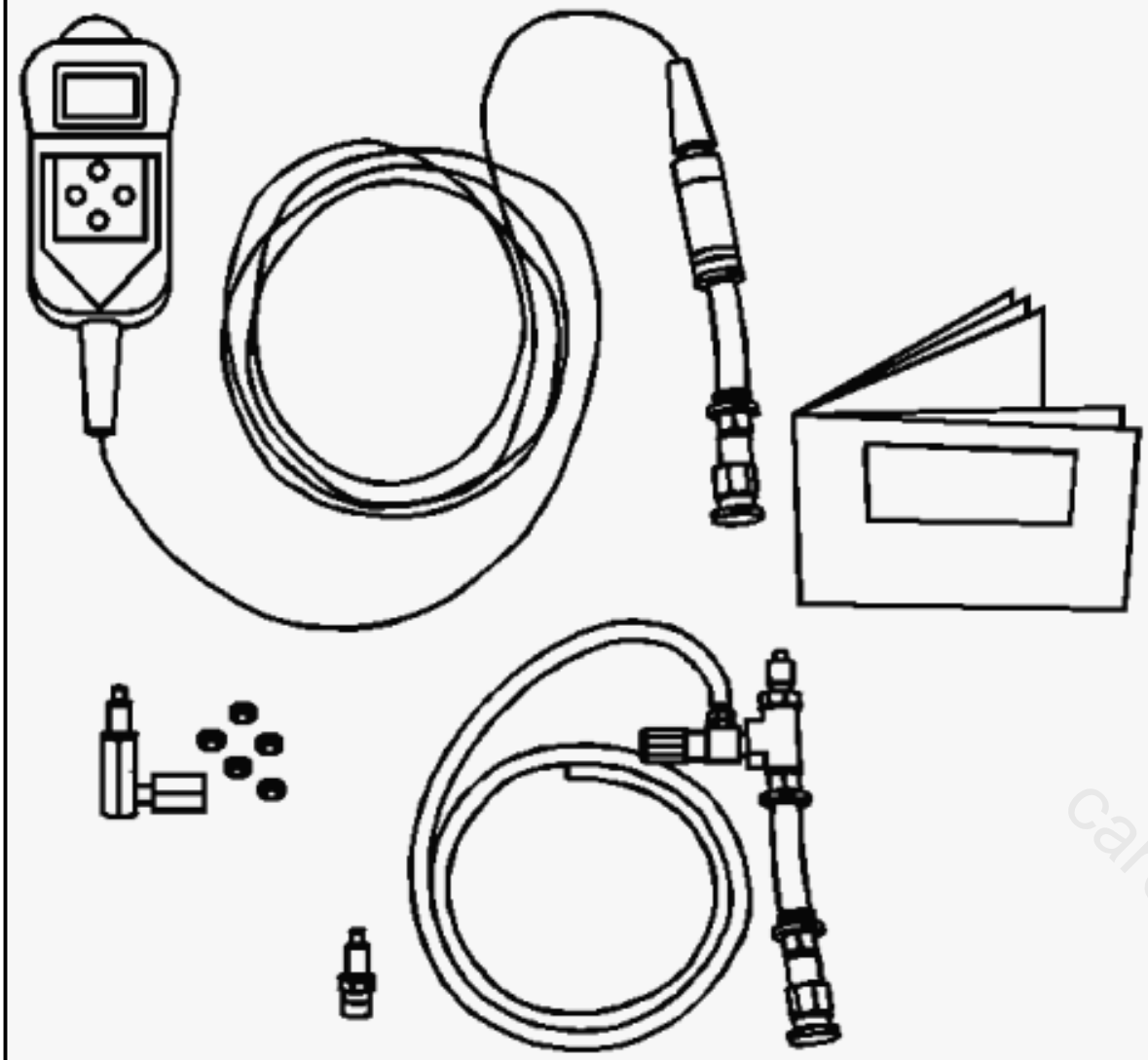
Illustration	Tool Number/Description
	CH-48027 Fuel Pressure Gauge

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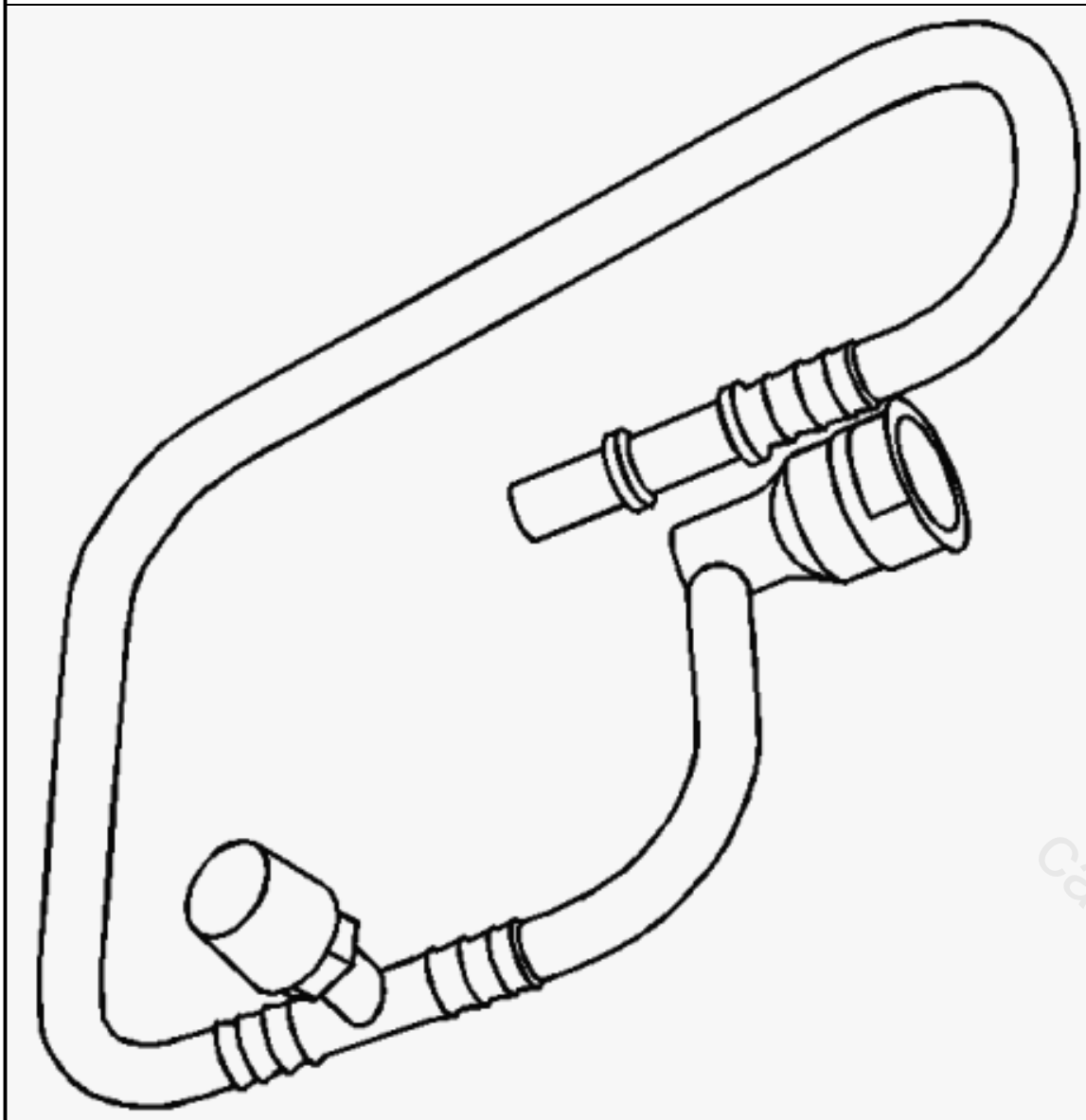
Illustration	Tool Number/Description
	CH-48096 EVAP Service Access Port Tool

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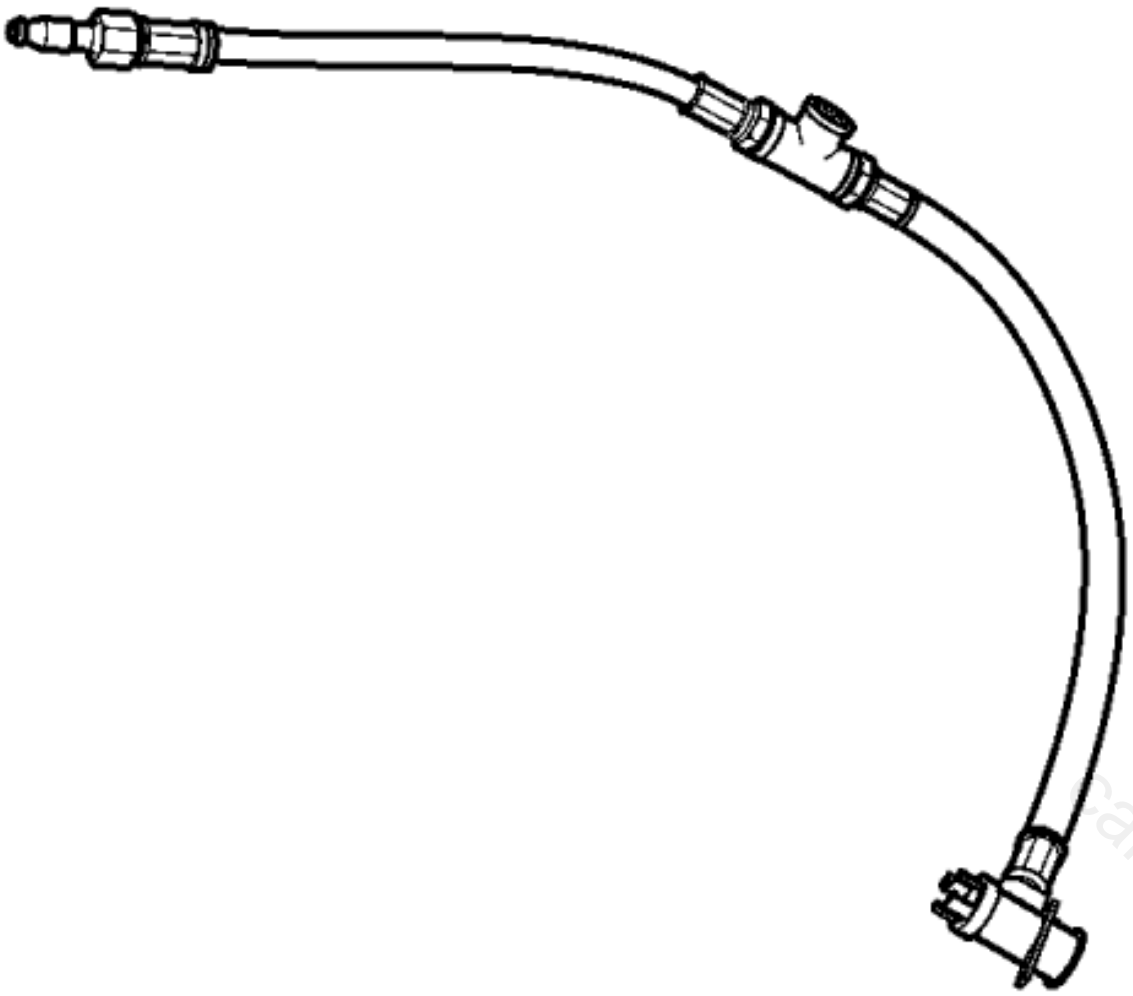
Illustration	Tool Number/Description
	CH-50375 Diesel Injector Return Line Pressure Adapter

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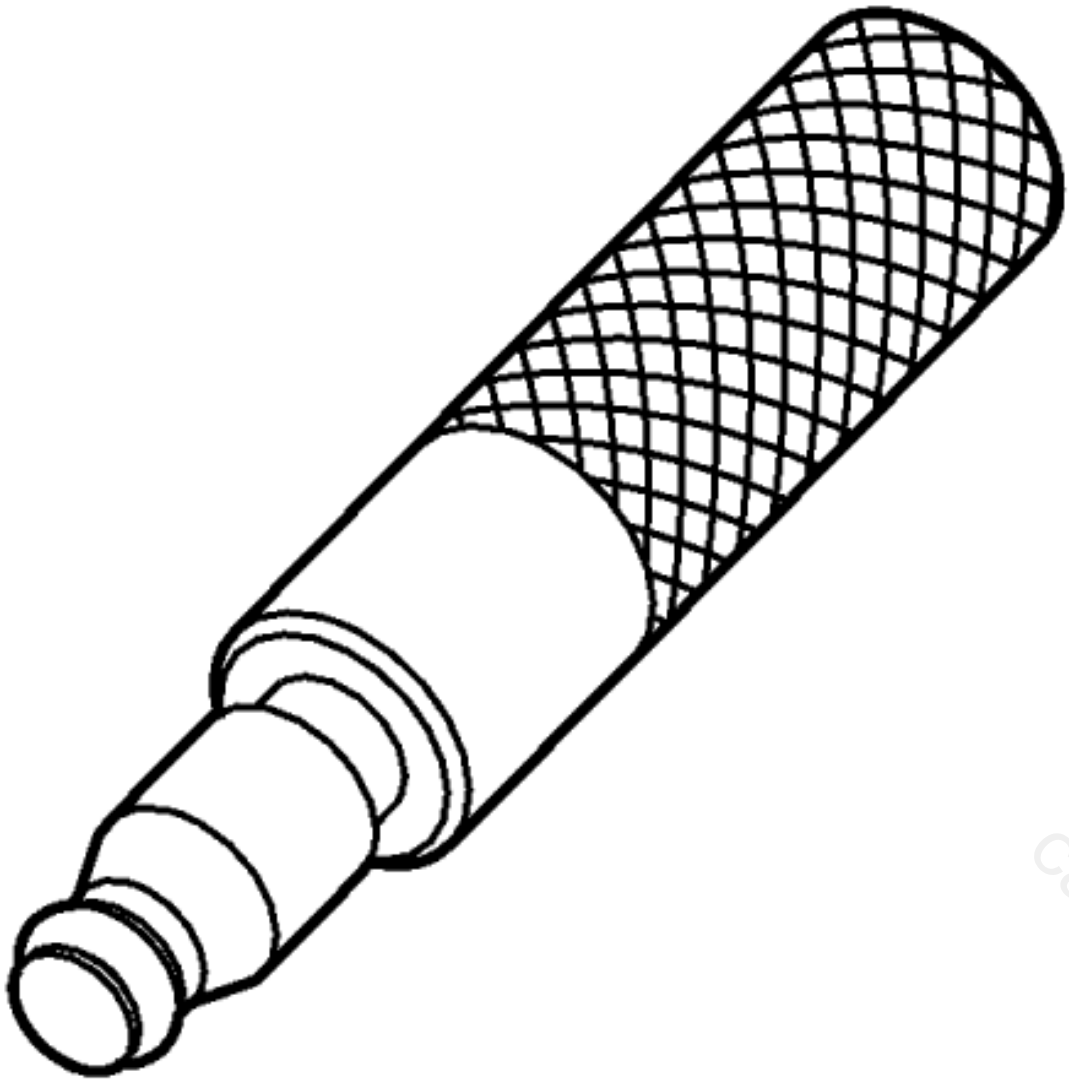
Illustration	Tool Number/Description
	CH-50377-A Injector Return Line Cap

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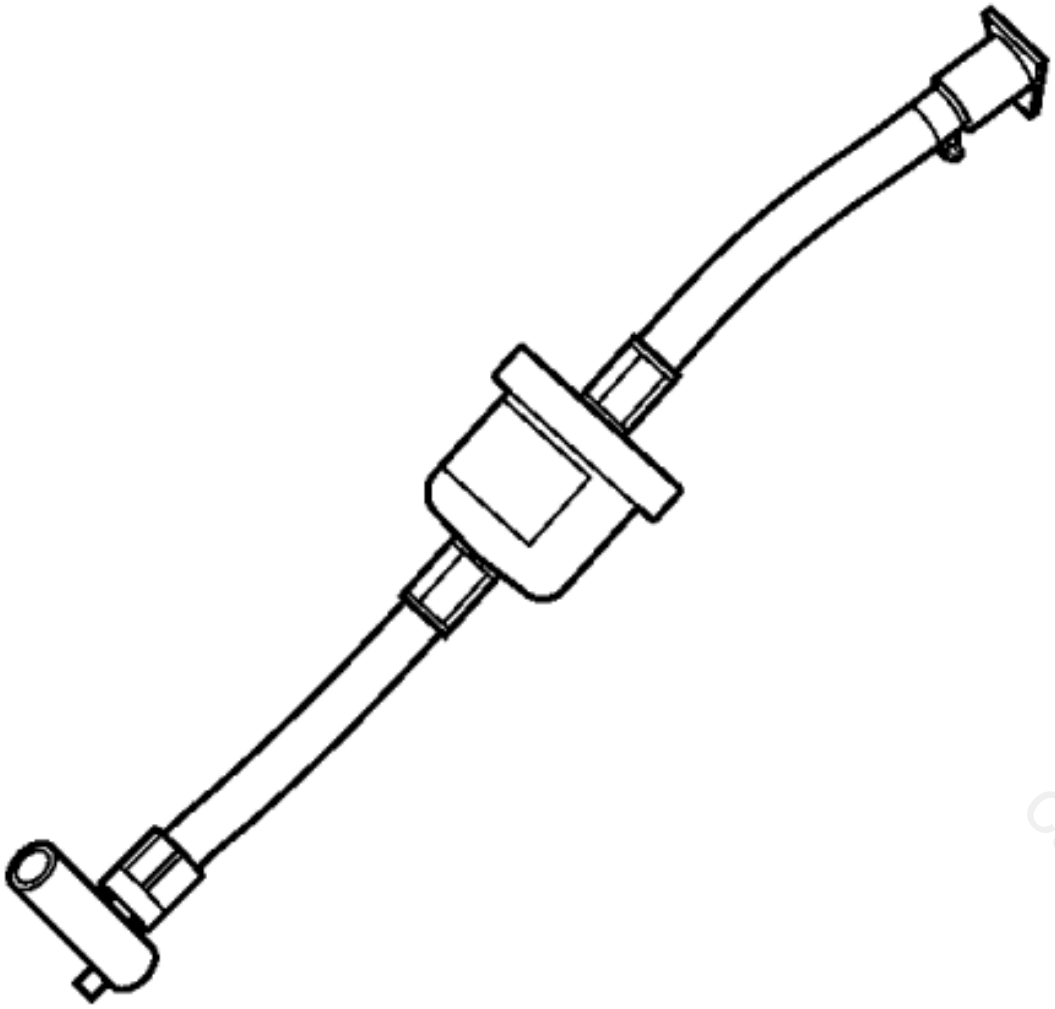
Illustration	Tool Number/Description
	CH-50378 Injector Return Leakage Test Adapter

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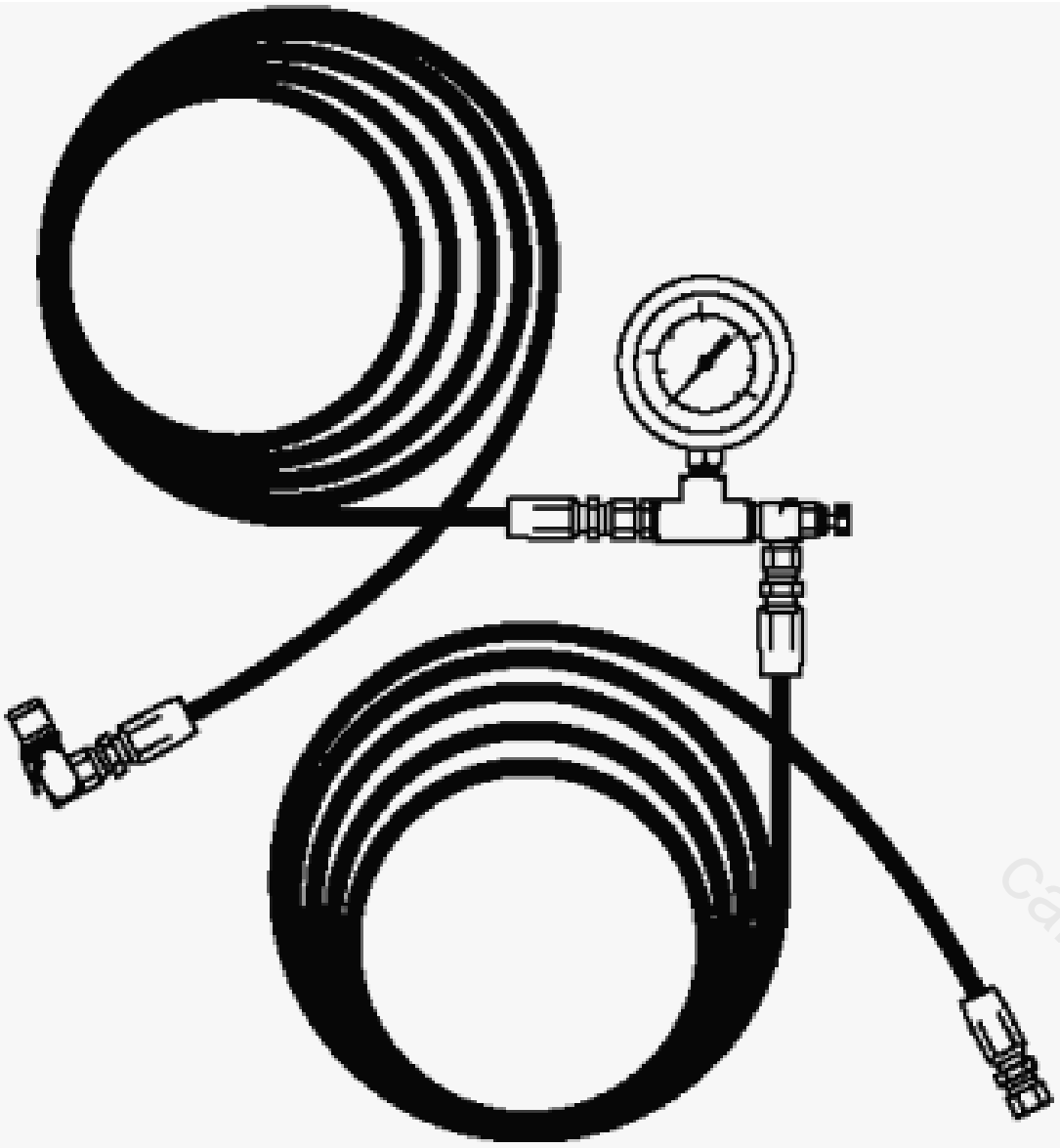
Illustration	Tool Number/Description
	CH-50933 Gauge Assembly, Liquid Propane Gas (LPG)

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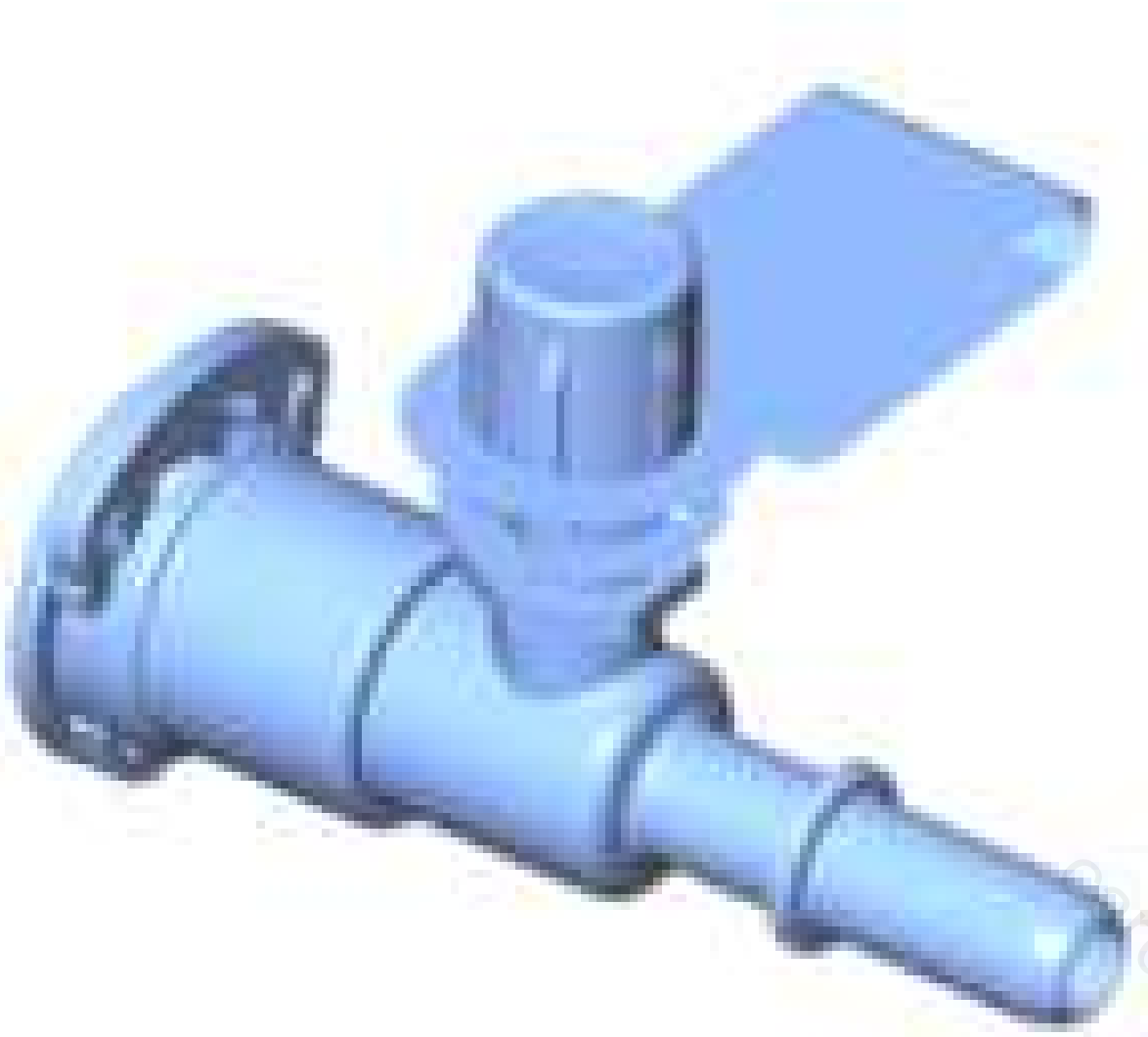
Illustration	Tool Number/Description
	CH-52519 EVAP Service Access Port Tool
	EL-26792 J-26792 HEI Spark Tester

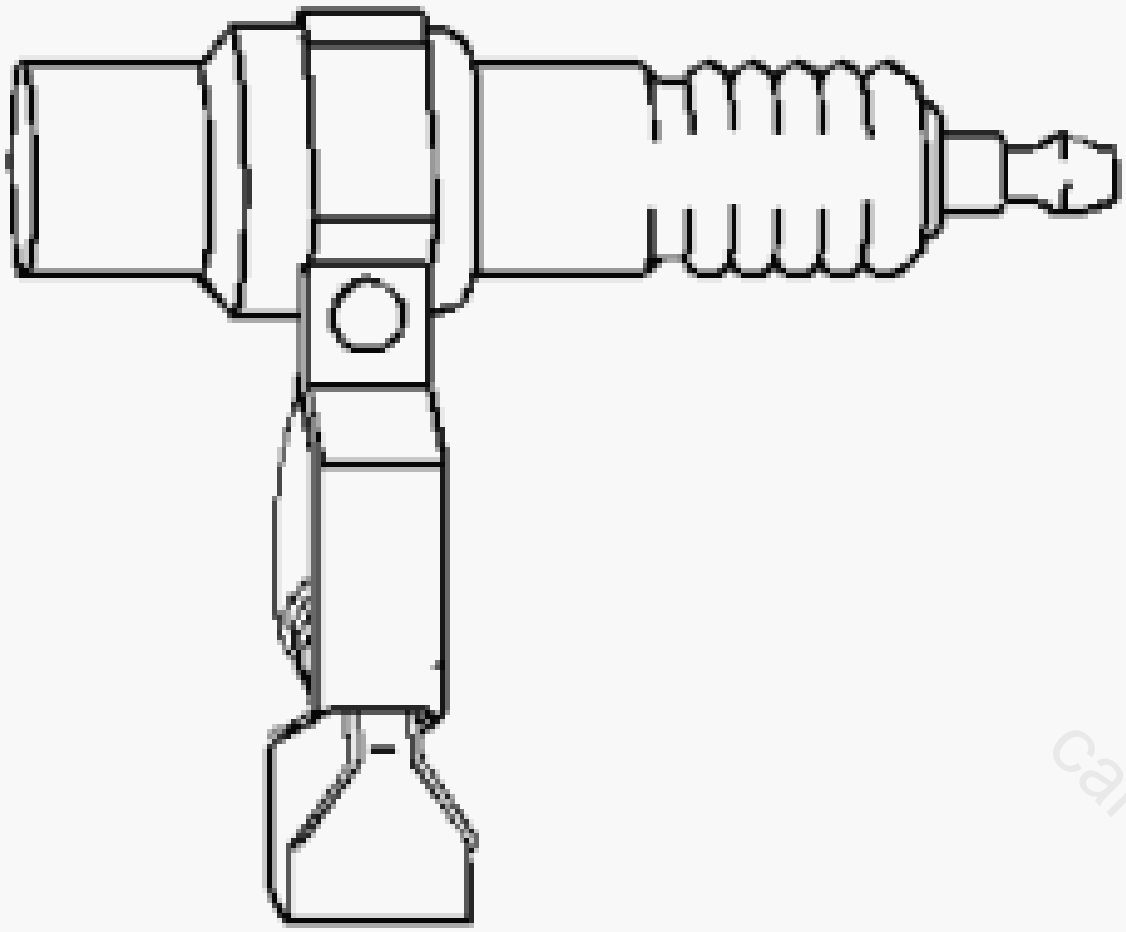
Illustration	Tool Number/Description
	EL-34730-405 J-34730-405 Injector Test Lamp

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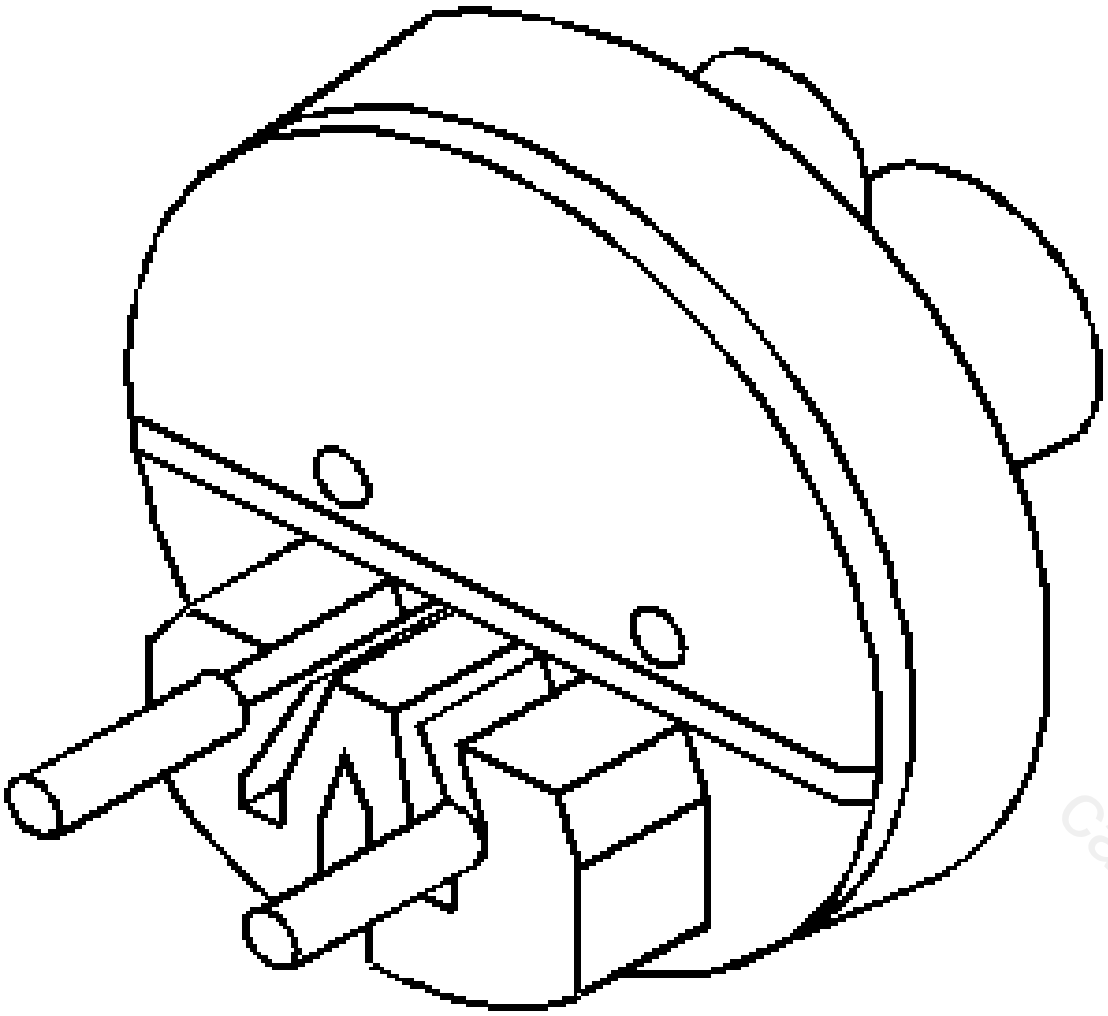
Illustration	Tool Number/Description
	

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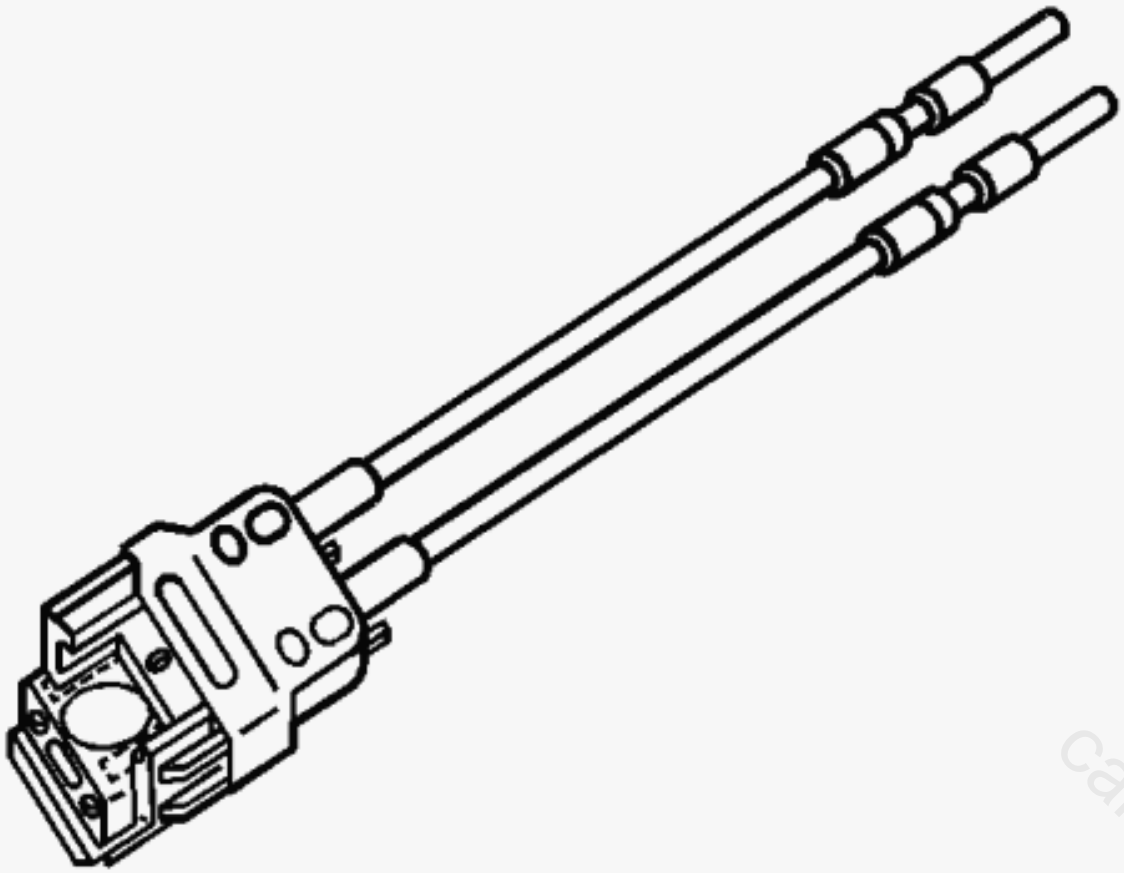
Illustration	Tool Number/Description
	EL-36169-HD Heavy Duty Fused Jumper
	EL-38522-A J-38522-A Variable Signal Generator

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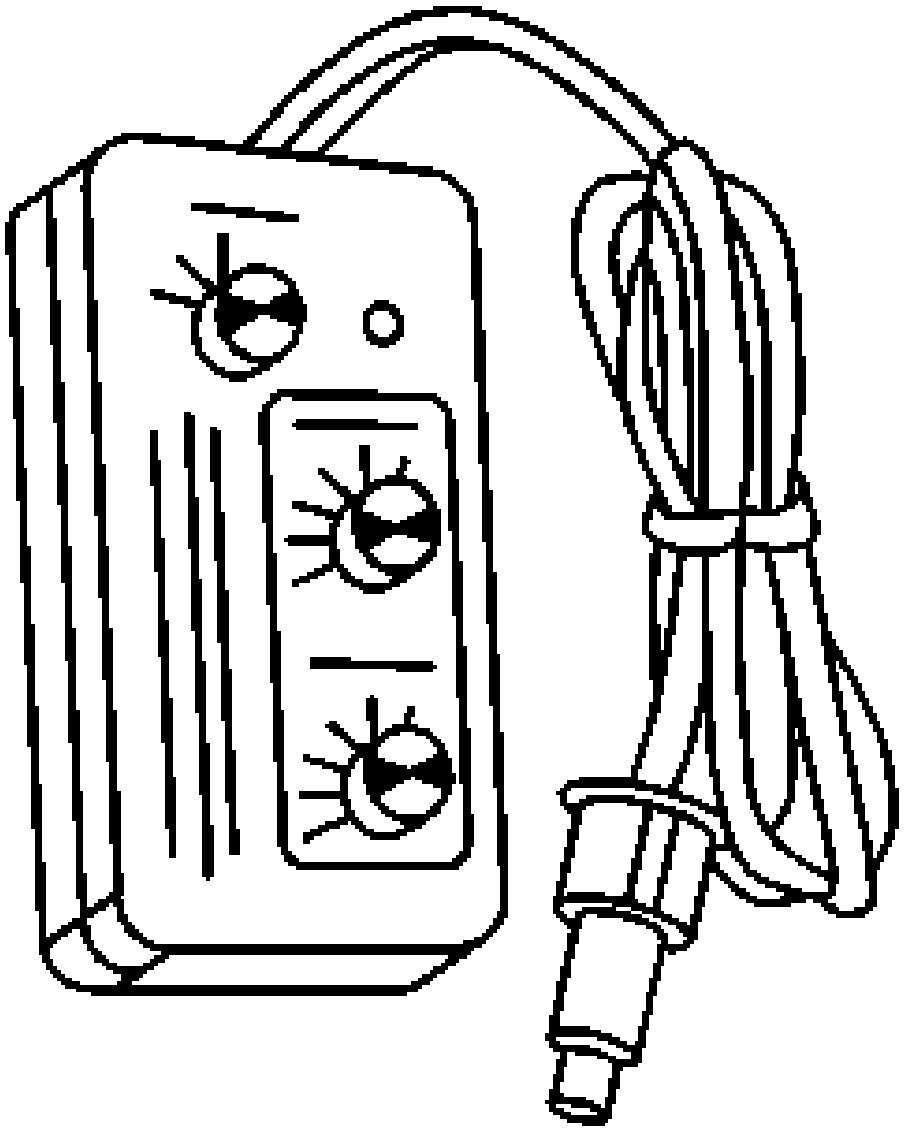
Illustration	Tool Number/Description
	

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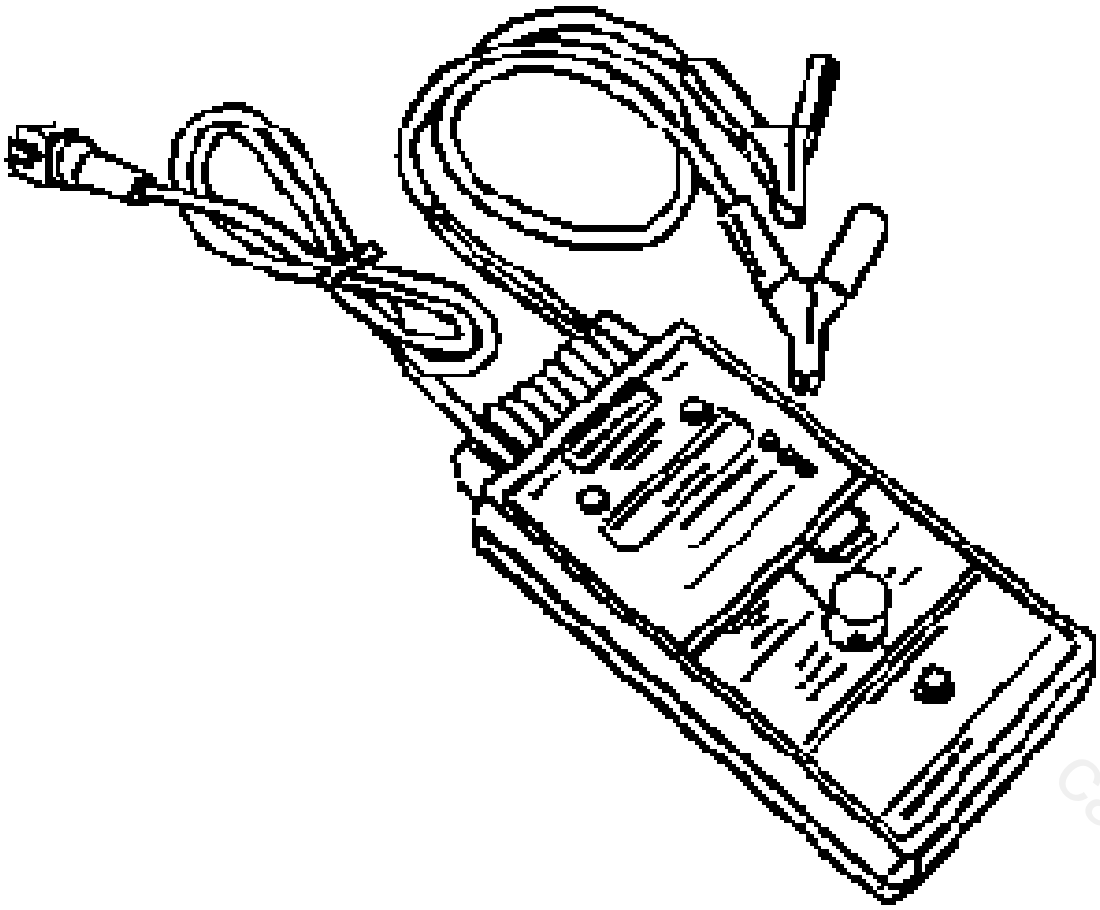
Illustration	Tool Number/Description
	EL-39021 J-39021 Fuel Injector Coil Balance Tester

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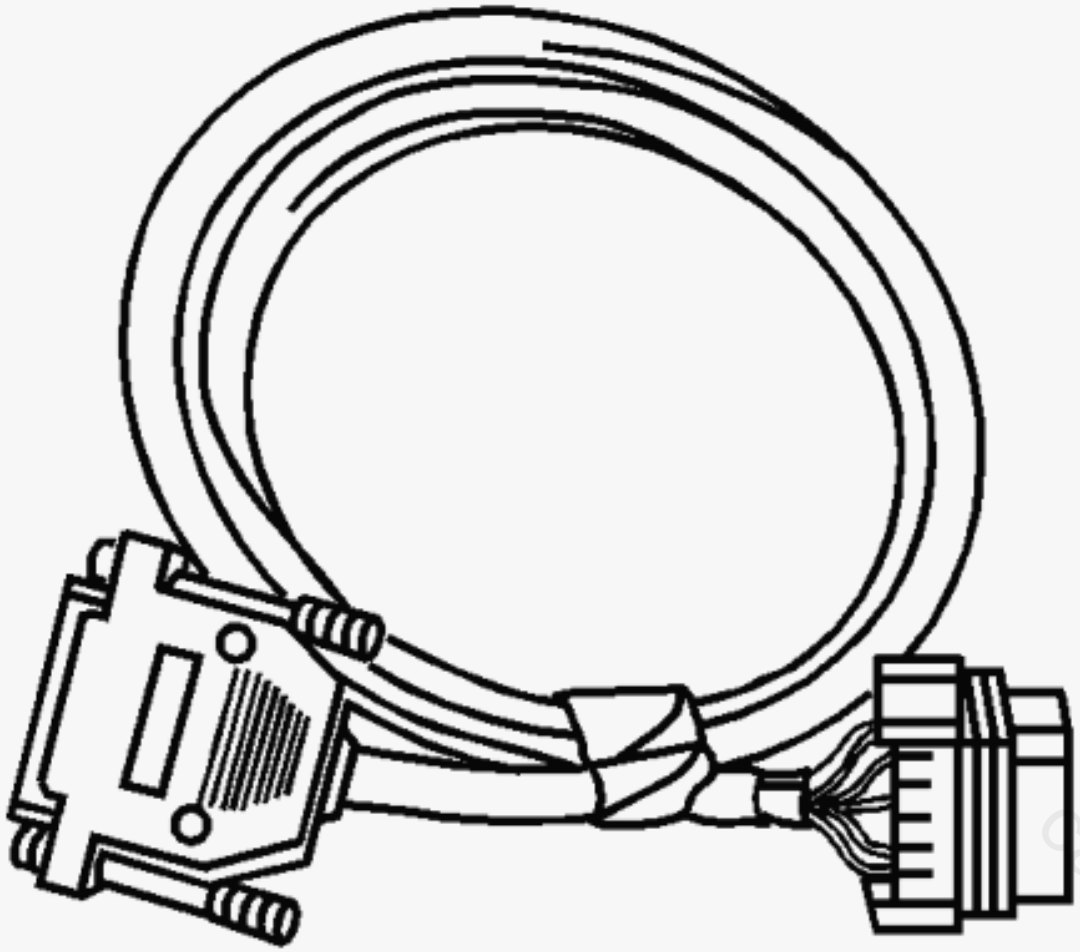
Illustration	Tool Number/Description
	EL-39021-460 J-39021-460 Fuel Injector Test Adapter

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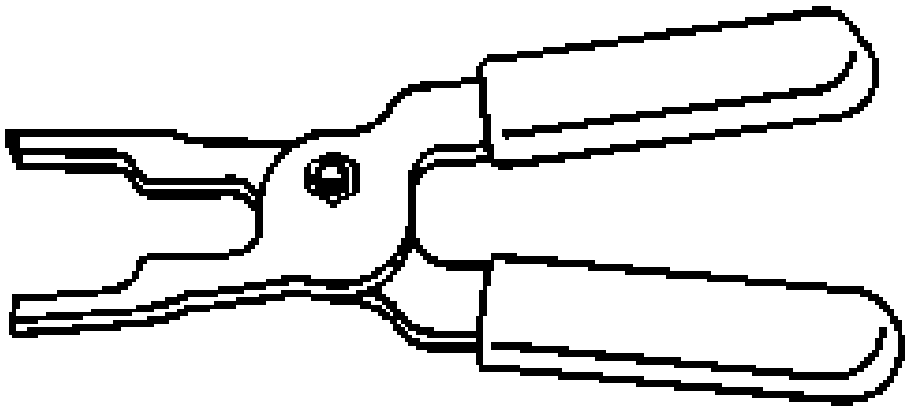
Illustration	Tool Number/Description
	EL-43244 J-43244 Relay Puller Pliers

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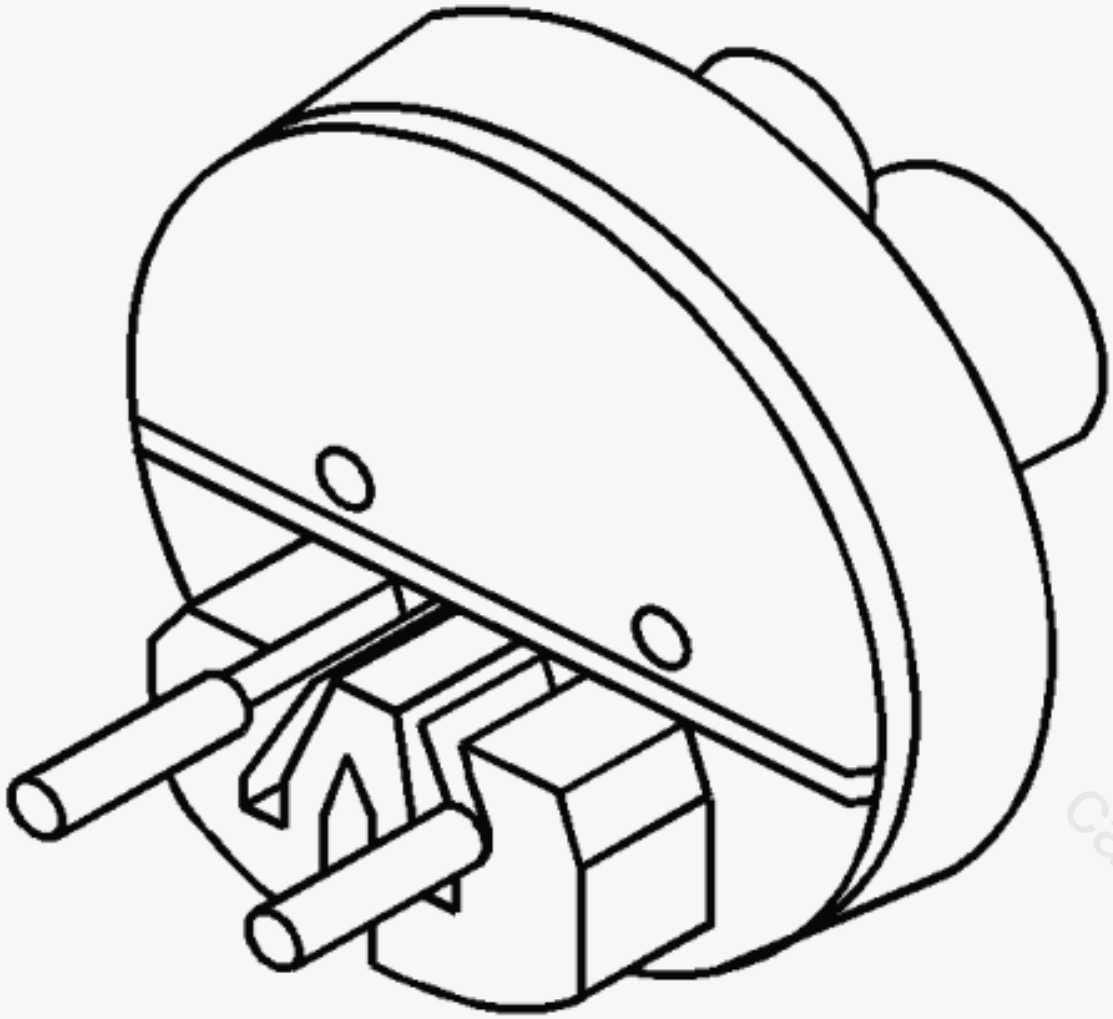
Illustration	Tool Number/Description
	EL-44603 J-44603 Injector Test Lamp

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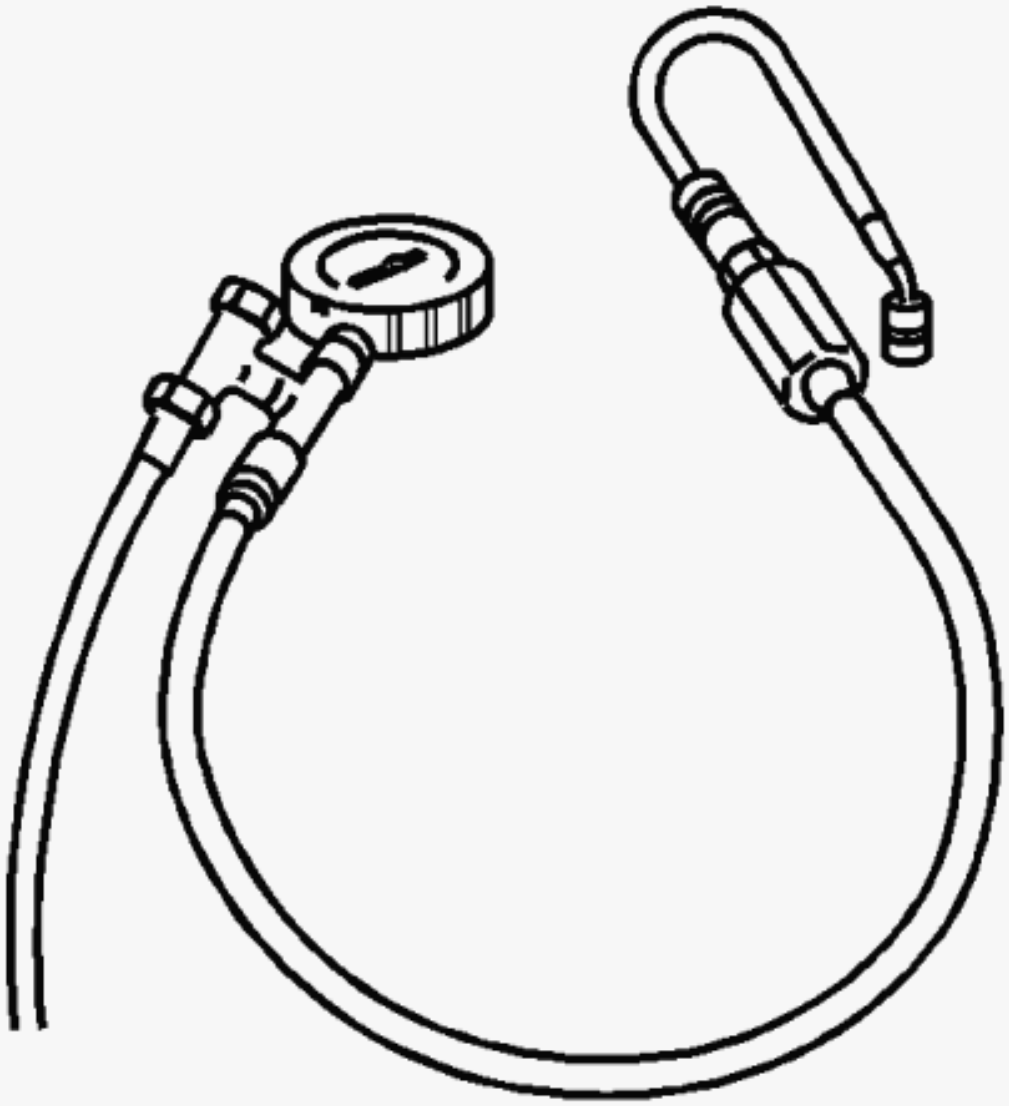
Illustration	Tool Number/Description
	EN-34730-91 J-34730-91 KM-J-34730-91 Pressure Tester
	EN-36012-A J-36012-A Ignition System Diagnosis Harness

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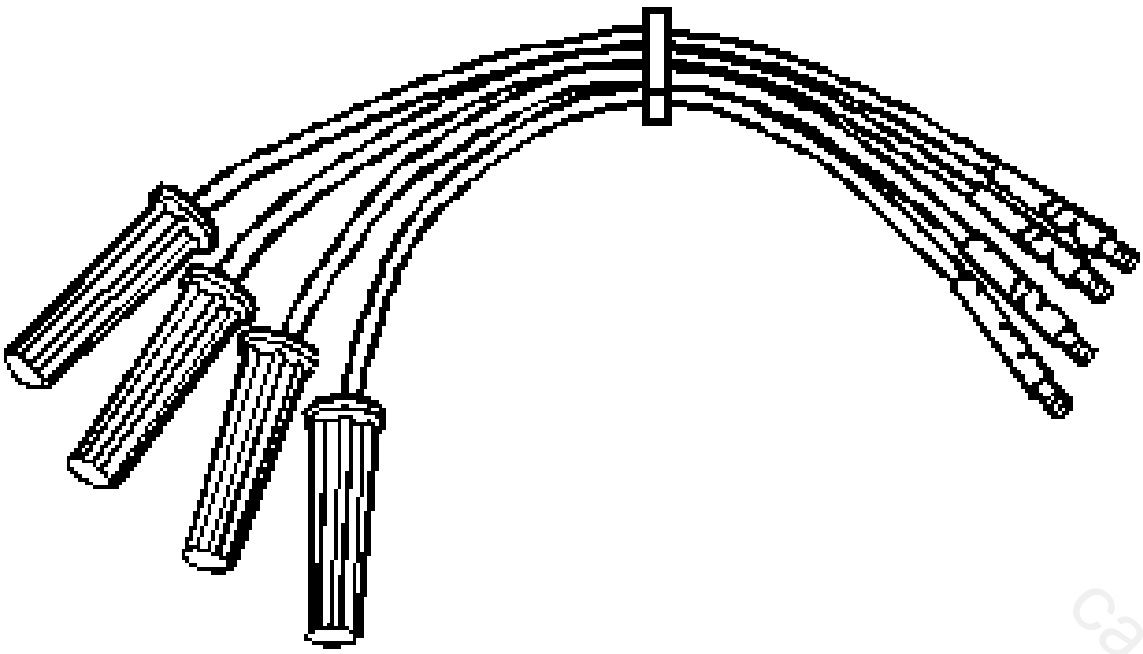
Illustration	Tool Number/Description
	
	EN-37287 J-37287 Fuel Line Shut-off Adapters

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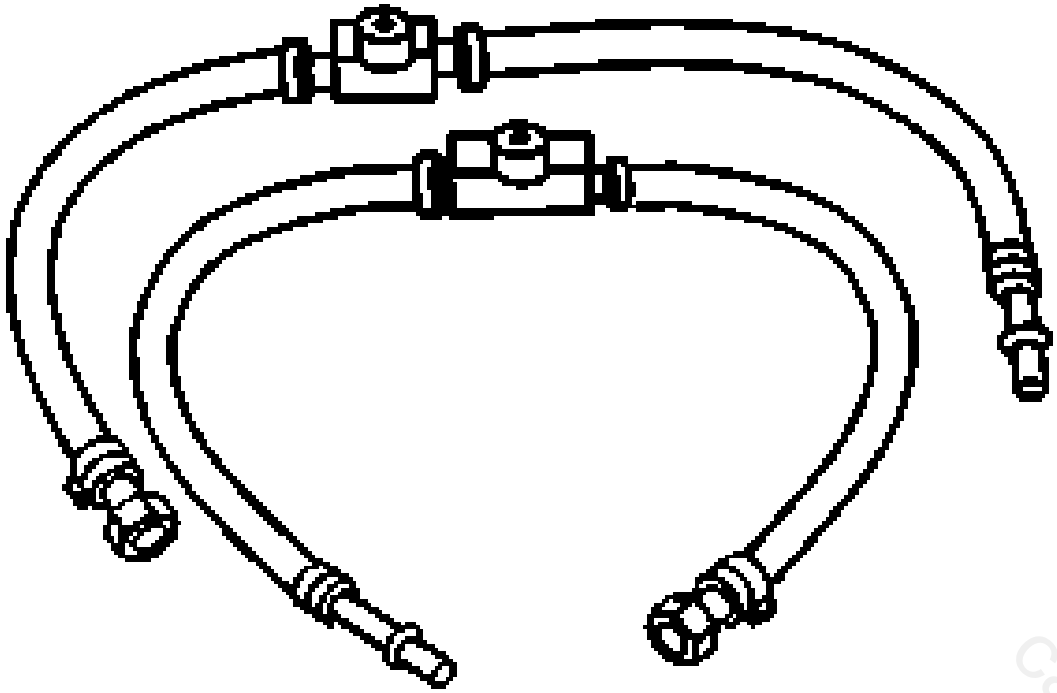
Illustration	Tool Number/Description
	

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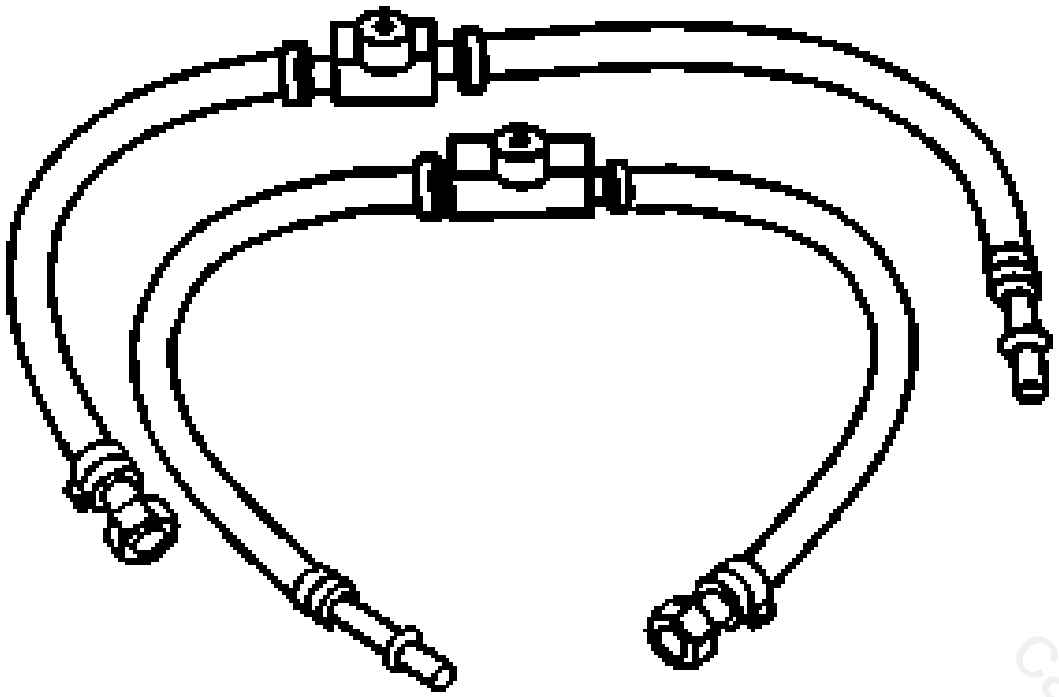
Illustration	Tool Number/Description
	EN-37287 - FF Fuel Line Shut-off Adapters

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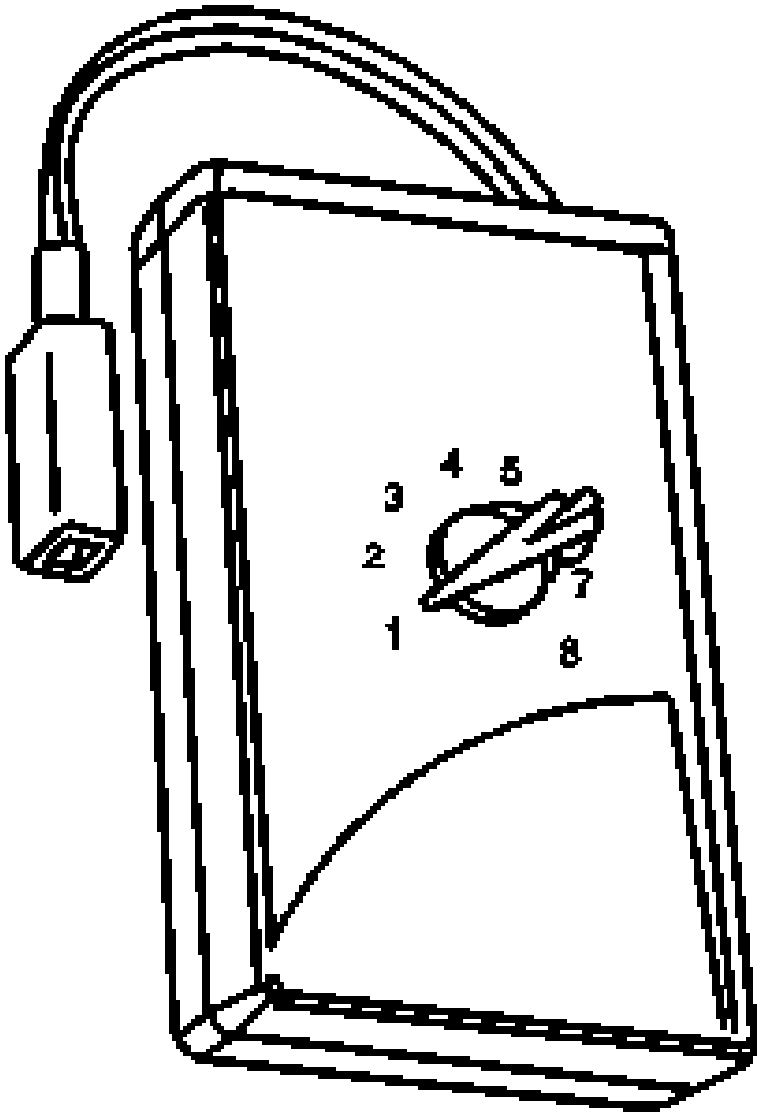
Illustration	Tool Number/Description
	EN-39021-210 J-39021-210 Injector Tester Adapter Box

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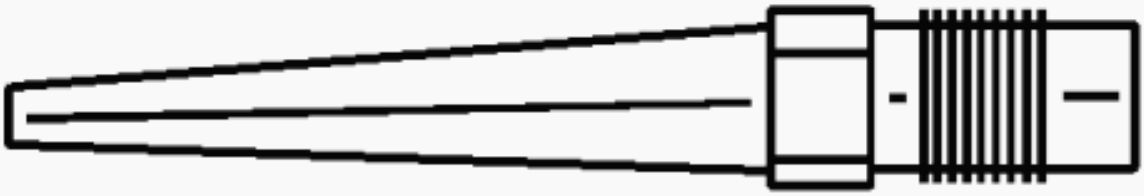
Illustration	Tool Number/Description
	EN-41413-311 J-41413-311 EVAP Plug

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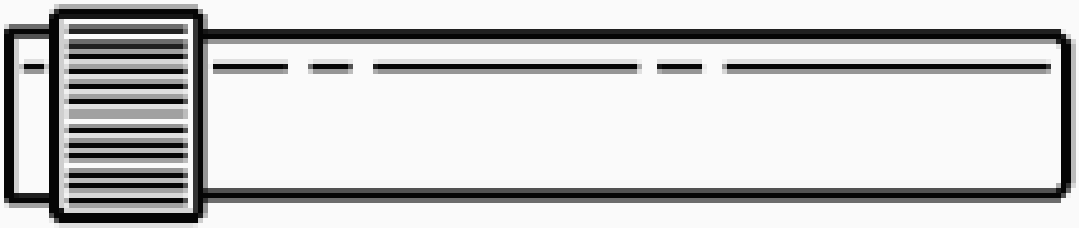
Illustration	Tool Number/Description
	EN-41413-VLV J-41413-VLV EVAP Service Port Vent Fitting
	EN-44602 J-44602 Injector Test Adapter

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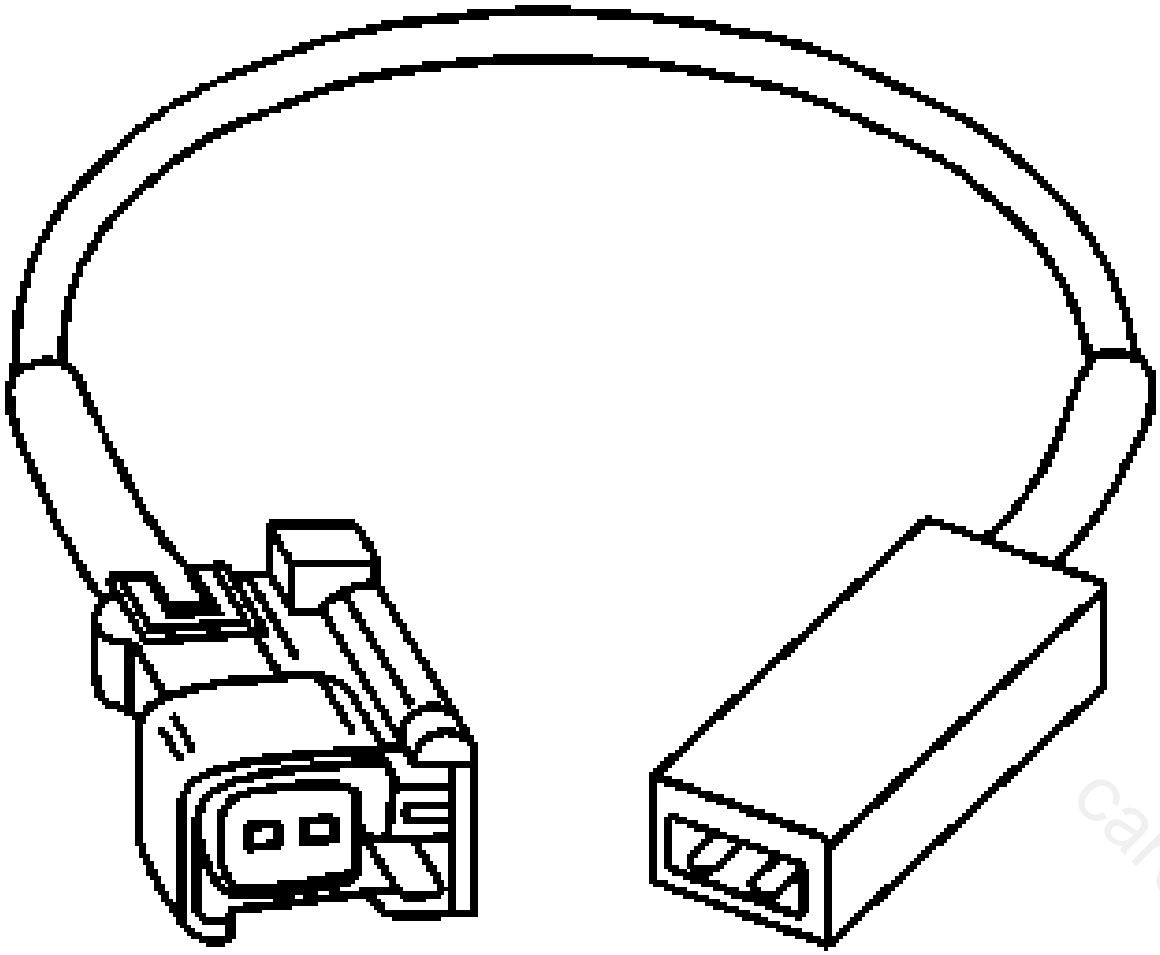
Illustration	Tool Number/Description
	

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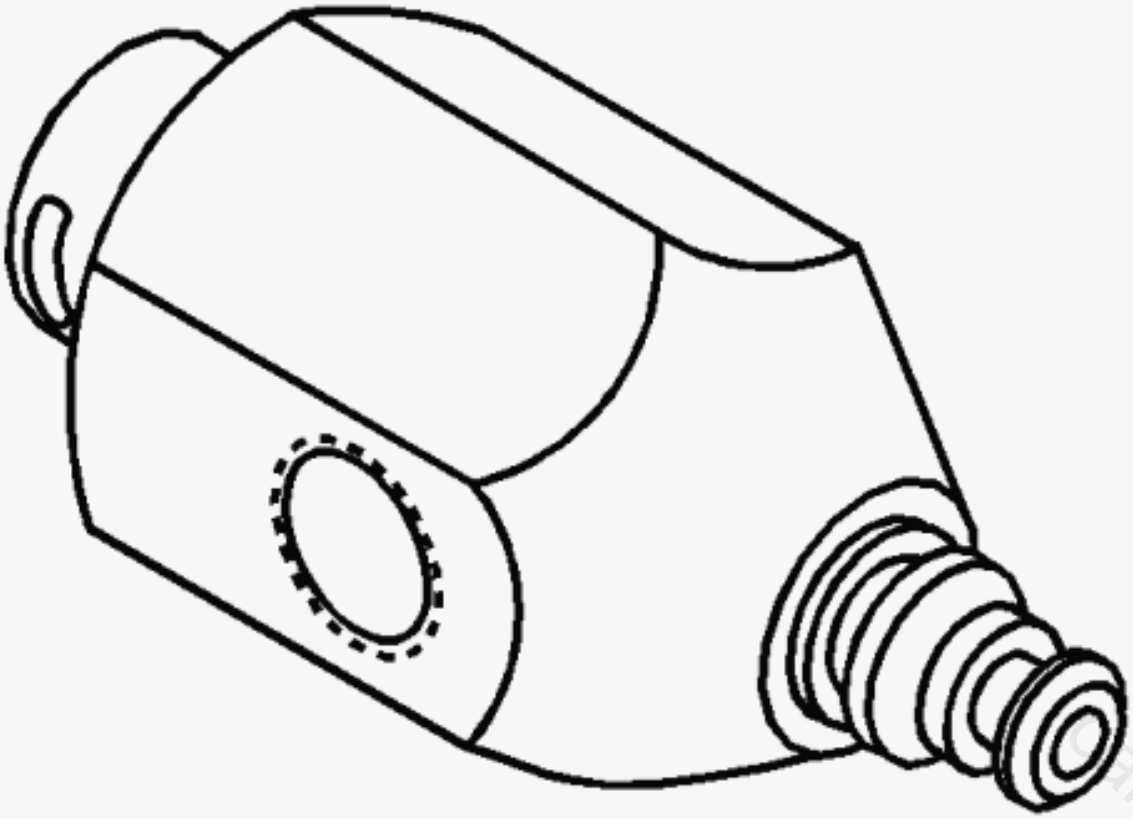
Illustration	Tool Number/Description
	EN-45873-30 J-45873-30 Injector Flow Test Adapter

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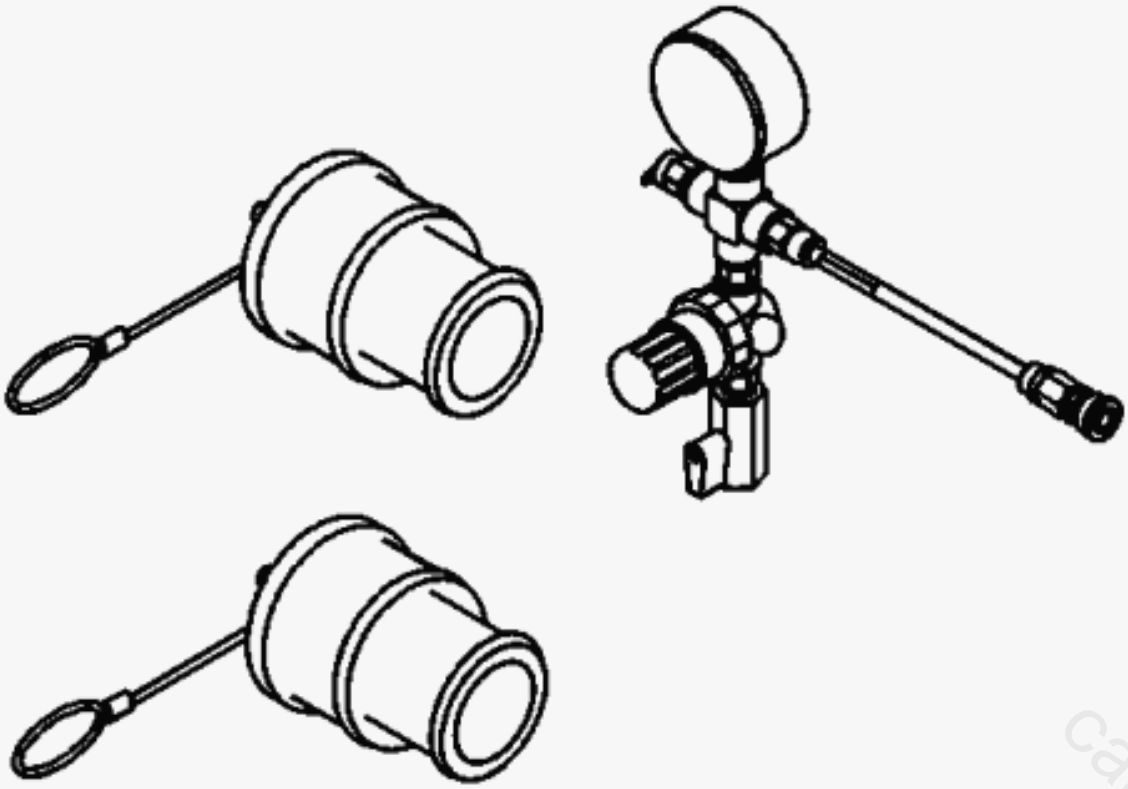
Illustration	Tool Number/Description
	EN-46091 J-46091 Charge Air Cooler Tester

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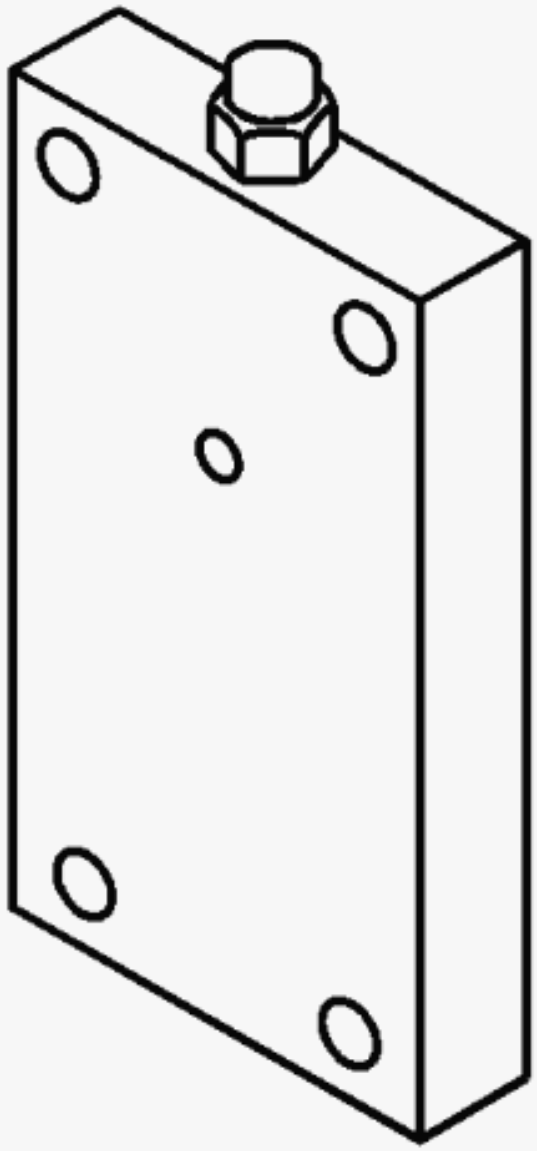
Illustration	Tool Number/Description
	EN-46091-5 J-46091-5 Charge Air Cooler Tester Adapter

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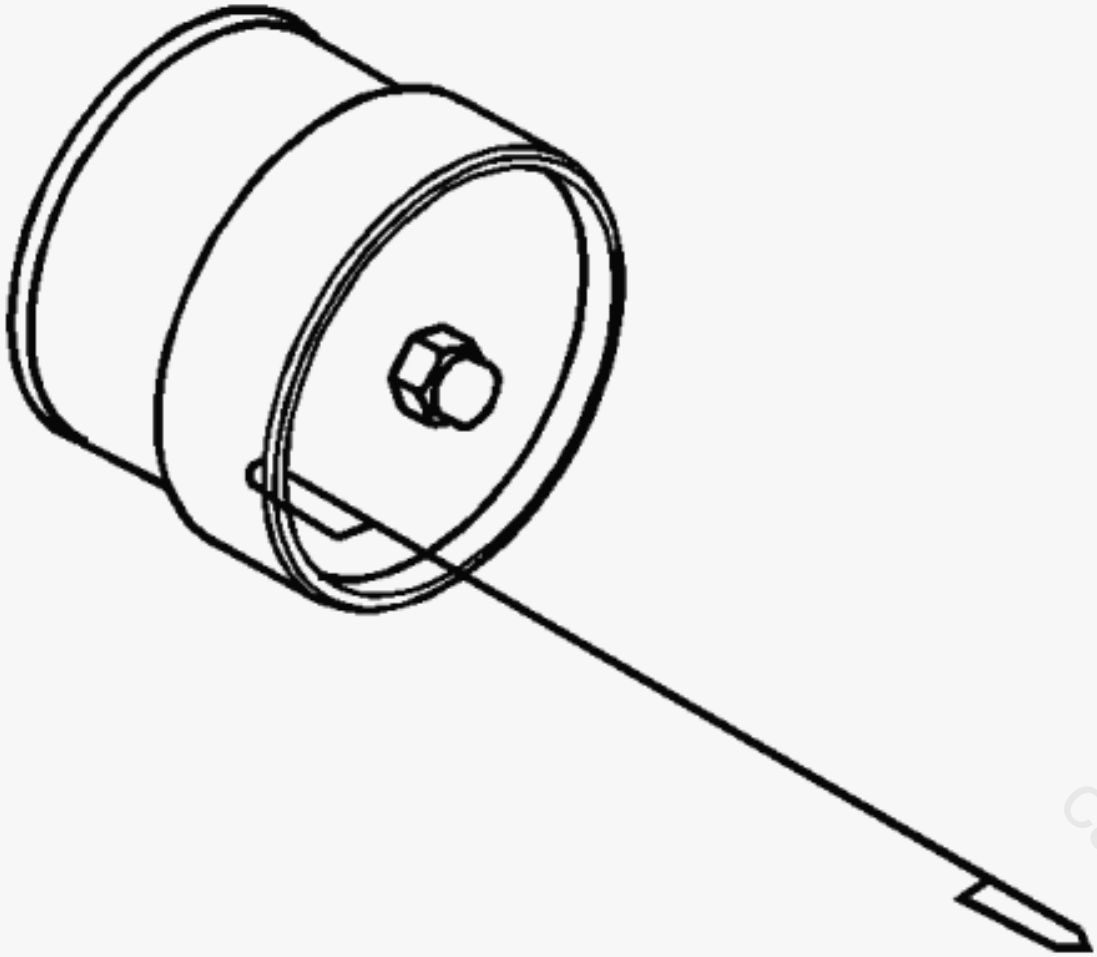
Illustration	Tool Number/Description
	EN-46091-10A Diesel Engine Pressure Test Adapter

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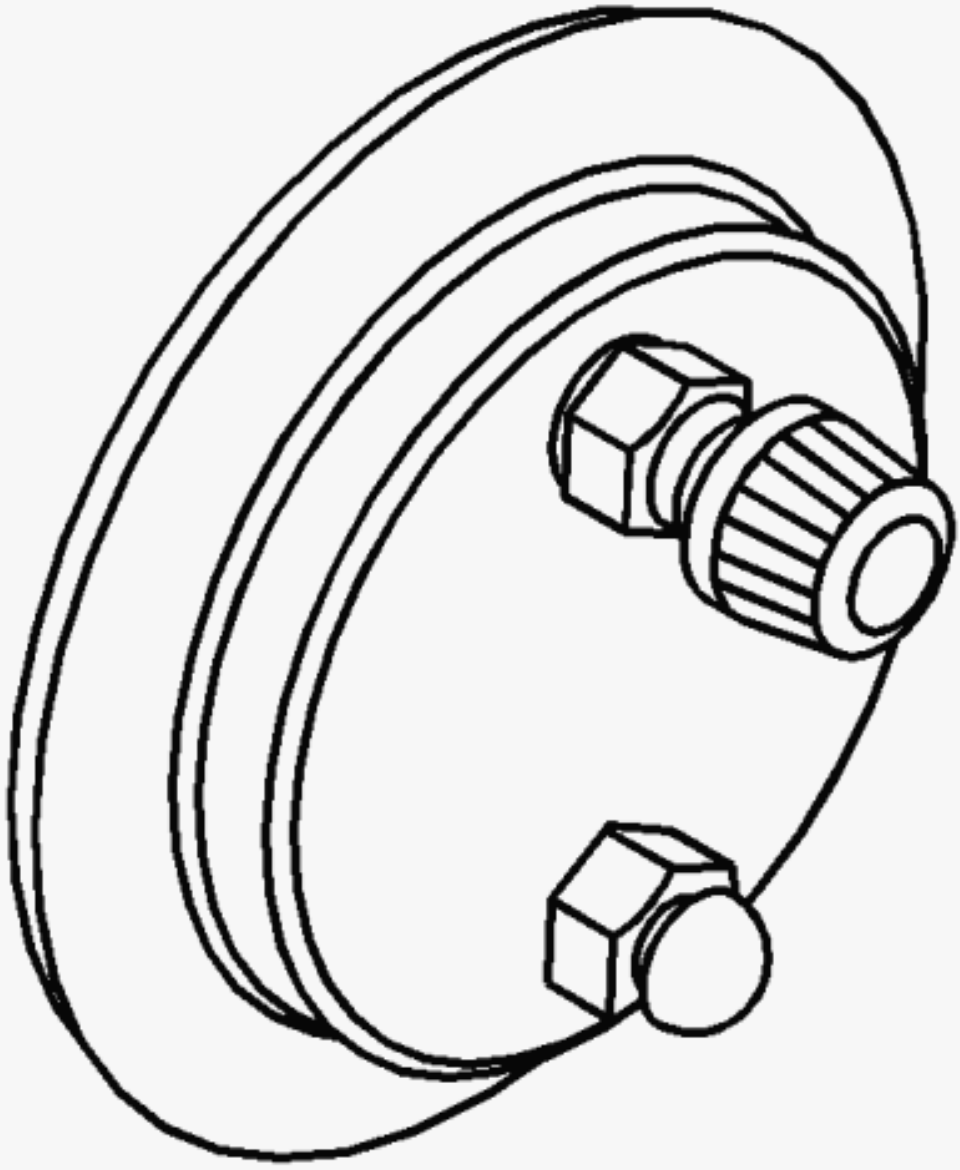
Illustration	Tool Number/Description
	EN-46091-15 J-46091-15 Engine Pressure Test Adapter

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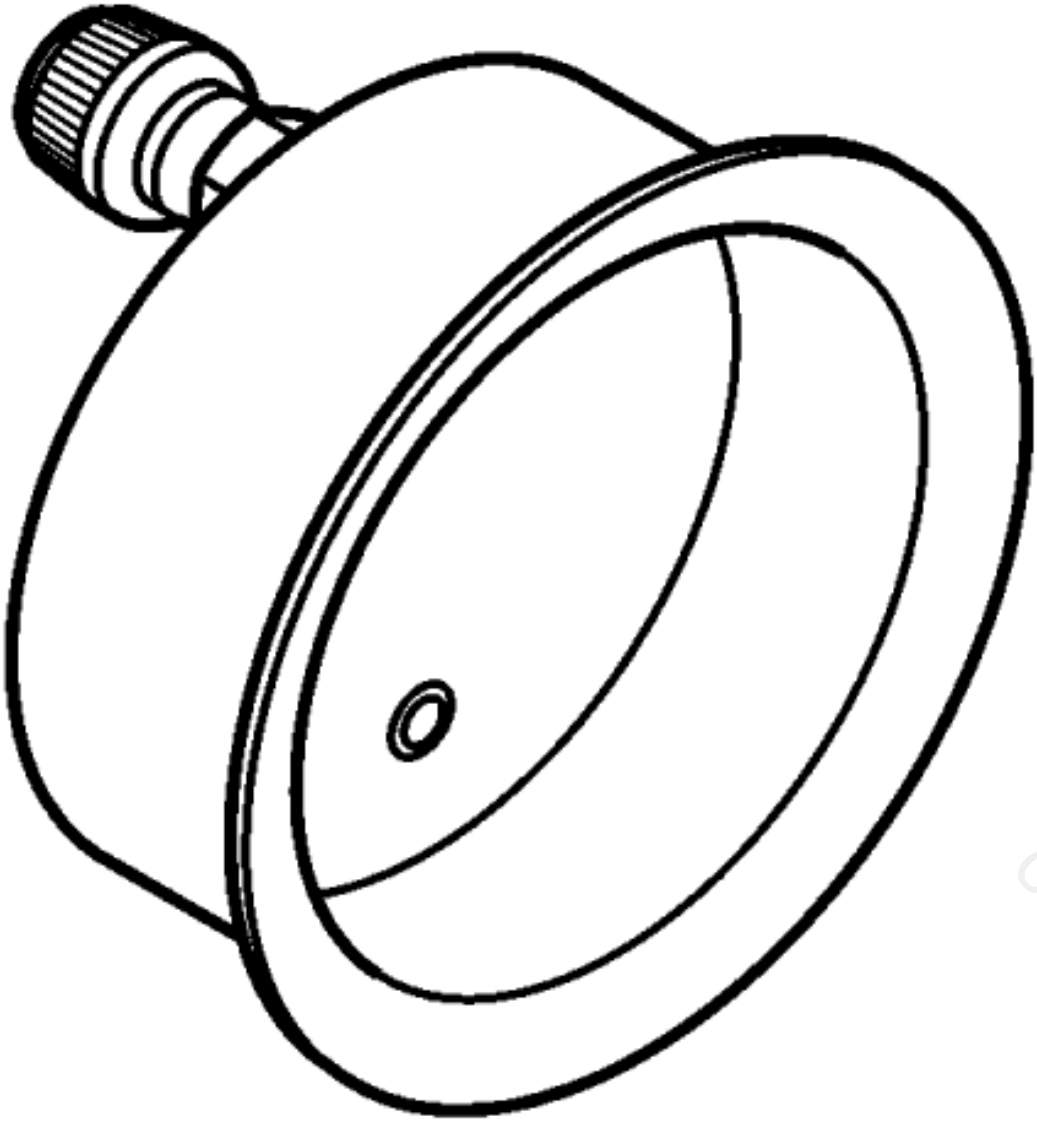
Illustration	Tool Number/Description
	EN-46091-15A J-46091-15A Diesel Engine Pressure Test Adapter

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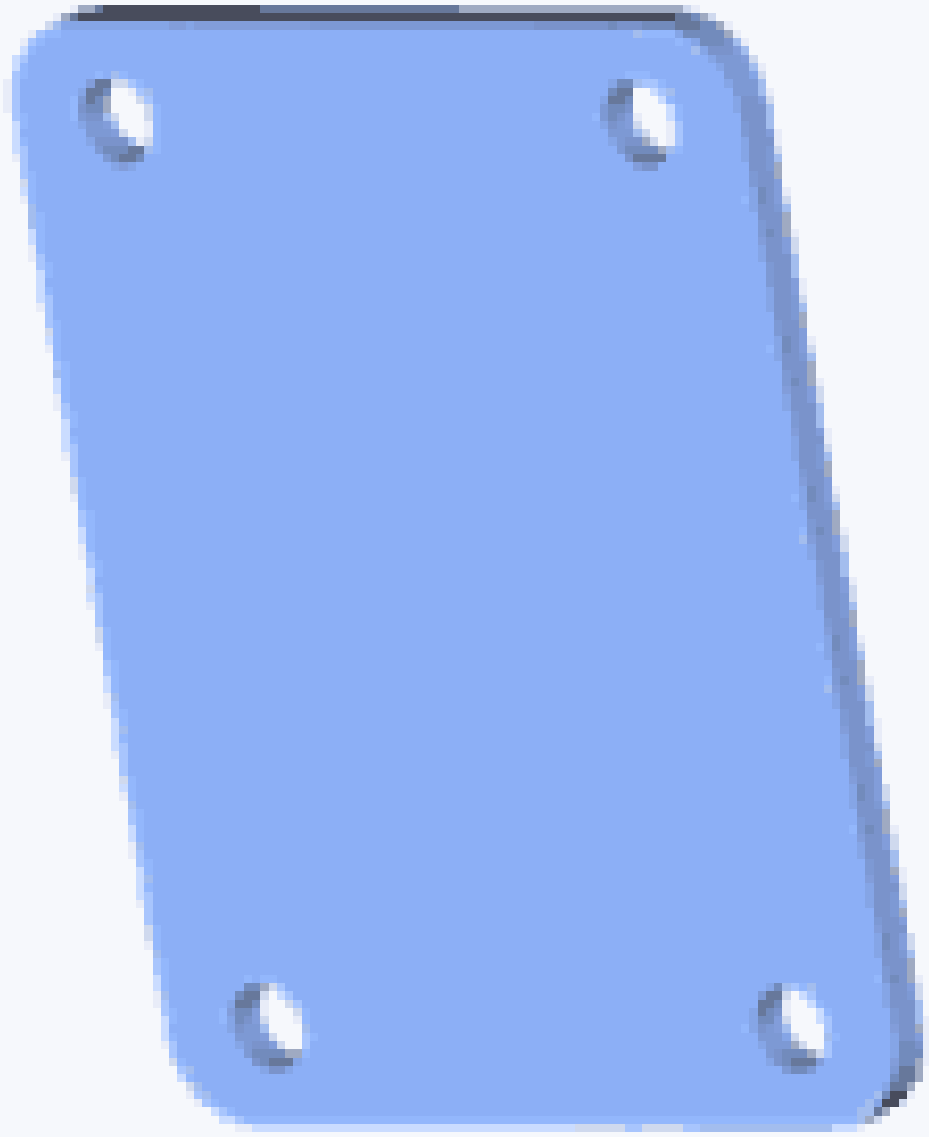
Illustration	Tool Number/Description
	EN-46091-25 J-46091-25 Diesel Engine Pressure Test Adapter

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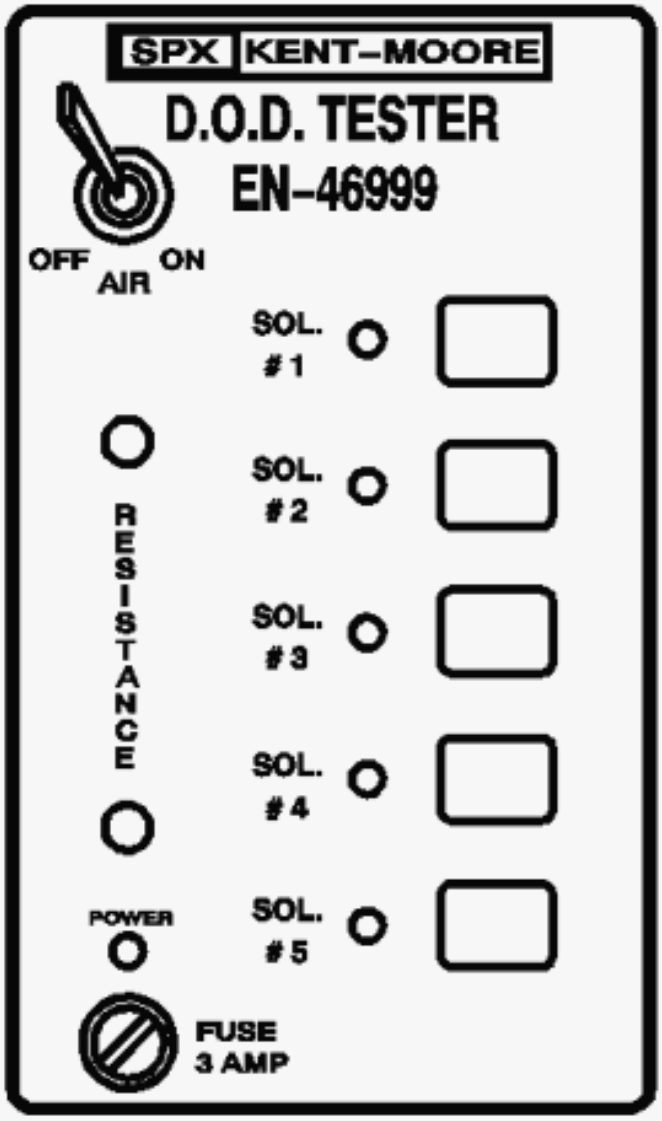
Illustration	Tool Number/Description
	EN-46999 Displacement On Demand Tester

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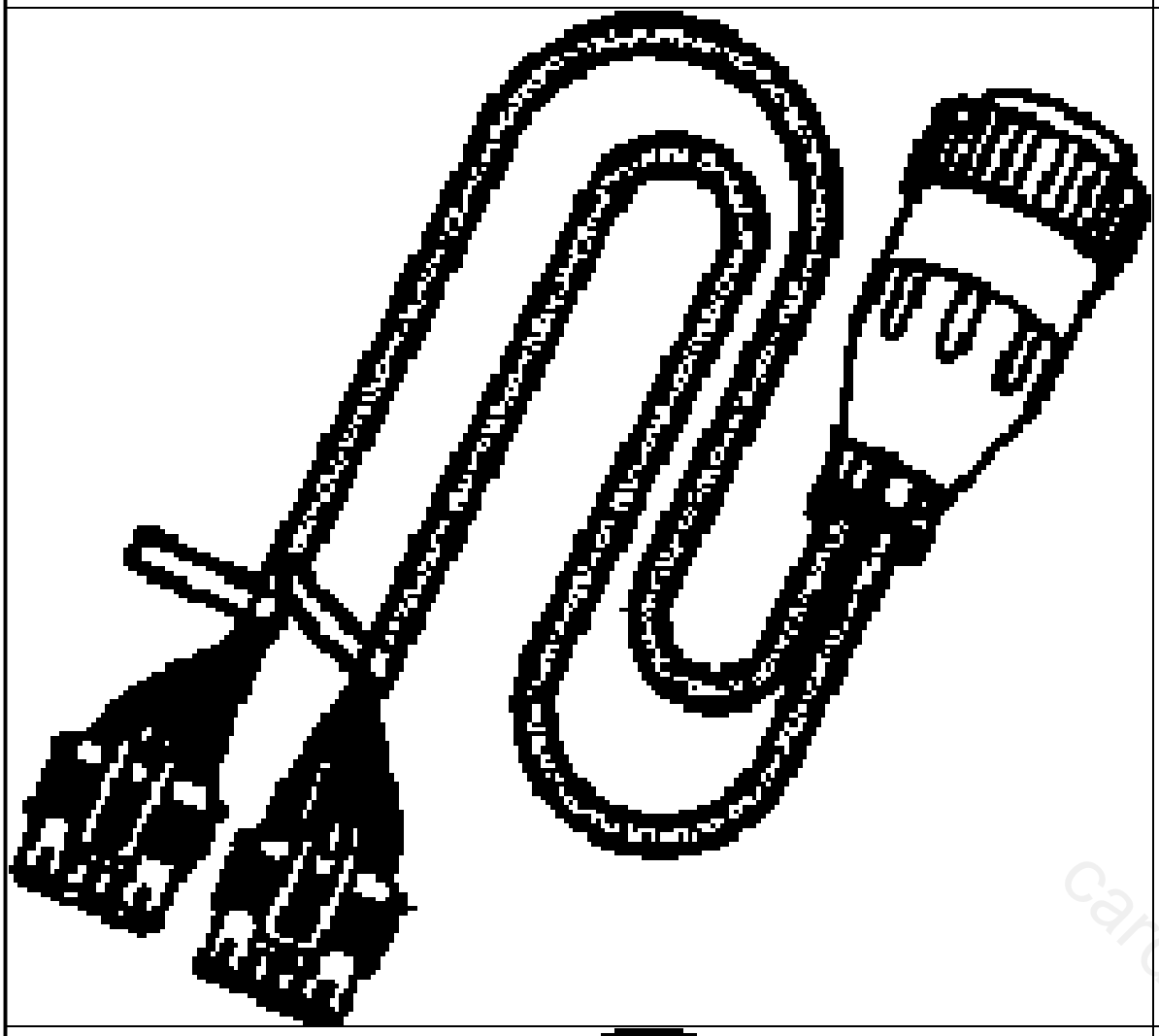
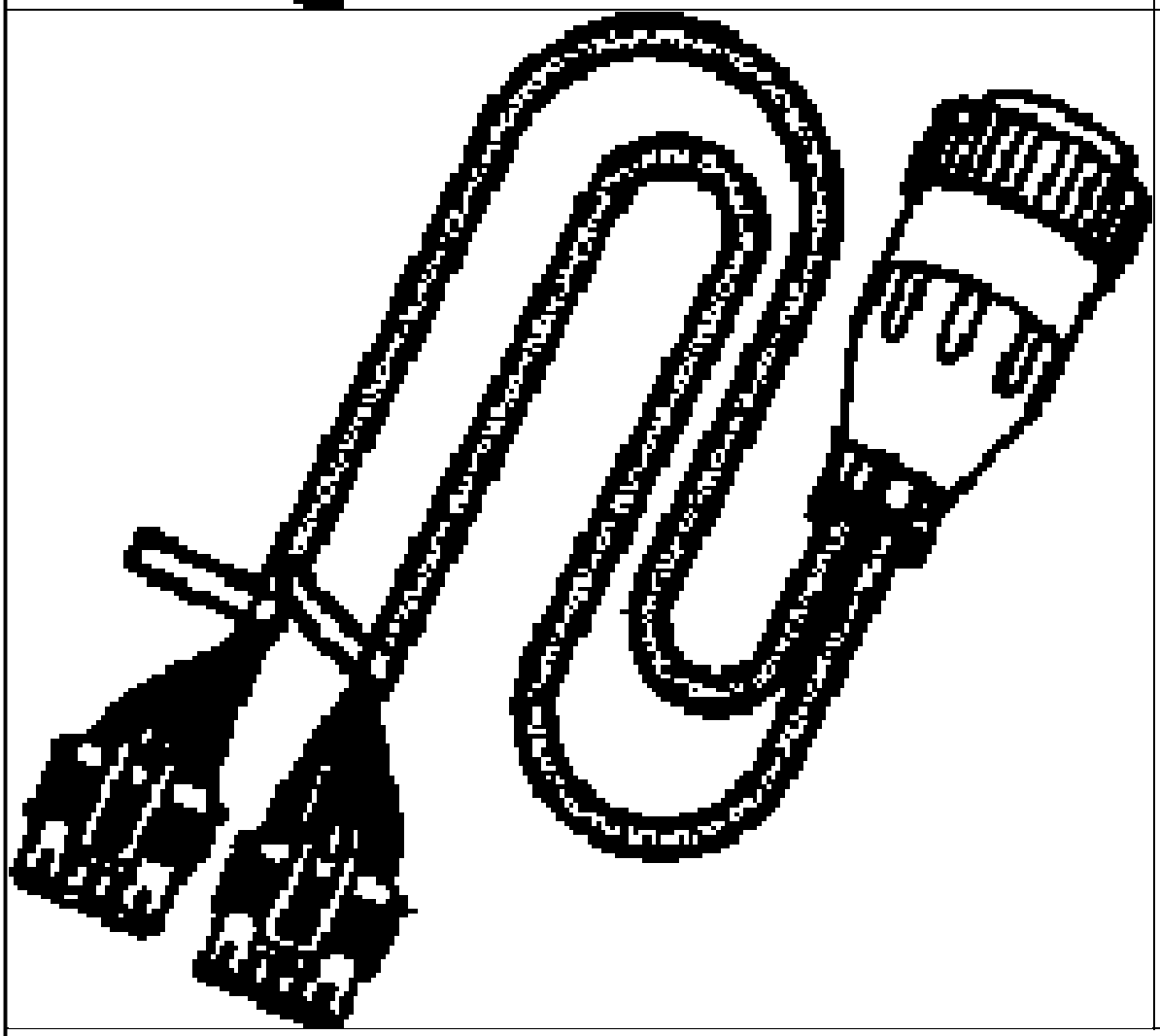
Illustration	Tool Number/Description
	EN-46999 - 15 Active Fuel Management Tester Harness - V6
	EN-46999 - 20 Active Fuel Management Tester Harness - Small Block V8

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Illustration	Tool Number/Description
	EN-47603 Compression Gauge Adapter

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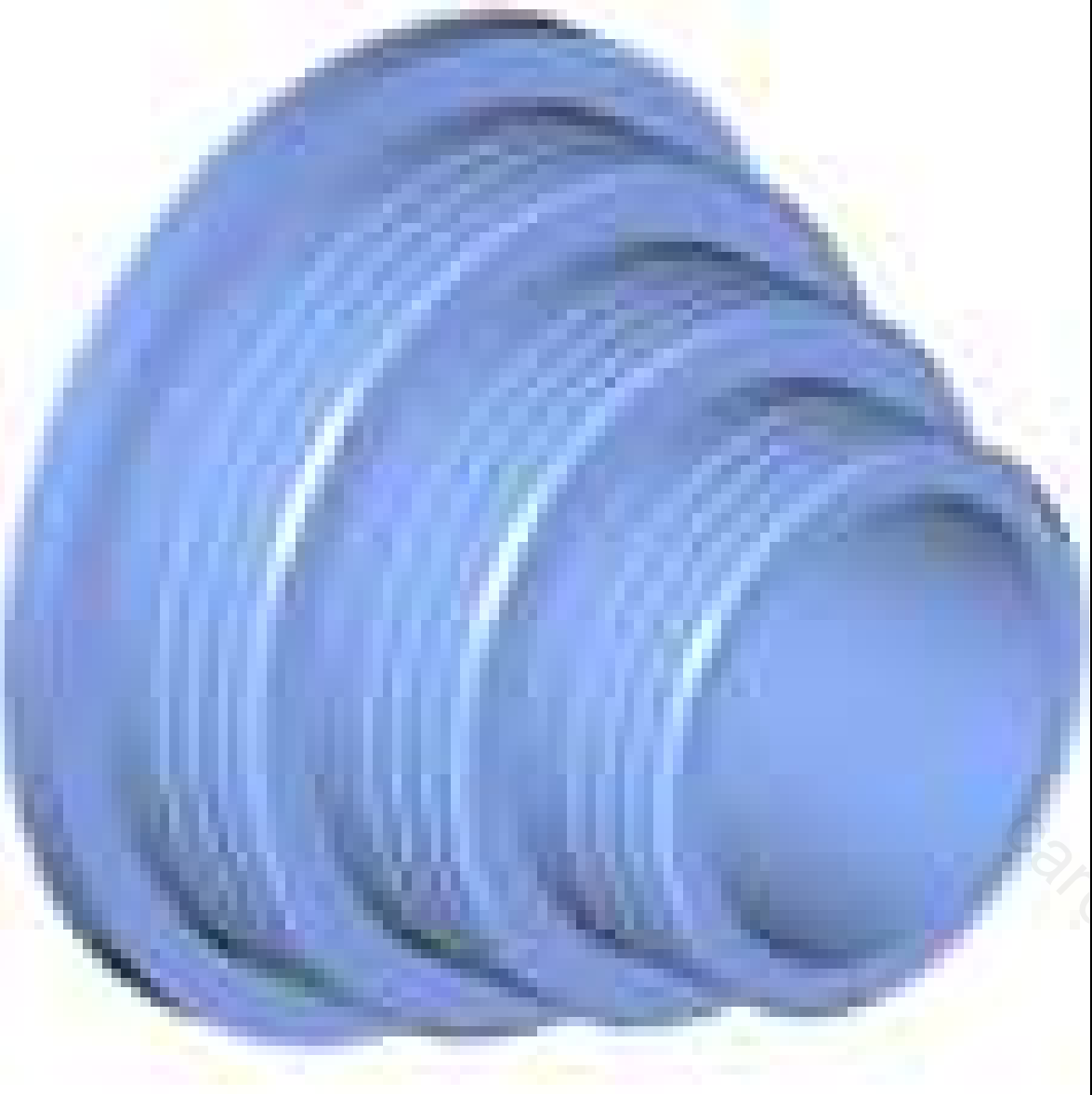
Illustration	Tool Number/Description
	EN-47656 - NA Pressure Test Plugs
	GE-23738-A J-23738-A Vacuum Pump

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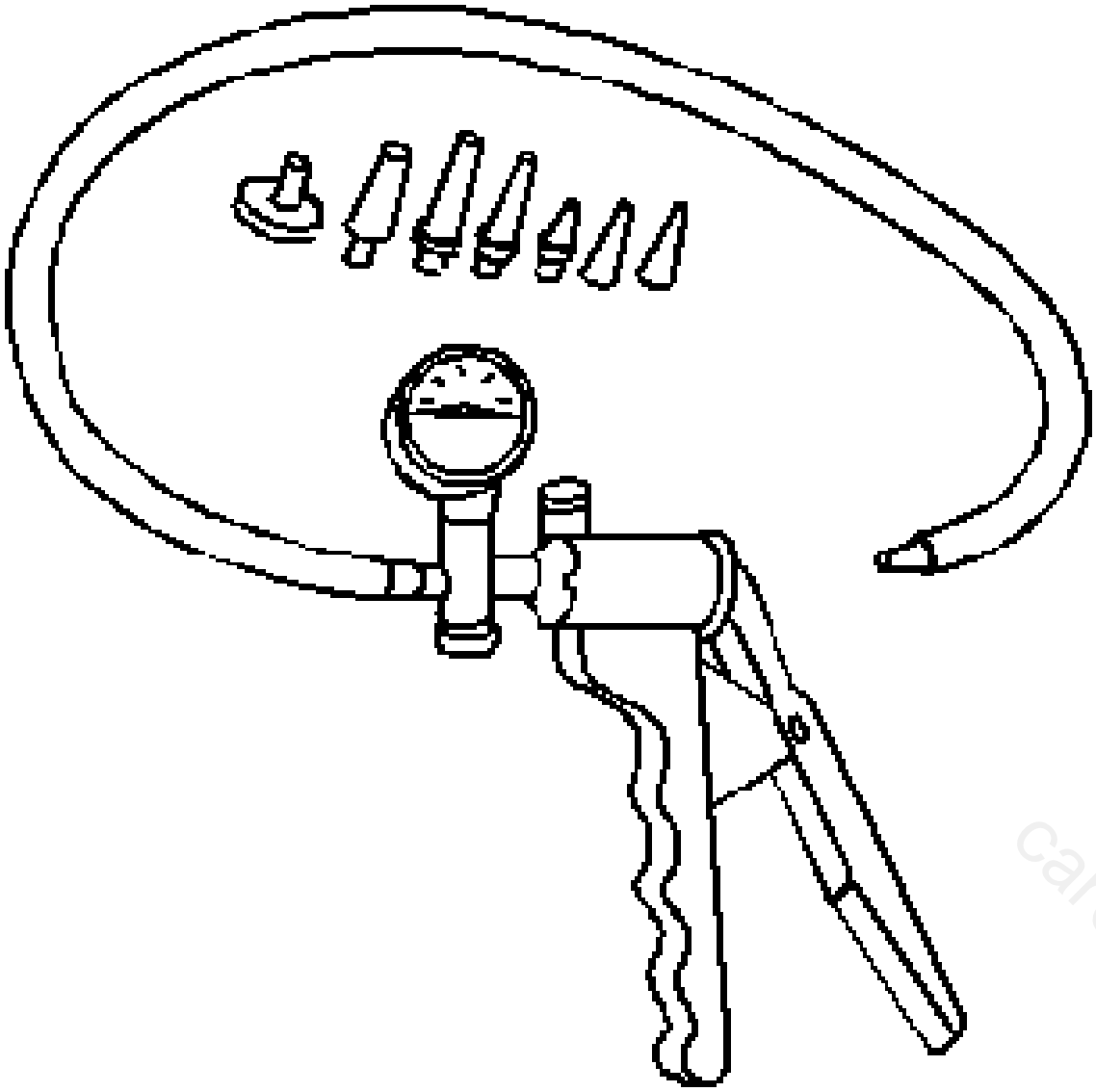
Illustration	Tool Number/Description
	

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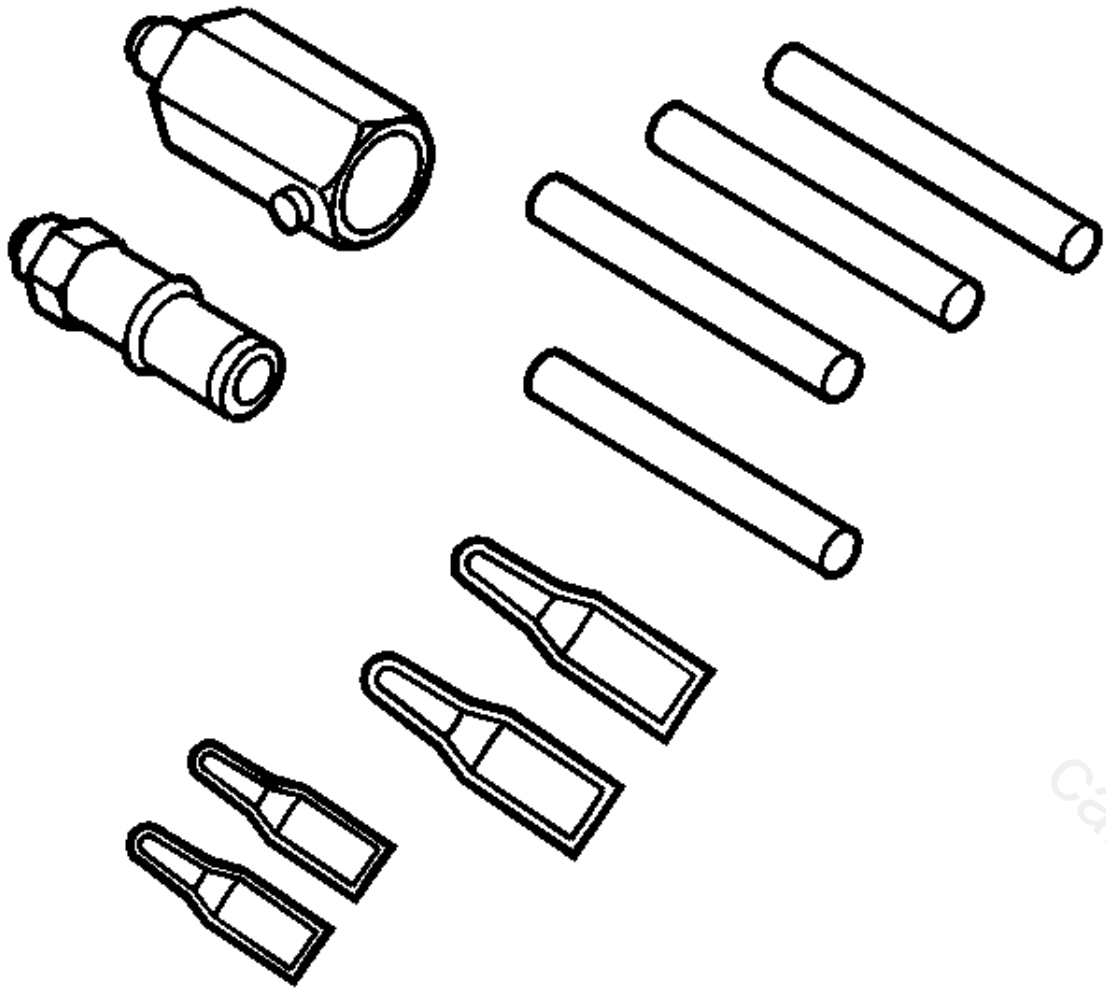
Illustration	Tool Number/Description
	GE-41413-300 EN-41413-300 J-41413-300 EVAP Cap and Plug Kit

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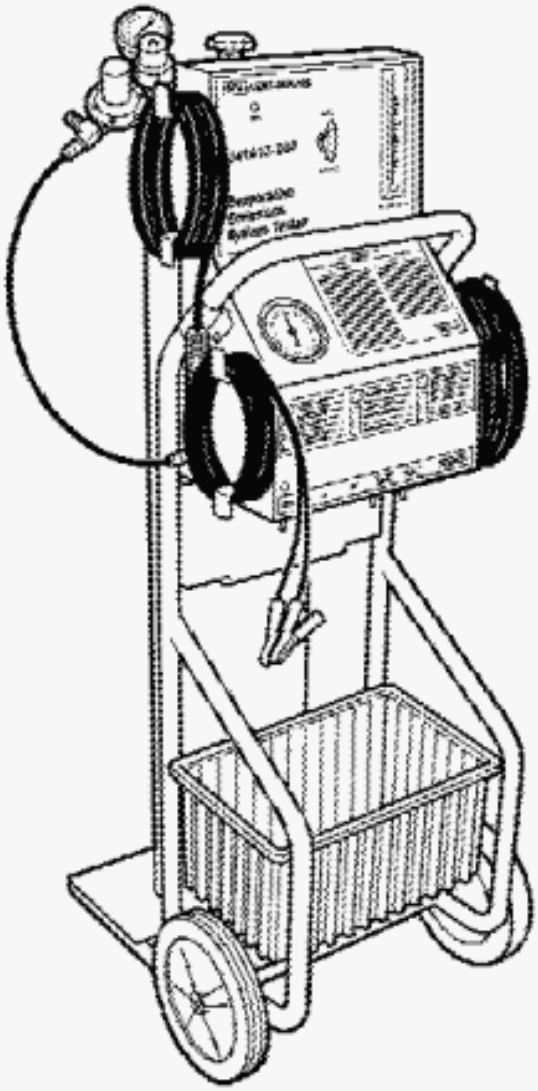
Illustration	Tool Number/Description
	GE-41413-A EN-41413-A J-41413-A Evaporative Emissions System Tester (EEST)
	GE-41413-B Evaporative Emissions System Tester (EEST)

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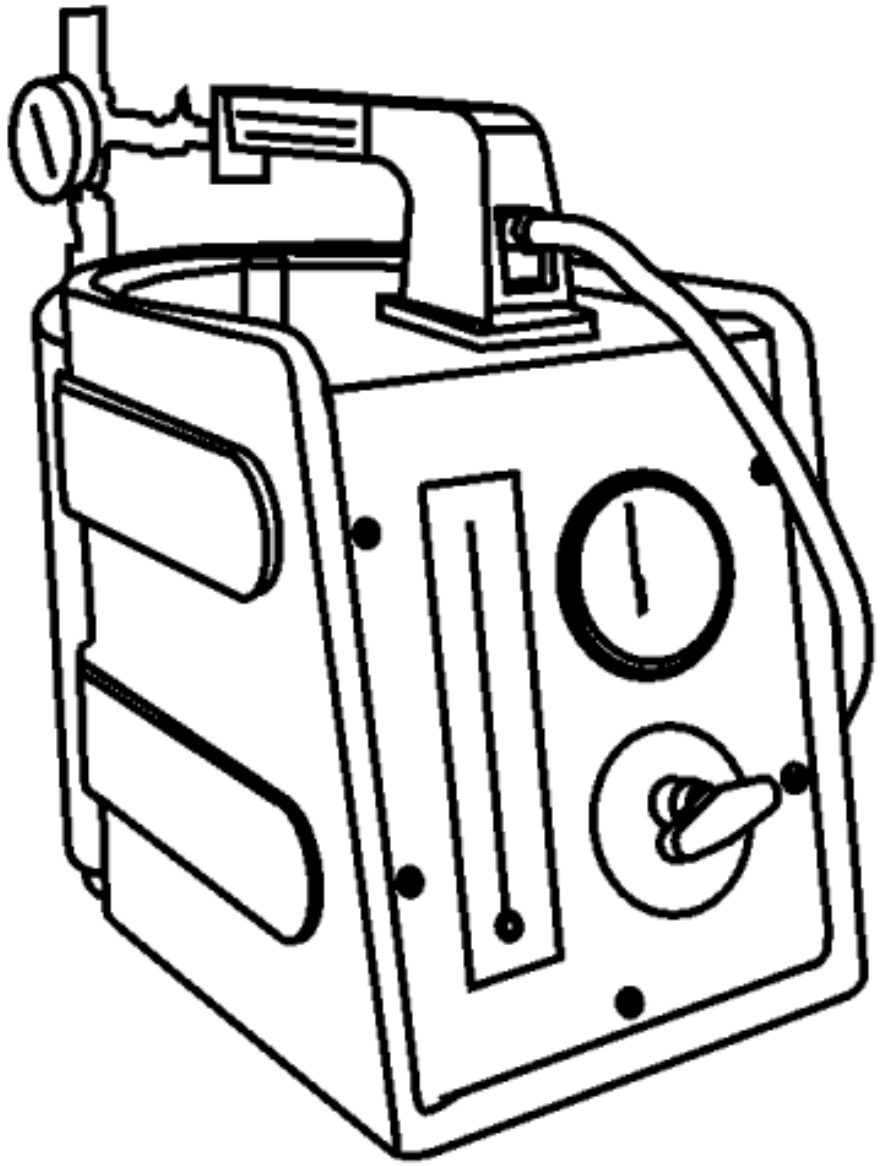
Illustration	Tool Number/Description
	

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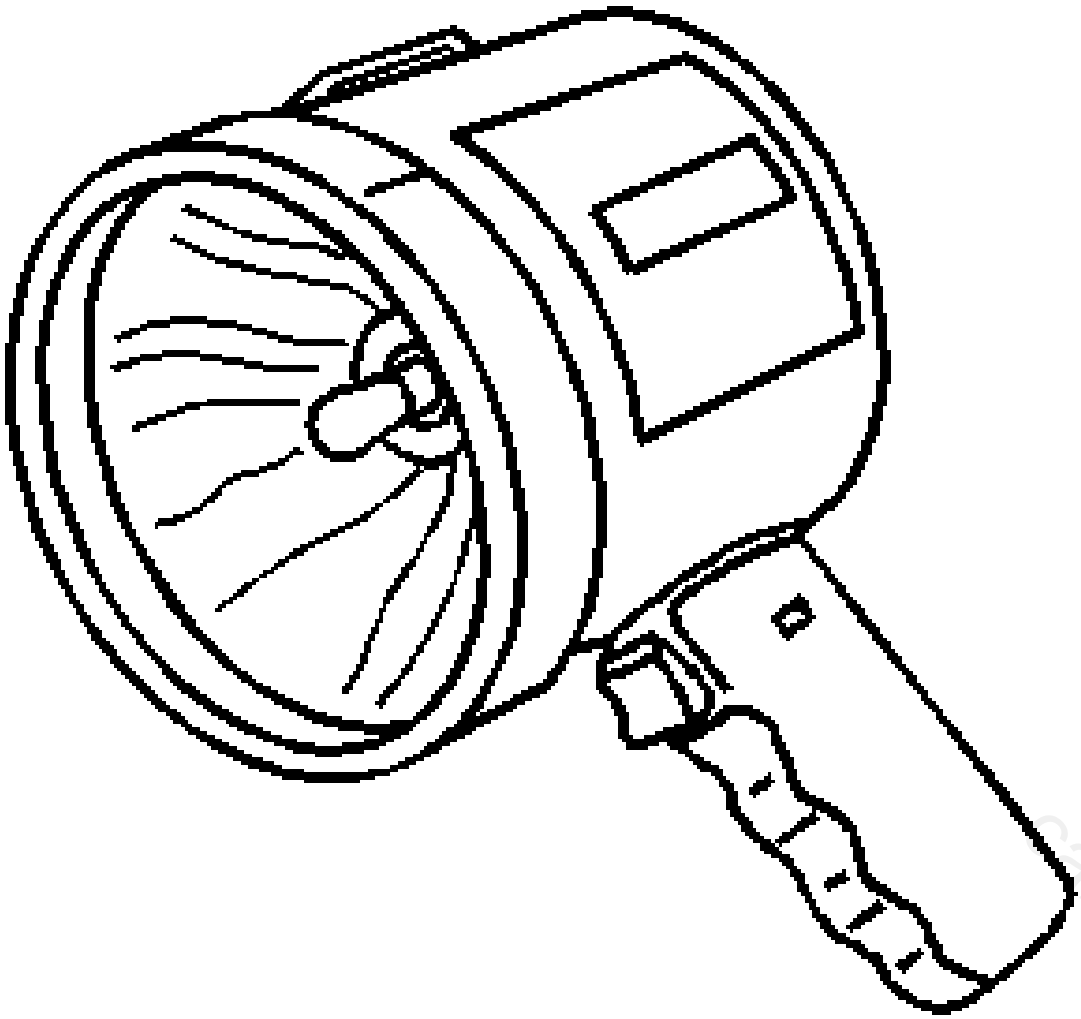
Illustration	Tool Number/Description
	GE-41413-SPT J-41413-SPT High Intensity White Light

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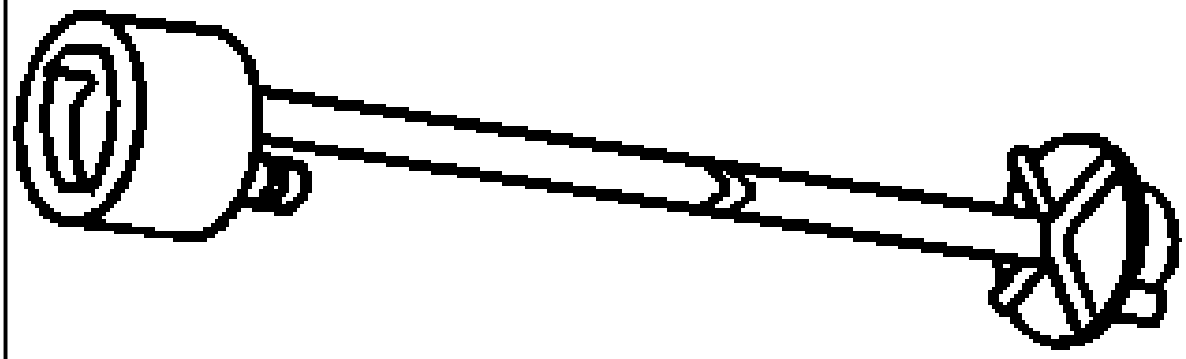
Illustration	Tool Number/Description
	GE-41415-50 J-41415-50 Fuel Tank Cap Adapter

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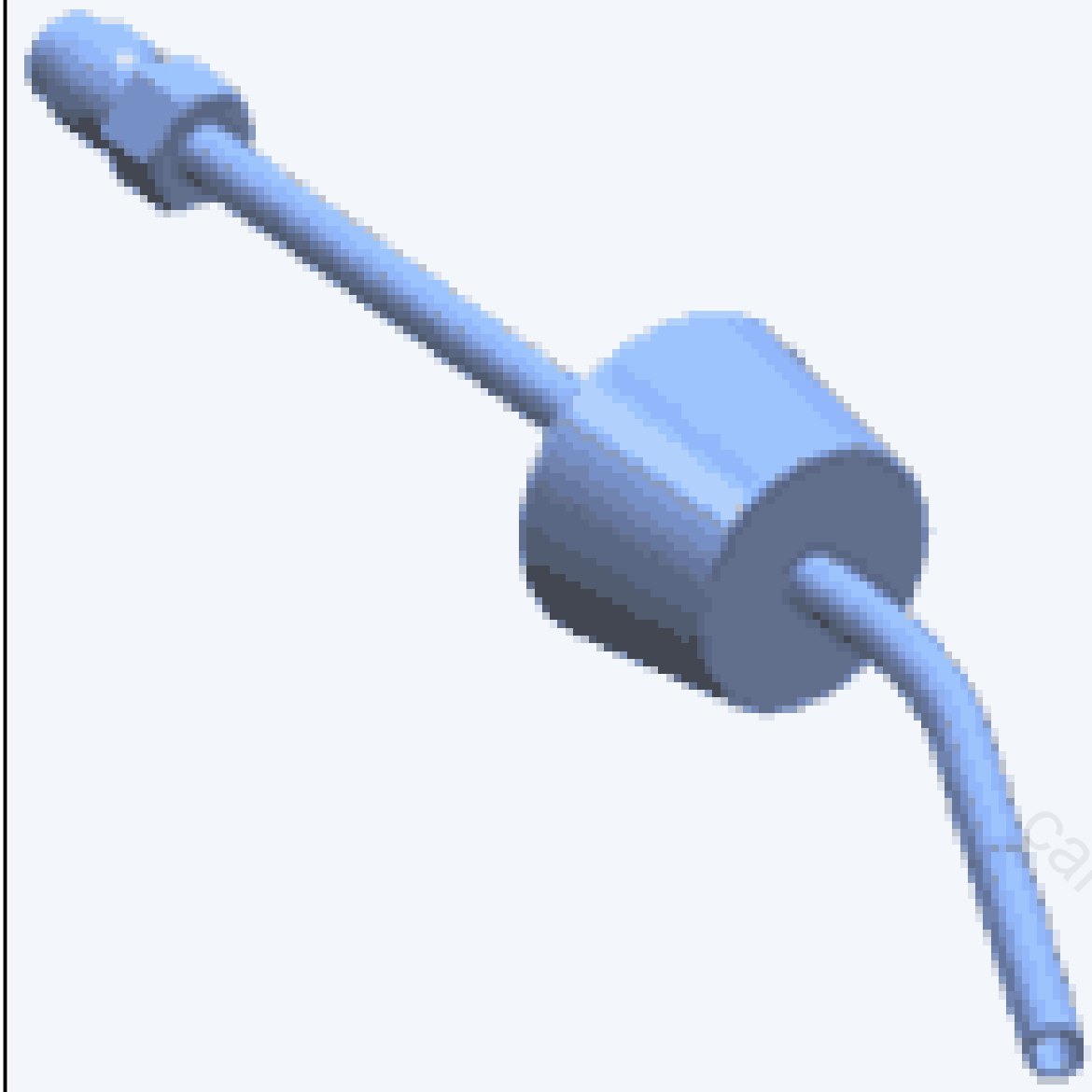
Illustration	Tool Number/Description
	GE-41415-60 Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter
	J-25070 Heat Gun 260 - 399Â°C (500 - 750Â°F)

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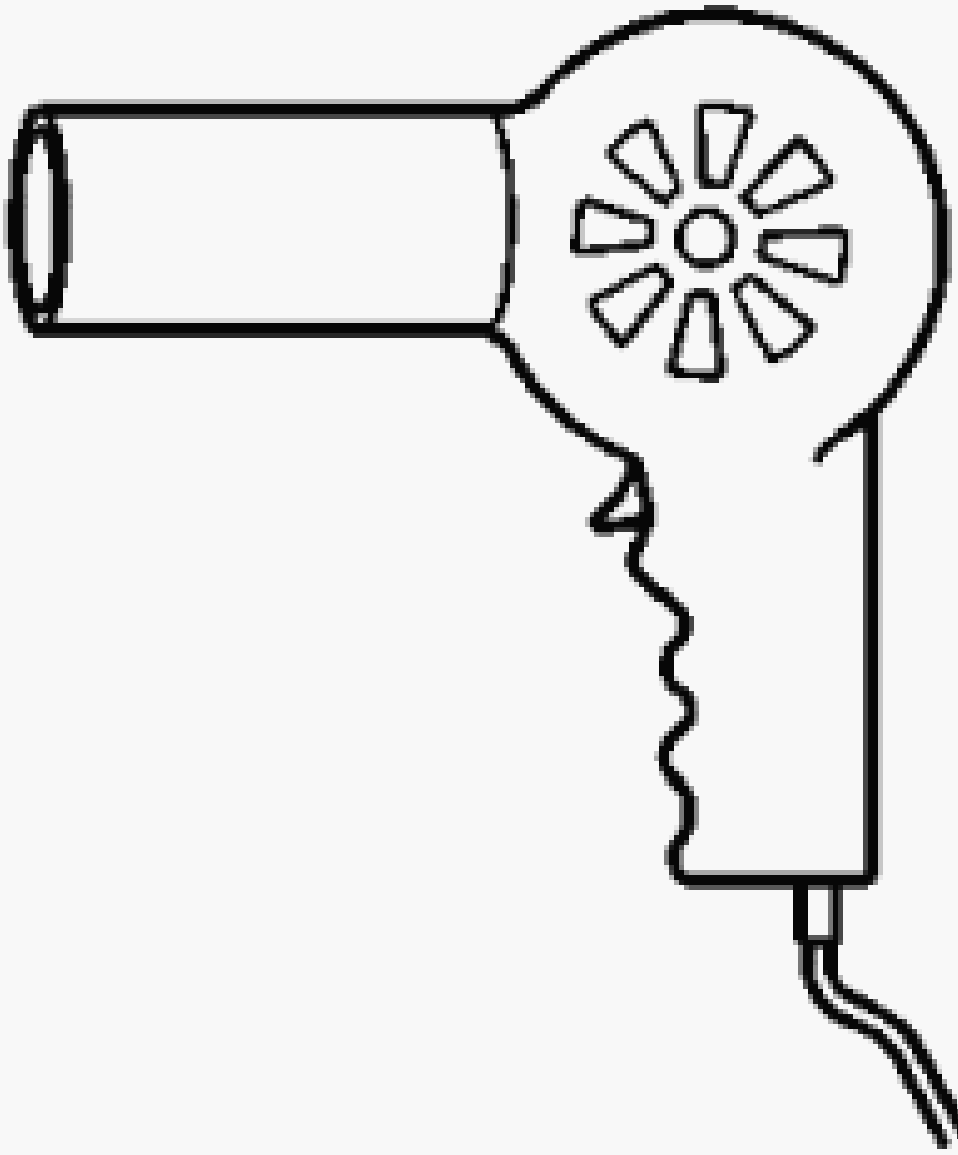
Illustration	Tool Number/Description
	
	J-34730-375 Injector Test Lamp

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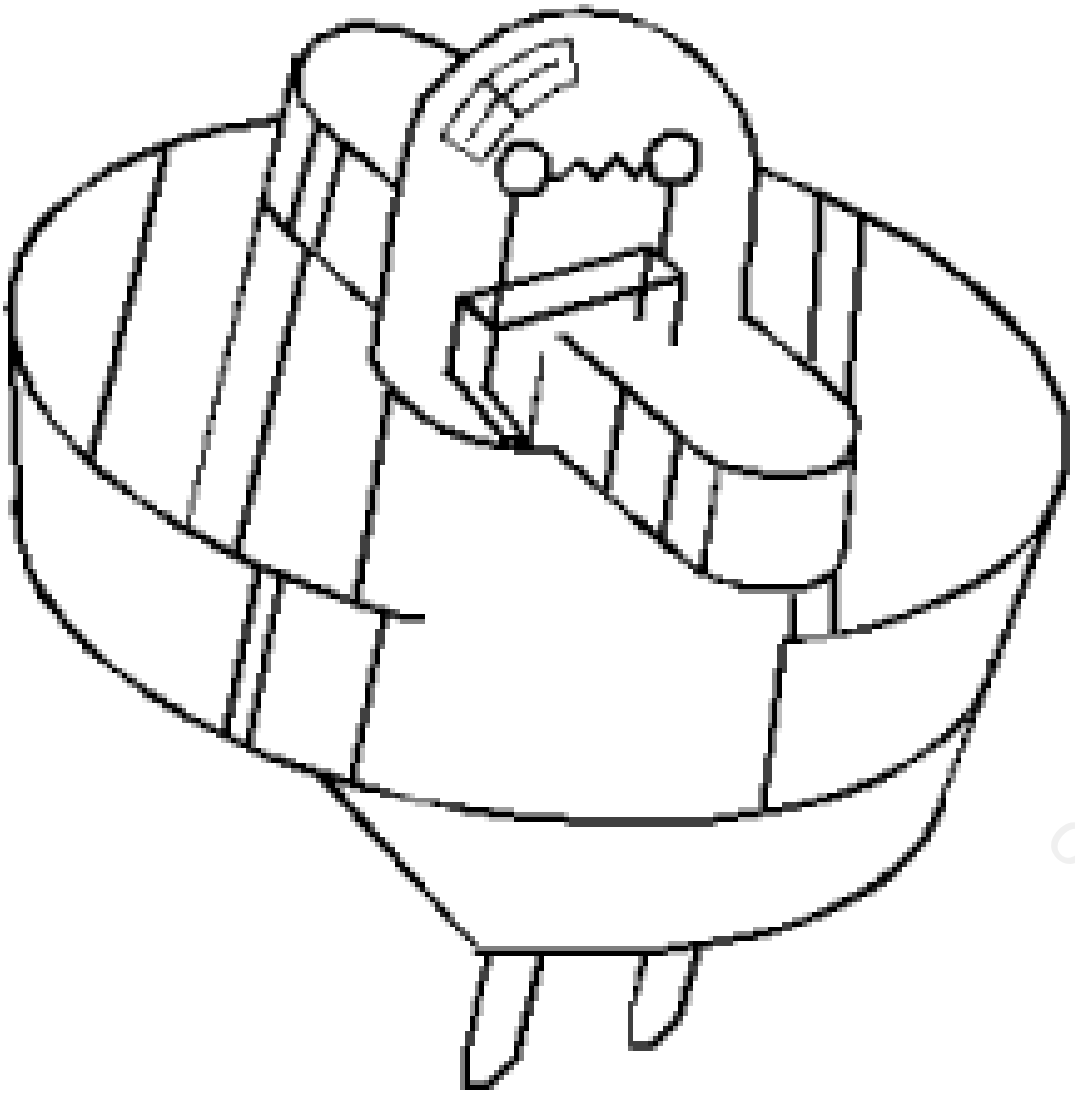
Illustration	Tool Number/Description
	

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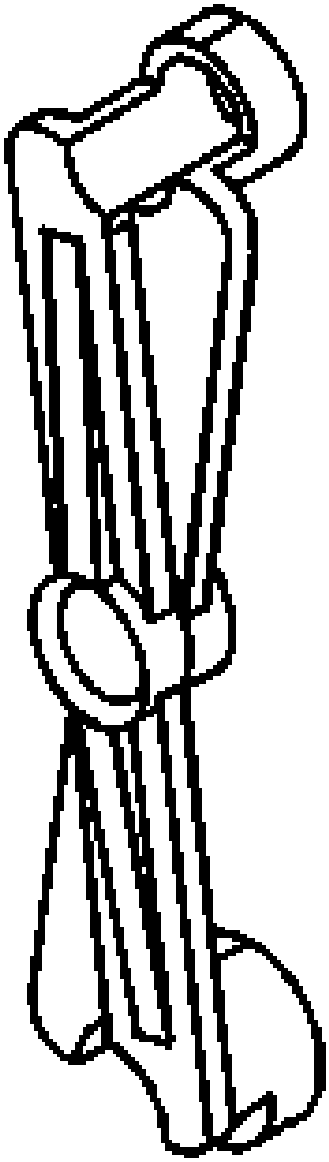
Illustration	Tool Number/Description
	J-44581 Fuel Line Disconnect Tool

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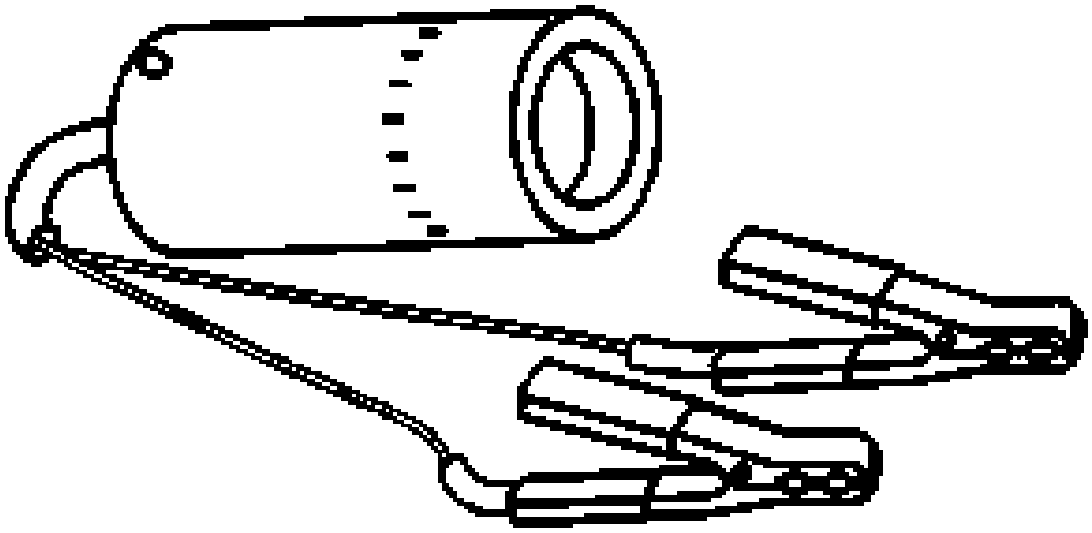
Illustration	Tool Number/Description
	J-28428 - E J 42220 CH 42220 Universal 12-Volt Leak Detection Lamp

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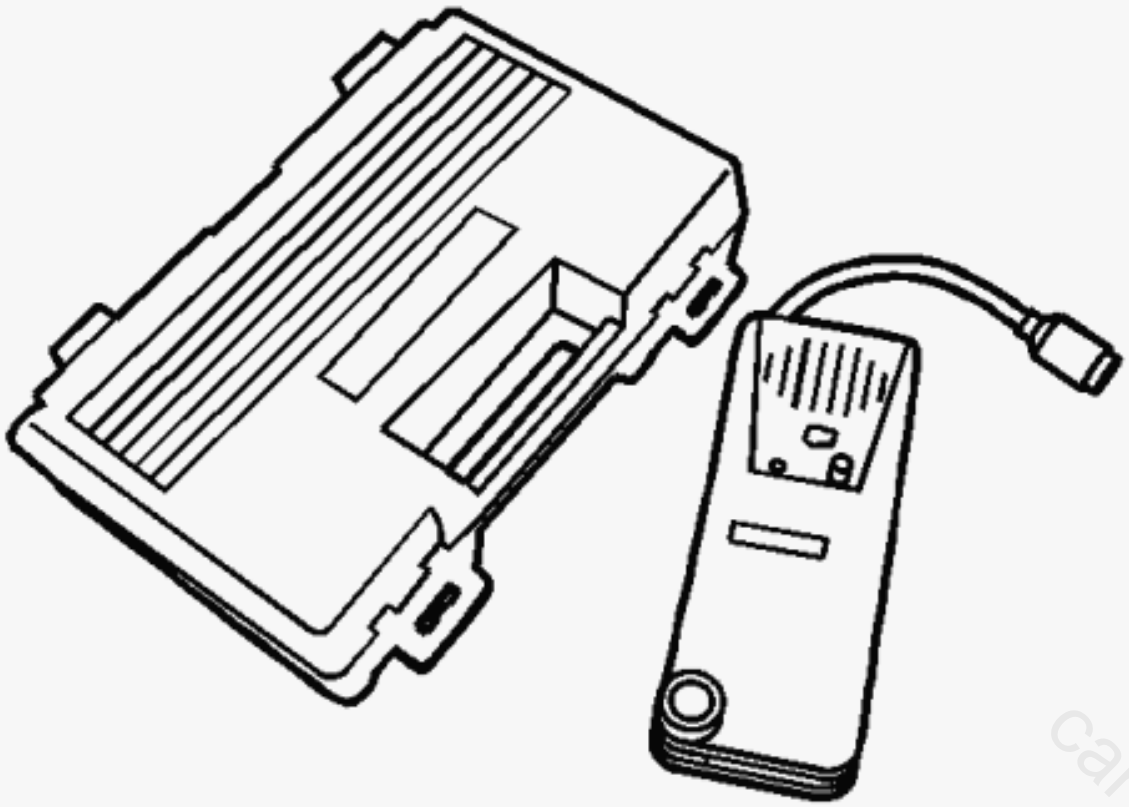
Illustration	Tool Number/Description
	J-45878 Combustible Gas Detector

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SPECIAL TOOLS (MECHANICAL TOOLS)

Illustration	Tool Number/ Description

Illustration	Tool Number/ Description
	CH-37287-1A Fuel Pressure Gauge Adapter 3/8"

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Illustration	Tool Number/ Description
	CH-41769 J-41769 Fuel Line Quick Disconnect Tool

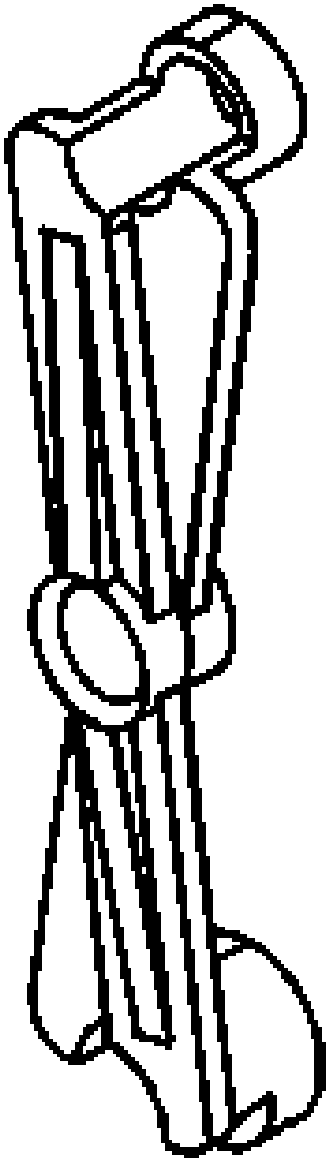
Illustration	Tool Number/ Description
	CH-44581 J-44581 Fuel Line Disconnect Tool

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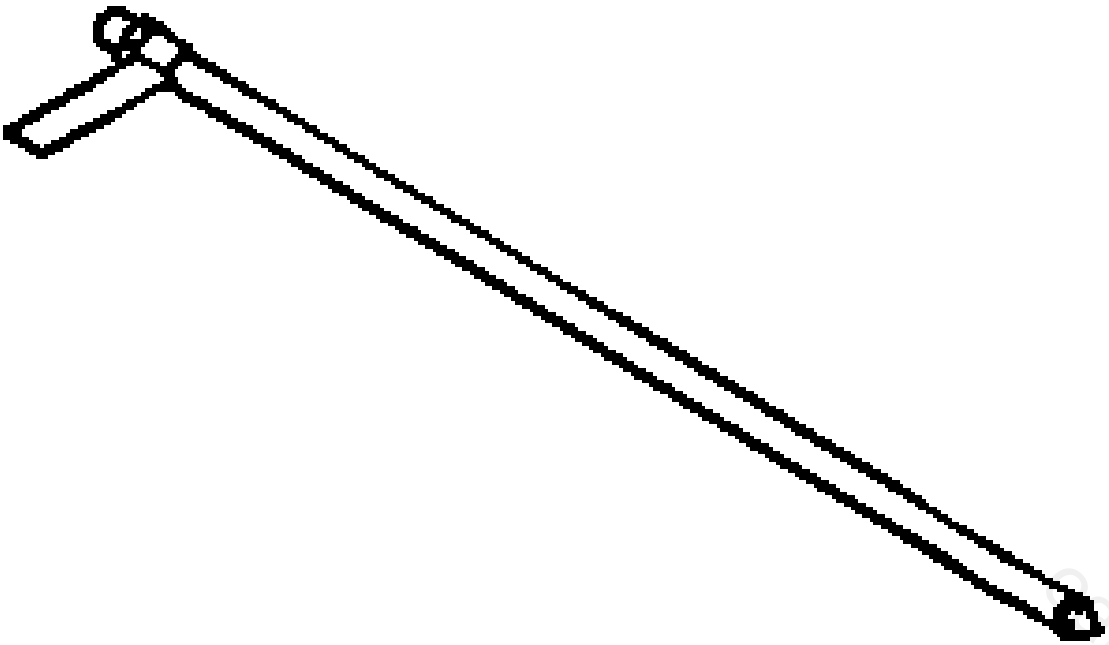
Illustration	Tool Number/ Description
	CH-45004 J-45004 Fuel Tank Drain Hose

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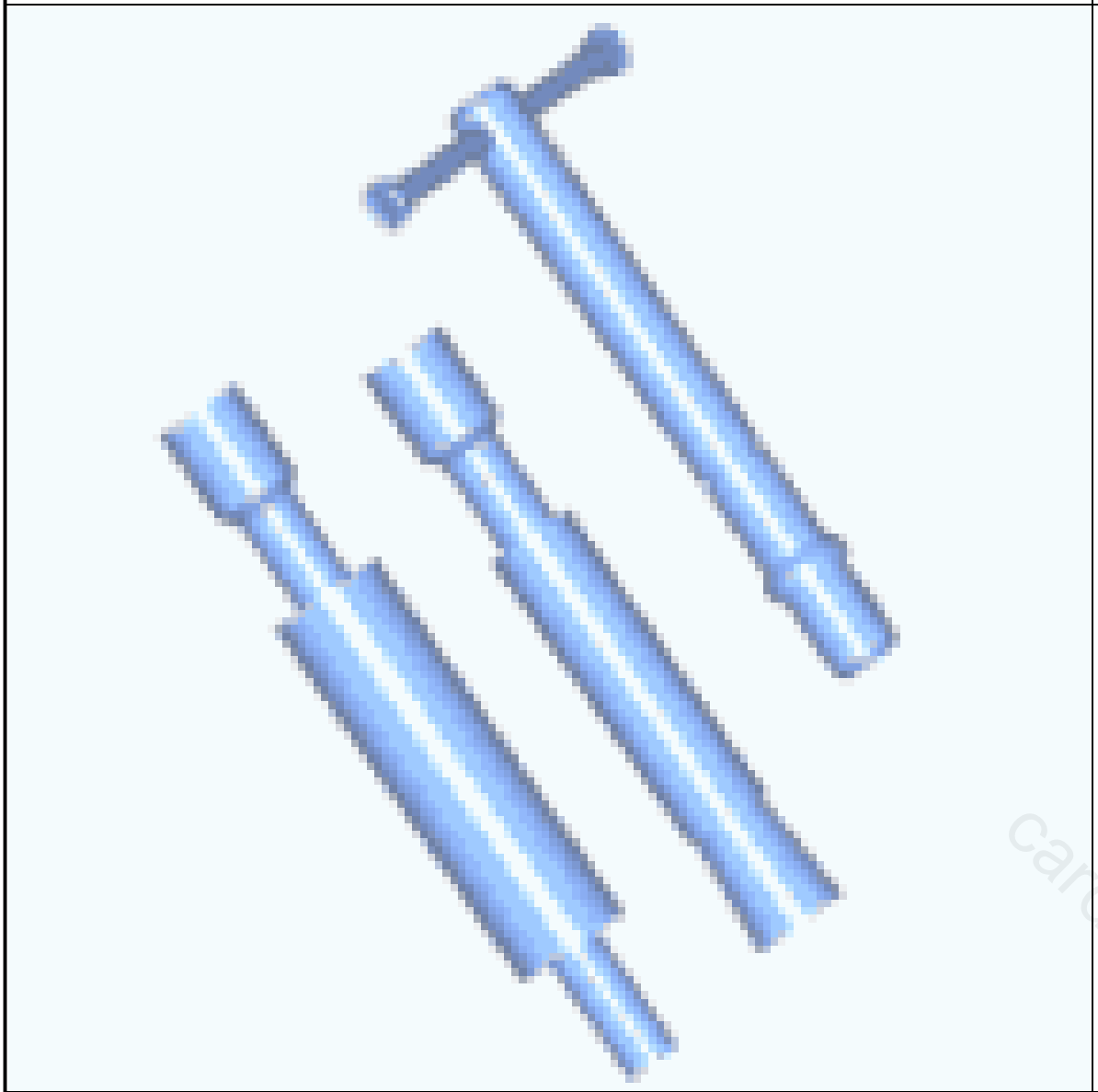
Illustration	Tool Number/ Description
	EN-47909 Injector Bore and Sleeve Cleaning Kit

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Illustration	Tool Number/ Description
	EN-49245 Fuel Injector Seal Install/Sizer

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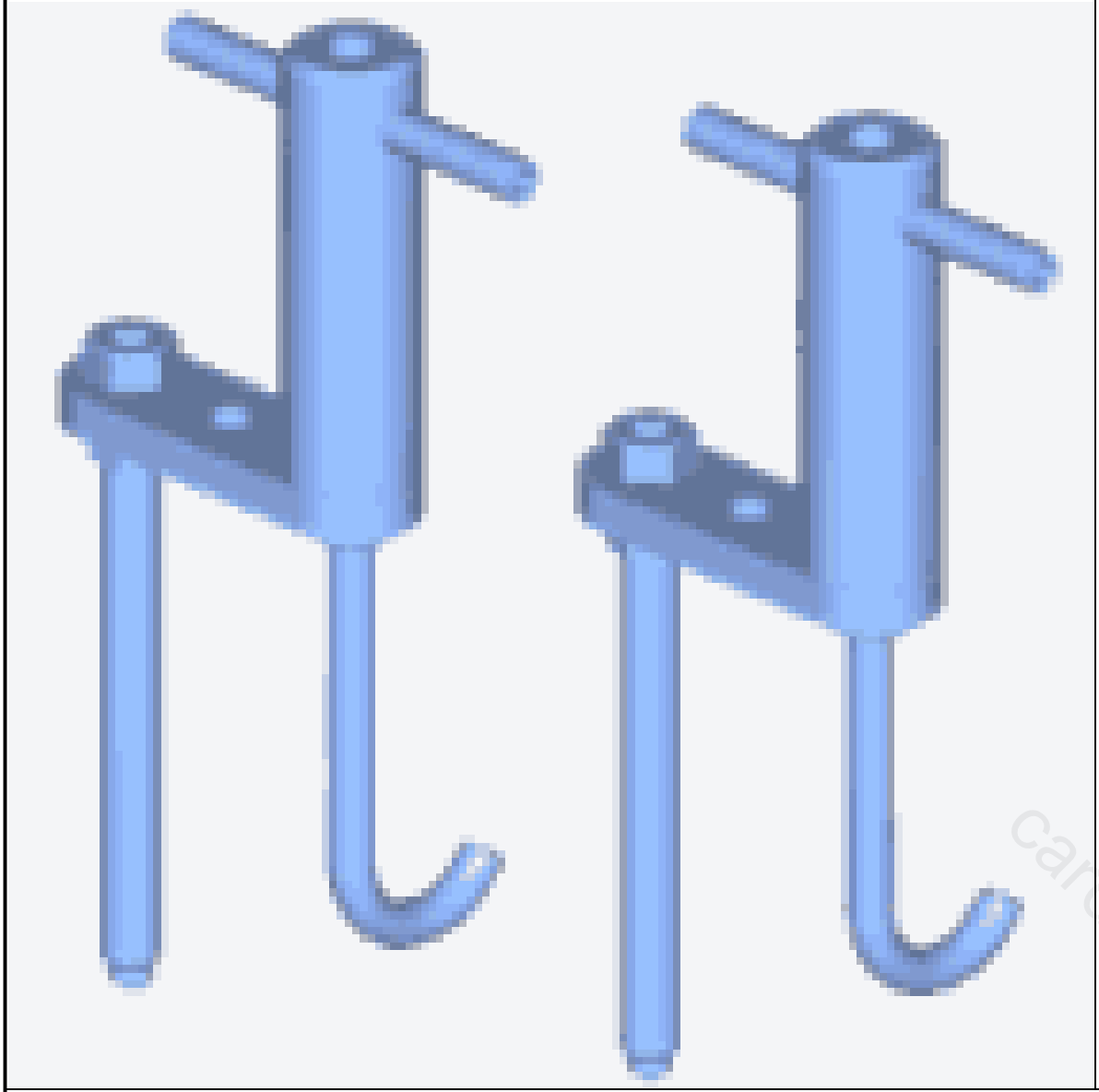
Illustration	Tool Number/ Description
	EN-49248 Injector Rail Assembly Remover

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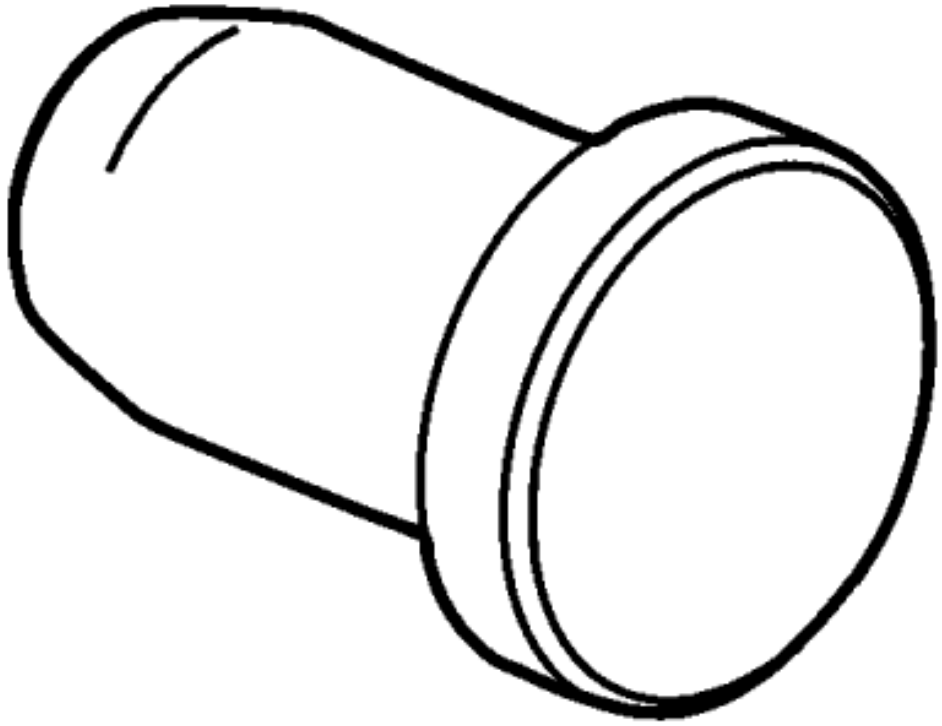
Illustration	Tool Number/ Description
	EN-50790 HP Fuel Pump Installation Alignment Gauge

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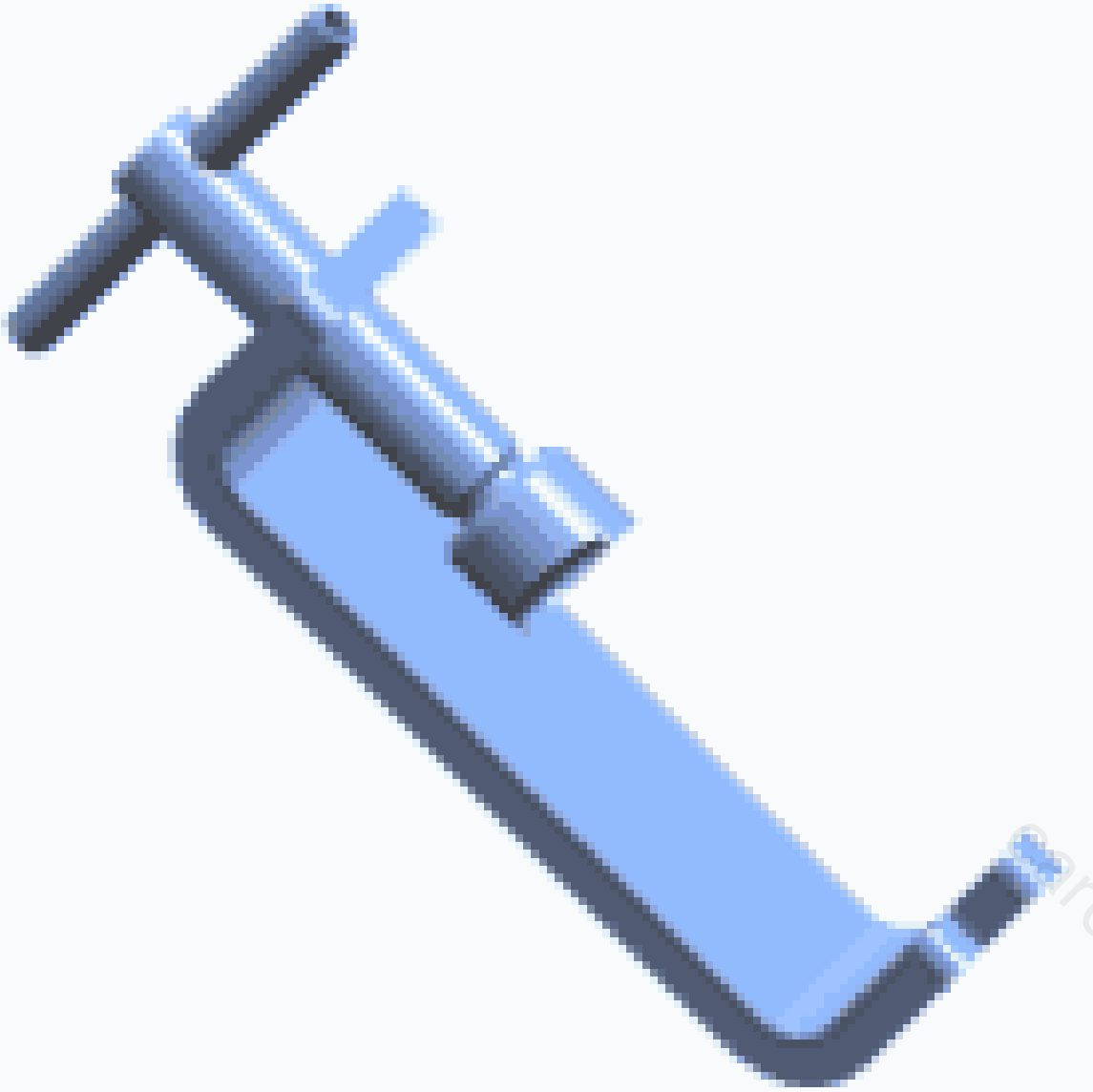
Illustration	Tool Number/ Description
	EN-50791 Fuel Injector Nozzle to Fuel Rail Installer

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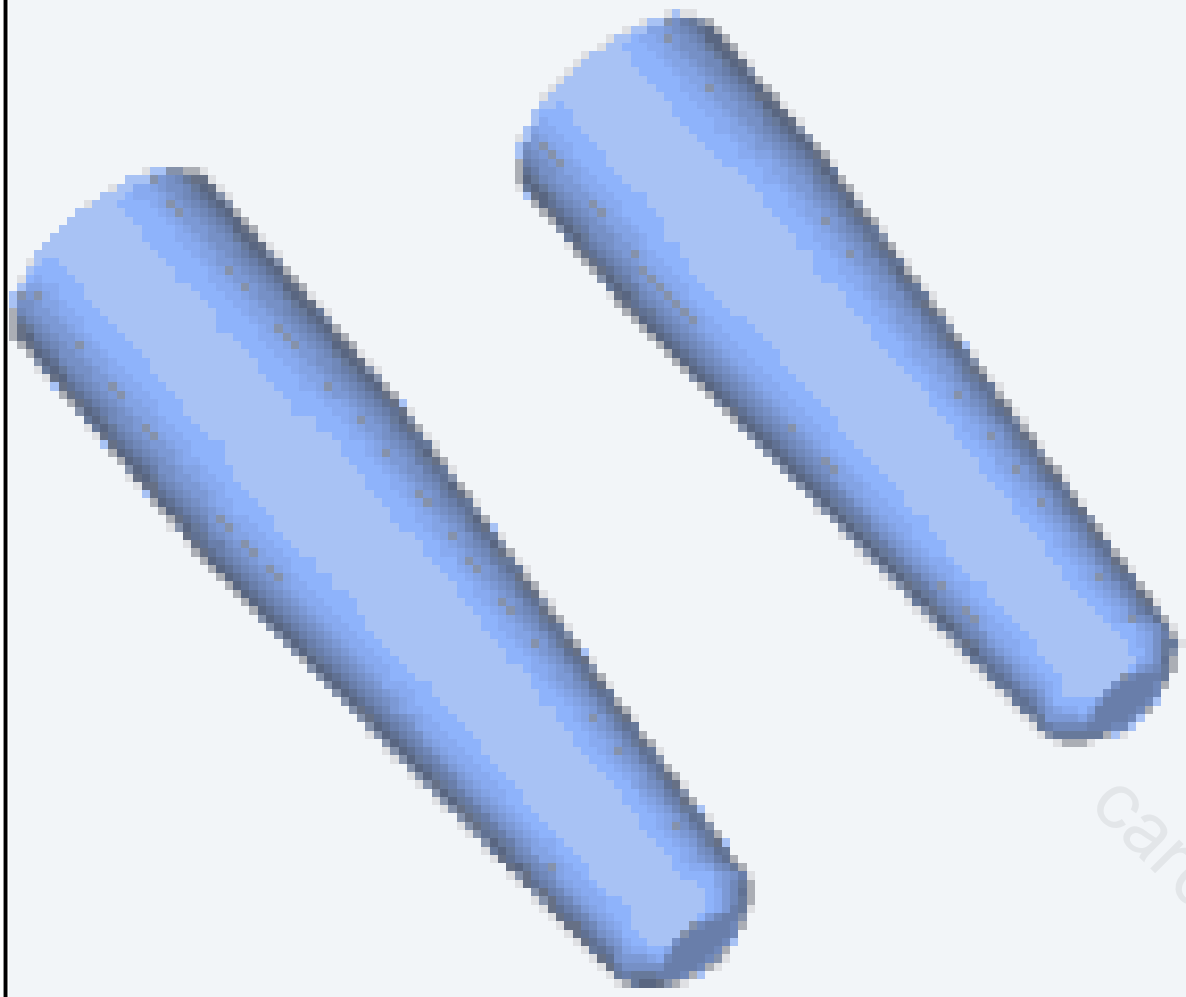
Illustration	Tool Number/ Description
	EN-51105 Injector Seal Installer and Sizer

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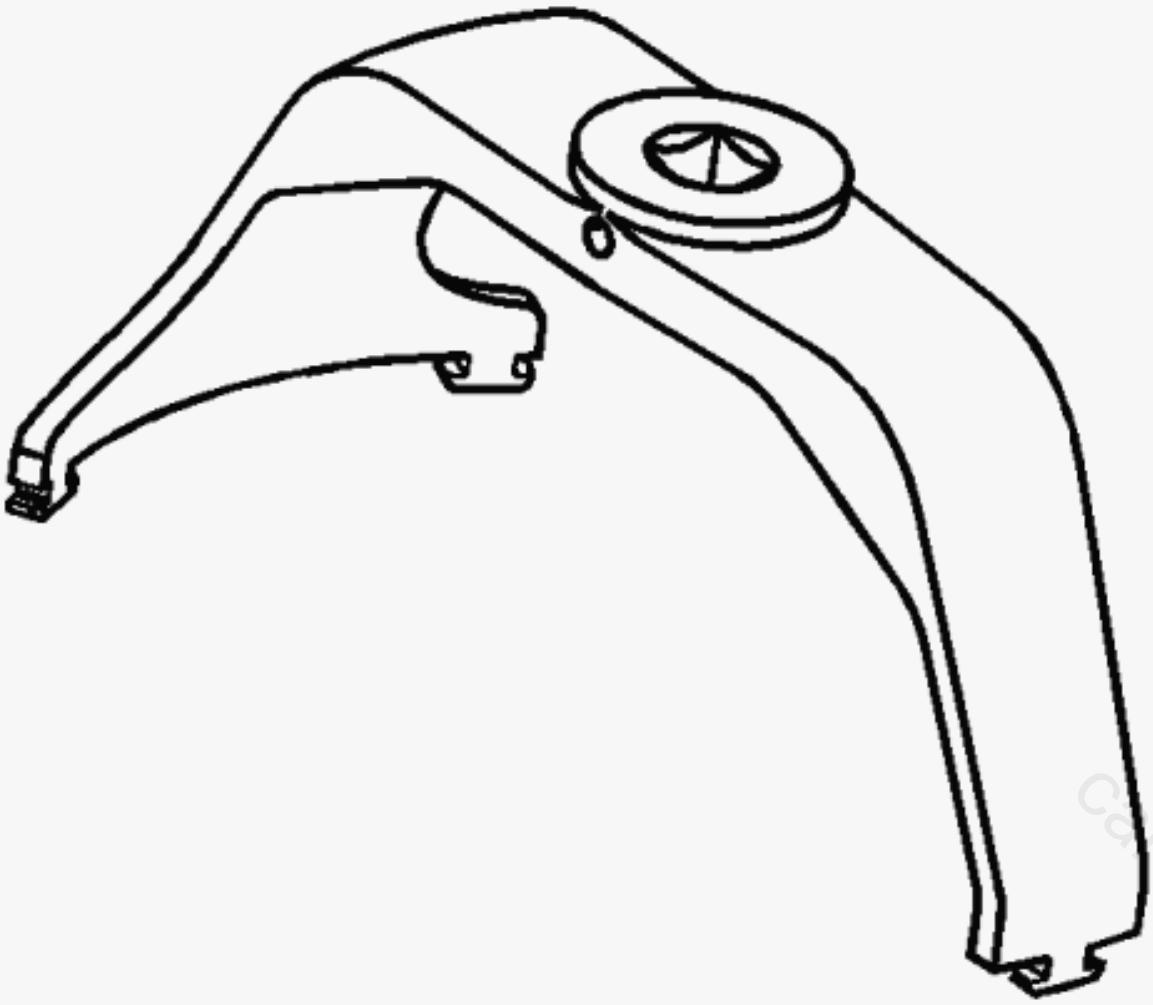
Illustration	Tool Number/ Description
	CH-52075 J-52075 Fuel Sender Lock Ring Wrench
	J-34730-1A Fuel Pressure Gauge

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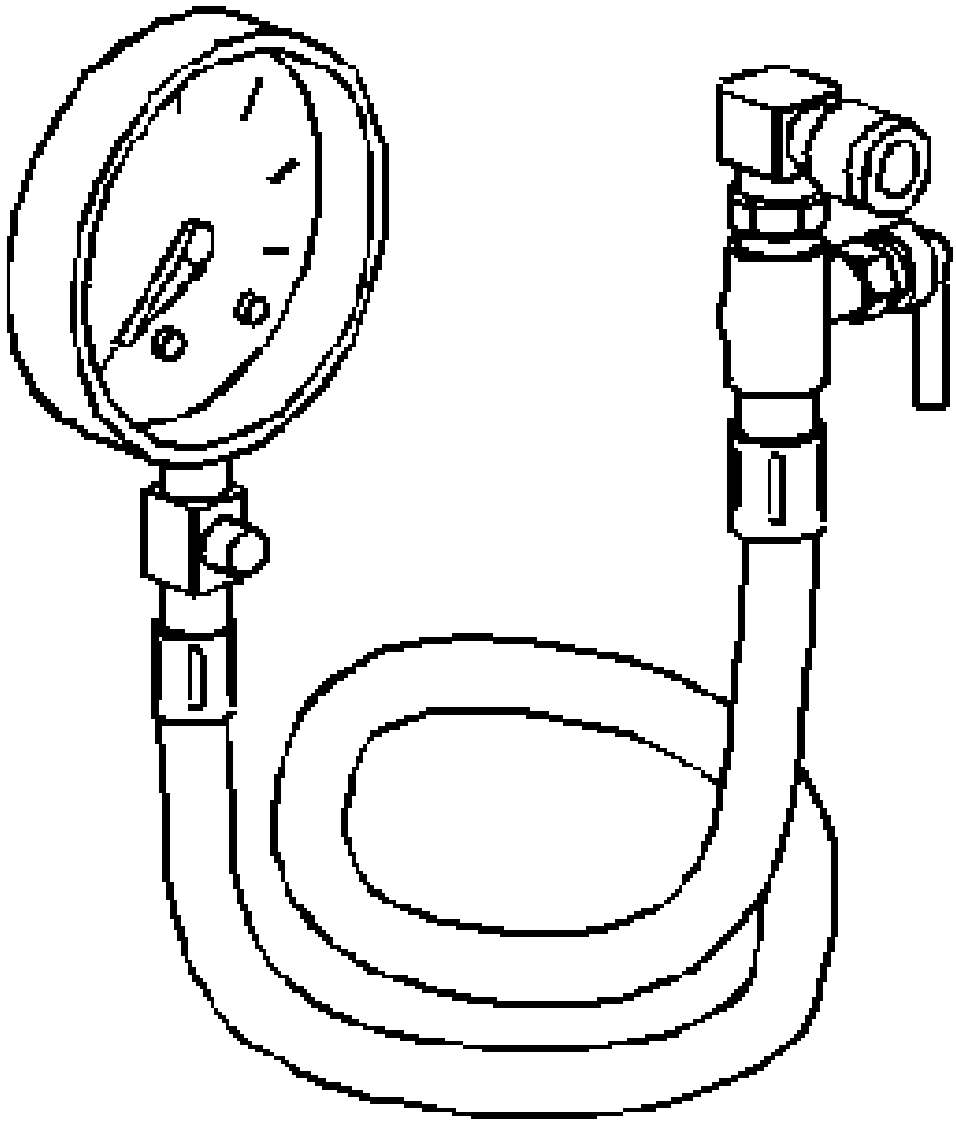
Illustration	Tool Number/ Description
	

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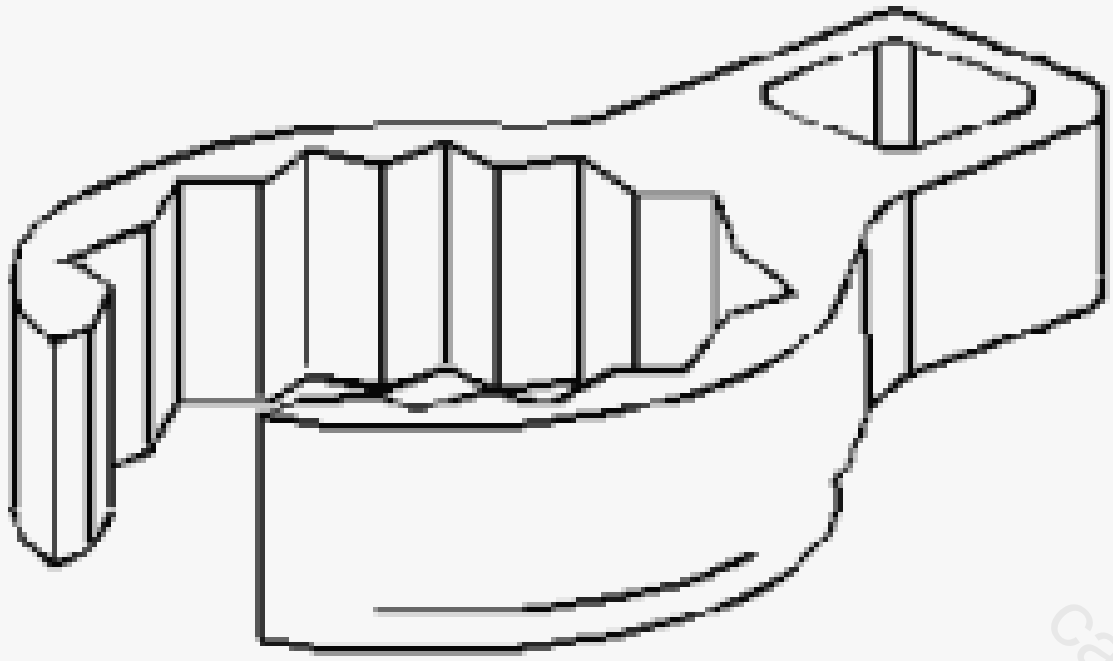
Illustration	Tool Number/ Description
	J-39194 Oxygen Sensor Wrench

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SPECIFICATIONS

TEMPERATURE VERSUS RESISTANCE - INTAKE AIR TEMPERATURE 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
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 1002ohms
45Â°C (113Â°F)	1167 to 1223ohms
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

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Temperature	Resistance
-15Â°C (5Â°F)	20559 to 22183 ohms
-20Â°C (-4Â°F)	27439 to 29725 ohms
-30Â°C (-22Â°F)	50264 to 54924 ohms
-40Â°C (-40Â°F)	95953 to 105777 ohms

ALTITUDE VERSUS BAROMETRIC PRESSURE

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)	Barometric Pressure Measured in Pounds Per Square Inch (PSI)
Determine your altitude by contacting a local weather station or by using another reference source.			
4, 267	14, 000	56 - 64	8.1 - 9.3
3, 962	13, 000	58 - 66	8.4 - 9.6
3, 658	12, 000	61 - 69	8.8 - 10.0
3, 353	11, 000	64 - 72	9.3 - 10.4
3, 048	10, 000	66 - 74	9.6 - 10.7
2, 743	9, 000	69 - 77	10.0 - 11.2
2, 438	8, 000	71 - 79	10.3 - 11.5
2, 134	7, 000	74 - 82	10.7 - 11.9
1, 829	6, 000	77 - 85	11.2 - 12.3
1, 524	5, 000	80 - 88	11.6 - 12.8
1, 219	4, 000	83 - 91	12.0 - 13.2
914	3, 000	87 - 95	12.6 - 13.8
610	2, 000	90 - 98	13.1 - 14.2
305	1, 000	94 - 102	13.6 - 14.8
0	0 Sea Level	96 - 104	13.9 - 15.1
-305	-1, 000	101 - 105	14.6 - 15.2

IGNITION SYSTEM SPECIFICATIONS

Application	Specification
Ignition System Type	T8 Ignition Coil - 1-4
Firing Order	1-3-4-2
Spark Plug Torque	Refer to: **Fastener Specifications**
Spark Plug Gap	Refer to: **Engine Mechanical Specifications**
Spark Plug Type	Refer to:Electronic Parts Catalog

FASTENER SPECIFICATIONS

Single Use Non-Threaded Fasteners/Components

NOTE:

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application
Camshaft Position Actuator Exhaust Solenoid Valve Seal

NOTE:
All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application
Camshaft Position Actuator Intake Solenoid Valve Seal
Camshaft Position Sensor Seal
Crankshaft Position Sensor Seal
Evaporative Emission Canister Vent Hose Tie Strap
Fuel Injector O-ring
Fuel Injector Seal
Fuel Injector Spacer
Fuel Pump Gasket
Fuel Tank Fuel Pump Module O-ring

Single Use Threaded Fastener/Component Tightening Specifications

NOTE:
All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application	Specification Metric (English)
Fuel Feed Intermediate Pipe/Fitting	
• First Pass:	15 N.m (11 lb ft)
• Final Pass:	30 N.m (22 lb ft)
Fuel Pump Bolt	
• First Pass:	8 N.m (71 lb in)
• Final Pass:	50 degrees

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)
Camshaft Position Actuator Exhaust Solenoid Valve Bolt	10 N.m (89 lb in)
Camshaft Position Actuator Intake 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 Inlet Air Tube Bolt	22 N.m (16 lb ft)
Crankshaft Position Sensor Bolt	10 N.m (89 lb in)
Engine Oil Pressure Sensor	35 N.m (26 lb ft)

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NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Evaporative Emission Canister Nut	9 N.m (80 lb in)
Front Intake Air Duct Nut	9 N.m (80 lb in)
Fuel Injection Fuel Rail Fuel Pressure Sensor	33 N.m (24 lb ft)
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 Pump Shield Bolt	10 N.m (89 lb in)
Fuel Rail Bolt	25 N.m (18 lb ft)
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	5 N.m (44 lb in)
Knock Sensor Bolt	25 N.m (18 lb ft)
Manifold Absolute Pressure Sensor Bolt	5 N.m (44 lb in)
Mass Airflow Sensor Bolt	4 N.m (35 lb in)
Oil Pump Flow Control Valve Bolt	10 N.m (89 lb in)
Oil Pump Flow Control Valve Electrical Wiring Harness Connector Bracket Bolt	9 N.m (80 lb in)
Oil Pump Flow Control Valve Heat Shield Bolt	58 N.m (43 lb ft)
Pump and Component Oil Heat Shield Bolt	9 N.m (80 lb in)
Spark Plug	20 N.m (15 lb ft)
Throttle Body Bolt	10 N.m (89 lb in)
Turbocharger Bypass Valve Solenoid Bolt	7.8 N.m (69 lb in)
Turbocharger Wastegate Actuator Bolt	20 N.m (15 lb ft)
Turbocharger Wastegate Regulator Solenoid Valve Bolt	7.8 N.m (69 lb in)
Vacuum Pump Bolt	10 N.m (89 lb in)

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
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)

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Application	Type of Material	GM Part Number
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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