

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 3.6L (LFX) - Description and Operation - Impala

DESCRIPTION AND OPERATION

CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

Camshaft Actuator System Overview

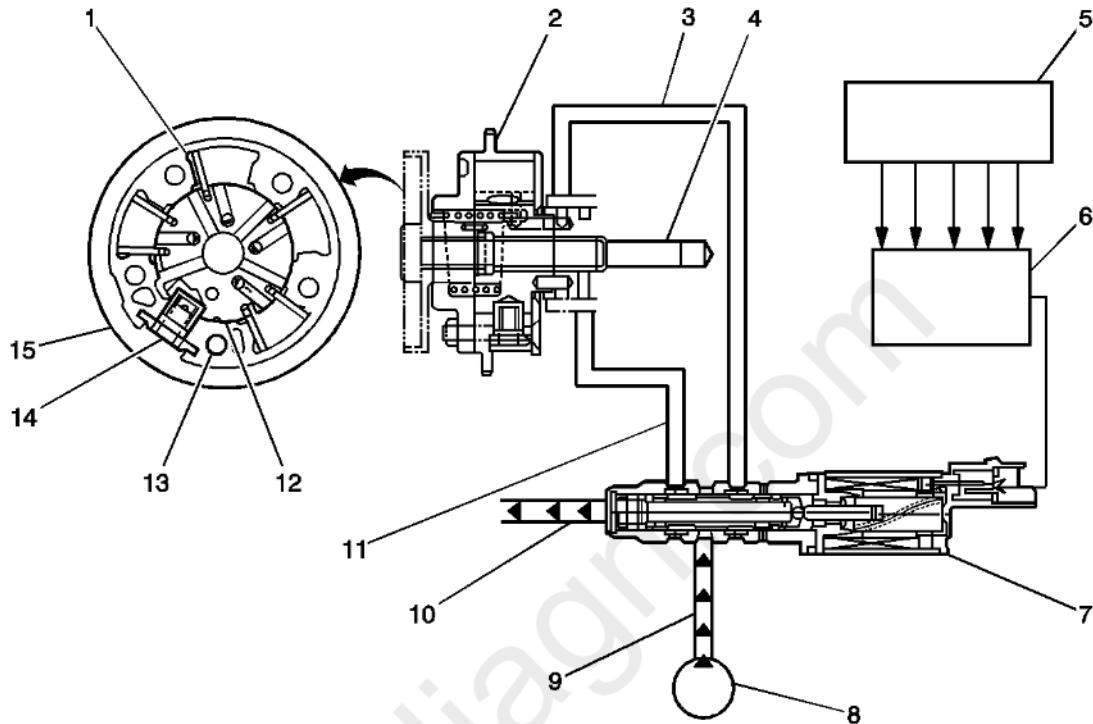


Fig. 1: Identifying Camshaft Actuator System Components

Courtesy of GENERAL MOTORS COMPANY

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

The camshaft actuator system enables the engine control module (ECM) to change camshaft timing of all 4 camshafts while the engine is operating. The camshaft position (CMP) actuator assembly (15) varies the camshaft position in response to directional changes in oil pressure. The CMP actuator

solenoid valve controls the oil pressure that is applied to advance or retard a camshaft. Modifying camshaft timing under changing engine demand provides better balance between the following performance concerns:

- Engine power output
- Fuel economy
- Tailpipe emissions

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

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

Operation

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

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

CMP Actuator System Operation

Driving Condition	Change in Camshaft Position	Objective	Result
Idle	No Change	Minimize Valve Overlap	Stabilized Idle Speed
Light Engine Load	Retarded Valve Timing	Decrease Valve Overlap	Stabled Engine Output
Medium Engine Load	Advanced Valve Timing	Increase Valve Overlap	Better Fuel Economy with Lower Emissions
Low to Medium RPM with Heavy Load	Advanced Valve Timing	Advance Intake Valve Closing	Improved Low to Mid-range Torque
High RPM with Heavy Load	Retarded Valve Timing	Retard Intake Valve Closing	Improved Engine Output

ELECTRONIC IGNITION SYSTEM DESCRIPTION

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

The electronic ignition system consists of the following components:

Crankshaft Position Sensor

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

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

Camshaft Position Sensor

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

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

Knock Sensor

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

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

If the ECM has determined that knock is present, it will retard the ignition timing to attempt to eliminate the knock. The ECM will always try to work back to a zero compensation level, or no spark retard. An abnormal knock sensor signal will stay outside of the noise channel or will not be present. Knock sensor diagnostics are calibrated to detect faults with the knock sensor circuitry inside the ECM, the knock

sensor wiring, or the knock sensor voltage output. Some diagnostics are also calibrated to detect constant noise from an outside influence such as a loose/damaged component or excessive engine mechanical noise.

Ignition Coils

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

Engine Control Module (ECM)

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

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

ENGINE CONTROL MODULE DESCRIPTION

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

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

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

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

ECM Function

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

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

EEPROM

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

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

Data Link Connector (DLC)

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

Malfunction Indicator Lamp (MIL)

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

ECM Service Precautions

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

Emissions Diagnosis For State I/M Programs

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

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

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

Aftermarket (Add-On) Electrical And Vacuum Equipment

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

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

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

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

Electrostatic Discharge (ESD) Damage

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

The electronic components that are used in the control systems are often designed to carry very low voltage. These electronic components are susceptible to damage caused by electrostatic discharge. Less

than 100 V of static electricity can cause damage to some electronic components. By comparison, it takes as much as 4, 000 V for a person to even feel a static discharge.

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

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

Emissions Control Information Label

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

This label is located in the engine compartment of every General Motors vehicle. If the label has been removed, it can be ordered from GM service parts operations (GMSPO).

EVAPORATIVE EMISSION CONTROL SYSTEM DESCRIPTION

Typical Evaporative Emission (EVAP) System Hose Routing Diagram

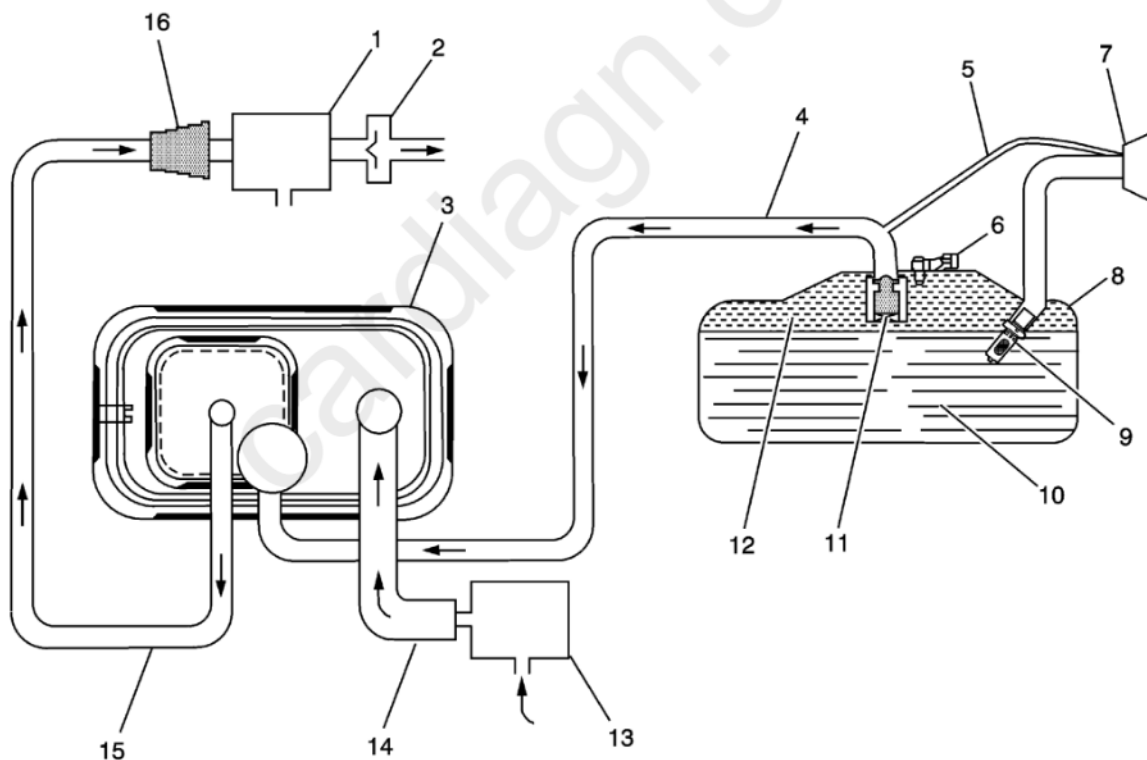


Fig. 2: View Of Typical Evaporative Emission (EVAP) System Hose Routing Diagram

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

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

EVAP System Operation

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

Purge Solenoid Valve Leak Test

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

Large Leak Test

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

Canister Vent Restriction Test

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

Small Leak Test

The engine off natural vacuum diagnostic is the small-leak detection diagnostic for the EVAP system. The engine off natural vacuum diagnostic monitors the EVAP system pressure with the ignition OFF. Because of this, it may be normal for the ECM to remain active for up to 40 min after the ignition is

turned OFF. This is important to remember when performing a parasitic draw test on vehicles equipped with engine off natural vacuum.

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

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

EVAP System Components

The EVAP system consists of the following components:

EVAP Purge Solenoid Valve

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

Purge Tube Check Valve

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

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

EVAP Canister

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

Vapor Recirculation Tube

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

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

Fuel Tank Pressure Sensor

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

Fuel Fill Pipe Check Valve

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

EVAP Vent Solenoid Valve

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

Fuel Fill Cap

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

Capless Fuel Fill

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

Fill Limit Vent Valve

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

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

FUEL SYSTEM DESCRIPTION (LFX)

Fuel System Overview

The fuel tank stores the fuel supply. The fuel pump module, located in the fuel tank, 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 in-tank fuel pump is controlled with a Chassis Control Module. The Engine Control Module (ECM) enables the Chassis Control Module and sends the desired fuel line pressure to the Chassis Control Module via GMLAN. The Chassis Control Module sends a pulse width modulated (PWM) voltage to the in-tank fuel pump allowing the fuel line pressure to be varied as commanded by the ECM. The high pressure fuel pump, fuel rail pressure, fuel injection timing, and injection duration are controlled by the ECM.

Fuel Tank

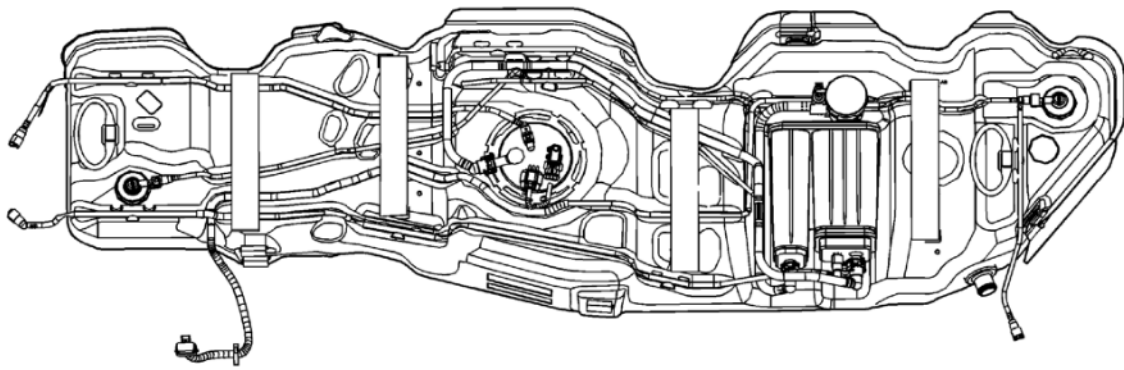


Fig. 3: Identifying Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

The fuel storage tank is made of high density polyethylene. The fuel storage tank is held in place by metal straps that are attached to the under body of the vehicle. The tank shape includes a sump in order to maintain a constant supply of fuel around the fuel pump strainer during low fuel conditions or during aggressive maneuvers.

On-Board Refueling Vapor Recovery (ORVR) System

The on-board refueling vapor recovery (ORVR) system is an on-board vehicle system to recover fuel vapors during the vehicle refueling operation. The flow of liquid fuel down to the fuel tank filler neck provides a liquid seal. The purpose of ORVR is to prevent refueling vapor from exiting the fuel tank filler neck. The ORVR components are listed below, with a brief description of their operation:

- The fuel tank - The fuel tank contains the modular fuel sender assembly.
- The fuel filler pipe - The fuel filler pipe carries fuel from the fuel nozzle to the fuel tank.
- The evaporative emission (EVAP) canister - The EVAP canister receives refueling vapor from the fuel system, stores the vapor, and releases the vapor to the engine upon demand.
- The vapor lines - The vapor lines transport fuel vapor from the tank assembly to the EVAP canister and engine.
- The check valve - The check valve limits fuel spit-back from the fuel tank during the refueling operation by allowing fuel flow only into the fuel tank. The check valve is located at the bottom of the fuel filler pipe.
- The modular fuel sender assembly - The modular fuel sender assembly pumps fuel to the engine from the fuel tank.
- The fuel tank pressure (FTP) sensor is located on top of the fuel sender assembly.
- The FLVV - The FLVV acts as a shut-off valve. The FLVV is located in the fuel sender assembly. This valve has the following functions:
 - Controlling the fuel tank fill level by closing the primary vent from the fuel tank
 - Preventing fuel from exiting the fuel tank via the vapor line to the canister
 - Providing fuel spillage protection in the event of a vehicle rollover by closing the vapor path from the tank to the engine
- The pressure vacuum relief valve - The pressure vacuum relief valve provides venting of excessive fuel tank pressure and vacuum. The valve is located in the fuel fill cap.

- The vapor recirculation line - The vapor recirculation line is used to transport vapor from the fuel tank to the top of the fill pipe during refueling to reduce vapor loading to the enhanced EVAP canister.

Fuel Tank Filler Pipe

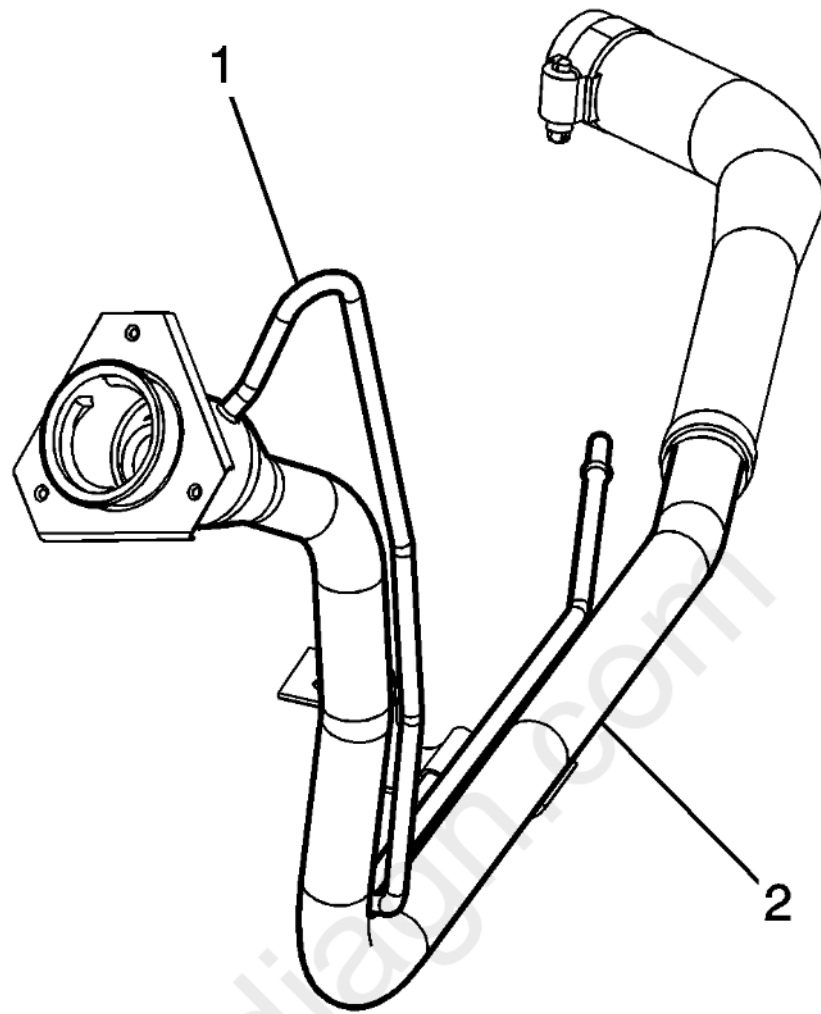


Fig. 4: Identifying Fuel Fill Pipe

Courtesy of GENERAL MOTORS COMPANY

In order to prevent refueling with leaded fuel, the fuel filler pipe has a built-in restrictor and a deflector. The opening in the restrictor will accept only the smaller unleaded gasoline fuel nozzle which must be fully inserted in order to bypass the deflector. The tank is vented during filling by an internal vent tube inside of the filler pipe.

Fuel Filler Cap

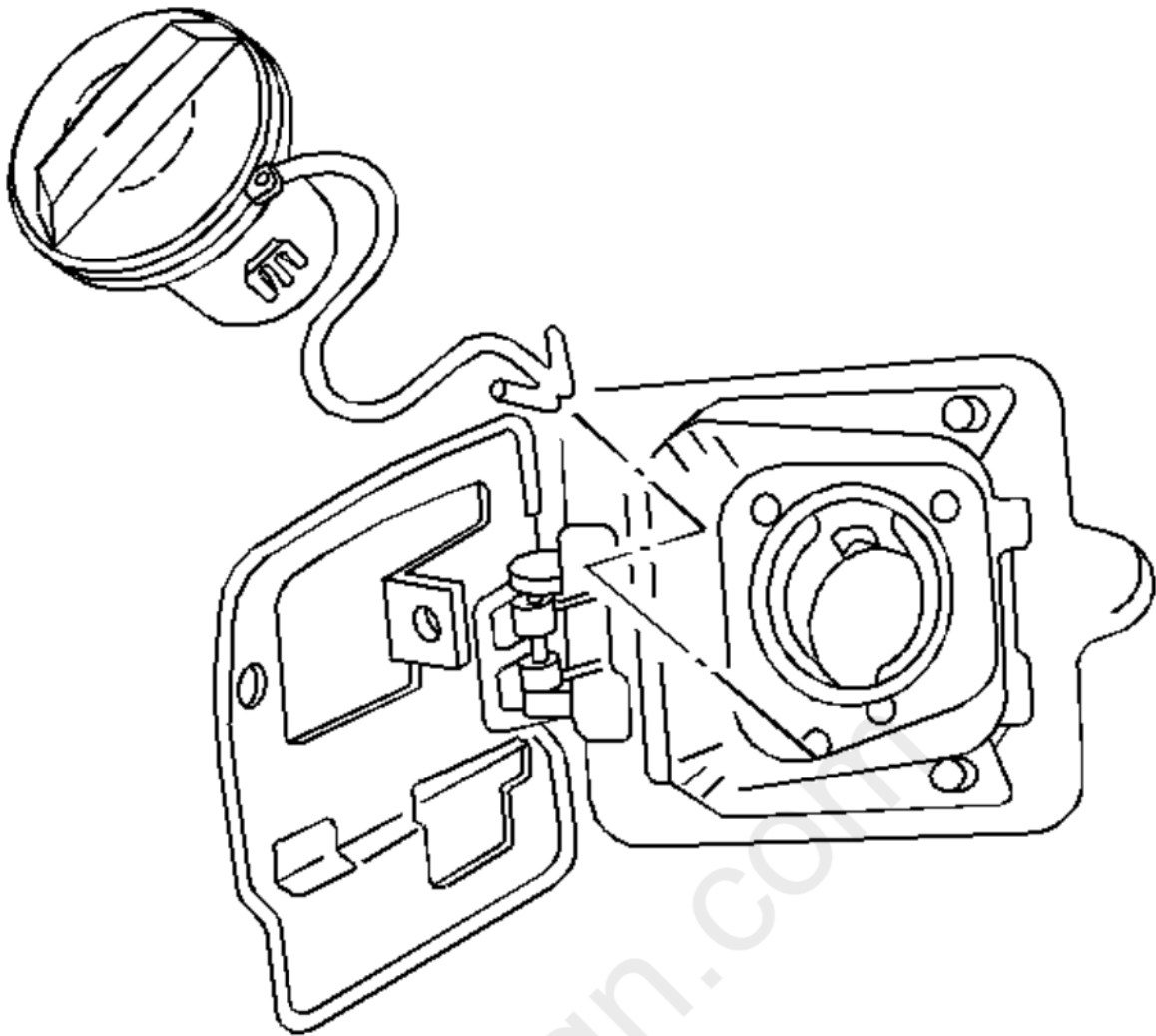


Fig. 5: View Of Fuel Filler Cap & Tether
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use a fuel tank filler pipe cap with the same features as the original when a replacement is necessary. Failure to use the correct fuel tank filler pipe cap can result in a serious malfunction of the fuel system.

The fuel tank filler pipe is equipped with a turn to vent, screw on type cap, which incorporates a ratchet action in order to prevent over-tightening.

The turn to vent feature allows for fuel tank pressure relief prior to removal. Instructions for proper use are imprinted on the cap cover. A vacuum safety relief valve is incorporated into this cap.

Fuel Sender Assembly

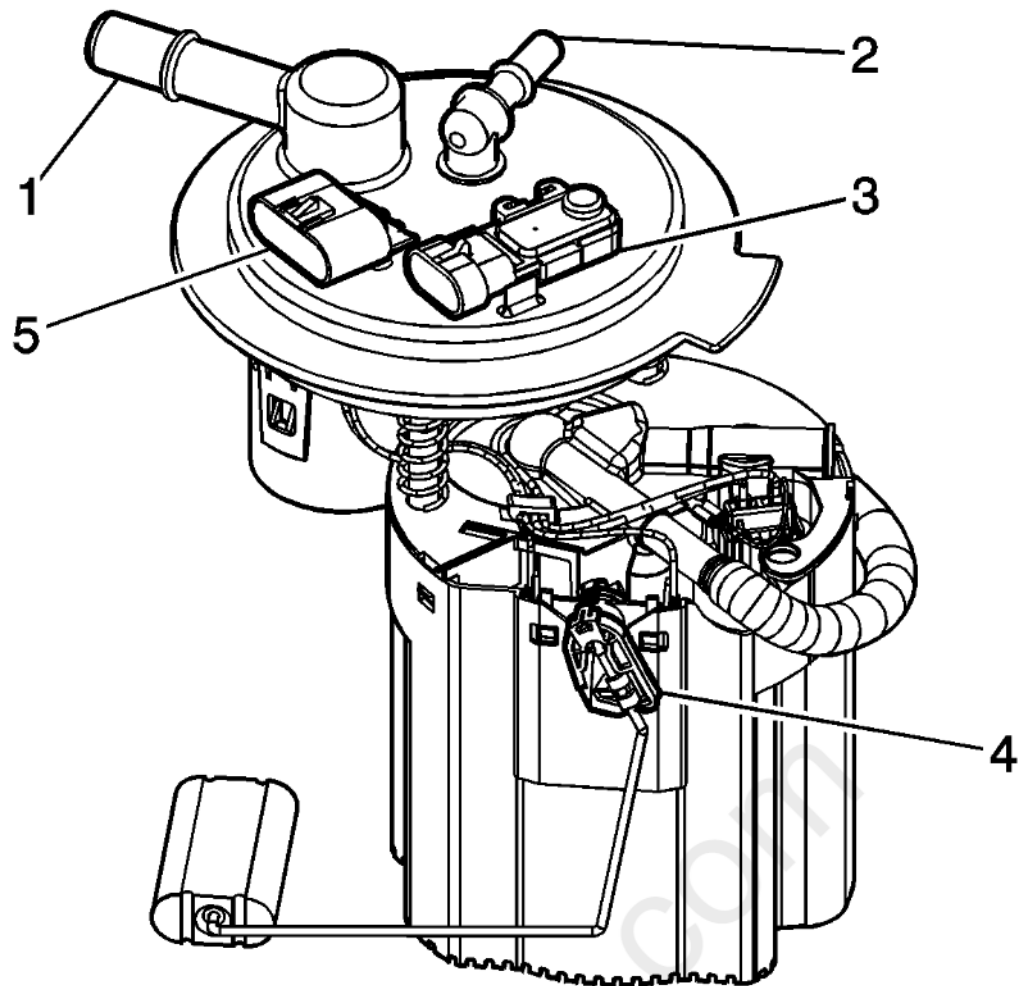


Fig. 6: View Of Fuel Sender Assembly

Courtesy of GENERAL MOTORS COMPANY

The fuel sender assembly consists of the following major components:

- The fill limit vent valve (1)
- The fuel feed pipe (2)
- The fuel tank pressure sensor (3)
- The fuel level sensor (4)
- The fuel pump electrical connector (5)

The modular fuel sender assembly mounts to the threaded opening of the plastic fuel tank with a seal and a retainer ring. The reservoir, containing the exterior inlet strainer, the electric fuel pump and the fuel filter, maintains contact with the tank bottom. This design provides:

- Optimum fuel level in the integral fuel reservoir during all fuel tank levels and during driving conditions
- An improved tank fuel level measuring accuracy
- An improved coarse straining and added pump inlet filtering
- More extensive internal fuel pump isolation for noiseless operation

Fuel Pump

The electric fuel pump is a turbine pump which is located inside of the modular fuel sender. The electric fuel pump operation is controlled by the Chassis Control Module.

Fuel Sender Strainer

The strainer acts as a coarse filter to perform the following functions:

- Filter contaminants
- Separate water from fuel
- Provide a wicking action that helps draw fuel into the fuel pump

Fuel stoppage at the strainer indicates that the fuel tank contains an abnormal amount of sediment or water. Therefore, the fuel tank will need to be removed and cleaned, and the filter strainer should be replaced.

Fuel Feed Hose/Pipe

The fuel feed pipe carries fuel from the fuel tank to the fuel rail assembly. The fuel pipes consist of 2 sections:

- The rear fuel pipe assembly connects from the top of the fuel tank module to the chassis fuel pipe. The rear fuel pipe is constructed of nylon.

CAUTION: Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .

NOTE: Precautions must be taken to prevent any form of contamination, that may cause the check valve to stick open, when servicing the fuel system. Particles in the fuel system larger than 75 microns may cause a condition.

- The chassis fuel hose/pipe is located under the vehicle and connects the rear fuel hose/pipe to the fuel inlet pipe at the high pressure fuel pump. The chassis fuel hose/pipe is constructed of steel and braided Teleflex® hose.

The flexible portion of the chassis fuel hose/pipe contains a check flow valve. The check valve does not hold pressure. It is designed to reduce the pressure pulsations going back to the in-tank fuel pump from the high pressure fuel pump. It is also designed to bleed off pressure from the high pressure fuel pump to the chassis fuel pipe during a hot soak.

Chassis Control Module

The Chassis Control Module is a serviceable GMLAN module. The Chassis Control Module receives the desired fuel pressure message from the Engine Control Module (ECM) and controls the fuel pump located within the fuel tank to achieve the desired fuel pressure. The Chassis Control Module sends a PWM signal to the fuel pump, and pump speed is changed by varying the duty cycle of this signal.

Liquid Fuel Pressure Sensor

The fuel pressure sensor is a serviceable 5-volt, 3-pin device. It is located on the fuel feed line forward of the fuel tank, and receives power and ground from the Chassis Control Module through a vehicle wiring harness. The sensor provides a fuel pressure signal to the Chassis Control Module, which is used to aid Closed Loop fuel pressure control.

Fuel Filter

The fuel filter is contained in the fuel sender assembly inside the fuel tank. The paper filter element of the fuel filter traps particles in the fuel that may damage the fuel injection system. There is no service interval for fuel filter replacement.

EVAP Lines and Hoses

The EVAP line extends from the fuel tank vent valve to the EVAP canister and into the engine compartment. The EVAP line is made of nylon and connects to the EVAP canister with a quick connect fitting.

Pressure Relief Regulator Valve

The pressure relief regulator valve replaces the typical fuel pressure regulator used on a mechanical returnless fuel system. The pressure relief regulator valve is closed during normal vehicle operation. The

pressure relief regulator valve is used to vent pressure during hot soaks and also functions as a fuel pressure regulator in the event of the fuel pump flow control module defaulting to 100 percent pulse width modulation (PWM) of the fuel pump. Due to variation in 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.

High Pressure Fuel Pump

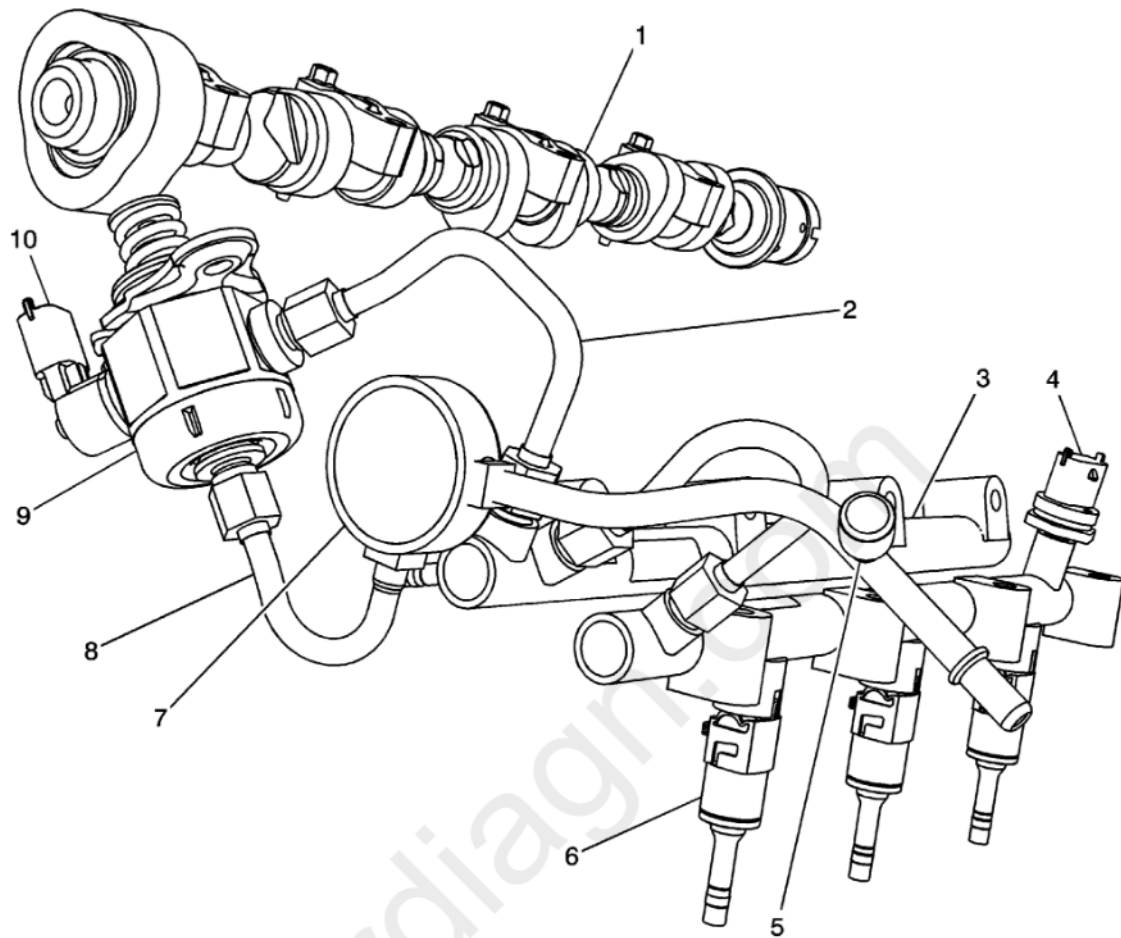


Fig. 7: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

The high pressure fuel pump (9) is a mechanical one cylinder design driven by an eccentric on the exhaust camshaft (1) of bank 2. High pressure fuel is regulated by the high pressure fuel pump actuator, which is a part of the high pressure fuel pump. The high pressure fuel pump actuator is a magnetic actuator which controls the inlet valve of the high pressure pump. The ECM provides battery voltage on the actuator high control circuit and ground on the actuator low control circuit. Both circuits are controlled by the ECM. When the ECM deactivates the high pressure fuel pump actuator, both circuits are disabled and the inlet valve is held open with spring pressure. When the ECM activates the high pressure fuel pump actuator, the low control circuit driver connects the low control circuit to ground and the high control circuit driver pulse-width modulates (PWM) the high control circuit. The ECM uses the camshaft and crankshaft position sensor inputs to synchronize the high pressure fuel pump actuator with the position of the eccentric on the camshaft. The ECM regulates fuel pressure by adjusting the portion of each pump stroke that provides fuel to the rail. The high pressure fuel pump also contains an integrated pressure relief valve.

Fuel Rail Fuel Pressure Sensor

The fuel rail pressure sensor (4) detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 volt reference voltage on the 5 volt reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the FRP 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 Rail Assembly

The fuel rail assembly (3) attaches to each cylinder head. The fuel rail distributes high pressure fuel to the fuel injectors. The fuel rail assembly consists of the following components:

- Six fuel injectors
- A fuel rail pressure (FRP) sensor

Fuel Injectors

The fuel injection system is a high pressure, direct injection, returnless on-demand design. The fuel injectors (6) are mounted in the cylinder head beneath the intake ports and spray fuel directly into the combustion chamber. Direct injection requires high fuel pressure due to the fuel injector's location in the combustion chamber. Fuel pressure must be higher than compression pressure requiring a high pressure fuel pump. The fuel injectors also require more electrical power due to the high fuel pressure. The ECM supplies a separate high voltage supply circuit and a high voltage control circuit for each fuel injector. The injector high voltage supply circuit and the high voltage control circuit are both controlled by the ECM. The ECM energizes each fuel injector by grounding the control circuit. The ECM controls each fuel injector with 65 volts. This is controlled by a boost capacitor in the ECM. During the 65 volt boost phase, the capacitor is discharged through an injector, allowing for initial injector opening. The injector is then held open with 12 volts.

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.

The fuel injectors will cause various driveability conditions if the following conditions occur:

- If the injectors will not open
- If the injectors are stuck open
- If the injectors are leaking
- If the injectors have a low coil resistance

Engine Fueling

The engine is fueled by six individual injectors, one for each cylinder, that are controlled by the ECM. The ECM controls each injector by energizing the injector coil for a brief period once every other engine revolution. The length of this brief period, or pulse, is carefully calculated by the ECM to deliver the correct amount of fuel for proper driveability and emissions control. The period of time when the injector is energized is called the pulse width and is measured in milliseconds, thousandths of a second.

While the engine is running, the ECM is constantly monitoring the inputs and recalculating the appropriate pulse width for each injector. The pulse width calculation is based on the injector flow rate, mass of fuel the energized injector will pass per unit of time, the desired air/fuel ratio, and actual air mass in each cylinder and is adjusted for battery voltage, short term, and long term fuel trim. The calculated pulse is timed to occur as each cylinders intake valves are closing to attain largest duration and most vaporization.

Fueling during a crank is slightly different than fueling during an engine run. As the engine begins to turn, a prime pulse may be injected to speed starting. As soon as the ECM can determine where in the firing order the engine is, the ECM begins pulsing the injectors. The pulse width during the crank is based on the coolant temperature and the engine load.

The fueling system has several automatic adjustments in order to compensate for the differences in the fuel system hardware, the driving conditions, the fuel used, and the engine aging. The basis for the fuel control is the pulse width calculation that is described above. Included in this calculation are an adjustment for the battery voltage, the short term fuel trim, and the long term fuel trim. The battery voltage adjustment is necessary since the changes in the voltage across the injector affect the injector flow rate. The short term and the long term fuel trims are fine and coarse adjustments to the pulse width that are designed in order to maximize the driveability and emissions control. These fuel trims are based on the feedback from the oxygen sensors in the exhaust stream and are only used when the fuel control system is in a Closed Loop operation.

Under certain conditions, the fueling system will turn OFF the injectors for a period of time. This is referred to as fuel shut-off. Fuel shut-off is used in order to improve traction, save fuel, improve emissions, and protect the vehicle under certain extreme or abusive conditions.

In case of a major internal problem, the ECM may be able to use a back-up fuel strategy for limp in mode that will run the engine until service can be performed.

Sequential Fuel Injection (SFI)

The ECM controls the fuel injectors based on information that the ECM receives from several information sensors. Each injector is fired individually in the engine firing order, which is called sequential fuel injection. This allows precise fuel metering to each cylinder and improves the driveability under all of the driving conditions.

The ECM has several operating modes for fuel control, depending on the information that has been received from the sensors.

Starting Mode

When the ECM detects reference pulses from the CKP sensor, the ECM will enable the fuel pump. The fuel pump runs and builds up pressure in the fuel system. The ECM then monitors the MAF, IAT, engine coolant temperature (ECT), and the throttle position (TP) sensor signal in order to determine the required injector pulse width for starting.

Clear Flood Mode

If the engine is flooded with fuel during starting and will not start, the Clear Flood Mode can be manually selected. To select Clear Flood Mode, push the accelerator to wide open throttle (WOT). With this signal, the ECM will completely turn OFF the injectors and will maintain this stage as long as the ECM indicates a WOT condition with engine speed below 1, 000 RPM.

Run Mode

The Run Mode has 2 conditions: Open Loop operation and Closed Loop operation. When the engine is first started and the engine speed is above 480 RPM, the system goes into Open Loop operation. In Open Loop operation, the ECM ignores the signals from the oxygen sensors and calculates the required injector pulse width based primarily on inputs from the MAF, IAT and ECT sensors.

In Closed Loop, the ECM adjusts the calculated injector pulse width for each bank of injectors based on the signals from each oxygen sensor.

Acceleration Mode

The ECM monitors the changes in the TP and the MAF sensor signals in order to determine when the vehicle is being accelerated. The ECM will then increase the injector pulse width in order to provide more fuel for improved performance.

Deceleration Mode

The ECM monitors changes in TP and MAF sensor signals to determine when the vehicle is being decelerated. The ECM will then decrease injector pulse width or even shut OFF injectors for short periods to reduce exhaust emissions, and for better (engine braking) deceleration.

Battery Voltage Correction Mode

The ECM can compensate in order to maintain acceptable vehicle driveability when the ECM sees a low battery voltage condition. The ECM compensates by performing the following functions:

- Increasing the injector pulse width in order to maintain the proper amount of fuel being delivered
- Increasing the idle speed to increase the generator output

Fuel Shut-Off Mode

The ECM has the ability to completely turn OFF all of the injectors or selectively turn OFF some of the injectors when certain conditions are met. These fuel shut-off modes allow the ECM to protect the

engine from damage and also to improve the vehicles driveability.

The ECM will disable all of the six injectors under the following conditions:

- Ignition OFF - Prevents engine run-on
- Ignition ON but no CKP signal - Prevents flooding or backfiring
- A high engine speed - Above the red line
- A high vehicle speed - Above the rated tire speed
- Closed throttle coast down - Reduces the emissions and increases engine braking.

The ECM will selectively disable the injectors under the following conditions:

- The torque management enabled - Transmission shifts or abusive maneuvers.
- The traction control enabled - In conjunction with the front brakes applying

SECONDARY AIR INJECTION SYSTEM DESCRIPTION

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

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

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

The ECM monitors the secondary air injection system pressure by tracking voltage signals from the pressure sensors, which are integral to the solenoid (shutoff and check) valve assemblies.

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

During phase 1, DTCs P0411, P2430 and P2435 run and both the secondary air injection pump and the solenoid (shutoff and check) valves are activated. Normal secondary air function occurs. Expected system pressure is 5 - 13 kPa (0.7 - 1.9 psi) above BARO.

During phase 2, DTCs P2430, P2435 and P2440 run and only the secondary air injection pump is activated. The valves are closed. Pressure sensor performance and valve deactivation are tested. Expected system pressure is 14 - 22 kPa (2.0 - 3.2 psi) above BARO.

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

The secondary air injection system includes the following components:

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

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

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

THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

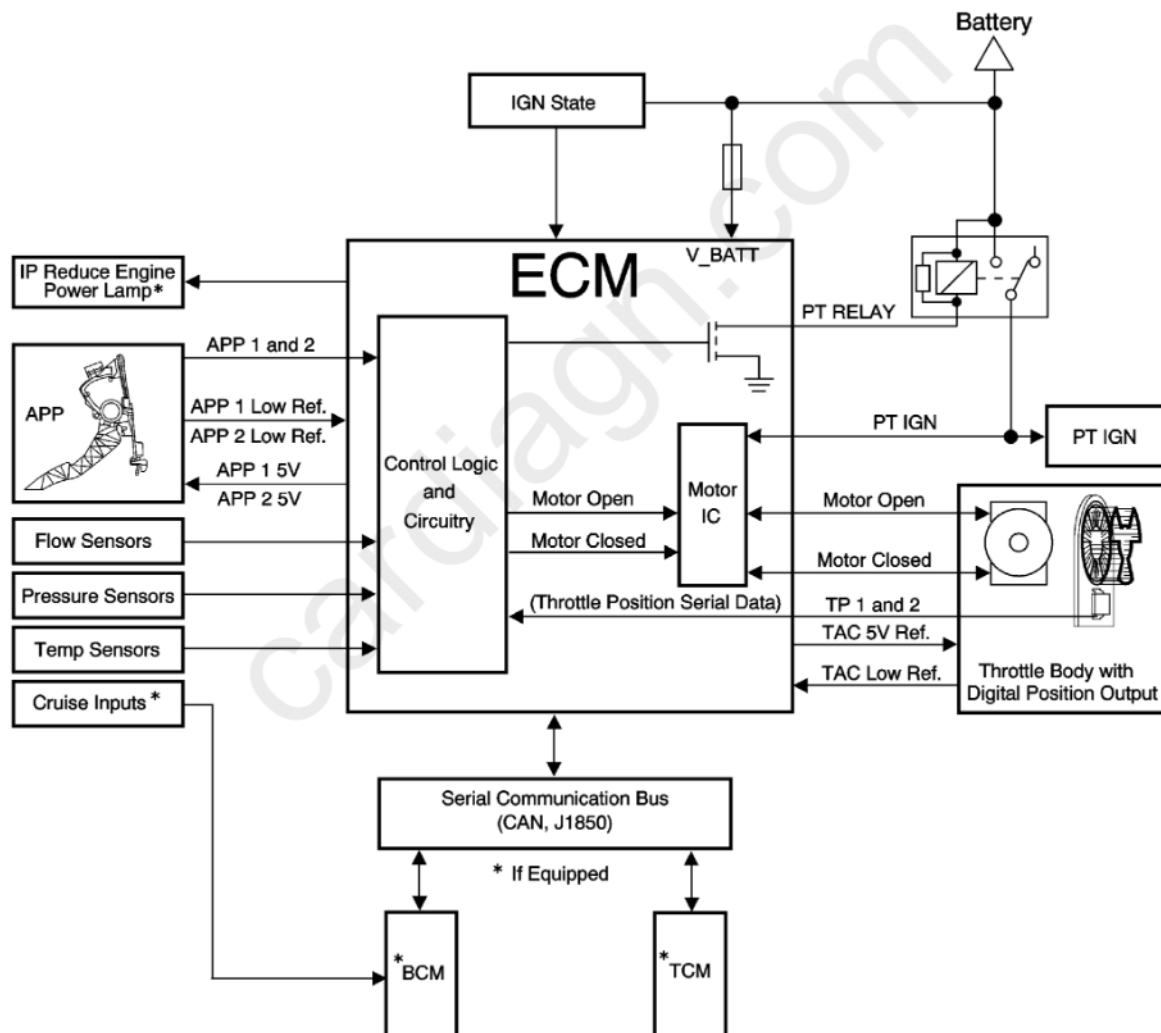


Fig. 8: Throttle Actuator Control (TAC) System Description
 Courtesy of GENERAL MOTORS COMPANY

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.

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 3.6L (LFX) - Diagnostic Information and Procedures - Impala

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P000A-P000D, P0011, P0014, P0021, OR P0024: INTAKE/EXHAUST CAMSHAFT POSITION SYSTEM SLOW RESPONSE BANK (LFR)

Diagnostic 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 P000A

Intake Camshaft Position System Slow Response Bank 1

DTC P000B

Exhaust Camshaft Position System Slow Response Bank 1

DTC P000C

Intake Camshaft Position System Slow Response Bank 2

DTC P000D

Exhaust Camshaft Position System Slow Response Bank 2

DTC P0011

Intake Camshaft Position System Performance Bank 1

DTC P0014

Exhaust Camshaft Position System Performance Bank 1

DTC P0021

Intake Camshaft Position System Performance Bank 2

DTC P0024

Exhaust Camshaft Position System Performance Bank 2

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
Camshaft Position Actuator Solenoid Valve High Control	P0010, P0013, P0020, P0023, P2088, P2090, P2092, P2094	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023, P2089, P2091, P2093, P2095	P0011, P0014, P0021, P0024
Camshaft Position Actuator Solenoid Valve Low Reference	-	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023	-	-

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 signal from the ECM is pulse width modulated (PWM). The ECM controls the camshaft position actuator solenoid duty cycle by controlling the amount of solenoid On time. The camshaft position actuator solenoid controls the advance or the retard of each camshaft. The camshaft position actuator solenoid controls the oil flow that applies the pressure to advance or retard the camshafts.

Conditions for Running the DTC

P000A - P000D

- DTC P0010, P0013, P0016 - P0020, P0024, P0341 - P0343, P0346, P0347, P0348, P0366 - P0368, P0391, P0393 or P2088 - P2095 is not set.
- The ignition voltage is between 11 - 32 V.
- The engine is running.
- Engine oil pressure is within specification.
- The desired camshaft position is not changing greater than 4.5° for at least 2.5 s.
- DTCs P000A - P000D run continuously when the above conditions are met.

P0011, P0014, P0021 or P0024

- DTC P0010, P0013, P0016 -P0020, P0023, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391 or P2088 - P2095 is not set.
- The ignition voltage is between 11 - 32 V.
- The engine is running.
- The desired camshaft position is not changing greater than 4.5° for at least 1 s.
- Both of the desired and actual camshaft position actuator values cannot be greater than 20° or less than 5° .
- DTCs P0011, P0014, P0021, and P0024 run continuously when the above conditions are met.

Conditions for Setting the DTC

P000A - P000D

The ECM detects the difference between the desired and actual camshaft position angle is greater than 6° and the difference between the highest or lowest camshaft position is greater than or equal to 1.5 degrees for greater 2.5 s for 10 consecutive events.

P0011 and P0021

The ECM detects the difference between the desired and actual camshaft position angle is greater than 5° for greater 2.5 s.

P0014 and P0024

The ECM detects the difference between the desired and actual camshaft position angle is greater than 5° for greater 10 s.

Action Taken When the DTC Sets

DTCs P000A-P000D, P0011, P0014, P0021, and P0024 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P000A-P000D, P0011, P0014, P0021, and P0024 are Type B DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFR)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- 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 parameter.
Advise the customer an oil change may be required.

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

1. Ignition On.

2. Verify that the engine has the correct oil level and the correct oil pressure. Refer to [Oil Pressure Diagnosis and Testing](#).

- If the oil level and the oil pressure are not correct

Repair as necessary

- If the oil level and the oil pressure are correct

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

3. Verify DTC P0010, P0013, P0016 - P0020, P0023, P0024, P0335, P0336, P0338, P0340 - P0343, P0345 - P0348, P0365 - P0368, P0390, P0391, P0393 or P2088 - P2095 is not set.

- If any of the DTCs are set

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

- If none of the DTCs are set

4. Engine idling.

5. Verify the scan tool parameters are less than 2° while increasing to RPM 2000 and back to idle.

- Intake Camshaft Position Variance Bank 1
- Exhaust Camshaft Position Variance Bank 1
- Intake Camshaft Position Variance Bank 2
- Exhaust Camshaft Position Variance Bank 2
- If 2° or greater

Refer to Circuit/System Testing.

- If less than 2°

6. Verify that DTC P000A, P000B, P000C, P000D, P0011, P0014, P0021 or P0024 is not set.

- If any of the DTCs are set

Refer to Circuit/System Testing.

- If none of the DTCs set

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

8. Verify the DTC does not set.

- If the DTC sets

Refer to Circuit/System Testing.

- If the DTC does not set

9. All OK.

Circuit/System Testing

1. Ignition Off, remove the Q6 Camshaft Position Actuator Solenoid Valve.

2. Verify the conditions listed below do not exist with the Q6 Camshaft Position Actuator Solenoid Valve:

1. Torn, restricted, mis-positioned, or missing screens.

2. Engine oil leak between the oil sealing lands of the solenoid. Inspect the lands of the solenoid for nicks.

3. Oil seepage at the solenoid connector.

- **If a condition is found**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If a condition is not found**

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

3. Ignition Off, swap the Q6 Camshaft Position Actuator Solenoid Valve with the Q6 Camshaft Position Actuator Solenoid Valve that is operating correctly.

4. Engine idling.

5. Verify the scan tool Camshaft Position Variance parameter is less than 2° while increasing to RPM 2000 and back to idle.

- **If 2° or greater**

Replace the mechanical camshaft position actuator.

- **If less than 2°**

6. 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 5 - 12 Ω between the control terminal 1 and the low reference terminal 2.

- **If not between 5 - 12 Ω**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If between 5 - 12 Ω**

3. Test for infinite resistance between each terminal and the Q6 camshaft position actuator solenoid valve housing.

- **If not infinite resistance**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If infinite resistance**

4. All OK.

Repair Instructions

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

- [Camshaft Position Actuator Replacement - Bank 1](#)
- [Camshaft Position Actuator Replacement - Bank 2](#)
- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 \(Right Side\) Intake](#)
- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 \(Right Side\) Exhaust](#)
- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 \(Left Side\) Intake](#)
- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 \(Left Side\) Exhaust](#)
- [Control Module References](#) for K20 ECM replacement, programming, and setup

DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, OR P2095: INTAKE/EXHAUST CAMSHAFT POSITION ACTUATOR SOLENOID VALVE CONTROL CIRCUIT BANK

Diagnostic Instructions

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

DTC Descriptors

DTC P0010

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1

DTC P0013

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1

DTC P0020

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2

DTC P0023

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2

DTC P2088

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 1

DTC P2089

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 1

DTC P2090

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 1

DTC P2091

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 1

DTC P2092

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 2

DTC P2093

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 2

DTC P2094

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 2

DTC P2095

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 2

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
Camshaft Position Actuator Solenoid Valve High Control	P0010, P0013, P0020, P0023, P2088, P2090, P2092, P2094	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023, P2089, P2091, P2093, P2095	P0011, P0014, P0021, P0024
Camshaft Position Actuator Solenoid Valve Low Reference	-	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023	-	-

Circuit/System Description

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

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

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The ignition switch is in the Crank or Run position.
- The ECM commanded the Camshaft Position Actuator Solenoid Valve On.
- DTCs P0010, P0013, P0020, P0023 and P2088 - P2095 run continuously when the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTCs P0010, P0013, P0020, P0023 and P2088 - P2095 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0010, P0013, P0020, P0023 and P2088 - P2095 are Type B DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

Component View Reference

Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

1. Ignition On.
2. Verify DTC 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.
 - **If none of the DTCs are set**
3. Verify the scan tool parameters listed below do not display Malfunction:
 - Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status Bank 1 or 2
 - Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status Bank 1 or 2
 - Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status Bank 1 or 2
 - **If Malfunction is displayed**
Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**
4. Engine idling at normal operating temperature.
5. Verify the scan tool parameters listed below do not display Malfunction when commanding the appropriate scan tool Camshaft Position Actuator from 0 - 25° and back to 0° with a scan tool:
 - Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status Bank 1 or 2
 - Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status Bank 1 or 2
 - Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status Bank 1 or 2

- **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

6. Raise the engine speed to 2,000 RPM for 10 s.

7. Verify that DTC P0010, P0013, P0020, P0023 or P2088 - P2095 is not set.

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

Refer to Circuit/System Testing.

- **If none of the DTCs set**

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

9. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

10. All OK

Circuit/System Testing

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 and ground.

- **If 5 Ω or greater**

1. Ignition Off, disconnect the harness connector at the K20 engine control module.

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

- If 2 Ω or greater, repair the open/high resistance in the circuit
- If less than 2 Ω , replace the K20 engine control module

- **If less than 5 Ω**

3. Ignition On.

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

4. Verify that a test lamp does not illuminate between the control circuit terminal 1 and ground.

- **If the test lamp illuminates**

1. Ignition Off, disconnect the harness connector at the K20 engine control module, ignition On.

2. Test for less than 1 V between the control circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit
- If less than 1 V, replace the K20 engine control module

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

5. Remove the test lamp.

6. Connect the DMM black lead to the control circuit terminal 1. Connect the DMM red lead to B+. Command the Camshaft Position Actuator Solenoid On and Off with a scan tool. Verify the voltage changes.

- **If the voltage 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.
- **If the voltage changes**

7. 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 5 - 12 Ω between the control terminal 1 and the low reference terminal 2.
 - **If not between 5 - 12 Ω**
Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If between 5 - 12 Ω**
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
 - **If not infinite resistance**
Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If infinite resistance**
4. All OK.

Repair Instructions

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

- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Control Module References** for K20 Engine Control Module replacement, programming and setup.

DTC P0011, P0014, P0021, OR P0024: INTAKE/EXHAUST CAMSHAFT POSITION SYSTEM PERFORMANCE BANK

Diagnostic Instructions

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

DTC Descriptors

DTC P0011

Intake Camshaft Position System Performance Bank 1

DTC P0014

Exhaust Camshaft Position System Performance Bank 1

DTC P0021

Intake Camshaft Position System Performance Bank 2

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Camshaft Position Actuator Solenoid Valve High Control	P0010, P0013, P0020, P0023, P2088, P2090, P2092, P2094	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023, P2089, P2091, P2093, P2095	P0011, P0014, P0021, P0024
Camshaft Position Actuator Solenoid Valve Low Reference	-	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023	-	-

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 signal from the ECM is pulse width modulated (PWM). The ECM controls the camshaft position actuator solenoid duty cycle by controlling the amount of solenoid On time. The camshaft position actuator solenoid controls the advance or the retard of each camshaft. The camshaft position actuator solenoid controls the oil flow that applies the pressure to advance or retard the camshafts.

Conditions for Running the DTC

- DTC P0010, P0013, P0020, P0023, P0016, P0017, P0018, P0019, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391 or P2088 - P2095 is not set.
- The ignition voltage is between 11 - 32 V.
- The engine is running.
- The desired camshaft position is not changing greater than 4.5° for at least 1 s.
- Both of the desired and actual camshaft position actuator values cannot be greater than 20° or less than 5° .
- DTCs P0011, P0014, P0021, and P0024 run continuously when the above conditions are met.

Conditions for Setting the DTC**P0011 and P0021**

The ECM detects the difference between the desired and actual camshaft position angle is greater than 5° for greater 2.5 s.

P0014 and P0024

The ECM detects the difference between the desired and actual camshaft position angle is greater than 5° for greater 10 s.

Action Taken When the DTC Sets

DTCs P0011, P0014, P0021, and P0024 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0011, P0014, P0021, and P0024 are Type B DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- 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 parameter. Advise the customer an oil change may be required.
- If a crankshaft or camshaft position sensor DTC is set, the Camshaft Position Actuator output control will not function.

1. Ignition On.

2. Verify that the engine has the correct oil level and the correct oil pressure. Refer to **Oil Pressure Diagnosis and Testing** .

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

Repair as necessary

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

NOTE:

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

3. Verify DTC P0016, P0017, P0018, P0019, P0335, P0336, P0338, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391 or P2088 - P2095 is not set.

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

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

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

4. Engine idling.

5. Verify the scan tool parameters are less than 2° in each of the commanded states when commanding the Camshaft Position Actuator from $0 - 20^{\circ}$ and back to 0° with the scan tool.

- Intake Camshaft Position Variance Bank 1
- Exhaust Camshaft Position Variance Bank 1
- Intake Camshaft Position Variance Bank 2
- Exhaust Camshaft Position Variance Bank 2
- **If 2° or greater**

Refer to Circuit/System Testing.

- **If less than 2°**

6. Verify that DTC P0011, P0014, P0021 or P0024 is not set.

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

Refer to Circuit/System Testing.

- **If none of the DTCs set**

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

8. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

9. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than $5\ \Omega$ between the low reference circuit terminal 2 and ground.

- **If $5\ \Omega$ or greater**

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

2. Test for less than $2\ \Omega$ in the low reference circuit end to end.

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

- **If less than $5\ \Omega$**

3. Ignition On.

4. Verify that a test lamp does not illuminate between the control circuit terminal 1 and ground.

- **If the test lamp illuminates**

1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On.

2. Test for less than 1 V between the control circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
5. Verify the test lamp illuminates when commanding the appropriate Camshaft Position Actuator Solenoid Valve On with a scan tool.
 - **If the test lamp does not illuminate**
 1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance or short to ground in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If the test lamp illuminates**
 6. Ignition Off, remove the Q6 Camshaft Position Actuator Solenoid Valve.
 7. Verify the conditions listed below do not exist with the Q6 Camshaft Position Actuator Solenoid Valve:
 1. Torn, restricted, mis-positioned, or missing screens.
 2. Engine oil leak between the oil sealing lands of the solenoid. Inspect the lands of the solenoid for nicks.
 3. Oil seepage at the solenoid connector.
 - **If a condition is found**

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

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

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

Replace the mechanical camshaft position actuator.
 - **If less than 2 $^{\circ}$**
11. 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 5 - 12 Ω between the control terminal 1 and the low reference terminal 2.
 - **If not between 5 - 12 Ω**

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

Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If infinite resistance**

Repair Instructions

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

- **Camshaft Position Actuator Replacement - Bank 1**
- **Camshaft Position Actuator Replacement - Bank 2**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Control Module References** for K20 ECM replacement, programming, and setup

DTC P0016, P0017, P0018, OR P0019: CRANKSHAFT POSITION

Diagnostic 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 Bank 1

DTC P0017

Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 1

DTC P0018

Crankshaft Position - Intake Camshaft Position Not Plausible Bank 2

DTC P0019

Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 2

Circuit/System Description

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

Conditions for Running the DTC

- DTC P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0641, or P0642 is not set.
- The crankshaft and camshaft position signals are synchronized.
- The engine is cranking or running.
- The camshaft position actuator is in the parked position.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P0016, P0017, P0018, or P0019

- The ECM detects that one camshaft is mis-aligned with the crankshaft. The ECM detects one of the following conditions:
 - Bank 1 intake camshaft is greater than 9° advanced or 12° retarded in relationship to the crankshaft.
 - Bank 1 exhaust camshaft is greater than 10° advanced or 13° retarded in relationship to the crankshaft.
 - Bank 2 intake camshaft is greater than 11° advanced or 13° retarded in relationship to the crankshaft.
 - Bank 2 exhaust camshaft is greater than 9° advanced or 13° retarded in relationship to the crankshaft.
- The ECM detects that all 4 camshafts are mis-aligned with the crankshaft. The ECM detects the following conditions:
 - Bank 1 intake camshaft is greater than 9° advanced or 12° retarded in relationship to the crankshaft.
 - Bank 1 exhaust camshaft is greater than 10° advanced or 13° retarded in relationship to the crankshaft.
 - Bank 2 intake camshaft is greater than 6° advanced or 9° retarded in relationship to the crankshaft.
 - Bank 2 exhaust camshaft is greater than 7° advanced or 9° retarded in relationship to the crankshaft.

Action Taken When the DTC Sets

DTCs P0016, P0017, P0018, and P0019 are type B DTCs.

Conditions for Clearing the DTC

DTCs P0016, P0017, P0018, and P0019 are type B DTCs.

Diagnostic Aids

- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed secondary timing chain can cause this DTC to set.
- This diagnostic algorithm is designed to detect an alignment condition between a primary intermediate sprocket and the secondary timing chain or the alignment between a primary intermediate sprocket and the crankshaft. Either condition would cause the camshaft timing for both cams on one bank to be off an equal number of degrees.
- DTCs P0016, P0017, P0018, and P0019 set at the same time indicate a possible condition with the primary timing chain and the alignment between both intermediate sprockets and the crankshaft. Also, the crankshaft reluctor wheel may have moved and is no longer referenced to top dead center (TDC).
- Observing the desired and actual camshaft angle parameters with a scan tool before a DTC sets may help to isolate whether a condition is specific to one camshaft, one bank, or caused by a condition with the primary crankshaft timing.

Reference Information

Description and Operation

Camshaft Actuator System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0010, P0013, P0020, P0023, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P2088, P2089, P2090, P2091, P2092, P2093, P2094, 20095 or P25CA-P25CE is not set.

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

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

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

3. Verify the conditions below do not exist:

- A Q6 Camshaft Position Actuator Solenoid Valve that is stuck in the full advance or retard position
- The correct installation of the Q6 Camshaft Position Actuator Solenoid Valves
- The correct installation of the B23 Camshaft Position Sensors
- The correct installation of the B26 Crankshaft Position Sensor
- A timing chain tensioner condition
- An incorrectly installed timing chain
- Excessive play in the timing chain
- A timing chain that jumped teeth
- A crankshaft reluctor wheel that has moved in relationship to top dead center (TDC) on the crankshaft

- **If a condition is found**

Repair as necessary.

- **If no condition is found**

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**

A mechanical condition listed above still exists.

- **If the DTC does not set**

6. All OK.

Repair Instructions

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

- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 \(Right Side\) Exhaust](#)
- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 \(Left Side\) Exhaust](#)
- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 \(Right Side\) Intake](#)
- [Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 \(Left Side\) Intake](#)
- [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Exhaust](#)
- [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Exhaust](#)
- [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Intake](#)
- [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Intake](#)
- [Camshaft Timing Drive Components Cleaning and Inspection](#)
- [Crankshaft Position Sensor Replacement](#)
- [Timing Chain Alignment Diagram](#)

**DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, OR P0161:
HO2S HEATER**

Diagnostic 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 P0030

HO2S Heater Control Circuit Bank 1 Sensor 1

DTC P0031

HO2S Heater Control Circuit Low Voltage Bank 1 Sensor 1

DTC P0032

HO2S Heater Control Circuit High Voltage Bank 1 Sensor 1

DTC P0036

HO2S Heater Control Circuit Bank 1 Sensor 2

DTC P0037

HO2S Heater Control Circuit Low Voltage Bank 1 Sensor 2

DTC P0038

HO2S Heater Control Circuit High Voltage Bank 1 Sensor 2

DTC P0050

HO2S Heater Control Circuit Bank 2 Sensor 1

DTC P0051

HO2S Heater Control Circuit Low Voltage Bank 2 Sensor 1

DTC P0052

HO2S Heater Control Circuit High Voltage Bank 2 Sensor 1

DTC P0053

HO2S Heater Resistance Bank 1 Sensor 1

DTC P0054

HO2S Heater Resistance Bank 1 Sensor 2

DTC P0056

HO2S Heater Control Circuit Bank 2 Sensor 2

DTC P0057

HO2S Heater Control Circuit Low Voltage Bank 2 Sensor 2

DTC P0058

DTC P0059

HO2S Heater Resistance Bank 2 Sensor 1

DTC P0060

HO2S Heater Resistance Bank 2 Sensor 2

DTC P0135

HO2S Heater Performance Bank 1 Sensor 1

DTC P0141

HO2S Heater Performance Bank 1 Sensor 2

DTC P0155

HO2S Heater Performance Bank 2 Sensor 1

DTC P0161

HO2S Heater Performance Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Heater Voltage Supply	P0030, P0036, P0037, P0050, P0056, P0057, P0097, P00F4, P0102, P0132, P0135, P0138, P0141, P0152, P0155, P0158, P0161, P2199, *	P0030, P0031, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0690	P0135, P0141, P0155, P0161
HO2S Heater Control	P0030, P0031, P0036, P0037, P0050, P0051, P0053, P0054, P0056, P0057, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0032, P0036, P0038, P0050, P0052, P0056, P0058, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161
* Opens Fuse				

Typical Scan Tool Data**HO2S Sensor 1 Current/HO2S Sensor 2 Current**

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 0.2 - 1.5 A			
HO2S Heater Low Control	0 A	0 A	0 A
HO2S Heater Voltage Supply	0 A	0 A	0.2 - 2 A

Circuit/System Description

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The

HO2S must reach operating temperature to provide an accurate voltage signal. A heating element inside the HO2S minimizes the time required for the sensors to reach operating temperature. Voltage is provided to the heater by an ignition voltage circuit through a fuse. With the engine running, ground is provided to the heater by the HO2S heater low control circuit through a low side driver within the engine control module (ECM). The ECM uses pulse width modulation (PWM) to control the HO2S heater operation to maintain a specific HO2S operating temperature range.

Conditions for Running the DTC

P0030-P0032, P0036-P0038, P0050-P0052, or P0056-P0058

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

P0053, P0054, P0059, or P0060

- DTCs P0112, P0113, P0117, P0118, or P2610 are not set.
- The engine run time is greater than 20 s.
- The Ignition voltage is less than 18 V.
- The ignition is OFF for greater than 8 h.
- The engine coolant temperature (ECT) is between -30 to +45°C (-22 to +113°F) at engine start-up.
- The ECT and the intake air temperature (IAT) are within 8°C (14°F) at engine start-up.
- The DTCs run once per drive cycle when the above conditions are met.

P0135, P0141, P0155, or P0161

- DTCs P0116, P0117, P0118, P0125, or P0128 are not set.
- The Ignition voltage is between 10 - 32 V.
- The HO2S is at operating temperature.
- The HO2S is commanded ON.
- The DTCs run once per drive cycle when the above conditions are met for 120 s.

Conditions for Setting the DTC

P0030, P0036, P0050, or P0056

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

P0031, P0037, P0051, or P0057

The engine control module detects a short to ground in the heater output low side driver circuit of the heated oxygen sensor when the heater is commanded OFF for greater than 13 s.

P0032, P0038, P0052, or P0058

The engine control module detects a short to voltage in the heater output low side driver circuit of the heated oxygen sensor when the heater is commanded ON for greater than 13 s.

P0053, P0054, P0059, or P0060

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

P0135 or P0155

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

P0141 or P0161

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

Action Taken When the DTC Sets

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

Conditions for Clearing the MIL/DTC

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the HO2S Heater Bank 1 or 2 Sensor 1 or 2 ON and OFF with a scan tool.
 - HO2S Heater Control Circuit Low Voltage Test Status Bank 1 or 2 Sensor 1 or 2
 - HO2S Heater Control Circuit Open Test Status Bank 1 or 2 Sensor 1 or 2
 - HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2
 - **If Malfunction is displayed**
Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B52 Heated Oxygen Sensor. Ignition ON.
2. Verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the fuse and replace as necessary.
 - **If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal D and the control circuit terminal C.
 - **If the test lamp illuminates**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2 parameter is OK when commanding the HO2S Heater ON with a scan tool.
 - **If the parameter is not OK**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module. Ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - **If the parameter is OK**

NOTE:

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

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

NOTE:

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

7. Verify the scan tool HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2 parameter is Malfunction when commanding the HO2S Heater ON with a scan tool.
 - **If the parameter is not Malfunction**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If the parameter is Malfunction**

8. Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

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

- [Heated Oxygen Sensor Replacement - Bank 1 Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Bank 1 Sensor 2](#)
- [Heated Oxygen Sensor Replacement - Bank 2 Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Bank 2 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 P0068 OR P1101: THROTTLE BODY AIR FLOW PERFORMANCE/INTAKE AIR FLOW SYSTEM PERFORMANCE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [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 air flow based on manifold absolute pressure (MAP) sensor, and mass air flow (MAF).

Conditions for Running the DTC

DTC P0068

- The engine speed is greater than 800 RPM.
- The ignition voltage is greater than 6.5 V.
- The throttle actuator control system is not in reduced power mode.
- The DTC runs continuously when the above conditions are met.

DTC P1101

- DTCs P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0335, or P0336 are not set
- The engine speed is between 600 - 6, 800 RPM
- The engine coolant temperature (ECT) is between -7 and +125Â°C (+19 and +257Â°F).
- The intake air temperature (IAT) sensor 1 is between -20 and +125Â°C (-4 to +257Â°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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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.
2. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
 - **If any of the DTCs are set**
Refer to DTC P0641, P0651, P0697, or P06A3 (ECM) for further diagnosis.
 - **If none of the DTCs are set**
3. Verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90 %.
 - **90 % or greater**
Refer to Throttle Body Inspection and Cleaning .
 - **If less than 90 %**
4. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
 - **If Disagree**
Refer to DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135 for further diagnosis.
 - **If Agree**
5. Determine the current vehicle testing altitude.

6. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure \(With LFX\)](#) table.

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

Refer to [DTC P0106 \(LFX\)](#) for further diagnosis.

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

7. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.

1. Engine idling
2. Perform the scan tool snapshot function.
3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
4. Exit from the scan tool snapshot and review the data.
5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **The MAF Sensor parameter does not change smoothly and gradually**

Refer to [DTC P0101](#) for further diagnosis.

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

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

9. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing for further diagnosis.

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

10. All OK.

Circuit/System Testing

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

1. 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
- Loose clamps, cracks, or other damage
- An air flow restriction
- Restricted air filter
- Splits, kinks, leaks, or improper connections at the vacuum hoses
- Vacuum leaks at the intake manifold, MAP sensor, and throttle body
- Water intrusion
- Any snow or ice buildup, in cold climates
- Contamination of the MAF sensor element
- Improper operation of the crankcase ventilation system - Refer to [Crankcase Ventilation System Inspection/Diagnosis](#) for further diagnosis.
- Missing, restricted, or leaking exhaust components - Refer to [Symptoms - Engine Exhaust](#) for further diagnosis.
- **If a condition is found**

Repair or replace component as appropriate.

- **If no condition is found**

2. Test the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#) for diagnosis.

- **If a condition is found**

Repair or replace component as appropriate.

- **If no condition is found**

3. All OK

Repair Instructions

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

[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 Solenoid 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 Bank 2 exhaust camshaft. This high pressure fuel pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2 to 15 MPa (290 to 2, 176 psi), depending on engine speed and load. Output drivers in the ECM provide the high pressure fuel pump actuator control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by closing and opening the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail. When the control solenoid is NOT powered, the pump operates at maximum flow rate. In the event of pump control failure, the high pressure system is protected by a relief valve in the high pressure fuel 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 high pressure fuel pump actuator to make sure it is operating within expected limits.

Conditions for Running the DTC

P0089, P228C, or P228D

- DTC P0016, P0017, P0018, P0019, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, or P0628, is not set.
- The ignition voltage is greater than 8 V.
- The low side fuel pressure is greater than 275 kPa (40 psi).
- The engine is running.
- The DTCs run continuously when the above conditions are met for 10 s.

P00C6

- DTC P0090, P0091, P0092, P00C8, P00C9, P00CA, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, or P0628, is not set.
- The ignition voltage is more than 8 V.
- The engine coolant temperature is less than 65°C (149°F).
- The low side fuel pressure is greater than 300 kPa (44 psi).
- The diagnostic runs once for each engine start.

Conditions for Setting the DTC

P0089

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

P00C6

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

P228C

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

P228D

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

Action Taken When the DTC Sets

- DTCs P0089 and P00C6 are Type B DTCs.
- DTCs P228C and P228D are Type A DTCs.
- A message center or an indicator displays Reduced Engine Power for P228C and P228D.

Conditions for Clearing the DTC

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

Diagnostic Aids

- A leak in the high pressure fuel system may set a DTC.
- A faulty valve, plunger, or solenoid in the high pressure fuel pump may set a DTC. High pressure fuel pump damage will most likely be undetectable upon visual inspection.
- A restricted fuel feed pipe between the high pressure fuel pump and the fuel rail pressure sensor may set a DTC.

- Any problem with the Bank 2 exhaust cam may set fuel pressure DTCs due to the location and design of the high pressure fuel pump. If DTC P0019 or P0391 are current or in history, a cam control issue may be the root cause.
- A leaking or restricted fuel injector may set DTC P0089.
- For DTC P00C6, park the vehicle outdoors overnight and perform a start in the morning.
- A short to voltage in the crankshaft position signal circuit may set a DTC.
- As little as 2 Ω on either circuit of the high pressure fuel pump actuator will cause these DTCs to set. Test the circuits of the high pressure fuel pump actuator for a high resistance if you suspect a condition.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON
2. Verify DTC P0016, P0017, P0018, P0019, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, or P0628 is not set.
 - **If any of the DTCs are set**
 Refer to Diagnostic Trouble Code (DTC) List - Vehicle .
 - **If none of the DTCs are set**
3. Engine at idle.
4. Verify the Fuel Rail Pressure Sensor parameter is between 1.9 - 5.0 MPa (276 - 725 psi).
 - **If not between 1.9 - 5.0 MPa (276 - 725 psi)**
 Refer to Circuit/System Testing.
 - **If between 1.9 - 5.0 MPa (276 - 725 psi)**
5. Verify the scan tool Fuel Rail Pressure Sensor parameter increases and decreases when commanding the Fuel Rail Pressure Control with a scan tool.
 - **If the Fuel Rail Pressure Sensor does not increase and decrease with each command**

Refer to Circuit/System Testing.

- If the Fuel Rail Pressure Sensor increases and decreases with each command

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

6. 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 7, 000 RPM. Repeat the test at least three times.

7. Verify DTCs P0089, P00C6, P228C, and P228D do not set.

- If any of the DTCs set

Refer to Circuit/System Testing.

- If none of the DTCs set

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 DTCs P0089, P00C6, P228C, and P228D do not set.

- If any of the DTCs set

Refer to Circuit/System Testing.

- If none of the DTCs set

10. All OK.

Circuit/System Testing

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

1. Clear all DTCs.

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

2. Road test the vehicle and perform a wide open acceleration from a stop until the transmission shifts into second gear. On manual transmission applications, shift to second gear or stop the test near 7, 000 RPM. Repeat the test at least three times.

3. Verify the scan tool Fuel Rail Pressure Sensor parameter is between 14 - 17 MPa (2031 - 2, 466 psi) while under load near 7, 000 RPM.

- If not within the specified range

1. Remove the G18 High Pressure Fuel Pump.

2. Inspect the lobes on the camshaft for unusual wear.

- If the camshaft lobes are worn, replace the camshaft.
- If the camshaft lobes appear normal, test or replace the G18 High Pressure Fuel Pump.

- If within the specified range

4. Verify none of the conditions listed below exist:

1. Contaminates in the fuel system, Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#)

2. A Leak in the high pressure fuel system.

3. A restricted fuel feed pipe between the G18 High Pressure Fuel Pump and the B47B Fuel Rail Pressure Sensor.

4. A leaking or restricted Q17 Fuel Injector, Refer to [Fuel Injector Solenoid Coil Test \(LFX\)](#) , and [Fuel Injector Balance Test](#) .

5. High resistance in the G18 High Pressure Fuel Pump actuator circuits.

- **If a condition exist**

Repair as necessary.

- **If none of the conditions exist**

5. All OK.

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 9 - 11 Ω at 25 $^{\circ}$ C (77 $^{\circ}$ F) of resistance between G18 High Pressure Fuel Pump actuator low control circuit terminal 1 and high control circuit terminal 2.

- **If not within the specified range**

Replace the G18 High Pressure Fuel Pump.

- **If within the specified range**

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

- **If less than infinite resistance**

Replace the G18 High Pressure Fuel Pump.

- **If infinite resistance**

4. All OK.

Repair Instructions

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

- [Camshaft Replacement - Left Side](#)
- [Fuel Pump Replacement \(LFX\)](#) for G18 High Pressure Fuel Pump replacement.

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

- Perform the Fuel Rail Pressure Relief Valve Reset procedure.

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

Diagnostic 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, P00C9	P0090, P00C8	P0092, P00C9, P00CA	-
High Pressure Fuel Pump Actuator Low Control	P0091, P0092, P00C9	P0090, P00C8	P0092, P00CA	-

Circuit/System Description

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

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 Bank 2 exhaust 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 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 pressure sensor operates on a 5 V reference circuit and it provides the feedback necessary to the ECM to control the high pressure fuel pump and the fuel injectors.

Conditions for Running the DTC

- The ignition voltage is between 11 - 18 V.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTC

P0090

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

P0091

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

P0092

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

P00C8

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

P00C9

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

P00CA

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

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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Description and Operation

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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 P0685, or P1682 are not set.
 - **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If none of the DTCs are set**
3. Verify the parameters listed below do not display Malfunction when commanding the Fuel Pressure Regulator ON and OFF with a scan tool.
 - Fuel Pressure Regulator Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator Control Circuit Open Test Status
 - Fuel Pressure Regulator Control Circuit Low Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit Open Test Status
 - Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
 - **If Malfunction is displayed**

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

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

[Circuit/System Testing](#)

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump, ignition ON. It may take up to 2 min for all vehicle systems to power down.
2. Verify that a test lamp does not illuminate between the high control circuit terminal 1 and ground.
 - **If the test lamp illuminates**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the high control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
3. Verify that a test lamp does not illuminate between the low control circuit terminal 2 and ground.
 - **If the test lamp illuminates**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the low control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
 - 4. Verify that a test lamp does not illuminate between the high control circuit terminal 1 and B+.
 - **If the test lamp illuminates**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the high control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
 - 5. Verify that a test lamp does not illuminate between the low control circuit terminal 2 and B+.
 - **If the test lamp illuminates**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the low control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
 - 6. Remove the test lamp, connect a 3 A fused jumper wire between the high control circuit terminal 2 and ground.
 - 7. Verify the Fuel Pressure Regulator High Control Circuit Low Voltage Test Status transitions from OK to Malfunction.
 - **If Malfunction is not displayed**
 1. Ignition OFF, remove the fused jumper, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the high control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If Malfunction is displayed**
 - 8. Connect a 3 A fused jumper wire between the low control circuit terminal 1 and B+.
 - 9. Verify the Fuel Pressure Regulator Control Circuit High Voltage Test Status transitions from OK to Malfunction.
 - **If Malfunction is not displayed**
 1. Ignition OFF, remove the fused jumper, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If Malfunction is displayed**
 - 10. Test or replace the G18 High Pressure Fuel Pump.

Static Test

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

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

2. Test for 9 - 11 Ω between low control circuit terminal 1 and high control circuit terminal 2.

- If not within the specified range

Replace the G18 High Pressure Fuel Pump.

- If within the specified range

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

- If less than infinite resistance

Replace the G18 High Pressure Fuel Pump.

- If infinite resistance

4. All OK.

Repair Instructions

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

- [Fuel Pump Replacement \(LFX\)](#) for G18 High Pressure Fuel Pump replacement.
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup.

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

- Perform the Fuel Rail Pressure Relief Valve Reset procedure.

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0096

Intake Air Temperature (IAT) Sensor 2 Performance

DTC P0111

Intake Air Temperature (IAT) Sensor 1 Performance

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0113, P0114, P2199*	P0111, P2199

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Reference	-	P0111, P0113, P0114, P2199, P2229, P2230	P0113, P0114, P2199, P2227, P2229*	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P0443, P2199	P0096, P0097, P00F4, P0101, P0102, P0178, P2199, P2230	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P00F4, P0102, P0178, P2199	-	P0096, P0102
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT Sensor 1

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

IAT Sensor 2

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

ECT Sensor

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

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

Circuit/System Description

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

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

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

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

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

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

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

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

IAT Sensor 2 - Temperature, Frequency Table

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

Conditions for Running the DTCs

P0096 and P0111

- DTCs P0097, P0098, P0112, P0113, P0116, P0117, P0118, P0119, or P1682 are not set.
- The vehicle has been OFF at least 8 hours.
- Ignition voltage is at least 11 V.
- These DTCs run once per ignition cycle when the enabling conditions are met.

Conditions for Setting the DTCs

P0096

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than 10Â°C (18Â°F).

AND

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

P0111

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than 10Â°C (18Â°F).

AND

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

Action Taken When the DTC Sets

- DTC P0096 is a Type B DTC - North America and Korea.
- DTC P0096 is a Type C DTC - Except North America and Korea.
- 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 - North America and Korea.
- DTC P0096 is a Type C DTC - Except North America and Korea.
- DTC P0111 is a Type B DTC.

Diagnostic Aids

- With the ignition ON, when the engine is OFF and cold; properly functioning IAT sensors 1 and 2 will gradually increase the scan tool IAT Sensor 1 and 2 parameters. This is due to the heat that is generated by the multifunction intake air sensor internal heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values: 10 Hz; -40Â°C (-40Â°F), and there are also Humidity Sensor DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

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

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

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

1. Ignition ON.
2. Verify the following scan tool parameters are within 10Â°C (18Â°F) of each other.
 - Start-Up IAT Sensor 1
 - IAT Sensor 2
 - Start-Up ECT
 - **If not within 10Â°C (18Â°F)**
Refer to Circuit/System Testing.
 - **If within 10Â°C (18Â°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
 - IAT Sensor 1
 - IAT Sensor 2
 - ECT Sensor
 - **If not between: -38 and +149Â°C (-36 and +300Â°F)**
Refer to Circuit/System Testing.
 - **If between: -38 and +149Â°C (-36 and +300Â°F)**
4. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
5. Verify the DTCs do not set.
 - **If any DTC sets**
Refer to Circuit/System Testing.
 - **If no DTC sets**
6. All OK

Circuit/System Testing

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

1. Verify none of the following conditions exist:

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

Repair or replace component as appropriate.

- **If no condition exists**

2. Ignition OFF and all systems OFF, it may take up to for 2 minutes 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.

- **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 sensor chassis ground.

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

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

- **If less than 2 Ω**

5. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.

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

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.

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

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.

2. Test for infinite resistance between the ignition voltage circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test all components connected to the ignition circuit, replace as necessary.

- **If a test lamp illuminates**

6. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature signal 1 circuit terminal 1 and ground.

- **If less than 4.8 V**

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

2. Test for infinite resistance between the signal circuit and ground.

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

3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **If greater than 5.2 V**

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

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8 - 5.2 V**
7. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than -39 $^{\circ}$ C (-38 $^{\circ}$ F).
 - **If warmer than -39 $^{\circ}$ C (-38 $^{\circ}$ F).**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If colder than -39 $^{\circ}$ C (-38 $^{\circ}$ 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 3 parameter is warmer than 150 $^{\circ}$ C (302 $^{\circ}$ F).
 - **If colder than 150 $^{\circ}$ C (302 $^{\circ}$ F).**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If warmer than 150 $^{\circ}$ C (302 $^{\circ}$ F).**
10. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature signal 2 circuit terminal 8 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**

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

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8 - 5.2 V**
11. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
 - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
 1. Test or replace the B75C Multifunction Intake Air sensor.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
 3. Verify the DTC does not set.
 - **If the DTC sets**

Replace the K20 Engine Control Module.
 - **If the DTC does not set**
 - **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.
 - **If between 28 - 32 Hz**
15. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

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

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

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

Replace the B75C Multifunction Intake Air sensor.
 - **If within the table values.**
3. All OK

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.

- **If not within 5%**

Replace the B75C Multifunction Intake Air sensor.

- **If within 5%**

2. All OK.

Repair Instructions

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

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

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0097

Intake Air Temperature (IAT) Sensor 2 Circuit Low Voltage

DTC P0098

Intake Air Temperature (IAT) Sensor 2 Circuit High Voltage

DTC P0099

Intake Air Temperature (IAT) Sensor 2 Circuit Intermittent

Diagnostic Fault Information

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P0443, P2199	P0096, P0097, P00F4, P0101, P0102, P0178, P2199, P2230	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P00F4, P0102, P0178, P2199, P2230	-	P0096, P0102

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

Typical Scan Tool Data

IAT Sensor 2

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

Circuit/System Description

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

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

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

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

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

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

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

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

IAT Sensor 2 - Temperature, Frequency Table

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

Conditions for Running the DTCs

P0097, P0098, and P0099

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

P0097

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

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

P0098

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

P0099

The ECM 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 - North America and Korea.
- DTCs P0097, P0098, and P0099 are Type C DTCs - Except North America and Korea.
- The ECM commands the cooling fans ON.

Conditions for Clearing the MIL/DTC

- DTCs P0097, P0098, and P0099 are Type B DTCs - North America and Korea.
- DTCs P0097, P0098, and P0099 are Type C DTCs - Except North America and Korea.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

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

[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

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

1. Ignition ON.
2. Verify the following scan tool parameters are within 10Â°C (18Â°F) of each other.
 - Start-Up IAT Sensor 1
 - IAT Sensor 2
 - Start-Up ECT
 - **If not within 10Â°C (18Â°F)**
Refer to Circuit/System Testing.
 - **If within 10Â°C (18Â°F)**
3. Engine idling, verify the following scan tool parameters are between: 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.
 - **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.
 - **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 systems OFF, it may take up to for 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
 - **If 2 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.

- If less than 2 Ω replace the K20 Engine Control Module.
 - **If less than 2 Ω**
3. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.
 - **If 2 Ω or greater**
 1. Ignition OFF. Disconnect the sensor chassis ground.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 2 Ω**
 4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
 2. Test for less than 2 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
 2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
 - **If a test lamp illuminates**
 5. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature sensor 2 signal circuit terminal 8 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**

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

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8 - 5.2 V**
6. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
 - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
 1. Test or replace the B75C Multifunction Intake Air sensor.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
 3. Verify the DTC does not set.
 - **If the DTC sets**

Replace the K20 Engine Control Module.

- **If the DTC does not set**

4. All OK.

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

7. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:

- Red lead to the signal circuit terminal 8 at the harness connector
- Black leads to ground
- Battery voltage supply lead to B+

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

- Signal switch to 5 V
- Duty Cycle switch to 50 % (Normal)
- Frequency switch to 30 Hz

9. Ignition ON, observe the scan tool IAT Sensor 2 parameter. The scan tool parameter should be between 28 - 32 Hz.

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

Replace the K20 Engine Control Module.

- **If between 28 - 32 Hz**

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

Component Testing

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.

- **If not within 5%**

Replace the B75C Multifunction Intake Air sensor.

- **If within 5%**

2. All OK.

Repair Instructions

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

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

DTC P00F4-P00F6: INTAKE AIR HUMIDITY SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P00F4

Intake Air Humidity Sensor Circuit Low Voltage

DTC P00F5

DTC P00F6

Intake Air Humidity Sensor Circuit Erratic

Diagnostic Fault Information**Intake Air Humidity**

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P0102, P0178, P0443, P00F4, P2199	P0096, P0097, P0101, P0102, P0178, P00F4, P2199	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P0102, P0178, P00F4, P2199, P2230	-	P0096, P0102

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

Typical Scan Tool Data**Intake Air Humidity**

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

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

Circuit/System Description

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

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

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

Conditions for Running the DTCs**P00F4, P00F5, and P00F6**

- DTC P1682 is not set.
- The ignition is ON.
- The ignition voltage is at least 11 V.
- These DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P00F4

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

P00F5

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

P00F6

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

Action Taken When the DTC Sets

- DTCs P00F4, P00F5, and P00F6 are Type B DTCs - North America and Korea.
- DTCs P00F4, P00F5, and P00F6 are Type C DTCs - Except North America and Korea.

Conditions for Clearing the MIL/DTC

- DTCs P00F4, P00F5, and P00F6 are Type B DTCs - North America and Korea.
- DTCs P00F4, P00F5, and P00F6 are Type C DTCs - Except North America and Korea.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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- [Circuit Testing](#)
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Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

[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

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

1. Ignition ON.
2. Verify the following scan tool parameters are within 10Â°C (18Â°F) of each other.
 - Start-Up IAT Sensor 1
 - IAT Sensor 2
 - Start-Up ECT
 - **If not within 10Â°C (18Â°F)**
Refer to Circuit/System Testing.
 - **If within 10Â°C (18Â°F)**
3. Engine idling, verify the scan tool Intake Air Humidity parameter is between 5 and 90 %.
 - **If not between 5 and 90 %**
Refer to Circuit/System Testing.
 - **If between 5 and 90 %**
4. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
5. Verify the DTCs do not set.
 - **If any DTC sets**
Refer to Circuit/System Testing.
 - **If no DTCs set**
6. All OK

Circuit/System Testing

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

2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 2 Ω**
4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
 2. Test for less than 2 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
 2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
 - **If a test lamp illuminates**
5. Ignition ON, test for 4.8 - 5.2 V between the humidity signal circuit terminal 8 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**

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

 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8 - 5.2 V**
6. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
 - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
 1. Test or replace the B75C Multifunction Intake Air sensor.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
 3. Verify the DTC does not set.
 - **If the DTC sets**

Replace the K20 Engine Control Module.
 - **If the DTC does not set**
 - **EL-38522-A, Variable Signal Generator; or equivalent is available**
4. All OK.
7. 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+
- Set the **EL-38522-A** Variable Signal Generator to the following specifications.
 - Signal switch to 5 V
 - Frequency switch to 250 Hz
 - Duty Cycle switch to 50 % (Normal)
 - Ignition ON, observe the scan tool Intake Air Humidity parameter. The scan tool parameter should be between 45 - 55 %.
 - **If not between 45 - 55 %.**

Replace the K20 Engine Control Module.

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

- Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

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

Replace the K20 Engine Control Module.

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

- All OK.

Repair Instructions

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

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

DTC P0101: MASS AIR FLOW (MAF) SENSOR PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0101

Mass Air Flow (MAF) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P0443, P2199	P0096, P0097, P00F4, P0101, P0102, P0178, P2199	P0690	P0096, P0101, P0103

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

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

Typical Scan Tool Data

MAF Sensor

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

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

Circuit Description

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

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

Conditions for Running the DTCs

- DTCs P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0335, or P0336 are not set
- The engine speed is greater than 500 RPM.
- The engine coolant temperature (ECT) is between -7 and +125Â°C (+19 and +257Â°F).
- The intake air temperature (IAT Sensor 1) 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 air flow from the MAF, MAP, and throttle position sensors is not within range of the calculated air flow that is derived from the system of models for greater than 2 s.

Action Taken When the DTC Sets

DTC P0101 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0101 is a Type B DTC.

Diagnostic Aids

- Any type of contamination on the MAF sensor heating elements will degrade the proper operation of the sensor. Certain types of contaminants act as a heat insulator, which will impair the response of the sensor to air flow changes. Water or snow can create the opposite effect, and cause the signal to increase rapidly.
- Certain aftermarket air filters may cause this DTC to set.
- Certain aftermarket air induction systems may cause this DTC to set.

- Modifications to the air induction system may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

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

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
 - **If any of the DTCs are set**
Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.
 - **If none of the DTCs are set**
3. Verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90 %.
 - **90 % or greater**
Refer to **Throttle Body Inspection and Cleaning** .
 - **If less than 90 %**
4. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
 - **If Disagree**
Refer to **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135** for further diagnosis.
 - **If Agree**
5. Determine the current vehicle testing altitude.

6. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure \(With LFX\)](#) table.

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

Refer to [DTC P0106 \(LFX\)](#) for further diagnosis.

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

7. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.

1. Engine idling
2. Perform the scan tool snapshot function.
3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
4. Exit from the scan tool snapshot and review the data.
5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **The MAF Sensor parameter does not change smoothly and gradually**

Refer to Circuit/System Testing for further diagnosis.

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

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

9. Verify a DTC does not set.

- **If the DTC sets**

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

- **If the DTC does not set**

10. All OK

Circuit/System Testing

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

1. Verify the integrity of the entire air induction system by verifying that none of the following conditions exist:

- Any damaged components
- Improperly installed components
- Collapsed, restricted, or damaged components
- Loose clamps, cracks, or other damage
- An air flow restriction
- Restricted air filter
- Splits, kinks, leaks, or improper connections at the vacuum hoses
- Vacuum leaks at the intake manifold, MAP sensor, and throttle body
- Water intrusion
- Any snow or ice buildup, in cold climates
- Contamination of the Multifunction Intake Air sensor element
- **If a condition is found**

Repair or replace component as appropriate.

- **If no condition is found**

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

3. Test for less than 2 Ω between the ground circuit terminal 7 and ground.

- **If 2 Ω or greater**

1. Ignition OFF. Disconnect the sensor chassis ground.
2. Test for less than $2\ \Omega$ in the ground circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, repair the open/high resistance in the ground connection.
- **If less than $2\ \Omega$**
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 $2\ \Omega$ in the ignition voltage circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
 2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
 - **If a test lamp illuminates**
5. Ignition ON, test for 4.8 - 5.2 V between the signal circuit terminal 6 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8 - 5.2 V**
6. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
 - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
 1. Test or replace the B75C Multifunction Intake Air sensor.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
 3. Verify the DTC does not set.
 - **If the DTC sets**

Replace the K20 Engine Control Module.
 - **If the DTC does not set**
 - **EL-38522-A, Variable Signal Generator; or equivalent is available**
4. All OK.
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.**

If not between 4, 950 - 5, 050 Hz, replace the K20 Engine Control Module.

- **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 repair.

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

DTC P0102 OR P0103: MASS AIR FLOW (MAF) 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 P0102

Mass Air Flow (MAF) Sensor Circuit Low Frequency

DTC P0103

Mass Air Flow (MAF) Sensor Circuit High Frequency

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P0443, P2199	P0096, P0097, P00F4, P0101, P0102, P0178, P2199	P0690	P0096, P0101, P0103
Signal	P0102	P0102	P0102*	P0101, P0103, P1101
Ground	-	P0096, P0097, P00F4, P0102, P0178, P2199	-	P0096, P0102

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

Typical Scan Tool Data

MAF Sensor

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

Circuit	Short to Ground	Open	Short to Voltage
Ignition Voltage	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz*
Ground	-	0 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

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

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

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

The multifunction intake air sensor houses the following:

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

P0102

The ECM detects that the MAF Sensor Signal is less than 800 Hz (about 0.90 g/s) for greater than 10 s.

P0103

The ECM detects that the MAF Sensor Signal parameter is greater than 14, 500 Hz (about 630 g/s) for greater than 10 s.

Action Taken When the DTC Sets

DTCs P0102 and P0103 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0102 and P0103 are Type B DTCs.

Reference Information

Schematic Reference

Connector End View Reference

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DTC Type Reference

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Scan Tool Reference

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

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

1. Engine idling, observe the scan tool MAF Sensor parameter. The reading should be between 2.5 - 8.8 g/s.
 - **If not between 2.5 - 8.8 g/s**
Refer to Circuit/System Testing.
 - **If between 2.5 - 8.8 g/s**
2. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
 1. Engine idling
 2. Perform the scan tool snapshot function.
 3. Increase the engine speed slowly to 3, 000 RPM and then back to idle.
 4. Exit from the scan tool snapshot and review the data.
 5. Observe the MAF Sensor parameter frame by frame with a scan tool.
 - **The MAF Sensor parameter does not change smoothly and gradually**
Refer to Circuit/System Testing.
 - **The MAF Sensor parameter changes smoothly and gradually**
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify a DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.

- If the DTC does not set.

5. All OK

Circuit/System Testing

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

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

- **If the DTC does not set**

4. All OK.

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

6. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:

- Red lead to the signal circuit terminal 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.**

If not between 4, 950 - 5, 050 Hz, replace the K20 Engine Control Module.

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

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

Repair Instructions

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

- **Mass Airflow Sensor with Intake Air Temperature 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 (LFX)

Diagnostic Instructions

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

DTC Descriptor

DTC P0106

Manifold Absolute Pressure (MAP) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0107, P0641	P0106, P0697	P0107	P0106, P0697	P0106, P0107
Signal	P0107	P0106, P0107	P0107	P0108*	P0106, P0107, P1101
Low Reference	-	P0106, P0108	P0106, P0108	-	P0106, P0108

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

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
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Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, transmission in Park or Neutral			
Parameter Normal Range: 20 - 48 kPa (2.9 - 7 PSI), varies with altitude			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)*
Low Reference	-	127 kPa (18.4 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

MAP Sensor, if equipped with Turbocharger

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

Circuit Description

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

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

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

Conditions for Running the DTC

- DTC P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335 or P0336 is not set.
- The engine speed is between 400 - 7,000 RPM.
- The intake air temperature (IAT) Sensor parameter is between -20°C to $+125^{\circ}\text{C}$ (-4°F to $+257^{\circ}\text{F}$).
- The engine coolant temperature (ECT) Sensor parameter is between 69°C - 127°C (156°F - 260°F).
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTCs

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

Action Taken When the DTC Sets

DTC P0106 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0106 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

GE - 23738-A Vacuum Pump

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

Circuit/System Verification

1. Ignition ON, verify that DTC P0641, P0651, P0697, or P06A3 is not set.
 - **If any of the DTCs are set**
Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.
 - **If none of the DTCs are set**
2. If you were sent here from DTC P0068, P0101, P0121, or P1101; refer to Circuit/System Testing.
3. Ignition ON, verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90%.
 - **If 90 % or greater**
Refer to **Throttle Body Inspection and Cleaning** .
 - **If less than 90 %**
4. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
 - **If Disagree**
Refer to **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135** for further diagnosis.
 - **If Agree**
5. Determine the current vehicle testing altitude.

6. Verify the scan tool MAP Sensor parameter is within the range specified in the [Altitude Versus Barometric Pressure \(With LFX\)](#) table.

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

Refer to Circuit/System Testing.

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

7. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 26 - 52 kPa (3.8 - 7.5 PSI) and changes with accelerator pedal input.

- **If not between 26 - 52 kPa (3.8 - 7.5 PSI) or does not change**

Refer to Circuit/System Testing.

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

8. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.

1. Engine idling
2. Perform the scan tool snapshot function.
3. Increase the engine speed slowly to 3000 RPM and then back to idle.
4. Exit from the scan tool snapshot and review the data.
5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **The MAF Sensor parameter does not change smoothly and gradually**

Refer to [DTC P0101](#) for further diagnosis.

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

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

10. Verify a DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

11. All OK.

Circuit/System Testing

1. Verify the integrity of the entire air induction system and verify that none of the following conditions exist:

- Any damaged components
- Improper operation of turbocharger wastegate actuator or bypass valve, if equipped
- Loose or improper installation of the turbocharger and the charge air cooler, including the flexible ductwork, if equipped
- An air flow restriction
- Any vacuum leak
- Improperly routed vacuum hoses
- In cold climates, inspect for any snow or ice buildup at the BARO port on the ECM, if equipped
- A restriction in the MAP Sensor port or the BARO port
- Proper operation of the Positive Crankcase Ventilation (PCV) system
- Missing, restricted or leaking exhaust components. Refer to [Symptoms - Engine Exhaust](#).
- Engine mechanical condition; for example: low compression or incorrect timing chain installation. Refer to [Symptoms - Engine Mechanical](#).
- **If a condition is found**

Repair or replace the component as appropriate.

- **If no condition is found**

2. Ignition OFF, and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down. Disconnect the harness connector at the B74 Manifold Absolute Pressure Sensor.
3. Test for less than 2 Ω between the low reference circuit terminal 2 and ground.

- **If 2 Ω or greater**

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

- **If less than 2 Ω**

4. Ignition ON, test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.

- **If less than 4.8 V**

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

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

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- **If greater than 5.2 V**

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

- **If between 4.8 - 5.2 V**

5. Ignition ON, verify the scan tool MAP Sensor parameter is less than 0.5 V.

- **If 0.5 V or greater**

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

- **If less than 0.5 V**

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

7. Ignition ON, verify the scan tool MAP Sensor voltage parameter is greater than 4.5 V.

- **If 4.5 V or less**

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

- If greater than 4.5 V

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

Component Testing

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

Skewed Sensor Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply 17 kPa (5.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A**. Verify the scan tool MAP pressure parameter decreases between 13 - 21 kPa (1.8 - 3.0 PSI).

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

Replace the B74 Manifold Absolute Pressure Sensor.

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

3. Apply 34 kPa (10.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A**. Verify the scan tool MAP pressure parameter decreases between 30 - 38 kPa (4.4 - 5.5 PSI).

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

Replace the B74 Manifold Absolute Pressure Sensor.

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

4. All OK.

Erratic Signal Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 2 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 3 of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply between 0-15 kPa (0 - 4.4 in Hg) of vacuum to the sensor with the **GE-23738-A**.
7. Verify the voltage changes, without any spikes or dropouts, between 0.2 - 4.9 V.

- If not between 0.2 - 4.9 V or has spikes or dropouts

Replace the B74 Manifold Absolute Pressure Sensor.

- If between 0.2 - 4.9 V and there are no spikes or dropouts

8. All OK.

Repair Instructions

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

- [Manifold Absolute Pressure Sensor Replacement](#)
- [Control Module References](#) for ECM replacement, programming, and setup

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

Diagnostic 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 P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

Diagnostic Fault Information

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

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

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, transmission in Park or Neutral Parameter Normal Range: 20 - 48 kPa (2.9 - 7 PSI), varies with altitude			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)*
Low Reference	-	127 kPa (18.4 PSI)	-

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

MAP Sensor, if equipped with Turbocharger

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

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

Circuit Description

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

The MAP sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5 V reference circuit. The ECM supplies a ground on a low reference circuit. The

MAP sensor provides a signal voltage to the ECM, relative to the pressure changes, on the MAP sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

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

Conditions for Running the DTC

P0107

This DTC runs continuously.

P0108

This DTC runs continuously.

Conditions for Setting the DTC

P0107

The ECM detects that the MAP Sensor voltage is less than 0.15 V for more than 13 ms.

P0108

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

Action Taken When the DTC Sets

DTCs P0107 and P0108 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0107 and P0108 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

GE-23738-A Vacuum Pump

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

Circuit/System Verification

1. Ignition ON, verify that DTC P0641, P0651, P0697, or P06A3 is not set.

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

Refer to [DTC P0641, P0651, P0697, or P06A3 \(ECM\)](#) for further diagnosis.

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

2. Determine the current vehicle testing altitude.

3. Verify the scan tool MAP Sensor parameter is within the range specified in the [Altitude Versus Barometric Pressure \(With LFX\)](#) table.

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

Refer to Circuit/System Testing for further diagnosis.

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

4. Verify the engine is equipped with a turbocharger.

- **If not equipped with a turbocharger**

Refer to Step 6.

- **If equipped with a turbocharger**

5. Engine idling, verify the scan tool MAP Sensor voltage parameter is between 0.3 - 4.8 V and changes with accelerator pedal input.

- **If not between 0.3 - 4.8 V or does not change**

Refer to Circuit/System Testing.

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

Refer to Step 7.

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

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

Refer to Circuit/System Testing.

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

7. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.

8. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

9. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B74 Manifold Absolute Pressure Sensor.

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

- **If 2 Ω or greater**

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

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

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

• **If less than 2 Ω**

3. Ignition ON, test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.

• **If less than 4.8 V**

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

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

•

• **If greater than 5.2 V**

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

• **If between 4.8 - 5.2 V**

4. Ignition ON, verify the scan tool MAP Sensor parameter is less than 0.5 V.

• **If 0.5 V or greater**

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

• **If less than 0.5 V**

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

6. Ignition ON, verify the scan tool MAP Sensor voltage parameter is greater than 4.5 V.

• **If 4.5 V or less**

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

• **If greater than 4.5 V**

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

Component Testing

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

Skewed Sensor Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply 17 kPa (5.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A** . Verify the scan tool MAP Sensor pressure parameter decreases between 13 - 21 kPa (1.8 - 3.0 PSI).

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

Replace the B74 Manifold Absolute Pressure Sensor.

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

3. Apply 34 kPa (10.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A** . Verify the scan tool MAP pressure parameter decreases between 30 - 38 kPa (4.4 - 5.5 PSI).

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

Replace the B74 Manifold Absolute Pressure Sensor.

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

4. All OK.

Erratic Signal Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 2 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 3 of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply between 0-15 kPa (0 - 4.4 in Hg) of vacuum to the sensor with the **GE-23738-A** .
7. Verify the voltage changes, without any spikes or dropouts, between 0.2 - 4.9 V.

- **If not between 0.2 - 4.9 V or has spikes or dropouts**

Replace the B74 Manifold Absolute Pressure Sensor.

- **If between 0.2 - 4.9 V and there are no spikes or dropouts**

8. All OK.

Repair Instructions

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

- [Manifold Absolute Pressure Sensor Replacement](#)
- [Control Module References](#) for ECM replacement, programming, and setup

DTC P0112, P0113, OR P0114: 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 Descriptors

DTC P0112

Intake Air Temperature (IAT) Sensor 1 Circuit Low Voltage

DTC P0113

Intake Air Temperature (IAT) Sensor 1 Circuit High Voltage

DTC P0114

Intake Air Temperature (IAT) Sensor 1 Circuit Intermittent

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0113, P0114, P2199*	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199, P2227, P2228, P2229,	P0113, P0114, P2199, P2227, P2229*	-

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

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running			
Parameter Normal Range: Varies with ambient temperature			
Signal	150Å°C (302Å°F)	-40Å°C (-40Å°F)	-40Å°C (-40Å°F)*
Low Reference	-	-40Å°C (-40Å°F)	-40Å°C (-40Å°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 Å°C (Å°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 and P0113

- The engine run time is greater than 1 s.
- The DTCs run continuously when the above conditions are met.

P0114

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

Conditions for Setting the DTCs

P0112

The ECM detects that the IAT sensor 1 signal is warmer than 149°C (300°F) for greater than 5 s.

P0113

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

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

P0114

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

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

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

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

1. Ignition ON.
2. Verify the following scan tool parameters are within 10°C (18°F) of each other.
 - Start-Up IAT Sensor 1
 - IAT Sensor 2
 - Start-Up ECT
 - **If not within 10°C (18°F)**
Refer to Circuit/System Testing.
 - **If within 10°C (18°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and $+149^{\circ}\text{C}$ (-36 and $+300^{\circ}\text{F}$).
 - IAT Sensor 1
 - IAT Sensor 2
 - ECT Sensor
 - **If not between: -38 and $+149^{\circ}\text{C}$ (-36 and $+300^{\circ}\text{F}$)**
Refer to Circuit/System Testing.
 - **If between: -38 and $+149^{\circ}\text{C}$ (-36 and $+300^{\circ}\text{F}$)**
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.
 - **If the DTC does not set.**
6. All OK

Circuit/System Testing

1. Ignition OFF and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than $2\ \Omega$ between the low reference circuit terminal 3 and ground.
 - **If $2\ \Omega$ or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for less than $2\ \Omega$ in the low reference circuit end to end.
 - If $2\ \Omega$ or greater, repair the open or high resistance in the circuit.
 - If less than $2\ \Omega$ replace the K20 engine control module.
 - **If less than $2\ \Omega$**
3. Ignition ON, test for $4.8 - 5.2\ \text{V}$ between the intake air temperature sensor 1 signal circuit terminal 1 and ground.
 - **If less than $4.8\ \text{V}$**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than $2\ \Omega$ in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 engine control module.
- **If greater than 5.2 V**

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

1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 engine control module.
- **If between 4.8 - 5.2 V**
4. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than -39°C (-38°F).
 - **If warmer than -39°C (-38°F).**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If colder than -39°C (-38°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 150°C (302°F).
 - **If colder than 150°C (302°F).**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If warmer than 150°C (302°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 \(Hitachi Sensor\)](#) table for Hitachi Sensors. The resistance values should be in range of the table values.
 - **If not within the table values.**

Replace the B75C Multifunction Intake Air sensor.

- If within the table values.

3. All OK

Repair Instructions

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

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

DTC P0116: ENGINE COOLANT TEMPERATURE (ECT) SENSOR PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0116

Engine Coolant Temperature (ECT) Sensor Performance

Diagnostic Fault Information

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

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running Parameter Normal Range: -39 to 149Â°C (-38 to 300Â°F)			
ECT Sensor	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-

Circuit/System Description

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

The ECM uses this high side coolant rationality diagnostic to determine if the input from the ECT sensor is skewed warmer than normal. The internal clock of the ECM will record the amount of time the ignition is OFF. If the calibrated ignition OFF time is met at start-up, the ECM will compare the temperature difference between the ECT and the intake air temperature (IAT) to determine if the temperatures are within an acceptable operating range of each other.

Conditions for Running the DTC

- DTC P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0502, P0503, P0601, or P2610 is not set.
- The vehicle has had a minimum ignition OFF time of 8 h.
- The ignition is ON.
- The start-up IAT is warmer than -7Â°C (+19Â°F).
- The Fuel Level Sensor is greater than 2.5%.

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

Conditions for Setting the DTC

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 30Â° C (54Â° F) warmer than the IAT sensor.

OR

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 15Â° C (27Â° F) warmer than the IAT sensor, and NO engine block heater was not detected.

OR

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 15Â° C (27Â° F) warmer than the IAT sensor, the engine cranked for greater than 10 s without starting and NO engine block heater was not detected.

Action Taken When the DTC Sets

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

Conditions for Clearing the MIL/DTC

DTC P0116 is a Type B DTC.

Diagnostic Aids

- Engine coolant that is leaking through the sensor will create a high resistance short to ground. This condition results in less voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a warmer ECT.
- An IAT sensor that is skewed colder at various ambient temperatures due to greater resistance than is normal will increase the range between these two sensors. Measure and record the resistance of the IAT sensor at various ambient temperatures, then compare those measurements to the **Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)** table.
- A slight to moderate resistance in the IAT sensor signal circuit or low reference circuit will increase the range between these two sensors. This condition results in a greater voltage on the IAT sensor signal circuit, which is interpreted by the ECM as a colder IAT.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ECT Sensor parameter is between -40 and 150°C (-40 and 302°F) and changes with engine run time.
 - **If not within the specified range or does not change**

Refer to Circuit/System Testing.
 - **If within the specified range and changes**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF. Disconnect the harness connector at the B34 Engine Coolant Temperature Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than $5\ \Omega$ between the low reference terminal A or 2 and ground.
 - **If $5\ \Omega$ or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for less than $2\ \Omega$ in the low reference circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **If less than $5\ \Omega$**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -39°C (-38°F).
 - **If warmer than -39°C (-38°F)**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If colder than -39°C (-38°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149°C (300°F).
 - **If 149°C (300°F) or colder**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Ignition OFF

4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **If warmer than 149 $^{\circ}$ C (300 $^{\circ}$ F)**

7. Test or replace the B34 Engine Coolant Temperature Sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance.
3. Verify the readings are within the range specified in the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table.

- **If not within the specified range**

Replace the B34 Engine Coolant Temperature Sensor.

- **If within the specified range**

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

- **If less than infinite resistance**

Replace the B34 Engine Coolant Temperature Sensor.

- **If infinite resistance**

5. All OK.

Repair Instructions

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

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

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

Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

DTC P0119

Engine Coolant Temperature (ECT) Sensor Circuit Intermittent

Diagnostic Fault Information

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

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

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions			
Parameter Normal Range: Varies with coolant temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-

Circuit/System Description

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

Conditions for Running the DTC

P0117

- The ignition is ON.
- OR
- The engine is running for greater than 10 s.
 - 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 and P0119 are Type B DTCs.
- The cooling fans will be commanded ON.
- The Engine Coolant Temperature Gauge is inoperative.
- The AC compressor will be commanded OFF.

Conditions for Clearing the DTC

DTC P0117, P0118 and P0119 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

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 between - 40 and 150°C (- 40 and 302°F) and changes with engine run time.
 - **If not between the specified range or does not change**
Refer to Circuit/System Testing.
 - **If within the specified range and changes**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF. Disconnect the B34 Engine Coolant Temperature sensor harness connector at the sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal A or 2 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 5 Ω**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -39°C (-38°F).
 - **If warmer than -39°C (-38°F)**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If colder than -39°C (-38°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149°C (300°F).
 - **If 149°C (300°F) or colder**
 1. Ignition OFF, remove the jumper wire, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Ignition OFF.
 - 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If warmer than 149°C (300°F)**
7. Test or replace the B34 Engine Coolant Temperature Sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance.
3. Verify the readings are within the range specified in Temperature Versus Resistance - Engine Coolant Temperature Sensor table.
 - **If not within the specified range**

Replace the B34 Engine Coolant Temperature Sensor.
 - **If within the specified range**
4. Test for infinite resistance between each terminal and the sensor housing.
 - **If less than infinite resistance**

Replace the B34 Engine Coolant Temperature Sensor.

- If infinite resistance

5. 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-P0123, P0222, P0223, P16A0-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.
- [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

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*

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0122*, P0222*, P16A0	P0122*, P0222*, P16A1	P0123*, P0223*, P16A1**	P0121*, P16A2, P2135*
Low Reference	-	P0123*, P0223*, P16A1	-	P0121*, P16A2, P2135*

* This DTC set indicates an internal throttle body condition.
** A short to voltage causes P16A1 to set. If DTC P16A0, P16A1, and P16A2 set at the same time, an intermittent circuit condition exists.

Typical Scan Tool Data

Throttle Position Sensor 1

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

Throttle Position Sensor 2

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

Circuit/System Description

The throttle body assembly contains a contact-less inductive throttle position sensing element that is managed by a customized integrated circuit. The throttle position sensor is mounted within the throttle body assembly and is not serviceable. The engine control module (ECM) supplies the throttle body with a 5 V reference circuit, a low reference circuit, an H-bridge motor directional control circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the throttle body to the ECM. The throttle body cannot receive data from the ECM over the signal/serial data circuit. The throttle position sensor provides a signal voltage that changes relative to throttle blade angle. The customized integrated circuit translates the voltage based position information into serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT) protocol. The throttle position sensor information is transmitted between the throttle body and the ECM on the signal/serial data circuit. The ECM decodes the serial data signal into separate voltages which are displayed on a scan tool as the voltage inputs from 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 +126Â°C (19 - 259Â°F).
- The intake air temperature (IAT) is -20 to +125Â°C (-4 to +257Â°F).
- The DTC runs continuously when the above conditions are met.

P0122, P0123, P0222, P0223

- DTC P06A3 is not set.
- The 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 run/crank voltage is greater than 6.41 V.
- The DTCs run continuously once the above conditions are met.

P2135

- DTCs P0122, P0123, P0222, P0223, or P06A3 are not set.
- 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 in range for greater than 1 s.

P0122

The ECM detects the throttle position sensor 1 signal voltage is less than 0.32 V for greater than 1 s.

P0123

The ECM detects the throttle position sensor 1 signal voltage is greater than 4.75 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 4.6 V for greater than 1 s.

P16A0

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

P16A1

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

P16A2

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

P2135

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

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (LEX)

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

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If none of the DTCs are set**
4. Verify the scan tool Throttle Body Idle Air flow Compensation parameter is less than 90 %.
 - **If 90 % or greater**

Refer to [Throttle Body Inspection and Cleaning](#) .
 - **If less than 90 %**
5. Verify that DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, or P2135 are not set.
 - **If DTC P0122, P0123, P0222, P0223, or P2135 are the only DTCs set**

Test or replace the Q38 Throttle Body Assembly.

- **If DTC P16A0, P16A1, or P16A2 is set with any of the DTCs**

Refer to Circuit/System Testing.

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

6. Verify the Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.

- **If Agree is not displayed**

Test or replace the Q38 Throttle Body Assembly.

- **If Agree is displayed**

7. Verify DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 is not set.

- **If a DTC is set**

Refer to Circuit/System Testing.

- **If a DTC is not set**

8. Determine the current vehicle testing altitude.

9. Verify the scan tool MAP Sensor pressure parameter is within range specified in the [Altitude Versus Barometric Pressure \(With LFX\)](#) table.

- **The MAP Sensor pressure is not in range**

Refer to [DTC P0106 \(LFX\)](#).

- **The MAP Sensor pressure is within range**

10. Engine idling.

11. Verify the scan tool MAP Sensor pressure parameter is between 26 - 52 kPa (3.8 - 7.5 psi) and changes with accelerator pedal input.

- **If not between 26 - 52 kPa (3.8 - 7.5 psi) or does not change**

Refer to [DTC P0106 \(LFX\)](#).

- **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.

- **The MAF Sensor parameter does not change smoothly and gradually**

Refer to [DTC P0101](#).

- **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.

- **If the DTC does not set**

15. All OK.

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

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at Q38 Throttle Body Assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 4 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 5 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8 - 5.2 V**
5. Test for 4.8 - 5.2 V between the signal circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8 - 5.2 V**
6. Test or replace the Q38 Throttle Body Assembly.

Repair Instructions

- [Throttle Body Assembly Replacement](#)
- [Control Module References](#) for engine control module replacement, programming, and setup

Repair Verification

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

- **If Agree is displayed**

Test or replace the Q38 Throttle Body Assembly.

- **If Agree is not displayed**

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

- **If DTC sets**

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

- **If DTC does not set**

8. All OK.

DTC P0128: ENGINE COOLANT TEMPERATURE (ECT) BELOW THERMOSTAT REGULATING TEMPERATURE

Diagnostic Instructions

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

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running at various operating conditions Parameter Normal Range: Varies with coolant temperature 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 ECT sensor to determine if the engine coolant will increase at the correct rate, and also meet the calibrated target temperatures under various operating conditions. The ECM uses the start-up ECT and the start-up intake air temperature (IAT) to begin the diagnostic calculation. The air flow into the engine is accumulated, and vehicle speed, distance, and engine run time are also factored in to determine if the ECT does increase normally and reach the calibrated target temperatures.

Conditions for Running the DTC

- DTC P0068, P0071, P0072, P0073, P0074, P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0222, P0223, P0502, P0503, P1101, P1516, P2101, or P2135 is not set.
- The start-up ECT is between -40°C and 66°C (-40°F and 151°F).
- The engine OFF time is greater than 30 m.
- The engine run time is between 2 and 24 m.
- The vehicle has traveled greater than 2.4 km (1.5 mi).
- The Ethanol in the fuel is less than 87 %.
- This DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

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

OR

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

Action Taken When the DTC Sets

- DTC P0128 is a Type B DTC.
- The Engine Coolant Temperature Gauge defaults to cold.
- The A/C is commanded OFF and inoperative.
- The Cooling Fans are commanded ON.

Conditions for Clearing the MIL/DTC

DTC P0128 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

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

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
 - **If a DTC is not set**
2. Verify the cooling system is filled to the correct coolant level. Refer to [Cooling System Draining and Filling \(Vacuum and Fill\)](#), [Cooling System Draining and Filling \(Static\)](#), and [Loss of Coolant](#).
 - **If the coolant level is not correct**

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

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

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the B34 Engine Coolant Temperature sensor harness connector at the sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal A or 2 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.

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

Refer to Component Testing.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table. The resistance values should be in range of the table values.
 - **If not within the specified range**
Replace the B34 Engine Coolant Temperature Sensor.
 - **If within the specified range**
3. Test for infinite resistance between each terminal and the sensor housing.
 - **If less than infinite resistance**
Replace the B34 Engine Coolant Temperature Sensor.
 - **If infinite resistance**
4. Refer to **Thermostat Diagnosis**.

Repair Instructions

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

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

DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, OR P0158: HO2S 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 P0131

HO2S Circuit Low Voltage Bank 1 Sensor 1

DTC P0132

HO2S Circuit High Voltage Bank 1 Sensor 1

DTC P0137

HO2S Circuit Low Voltage Bank 1 Sensor 2

DTC P0138

HO2S Circuit High Voltage Bank 1 Sensor 2

DTC P0151

HO2S Circuit Low Voltage Bank 2 Sensor 1

DTC P0152

HO2S Circuit High Voltage Bank 2 Sensor 1

DTC P0157

HO2S Circuit Low Voltage Bank 2 Sensor 2

DTC P0158

HO2S Circuit High Voltage Bank 2 Sensor 2

Diagnostic Fault Information

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

Typical Scan Tool Data

HO2S Sensor 1 Voltage, HO2S Sensor 2 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200 - 800 mV			
HO2S High Signal	0.00 V	Approximately 1.9 V	Approximately 1.9 V
HO2S Low Signal	0.00 V	Approximately 1.9 V	Approximately 1.9 V

Circuit/System Description

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

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

Conditions for Running the DTC

P0131, P0137, P0151, or P0157

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is operating in Closed Loop.
- The Ignition voltage is between 10 - 32 V.
- The fuel level is greater than 10 percent.
- The throttle position (TP) is between 3 - 70 percent.
- The DTCs run continuously when the above conditions are met for 2 s.

P0132, P0138, P0152, or P0158

- 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 engine is operating in Closed Loop.
- The Ignition voltage is between 10 - 32 V.
- The fuel level is greater than 10 percent.
- The throttle position (TP) is between 0 - 70 percent.
- The DTCs run continuously when the above conditions are met for 3 s.

Conditions for Setting the DTC

P0131, P0137, P0151, or P0157

- The ECM detects that the HO2S voltage is less than 50 mV.
- The DTCs set within 50 s when the above condition is met.

P0132, P0138, P0152, or P0158

- The ECM detects that the HO2S voltage is greater than 1, 050 mV.
- The DTCs set within 50 s when the above condition is met.

Action Taken When the DTC Sets

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

Conditions for Clearing the MIL/DTC

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If a DTC is not set**
3. Engine running at operating temperature.
4. Verify the scan tool HO2S Bank 1 or 2 Sensor 1 or 2 parameters are between 50 - 1,050 mV.
 - **If not between 50 - 1,050 mV**

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

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the appropriate B52 Heated Oxygen Sensor harness connector. It may take up to 2 minutes for all vehicle systems to power down. Ignition ON.

2. Test for 1.7 - 3.0 V between the high signal circuit terminal B and ground.

- **If less than 1.7 V**

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

2. Test for infinite resistance between the high signal circuit and ground.

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

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

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

- **If greater than 3.0 V**

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

2. Test for less than 1 V between the high signal circuit and ground.

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

- **If between 1.7 - 3.0 V**

3. Verify the scan tool heated oxygen sensor Bank 1 or 2 Sensor 1 or 2 parameter is between 1.7 - 2.1 V

- **If less than 1.7 V**

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

2. Test for infinite resistance between the low signal circuit terminal A and ground.

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

- **If between 1.7 - 2.1 V**

4. Connect a 3 A fused jumper wire between the high signal circuit terminal B and the low signal circuit terminal A.

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

5. Verify the scan tool HO2S Bank 1 or 2 Sensor 1 or 2 parameter displays 0.0 V.

- **If greater than 0.0 V**

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

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

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

3. Test for less than 1 V between the low signal circuit terminal A and ground.

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

- **If 0.0 V**

6. Verify none of the following conditions exist:

- Water intrusion in the B52 HO2S harness connector
- Low or high fuel system pressure - Refer to [Fuel System Diagnosis \(LFX\)](#) .
- Fuel that is contaminated - Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) .
- Fuel saturation of the evaporative emission (EVAP) canister
- Exhaust leaks
- Engine vacuum leaks
- **If any of the conditions exist**

Repair as necessary.

- **If none of the conditions exist.**

7. Test or replace the B52 Heated Oxygen Sensor

Repair Instructions

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

- [Heated Oxygen Sensor Replacement - Bank 1 Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Bank 1 Sensor 2](#)
- [Heated Oxygen Sensor Replacement - Bank 2 Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Bank 2 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 P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D, OR P2270-P2273: HO2S

Diagnostic Instructions

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

DTC Descriptors

DTC P0133

HO2S Slow Response Bank 1 Sensor 1

DTC P013A

HO2S Slow Response Rich to Lean Bank 1 Sensor 2

DTC P013B

HO2S Slow Response Lean to Rich Bank 1 Sensor 2

DTC P013C

HO2S Slow Response Rich to Lean Bank 2 Sensor 2

DTC P013D

HO2S Slow Response Lean to Rich Bank 2 Sensor 2

DTC P013E

HO2S Delayed Response Rich to Lean Bank 1 Sensor 2

DTC P013F

HO2S Delayed Response Lean to Rich Bank 1 Sensor 2

DTC P014A

HO2S Delayed Response Rich to Lean Bank 2 Sensor 2

DTC P014B

HO2S Delayed Response Lean to Rich Bank 2 Sensor 2

DTC P0153

DTC P015A

HO2S Delayed Response Rich to Lean Bank 1 Sensor 1

DTC P015B

HO2S Delayed Response Lean to Rich Bank 1 Sensor 1

DTC P015C

HO2S Delayed Response Rich to Lean Bank 2 Sensor 1

DTC P015D

HO2S Delayed Response Lean to Rich Bank 2 Sensor 1

DTC P2270

HO2S Signal Stuck Lean Bank 1 Sensor 2

DTC P2271

HO2S Signal Stuck Rich Bank 1 Sensor 2

DTC P2272

HO2S Signal Stuck Lean Bank 2 Sensor 2

DTC P2273

HO2S Signal Stuck Rich Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D

Typical Scan Tool Data**HO2S Bank 1, 2 Sensor 1, 2**

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

Circuit/System Description

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

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

Conditions for Running the DTC

P0133 or P0153

- 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 engine coolant temperature (ECT) is greater than 54°C (129°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F).
- The Ignition voltage is between 10 - 32 V.
- The fuel level is greater than 10%.
- The engine run time is greater than 60 s.
- The engine speed is between 1, 000 - 3, 000 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 15 - 43 g/s.
- The fuel system is in Closed Loop.
- The throttle position (TP) is greater than 5%.
- The DTCs run once per drive cycle when the above conditions are met.

P013A P013C, P013E, or P014A

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

P013B P013D, P013F, or P014B

- Before the ECM can report DTC P013B, or P013D failed, DTCs P013A, P013C, P013E, P013F, P014A, P014B, P2270, P2271, P2272, and P2273 must run and pass.

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

P015A, P015B, P015C or P015D

- 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 engine coolant temperature (ECT) is warmer than 54°C (129°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F).
- The Ignition voltage is between 10 - 32 V.
- The fuel level is greater than 10%.
- The engine run time is greater than 60 s.
- The engine speed is between 1,025 - 2,325 RPM.
- The vehicle speed is between 70 km/h (44 mph).
- The mass airflow (MAF) is between 3 - 12 g/s.
- The fuel system is in Closed Loop.
- The DTCs run once per drive cycle when the above conditions are met.

P2270 or P2272

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The system voltage is between 10 - 32 V.
- The fuel level is greater than 10%.
- The engine speed is between 1,100 - 2,300 RPM.
- The engine airflow is between 3 - 11 g/s.
- The vehicle speed is between 64 km/h (39.8 mph) and 120 km/h (74 mph).
- The fuel state is in Closed Loop.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The heated oxygen sensor heaters are ON for more than 180 s.
- The predicted catalytic converter temperature is between 600 - 900°C (1,112 - 1,652°F).
- This DTC runs once per trip when all of the above conditions have been met for 3 s.

P2271 or P2273

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270 are not set.
- The system voltage is between 10 - 32 V.
- The fuel level is greater than 10%.

- The engine speed is 1, 150 - 2, 300 RPM.
- The engine airflow is between 3 - 11 g/s.
- The vehicle speed is between 70 - 120 km/h (44 - 74 mph).
- The fuel state is in Closed Loop.
- The EVAP is not in control of purge.
- Power take-off is not active.
- The heated oxygen sensor heaters have been on more than 180 s.
- The predicted catalyst temperature is between 500 - 980Â°C (1, 112 - 1, 652Â°F).
- DTCs P013A, P013E, and P2270 have run and passed.

THEN

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

Conditions for Setting the DTC

P0133, P0153, P015A, P015B, P015C or P015D

- The ECM detects that the HO2S 1 rich-to-lean or lean-to-rich average response time is greater than a calibrated value.
- The DTCs set within 60 s when the above condition is met.

P013A or P013C

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

P013B or P013D

The ECM detects that the accumulated mass air flow monitored during lean-to-rich transitions between 350 - 650 mV is greater than 75 grams.

P013E or P014A

The ECM detects that the HO2S voltage has not decreased below 450 mV within a calibrated value of accumulated air flow.

P013F or P014B

The ECM detects that the HO2S voltage has not increased above 350 mV within a calibrated value of accumulated air flow.

P2270 or P2272

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

P2271 or P2273

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

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no HO2S heater DTCs are set.
 - **If a DTC is set**
Refer to Diagnostic Trouble Code (DTC) List - Vehicle .
 - **If a DTC is not set**
3. Verify none of the conditions listed below exist:
 - Lean or rich fuel injectors - Refer to Fuel Injector Solenoid Coil Test (LFX) .
 - Water intrusion in the HO2S harness connector
 - Low or high fuel system pressure - Refer to Fuel System Diagnosis (LFX) .
 - Fuel that is contaminated - Refer to Alcohol/Contaminants-in-Fuel Diagnosis .
 - Fuel saturation of the evaporative emission (EVAP) canister
 - Exhaust leaks - Refer to Exhaust Leakage .
 - Engine vacuum leaks
 - Engine oil consumption - Refer to Oil Consumption Diagnosis .
 - Engine coolant consumption - Refer to Loss of Coolant .
 - **If any of the conditions exist**
Repair as necessary.
 - **If none of the conditions exist**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - **If the DTC sets**
Test or replace the appropriate B52 Heated Oxygen Sensor.

- If the DTC does not set

6. All OK.

Repair Instructions

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

- [Heated Oxygen Sensor Replacement - Bank 1 Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Bank 1 Sensor 2](#)
- [Heated Oxygen Sensor Replacement - Bank 2 Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Bank 2 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, P0172, P0174, OR P0175: 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 Bank 1

DTC P0172

Fuel Trim System Rich Bank 1

DTC P0174

Fuel Trim System Lean Bank 2

DTC P0175

Fuel Trim System Rich Bank 2

Circuit/System Description

The engine control module (ECM) controls a closed loop air/fuel metering system in order to provide the best possible combination of drivability, 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-P0103, P0106-P0108, P010B-P010D, P0111- P0114, P0121-P0123, P012B- P012D, P0131-P0135, P015A, P0178, P0179, P0201-P0206, P0222, P0223, P0236-P0238, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300-P0306, P0403- P0406, P0411, P042E, P0442, P0455, P0458, P0489, P0490, P0496, P0506, P0507, P1133, P1221, P1247- P1249, P124A-P124F, P1426, P1437, P2148, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2227-P2230, P2269, or P2444 are not set.

- The barometric pressure is greater than 70 kPa (10.2 psi).
- The catalyst monitor diagnostic intrusive test, post HO2S diagnostic intrusive test, device control, EGR diagnostic intrusive test, and EVAP leak test are not active.
- The engine is in Closed Loop status.
- The engine coolant temperature is between -20 and +150Â°C (-4 and +302Â°F).
- The engine speed is between 400 - 6, 600 RPM.
- The fuel level is greater than 10 %.
- The intake air temperature is between -20 and +150Â°C (-4 and +302Â°F).
- The manifold absolute pressure is between 5 - 255 kPa (0.725 - 37 psi).
- The mass air flow is between 1 - 510 g/s.
- This diagnostic runs continuously when the above conditions have been met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTCs P0171, P0172, P0174, and P0175 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0171, P0172, P0174, and P0175 are Type B DTCs.

Diagnostic Aids

- Allow the engine to reach operating temperature. With the engine running, observe the HO2S parameter with a scan tool. The HO2S Bank 1 or 2, Sensor 1 or 2 value should vary from approximately 40 mV to approximately 900 mV, and respond to fueling changes.
- With the engine running at operating temperature, the normal Short Term Fuel Trim and Long Term Fuel Trim parameters should be between +10 and -10% with 0% the optimum.
- Any un-metered air into the engine causes this DTC to set. Thoroughly inspect all areas of the engine for vacuum leaks. An un-metered air leak in the induction system or a small vacuum leak may cause the ECM to 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 scan tool Idle Learn procedure to ensure any symptoms are corrected
- 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 the air filter is the correct one for this application, the engine oil fill cap is in place and is tight, and the engine oil dip stick is fully seated.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

1. Ignition ON.
2. Verify no other DTCs are set.
 - **If any other DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If no other DTCs are set**
3. Verify DTC P0171, P0172, P0174, or P0175 is not set.
 - **If a DTC is set**
Refer to Circuit/System Testing.
 - **If no DTC is set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
5. Verify DTC P0171, P0172, P0174, or P0175 is not set.
 - **If any of the DTCs set**
Refer to Circuit/System Testing.
 - **If none of the DTCs set**
6. All OK.

Circuit/System Testing

1. Ignition ON.
2. Verify no other DTCs are set.
 - **If any other DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If no other DTCs are set**
3. Verify the MAP sensor pressure parameter is within the range specified for your altitude. Refer to [Altitude Versus Barometric Pressure \(With LFX\)](#) .
 - **If not within the specified range**
Refer to [DTC P0106 \(LFX\)](#).
 - **If within the specified range**

NOTE: Fuel vapor introduced into the intake manifold during evaporative

emission system purge can temporarily cause fuel trim parameter readings to be outside the normal range.

4. Engine running at the operating temperature, EVAP Purge Solenoid Valve Command 0%.

5. Verify the appropriate Long Term Fuel Trim Bank 1 or 2 parameter is between -10% and +10%.

- **If greater than +10%**

1. Ignition OFF.

2. Verify the conditions listed below do not exist:

- Mass air flow sensor signal skewed. If the Short Term Fuel Trim or Long Term Fuel Trim parameters for both banks changes greater than 20% when the MAF sensor is disconnected, refer to [DTC P0101](#).
- Verify the EVAP Purge Solenoid Valve is commanded to 0%
- 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 Solenoid Coil Test \(LFX\)](#).
- Split, kinked, or improperly connected vacuum hoses.
- Insufficient fuel in the tank.
- Low fuel pressure. Refer to [Fuel System Diagnosis \(LFX\)](#).
- 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, including mechanical sound enhancer, if equipped.
- Missing air filter element.
- Cracked evaporative emissions 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, test the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#).

- **If less than -10%**

1. Ignition OFF.

2. Verify the conditions listed below do not exist:

- Mass air flow (MAF) sensor signal skewed. If the Short Term Fuel Trim or Long Term Fuel Trim parameters for both banks changes greater than 20% when the MAF sensor is disconnected, refer to [DTC P0101](#).
- Fuel contamination. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
- Missing, restricted, or leaking exhaust components. Refer to [Symptoms - Engine Exhaust](#).
- Malfunctioning fuel injectors. Refer to [Fuel Injector Solenoid Coil Test \(LFX\)](#).
- Collapsed or restricted air intake duct.
- Excessive fuel pressure. Refer to [Fuel System Diagnosis \(LFX\)](#).
- Dirty or restricted air filter.
- Objects blocking the throttle body.
- Improper operation of the evaporative emissions control system.
- Excessive fuel in the crankcase. Change the engine oil as necessary.
 - If a condition is found, repair as necessary.
 - If no condition is found, test the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#).

- **If between -10% and +10%**

6. 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.

7. Verify DTC P0171, P0172, P0174, or P0175 is not set.

- **If any of the DTCs set**

Refer to conditions listed above.

- **If none of the DTCs set**

8. All OK.

Repair Instructions

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

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

DTC P018B-P018D: FUEL PRESSURE SENSOR (CHASSIS CONTROL MODULE)

Diagnostic Instructions

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

DTC Descriptors

DTC P018B

Fuel Pressure Sensor Performance

DTC P018C

Fuel Pressure Sensor Circuit Low Voltage

DTC P018D

Fuel Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0641, P06A6	P018C	P018D	P06A6
Signal	P018C	P018C	P018D	P018B
Low Reference	-	P018D	-	P06A6

Circuit/System Description

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

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

detect fuel pressure sensor output that is stuck within the normal operating range of the sensor.

Action Taken When the DTC Sets

DTC P018B, P018C and P018D are Type A DTCs.

Conditions for Clearing the DTC

DTC P018B, P018C and P018D are Type A DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description (LFX)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify the scan tool Fuel Pressure Sensor Voltage parameter is between 0.2 - 4.8 V.
 - **If not between 0.2 - 4.8 V**
Refer to Circuit/System Testing.
 - **If between 0.2 - 4.8 V**
3. All OK.

Circuit/System Testing

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

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B47 Fuel Pressure Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If less than 10 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K38 Chassis Control Module.
 - **If between 4.8 - 5.2 V**
5. Verify the scan tool Fuel Pressure Sensor Voltage parameter is less than 1 V.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K38 Chassis Control Module.
 - **If less than 1 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3, wait 15 seconds.
7. Verify the scan tool Fuel Pressure Sensor Voltage parameter is greater than 4.8 V.
 - **If 4.8 V or less**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If greater than 4.8 V**
8. Test or replace the B47 Fuel Pressure Sensor.

Repair Instructions

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

DTC P0191: FUEL RAIL PRESSURE SENSOR PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0191

Fuel Rail Pressure Sensor Performance

Diagnostic Fault Information

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

Circuit/System Description

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 low reference 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.

Conditions for Running the DTC

Condition 1

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0122, P0123, P0201 - P0206, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301 - P0306, P0351 - P0356, P0506, P0507, P0722, P0723, P1248, P1249, P124A, P124B, P2122, P2123, P2127, P2128, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157 are not set.
- The engine is running.
- The accelerator pedal position is 0 percent for 4 s.
- The ignition voltage is greater than 11 V.
- The low side fuel pressure is greater than 275 kPa (40 psi).
- The vehicle speed is less than 1 km/h (0.62 mph).
- The diagnostic runs continuously when the above conditions are met.

Condition 2 and 3

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0122, P0123, P0201 - P0206, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301 - P0306, P0351 - P0356, P0506, P0507, P0722, P0723, P1248, P1249, P124A, P124B, P2122, P2123, P2127, P2128, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157 are not set.
- The ignition voltage is greater than 11 V.
- The low side fuel pressure is greater than 275 kPa (40 psi).

- The desired fuel rail pressure is between 4 - 6 MPa (580 - 870 psi).
- The engine speed is between 1, 000 - 3, 000 RPM.
- The vehicle speed is greater than 30 km/h (18.64 mph).
- The diagnostic runs continuously when the above conditions are met.

Condition 4

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0122, P0123, P0201 - P0206, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301 - P0306, P0351 - P0356, P0506, P0507, P0722, P0723, P1248, P1249, P124A, P124B, P2122, P2123, P2127, P2128, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157 are not set.
- The engine speed is greater than 2, 000 RPM.
- The vehicle speed is greater than 30 km/h (18.64 mph).
- DTC P0191 runs once an ignition cycle at engine start up when the above conditions have been met.

Conditions for Setting the DTC

Condition 1

The low side fuel pressure is at least 0.8 MPa (116 psi) less than the high side fuel pressure or the high side fuel pressure is at least 0.3 MPa (44 psi) greater than the low side fuel pressure with the high pressure fuel pump actuator commanded OFF.

The condition exists for greater than 3 s.

Condition 2

The measured fuel rail pressure is at least 2 MPa (290 psi) less than the calibrated relief pressure for greater than 3 s.

Condition 3

The difference between the desired fuel rail pressure and the actual fuel rail pressure is greater than 2 MPa (290 psi) for 3 s.

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) for greater than 10 s.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

DTC P0191 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Verification](#)

1. Ignition ON.
2. Verify DTC P0628, P069E, or U0109 is not set.
 - **If any of the DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
 - **If none of the DTCs are set**
3. Engine at idle.
4. Verify the scan tool Fuel Rail Pressure Sensor parameter is between 1.9 - 5.0 MPa (276 - 725 psi).
 - **If not within the specified range**
Refer to Circuit/System Testing.
 - **If within the specified range**
5. Verify the scan tool Fuel Rail Pressure Sensor and Desired Fuel Rail Pressure parameters closely match.
 - **If the parameters do not match**
Refer to Circuit/System Testing.
 - **If the parameters match**
6. Move related harnesses/connectors of the B47B Fuel Rail Fuel Pressure Sensor.
7. Verify the engine does not stumble, stall, or change engine speed.
 - **If the engine stumbles, stalls, or changes engine speed**
Test or repair the suspected harness or connection.
 - **If the engine does not stumbles, stalls, or changes engine speed**
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 DTC P0191 is not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
10. All OK.

[Circuit/System Testing](#)

1. Ignition OFF, all vehicle systems OFF, disconnect the B47B Fuel Rail Pressure Sensor connector.
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 C and ground.

- **If 5 Ω or greater**

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

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

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

- **If less than 5 Ω**

3. Ignition ON.

4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal A and ground.

- **If less than 4.8 V**

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

2. Test for infinite resistance between the 5 V reference circuit and ground.

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

3. Test for less than 2 Ω in the 5 V reference circuit end to end.

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

- **If greater than 5.2 V**

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

2. Test for less than 1 V between the 5 V reference circuit and ground.

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

- **If within 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 X2 harness connector at the K20 Engine Control Module, ignition ON.

2. Test for less than 1 V between the signal circuit and ground.

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

- **If less than 0.02 V**

6. Connect a 3 A fused jumper wire between the signal circuit terminal B and the 5 V reference circuit terminal A.

7. Verify the scan tool Fuel Rail Pressure Sensor Voltage parameter is greater than 4.96 V.

- **If 4.96 V or less**

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

2. Test for infinite resistance between the signal circuit terminal 12 and ground.

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

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

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

- **If greater than 4.96 V**

8. Test or replace the B47B Fuel Rail Pressure Sensor.

Repair Instructions

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

- [Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail](#)
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup.

DTC P0192 OR P0193: FUEL RAIL PRESSURE SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P0192

Fuel Rail Pressure Sensor Circuit Low Voltage

DTC P0193

Fuel Rail Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

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

Circuit/System Description

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.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is between 11 - 18 V.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTC

P0192

The engine control module detects that the fuel rail pressure sensor signal voltage is low.

P0193

The engine control module detects that the fuel rail pressure sensor signal voltage is high.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

DTCs P0192 and P0193 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0641, P0651, P0697, or P06A3 is not set.
 - **If any of the DTCs are set**
Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .
 - **If none of the DTCs are set**
3. Engine running.
4. Verify the scan tool Fuel Rail Pressure Sensor parameter is between 0.25 - 4.75 V.
 - **If not between 0.25 - 4.75 V**
Refer to Circuit/System Testing.
 - **If between 0.25 - 4.75 V**
5. Verify the scan tool Fuel Rail Pressure Sensor increases or decreases when commanding an increase and decrease in Fuel Rail Pressure with a scan tool.
 - **If the parameter does not change**
Refer to Circuit/System Testing.
 - **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**

- **If the DTC does not set**

8. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the B47B Fuel Rail Pressure Sensor connector. 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 C and ground.

- **If 5 Ω or greater**

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

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

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

- **If less than 5 Ω**

3. Ignition ON.

4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal A and ground.

- **If less than 4.8 V**

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

2. Test for infinite resistance between the 5 V reference circuit and ground.

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

3. Test for less than 2 Ω in the 5 V reference circuit end to end.

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

- **If greater than 5.2 V**

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

2. Test for less than 1 V between the 5 V reference circuit and ground.

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

- **If within 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 X2 harness connector at the K20 Engine Control Module, ignition ON.

2. Test for less than 1 V between the signal circuit and ground.

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

- **If less than 0.02 V**

6. Connect a 3 A fused jumper wire between the signal circuit terminal B and the 5 V reference circuit terminal A.

7. Verify the scan tool Fuel Rail Pressure Sensor Voltage parameter is greater than 4.96 V.

- **If 4.96 V or less**

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

2. Test for infinite resistance between the signal circuit terminal 12 and ground.

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

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

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

- If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 4.96 V**

8. Test or replace the B47B Fuel Rail Pressure Sensor.

Repair Instructions

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

- [Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail](#)
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup.

DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, OR P0277: CYLINDER INJECTOR CONTROL (LFX)

Diagnostic 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 P0205

Cylinder 5 Injector Control Circuit

DTC P0206

Cylinder 6 Injector Control Circuit

DTC P0261

Cylinder 1 Injector Control Circuit Low Voltage

DTC P0262

Cylinder 1 Injector Control Circuit High Voltage

DTC P0264

Cylinder 2 Injector Control Circuit Low Voltage

DTC P0265

Cylinder 2 Injector Control Circuit High Voltage

DTC P0267

DTC P0268

Cylinder 3 Injector Control Circuit High Voltage

DTC P0270

Cylinder 4 Injector Control Circuit Low Voltage

DTC P0271

Cylinder 4 Injector Control Circuit High Voltage

DTC P0273

Cylinder 5 Injector Control Circuit Low Voltage

DTC P0274

Cylinder 5 Injector Control Circuit High Voltage

DTC P0276

Cylinder 6 Injector Control Circuit Low Voltage

DTC P0277

Cylinder 6 Injector Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Direct Fuel Injector High Voltage Supply Cylinder 1	P2147	P0201	P2148	P1248
Direct Fuel Injector High Voltage Control Cylinder 1	P0261	P0201	P0262	P1248
Direct Fuel Injector High Voltage Supply Cylinder 2	P2150	P0202	P2151	P1249
Direct Fuel Injector High Voltage Control Cylinder 2	P0264	P0202	P0265	P1249
Direct Fuel Injector High Voltage Supply Cylinder 3	P2153	P0203	P2154	P124A
Direct Fuel Injector High Voltage Control Cylinder 3	P0267	P0203	P0268	P124A
Direct Fuel Injector High Voltage Supply Cylinder 4	P2156	P0204	P0270, P2157	P124B
Direct Fuel Injector High Voltage Control Cylinder 4	P0270, P2156	P0204	P0271, P2157	P124B
Direct Fuel Injector High Voltage Supply Cylinder 5	P216B	P0205	P216C	P124C
Direct Fuel Injector High Voltage Control Cylinder 5	P0273	P0205	P0274	P124C
Direct Fuel Injector High Voltage Supply Cylinder 6	P216E	P0206	P216F	P124D
Direct Fuel Injector High Voltage Control Cylinder 6	P0276	P0206	P0277	P124D

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 fuel injector high voltage control circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is between 11 - 18 V.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0201, P0202, P0203, P0204, P0205, or P0206

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

P0261, P0264, P0267, P0270, P0273, or P0276

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

P0262, P0265, P0268, P0271, P0274, or P0277

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

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Solenoid Coil Test (LFX)**.
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Cylinder 1 - 6 Injector Circuit Status parameters. An Injector Circuit Status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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Fuel System Description (LFX)

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

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Verification](#)

1. Ignition ON.
2. Verify DTC P0685 or P1682 is not set.
 - **If DTC P0685 or P1682 is set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If DTC P0685 or P1682 is not set**
3. Engine idling.
4. Verify the scan tool Cylinder 1 - 6 Injector Control Circuit Status parameters display OK.
 - **If any parameters do not display OK**
Refer to Circuit/System Testing.
 - **If all parameters display OK**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 does not set.
 - **If any DTC sets**
Refer to Circuit/System Testing.
 - **If no DTC sets**
7. All OK.

[Circuit/System Testing](#)

1. Ignition OFF and all vehicle systems OFF, disconnect the appropriate multi-way harness connector X160 or X161, at the rear of the intake manifold, ignition ON. It may take up to 2 min for all vehicle systems to power down.
2. Verify the scan tool Cylinder 1 - 6 Injector Control Circuit Status parameters display Open.

- **If Open is not displayed**

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

NOTE: **Test on the Engine Control Module side of the multi-way harness connector.**

2. Test for infinite resistance between the appropriate Q17 Fuel Injector control circuit and ground.
 - If less than infinite, repair the short to ground on the circuit.
 - If infinite resistance
3. Ignition ON.
4. Test for less than 1 V between the appropriate 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, test or replace the K20 Engine Control Module.
 - **If Open is displayed**
3. Ignition ON, connect a test lamp between the appropriate Q17 Fuel Injector high voltage supply circuit and control circuits.
 4. Verify the appropriate Cylinder 1 - 6 Injector Control Circuit Status transitions from Open to OK.
 - **If the parameter does not transition**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω on the appropriate Q17 Fuel Injector high voltage supply 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 appropriate Q17 Fuel Injector low control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , test or replace the K20 Engine Control Module.
 - **If the parameter transitions**

NOTE: Testing for the following steps is performed on the fuel injector side of the multi-way harness connector. It may be necessary to remove the intake manifold to isolate the condition.

5. Test for 2-3 Ω between the appropriate Q17 Fuel Injector high voltage supply circuit and control circuit.
 - **If less 2 Ω**
 1. Disconnect the harness connector at the appropriate Q17 Fuel Injector.
 2. Test for infinite resistance between the appropriate Q17 Fuel Injector high voltage supply circuit and control circuit.
 - If less than infinite, repair the short between the circuits.
 - If infinite resistance, test or replace the Q17 Fuel Injector.
 - **If greater than 3 Ω**
 1. Disconnect the harness connector at the appropriate Q17 Fuel Injector.
 2. Test for less the 2 Ω in the appropriate Q17 Fuel Injector high voltage supply 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 the 2 Ω in the appropriate Q17 Fuel Injector control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , test or replace the Q17 Fuel Injector.
 - **If between 2-3 Ω**
6. Test for infinite resistance between the appropriate Q17 Fuel Injector control circuit and ground.
 - **If less than infinite resistance**
 1. Disconnect the harness connector at the appropriate Q17 Fuel Injector.
 2. Test for infinite resistance between the appropriate Q17 Fuel Injector high voltage supply circuit and ground.
 - If less than infinite, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for infinite resistance between the appropriate Q17 Fuel Injector control circuit and ground.
 - If less than infinite, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the Q17 Fuel Injector.
 - **If infinite resistance**

7. Ignition ON.

8. Test for less than 1 V between the appropriate 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**

9. All OK.

Component Testing

- [Fuel Injector Solenoid Coil Test \(LFX\)](#)
- [Fuel Injector Balance Test](#)

Repair Instructions

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

- [Fuel Injection Fuel Rail Assembly Replacement - Bank 1 \(LFX\)](#)
- [Fuel Injection Fuel Rail Assembly Replacement - Bank 2 \(LFX\)](#)
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup.

DTC P0231, P0232, OR P023F: FUEL PUMP CONTROL (CHASSIS CONTROL MODULE)

Diagnostic Instructions

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

DTC Descriptors

DTC P0231

Fuel Pump Control Circuit Low Voltage

DTC P0232

Fuel Pump Control Circuit High Voltage

DTC P023F

Fuel Pump Control Circuit

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

P0231

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

P0232

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

P023F

- The ignition voltage is greater than 7 V.
- The commanded duty cycle is between 30 - 60 %.
- The DTC runs continuously when the conditions above are met.

Conditions for Setting the DTC

P0231

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

P0232

The fuel pump driver control module detects that the fuel pump output circuit voltage is greater than 4.0 V for 1 s when the voltage should be 0 V.

P023F

The fuel pump driver control module detects that the fuel pump current is less than 1 A and the fuel pump duty cycle is approximately 30 - 60 % for 1 s.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Diagnostic Aids

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

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Fuel System Description (LFX)

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 fuel pump turns ON and OFF when commanding the Fuel Pump Enable On and Off with a scan tool.
 - **If the fuel pump does not turn ON and OFF**
Refer to Circuit/System Testing.
 - **If the fuel pump turns ON and OFF**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor 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 2 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If less than 5 Ω**
3. Connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
4. Ignition ON.
5. Verify the test lamp turns ON and OFF when commanding the Fuel Pump Enable On and Off with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
- **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K38 Chassis Control Module.
 - **If the test lamp turns ON and OFF**
6. Test or replace the A7 Fuel Pump and Level Sensor Assembly.

Repair Instructions

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

[Control Module References](#) for K38 Chassis Control Module replacement, programming, and setup

DTC P025A: FUEL PUMP CONTROL MODULE ENABLE CIRCUIT (CHASSIS CONTROL MODULE)

Diagnostic Instructions

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

DTC Descriptor

DTC P025A

Fuel Pump Control Module Enable Circuit

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

Ignition On/Vehicle in Service Mode

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P025A is a Type A DTC.

Conditions for Clearing the DTC

DTC P025A is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description (LFX)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

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

NOTE: The Fuel Pump Primary Relay Control Circuit referred to below is circuit number 465.

The Fuel Pump Controller Data Output Signal referred to below is circuit number 5660.

1. Ignition/Vehicle Off and all vehicle systems Off, disconnect the harness connector at the K38 Chassis Control Module, Ignition On/Vehicle in Service Mode.
2. Connect a test lamp between the Fuel Pump Primary Relay Control Circuit or the Fuel Pump Controller Data Output Signal Circuit and ground.
3. Verify the test lamp turns On and Off when commanding the fuel pump On and Off using the scan tool ECM fuel pump enable control function.
 - **If the test lamp is always Off**
 1. Ignition/Vehicle Off, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the control circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.
- **If the test lamp is always On**
 1. Ignition/Vehicle Off, disconnect the harness connector at the K20 Engine Control Module, Ignition On/Vehicle in Service Mode.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **If the test lamp turns On and Off**
 4. Test or replace the K38 Chassis Control Module.

Repair Instructions

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

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

DTC P0300-P0306, P1328, P1329, OR P132A-P132E: ENGINE/CYLINDER 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

DTC P0305

Cylinder 5 Misfire Detected

DTC P0306

Cylinder 6 Misfire Detected

Circuit/System Description

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

Extreme cylinder misfire events can cause catalytic converter damage. The malfunction indicator lamp (MIL) will flash when the conditions for catalytic converter damage are present. DTCs P0301 through P0306 correspond to cylinders 1 through 6. When the ECM detects that one or more specific cylinders are misfiring, the DTC for the respective misfiring cylinder will set and up to 2 of the corresponding fuel injectors are disabled for a minimum of 30 s. The ECM will then re-enable the fuel injector and, after approximately 200 engine revolutions, will determine if the misfire is still present. If the misfire is still present, the ECM will disable the fuel injector again repeating the process. If the misfire is not present, the fuel injector will remain enabled by the ECM. In Spark Ignition Direct Injection (SIDI) system applications, if a fuel injector fault DTC is set during a misfire event, the ECM will not re-enable the injector.

Conditions for Running the DTC

- DTC P0010, P0011, P0013, P0014, P0016, P0017, P0018, P0019, P0020, P0021, P0023, P0024, P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0122, P0123, P0191, P0192, P0193, P0222, P0223, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0601, P0604, P0606, P0651, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2227, P2228, P2229, or P2230 is not set.
- DTC P0806, P0807, or P0808 is not set when equipped with manual transmission.
- The engine speed is less than 1,000 RPM and DTC P0315 is set.
- The engine speed is greater than 1,500 RPM.
- The crankshaft position and camshaft position sensors are synchronized.
- The engine coolant temperature (ECT) is between -7 and 130°C (19 - 266°F).
- If the ECT is colder than -7°C (19°F) at start-up, this diagnostic will not run until the ECT is between 21 - 130°C (70 - 266°F).
- The battery voltage is between 9 - 32 V.
- The vehicle is not in an acceleration or deceleration condition.
- The ECM is not detecting a rough road signal.
- The fuel level is at least 11%.
- The ECM is not in fuel cut-off or deceleration fuel cut-off mode.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0300

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

P0301, P0302, P0303, P0304, P0305, or P0306

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 - P0306 are Type A DTCs.
- When a catalyst damaging level of misfire is present, the ECM may disable the fuel injectors for up to 2 misfiring cylinders and will flash the malfunction indicator lamp (MIL).

Conditions for Clearing the DTC

DTCs P0300 - P0306 are Type A DTCs.

Diagnostic Aids

- A misfire DTC could be caused by an excessive vibration from sources other than the engine. Inspect for the conditions listed below:
 - A tire or wheel that is out of round or out of balance

- Variable thickness brake rotors
- An unbalanced drive shaft
- Certain rough road conditions
- Transmission operation
- A damaged or defective accessory drive component or belt
- Observe misfire counters after Active Fuel Management is commanded Off for a sticking lifter.
- High resistance in the circuits of the injectors may set a misfire DTC without setting an injector DTC. Test the injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- If the condition is intermittent, observing the scan tool IC Circuit Test and Fuel Injector Circuit Test Status parameters may help isolate the condition. The circuit test status parameters will change from OK or Not Run to Fault/Malfunction if a condition exists.
- A condition in the heated O2 sensor (HO2S) heater control circuits may set a DTC P0300.

Reference Information

Description and Operation

- [Electronic Ignition System Description](#)
- [Fuel System Description \(LFX\)](#)

DTC Type Reference

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

Scan Tool Reference

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

Special Tools

EL26792 HEI Spark Tester

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

Circuit/System Verification

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

1. Engine Running at normal operating temperature.
2. Verify there is no abnormal engine noise.
 - **If abnormal engine noise is present**
Refer to [Symptoms - Engine Mechanical](#) .
 - **If abnormal engine noise is not present**
3. Perform the scan tool [Crankshaft Position Variation Learn](#) procedure.
4. Verify no DTCs are set.
 - **If any DTCs other than P0300 - P0306 are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If DTC P0300 - P0306 is set**
Refer to Circuit/System Testing.

- **If no DTCs are set**

5. Verify the scan tool Cylinder 1 - 6 Current Misfire Counter parameters do not increment.

- **If increments**

Refer to Circuit/System Testing.

- **If does not increment**

6. Engine Running, perform the Cylinder Power Balance Test with a scan tool.

7. Verify the engine speed changes when each injector is disabled and then enabled.

- **If engine speed does not change**

Refer to Circuit/System Testing.

- **If engine speed does change**

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

9. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

10. All OK.

Circuit/System Testing

1. Verify none of the 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 \(LFX\)](#) .
- Contaminated fuel. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) .
- Exhaust system restrictions

- **If a condition exists**

Repair or replace as necessary.

- **If no conditions exist**

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

2. Ignition OFF, remove the appropriate T8 Ignition Coil and connect the **EL 26792** to the spark plug boot, engine Cranking.

3. Verify the spark output.

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

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

- **If the output is good**

4. Ignition OFF.

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

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

Repair or replace as necessary.

- **If no conditions exist**

6. Exchange the suspect spark plug with another cylinder that is operating correctly.
7. Engine Running.
8. Verify the scan tool Cylinder 1 - 6 Current Misfire Counter does not increment for the cylinder where the suspect spark plug was installed.

- **If increments**

Replace the spark plug.

- **If does not increment**

9. Verify the conditions listed below do not exist:
 - A lean or rich Q17 Fuel Injector - Refer to [Fuel Injector Balance Test](#) .
 - An engine mechanical condition - Refer to [Symptoms - Engine Mechanical](#) .

Repair Instructions

- [Ignition Coil Replacement - Bank 1](#)
- [Ignition Coil Replacement - Bank 2](#)
- [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 - 6 Current Misfire Counter parameters do not increment.
 - If the misfire counter parameters increment, a misfire condition still exists.
7. To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420 or P0430. Refer to [DTC P0420 or P0430](#) .

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

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

- **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 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 P0324

Knock Sensor System Performance

DTC P0326

Knock Sensor Performance Bank 1

DTC P0331

Knock Sensor Performance Bank 2

DTC P06B6

Control Module Knock Sensor Processor 1 Performance

DTC P06B7

Control Module Knock Sensor Processor 2 Performance

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTCs

P0324

- Engine is running for 2 s or greater.
- Engine speed is 8, 500 RPM or less.
- Engine air flow is between 200 - 2, 000 mg per cylinder.
- The engine coolant temperature (ECT) is -40Â°C (-40Â°F) or warmer.
- The intake air temperature (IAT) sensor 1 is -40Â°C (-40Â°F) or warmer.

AND

- Engine speed is 400 RPM or greater.

OR

- Engine speed is 8, 500 RPM or less.

P0326 and P0331

- Engine is running for 2 s or greater.
- Engine speed is 8, 500 RPM or less.
- Engine air flow is between 200 - 2, 000 mg per cylinder.
- The engine coolant temperature (ECT) is -40°C (-40°F) or warmer.
- The intake air temperature (IAT) sensor 1 is -40°C (-40°F) or warmer.

AND

- Engine speed is 400 RPM or greater for 167 or more cumulative revolutions.

OR

- Engine speed is 8, 500 RPM or less for 100 or more cumulative revolutions.

OR

- Engine speed is 8, 500 RPM or less for 5 or more cumulative revolutions.

P06B6 and P06B7

- Engine is running for 2 s or greater.
- Engine speed is between 400 - 4, 000 RPM for 200 or more cumulative revolutions.
- Engine air flow is between 10 - 2, 000 mg per cylinder.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0324

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

P0326

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

P0331

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

P06B6 and P06B7

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

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Reference Information

Electronic Ignition System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

Refer to **DTC P0325, P0327, P0328, P0330, P0332, or P0333.**
 - **If only DTC P06B6 or P06B7 is set**

Replace the K20 Engine Control Module.
 - **If none of the DTCs are set**
3. Ignition OFF.
4. Verify none of the conditions listed below exist:
 - B68 Knock Sensor or wiring harness damage.
 - Incorrect B68 Knock Sensor installation. Refer to **Fastener Specifications** .
 - B68 Knock Sensor and engine mounting surface burrs, casting flash, and foreign material.
 - Close proximity of hoses, brackets, and engine wiring.
 - Loose brackets.
 - Loose or broken accessory drive belts, brackets, components.
 - An engine mechanical condition. Refer to **Symptoms - Engine Mechanical** .
 - Contaminated or poor quality fuel.
 - **If a condition exists**

Repair or replace as necessary.
 - **If no conditions exist**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 - **If the DTC sets**

Test or replace the appropriate B68 Knock Sensor.
 - **If the DTC does not set**
6. All OK.

Repair Instructions

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

- **Knock Sensor Replacement - Bank 1**
- **Knock Sensor Replacement - Bank 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 Circuit Bank 1

DTC P0327

Knock Sensor Circuit Low Voltage Bank 1

DTC P0328

Knock Sensor Circuit High Voltage Bank 1

DTC P0330

Knock Sensor Circuit Bank 2

DTC P0332

Knock Sensor Circuit Low Voltage Bank 2

DTC P0333

Knock Sensor Circuit High Voltage Bank 2

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTCs

P0325 and P0330

- Engine is running for 2 s or greater.
- Engine speed is between 400 - 5, 500 RPM for 100 or more cumulative revolutions.
- Engine air flow is between 10 - 2000 mg per cylinder.
- The engine coolant temperature (ECT) is -40Â°C (-40Â°F) or warmer.

- The intake air temperature (IAT) sensor 1 is -40Å°C (-40Å°F) or warmer.

P0327, P0328, P0332, and P0333

Engine speed is less than 8, 500 RPM.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0325

The ECM detects knock sensor 1 signal circuit is open.

P0327

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

P0328

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

P0330

The ECM detects knock sensor 2 signal circuit is open.

P0332

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

P0333

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

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Diagnostic Aids

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

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electronic Ignition System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

1. Engine Running.
2. Verify DTC P0325, P0327, P0328, P0330, P0332, or P0333, is not set.
 - **If the DTC is set**
Refer to Circuit/System Testing.
 - **If the DTC is not set**
3. Verify the appropriate B68 Knock Sensor mounting bolt is properly tightened. Refer to [Fastener Specifications](#).
 - **If not tightened to the correct specification**
Repair as necessary.
 - **If tightened to the correct specification**
4. Verify the scan tool parameters listed below display No while moving the related harnesses and connectors of the B68 Knock Sensor.
 - Cylinder 1 Knock Detected
 - Cylinder 2 Knock Detected
 - Cylinder 3 Knock Detected
 - Cylinder 4 Knock Detected
 - Cylinder 5 Knock Detected
 - Cylinder 6 Knock Detected
 - **If No is not displayed**
Repair the wiring harness or connectors.
 - **If No is displayed**
5. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B68 Knock Sensor, ignition ON.

2. Test for 1 - 2 V between the low signal circuit terminal 2/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/B and ground.

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

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

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

- **If greater than 2 V**

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

2. Test for less than 1 V between the low signal circuit and ground.

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

- **If between 1 - 2 V**

3. Test for 2 - 4 V between the high signal circuit terminal 1/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/A and ground.

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

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

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

- **If greater than 4 V**

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

2. Test for less than 1 V between the high signal circuit and ground.

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

- **If between 2 - 4 V**

4. Test or replace the B68 Knock Sensor.

Repair Instructions

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

- [Knock Sensor Replacement - Bank 1](#)
- [Knock Sensor Replacement - Bank 2](#)
- [Control Module References](#) for engine control module replacement, programming, and setup.

DTC P0335 OR P0336: CRANKSHAFT POSITION SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P0335

Crankshaft Position Sensor Circuit

DTC P0336

Crankshaft Position Sensor Performance

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

P0335 Condition 1

- The starter is engaged and the engine control module detects camshaft position sensor pulses.
- Or
- DTCs P0101, P0102 and P0103 are not set.
- And
- The airflow into the engine is greater than 3 g/s.

Condition 2

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

Condition 3

- DTCs P0365, P0366, P0641, and P0651 are not set.
- The engine is running or the starter is engaged.

P0336 Condition 1

- DTCs P0335 or P0651 are not set.
- The airflow into the engine is greater than 3 g/s.

- Engine speed is greater than 450 RPM.

Condition 2

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

Condition 3

- The starter is engaged and the engine control module detects camshaft position sensor pulses.
- Or
- DTCs P0101, P0102, and P0103 are not set.
 - The airflow into the engine is greater than 3 g/s.

Condition 4

- DTCs P0365, P0366, P0641, and P0651, 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 1.0 s.

Condition 3

The ECM does not detect a crankshaft position sensor pulse for 2 out of 10 engine revolutions.

P0336 Condition 1

The ECM detects that 10 or more crankshaft resynchronization have occurred within 10.0 s.

Condition 2

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

Condition 3

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

Condition 4

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

Action Taken When the DTC Sets

- DTCs P0335 and P0336 are Type A DTCs.
- An engine driveability issue occurs after the first failure.
- 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 A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Electronic Ignition System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0651 is not set.
 - **If the DTC is set**

Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .
 - **If the DTC is not set**
3. Engine running.
4. Verify the scan tool Crankshaft Position Active Counter parameter increments.
 - **If the counter does not increment**

Refer to Circuit/System Testing.
 - **If the counter increments**
5. Verify the scan tool Crankshaft Position Resync Counter parameter displays 0 counts and the engine does not stumble or stall while moving the related harness/connectors of the B26 Crankshaft Position Sensor.
 - **If greater than 0 counts and the engine stumbles or stalls**

Refer to Circuit/System Testing.
 - **If 0 counts and the engine does not stumble or stall**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
7. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

8. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B26 Crankshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2/B and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If 2 Ω or less, replace the K20 Engine Control Module.
 - **If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1/A and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8 - 5.2 V**
5. Test for 4.8 - 5.2 V between the signal circuit terminal 3/C and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8 - 5.2 V**
6. Ignition OFF, connect a 3 A fused jumper wire to the signal circuit terminal 3/C, ignition ON.

NOTE: Additional DTCs may set when performing this test.

7. Verify the scan tool Crankshaft Position Sensor Active Counter parameter increments while rapidly tapping the fused jumper wire end to ground.

- **If the counter does not increment**

Replace the K20 Engine Control Module.

- **If the counter increments**

8. Verify DTC P0336 is not set.

- **If the DTC is set**

Inspect for the conditions listed below:

- Excessive play or looseness of the B26 Crankshaft Position Sensor or the reluctor wheel
- Improper installation of the B26 Crankshaft Position Sensor
- Foreign material passing between the B26 Crankshaft Position Sensor and the reluctor wheel
- Damaged reluctor wheel
- Excessive air gap between the B26 Crankshaft Position Sensor and the reluctor wheel
- Engine oil for debris
- Timing chain, tensioner, and sprockets for wear or damage
 - If any of the conditions above are found, repair as necessary.
 - If all components test normal, test or replace the B26 Crankshaft Position Sensor.

- **If the DTC is not set**

9. Test or replace the B26 Crankshaft Position Sensor.

Repair Instructions

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

- [Crankshaft Position Sensor Replacement](#)
- [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0340, P0341, P0345, P0346, P0365, P0366, P0390, OR P0391: INTAKE/EXHAUST CAMSHAFT POSITION SENSOR (LFX)

Diagnostic Instructions

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

DTC Descriptors

DTC P0340

Intake Camshaft Position Sensor Circuit Bank 1

DTC P0341

Intake Camshaft Position Sensor Performance Bank 1

DTC P0345

Intake Camshaft Position Sensor Circuit Bank 2

DTC P0346

Intake Camshaft Position Sensor Performance Bank 2

DTC P0365

DTC P0366

Exhaust Camshaft Position Sensor Performance Bank 1

DTC P0390

Exhaust Camshaft Position Sensor Circuit Bank 2

DTC P0391

Exhaust Camshaft Position Sensor Performance Bank 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0107, P0192, P0236, P0237, P0340, P0345, P0365, P0390, P0452, P0522, P0532, P0641, P2228	P0340, P0345, P0365, P0390	P0193, P0236, P0345, P0453, P0506, P0533, P0641, P1101, P2227, P222B	-
Signal	P0340, P0345, P0365, P0390	P0340, P0345, P0365, P0390	P0340, P0345, P0365, P0390	P0341, P0346, P0366, P0391
Low Reference	-	P0340, P0345, P0365, P0390	-	-

Circuit/System Description

The 4 camshaft position sensors each have 3 circuits consisting of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The camshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the camshaft position sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency with 4 varying width output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the camshaft position sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM uses the cylinder 1 exhaust camshaft position sensor to determine injector and ignition system synchronization. The intake and exhaust camshaft position sensors are also used to determine camshaft to crankshaft relationship. The ECM also uses camshaft position sensor output information to determine the camshaft relative position to the crankshaft to control camshaft phasing and limp-home operation.

Conditions for Running the DTC**P0340, P0345, P0365, or P0390 Condition 1**

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

OR

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

Condition 2

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

Condition 3

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

Condition 4

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

P0341, P0346, P0366, or P0391 Condition 1

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

Condition 2

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

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0340, P0345, P0365, or P0390 Condition 1

- The ECM does not detect a camshaft position sensor pulse for greater than 5.5 s.
- OR
- The ECM does not detect a camshaft position sensor pulse for greater than 4.0 s since the time the starter has been engaged.

Condition 2

The ECM detects less than 4 camshaft position sensor pulses for greater than 3.0 s.

Condition 3

The ECM does not detect a camshaft position sensor pulse during the first 2 engine revolutions.

Condition 4

The ECM does not detect a camshaft position sensor pulse during 200 engine revolutions.

P0341, P0346, P0366, or P0391 Condition 1

- The ECM detects less than 4 camshaft position sensor pulses during 2 engine revolutions.
- OR
- The ECM detects greater than 10 camshaft position sensor pulses during 2 engine revolutions.

Condition 2

The ECM detects less than 398 or greater than 402 camshaft position sensor pulses during 200 engine revolutions.

Action Taken When the DTC Sets

- DTCs P0340, P0341, P0345, P0346, P0365, P0366, P0391, and P0390 are Type B DTCs.

- The camshaft position actuator is commanded to the Home or Parked position.
- The ignition system defaults to a failed camshaft position sensor limp home mode.

Conditions for Clearing the DTC

DTCs P0340, P0341, P0345, P0346, P0365, P0366, P0391, and P0390 are Type B DTCs.

Diagnostic Aids

- With a DTC set, the engine may crank for an extended period of time at start-up
- The exhaust camshaft position sensor is used for injector and ignition system synchronization. A stalling condition will occur if the camshaft position sensor signal is intermittent and a DTC will not set. Inspect all camshaft position sensor circuits for poor connections.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0641 or P0651 is not set.
 - **If any of the DTCs are set**
Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .
 - **If none of the DTCs are set**
3. Engine running.
4. Verify the scan tool parameters listed below increment:
 - Exhaust Camshaft Position Active Counter Bank 1
 - Exhaust Camshaft Position Active Counter Bank 2
 - Intake Camshaft Position Active Counter Bank 1
 - Intake Camshaft Position Active Counter Bank 2
 - **If any counter does not increment**

Refer to Circuit/System Testing.

- **If all counters increment**

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

6. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B23 Camshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 5 Ω between the low reference circuit terminal 1/A and ground.

- **If 5 Ω or greater**

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

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

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

- **If less than 5 Ω**

3. Ignition ON.

4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 3/C and ground.

- **If less than 4.8 V**

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

2. Test for infinite resistance between the 5 V reference circuit and ground.

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

3. Test for less than 2 Ω in the 5 V reference circuit end to end.

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

- **If greater than 5.2 V**

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

2. Test for less than 1 V between the 5 V reference circuit and ground.

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

- **If between 4.8 - 5.2 V**

5. Test for 4.8 - 5.2 V between the signal circuit terminal 2/B and ground.

- **If less than 4.8 V**

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

2. Test for infinite resistance between the signal circuit and ground.

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

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

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

- **If greater than 5.2 V**

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

2. Test for less than 1 V between the signal circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8 - 5.2 V**
6. Verify DTC P0341, P0346, P0366, or P0391 is not set.
- **If any of the DTCs are set**
- Verify the conditions listed below do not exist:
- Excessive play or looseness of the B23 Camshaft Position Sensor or the reluctor wheel
 - Improper installation of the B23 Camshaft Position Sensor
 - Foreign material passing between the B23 Camshaft Position Sensor and the reluctor wheel
 - Damaged reluctor wheel
 - Excessive air gap between the B23 Camshaft Position Sensor and the reluctor wheel
 - Engine oil for debris
 - Timing chain, tensioner, and sprockets for wear or damage
 - If a conditions exist, repair as necessary.
 - If none of the condition exist test or replace the B23 Camshaft Position Sensor.
 - **If none of the DTCs are set**
7. Test or replace the B23 Camshaft Position Sensor.

Repair Instructions

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

- [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Exhaust](#)
- [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Exhaust](#)
- [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Intake](#)
- [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Intake](#)
- [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, OR P2316: IGNITION COIL CONTROL

Diagnostic Instructions

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

DTC Descriptors

DTC P0351

Ignition Coil 1 Control Circuit

DTC P0352

Ignition Coil 2 Control Circuit

DTC P0353

Ignition Coil 3 Control Circuit

DTC P0354

Ignition Coil 4 Control Circuit

DTC P0355

Ignition Coil 5 Control Circuit

DTC P0356

Ignition Coil 6 Control Circuit

DTC 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

DTC P2312

Ignition Coil 5 Control Circuit Low Voltage

DTC P2313

Ignition Coil 5 Control Circuit High Voltage

DTC P2315

Ignition Coil 6 Control Circuit Low Voltage

DTC P2316

Ignition Coil 6 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Coil 1 Control	P0300, P2300	P0300, P0351	P0300, P2301	P0300, P0351
Ignition Coil 2 Control	P0300, P2303	P0300, P0352	P0300, P2304	P0300, P0352
Ignition Coil 3 Control	P0300, P2306	P0300, P0353	P0300, P2307	P0300, P0353
Ignition Coil 4 Control	P0300, P2309	P0300, P0354	P0300, P2310	P0300, P0354
Ignition Coil 5 Control	P0300, P2312	P0300, P0355	P0300, P2313	P0300, P0355
Ignition Coil 6 Control	P0300, P2315	P0300, P0356	P0300, P2316	P0300, P0356

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Coil 1 Ground	-	P0300, P0351	-	P0300, P0351
Ignition Coil 2 Ground	-	P0300, P0352	-	P0300, P0352
Ignition Coil 3 Ground	-	P0300, P0353	-	P0300, P0353
Ignition Coil 4 Ground	-	P0300, P0354	-	P0300, P0354
Ignition Coil 5 Ground	-	P0300, P0355	-	P0300, P0355
Ignition Coil 6 Ground	-	P0300, P0356	-	P0300, P0356

Circuit/System Description

The ignition system on this engine uses an individual coil for each cylinder. The engine control module (ECM) controls the spark event for each cylinder through the 6 individual ignition control circuits. When the ECM commands the ignition control circuit ON, electrical current will flow through the primary winding of the ignition coil, creating a magnetic field. When a spark event is requested, the ECM will command the ignition control circuit OFF, interrupting current flow through the primary winding. The magnetic field created by the primary winding will collapse across the secondary coil windings, producing a high voltage across the spark plug electrodes. The ECM uses information from the crankshaft position sensor, and the camshaft position sensor for sequencing and timing of the spark events. The ECM monitors each ignition control circuit for improper voltage levels.

Conditions for Running the DTC

- The engine is cranking or running.
- Ignition voltage greater than 5 V.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match.

Action Taken When the DTC Sets

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315 and P2316 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315 and P2316 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

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

- [Wiring Repairs](#)

DTC Type Reference

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

Scan Tool Reference

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

Special Tools

EL 26792 HEI Spark Tester

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

[Circuit/System Verification](#)

1. Engine Running.
2. Verify the scan tool parameters listed below do not display Malfunction:
 - Ignition Coil 1 - 6 Control Circuit High Voltage Test Status
 - Ignition Coil 1 - 6 Control Circuit Low Voltage Test Status
 - Ignition Coil 1 - 6 Control Circuit Open Test Status
 - **If Malfunction is displayed**

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

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

[Circuit/System Testing](#)

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate T8 Ignition Coil. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the ground circuit terminal 1/A and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 5 Ω**
3. Verify the scan tool Ignition Coil Control Circuit Low Voltage Test Status does not display Malfunction.
 - **If Malfunction is displayed**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the control circuit.
 - If infinite resistance, replace the K20 Engine Control Module.

- **If Malfunction is not displayed**

4. Verify the scan tool Ignition Coil Control Circuit High Voltage Test Status does not display Malfunction.

- **If Malfunction is displayed**

1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.

- **If Malfunction is not displayed**

5. Ignition OFF, install a 3 A fused jumper wire between the control circuit terminal 3/C and ground, engine Running.

6. Verify the scan tool Ignition Coil Control Circuit Low Voltage Test Status displays Malfunction.

- **If Malfunction is not displayed**

1. Ignition OFF, remove the fused jumper, and disconnect the X3 harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If Malfunction is displayed**

7. Test or replace the T8 Ignition Coil.

Component Test

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

1. Ignition OFF, connect the **EL 26792** HEI spark tester to the appropriate T8 Ignition Coil.
2. Engine Running.
3. Verify the spark output of the T8 Ignition Coil.

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

Replace the T8 Ignition Coil.

- **If the output is normal**

4. All OK.

Repair Instructions

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

- **Ignition Coil Replacement - Bank 1**
- **Ignition Coil Replacement - Bank 2**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0411: SECONDARY AIR INJECTION SYSTEM INCORRECT AIR FLOW 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 P0411

Secondary Air Injection System Incorrect Air Flow Detected

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. A pressure sensor in each bank is used to monitor the air flow from the secondary air injection pump. The engine control module (ECM) supplies voltage to the 5-volt reference circuits and supplies a ground to the low reference circuits. The sensors provide a signal voltage to the ECM relative to the pressure changes within the secondary air injection system.

Ignition voltage is supplied to the secondary air injection pump relay and the secondary air injection solenoid valve (shutoff and check valve) relay. The ECM activates the relays by grounding the control circuits. When the relay contacts close, voltage is supplied to the pump and the valves, which turns the pump on and opens the valves.

The diagnostic uses 3 phases to test the secondary air injection system:

- DTCs P0411, P2430 and P2435 run during Phase 1
- DTCs P2430, P2435 and P2440 run during Phase 2
- DTC P2444 runs during Phase 3

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

During phase 2, only the secondary air injection pump is activated. The solenoid valves are closed. Pressure sensor performance and solenoid valve deactivation are tested. Expected system pressure is 14 - 22 kPa (2.0 - 3.2 psi) above BARO.

During phase 3, neither the secondary air injection pump nor the secondary air injection solenoid valves are activated. Secondary air injection pump deactivation is tested. Expected system pressure equals BARO.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300, P0351, P0352, P0353, P0354, P0355, P0356, P0412, P0418, P0420, P0430, P0606, P0641, P0651, P124A, P124B, P124C, P124D, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2227, P2228, P2229, P2230, P2430, P2431, P2432, P2433, P2435, P2436, P2437, or P2438 is not set.
- Greater than 60 min has elapsed since the last cold start.
- Ignition voltage is between 10 - 32 V.
- Engine speed is less than 5,000 RPM.
- Intake air temperature (IAT) is greater than -10°C ($+14^{\circ}\text{F}$).
- Engine coolant temperature (ECT) is between -10 and $+56^{\circ}\text{C}$ ($14 - 133^{\circ}\text{F}$).
- Barometric pressure (BARO) is greater than 74 kPa (10.7 psi).
- Manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- Mass air flow (MAF) is less than 50 g/s.
- Secondary air injection pump is commanded On.
- DTC P0411 runs once per ignition cycle when the above conditions are met for greater than 7 s.

Conditions for Setting the DTC

- The actual system pressure in either bank is at least 7 kPa (1.0 psi) greater or 7 kPa (1.0 psi) less than the predicted system pressure for greater than 7 s.

OR

- The difference between the predicted magnitude of pressure pulsations and the actual magnitude of pressure pulsations, in either bank over a specific length of time, exceeds a calibrated threshold.

Action Taken When the DTC Sets

DTC P0411 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0411 is a Type B DTC.

Diagnostic Aids

Ice buildup due to condensation/water in the air passages or pump may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics (LEX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-36169-HD Fused Jumper

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

Circuit/System Verification

NOTE: Verify the battery is fully charged before proceeding with this diagnostic procedure. The secondary air injection pump output will vary with system voltage.

1. Ignition On
2. Verify that DTC P0412, P0418, P2430, P2431, P2432, P2433, P2435, P2436, P2437, P2438, P2440, or P2444 is not set.
 - **If any of the DTCs are set**

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

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

3. Verify the scan tool BARO pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure \(With LFX\)](#) table.

- **If not within the specified range**

Refer to [DTC P2227-P2230 \(LFX\)](#).

- **If within the specified range**

NOTE: Engine coolant temperature must be greater than 5Â°C (41Â°F) to enable scan tool device control. It may be necessary to use one of the methods listed below to verify valve operation:

- Use a stethoscope to listen for valve operation.
- Disconnect the secondary air injection pipe from the secondary air injection solenoid valve and visually inspect the valve inlet port for valve stem movement.
- Disconnect the Q29 Secondary Air Injection Solenoid Valve and verify airflow through the valve when commanding the Secondary Air Injection System Active with a scan tool.

4. Verify the Q29 Secondary Air Injection Solenoid Valves open and close when commanding the Secondary Air Injection Solenoid On and Off with a scan tool.

- **If the valves do not open and close**

Refer to Circuit/System Testing - Secondary Air Injection Solenoid Valve Malfunction

- **If the valves open and close**

NOTE: To prevent the secondary air injection pump from overheating, do not operate the pump consecutively for greater than 2 minutes. The pump is provided with a thermal protector that will automatically reset when allowed to cool.

5. Verify the G21 Secondary Air Injection Pump turns On and Off when commanding the Secondary Air Injection Pump Relay On and Off with a scan tool.

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

Refer to Circuit/System Testing - Secondary Air Injection Pump Malfunction

- **If the pump turns On and Off**

6. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1, Secondary Air Injection Pressure Sensor Bank 2 and the BARO pressure parameters are within 3 kPa (0.4 psi).

- **If not within the specified range**

Replace the appropriate Q29 Secondary Air Injection Solenoid Valve(s).

- **If within the specified range**

7. Engine running

8. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 and Secondary Air Injection Pressure Sensor Bank 2 parameters increase between 14 - 22 kPa (2.0 - 3.2 psi) when the Secondary Air Injection Pump Relay is commanded On with a scan tool.

- **If not within the specified range**

Refer to Circuit/System Testing - Secondary Air Injection System Pressure Not In Range.

- **If within the specified range**

9. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 and Secondary Air Injection Pressure Sensor Bank 2 parameters increase between 5 - 13 kPa (0.7 - 1.9 psi) when the Secondary Air Injection System is commanded On with a scan tool.

- **If not within the specified range**

Refer to Circuit/System Testing - Secondary Air Injection System Pressure Not In Range.

- **If within the specified range**

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

11. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

12. All OK.

Circuit/System Testing

Secondary Air Injection Shutoff and Check Valve Malfunction

1. Ignition Off and all vehicle systems Off. It may take up to 2 minutes for all vehicle systems to power down. Disconnect the harness connectors at both Q29 Secondary Air Injection Solenoid Valves.

2. Test for less than 10 Ω between the ground circuit terminal 4 of the appropriate Q29 Secondary Air Injection Solenoid Valve and ground.

- **If 10 Ω or greater**

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

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

- **If less than 10 Ω**

3. Connect a test lamp between the control circuit terminal 5 and ground, ignition On.

4. Verify the test lamp turns On and Off when commanding the Secondary Air Injection Solenoid Valve On and Off with a scan tool.

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

1. Ignition Off, disconnect the X3 harness connector at the X50A Fuse Block-Underhood, ignition On.

2. Verify a test lamp does not illuminate between terminal X3-16 at the X50A Fuse Block-Underhood and ground.

- If the test lamp illuminates

Replace the X50A Fuse Block-Underhood.

- If the test lamp does not illuminate

Repair the short to voltage on the control circuit.

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

1. Ignition Off, test for infinite resistance between the control circuit terminal 5 and ground.

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

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 X50A Fuse Block-Underhood.

- **If the test lamp turns On and Off**

5. Test or replace the Q29 Secondary Air Injection Solenoid Valve.

Secondary Air Injection Pump Malfunction

1. Ignition Off, disconnect the KR25 Secondary Air Injection Pump relay.
2. Verify a test lamp illuminates between the B+ circuit terminal 87 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 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.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Disconnect the harness connector at the G21 Secondary Air Injection Pump.
 4. Test for infinite resistance between the control circuit terminal A and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 5. Test or replace the G21 Secondary Air Injection Pump.
 - **If the test lamp illuminates**
3. Disconnect the harness connector at the G21 Secondary Air Injection Pump.
4. Ignition Off, test for less than 10 Ω between the G21 Secondary Air Injection Pump ground circuit terminal B and ground.
 - **If 10 Ω or greater**
 1. Ignition Off.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 10 Ω**
5. Connect the harness connector at the G21 Secondary Air Injection Pump.
6. Connect a 40 A **EL 36169-HD** between the B+ circuit terminal 87 and the control circuit terminal 30.

NOTE: To prevent the secondary air injection pump from overheating, do not operate the pump consecutively for greater than 2 minutes. The pump is provided with a thermal protector that will automatically reset when allowed to cool.

7. Verify the G21 Secondary Air Injection Pump is activated.
 - **If the G21 Secondary Air Injection Pump does not activate**
 1. Ignition Off, disconnect the harness connector at the G21 Secondary Air Injection Pump.
 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 ,
 3. Test or replace the G21 Secondary Air Injection Pump.
 - **If the G21 Secondary Air Injection Pump activates**
8. Test or replace the KR25 Secondary Air Injection Pump relay.

Secondary Air Injection System Pressure Not In Range

1. Verify the following conditions do not exist with the secondary air injection system:
 - Hoses/pipes restricted or blocked
 - Hoses/pipes leaking or disconnected

- Damaged secondary air injection shutoff and check valve
- Restricted or blocked cylinder head secondary air injection inlet ports and passages
- **If a condition is located**

Repair or replace the affected component as necessary.

- **If all components test normal**

2. Disconnect the secondary air injection hose/pipe from the appropriate Q29 Secondary Air Injection Solenoid Valve.
3. Ignition On, command the Secondary Air Injection Pump Relay On with a scan tool.
4. Verify airflow to the Q29 Secondary Air Injection Solenoid Valve.

- **If no airflow**

Replace the G21 Secondary Air Injection Pump.

- **If airflow**

5. Replace the Q29 Secondary Air Injection Solenoid Valve.

Component Testing

KR25 Secondary Air Injection Pump Relay Test

1. Ignition Off, disconnect the KR25 Secondary Air Injection Pump Relay.
2. Test for 70 - 110 Ω between terminals 85 - 86 or 1 - 2.

- **If less than 70 Ω or greater than 110 Ω**

Replace the KR25 Secondary Air Injection Pump Relay.

- **If between 70 - 110 Ω**

3. Test for infinite resistance between the terminals listed below:

- 30 - 86 or 1 - 3
- 30 - 87 or 3 - 5
- 30 - 85 or 2 - 3
- 85 - 87 or 2 - 5

- **If less than infinite resistance**

Replace the KR25 Secondary Air Injection Pump Relay.

- **If infinite resistance**

4. Install a 15 A fused jumper wire between relay terminal 85 or 2 and 12 V. Install a jumper wire between relay terminal 86 or 1 and ground.
5. Test for less than 2 Ω between terminals 30 - 87 or 3 - 5.

- **If 2 Ω or greater**

Replace the KR25 Secondary Air Injection Pump Relay.

- **If less than 2 Ω**

6. All OK.

Q29 Secondary Air Injection Solenoid Valve Static Test

1. Ignition Off, disconnect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
2. Test for 4 - 15 Ω between the voltage supply terminal 5 and the ground circuit terminal 4 at the valve.

- **If less than 4 Ω or greater than 15 Ω**

Replace the Q29 Secondary Air Injection Solenoid Valve.

- If between 4 - 15 Ω

3. All OK

Q29 Secondary Air Injection Solenoid Valve Dynamic Test

1. Ignition Off, disconnect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
2. Install a 15 A fused jumper wire between the voltage supply terminal 5, at the valve, and 12 V. Install a jumper wire to the ground circuit terminal 4 at the valve.
3. Verify the valve opens and closes when connecting and disconnecting the jumper wire to ground.

- **If the valve does not open and close**

Replace the Q29 Secondary Air Injection Solenoid Valve.

- **If the valve opens and closes**

4. All OK

Repair Instructions

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

- [Fuse Block Replacement](#)
- [Relay Replacement \(Attached to Wire Harness\)](#) [Relay Replacement \(Within an Electrical Center\)](#)
- [Secondary Air Injection Pump Replacement](#)
- [Secondary Air Injection Bypass Valve Replacement - Bank 2](#) for secondary air injection solenoid valve replacement - Bank 2
- [Secondary Air Injection Bypass Valve Replacement - Bank 1](#) for secondary air injection solenoid valve replacement - Bank 1

DTC P0412, P041F, OR P044F: SECONDARY AIR INJECTION VALVE CONTROL

Diagnostic Instructions

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

DTC Descriptors

DTC P0412

Secondary Air Injection Valve Control Circuit

DTC P041F

Secondary Air Injection Valve Control Circuit Low Voltage

DTC P044F

Secondary Air Injection Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Secondary Air Injection Valve Control Circuit Voltage Supply	P0412, P041F*	P0412, P041F	P0690	-
Air Injection Reaction Solenoid Relay Coil Control	P0412, P041F	P0412, P041F	P044F, P0690	-
* Supply fuse opens				

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. Ignition voltage is supplied directly to the secondary air injection pump relay and secondary air solenoid valve relay. The secondary air injection solenoid valve relay is integral to the underhood fuse block. The relay is soldered directly to a printed circuit board (PCB) within the fuse block and is not serviceable as a separate component. The engine control module (ECM) controls the relays by grounding the control circuit with a solid state device called a driver. The ECM monitors the control circuits for open, short to ground, or short to voltage conditions.

Conditions for Running the DTC

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

Conditions for Setting the DTC

P0412

The ECM detects an open circuit condition of the low side driver circuit for greater than 6 s.

P041F

The ECM detects a short to ground on the low side driver circuit for greater than 6 s.

P044F

The ECM detects a short to voltage on the low side driver circuit for greater than 6 s.

Action Taken When the DTC Sets

DTC P0412, P041F and P044F are Type B DTCs.

Conditions for Clearing the DTC

DTC P0412, P041F and P044F are Type B DTCs.

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Secondary Air Injection Solenoid Valve Control Circuit status parameters. The circuit status parameter changes from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection System Description

Electrical Information Reference

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

- [Wiring Repairs](#)

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Verification](#)

1. Ignition On
2. Verify the circuit status parameters listed below do not display Malfunction when commanding the Secondary Air Injection Solenoid Valve On and Off with a scan tool:
 - Secondary Air Injection Solenoid Valve Control Circuit Low Voltage Test Status
 - Secondary Air Injection Solenoid Valve Control Circuit Open Test Status
 - Secondary Air Injection Solenoid Valve Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing
 - **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 a DTC does not set.
 - **If a DTC sets**

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

[Circuit/System Testing](#)

1. Ignition Off, disconnect the X1 Harness Connector at the K20 Engine Control Module, ignition On.
2. Verify the Q29A and Q29B Secondary Air Injection Valves are not activated.
 - **If activated**
 1. Ignition Off, disconnect the X3 Harness Connector at the X50A Fuse Block-Underhood.
 2. Test for infinite resistance between the control circuit terminal X3-10 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the X50A Fuse Block-Underhood.
 - **If not activated**

NOTE: If the 3 A fuse in the jumper at terminal X1-56 opens, there is a short to voltage on the circuit.

3. Connect a 3 A fused jumper wire between the K20 Engine Control Module control circuit terminal X1-56 and ground and connect a 3 A fused jumper wire between K20 Engine Control Module control circuit terminal X1-72 and ground.
4. Verify the Q29A and Q29B Secondary Air Injection Valves are activated.
 - **If not activated**

NOTE: Disconnecting the X3 Harness Connector at the X50A Fuse Block-Underhood may de-energize a circuit which is causing a short to voltage, resulting in a false pass and unnecessary replacement of the fuse block.

1. Ignition Off, remove the jumper wires, disconnect the X3 Harness Connector at the X50A Fuse Block-Underhood, ignition On.
2. Test for less than 1 V between the control circuit terminal X3-10 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 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 X50A Fuse Block-Underhood.
- **If activated**
5. Replace the K20 Engine Control Module.

Repair Instructions

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

- [Fuse Block Replacement](#)
- [Control Module References](#) for Engine Control Module replacement, programming and setup.

DTC P0418, P2257, OR P2258: SECONDARY AIR INJECTION PUMP RELAY CONTROL

Diagnostic Instructions

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

DTC Descriptors

DTC P0418

Secondary Air Injection Pump Relay Control Circuit

DTC P2257

Secondary Air Injection Pump Relay Control Circuit Low Voltage

DTC P2258

Secondary Air Injection Pump Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Secondary Air Injection Pump Relay Coil Voltage Supply	-	P0418, P2257	P0690	-
Secondary Air Injection Pump Relay Coil Control	P0418	P0418, P2257	P0690, P2258	-

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. Ignition voltage is supplied directly to the secondary air injection pump relay and secondary air solenoid valve relay. The engine control module (ECM) controls the relays by grounding the control circuit with a solid state device called a driver. The ECM monitors the control circuits for open, short to ground, or short to voltage conditions.

Conditions for Running the DTC

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

Conditions for Setting the DTC

P0418

The ECM detects an open circuit condition of the low side driver circuit for greater than 6 s.

P2257

The ECM detects a short to ground on the low side driver circuit for greater than 6 s.

P2258

The ECM detects a short to voltage on the low side driver circuit for greater than 6 s.

Action Taken When the DTC Sets

DTC P0418, P2257 and P2258 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0418, P2257 and P2258 are Type B DTCs.

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Secondary Air Injection Pump Relay Control Circuit status parameters. The circuit status parameter changes from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On

2. Verify a click is heard or felt from the KR25 Secondary Air Injection Pump Relay when commanding the Secondary Air Injection Pump Relay On and Off with a scan tool.

- **If a click is not heard or felt**

Refer to Circuit/System Testing

- **If a click is heard or felt**

3. Verify the circuit status parameters listed below do not display Malfunction when commanding the Secondary Air Injection Pump Relay On and Off with a scan tool:

- Secondary Air Injection Pump Relay Control Circuit Low Voltage Test Status
- Secondary Air Injection Pump Relay Control Circuit Open Test Status
- Secondary Air Injection Pump Relay Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Refer to Circuit/System Testing

- **If Malfunction is not displayed**

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

5. Verify a DTC does not set.

- **If a DTC sets**

Refer to Circuit/System Testing

- **If a DTC does not set**

6. All OK

Circuit/System Testing

1. Ignition Off, disconnect the KR25 Secondary Air Injection Pump Relay. Ignition On.

2. Verify a test lamp illuminates between the relay coil ignition circuit terminal 86 and ground.

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

1. Ignition Off.

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

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

- **If the test lamp illuminates**

3. Connect a DMM, set on the diode setting, between the control circuit terminal 85 and ground.

4. Verify the DMM reading is greater than 2.5 V or displays O.L. when commanding the Secondary Air Injection Pump Relay Off with a scan tool.

- **If 2.5 V or less**

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

2. Test for less than 1 V between the control circuit and ground.

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

3. Ignition Off.

4. Test for infinite resistance between the control circuit and ground.

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

- **If greater than 2.5 V or displays O.L.**

5. Verify the DMM reading is less than 1 V when commanding the Secondary Air Injection Pump Relay On with a scan tool.

- **If 1 V or greater**

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

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

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

- **If less than 1 V**

6. Test or replace the KR25 Secondary Air Injection Pump Relay.

Component Testing

Relay Test

1. Ignition Off, disconnect the KR25 Secondary Air Injection Pump Relay.
2. Test for 70 - 110 Ω between terminals 85 - 86.

- **If less than 70 Ω or greater than 110 Ω**

Replace the KR25 Secondary Air Injection Pump Relay.

- **If between 70 - 110 Ω**

3. Test for infinite resistance between the terminals listed below:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87

- **If less than infinite resistance**

Replace the KR25 Secondary Air Injection Pump Relay.

- **If infinite resistance**

4. Install a 15 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.

5. Test for less than 2 Ω between terminals 30 and 87.

- **If 2 Ω or greater**

Replace the KR25 Secondary Air Injection Pump Relay.

- **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

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 3.6L (LFX) - Diagnostic Information and Procedures - Impala

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0420 OR P0430: CATALYST SYSTEM LOW EFFICIENCY BANK

Diagnostic 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 Bank 1

DTC P0430

Catalyst System Low Efficiency Bank 2

Circuit/System Description

A 3-way catalytic converter controls emissions of hydrocarbons, CO and 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 CO₂, and reduces the NOx, converting the NOx into nitrogen. The catalytic converter also stores oxygen. The ECM monitors this process by using a heated oxygen sensor (HO2S) that is in the exhaust stream after the 3-way catalytic converter. The HO2S 2 produces an output signal that the ECM uses to calculate the oxygen storage capacity of the catalyst. This indicates the ability of the catalyst to convert the exhaust emissions efficiently. The ECM monitors the efficiency of the catalyst by allowing the catalyst to heat, then wait for a stabilization period while the engine is idling. The ECM then adds and removes fuel while monitoring the HO2S 2. When the catalyst is functioning properly, the HO2S 2 response to the extra fuel is slow compared to the response of the HO2S 1, which is located before the catalytic converter. When the HO2S 2 response is near that of the HO2S 1, the oxygen storage capability and efficiency of the catalyst may be degraded below an acceptable threshold.

Conditions for Running the DTC

- DTC P0016, P0017, P0018, P0019, P0053, P0054, P0059, P0060, P0068, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101, P0102, P0103, P0112, P0113, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0135, P0137, P0138, P013A, P013B, P013C, P013D, P013E, P013F, P0140, P0141, P014A, P014B, P0151, P0152, P0153, P0155, P0157, P0158, P0160, P0161, P0171, P0172, P0174, P0175, P0191, P0192, P0193, P0222, P0223, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0335, P0336, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0443, P0506, P0507, P0606, P1153, P16F3, P2101, P2122, P2123, P2127, P2128, P2135, P2138, P2227, P2228, P2229, P2230, P2270, P2271, P2272, or P2273 is not set.
- Before the ECM performs the idle test, the vehicle must be driven under the following conditions:
 - Engine speed is greater than 965 RPM
 - Engine run time is greater than a calibrated value
 - Both conditions exist for greater than 15 s
- Throttle is in the rest position.
- Intake air temperature (IAT) is between -20 to +250Â°C (-4 to +482Â°F).
- Ignition voltage is greater than 11 V.

- Engine coolant temperature (ECT) is between 40 - 127Â°C (104 - 261Â°F).
- Barometric pressure (BARO) is greater than 70 kPa.
- Engine has been idling less than 50 s.
- Vehicle speed is less than 2 km/h (1 mph).
- Short term fuel trim is learned.
- Mass air flow (MAF) is between 3 - 13 g/s.
- Evaporative emissions (EVAP) purge concentration is learned.
- Catalytic converter calculated temperature is between 450 - 850Â°C (842 - 1,562Â°F).
- Engine is operating in closed loop.
- Transmission is not in P/N (automatic transmission only).

This diagnostic attempts one test during each valid idle period once the above conditions have been met. This diagnostic attempts up to 8 tests during each drive cycle.

Conditions for Setting the DTC

The ECM determines that the efficiency of the catalyst has degraded below a calibrated threshold.

Action Taken When the DTC Sets

DTC P0420 and P0430 are Type A DTCs.

Conditions for Clearing the DTC

DTC P0420 and P0430 are Type A DTCs.

Diagnostic Aids

Inspect for the conditions listed below, which may cause a catalyst to degrade:

- Engine misfire
- High engine oil or high coolant consumption
- Retarded spark timing
- Weak or poor spark
- Lean fuel mixture
- Rich fuel mixture
- Damaged oxygen sensor or wiring harness

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify there are no other DTCs set.

- **If other DTCs are set**

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

- **If no other DTCs are set**

3. Operate the vehicle within the Conditions for Running the DTC.
4. Verify the scan tool Catalyst Monitor Not At Idle Test Conditions Met parameter changes to Yes.

- **If Yes is not displayed**

Refer to step 3.

- **If Yes is displayed**

5. When the conditions are safe, stop and idle the vehicle in gear if equipped with automatic transmission or neutral if equipped with manual transmission.
6. Verify the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters display Passed when performing the steps listed below:
 1. Apply the service brake.
 2. Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.

NOTE: When the test has completed, the Catalyst Monitor Test Counter Bank 1 and Bank 2 parameters will increment by one and the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters will indicate Passed, Failed or No Result.

3. Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.
4. Verify the scan tool Catalyst Monitor Test Result Bank 1 or Bank 2 parameter displays Passed.

- **If No Result is displayed**

Repeat steps 3 - 6 until the Test Result parameters indicate Passed or Failed.

- **If Failed is displayed**

Refer to Circuit /System Testing.

- **If Passed is displayed**

7. All OK.

Circuit/System Testing

1. Verify the conditions listed below do not exist with the appropriate catalytic converter:

- Dents
- Severe discoloration caused by excessive temperatures.
- Road damage.
- Internal rattles caused by damaged catalyst substrate.
- Restrictions

- **If a condition is found**

Replace the catalytic converter.

- **If no condition is found**

2. Verify the conditions listed below do not exist with the exhaust system:

- Leaks.
- Physical damage.
- Loose or missing hardware.

- **If a condition is found**

Repair or replace the component as necessary.

- **If no condition is found**

3. Verify the conditions listed below do not exist with the appropriate B52B Heated Oxygen Sensor 2:

- The HO2S is not at the correct torque.

- Damage.

- **If a condition is found**

Replace the B52B Heated Oxygen Sensor 2 or repair the condition as necessary.

- **If no condition is found**

4. Replace the catalytic converter.

Repair Instructions

NOTE: A new converter with less than 100 miles on it may set DTC P0420 or P0430 due to out-gassing of the internal matting. Operating the vehicle at highway speeds for approximately 1 hour may correct the condition.

- Exhaust Leakage
- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Perform the HO2S Heater Learn procedure with a scan tool after replacing the Heated Oxygen Sensor.
- Restricted Exhaust
- Three-Way Catalytic Converter Replacement (LFX - Bank 2) Three-Way Catalytic Converter Replacement (LFX - Bank 1)

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Turn Off the ignition for 60 s.
5. Operate the vehicle within the Conditions for Running the DTC.
6. Verify the scan tool Catalyst Monitor Not At Idle Test Conditions Met parameter changes to Yes.
 - **If Yes is not displayed**
Refer to step 5.
 - **If Yes is displayed**
7. When the conditions are safe, stop and idle the vehicle in gear if equipped with automatic transmission or neutral if equipped with manual transmission.
8. Verify the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters display Passed when performing the steps listed below:
 1. Apply the service brake.
 2. Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.

NOTE: When the test has completed, the Catalyst Monitor Test Counter Bank 1 and Bank 2 parameters will increment by one and the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters will indicate Passed, Failed or No Result.

3. Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.
4. Verify the scan tool Catalyst Monitor Test Result Bank 1 or Bank 2 parameter displays Passed.
- **If No Result is displayed**
Repeat steps 5 - 8 until the Test Result parameters indicate Passed or Failed.

- **If Failed is displayed**

Refer to Circuit /System Testing.

- **If Passed is displayed**

9. All OK.

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

Diagnostic Instructions

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

DTC Descriptor

DTC P0442

Evaporative Emission (EVAP) System Small Leak Detected

Circuit/System Description

The engine off natural vacuum test is the small leak detection diagnostic for the evaporative emission (EVAP) system. This diagnostic tests the EVAP system for a small leak when the key is turned OFF and the correct conditions are met. Heat from the exhaust system is transferred into the fuel tank while the vehicle is operating. When the vehicle is turned OFF and the EVAP system is sealed a change in the fuel tank vapor temperature occurs which results in a corresponding pressure change in the fuel tank vapor space. This change is monitored by the engine control module (ECM) using the fuel tank pressure sensor input. With a leak in the system, the amount of pressure change will be less than that of a sealed system.

Conditions for Running the DTC

- DTCs P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0125, P012B, P012C, P012D, P0128, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0502, P0503, P0722, P0723, P2227, P2228, P2229, P2610 are not set.
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant sensor (ECT) is greater than 70°C (158°F)
- No key cycle during engine off natural vacuum or test will abort.
- The fuel level is between 10 - 90%.
- The start-up engine coolant temperature (ECT) and the start-up intake air temperature (IAT) are within 8°C (14°F).
- The engine run time before shut-off was greater than 10 min.
- The drive distance before engine shut-off was more than 8 km (5 mi).
- The ambient air temperature at the end of the drive cycle is between 0 - 34°C (32 - 93°F).
- DTC P0442 runs once per drive cycle during the hot soak period after the ignition is turned OFF and may require up to 40 min to complete. The controller will not make more than 2 test attempts per day. The time since the last completed 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 remove the fuel fill cap, or temporarily leave the EVAP Vent Solenoid Valve open, until smoke is observed then close the system and continue testing. If using a fuel cap adapter at the filler neck, use the **EN 41413-VLV** at the service port to allow the system to fill faster.
- To help locate intermittent leaks using the **GE 41413-A** , move all EVAP components while observing smoke with the **GE 41413-SPT** .
- Individual components can be isolated and tested using adapters in the **GE 41413-300** .
- When servicing the EVAP system, test pressure must not exceed 13 in H2O (0.5 PSI) as pressure in excess of this could cause system components to perform inaccurately.
- A condition may exist where a leak in the EVAP system only exists under a vacuum condition. This type of leak may be detected by using the scan tool EVAP Purge/Seal function to create a vacuum in the EVAP system and then observe the Fuel Tank Pressure Sensor parameter for vacuum decay.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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Powertrain Component View

Powertrain Component Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48096** EVAP Service Port Access Tool
- **EN 41413-VLV** EVAP Service Port Vent Fitting
- **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 System Seal or Not Venting with a scan tool to seal the EVAP system.
4. Use the flow meter on the **GE 41413-A** calibrated to 0.51 mm (0.020 in) to determine if there is a leak.
 - **If a leak is detected**
 1. Use the **GE 41413-A** to apply smoke to the EVAP system at the purge tube service port until the leak is located using the **GE 41413-SPT**
 - If leak is detected, repair or replace the affected component as necessary.
 - **If no leak is detected**
5. All OK.

Repair Instructions

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

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0443

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit

DTC P0458

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

DTC P0459

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

Diagnostic Fault Information

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

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

Circuit/System Description

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

P0443

The ECM detects the EVAP purge solenoid valve control circuit is open within 0.25 s.

P0458

The ECM detects the EVAP purge solenoid valve control circuit is shorted to ground within 0.25 s.

P0459

The ECM detects the EVAP purge solenoid valve control circuit is shorted to voltage within 0.25 s.

Action Taken When the DTC Sets

DTC P0443, P0458 and P0459 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0443, P0458 and P0459 are Type B DTCs.

Diagnostic Aids

- 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.
- Verify the EVAP Purge Solenoid Valve control circuit parameters do not display Malfunction when moving the related harnesses and connectors of the Q12 Evaporative Emission Purge Solenoid Valve.
- Use a hand vacuum pump to verify the purge solenoid actually flows vacuum during the dynamic testing.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Evaporative Emission Control 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. Ignition ON, verify DTC P0690 is not set.

- **If the DTC is set**

Refer to [DTC P0685-P0687, P0689, P0690, or P1682](#)

- **If the DTC is not set**

2. Verify the control circuit status parameters listed below do not display Malfunction while commanding the EVAP Purge Solenoid Valve from 0% to 50% and back to 0% with a scan tool:

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

Refer to Circuit/System Testing

- **If Malfunction is not displayed**

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

4. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing

- **If the DTC does not set**

5. All OK.

[Circuit/System Testing](#)

1. Ignition OFF, disconnect the harness connector at the Q12 Evaporative Emission Purge Solenoid Valve, ignition ON.

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

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

1. Ignition OFF, remove the test lamp.

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse

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

1. Ignition OFF, remove the test lamp.

2. Test for infinite resistance between the ignition circuit and ground

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

- If infinite resistance, test all components connected to the ignition voltage circuit for a short and replace as necessary.
 - **If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the ignition circuit terminal A or 1 and the control circuit terminal B or 2.
 - **If the test lamp illuminates**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
 4. Remove the test lamp.
 5. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the EVAP Purge Solenoid Valve to 50% with a scan tool.
 - **If OK is not displayed**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If OK is displayed**
 6. Install a 3 A fused jumper wire between the control circuit terminal B or 2 and the ignition circuit terminal A or 1.
 7. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the EVAP Purge Solenoid Valve to 50% with a scan tool.
 - **If Malfunction is not displayed**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.
 - **If Malfunction is displayed**
 8. Test or replace the Q12 Evaporative Emission Purge Solenoid Valve.

Component Testing

Static Test

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

Dynamic Test

1. Ignition OFF, disconnect the harness connector at the Q12 Evaporative Emission Purge Solenoid Valve.

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

Replace the Q12 Evaporative Emission Purge Solenoid Valve.

- **If it turns on & off/clicks and flows vacuum.**
4. All OK

Repair Instructions

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

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

DTC P0446: EVAPORATIVE EMISSION (EVAP) VENT SYSTEM PERFORMANCE

Diagnostic Instructions

- 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
Greater than 1.5 V	Negative Pressure / Vacuum

Circuit/System Description

This DTC tests the evaporative emission (EVAP) system for a restricted or blocked EVAP vent path that would cause excess amounts of vacuum to be developed in the EVAP system. The engine control module (ECM) commands the EVAP purge solenoid valve Open and the EVAP vent solenoid valve Closed. This allows vacuum to be applied to the EVAP system. Once a calibrated vacuum level has been reached, the ECM commands the EVAP purge solenoid valve Closed and the EVAP vent solenoid valve Open. The ECM monitors the fuel tank pressure (FTP) sensor for a decrease in vacuum. If the vacuum does not decrease to near 0 in H₂O in a calibrated time, this DTC sets.

The 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

- DTC P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0121, P0122, P0123, P0128, P0191, P0192, P0193, P0222, P0223, P0443, P0601, P0604, P0606, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2176, is not set.
- The ignition voltage is between 11 - 32 V.

- The start up IAT is between 4 - 30Â°C (39 - 86Â°F).
- The start up ECT is less than 35Â°C (95Â°F)
- The barometric pressure (BARO) is greater than 70 kPa.
- The fuel level is between 10 - 90%.
- This test will start and run once per cold start for no greater than 17 min.

Conditions for Setting the DTC

NOTE: There are two stages to setting this DTC. Stage one, prep test, then stage two test.

- If the fuel tank pressure sensor reading is less than -3.0 kPa (-12 in) H₂O of vacuum for 5 s before 6 L (1.6 gal) of purge volume.

OR

- If the fuel tank pressure sensor reading is greater than 0.62 kPa (2.5 in) H₂O of pressure or less than -1.24 kPa (-5 in) H₂O of vacuum for 60 s.
- After setting the DTC for the first time, 2 L (0.5 gal) of fuel must be consumed before setting the DTC for the second time.

Action Taken When the DTC Sets

DTC P0446 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0446 is a Type B DTC.

Diagnostic Aids

An intermittent condition could be caused by:

- A damaged EVAP vent housing
- A temporary blockage at the EVAP vent solenoid valve inlet
- A pinched vent hose
- A blockage in the vent system may also cause a poor fuel fill problem.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 41415-30** Fuel Tank Cap Adapter
- **GE 41413-A** Evaporative Emissions System Tester
- **GE 41415 - 60** Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter

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

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0449 is not set.
 - **If the DTC is set**
Refer to Diagnostic Trouble Code (DTC) List - Vehicle .
 - **If the DTC is not set**
3. Ignition OFF, remove the fuel tank filler cap or install GE 41415 - 60 for capless vehicles. 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.
 - **If between the 1.3 - 1.7 V**
5. Install the fuel tank filler cap or remove the GE 41415 - 60. Engine idling at operating temperature for 5 min,
6. Verify the scan tool Fuel Tank Pressure Sensor parameter does not increase to greater than 2.5 V when commanding the EVAP Purge Solenoid Valve to 50%.
 - **If greater than 2.5 V**
Refer to Circuit System Testing.
 - **If 2.5 V or less**
7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/failure Records data.
 - **If the DTC sets**
Refer to Circuit System Testing.
 - **If the DTC does not set**
8. All OK.

Circuit/System Testing

NOTE: Perform the Circuit/System Verification before proceeding with the Circuit/System Testing.

1. Verify a blockage or restriction does not exist in the EVAP system components listed below.
 - Evaporative Emission Vent System Hoses
 - Evaporative Emission Canister

- Q13 Evaporative Emission Vent Solenoid Valve
- Evaporative Emission Vent Filter
- **If a condition exists**

Repair or replace the component as necessary

- **If none of the conditions exist**

2. Reconnect all previously disconnected EVAP hardware.

NOTE: Refer to the **GE 41413-A operation manual for detailed instructions in Evaporative Emission System Diagnosis.**

3. Remove the fuel fill cap and connect the CH 41415-30 to the fuel tank filler neck or install GE 41415 - 60 on capless fuel fill vehicles. Connect the GE 41413-A to the CH 41415-30 or GE 41415 - 60.
4. Ignition ON, command the EVAP Purge/Seal function to System Seal or Not Venting with a scan tool to seal the EVAP system.
5. Turn the nitrogen/smoke valve on the GE 41413-A to nitrogen.

NOTE: **DO NOT exceed the specified value in this step. Exceeding the specified value may produce incorrect test results.**

6. Use the remote switch to activate the GE 41413-A and pressurize the fuel tank to 5.0 in H2O.
7. Verify the scan tool Fuel Tank Pressure Sensor parameter is 0 in H2O when commanding the EVAP Vent Solenoid Valve to OFF or Venting.

- **If not 0 in H2O**

1. Ignition OFF

2. Verify a blockage or a restriction does not exist in the EVAP vent hose or inlet.

- **If a condition exists**

Repair or replace the component as necessary

- **If none of the conditions exist**

Replace the Q13 Evaporative Emission Vent Solenoid Valve

- **If 0 in H2O**

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

- **If the DTC sets**

Refer to step 1 above.

- **If the DTC does not set**

9. All OK.

Repair Instructions

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

- **Evaporative Emission Canister Vent Solenoid Valve Replacement**
- **Evaporative Emission Canister Replacement**
- **Fuel Tank Pressure Sensor Replacement (NT5, NT7) Fuel Tank Pressure Sensor Replacement (NU6)**

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

Diagnostic Instructions

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

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

Battery voltage is supplied to the evaporative emission (EVAP) vent solenoid valve through a fuse. The engine control module (ECM) grounds the EVAP vent solenoid valve control circuit through an internal switch called a driver. The ECM monitors the status of the driver. A scan tool will display the commanded state of the EVAP vent solenoid valve as ON (Not Venting) or OFF (Venting).

Conditions for Running the DTC

The DTCs run continuously.

Conditions for Setting the DTC

P0449

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

P0498

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

P0499

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

Diagnostic Aids

- An audible click may be heard when performing verification step 2 below.
- Verify the EVAP Vent Solenoid Valve control circuit parameters do not display Malfunction when moving the related harnesses and connectors of the Q13 Evaporative Emission Vent Solenoid Valve

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the control circuit status parameters listed below do not display Malfunction while commanding the EVAP Vent Solenoid Valve to ON (Not Venting) and OFF (Venting) with a scan tool:
 - EVAP Vent Solenoid Valve Control Circuit Open Test Status
 - EVAP Vent Solenoid Valve Control Circuit Low Voltage Test Status
 - EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

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

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q13 Evaporative Emission Vent Solenoid Valve, Ignition ON,

2. Verify that a test lamp illuminates between the B+ circuit terminal A or 2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test all components connected to the B+ circuit for a short and replace as necessary.
 - **If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the B+ circuit terminal A or 2 and the control circuit terminal B or 1.
 - **If the test lamp illuminates**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the EVAP Vent Solenoid Valve to ON (Not Venting) with a scan tool.
 - **If OK is not displayed**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, Ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If OK is displayed**
6. Install a 3 A fused jumper wire between the control circuit terminal 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.
 - **If Malfunction is displayed**
8. Test or replace the Q13 Evaporative Emission Vent Solenoid Valve.

Component Testing

1. Ignition OFF, disconnect the harness connector at the Q13 Evaporative Emission Vent Solenoid Valve.
2. Test for 10-30 Ω between the control terminal B or 1 and the B+ circuit terminal A or 2.

- If not between 10-30 Ω

Replace the Q13 Evaporative Emission Vent Solenoid Valve.

- If between 10-30 Ω

3. All OK.

Repair Instructions

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

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

DTC P0451-P0454: FUEL TANK PRESSURE SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P0451

Fuel Tank Pressure Sensor Performance

DTC P0452

Fuel Tank Pressure Sensor Circuit Low Voltage

DTC P0453

Fuel Tank Pressure Sensor Circuit High Voltage

DTC P0454

Fuel Tank Pressure Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P018C, P0192, P0452, P0522, P0532, P0641, P2227, P2228	P0451	P0446, P0452	P018D, P0193, P0453, P0523, P0641, P2227	-
Signal	P0452	P0451	P0452, P0453	P0453	P0451, P0454
Low Reference	-	P0446, P0451	P0446, P0453, P0463	-	P0451

Typical Scan Tool Data

Fuel Tank Pressure Sensor Voltage

Circuit	Short to Ground	Open	Short to Voltage

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	-	4.96 V	-

Circuit/System Description

The fuel tank pressure sensor measures vapor pressure or vacuum in the evaporative emission (EVAP) system. The engine control module (ECM) supplies a 5 V reference and a low reference circuit to the fuel tank pressure sensor. The fuel tank pressure sensor signal voltage varies depending on EVAP system pressure or vacuum. The controller also uses this fuel tank pressure signal to determine atmospheric pressure for use in the engine-off small leak test, DTC P0442. Before using this signal as an atmospheric reference it must first be re-zeroed.

Conditions for Running the DTC

P0451

- DTC P0451 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- The number of times this test runs can range from 0 - 2 per engine-off period. The length of the test can be up to 10 min.

P0452 and P0453

DTC P0452 and P0453 run continuously when the ignition is ON.

P0454

- DTC P0454 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- This test can run once per engine-off period. The length of the test can be up to 10 min.
- A refueling event is not detected. A refueling event is confirmed if the fuel level has a persistent change of 10% for 30 s during a 10 min refueling rationality test.

Conditions for Setting the DTC

P0451

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

P0452

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

P0453

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

P0454

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

Action Taken When the DTC Sets

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

Diagnostic Aids

P0451 and P0454

- A restriction in the EVAP canister or vent lines could prevent fuel vapor pressure from bleeding off fast enough. If the vent system cannot bleed off pressure fast enough, the re-zero procedure may not complete successfully, which could cause this code to set.
- Ensure that the reference port on the fuel tank pressure sensor is unobstructed.
- A fuel tank pressure sensor that is skewed or does not have a linear transition from low to high may cause this code to set. Scan tool output controls, snapshot, and plot functions can help detect erratic sensor response. To test the sensor signal under vacuum conditions, use the Quick Snapshot and the Purge/Seal functions to capture data while commanding purge to 20%, then plot or review 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 or reviewing stored data.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **GE 41413-A** Evaporative Emission System Tester (EEST)
- **GE 41415 - 60** Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter

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

Circuit/System Verification

1. Remove the fuel cap or install GE 41415 - 60 for capless fuel fill vehicles.

2. Ignition ON, engine OFF.

3. Verify the scan tool Fuel Tank Pressure Sensor parameter is between 1.3 and 1.7 V.

- **If not between 1.3 - 1.7 V**

Refer to Circuit/System Testing

- **If between 1.3 - 1.7 V**

4. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF. Disconnect the harness connector at the B150 Fuel Tank Pressure Sensor. This may take up to 2 min, for all vehicle systems to power down..

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

- **If 5 Ω or greater**

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

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

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

- **If less than 5 Ω**

3. Ignition ON.

4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 3 and ground.

- **If less than 4.8 V**

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

2. Test for infinite resistance between the 5 V reference circuit and ground.

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

3. Test for less than 2 Ω in the 5 V reference circuit end to end.

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

- **If greater than 5.2 V**

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

2. Test for less than 1 V between the 5 V reference circuit and ground.

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

- **If between 4.8 - 5.2 V**

5. Verify the scan tool Fuel Tank Pressure Sensor parameter is less than 0.2 V.

- **If 0.2 V or greater**

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

2. Test for less than 1 V between the signal circuit terminal 1 and ground.

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

- **If less than 0.2 V**

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

7. Verify the scan tool Fuel Tank Pressure Sensor parameter is greater than 4.7 V.

- **If 4.7 V or less**

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

2. Test for infinite resistance between the signal circuit terminal 1 and ground.

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

- If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 4.7 V**
 8. Test or replace the B150 Fuel Tank Pressure Sensor.

Repair Instructions

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

- **Control Module References** for ECM replacement, programming and setup
- **Fuel Tank Pressure Sensor Replacement (NT5, NT7) Fuel Tank Pressure Sensor Replacement (NU6)**

DTC P0455 OR P0497: EVAPORATIVE EMISSION (EVAP) 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 P0455

Evaporative Emission (EVAP) System Large Leak Detected

DTC P0497

Evaporative Emission (EVAP) System No Flow During Purge

Circuit/System Description

The engine control module (ECM) tests the Evaporative Emission (EVAP) System for a large leak or restrictions to the purge path in the EVAP system. When the enabling criteria has been met the ECM commands the EVAP vent solenoid valve and purge solenoid valve ON, allowing vacuum into the EVAP system. The ECM monitors the fuel tank pressure (FTP) sensor voltage to verify that the system is able to reach a predetermined level of vacuum before a calibrated amount of purge volume has passed through the system.

Fuel Tank Pressure Sensor Signal Voltage	Fuel Tank Pressure
High, Approximately 1.5 V or Greater	Negative Pressure/Vacuum
Low, Approximately 1.5 V or Less	Positive Pressure

The table below illustrates the relationship between the ON and OFF states, and the OPEN or CLOSED states of the EVAP purge and vent solenoid valves.

Control Module Command	EVAP Canister Purge Valve	EVAP Canister Vent Valve
ON	Open	Closed, Not Venting
OFF	Closed	Open, Venting

Conditions for Running the DTC

- DTC P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P0420, P0430, P0442, P110A, P110B, P110C, P110D, P114A, P114B, P114C, P114D, P2096, P2097, P2098, P2099, P2177, P2178, P2179, P2180, P2187, P2188, P2189, P2190, P219A, P219B, P2270, P2271, P2272 or P2273 is not set.
- The ignition voltage is between 10.9-18.0 V.

- The engine run time is greater than 10 min or the fuel trim is stable.
- The fuel tank pressure is between - 2.69-1.3 kPa, -20.25-9.8 mm Hg (-10.8-5.2 in H₂O).
- The closed loop fuel control is enabled.
- The engine is idling and closed throttle.
- The barometric pressure (BARO) is greater than 68 kPa.
- The fuel level is between 10 - 90%.
- The ambient air (IAT) temperature is between 3.8-35.3°C (38.8-95.5°F).
- The difference between engine coolant temperature (ECT) at start and ambient air temperature is less than 14.3°C (57.7°F).
- The vehicle speed sensor (VSS) is less than 3 km/h (2 mph).
- The above conditions are met for greater than 20 s

Conditions for Setting the DTC

- The ECM detects the EVAP system is not able to achieve or maintain vacuum during the diagnostic test. This condition can be the result of a large leak or a restriction in the EVAP system.
- The condition exists for greater than 8 s or for a cumulative of 20 s.

Action Taken When the DTC Sets

DTCs P0455 and P0497 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0455 and P0497 are Type B DTCs.

Diagnostic Aids

- Inspect for a loose, missing, damaged, or incorrect fuel fill cap.
- Inspect for a damaged fuel filler neck seal surface.
- A blockage or restriction in the EVAP purge solenoid valve, purge pipe, EVAP canister, or vapor pipe, can cause this DTC to set.
- The EVAP system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. For example, when injecting smoke at the service port remove the fuel fill cap, or temporarily leave the vent open, until smoke is observed, then close the system and continue testing. If using a fuel cap adapter at the filler neck, use the **J-41413-VLV** at the service port to allow the system to fill faster.
- To help locate intermittent leaks using the **GE-41413-A**, move all EVAP components while observing smoke with the **GE-41413-SPT**.
- Individual components can be isolated and tested using adapters in the **J-41413-300**.
- When servicing the EVAP system, test pressure must not exceed 13 in H₂O (0.5 PSI) as pressure in excess of this could cause system components to perform inaccurately.
- A condition may exist where a leak in the EVAP system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the EVAP system and then observe the Fuel Tank Pressure Sensor parameter for vacuum decay.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Evaporative Emission Control System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Special Tools

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

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

Circuit/System Testing

NOTE:

- Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize or produce smoke from a leak.
- Refer to the **GE-41413-A** operation manual for detailed instructions in [Evaporative Emission System Diagnosis](#).

1. Disconnect the purge tube at the quick connector on the EVAP canister side of the Q12 Evaporative Emission Purge Solenoid Valve. Install the **CH-48096** .
2. Connect the **GE-41413-A** to the vehicle EVAP service access port tool.
3. Command the EVAP Purge/Seal function to Not Venting with a scan tool to seal the EVAP system.
4. Verify that there is no leak in the EVAP system using the flow meter on the **GE-41413-A** , calibrated to 0.51 mm (0.020 in).
 - **If a leak is detected**
 1. Apply smoke to the EVAP system at the service access port tool with the **GE-41413-A** .
 2. Locate the leak using the **GE-41413-SPT** .
 - When the leak is located, repair or replace the affected component as necessary.
 - **If no leak detected**

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

•

5. Connect the **GE-41413-A** nitrogen/smoke hose to the **J-41413-311**.
6. Disconnect the hose at the fuel cap end of the **GE-41415-30** and connect to the **J-41413-311**.
7. Install the **GE-41415-30**, filler neck end only, to the vehicle.
8. Engine idling, command the Purge/Seal function to Not Venting with a scan tool to seal the system.
9. Command the EVAP Purge Solenoid Valve to 30% with a scan tool.
10. Verify the vacuum/pressure gauge on the **GE-41413-A** and the scan tool Fuel Tank Pressure Sensor parameter both show vacuum.
 - **If the vacuum/pressure gauge shows vacuum but the Fuel Tank Pressure Sensor parameter does not show vacuum**
Replace the B150 Fuel Tank Pressure Sensor.
 - **If both do not show vacuum**
Repair the restriction in the purge path.
 - **If both show vacuum**
11. Verify that the Fuel Tank Pressure Sensor parameter increases to greater than 3.2 V, and the pressure values are similar between the scan tool Fuel Tank Pressure Sensor and the vacuum/pressure gauge on the **GE-41413-A**.
 - **If not within the specified range**
Replace the B150 Fuel Tank Pressure Sensor.
 - **If within the specified range**
12. All OK.

Repair Instructions

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

Fuel Tank Pressure Sensor Replacement (NT5, NT7) Fuel Tank Pressure Sensor Replacement (NU6)

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

Diagnostic Instructions

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

DTC Descriptor

DTC P0496

Evaporative Emission (EVAP) System Flow During Non-Purge

Circuit/System Description

This DTC tests for undesired intake manifold vacuum flow to the evaporative emission (EVAP) system. The engine control module (ECM) seals the EVAP system by commanding the EVAP purge solenoid valve OFF and the vent solenoid valve ON. The ECM monitors the fuel tank pressure (FTP) sensor to determine if a vacuum is being drawn on the EVAP system. If vacuum in the EVAP system is greater 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

ECM Command	EVAP Purge Solenoid Valve	EVAP Vent Solenoid Valve
ON	Open	Closed
OFF	Closed	Open

Conditions for Running the DTC

- DTCs P0068, P00C8, P00C9, P00CA, P0090, P0091, P0092, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0122, P0123, P0125, P0128, P0191, P0192, P0193, P0222, P0223, P0601, P0604, P0606, P0697, P06A3, P06DB, P06DE, P0A1D, P1104, P127A, P127C, P127D, P15F2, P160D, P160E, P1682, P16A0, P16A1, P16A2, P16F3, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0722, P0723, P2100, P2101, P2102, P2103, P2122, P2123, P2127, P2128, P2135, P2138, P215B, P2176, P228C, P228D, U0073, U0074, U0293, U1817, are not set.
- The ignition voltage is between 11 - 32 V.
- The engine OFF time is greater than 48 min,
- The barometric pressure (BARO) is greater than 70 kPa.
- The fuel level is between 10 - 90%.
- The startup engine coolant temperature (ECT) is less than 35Â°C (95Â°F).
- The startup intake air temperature (IAT) is between 4 - 34Â°C (39 - 93Â°F).
- DTC P0496 runs once per cold start, for up to 17 min, when the above conditions are met. This test will run with the purge valve and the vent valve closed.

Conditions for Setting the DTC

The ECM detects greater than 10 in H2O vacuum for 5 s during a non-purge condition.

Action Taken When the DTC Sets

DTC P0496 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0496 is a Type B DTC.

Diagnostic Aids

An intermittent condition could be caused by:

- An improperly installed or damaged EVAP Purge Solenoid Valve
- A temporary blockage or restriction in the EVAP Purge Solenoid Valve

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- Circuit Testing

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

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Verification](#)

1. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
2. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing
 - **If the DTC does not set**
3. All OK

[Circuit/System Testing](#)

1. Ignition ON, engine OFF.
2. Command the EVAP Purge/Seal function to System Seal or Not Venting with a scan tool to seal the EVAP system.
3. Start the engine.
4. Observe the Fuel Tank Pressure Sensor with a scan tool. The Fuel Tank Pressure Sensor parameter should be less than 1.7 V after 90 s.
 - **If not within specifications**
Replace the Q12 Evaporative Emission Purge Solenoid Valve
 - **Within Specifications**
5. All OK

[Repair Instructions](#)

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

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

DTC P0506 OR P0507: IDLE SPEED

[Diagnostic Instructions](#)

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

[DTC Descriptors](#)

DTC P0506

Idle Speed Low

DTC P0507

Idle Speed High

Circuit/System Description

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

Conditions for Running the DTC

- DTCs P0068, P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0171, P0172, P0174, P0175, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300 - P0306, P0351 - P0356, P0461 - P0464, P0496, P0627, P0628, P0629, P0722, P1516, P2066 - P2068, are not set.
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant temperature (ECT) is greater than 60°C (140°F).
- The engine run time is greater than 60 s.
- The ignition voltage is between 11 - 32 V.
- The transmission is not changing gears.
- The torque converter clutch (TCC) is not changing states.
- The intake air temperature (IAT) is warmer than -20°C (-4°F).
- The vehicle speed is less than 3 km/h (2 mph).
- The commanded engine speed is steady within 25 RPM.
- The engine is idling for greater than 5 s.
- The DTCs run when the above conditions are met.

Conditions for Setting the DTC

P0506

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

P0507

The actual engine speed is 188 RPM greater than the desired idle speed for 10 s.

Action Taken When the DTC Sets

DTCs P0506 and P0507 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0506 and P0507 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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

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

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Verification](#)

1. Ignition ON.
2. Verify there are no other DTCs set.
 - **If any other DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If no other DTCs are set**
3. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
 - **If 90 % or greater**
Refer to [Throttle Body Inspection and Cleaning](#).
 - **If less than 90 %**
4. Engine Idling at the normal operating temperature.
5. Verify the actual Engine Speed is not 100 RPM less than the Desired Idle Speed.
 - **If 100 RPM less than the Desired Idle Speed**
Refer to Circuit/System Testing.
 - **If 100 RPM greater than the Desired Idle Speed**
6. Verify the actual Engine Speed is not 200 RPM greater than the Desired Idle Speed.
 - **If 200 RPM greater than the Desired Idle Speed**
Refer to Circuit/System Testing.
 - **If 200 RPM less than the Desired Idle Speed**
7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
8. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
9. All OK

[Circuit/System Testing](#)

P0506

1. Verify the conditions listed below do not exist.
 - Restricted exhaust
 - Mechanical conditions that limits engine speed
 - Parasitic load on the engine - For example, a transmission condition, a belt driven accessory condition.
 - **If a condition is found**

Repair as necessary.

- **If a condition is not found**

2. All OK.

P0507

1. Verify the conditions listed below do not exist.

- Vacuum leaks
- A throttle valve that does not close correctly
- Verify the correct operation of the crankcase ventilation system. Inspect for the conditions listed below:
 - Improper routing of the positive crankcase ventilation (PCV) system
 - Vacuum leaks in the PCV system - Refer to [Crankcase Ventilation System Inspection/Diagnosis](#) .
- **If a condition is found**

Repair as necessary.

- **If a condition is not found**

2. All OK.

Repair Instructions

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

[Throttle Body Assembly Replacement](#)

DTC P050B: COLD START IGNITION TIMING 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](#) provide an overview of each diagnostic category.

DTC Descriptor

DTC P050B

Cold Start Ignition Timing Performance

Circuit/System Description

The throttle actuator control (TAC) motor is controlled by the engine control module (ECM). The DC motor located in the throttle body drives the throttle blade. In order to decrease idle speed, along with spark and fuel delivery changes the ECM commands the throttle closed reducing air flow into the engine and the idle speed decreases. In order to increase idle speed, the ECM commands the throttle plate open allowing more air to pass the throttle plate. The catalyst must be warmed to efficiently reduce the emissions. The cold start strategy is to reduce the amount of time it takes to warm the catalyst. During a cold start, the engine idle speed is elevated to allow the catalyst to warm quickly.

Conditions for Running the DTC

- The battery voltage is greater than 10 V.
- The engine speed is at idle.
- The engine coolant temperature (ECT) is greater than -9.75°C (14.45°F).
- DTC P050B runs continuously when the above conditions are met.

Conditions for Setting the DTC

The actual ignition timing retard value is insufficient for 5 s or more during 10 s of P050B monitoring duration at cold start.

Action Taken When the DTC Sets

DTC P050B is a Type B DTC.

Conditions for Clearing the DTC

DTC P050B is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, compare the Desired Idle Speed to the actual engine idle speed parameter. The actual engine idle speed should not deviate more than 175 RPM from the Desired Idle Speed.
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.

Circuit/System Testing

1. Verify that no other DTCs are present.
 - If any DTC is present, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** to diagnose that DTC prior to this diagnostic.
2. Inspect for any condition that can reduce idle speed by increasing engine load.
 - Incorrect torque converter clutch (TCC) operation
 - Accessories that require additional torque to operate
 - Excessive deposits in the throttle body
 - Restricted exhaust
 - Mechanical conditions that limit engine speed
3. Inspect for the following conditions:
 - Vacuum leaks
 - A faulty positive crankcase ventilation system
4. Inspect the ignition coil spark plug boots for the following conditions:
 - Damage
 - Carbon tracking

- Oil contamination
- Water intrusion
- If you find any of the above conditions, repair as necessary.

Repair Instructions

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

[Control Module References](#) for ECM replacement, setup, and programming

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 Fuel Injectors are energized twice during each injection event. As with misfire diagnosis, in dual-pulse mode the ECM monitors the crankshaft position sensor and the camshaft position 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, P0016, P0017, P0018, P0019, P0020, P0021, P0023, P0024, P0089, P0090 - P0092, P00C6, P00C8, P00C9, P00CA, P0101 - P0103, P0106 - P0108, P0112 - P0114, P0116 - P0118, P0121 - P0123, P0128, P0192, P0193, P0201 - P0206, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0315, P0335, P0336, P0351 - P0356, P0627 - P0629, P069E, P0716, P0717, P0722, P0723, P0850 - P0852, P1248, P1249, P124A, P124B, P124C, P124D, P1258, P135A, P135B, P150C, P163A, P1762, P1763, P1915, P2122, P2123, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P228C, P228D, U0109 are not set.
- The catalyst temperature is less than 100Â°C (212Â°F).
- The engine coolant temperature is warmer than 10Â°C (14Â°F).
- The barometric pressure is greater than 70 kPa.
- The engine speed is between 450 - 1800 RPM.
- The engine is running 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 Engine Control Module detects variations in crankshaft rotation speed caused by the lack of adequate fuel delivery during dual-pulse mode.

Action Taken When the DTC Sets

- DTC P050D is a Type B DTC.
- The Engine Control Module disables dual pulse mode and energizes the fuel injector as it would for a warm engine.

Conditions for Clearing the DTC

DTC P050D is a Type B DTC.

Diagnostic Aids

- This DTC may be set with a misfire DTC, however the existence of this DTC is a higher priority and indicates the condition to diagnose is related to fuel and/or injectors, not the ignition/spark system.
- A restricted Fuel Injector may cause this DTC to set.
- High resistance in the circuits of the Fuel Injectors could set this DTC without setting a Fuel Injector DTC. Test the Fuel Injector circuits of the affected cylinders for a high resistance if you suspect a condition.
- A drop in system voltage during cold start may set this DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

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 Testing

NOTE: **Circuit/System Testing requires cold start. Do not start vehicle prior to connecting scan tool and preparing to evaluate the condition during engine crank.**

1. Start the engine and observe the Cylinder 1 - 6 Current Misfire Counters during the first 500 engine cycles. The Cylinder 1 - 6 Current Misfire Counters should not be incrementing.
 - **If the misfire counters are incrementing on one or more cylinders**
 1. Ignition OFF.
 2. Verify that the following conditions do not exist:
 - Fuel pressure that is too low or too high - Refer to [Fuel System Diagnosis \(LFX\)](#).
 - Contaminated fuel - Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
 - If a condition exist, repair as necessary.
 - If none of the conditions exist, replace the Q17 Fuel Injectors as indicated by high misfire counts.
 - **If the misfire counters are not incrementing**
2. All OK.

Repair Instructions

- [Fuel Injection Fuel Rail Assembly Replacement - Bank 1 \(LFX\)](#)

- [Fuel Injection Fuel Rail Assembly Replacement - Bank 2 \(LFX\)](#)

Repair Verification

NOTE: Repair Verification requires cold start.

1. Ignition ON, engine OFF, clear the DTCs with a scan tool.
2. Start the engine.
3. Verify the DTC does not reset.

DTC P05CC-P05CF: COLD START INTAKE CAMSHAFT POSITION SYSTEM PERFORMANCE BANK

Diagnostic 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 Bank 1

DTC P05CD

Cold Start Intake Camshaft Position System Performance Bank 2

DTC P05CE

Cold Start Exhaust Camshaft Position System Performance Bank 1

DTC P05CF

Cold Start Exhaust Camshaft Position System Performance Bank 2

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 signal from the ECM is Pulse Width Modulated (PWM). The ECM controls the camshaft position actuator solenoid duty cycle by controlling the amount of solenoid On time. The camshaft position actuator solenoid controls the advance or the retard of each camshaft. The camshaft position actuator solenoid controls 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.
- The ignition voltage is greater than 11 V.
- The engine is running.
- The desired camshaft position is greater than 0 degrees.
- The desired camshaft position is not changing greater than 4.5° for at least 1 s.
- Both of the desired and actual camshaft position actuator values cannot be greater than 20 degrees or less than 5 degrees.
- DTCs P05CC, P05CD, P05CE, and P05CF run continuously once 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, P05CD, P05CE, and P05CF are type B DTCs.

Conditions for Clearing the DTC

DTCs P05CC, P05CD, P05CE, and P05CF are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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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

Diagnostic Aids

- Verify the correct engine oil type and viscosity were used during recent oil changes.
- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this DTC. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life parameter. Advise the customer an oil change may be required.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain can cause this DTC to set.

Circuit/System Verification

NOTE:

- **Correct engine oil type and viscosity are critical to the performance of the camshaft position actuator system.**
- **The engine oil level and the oil pressure are critical to the correct operation of the camshaft position actuator system. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic.**
- **The engine oil condition has a major impact on the camshaft actuator system. Debris in the oil can interfere with the camshaft position actuator solenoid and the mechanical**

camshaft actuator operation. Inspect for dirty or degraded crankcase oil. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life Remaining parameter. Advise the customer an oil change may be required.

1. Ignition On.
2. Verify the engine has the correct oil level and the correct oil pressure.

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

Repair as necessary

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

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

3. Verify DTC P0010, 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.

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

4. Engine idling at normal operating temperature.
5. Verify the scan tool parameters are less than 2° in each of the commanded states when commanding the Camshaft Position Actuator from 0° to maximum range and back to 0° with the scan tool.

- Intake Camshaft Position Variance Bank 1
- Exhaust Camshaft Position Variance Bank 1
- Intake Camshaft Position Variance Bank 2
- Exhaust Camshaft Position Variance Bank 2
- **If 2° or greater**

Refer to Circuit/System Testing.

- **If less than 2°**

6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

- **If any DTC sets**

Refer to Circuit/System Testing.

- **If a DTCs does not set**

7. All OK.

Circuit/System Testing

NOTE: If debris is found on CMP screens, clean the screens and reinspect for damage. If the screens are not damaged, reinstall in the engine.

1. Remove the Q6 Camshaft Position Actuator Solenoid Valve and verify the following conditions do not exist:

- Torn, mis-positioned, or missing screens at the CMP actuator solenoid
- Engine oil leak between the oil sealing lands of the CMP actuator solenoid - Inspect the lands of the CMP actuator solenoid for nicks.
- Oil seepage at the CMP actuator solenoid connector

- **If a condition is found**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If no condition is found**

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

2. Ignition Off, swap the intake or exhaust Q6 Camshaft Position Actuator Solenoid Valve with the Q6 Camshaft Position Actuator Solenoid Valve that is operating correctly.
3. Engine idling.
4. Verify the scan tool Camshaft Position Variance parameter is less than 2° in each of the commanded states when commanding the Camshaft Position Actuator from 0° to maximum range and back to 0° with a scan tool.

- **If 2° or greater**

Replace the mechanical camshaft position actuator.

- **If less than 2°**

5. 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 5 - 12 Ω between the control circuit terminal 1/A and the low reference circuit terminal 2/B of the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If not between the specified values**
Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If between the specified values**
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
 - **If less than infinite resistance**
Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If infinite resistance**
4. All OK.

Repair Instructions

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

- **Camshaft Position Actuator Replacement - Bank 1**
- **Camshaft Position Actuator Replacement - Bank 2**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P057B-P057D: BRAKE PEDAL POSITION SENSOR

Diagnostic Instructions

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

DTC P057D

Brake Pedal Position Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P057C	P057C	P057D	P057B
5 V Reference	P057C P0651	P057C	P057D, P0651	-
Low Reference	-	P057D	P057D	-

Typical Scan Tool Data

Brake Pedal Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. Normal Range: 0.25 - 4.75 V			
5 V Reference	0 V	0 V	-
Signal	0 V	0 V	5 V
Low Reference	-	5 V	-

Circuit/System Description

The brake pedal position (BPP) sensor is part of the engine brake pedal override feature. The engine control module (ECM) continuously monitors the vehicle speed and the position of the brake pedal. These two main inputs, along with other ECM inputs are used to determine if the vehicle is decelerating at the proper speed and rate with the brake pedal applied. When the engine brake pedal override system is active, the ECM reduces engine torque to assist in reducing vehicle speed.

The BPP sensor is a six wire sensor, and is part of a dual brake position sensor. One BPP Sensor is used for the stop lamps and the other BPP Sensor is used for the engine brake pedal override feature. The BPP Sensor for engine brake pedal override communicates with the ECM. The ECM supplies a 5 V reference circuit, low reference circuit, and signal circuit to the BPP sensor. The BPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage greater than 0.25 V when the brake pedal is released to a voltage less than 4.75 V when the brake pedal is fully applied.

For information on the Stop Lamps side of the BPP Sensor, refer to [Exterior Lighting Systems Description and Operation](#).

Conditions for Running the DTC

P057B

- 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 or P057D

- Ignition voltage is greater than 10 V.
- DTC runs continuously when above condition is met.

Conditions for Setting the DTC

P057B

ECM detects the 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.

Action Taken When the DTC Sets

- P057B, P057C, and P057D are Type A DTCs.
- Brake Pedal Position Sensor parameter defaults to 0 %.

Conditions for Clearing the DTC

P057B, P057C, and P057D are Type A DTCs

Reference Information

Schematic Reference

- [Engine Controls Schematics \(LFX\)](#)
- [Exterior Lights Schematics](#)

Connector End View Reference

- [COMPONENT CONNECTOR END VIEWS - INDEX](#)
- [INLINE HARNESS CONNECTOR END VIEWS - INDEX](#)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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

Circuit/System Verification

NOTE: The Brake Pedal Position sensor scan tool data is located in the ECM automatic transmission data list.

1. Ignition ON.
2. Verify DTC P0641, P0651, P0697, or P06A3 is not set.
 - **If any of the DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If none of the DTCs are set**
3. Transmission in Park, and service brake pedal released.
4. Verify the scan tool Brake Pedal Position Sensor parameter in the ECM displays greater than 0.25 V.
 - **If 0.25 V or less**
Refer to Circuit/System Testing.
 - **If greater than 0.25 V**
5. Verify the scan tool Brake Pedal Position Sensor parameter voltage changes as the brake pedal is applied and displays less than 4.75 V when the brake pedal is fully applied.
 - **If the voltage does not change, or is greater than 4.74 V**
Refer to Circuit/System Testing.
 - **If the voltage changes and less than 4.75 V**
6. Verify the scan tool Brake Pedal Position Sensor Learned Release Position parameter is within 0.1 V of the Brake Pedal Position Sensor parameter when the brake pedal is fully released.
 - **If difference is greater than 0.1 V**
Perform the [Brake Pedal Position Sensor Learn](#) .
 - **If difference is 0.1 V or less**
7. Verify the Brake Pedal Position Sensor parameter transitions smoothly without any spikes or dropouts when slowly applying and releasing the brake pedal.
 - **If parameter does not transition smoothly or has spikes or dropouts**
Refer to Circuit/System Testing.
 - **If parameter transitions smoothly and there are no spikes or dropouts**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
10. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B22 Brake Pedal Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

NOTE: All terminal references are for the vehicle harness brake pedal position sensor connector.

2. Test for less than 10 Ω between the low reference circuit terminal 5 and ground.
 - **If 10 Ω or greater**
 1. Disconnect the X1 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 10 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 6 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8 - 5.2 V**
5. Verify the scan tool Brake Pedal Position Sensor parameter is less than 0.25 V.
 - **If 0.25 V or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 0.25 V between the signal circuit terminal 4 and ground.
 - If 0.25 V or greater, repair the short to voltage on the circuit.
 - If less than 0.25 V, replace the K20 Engine Control Module.
 - **If less than 0.25 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 6.
7. Verify the scan tool Brake Pedal Position Sensor parameter is greater than 4.8 V.
 - **If 4.8 V or less**
 1. Ignition OFF, remove the jumper wire, and disconnect the X1 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 4.8 V**

8. Replace the B22 Brake Pedal Position Sensor.

Repair Instructions

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

- [Brake Pedal Position Sensor Replacement](#)
- Perform the [Brake Pedal Position Sensor Learn](#) following the replacement of the ECM or BPP sensor, or any repair that effects the BPP sensor alignment.
- [Control Module References](#) for Engine Control Module replacement, programming and setup.

DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, OR P262B: CONTROL MODULE (ECM)

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [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 P16F3

Control Module Redundant Memory Performance

DTC P262B

Control Module Power Off Timer Performance

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). This diagnostic also addresses if the ECM is not programmed.

Conditions for Running the DTCs

P0601, P0602, P0630

These DTCs run continuously when the ignition is ON.

P0603, P062F

These DTCs run during ECM power up.

P0604

DTC P0604 runs continuously when the ignition is ON for greater than 30 s.

P0606, P062B

- The ignition is ON.
- The system voltage is greater than 11 V.
- These DTCs run continuously when the above conditions are met.

P16F3

- The engine speed is greater than 550 RPM.
- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P2227, P2228, P2229, or P2230 are not set.
- DTC P16F3 runs continuously when the above conditions are met.

P262B

DTC P262B runs during ECM power down.

Conditions for Setting the DTCs

The ECM detects an internal failure or incomplete programming for more than 10 s.

Actions Taken When the DTC Sets

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P0630, and P16F3 are Type A DTCs.
- DTCs P062F and P262B are Type B DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P0630, and P16F3 are Type A DTCs.
- DTCs P062F and P262B are Type B DTCs.

Diagnostic Aids

Low voltage or a momentary loss of power or ground to the ECM may cause a DTC to set. Verify the following:

- The battery cables are clean and tight, and the battery is fully charged. Refer to [Battery Inspection/Test](#).
- The ECM ground circuits do not have an open or high resistance.
- The ECM power circuits do not have an open, short to ground, or high resistance.

Reference Information

Schematic Reference

[Engine Controls Schematics \(LFX\)](#)

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, clear the DTC information with a scan tool.
2. Verify no other DTCs are set.
 - **If any other DTCs are set**
Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
 - **If no other DTCs are set**
3. Verify DTC P0602 or P0630 is not set.
 - **If any of the DTCs are set**
 1. Program the K20 Engine Control Module. Refer to **Control Module References** .
 2. Verify DTC P0602 or P0630 is not set.
 - If any of the DTCs are set, replace the K20 Engine Control Module.
 - If none of the DTCs are set
 - 3. All OK.
 - **If none of the DTCs are set**
4. Verify DTC P0601, P0603, P0604, P0606, P062B, P062F, P16F3, or P262B is not set.
 - **If any of the DTCs are set**
Replace the K20 Engine Control Module.
 - **If none of the DTCs are set**
5. All OK.

Repair Instructions

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

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

DTC P0628: FUEL PUMP ENABLE CIRCUIT LOW VOLTAGE

Diagnostic Instructions

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

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

DTC Descriptor

DTC P0628

Fuel Pump Enable Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Pump Enable	P0628, P069E	P069E	-	-

Circuit/System Description

The engine control module (ECM) provides ignition voltage to the chassis control module whenever the engine is cranking or running. The engine control module enables the chassis control module as long as the engine is cranking or running, and ignition system reference pulses are received. While this enable voltage is being received, the chassis control module supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC

- The engine speed is greater than 0 RPM.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously when the conditions above are met.

Conditions for Setting the DTC

- The engine control module detects that the commanded state of the driver and the actual state of the control circuit do not match.
- The above condition is met for a minimum of 2.5 s.

Action Taken When the DTC Sets

DTC P0628 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0628 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

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 for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the parameters listed below display OK or Not Run 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 OK or Not Run are not displayed**

Refer to Circuit/System Testing.
 - **If OK or Not Run are displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**

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

Circuit/System Testing

1. Ignition OFF, all vehicle system OFF, disconnect the harness connector at the K38 Chassis Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 1 V between the K38 Chassis Control Module enable circuit terminal 13 and ground.
 - **If 1 V or greater**
 1. Disconnect the X1 harness connector at the K20 Engine Control Module.
 2. Test for less than 1 V between the K38 Chassis Control Module enable circuit terminal 13 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the K20 Engine Control Module.
 - **If less than 1 V**
3. Ignition ON, command the Fuel Pump Enable ON with a scan tool.
4. Test for B+ on the enable circuit terminal 13 of the K38 Chassis Control Module.
 - **If less than B+**
 1. Disconnect the X1 harness connector at the K20 Engine Control Module.
 2. Test for infinite between the K38 Chassis Control Module enable circuit terminal 13 and ground.
 - If less than infinite, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω on the K38 Chassis Control Module enable circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , test or replace the K20 Engine Control Module.
 - **If B+**
5. Test or replace the K38 Chassis Control Module.

Repair Instructions

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

[Control Module References](#) for K20 Engine Control Module or K38 Chassis Control Module replacement, programming, and setup.

DTC P0641 OR P06A6: 5V REFERENCE (CHASSIS CONTROL MODULE)

Diagnostic Instructions

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

DTC Descriptors

DTC P0641

5V Reference Circuit

DTC P06A6

5V Reference 1 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0641, P06A6	P018C	P018D, P0641, P06A6	P06A6
Signal	P018C	P018B, P018C	P018D	P018B
Low Reference	-	P0641, P06A6	-	P06A6

Circuit/System Description

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

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The chassis control module detects that the fuel pressure 5 V reference is above or below a predetermined voltage threshold.

Action Taken When the DTC Sets

DTCs P0641 and P06A6 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0641 and P06A6 are Type A DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description (LFX)

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 and all vehicle systems OFF, disconnect the harness connector at the B47 Fuel Pressure Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If less than 10 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K38 Chassis Control Module.
 - **If between 4.8 - 5.2 V**
5. Verify the scan tool Fuel Pressure Sensor Voltage parameter is less than 1 V.
 - **If 1 V or greater**

1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K38 Chassis Control Module.
- **If less than 1 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3, wait 15 seconds.
7. Verify the scan tool Fuel Pressure Sensor Voltage parameter is greater than 4.8 V.
 - **If 4.8 V or less**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If greater than 4.8 V**
8. Test or replace the B47 Fuel Pressure Sensor.

Repair Instructions

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

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

DTC P0641, P0651, P0697, OR P06A3: 5V REFERENCE (ECM)

Diagnostic Instructions

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

DTC Descriptors

DTC P0641

5V Reference 1 Circuit

DTC P0651

5V Reference 2 Circuit

DTC P0697

5V Reference 3 Circuit

DTC P06A3

5V Reference 4 Circuit

Circuit/System Description

The engine control module (ECM) has 4 internal 5V reference circuits. Each internal reference circuit provides external 5V reference circuits for more than one sensor. A short to ground or short to voltage on one external 5V reference circuit can affect all the other components connected to the same internal 5V reference circuit.

Conditions for Running the DTC

- Ignition voltage is greater than 6.4 V.
- DTCs P0641, P0651, P0697, and P06A3 run continuously when the above condition is met.

Conditions for Setting the DTC

The ECM detects a short to ground or voltage on any of the 5V reference circuits for greater than 0.5 s.

Action Taken When the DTC Sets

DTCs P0641, P0651, P0697, and P06A3 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0641, P0651, P0697, and P06A3 are Type A DTCs.

Diagnostic Aids

DTC P0641

The 5V reference 1 circuit provides 5 V to the sensors listed below:

- A/C refrigerant pressure sensor
- All four camshaft position sensors
- Fuel rail pressure sensor
- Fuel tank pressure sensor
- Multifunction intake air sensor

DTC P0651

The 5V reference 2 circuit provides 5 V to the sensors listed below:

- Brake pedal position sensor
- Crankshaft position sensor

DTC P0697

The 5V reference 3 circuit provides 5 V to the sensors listed below:

- Accelerator pedal position sensor 2
- Manifold absolute pressure sensor

DTC P06A3

The 5V reference 4 circuit provides 5 V to the sensors listed below:

- Accelerator pedal position sensor 1
- Throttle position sensor

Disconnecting one component at a time from the affected 5V reference circuit while observing the scan tool 5V Reference Circuit Status parameter may help locate the fault. The scan tool parameter will change from Malfunction to OK when the source of the fault is disconnected. If all 5V reference components have been disconnected and a fault is still indicated, the fault may exist in the wiring harness.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

1. Ignition ON.
2. Verify all scan tool 5V Reference Circuit Status parameters do not display Malfunction.
 - **If Malfunction is displayed**
Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
5. All OK.

Circuit/System Testing

NOTE: Additional DTCs will set when disconnecting the components.

1. Ignition OFF, disconnect the harness connector at all appropriate sensors for the applicable DTC.
Refer to Diagnostic Aids.
2. Ignition ON.
3. Test for 4.8 - 5.2 V between one of the 5V reference circuits and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5V reference circuit for each applicable component and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
 2. Test for less than 1 V between the 5V reference circuit for each applicable component and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.

- If between 4.8 - 5.2 V

NOTE: A short to voltage or ground on the signal circuit of certain components may cause this DTC to set.

4. Verify the appropriate scan tool 5V Reference 1, 2, 3, or 4 Circuit Status parameter displays OK while connecting each component associated with the 5V reference circuit one at a time.

- If OK is not displayed when a component is connected

Test the signal circuit of that component for a short to ground or voltage. If the circuit tests normal, replace the component.

- If OK is displayed after all components have been connected

5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Accelerator Pedal Position Sensor Replacement
- Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement
- Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake
- Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust
- Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake
- Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust
- Crankshaft Position Sensor Replacement
- Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail
- Fuel Tank Pressure Sensor Replacement (NT5, NT7) Fuel Tank Pressure Sensor Replacement (NU6)
- Manifold Absolute Pressure Sensor Replacement
- Mass Airflow Sensor with Intake Air Temperature Sensor Replacement for multifunction intake air 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

Diagnostic Instructions

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

DTC Descriptor

DTC P0650

Malfunction Indicator Lamp (MIL) Control Circuit

DTC P263A

Malfunction Indicator Lamp (MIL) Control Circuit Low Voltage

DTC P263B

Malfunction Indicator Lamp (MIL) Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P0650	P0650	-	-
Control	P0650, P263A*	P0650, P263A	P263B	-
* The MIL remains ON				

Circuit/System Description

The malfunction indicator lamp (MIL) illuminates to inform the driver that an emission system fault has occurred and the powertrain control system requires service. Ignition voltage is supplied directly to the MIL. The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit when the emission system fault occurs. Under normal operating conditions, the MIL should be ON only when the ignition is ON and the engine is OFF.

Conditions for Running the DTC

- The ignition voltage is between 11 - 32 V.
- Remote vehicle start is not active.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P0650 or DTC P263A

The ECM detects low voltage during the MIL control circuit driver OFF state. This indicates either a shorted to ground or an open MIL control circuit.

DTC P263B

The ECM detects high voltage on the MIL control circuit during the driver ON state. This indicates a shorted to voltage MIL control circuit.

Action Taken When the DTC Sets

DTC P0650, P263A, and P263B are Type B DTCs.

Conditions for Clearing the DTC

DTC P0650, P263A, and P263B are Type B DTCs.

Diagnostic Aids

- If the condition is intermittent, move the related harnesses and connectors while monitoring the scan tool MIL control circuit status parameters. Perform this test with the ignition ON and the engine OFF, and with the engine running. The MIL control circuit status parameters change from OK or Not Run to Malfunction if there is a condition with a circuit or a connection.
- If the ECM detects low voltage on the MIL control circuit during the control circuit driver OFF state, DTCs P0650 and DTC P263A may set simultaneously.

Reference Information

Schematic Reference

- [Engine Controls Schematics \(LFX\)](#)
- [Instrument Cluster Schematics](#)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Verification](#)

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool:
 - MIL Control Circuit Low Voltage Test Status
 - MIL Control Circuit Open Test Status
 - MIL Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**
Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**
3. Engine running.
4. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool:
 - MIL Control Circuit Low Voltage Test Status
 - MIL Control Circuit Open Test Status
 - MIL Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**
Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**
5. Verify the malfunction indicator lamp turns ON and OFF when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
 - **If the malfunction indicator lamp does not turn ON and OFF**
Refer to Circuit/System Testing.
 - **If the malfunction indicator lamp turns ON and OFF**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 - **If the DTC sets**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
 - **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 46 and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance, replace the P16 Instrument Cluster.
- **If the malfunction indicator lamp does not illuminate**
4. Connect a 3 A fused jumper wire between the control circuit terminal 46 and ground.
5. Verify the malfunction indicator lamp illuminates.

- **If the malfunction indicator lamp illuminates**

Replace the K20 Engine Control Module.

- **If the malfunction indicator lamp does not illuminate**

1. Test for less than 1 V between the control circuit terminal 46 and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V
2. Ignition OFF.
3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω .
6. Ignition OFF, disconnect the X1 harness connector at the instrument cluster.
7. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal 8 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - **If the test lamp illuminates**
8. Replace the P16 Instrument Cluster.

Repair Instructions

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

- [Instrument Cluster Replacement](#)
- [Control Module References](#) for control module replacement, programming, and setup

DTC P0685-P0687, P0689, P0690, OR P1682: ENGINE CONTROLS IGNITION/IGNITION 1 SWITCH CIRCUIT 2

Diagnostic Instructions

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

DTC Descriptors

DTC P0685

Engine Controls Ignition Relay Control Circuit

DTC P0686

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	-	P0685, P0689, P1682	-
Relay Control Circuit	P0686, P0690	P1682	P0685, P0687, P0689, P1682
Relay Feedback Circuit	P0689, P1682	P0689, P1682	P0690

Typical Scan Tool Data**Engine Controls Ignition Relay Control Circuit Low Voltage, Open, and High Voltage Test Status - Component Commanded OFF**

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded OFF Parameter Normal Range: The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
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 and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
B+	Not Run	Not Run	-
Control	Not Run	Not Run	Malfunction

Circuit/System Description

There are 2 ignition voltage circuits supplied to the engine control module (ECM). One is supplied by the engine controls ignition relay and the other is supplied by the ignition main relay. The ECM monitors and compares the ignition voltage supplied by the two relays.

Conditions for Running the DTC

P0685, P0686, P0687

The DTC runs continuously when the ignition voltage is greater than 11 V.

P0689

- The engine controls ignition relay is commanded ON.
- The ignition voltage is greater than 11 V.
- DTC P0685 is not set.
- The DTC runs continuously when the above conditions are met.

P0690

- The engine controls ignition relay is commanded OFF.
- DTC P0685 is not set.
- The DTC runs continuously when the above conditions are met.

P1682

- The engine controls ignition relay is commanded ON.
- The ignition voltage is greater than 5.5 V.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0685

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 s.

P0686

The ECM detects a short to ground on the control circuit for greater than 2 s.

P0687

The ECM detects a short to voltage on the control circuit for greater than 2 s.

P0689

The engine controls ignition relay voltage is less than 5 V for greater than 5 s.

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 there is greater than 3 V difference between the ignition main relay signal and the engine controls ignition relay signal circuits for greater than 1 s.

Action Taken When the DTC Sets

- DTC P1682 is a Type A DTC.
- DTCs P0685, P0686, P0687, and P0690 are Type B DTCs.
- DTC P0689 is a Type C DTC.

Conditions for Clearing the DTC

- DTC P1682 is a Type A DTC.

- DTCs P0685, P0686, P0687, and P0690 are Type B DTCs.
- DTC P0689 is a Type C 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 1 relay, the ignition run relay, or the ignition relay.

Reference Information

Schematic Reference

- [Engine Controls Schematics \(LEX\)](#)
- [Power Distribution Schematics](#)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

NOTE:

- A short to voltage on other components may cause DTC P0690 to set. If any other DTC is set, diagnose that DTC first.
- If you were sent here from [Engine Cranks But Does Not Run](#), proceed to Circuit/System Testing.

1. Ignition ON, observe the scan tool DTC information. Verify DTC P0685, P0686, P0687, P0689, P0690, or P1682 is not set.

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

Refer to Circuit/System Testing.

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

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

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

Refer to Circuit/System Testing.

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

3. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing unless sent here from Engine Cranks But Does Not Run.

1. Ignition OFF, disconnect the KR75 Engine Controls Ignition Relay.
2. Verify a test lamp illuminates between ground and the relay circuit terminals listed below:

- Terminal 85
- Terminal 30
- **If the test lamp does not illuminate**

Replace the front compartment fuse block.

- **If the test lamp illuminates**

NOTE:

- High resistance in the circuit/underhood fuse block for either the KR75 Engine Controls Ignition Relay or the KR73 Ignition Main Relay can cause DTC P1682 to set.
- A short to voltage on any of the circuits supplied by the engine controls ignition relay can cause DTC P0690 to set.

3. Ignition ON.
4. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal 87 and ground.

- **If the test lamp illuminates**

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.

2. Ignition ON.

3. Test for less than 1 V between ground and connector terminal 73.

- If 1 V or greater, repair the short to voltage in the circuit.
- If less than 1 V, replace the K20 Engine Control Module.

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

5. Ignition OFF, connect a 20 A fused jumper wire between the relay switch B+ circuit terminal 30 and the relay switch ignition voltage circuit terminal 87.

6. Ignition ON.

7. Verify the scan tool Engine Controls Ignition Relay Feedback Signal parameter displays B+.

- **If B+ is not displayed**

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.

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

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

3. Test for infinite resistance between the relay switch ignition voltage circuit and ground.

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

- **If B+ is displayed**

8. Ignition OFF, connect a DMM, set to the diode setting, between control circuit terminal 86 and ground.

9. Verify the DMM displays OL.

- **If OL is not displayed**

1. Disconnect the X1 harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between ground and the relay control circuit.

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

- **If OL is displayed**

10. Ignition ON.

11. Verify the DMM displays less than 1 V.

- **If 1 V or greater**

1. Ignition OFF, disconnect the X1 connector at the K20 Engine Control Module.

2. Ignition ON.

3. Test for less than 1 V on the relay control circuit.

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

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

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

- **If less than 1 V**

12. Test or replace the KR75 Engine Controls Ignition Relay.

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.

- **If between 70 - 110 Ω**

3. Test for infinite resistance between the terminals listed below:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87

- **If less than infinite resistance**

Replace the KR75 Engine Controls Ignition Relay.

- **If infinite resistance**

4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.

5. Test for less than 2 Ω between terminals 30 and 87.

- **If 2 Ω or greater**

Replace the KR75 Engine Controls Ignition Relay.

- **If less than 2 Ω**

6. All OK.

Repair Instructions

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

- [Front Compartment Fuse Block Replacement](#)

- [Relay Replacement \(Attached to Wire Harness\) Relay Replacement \(Within an Electrical Center\)](#)
- [Control Module References](#) for engine control module replacement, programming, and setup.

DTC P069E: FUEL PUMP CONTROL MODULE REQUESTED MIL ILLUMINATION

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) Prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptor

DTC P069E

Fuel Pump Control Module Requested MIL Illumination

Circuit/System Description

The chassis control module, sometimes called the fuel pump control module, constantly monitors the fuel pump control system for any condition which may adversely affect vehicle emissions. If a condition is detected, the chassis control module sets a DTC and sends a serial data message to the engine control module (ECM). The ECM sets DTC P069E to inform the technician that the chassis control module has set the emission related DTC. The serial data message sent by the chassis control module also contains a request for the ECM to illuminate the malfunction indicator lamp (MIL).

The technician can observe the DTC that was set by the chassis control module by reviewing the ECM Freeze Frame records on the scan tool. The ECM Freeze Frame records also contain the engine operating conditions present when the chassis control module DTC set.

Conditions for Running the DTC

The ignition is ON, or the engine is running for greater than 3 s.

Conditions for Setting the DTC

The ECM receives a serial data message from the chassis control module indicating that an emission related DTC has set in the chassis control module.

Action Taken When the DTC Sets

- DTC P069E is a Type A DTC.
- DTC P069E will continue to be current or active as long as the chassis control module is requesting MIL illumination.

Conditions for Clearing the DTC

DTC P069E is a Type A DTC.

Diagnostic Aids

- Communication codes, U-codes, as well as powertrain codes, P-codes, set in the chassis control module will cause the chassis control module to request DTC P069E to be set in the ECM.
- On some vehicle applications the chassis control module may control components other than the fuel pump, such as the active grille air shutter system. Therefore, all DTCs that may be set in the chassis control module should be investigated whenever DTC P069E is set in the ECM.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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

Circuit/System Verification

NOTE:

- Do not replace the engine control module for this DTC. DTC P069E is an informational DTC.
- Correct any engine control and communication DTCs before diagnosing chassis control module DTCs.

1. Verify there are no engine control or communication DTCs set.

- If a DTC is set

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

- If a DTC is not set

2. Verify the DTCs are set only as History in the chassis control module.

- If a DTC is not set only as History

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

- If a DTC is set only as History

Refer to [Testing for Intermittent Conditions and Poor Connections](#) .

- If a DTC is not set

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

4. Verify the DTC does not set.

- If the DTC sets

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

- If the DTC does not set

5. All OK.

Repair Instructions

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

DTC P0700: TRANSMISSION CONTROL MODULE REQUESTED MIL ILLUMINATION

Diagnostic Instructions

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

DTC Descriptor

DTC P0700

Transmission Control Module Requested MIL Illumination

Circuit/System Description

The Transmission Control Module (TCM) constantly monitors the transmission system for any condition which may adversely affect vehicle emissions. If a condition is detected, the TCM sets a DTC and sends a serial data message to the ECM. The ECM sets DTC P0700 to inform the technician that the

TCM has set the emission related DTC. The serial data message sent by the TCM also contains a request for the ECM to illuminate the Malfunction Indicator Lamp (MIL)

The technician can observe the DTC that was set by the TCM by reviewing the ECM Freeze Frame records on the scan tool. The ECM Freeze Frame records also contain the engine operating conditions present when the transmission DTC set.

Conditions for Running the DTC

- The ignition is ON or the engine is running.
- DTC P0700 runs continuously.

Conditions for Setting the DTC

The ECM receives a serial data message from the TCM indicating that an emission related DTC has set in the TCM.

Action Taken When the DTC Sets

DTC P0700 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P0700 is a Type A DTC.

Diagnostic Aids

Communication codes, U-codes, as well as powertrain codes, P-codes, set in the TCM can cause the TCM to request DTC P0700 to be set in the ECM.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **Do not replace the engine control module for this DTC. DTC P0700 is an informational DTC.**
- **Correct any engine control and communication DTCs before diagnosing transmission control module DTCs.**

1. Verify there are no engine control or communication DTCs set.

- **If a DTC is set**

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

- **If a DTC is not set**

2. Verify there are no transmission control module DTCs set.

- **If a DTC is set**

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

- **If a DTC is not set**

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

4. Verify the DTC does not set.

- If the DTC sets

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

- If the DTC does not set

5. All OK.

Repair Instructions

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

DTC P1011-P1014: INTAKE/EXHAUST CAMSHAFT POSITION ACTUATOR PARK POSITION BANK

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 P1011

Intake Camshaft Position Actuator Park Position Bank 1

DTC P1012

Exhaust Camshaft Position Actuator Park Position Bank 1

DTC P1013

Intake Camshaft Position Actuator Park Position Bank 2

DTC P1014

Exhaust Camshaft Position Actuator Park Position Bank 2

Circuit/System Description

Each camshaft position actuator contains one locking pin. The locking pins are necessary to keep the camshafts in the park position during engine start. Once sufficient oil pressure for accurate camshaft control is available, the camshaft locking pins are released and the camshafts can be phased. If the enable conditions are met, the difference between the park position and the measured camshaft is averaged. If after a calibrated number of camshaft sensor measurements, the absolute value of the average deviation is greater than or equal to a calibrated threshold, the DTC is set.

Conditions for Running the DTC

- Engine running.
- DTCs run once per drive cycle when the above conditions are met.

Conditions for Setting the DTC

The ECM detects the difference between the park and actual camshaft position angle at engine start-up is greater than 10Å°.

Actions Taken When the DTC Sets

DTCs P1011, P1012, P1013, P1014 are Type C DTCs.

Conditions for Clearing the DTC

DTCs P1011, P1012, P1013, P1014 are Type C DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

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 parameter. Advise the customer an oil change may be required.
- If a crankshaft or camshaft position sensor DTC is set, the Camshaft Position Actuator output control will not function.

1. Ignition - On / Vehicle - In Service Mode

2. Verify that the engine has the correct oil level and the correct oil pressure. Refer to **Oil Pressure Diagnosis and Testing** .

- If the oil level and the oil pressure are not correct

Repair as necessary

- If the oil level and the oil pressure are correct

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

3. Verify DTC P000A-P000D, P00BC, P0011, P0013, P0014, P0016 - P0021, P0023, P0024, P0341, P0342, P0346, P0347, P0348, P0366, P0367, P0368, P0391, P0392, P0393, or P2088 - P2095 is not set.

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

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

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

4. Verify the appropriate Camshaft Position Actuator Park Lock Test listed below displays Pass when performed with a scan tool.

- Exhaust Camshaft Position Actuator Park Lock Test Status Bank 1
- Intake Camshaft Position Actuator Park Lock Test Status Bank 1
- Exhaust Camshaft Position Actuator Park Lock Test Status Bank 2
- Intake Camshaft Position Actuator Park Lock Test Status Bank 2
- **If the test does not pass**

Replace the component: Mechanical camshaft position actuator.

- **If the test passes**

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**

Replace the component: Mechanical camshaft position actuator.

- **If the DTC is not set**

7. All OK.

Repair Instructions

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

- [Camshaft Position Actuator Replacement - Bank 1](#)
- [Camshaft Position Actuator Replacement - Bank 2](#)
- For control module replacement, programming, and setup refer to: [Control Module References](#)

DTC P1248-P124D: CYLINDER INJECTOR HIGH 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 P1248

Cylinder 1 Injector High Control Circuit Shorted to Control Circuit

DTC P1249

Cylinder 2 Injector High Control Circuit Shorted to Control Circuit

DTC P124A

Cylinder 3 Injector High Control Circuit Shorted to Control Circuit

DTC P124B

Cylinder 4 Injector High Control Circuit Shorted to Control Circuit

DTC P124C

Cylinder 5 Injector High Control Circuit Shorted to Control Circuit

DTC P124D

Cylinder 6 Injector High Control Circuit Shorted to Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Direct Fuel Injector High Voltage Supply Cylinder 1	P2147	P0201	P2148	P1248
Direct Fuel Injector High Voltage Control Cylinder 1	P0261	P0201	P0262	P1248
Direct Fuel Injector High Voltage Supply Cylinder 2	P2150	P0202	P2151	P1249
Direct Fuel Injector High Voltage Control Cylinder 2	P0264	P0202	P0265	P1249
Direct Fuel Injector High Voltage Supply Cylinder 3	P2153	P0203	P2154	P124A
Direct Fuel Injector High Voltage Control Cylinder 3	P0267	P0203	P0268	P124A
Direct Fuel Injector High Voltage Supply Cylinder 4	P2156	P0204	P2157	P124B
Direct Fuel Injector High Voltage Control Cylinder 4	P0270	P0204	P0271	P124B
Direct Fuel Injector High Voltage Supply Cylinder 5	P216B	P0205	P216C	P124C
Direct Fuel Injector High Voltage Control Cylinder 5	P0273	P0205	P0274	P124C
Direct Fuel Injector High Voltage Supply Cylinder 6	P216E	P0206	P216F	P124D
Direct Fuel Injector High Voltage Control Cylinder 6	P0276	P0206	P0277	P124D

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 fuel injector high voltage control circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is between 11 - 18 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTCs P1248, P1249, P124A, P124B, P124C, and P124D are Type A DTCs.

Conditions for Clearing the DTC

DTCs P1248, P1249, P124A, P124B, P124C, and P124D are Type A DTCs.

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to [**Fuel Injector Solenoid Coil Test \(LFX\)**](#).
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Cylinder 1 - 6 Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description (LFX)

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 DTC P0685 or P1682 is set**
Refer to [**Diagnostic Trouble Code \(DTC\) List - Vehicle**](#) .
 - **If DTC P0685 or P1682 is not set**
3. Engine idling.
4. Verify the scan tool Cylinder 1 - 6 Injector Control Circuit Status parameters display OK.
 - **If any parameters do not display OK**

Refer to Circuit/System Testing.

- **If all parameters display OK**

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

6. Verify DTC P1248, P1249, P124A, P124B, P124C, or P124D does not set.

- **If any DTC sets**

Refer to Circuit/System Testing.

- **If no DTC sets**

7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the appropriate multi-way harness connector X160 or X161, at the rear of the intake manifold, ignition ON. It may take up to 2 min for all vehicle systems to power down.

2. Verify the scan tool Cylinder 1 - 6 Injector Control Circuit Status parameters display Open.

- **If Open is not displayed**

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

NOTE: Test on the engine control module side of the multi-way harness connector.

2. Test for infinite resistance between the appropriate Q17 Fuel Injector high voltage supply circuit and high voltage control circuit.

- If less than infinite, repair the short between the circuits.
- If infinite resistance, replace the K20 Engine Control Module.

- **If Open is displayed**

NOTE: Testing for the following steps is performed on the fuel injector side of the multi-way harness connector. It may be necessary to remove the intake manifold to isolate the condition.

3. Ignition OFF, disconnect the harness connector at the appropriate Q17 Fuel Injector.

4. Test for infinite resistance between the appropriate Q17 Fuel Injector high voltage supply circuit and high voltage control circuit.

- **If less than infinite resistance**

Repair the short between the circuits.

- **If infinite resistance**

5. Test or replace the appropriate Q17 Fuel Injector.

Component Testing

- **Fuel Injector Solenoid Coil Test (LFX)**
- **Fuel Injector Balance Test**

Repair Instructions

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

- **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LFX)**
- **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LFX)**
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup.

DTC P1255 OR P064A: FUEL PUMP CONTROL MODULE (CHASSIS CONTROL MODULE)

Diagnostic Instructions

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

DTC Descriptors

DTC P064A

Fuel Pump Control Module Performance

DTC P1255

Fuel Pump Control Module Driver High Temperature

Circuit/System Description

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

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

The chassis control module detects an over-temperature fault.

Action Taken When the DTC Sets

DTCs P064A and P1255 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P064A and P1255 are Type A DTCs.

Diagnostic Aids

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

Beginning in the 2014 model year the K27 Fuel Pump Control Module (FPCM) will now be called the chassis control module (CCM). The component code for the chassis control module will be K38. The chassis control module name will be used in Service Information, the Global Diagnostic System and the Service Programming System.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 DTC P0231, P0232 or P023F is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If none of the DTCs are set**
3. Verify that the area where the K38 Chassis Control Module is located is free of debris, clutter, or any insulating material that would cause the K38 Chassis Control Module to overheat.
 - **If any debris, clutter, or other material is found**
 1. Clear the area where the K38 Chassis Control Module is located.
 2. Clear the DTC and test drive the vehicle.
 3. Verify DTC P1255 or P064A is not set.
 - If DTC P1255 or P064A is set, replace the K38 Chassis Control Module.
 - If DTC P1255 or P064A is not set
 - 4. All OK.
 - **If no debris, clutter, or other material is found**
4. Clear the DTC and test drive the vehicle.
5. Verify DTC P1255 or P064A is not set.
 - **If DTC P1255 or P064A is set**

Replace the K38 Chassis Control Module.
 - **If DTC P1255 or P064A is not set.**
6. All OK.

Repair Instructions

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

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

DTC P135A OR P135B: IGNITION COIL SUPPLY VOLTAGE CIRCUIT BANK

Diagnostic 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

DTC P135B

Ignition Coil Supply Voltage Circuit Bank 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0351, P0352, P0353, P0354, P0355, P0356, P135A, P135B	P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0351, P0352, P0353, P0354, P0355, P0356, P135A, P135B	-	-

Circuit/System Description

The ignition system uses an individual ignition coil for each cylinder. The engine control module (ECM) monitors the ignition voltage from the fuse to the individual coils.

Conditions for Running the DTC

- The ignition is ON.
- Ignition Run/Crank and PT relay voltages are greater than 11 V

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects less than 2.5 V on the ignition coil supply voltage circuit for greater than 313 ms.

Action Taken When the DTC Sets

DTC P135A and P135B are Type A DTCs.

Conditions for Clearing the DTC

DTC P135A and P135B are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

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 appropriate scan tool Ignition Coil Supply Voltage parameter displays On.
 - **If On is not displayed**
Refer to Circuit/System Testing.
 - **If On is displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
2. Connect a 3 A fused jumper wire between the control circuit terminal 72 and ground, ignition ON.
3. Verify a test lamp illuminates between the appropriate ignition circuit terminal listed below and ground.
 - Terminal 62
 - Terminal 67
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**

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

1. Ignition OFF, remove the test lamp, and disconnect all components on the circuit.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Replace the fuse, ignition ON.
4. Verify the fuse is good after connecting each of the components one at a time.
 - If the fuse opens, replace the component that opens the fuse when connected.
 - If the fuse is good, all OK.
- **If the test lamp illuminates**
4. Replace the K20 Engine Control Module.

Repair Instructions

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

- **Ignition Coil Replacement - Bank 1**
- **Ignition Coil Replacement - Bank 2**
- **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 catalytic converter must be warmed to efficiently reduce the emissions. The cold start strategy is to reduce the amount of time it takes to warm the catalytic converter. During a cold start, the engine idle speed is elevated and spark timing is retarded to allow the catalyst to warm quickly. This diagnostic monitors the following to build an exhaust energy model:

- Engine speed
- Spark advance
- Throttle position
- Engine coolant temperature
- Engine runtime
- Park/neutral position
- Vehicle speed

The actual model is then compared to the expected exhaust energy model.

Conditions for Running the DTC

- The engine is running, and a cold start has been detected.
- Vehicle speed is less than 3 km/h (2 MPH).
- The engine is at idle with no input from the accelerator pedal.
- The calculated catalyst temperature is less than 350°C (662°F).
- Engine coolant is greater than -10°C (14°F) and less than 56°C (132°F).
- Barometric pressure is greater than 74 kPa (10.7 psi).
- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0335, P0336, P0351, P0352, P0353, P0501, P0502, P0506, P0507, P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, P0641, P0651, P1101, P1516, P1682, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2176, P2610 are not set.
- This DTC runs for 10 s within the first 18 s of start-up, or until the calculated catalyst temperature is greater than 900°C (1,652°F). 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 MIL/DTC

DTC P1400 is a Type A DTC.

Reference Information

Description and Operation

Engine Control Module Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Diagnostic Aids

Any loading of the engine that lowers engine RPM, such as with partial application of the clutch, A/C cycling etc., during the first 18 s of engine run time may set this DTC.

Circuit/System Verification

1. Verify that the conditions listed below do not exist:

- Damage, restriction, water intrusion or modification of the air intake system.
- Dirty or deteriorating air filter element
- Crankcase ventilation system for correct operation - Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
- Vacuum leak or other un-metered air downstream of the mass air flow (MAF) sensor
- Intake manifold leak
- Exhaust leak
- Water intrusion
- Damaged, restricted, modified or enhanced exhaust system - Refer to **Symptoms - Engine Exhaust** .
- **If any of the conditions exist**

Repair as necessary.

- **If none of the conditions exist**

2. Verify an engine mechanical condition does not alter the air flow into the combustion chamber. Refer to **Symptoms - Engine Mechanical** .

- **If any of the conditions exist**

Repair as necessary.

- **If none of the conditions exist**

3. Vehicle OFF, allow the engine to cool to be within the temperatures listed in the Conditions for Running the DTC.

4. Engine running.

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 step 1

- If the DTC does not set

7. 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

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

NOTE:

- DTC P150C is an informational DTC.
- Diagnose all other engine control module DTCs prior to DTC P150C.

1. Verify that no other DTCs are set except for DTC P150C.

- **If any other DTCs are set**

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

- **If only DTC P150C is set**

2. Replace the K71 Transmission Control Module.

3. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

4. Verify the DTC does not set.

- **If the DTC sets**

Replace the K20 Engine Control Module.

- **If the DTC does not set**

5. All OK.

Repair Instructions

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

[Control Module References](#) for ECM or TCM replacement, programming, and setup

DTC P1516, P2101, P2119, OR P2176: THROTTLE ACTUATOR CONTROL (TAC) MODULE THROTTLE ACTUATOR POSITION PERFORMANCE

Diagnostic 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 P1516**

Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance

DTC P2101

Throttle Actuator Position Performance

DTC P2119

Throttle Closed Position Performance

DTC P2176

Minimum Throttle Position Not Learned

Diagnostic Fault Information

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

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
TAC Motor Control Closed	P2101	P2101	P2101	P1516, P2101, P2176
TAC Motor Control Open	P2119	P2101	P2101	P1516, P2101, P2176

Circuit/System Description

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

The ECM controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the TP sensor signal/serial data circuit to determine the actual throttle valve position.

Conditions for Running the DTC

P1516

- The run/crank or powertrain relay voltage is greater than 6.4 V and reduced power is not active.
- DTC P1516 runs continuously when the above conditions are met.

P2101

- DTC P1682 is not set.
- The run/crank or powertrain relay voltage is greater than 6.4 V and reduced power is not active.
- The engine is running or the following conditions are met:
 - The engine is not running.
 - The ignition voltage is greater than 11 V.
 - The TAC system is not in the Battery Saver mode.
 - The ECM is commanding the throttle.
 - The ECM has learned the minimum throttle position.
- DTC P2101 runs continuously when the above conditions are met.

P2119

- DTCs P0122, P0123, P0222, P0223, or P06A3 is not set.
- The run/crank or powertrain relay voltage is greater than 6.4 V and reduced power is not active.
- The system is not in the Battery Save mode.
- The ECM is not commanding the throttle.
- DTC P2119 runs continuously when the above conditions are met.

P2176

- The run/crank or powertrain relay voltage is greater than 6.4 V and reduced power is not active.
- DTC P2176 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P1516

The ECM detects an unstable throttle position for greater than 1 s.

P2101

- The ECM detects the actual throttle position does not match the predicted throttle position for greater than 1 s.

OR

- The ECM detects the throttle control is driving the throttle in the incorrect direction or exceed the reduced power limit.

P2119

The ECM determines that the throttle blade did not return to the rest position within 1 s.

P2176

The ECM detects that both throttle position (TP) sensors were greater than a predetermined voltage during the minimum throttle learn procedure for greater than 2 s.

Action Taken When the DTC Sets

- DTCs P2101, and P2176 are Type A DTCs.
- DTC P1516 is a Type B DTC.
- DTC P2119 is a Type C DTC.
- The ECM commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions, the control module commands the engine OFF.

Conditions for Clearing the MIL/DTC

- DTCs P2101, and P2176 are Type A DTCs.
- DTC P1516 is a Type B DTC.
- DTC P2119 is a Type C DTC.

Diagnostic Aids

- Depending on the Start Up ECT, the Desired Throttle Position percentage maybe greater or less than the Throttle Position with the TAC motor at rest. When the ignition is initially turned ON, or when the engine is cranking or running the Desired and Actual Throttle positions should closely match.
- Inspect for a condition in which the throttle valve may have been held open. For example, ice may have formed in the throttle bore causing the throttle valve not to close.
- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- A low battery condition may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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.

NOTE: A low battery voltage or charging system condition may cause a DTC to set.

2. Verify DTC P0121, P0122, P0123, P0222, P0223, P0562, P0621, P0622, or P2135 is not set.

- If any of the DTCs are set

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

- If none of the DTCs are set

3. Verify the scan tool Throttle Body Idle Air flow Compensation parameter is less than 90 %.

- If 90 % or greater

Refer to [Throttle Body Inspection and Cleaning](#) .

- If less than 90 %

4. Clear the DTCs with a scan tool.

5. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.

6. Ignition ON.

7. Verify the scan tool TAC Motor parameter displays Enabled while slowly depressing the accelerator pedal.

- If Enabled is Not displayed

Refer to Circuit/System Testing.

- If Enabled is displayed

8. Verify DTC P1516, P2101, P2119, or P2176 is not set.

- If any of the DTCs are set

Refer to Circuit/System Testing.

- If none of the DTCs are set

NOTE: If there is a condition with the throttle body, the TAC Motor Command parameter will go to 99 % for a predetermined amount of time and then a DTC sets. Once a DTC is set, the TAC Motor

Command parameter will go to 0 % and the TAC Motor parameter will display Disabled.

9. Verify the scan tool TAC Motor parameter displays Enabled while performing the Throttle Sweep Test with a scan tool.

- **If Enabled is Not displayed**

Replace the Q38 Throttle Body assembly.

- **If Enabled is displayed**

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

11. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

12. All OK

Circuit/System Testing

1. Ignition OFF.

WARNING: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

2. Verify the conditions listed below do not exist with the Q38 Throttle Body:

NOTE:

- The rest position is defined as the actual Throttle Position percentage when the ignition is OFF or with the ignition ON for greater than 30 seconds.
- When the ignition is OFF, spring tension should hold the throttle plate in the rest position. You should be able to open the throttle plate to wide open throttle (WOT) or push the throttle plate to the fully closed position. In each case, the throttle plate should return to the rest position without assistance.

- A throttle blade that is not in the rest position
- A throttle blade that is binding open or closed
- A throttle blade that is free to move open or closed without spring pressure
- **If a condition is found**

Replace the Q38 Throttle Body.

- **If a condition is not found**

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

3. Disconnect the harness connector at the Q38 Throttle Body Assembly, ignition ON.

NOTE: The test lamp may illuminate briefly when the ignition switch is turned on, but should not remain illuminated.

4. Verify that a test lamp does Not illuminate continuously between each motor control circuit listed below and ground.

- TAC Motor Control Closed circuit terminal 1
- TAC Motor Control Open circuit terminal 2
- **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module, ignition ON
 2. Test for less than 1 V between the motor control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **If the test lamp is always OFF**
- 5. Verify that a test lamp does not illuminate between each motor control circuit listed below and B+.
 - TAC Motor Control Closed circuit terminal 1
 - TAC Motor Control Open circuit terminal 2
 - **If the test lamp illuminates**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
- 6. Ignition OFF, remove the test lamp, set the DMM to the 40 V scale, select the Min/Max Recording Mode, and set the Peak Min/Max response time to 1 ms.

NOTE:

- **The ignition must be OFF and the ECM completely powered down before testing each circuit or a lower voltage will be recorded. It may take up to 2 min for all vehicle systems to power down.**
 - **The DMM Min/Max Recording Mode and the response time of 1 ms must be reset after testing each circuit or a lower voltage will be recorded.**
7. Verify the Max voltage is within 3 V of B+, while using DMM Min/Max Recording Mode function, with the DMM connected to each control circuit listed below and ground, as the ignition is turned ON.
 - TAC Motor Control Closed circuit terminal 1
 - TAC Motor Control Open circuit terminal 2
 - **If not within 3 V of B+**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If within 3 V of B+**
 8. Replace the Q38 Throttle Body.

Repair Instructions

- **Throttle Body Assembly Replacement**
- **Control Module References** for ECM replacement, programming, and setup

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.

4. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
5. Ignition ON.
6. Verify the scan tool TAC Motor parameter displays Enabled while performing the Throttle Sweep Test with a scan tool.
 - **If Disabled**

Test or replace the Q38 Throttle Body assembly.
 - **If Enabled**
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 again.
 - **If DTC sets**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If DTC does not set**
8. All OK

DTC P163A: CONTROL MODULE FUEL PRESSURE REGULATOR 1 CONTROL SYSTEM CIRCUITRY PERFORMANCE

Diagnostic Instructions

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

Conditions for Running the DTC

- The engine is running or cranking.
- The ignition voltage is between 8-18 V.
- DTC P163A runs continuously when the conditions are met for greater than 500 mS.

Conditions for Setting the DTC

The ECM detects a condition with the integrated high pressure fuel pump actuator circuits or detects the current used to drive the high pressure fuel pump actuator is out of range for greater than 4 s.

Action Taken When the DTC Sets

DTC P163A is a Type C DTC.

Conditions for Clearing the DTC

DTC P163A is a Type C DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

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](#) for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool parameters listed below do not display Malfunction when commanding the Fuel Pressure Regulator On and Off with a scan tool.
 - Fuel Pressure Regulator Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator Control Circuit Open Test Status
 - Fuel Pressure Regulator Control Circuit Low Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit Open Test Status
 - Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
 - **If Malfunction is displayed**

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

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump. It may take up to 2 min for all vehicle systems to power down.
2. Verify that a test lamp does not illuminate between the high pressure fuel pump actuator low control circuit terminal 1 and B+.
 - **If the test lamp illuminates**
 1. Remove the test lamp.
 2. Disconnect the X3 harness connector at the K20 Engine Control Module.

3. Test for infinite resistance between the low control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
3. Ignition ON.
4. Verify a test lamp does not illuminate between the high pressure fuel pump actuator high control circuit terminal 2 and ground.
 - **If the test lamp illuminates**
 1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module. Ignition ON.
 2. Test for less than 1 V between the high 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 K20 Engine Control Module.
 - **If the test lamp does not illuminate**
5. Verify the test lamp illuminates when the Fuel Pressure Regulator is commanded On with a scan tool.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the high control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , test or replace the K20 Engine Control Module.
 - **If the test lamp illuminates**
6. Ignition OFF, connect a test lamp between the high pressure fuel pump actuator low control circuit terminal 1 and B+. Ignition ON.
7. Verify the test lamp illuminates when the Fuel Pressure Regulator is commanded On with a scan tool.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module. Ignition ON.
 2. Test for less than 1 V between the low control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 Ω in the low control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , test or replace the K20 Engine Control Module.
 - **If the test lamp illuminates**
8. Test or replace the G18 High Pressure Fuel Pump.

Component Testing

Static Test

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

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

2. Test for 9-12 Ω between low control circuit terminal 1 and high control circuit terminal 2.

- **If not within the specified range**

Replace the G18 High Pressure Fuel Pump.

- **If within the specified range**

3. Test for infinite resistance between each terminal and the high pressure fuel pump housing/case.

- **If less than infinite resistance**

Replace the G18 High Pressure Fuel Pump.

- **If infinite resistance**

4. All OK.

Repair Instructions

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

- **Fuel Pump Replacement (LFX)** for G18 High Pressure Fuel Pump replacement
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup

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

- Perform the Fuel Rail Pressure Relief Valve Reset procedure.

DTC P2096 OR P2098: POST CATALYST FUEL TRIM SYSTEM (LFX)

Diagnostic 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 P2096

Post Catalyst Fuel Trim System Low Limit Bank 1

DTC P2098

Post Catalyst Fuel Trim System Low Limit Bank 2

Circuit Description

Fuel trim bias is used to keep the post catalyst air/fuel ratio within a predetermined range. This allows optimal catalyst efficiency under various operating conditions. The engine control module (ECM) constantly monitors how lean or rich the fuel trim bias is commanded, to determine if the fuel trim bias is greater than a calibrated amount.

Conditions for Running the DTC

- DTC P0016, P0017, P0018, P0019, P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0131 - P0135, P0137, P0138, P013A - P013F, P0140, P0141, P014A, P014B, P0151 - P0155, P0157, P0158, P015A - P015D, P0160, P0161, P0178, P0179, P0201 - P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300 - P0306, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0498, P0499, P1248, P1249, P124A, P124B, P124C, P124D, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P219A, P219B, P2227, P2228, P2229, P2230, P2269, P2270, P2271, P2272, or P2273 is not set.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 PSI).
- The manifold absolute pressure (MAP) is between 10 - 255 kPa (1.5 - 37 PSI).

- The intake air temperature (IAT) is between - 20 and +150Â°C (-4 and +302Â°F).
- The engine start-up coolant temperature is warmer than - 20Â°C (- 4Â°F).
- The engine is in Closed Loop status.
- The fuel control intrusive diagnostics are not active.
- DTCs P2096 and P2098 run continuously when the conditions above have been met.

Conditions for Setting the DTC

The lean correction limit for a condition causing a rich air/fuel ratio has been exceeded.

Action Taken when the DTC Sets

DTCs P2096 and P2098 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2096 and P2098 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.
- Failure to perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing an HO2S, clearing HO2S diagnostic trouble codes, or after battery disconnection may cause inaccurate post catalyst fuel trim readings.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

2. Verify no other HO2S or fuel trim DTC is set.

- **If any other HO2S or fuel trim DTC is set**

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

- **If no other HO2S or fuel trim DTC is set**

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

4. Verify DTC P2096 or P2098 is not set.

- **If a DTC is set**

Refer to Circuit/System Testing.

- **If no DTC is set**

5. All OK.

Circuit/System Testing

Verify the conditions listed below do not exist:

- Air intake duct collapsed or restricted.
- Air filter dirty or restricted.
- Objects blocking the throttle body.
- Excessive fuel in the crankcase. Change engine oil as necessary.
- Rich fuel injectors. Refer to [Fuel Injector Solenoid Coil Test \(LFX\)](#).
- High fuel system pressure. Refer to [Fuel System Diagnosis \(LFX\)](#).
- Contaminated fuel. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
- Fuel saturation of the evaporative emissions (EVAP) canister
- EVAP purge valve stuck open or leaking
- Restricted exhaust
- Incorrect crankcase ventilation system operation. Refer to [Crankcase Ventilation System Inspection/Diagnosis](#)

- **If a condition is found**

Repair as necessary.

- **If no condition is found**

Test fuel trim cylinder balance. Refer to [DTC P219A or P219B \(LFX\)](#).

Repair Instructions

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

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

DTC P2097 OR P2099: POST CATALYST FUEL TRIM SYSTEM (LFX)

Diagnostic 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 P2097

Post Catalyst Fuel Trim System High Limit Bank 1

Post Catalyst Fuel Trim System High Limit Bank 2**Circuit Description**

Fuel trim bias is used to keep the post catalyst air/fuel ratio within a predetermined range. This allows optimal catalyst efficiency under various operating conditions. The engine control module (ECM) constantly monitors how lean or rich the fuel trim bias is commanded, to determine if the fuel trim bias is greater than a calibrated amount.

Conditions for Running the DTC

- DTC P0016, P0017, P0018, P0019, P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0131 - P0135, P0137, P0138, P013A - P013F, P0140, P0141, P014A, P014B, P0151 - P0155, P0157, P0158, P015A - P015D, P0160, P0161, P0178, P0179, P0201 - P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300 - P0306, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0498, P0499, P1248, P1249, P124A, P124B, P124C, P124D, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P219A, P219B, P2227, P2228, P2229, P2230, P2269, P2270, P2271, P2272, or P2273 is not set.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 PSI).
- The manifold absolute pressure (MAP) is between 10 - 255 kPa (1.5 - 37 PSI).
- The intake air temperature (IAT) is between - 20 and +150°C (-4 and +302°F).
- The engine start-up coolant temperature is warmer than - 20°C (-4°F).
- The engine is in Closed Loop status.
- The fuel control intrusive diagnostics are not active.
- DTCs P2097 and P2099 run continuously when the conditions above have been met.

Conditions for Setting the DTC

The rich correction limit for a condition causing a lean air/fuel ratio has been exceeded.

Action Taken when the DTC Sets

DTCs P2097 and P2099 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2097 and P2099 are Type B DTCs.

Diagnostic Aids

- The post catalyst fuel trim diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may cause a DTC to set.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no other HO2S or fuel trim DTC is set.
 - **If any other HO2S or fuel trim DTC is set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If no other HO2S or fuel trim DTC is set**
3. Verify the conditions listed below do not exist:
 - Exhaust system leaks. Refer to [Symptoms - Engine Exhaust](#)
 - Vacuum hoses split, kinked, or improperly connected
 - Insufficient fuel in the tank
 - Leaks in the air induction system and the air intake ducts
 - Missing air filter element
 - A cracked evaporative canister
 - Evaporative pipes plugged, obstructed, or leaking
 - Leaks in the crankcase ventilation system. Refer to [Crankcase Ventilation System Inspection/Diagnosis](#)
 - Engine vacuum leaks
 - Low fuel system pressure. Refer to [Fuel System Diagnosis \(LFX\)](#).
 - Contaminated fuel. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
 - Lean fuel injectors. Refer to [Fuel Injector Solenoid Coil Test \(LFX\)](#).
 - **If a condition is found**
Repair as necessary.
 - **If no condition is found**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
5. Verify DTC P2097 or P2099 is not set.
 - **If a DTC is set**
Refer to Circuit/System Testing.
 - **If no DTC is set**
6. 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 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](#) provides an overview of each diagnostic category.

DTC Descriptors

DTC P2122

Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

DTC P2123

Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage

DTC P2127

Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage

DTC P2128

Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

DTC P2138

Accelerator Pedal Position (APP) Sensors 1-2 Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Sensor 1 5 V Reference Circuit	P06A3	P2138	P2122	P06A3	P2138
Sensor 2 5 V Reference Circuit	P0106, P0108, P0107, P0697	P2138	P2127	P0106, P0108, P0697	P2138
Sensor 1 Signal	P2122	P2138	P2122	P2123, P2138	P2138
Sensor 2 Signal	P2127	P2138	P2127	P2128, P2138	P2138
Sensor 1 Low Reference	-	P2138	P2123	-	P2138
Sensor 2 Low Reference	-	P2138	P2128	-	P2138

Typical Scan Tool Data

APP Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating at idle. Parameter Normal Range: APP Sensor 1 0.88 - 1.08 V			
5 V Reference	0.00 V	0.00 V	2 - 3 V
Signal	0.00 V	0.00 V	4 - 5 V

Circuit	Short to Ground	Open	Short to Voltage
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			
5 V Reference	0.00 V	0.00 V	1 - 3 V
Signal	0.00 V	0.00 V	2 - 5 V
Low Reference	-	4 - 5 V	-

Circuit/System Description

The accelerator pedal assembly contains 2 APP sensors. The APP sensors are mounted to the accelerator pedal assembly and are not serviceable. The APP sensors provide a signal voltage that change relative to pedal position. The engine control module (ECM) supplies each APP sensor with a 5 V reference circuit, a low reference circuit, and a signal circuit.

Both the APP sensors 1 and 2 signal percentages increase as the pedal is depressed, from approximately 0 % at rest to above 95 % when fully depressed.

Conditions for Running the DTC

P2122, P2123, P2127, or P2128

- DTC P06A3 or P0697 are not set.
- The ignition is ON or the engine is operating.
- The ignition voltage is greater than 6.41 V.
- The ECM is not commanding reduced power.
- The DTCs run continuously when the above conditions are met.

P2138

- DTCs P06A3, P0697, P2122, P2123, P2127, or P2128 are not set.
- The ignition is ON or the engine is operating.
- The ignition voltage is greater than 6.41 V.
- The ECM is not commanding reduced power.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2122

The ECM detects that the APP sensor 1 voltage is less than 0.46 V for less than 1 s.

P2123

The ECM detects that the APP sensor 1 voltage is greater than 4.7 V for less than 1 s.

P2127

The ECM detects that the APP sensor 2 voltage is less than 0.32 V for less than 1 s.

P2128

The ECM detects that the APP sensor 2 voltage is greater than 2.6 V for less than 1 s.

P2138

The ECM detects that APP sensor 1 and APP sensor 2 disagree greater than 10 % for less than 1 s.

OR

The ECM detects that both APP sensor 1 and APP sensor 2 are 5 % greater than the learned minimum position for less than 1 s.

Action Taken When the DTC Sets

- DTCs P2122, P2123, P2127, P2128, and P2138 are type A DTCs.
- The ECM commands the TAC system to operate in a Reduced Engine Power mode.

Conditions for Clearing the DTC

DTCs P2122, P2123, P2127, P2128, and P2138 are type A DTCs.

Diagnostic Aids

- A high resistance condition on the accelerator pedal position circuits could cause a DTC to set.
- Ensure that the in-line harness connector seals are installed correctly. Improper installation could result in water intrusion into the connector and cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)**
 - **If none of the DTCs are set**
3. Verify the APP Sensor 1 Circuit Status and APP Sensor 2 Circuit Status displays OK.
 - **If OK is not displayed**

Refer to Circuit/System Testing.

- **If OK is displayed**

4. Verify the scan tool APP Sensor 1 and 2 Agree/Disagree parameter displays Agree while performing the tests listed below:

- Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.
- Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.
- **If Agree is not displayed**

Refer to Circuit/System Testing.

- **If Agree is displayed**

5. Verify that DTC P2122, P2123, P2127, P2128, or P2138 is not set.

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

Refer to Circuit/System Testing.

- **If none of the DTCs set**

6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

7. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

8. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B107 Accelerator Pedal Position Sensor. It may take up to 2 min for all vehicle systems to power down.

2. Test for less than 5 Ω between each low reference circuit terminal listed below and ground:

- Low reference circuit terminal 4 or D
- Low reference circuit terminal 5 or A

- **If 5 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the low reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If less than 5 Ω**

3. Ignition ON.

4. Test for 4.8 - 5.2 V between each 5 V reference circuit terminal listed below and ground.

- 5 V reference circuit terminal 1 or C
- 5 V reference circuit terminal 2 or F

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the 5 V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the 5 V reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8 - 5.2 V**
5. Verify each APP sensor voltage parameter is less than 0.2 V.
 - **If 0.2 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal listed below and ground.
 - APP sensor 1 signal circuit terminal 3 or E
 - APP sensor 2 signal circuit terminal 6 or B
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If less than 0.2 V**
6. Install a 3 A fused jumper wire between the appropriate signal circuit terminal listed below and the 5 V reference circuit terminal 1 or C.
 - APP sensor 1 signal circuit terminal 3 or E
 - APP sensor 2 signal circuit terminal 6 or B
7. Verify the scan tool APP Sensor 1 or 2 voltage parameter is greater than 4.8 V.
 - **If 4.8 V or less**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 4.8 V**
8. Test or replace the B107 Accelerator Pedal Position Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Accelerator Pedal Position Sensor Replacement](#)
- [Control Module References](#) for ECM replacement, programming, and setup

DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, OR P216F: CYLINDER INJECTOR HIGH CONTROL

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptors

DTC P2147

Cylinder 1 Injector High Control Circuit Low Voltage

DTC P2148

Cylinder 1 Injector High Control Circuit High Voltage

DTC P2150

Cylinder 2 Injector High Control Circuit Low Voltage

DTC P2151

Cylinder 2 Injector High Control Circuit High Voltage

DTC P2153

Cylinder 3 Injector High Control Circuit Low Voltage

DTC P2154

Cylinder 3 Injector High Control Circuit High Voltage

DTC P2156

Cylinder 4 Injector High Control Circuit Low Voltage

DTC P2157

Cylinder 4 Injector High Control Circuit High Voltage

DTC P216B

Cylinder 5 Injector High Control Circuit Low Voltage

DTC P216C

Cylinder 5 Injector High Control Circuit High Voltage

DTC P216E

Cylinder 6 Injector High Control Circuit Low Voltage

DTC P216F

Cylinder 6 Injector High Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Direct Fuel Injector High Voltage Supply Cylinder 1	P2147	P0201	P2148	P1248
Direct Fuel Injector High Voltage Control Cylinder 1	P0261	P0201	P0262	P1248
Direct Fuel Injector High Voltage Supply Cylinder 2	P2150	P0202	P2151	P1249
Direct Fuel Injector High Voltage Control Cylinder 2	P0264	P0202	P0265	P1249
Direct Fuel Injector High Voltage Supply Cylinder 3	P2153	P0203	P2154	P124A
Direct Fuel Injector High Voltage Control Cylinder 3	P0267	P0203	P0268	P124A
Direct Fuel Injector High Voltage Supply Cylinder 4	P2156	P0204	P0270, P2157	P124B

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Direct Fuel Injector High Voltage Control Cylinder 4	P0270, P2156	P0204	P0271, P2157	P124B
Direct Fuel Injector High Voltage Supply Cylinder 5	P216B	P0205	P216C	P124C
Direct Fuel Injector High Voltage Control Cylinder 5	P0273	P0205	P0274	P124C
Direct Fuel Injector High Voltage Supply Cylinder 6	P216E	P0206	P216F	P124D
Direct Fuel Injector High Voltage Control Cylinder 6	P0276	P0206	P0277	P124D

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 fuel injector high voltage control circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is between 11 - 18 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P2147, P2150, P2153, P2156, P216B, or P216E

The engine control module detects the fuel injector high voltage supply circuit is shorted to ground for greater than 2 s.

P2148, P2151, P2154, P2157, P216C, or P216F

The engine control module detects the fuel injector high voltage supply circuit is shorted to voltage for greater than 2 s.

Action Taken When the DTC Sets

DTCs P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, and P216F are Type A DTCs.

Conditions for Clearing the DTC

DTCs P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, and P216F are Type A DTCs.

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Solenoid Coil Test (LFX)**.
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Cylinder 1 - 6 Injector Circuit Status parameters. An Injector Circuit Status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description (LFX)

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 DTC P0685 or P1682 is set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If DTC P0685 or P1682 is not set**
3. Engine idling.
4. Verify the scan tool Cylinder 1 - 6 Injector Control Circuit Status parameters display OK.
 - **If any parameters do not display OK**

Refer to Circuit/System Testing.
 - **If all parameters display OK**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F does not set.
 - **If any DTC sets**

Refer to Circuit/System Testing.
 - **If no DTC sets**
7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the appropriate multi-way harness connector X160 or X161, at the rear of the intake manifold, ignition ON. It may take up to 2 min for all vehicle systems to power down.
2. Verify the scan tool Cylinder 1 - 6 Injector Control Circuit Status parameters display Open.
 - **If Open is not displayed**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.

NOTE: Test on the engine control module side of the multi-way harness connector.

2. Test for infinite resistance between the appropriate Q17 Fuel Injector control circuit and ground.
 - If less than infinite, repair the short to ground on the circuit.
 - If infinite resistance
3. Ignition ON.
4. Test for less than 1 V between the appropriate 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, test or replace the K20 Engine Control Module.
- **If Open is displayed**
3. Ignition ON, connect a test lamp between the appropriate Q17 Fuel Injector high voltage supply circuit and control circuits.
4. Verify the appropriate Cylinder 1 - 6 Injector Control Circuit Status transitions from Open to OK.
 - **If the parameter does not transition**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω on the appropriate Q17 Fuel Injector high voltage supply 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 appropriate Q17 Fuel Injector low control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , test or replace the K20 Engine Control Module.
 - **If the parameter transitions**

NOTE: Testing for the following steps is performed on the fuel injector side of the multi-way harness connector. It may be necessary to remove the intake manifold to isolate the condition.

5. Test for 2-3 Ω between the appropriate Q17 Fuel Injector high voltage supply circuit and control circuit.
 - **If less than 2 Ω**
 1. Disconnect the harness connector at the appropriate Q17 Fuel Injector.
 2. Test for infinite resistance between the appropriate Q17 Fuel Injector high voltage supply circuit and control circuit.
 - If less than infinite, repair the short between the circuits.
 - If infinite resistance, test or replace the Q17 Fuel Injector.
 - **If greater than 3 Ω**
 1. Disconnect the harness connector at the appropriate Q17 Fuel Injector.
 2. Test for less the 2 Ω in the appropriate Q17 Fuel Injector high voltage supply 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 the 2 Ω in the appropriate Q17 Fuel Injector control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , test or replace the Q17 Fuel Injector.
 - **If between 2-3 Ω**
6. Test for infinite resistance between the appropriate Q17 Fuel Injector control circuit and ground.
 - **If less than infinite resistance**
 1. Disconnect the harness connector at the appropriate Q17 Fuel Injector.

2. Test for infinite resistance between the appropriate Q17 Fuel Injector high voltage supply circuit and ground.
 - If less than infinite, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for infinite resistance between the appropriate Q17 Fuel Injector control circuit and ground.
 - If less than infinite, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the Q17 Fuel Injector.
- **If infinite resistance**
7. Ignition ON.
8. Test for less than 1 V between the appropriate 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**
9. All OK.

Component Testing

- [Fuel Injector Solenoid Coil Test \(LFX\)](#)
- [Fuel Injector Balance Test](#)

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Fuel Injection Fuel Rail Assembly Replacement - Bank 1 \(LFX\)](#)
- [Fuel Injection Fuel Rail Assembly Replacement - Bank 2 \(LFX\)](#)
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup.

DTC P2199: INTAKE AIR TEMPERATURE (IAT) SENSORS 1-2 NOT PLAUSIBLE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptor

DTC P2199

Intake Air Temperature (IAT) Sensors 1-2 Not Plausible

Diagnostic Fault Information

IAT 1 Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0113, P0114, P2199*	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199, P2227, P2228, P2229	P0113, P0114, P2199, P2227, P2229*	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P0443, P2199	P0096, P0097, P00F4, P0101, P0102, P0178, P2199, P2230	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P00F4, P0102, P0178, P2199, P2230	-	P0096, P0102

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data**IAT 1 Sensor**

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: Varies with ambient temperature; and engine bay conditions			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*

*Internal ECM or sensor damage may occur if the circuit is shorted to B+

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: Varies with ambient temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F)* 10 Hz
Ground	-	-40Â°C (-40Â°F) 10 Hz	-

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Circuit/System Description

The sensors listed below are integrated within the mass air flow/multifunction intake air sensor:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

The intake air temperature (IAT) sensor 1 is a variable resistor that changes the voltage on the engine control module (ECM) supplied 5 V signal circuit. The signal varies with inlet air temperature in the sensor bore and is displayed by the scan tool as Â°C (Â°F). The IAT sensor 2 and the humidity sensor share the same circuit. The IAT sensor 2 signal is displayed by the scan tool as Hertz (Hz) and Â°C (Â°F).

The sensors listed below share an ECM supplied 5 V reference circuit:

- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

The sensors listed below share an ECM supplied low reference circuit:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

IAT Sensor 1 - Temperature, Resistance, Voltage Table

IAT Sensor 1	IAT Sensor 1 Resistance	IAT Sensor 1 Signal Voltage
Cold	High	High
Warm	Low	Low

IAT Sensor 2 - Temperature, Frequency Table

IAT Sensor 2	IAT Sensor 2 Frequency	IAT Sensor 2 Temperature
Cold	45 Hz	-40°C (-40°F)
Warm	302 Hz	104°C (219°F)

Conditions for Running the DTC

- DTC P1682 is not set.
- The ignition is ON.
- Ignition voltage is at least 11 V.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

The ECM detects that the absolute difference between the IAT sensor 1 and the IAT sensor 2 temperatures is greater than 55°C (99°F) for longer than 5 s.

Action Taken When the DTC Sets

DTC P2199 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2199 is a Type B DTC.

Diagnostic Aids

- With the ignition ON, the engine OFF and the engine is cold, a properly functioning IAT sensor 2 will gradually increase the scan tool IAT Sensor 2 parameter. This is due to the heat that is generated by the multifunction intake air sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values: 10 Hz; -40°C (-40°F), and there are Humidity Sensor DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

- [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](#)

NOTE: To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 1 and 2 of this verification procedure only if the ignition has been OFF for 8 hours or more.

1. Ignition ON.
2. Verify the following scan tool parameters are within 55Â°C (99Â°F) of each other.
 - Start-Up IAT Sensor 1
 - IAT Sensor 2
 - Start-Up ECT
 - **If not within 55Â°C (99Â°F)**
Refer to Circuit/System Testing.
 - **If within 55Â°C (99Â°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
 - IAT Sensor 1
 - IAT Sensor 2
 - ECT Sensor
 - **If not between: -38 and +149Â°C (-36 and +300Â°F)**
Refer to Circuit System Testing.
 - **If between: -38 and +149Â°C (-36 and +300Â°F)**
4. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
5. Verify the DTC does not set.
 - **If the DTC sets.**
Refer to Circuit/System Testing.

- If the DTC does not set.

6. All OK

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Verify none of the following conditions exist:

- A restricted or collapsed air intake duct
- An intake manifold leak
- A MAP sensor seal that is leaking, missing, or damaged
- A misaligned or damaged air intake duct
- Any water intrusion in the induction system
- An Intake Manifold Resonator with a leaking seal, or a cracked or broken housing
- **If a condition exists**

Repair or replace the component as appropriate.

- **If no condition exists**

2. Ignition OFF and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.

3. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the low reference circuit end to end.

- If 2 Ω or greater, repair the open or high resistance in the circuit.
- If less than 2 Ω replace the K20 Engine Control Module.

- **If less than 2 Ω**

4. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the ground circuit end to end.

- If 2 Ω or greater, repair the open or high resistance in the circuit.
- If less than 2 Ω , repair the open/high resistance in the ground connection.

- **If less than 2 Ω**

5. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.

2. Test for less than 2 Ω in the ignition voltage circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.

2. Test for infinite resistance between the ignition voltage circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test all components connected to the ignition circuit, replace as necessary.

- **If a test lamp illuminates**

6. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature signal 1 circuit terminal 1 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8 - 5.2 V**

7. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than -39 $^{\circ}$ C (-38 $^{\circ}$ F).

- **If warmer than -39 $^{\circ}$ C (-38 $^{\circ}$ F).**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If colder than -39 $^{\circ}$ C (-38 $^{\circ}$ 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 3 parameter is warmer than 150 $^{\circ}$ C (302 $^{\circ}$ F).

- **If colder than 150 $^{\circ}$ C (302 $^{\circ}$ F).**

1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Ignition OFF.
4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If warmer than 150 $^{\circ}$ C (302 $^{\circ}$ 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**

NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8 - 5.2 V**
11. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
 - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
 1. Test or replace the B75C Multifunction Intake Air sensor.
 2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
 3. Verify the DTC does not set.
 - **If the DTC sets**
Replace the K20 Engine Control Module.
 - **If the DTC does not set**
 - **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.
 - **If between 28 - 32 Hz**
15. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.

NOTE: A thermometer can be used to test the sensor off the vehicle.

2. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)** table for Hitachi Sensors. The resistance values should be in range of the table values.
 - **If not within the table values.**

Replace the B75C Multifunction Intake Air sensor.

- **If within the table values.**

3. All OK

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.

- **If not within 5%**

Replace the B75C Multifunction Intake Air sensor.

- **If within 5%**

2. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) for multifunction intake air sensor replacement.
- [Control Module References](#) for engine control module replacement, programming, and setup

DTC P219A OR P219B: FUEL TRIM CYLINDER BALANCE BANK (LFX)

Diagnostic 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 P219A

Fuel Trim Cylinder Balance Bank 1

DTC P219B

Fuel Trim Cylinder Balance Bank 2

Circuit/System Description

The Fuel Trim Cylinder Balance diagnostic detects a rich or lean cylinder to cylinder air/fuel ratio imbalance in each bank. 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, P0018, P0019, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0201 - P0206, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300, P0301 - P0306, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0442, P0455, P0458, P0496, P1248, P1249, P124A, P124B, P124C, P124D, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F are not set.
- The EVAP device controls and intrusive diagnostics are not active.
- The secondary air injection reaction pump is not on, if equipped.

- The engine overspeed protection is not active.
- Engine run time is greater than 30 s.
- The engine is in Closed Loop status for greater than 5 s.
- The fuel level is greater than 10% and no fuel level sensor fault is present.
- The system voltage is greater than 11 V.
- The engine coolant temperature (ECT) is warmer than -20Â°C (-4Â°F).
- The engine speed is between 1, 600 - 4, 000 RPM.
- The mass air flow is between 0 - 1, 000 g/s.
- DTCs P219A and P219B run 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

DTCs P219A and P219B are Type A DTCs.

Conditions for Clearing the MIL/DTC

DTCs P219A and P219B are Type A DTCs.

Diagnostic Aids

- The fuel trim cylinder balance diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may cause a DTC to set.
- Monitoring the misfire current counters, or misfire graph, may help to isolate the cylinder that is causing the condition.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Circuit/System Verification

1. Ignition ON.
2. Verify no other DTCs are set.
 - **If any other DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If no other DTCs are set**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
4. Verify DTC P219A or P219B is not set.
 - **If a DTC is set**

Refer to Circuit/System Testing.
 - **If no DTC is set**
5. 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 \(LFX\)](#) .
 - **If within the specified range**
2. Verify the conditions listed below do not exist:
 - Modified, damaged, leaking, or restricted air induction system components.
 - Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.
 - 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 Solenoid Coil Test \(LFX\)](#).
 - Fuel contamination. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
 - Excessive fuel in the crankcase due to leaking injectors. Change engine oil as necessary.
 - Improperly operating ignition system. Refer to [Electronic Ignition System Diagnosis](#).
 - **If a condition is found**

Repair as necessary.
 - **If no condition is found**
3. Test the engine for any mechanical conditions such as sticking valves, lifters, etc., which could alter the flow into the combustion chamber. Refer to [Symptoms - Engine Mechanical](#) .

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Perform the scan tool Fuel Trim Reset after completing the repair.

DTC P2227-P2230: BAROMETRIC PRESSURE (BARO) SENSOR (LFX)

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptors

DTC P2227

Barometric Pressure (BARO) Sensor Performance

DTC P2228

Barometric Pressure (BARO) Sensor Circuit Low Voltage

DTC P2229

Barometric Pressure (BARO) Sensor Circuit High Voltage

DTC P2230

Barometric Pressure (BARO) Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641, P2227, P2228	P2227, P2228	P0193, P0641, P2227, P2229	P2227
Signal	P2227, P2228	P2227, P2228	P2227, P2229	P2227
Low Reference	-	P0113, P2199, P2227, P2228, P2229	-	P2227

Typical Scan Tool Data

BARO

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition On, Engine Off Parameter Normal Range: 56 - 105 kPa (8.1 - 15.2 psi), varies with altitude			
5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	128 kPa (18.6 psi)
Signal	0 kPa (0 psi)	0 kPa (0 psi)	128 kPa (18.6 psi)
Low Reference	-	128 kPa (18.6 psi)	-

Circuit/System Description

The barometric pressure (BARO) sensor is integral to the multifunction intake air sensor and responds to changes in altitude and atmospheric conditions. This gives the ECM an indication of barometric pressure. The ECM uses this information to calculate fuel delivery. The BARO sensor provides a voltage signal to the ECM relative to the atmospheric pressure changes. The ECM monitors the BARO sensor signal for a voltage outside of the normal range.

Conditions for Running the DTC

P2227

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0121, P0122, P0123, P0222, P0223, P2101, P2135, P2228, or P2229 is not set.
- The engine is running.

OR

- DTC P0106, P0107, P0108, P2228, P2229, P2230, or P2610 is not set and P0107, P0108, P2228, or P2229 is not pending.
- Ignition On, engine Off
- The time between the current ignition cycle and the last time the engine was running is greater than 7 min.
- DTC P2227 runs continuously when the above conditions are met.

P2228 or P2229

- The engine is running.
- The DTCs run continuously when the above condition is met.

P2230

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0121, P0122, P0123, P0222, P0223, P2101, P2135, P2228, or P2229 is not set.
- The ignition is On.
- DTC P2230 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2227

- The engine is running.
- The ECM detects that the difference between the BARO signal and the calculated BARO is greater than 15 kPa (2.2 psi) if the vehicle has traveled at most 2.0 km (1.2 mi) since the last calculated BARO update, or the ECM detects that the difference between the BARO signal and the calculated BARO is greater than 20 kPa (2.9 psi) if the vehicle has traveled greater than 2.0 km (1.2 mi) since the last calculated BARO update.

OR

- Ignition On, engine Off
- The ECM detects that the BARO pressure is less than 50 kPa (7.3 psi) or greater than 115 kPa (16.7 psi).

P2228

The ECM detects that the BARO sensor voltage is less than 2.0 V for greater than 4 s.

P2229

The ECM detects that the BARO sensor voltage is greater than 4.5 V for greater than 4 s.

P2230

The ECM detects that the cumulative difference between BARO sensor readings, over a specific length of time, is greater than a calibrated threshold.

Action Taken When the DTC Sets

DTCs P2227, P2228, P2229, and P2230 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2227, P2228, P2229, and P2230 are Type B DTCs.

Diagnostic Aids

Inspect the inlet port on the BARO sensor for moisture or debris and attempt to dry or clean the inlet, if contaminated.

Schematic Reference

Engine Controls Schematics (LFX)

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 DTC P0106, P0107, P0108, or P0697 is not set.
 - **If any of the DTCs are set**
Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If none of the DTCs are set**
3. Verify the scan tool MAP Sensor parameter is within the range specified in the **Altitude Versus Barometric Pressure (With LFX)** table.
 - **If not within the specified range**
Refer to **DTC P0106 (LFX)** .
 - **If within the specified range**
4. Verify the scan tool BARO pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure (With LFX)** table.
 - **If not within the specified range**
Refer to Circuit/System Testing.
 - **If within the specified range**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Verify the conditions listed below do not exist with the B75C Multifunction Intake Air Sensor:

- Damage
- Restrictions in the inlet port
- **If a condition exists**

Repair or replace the B75C Multifunction Intake Air Sensor as necessary.

- **If none of the conditions exist**

2. Ignition Off, and all vehicle systems Off, it may take up to 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.

3. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.

- **If 5 Ω or greater**

1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the low reference circuit end to end.

- If greater than the specified value, repair the open or high resistance in the circuit.
- If 2 Ω or less replace the K20 Engine Control Module.

- **If less than 5 Ω**

4. Ignition On.

5. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 2 and ground.

- **If less than 4.8 V**

1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the 5 V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the 5 V reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On.

2. Test for less than 1 V between the 5 V reference circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8 - 5.2 V**

6. Verify the scan tool BARO Sensor parameter is less than 0.2 V.

- **If 0.2 V or greater**

1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On.

2. Test for less than 1 V between the signal circuit terminal 4 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K20 Engine Control Module.

- **If less than 0.2 V**

7. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 2.

8. Verify the scan tool BARO Sensor parameter is greater than 4.5 V.

- **If 4.5 V or less**

1. Ignition Off, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the signal circuit terminal 4 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 4.5 V**

9. Test or replace the B75C Multifunction Intake Air Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) for multifunction intake air sensor replacement
- [Control Module References](#) for engine control module replacement, programming, and setup

DTC P2269: WATER IN FUEL

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptor

DTC P2269

Water in Fuel

Circuit/System Description

Alcohol content information is supplied to the engine control module from the fuel composition sensor. The fuel composition sensor has a battery positive circuit, a signal circuit, and a ground circuit. The fuel composition sensor uses a microprocessor inside the sensor to measure the ethanol percentage and changes the output signal accordingly. The signal circuit carries the ethanol percentage via the frequency signal. The ECM provides an internal pull up to 5 V on the signal circuit, and the fuel composition sensor pulls the 5 V to ground in pulses. The normal range of operating frequency is between 50 - 150 Hz. The microprocessor inside the sensor is capable of a certain amount of self-diagnosis. An output frequency between 180 Hz and 190 Hz indicates that the fuel is contaminated.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

The engine control module detects that the fuel composition sensor output frequency is greater than 185 Hz for greater than 6 s.

Action Taken When the DTC Sets

DTC P2269 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2269 is a Type B DTC.

Diagnostic Aids

A momentary slug of water in the fuel system may set this DTC.

Reference Information

Schematic Reference

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 44175 - A Alcohol Tester Kit**
- **EL 38522 - A Variable Signal Generator**

For equivalent regional tools, Refer to **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

Circuit/System Verification

1. Engine running, verify the scan tool Fuel Composition Sensor parameter is between 50 - 150 Hz.
 - **If not between 50 - 150 Hz**
Refer to Circuit/System Testing.
 - **If between 50 - 150 Hz**
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 DTC is set**
Refer to Circuit/System Testing.
 - **If DTC is not set**
4. All OK.

Circuit/System Testing

1. Verify that there are no contaminants, water, or too high of a concentration of ethanol in the fuel.
Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** and the **CH 44175 - A** Instruction Manual.
 - **If the fuel tested is not within acceptable levels**
Refer to **Fuel System Cleaning**
 - **If the fuel tested is within acceptable levels**
2. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B198 Fuel Composition Sensor. It may take up to 2 minutes for all vehicle systems to power down.
3. Test for less than 5 Ω between the ground circuit terminal 2 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF.

2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the ground connection.
- **If less than 5 Ω**
4. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the fuse is not opened**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is good and voltage is supplied to the fuse.
 - **If the test lamp does not illuminate and the fuse is opened**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the B+ circuit and ground
 - If less than infinite, repair the short to ground in the circuit.
 - If infinite, test all the components connected to the circuit, and repair or replace as necessary.
 - **If the test lamp illuminates**
5. Ignition ON, test for 4.8 - 5.2 V between the signal circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector X1 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 , test or replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, test or replace the K20 Engine Control Module.
 - **If within 4.8 - 5.2 V**
6. Ignition OFF, connect the red lead of the **EL 38522 - A** Variable Signal Generator to the signal circuit terminal 3 at the B198 Fuel Composition Sensor harness connector. Connect the battery voltage supply to B+, and the black lead to ground.
7. Set the **EL 38522 - A** Variable Signal Generator Signal to 5 V, the Frequency to 60 Hz, and the Duty Cycle to Normal.
8. Ignition ON.
9. Clear the DTCs with a scan tool.
10. Verify the scan tool Fuel Composition Sensor parameter is at 60 Hz.
 - **If not 60 Hz**

Test or replace the K20 Engine Control Module.
 - **If 60 Hz**
11. Test or replace the B198 Fuel Composition Sensor.

Component Testing

1. Test the fuel composition using the **CH 44175 - A** Alcohol Tester Kit and the CH 44175 - A Instruction Manual. Record the frequency.
2. Compare the special tool test frequency and the scan tool Fuel Composition Sensor frequency parameter.
3. Verify the difference between the tool and the sensor is 12 Hz or less.

- **If greater than the specified value**

Replace the B198 Fuel Composition Sensor.

- **If less than the specified value**

4. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Flexible Fuel Sensor Replacement](#)
- [Fuel System Cleaning](#)
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup.

DTC P2430, P2431, P2435, OR P2436: SECONDARY AIR INJECTION SYSTEM 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 P2430

Secondary Air Injection System Pressure Sensor Circuit Bank 1

DTC P2431

Secondary Air Injection System Pressure Sensor Performance Bank 1

DTC P2435

Secondary Air Injection System Pressure Sensor Circuit Bank 2

DTC P2436

Secondary Air Injection System Pressure Sensor Performance Bank 2

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. A pressure sensor in each bank is used to monitor the air flow from the secondary air injection pump. The engine control module (ECM) supplies voltage to the 5-volt reference circuits and supplies a ground to the low reference circuits. The sensors provide a signal voltage to the ECM relative to the pressure changes within the secondary air injection system.

Ignition voltage is supplied to the secondary air injection pump relay and the secondary air injection solenoid valve (shutoff and check valve) relay. The ECM activates the relays by grounding the control circuits. When the relay contacts close, voltage is supplied to the pump and the valves, which turns the pump on and opens the valves.

The diagnostic uses 3 phases to test the secondary air injection system:

- DTCs P0411, P2430 and P2435 run during Phase 1
- DTCs P2430, P2435 and P2440 run during Phase 2
- DTC P2444 runs during Phase 3

During phase 1, both the secondary air injection pump and the secondary air injection solenoid valves are activated. Normal secondary air function occurs. Expected system pressure is 5 - 13 kPa (0.7 - 1.9 psi) above BARO.

During phase 2, only the secondary air injection pump is activated. The solenoid valves are closed. Pressure sensor performance and solenoid valve deactivation are tested. Expected system pressure is 14 - 22 kPa (2.0 - 3.2 psi) above BARO.

During phase 3, neither the secondary air injection pump nor the secondary air injection solenoid valves are activated. Secondary air injection pump deactivation is tested. Expected system pressure equals BARO.

Conditions for Running the DTC

P2430 and P2435

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300, P0351, P0352, P0353, P0354, P0355, P0356, P0411, P0412, P0418, P0420, P0430, P0606, P0641, P0651, P124A, P124B, P124C, P124D, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2227, P2228, P2229, P2230, P2431, P2432, P2433, P2436, P2437, or P2438 is not set.
- Greater than 60 min has elapsed since the last cold start.
- Ignition voltage is between 10 - 32 V.
- Engine speed is less than 5,000 RPM.
- Intake air temperature (IAT) is greater than -10°C ($+14^{\circ}\text{F}$).
- Engine coolant temperature (ECT) is between -10 and $+56^{\circ}\text{C}$ ($14 - 133^{\circ}\text{F}$).
- Barometric pressure (BARO) is greater than 74 kPa (10.7 psi).
- Manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- Mass air flow (MAF) is less than 50 g/s.
- Secondary air injection pump is commanded On.
- DTC P2430 and P2435 run once per ignition cycle when the above conditions are met.

P2431 and P2436

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300, P0351, P0352, P0353, P0354, P0355, P0356, P0411, P0412, P0418, P0420, P0430, P0606, P0641, P0651, P124A, P124B, P124C, P124D, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2227, P2228, P2229, P2230, P2430, P2432, P2433, P2435, P2437, or P2438 is not set.
- Greater than 60 min has elapsed since the last cold start.
- Ignition voltage is between 10 - 32 V.
- Engine speed is less than 5,000 RPM.
- Intake air temperature (IAT) is greater than -10°C ($+14^{\circ}\text{F}$).
- Engine coolant temperature (ECT) is between -10 and $+56^{\circ}\text{C}$ ($14 - 133^{\circ}\text{F}$).
- Barometric pressure (BARO) is greater than 74 kPa (10.7 psi).
- Manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- Mass air flow (MAF) is less than 50 g/s.
- DTC P2431 and P2436 run continuously when the above conditions are met.

Conditions for Setting the DTC

P2430 or P2435

The ECM determines that the pressure sensor value change in either bank is less than 0.5 kPa and the signal variation is less than 0.15 kPa for greater than 5 s when the secondary air injection pump is commanded On.

P2431 or P2436

- The difference between the actual system pressure in either bank and BARO is greater than 18 kPa (2.6 psi) or less than -10 kPa (-1.5 psi) for greater than 5 s when the secondary air injection pump is commanded Off.

OR

- The difference between the actual system pressure in either bank and BARO is greater than 50 kPa (7.3 psi) for greater than 5 s when the secondary air injection pump is commanded On.

Action Taken When the DTC Sets

DTCs P2430, P2431, P2435, and P2436 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2430, P2431, P2435, and P2436 are Type B DTCs.

Diagnostic Aids

- Ice buildup due to condensation/water in the air passages or pump may cause the DTC to set.
- A partially blocked or restricted exhaust system may cause the DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-36169-HD Fused Jumper

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)** .

Circuit/System Verification

NOTE: Verify the battery is fully charged before proceeding with this diagnostic procedure. The secondary air injection pump output will

vary with system voltage.

1. Ignition On

2. Verify that DTC P0412, P0418, P041F, P044F, P2257, P2258, P2432, P2433, P2237, P2238, P2440, or P2444 is not set.

- **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).

- **If none of the DTCs are set.**

3. Verify the scan tool BARO pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure \(With LFX\)](#) table.

- **If not within the specified range**

Refer to [DTC P2227-P2230 \(LFX\)](#).

- **If within the specified range**

NOTE: To prevent the secondary air injection pump from overheating, do not operate the pump consecutively for greater than 2 minutes. The pump is provided with a thermal protector that will automatically reset when allowed to cool.

4. Verify the G21 Secondary Air Injection Pump turns On and Off when commanding the Secondary Air Injection Pump Relay On and Off with a scan tool.

- **If the pump does not turn On and Off**

Refer to Circuit/System Testing - Secondary Air Injection Pump Malfunction

- **If the pump turns On and Off**

5. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1, Secondary Air Injection Pressure Sensor Bank 2 and the BARO pressure parameters are within 3 kPa (0.4 psi).

- **If not within the specified range**

Replace the appropriate Q29 Secondary Air Injection Solenoid Valve(s).

- **If within the specified range**

6. Engine running

7. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 and Secondary Air Injection Pressure Sensor Bank 2 parameters increase between 14 - 22 kPa (2.0 - 3.2 psi) when the Secondary Air Injection Pump Relay is commanded On with a scan tool.

- **If not within the specified range**

Refer to Circuit/System Testing - Secondary Air Injection System Pressure Not In Range.

- **If within the specified range**

8. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 and Secondary Air Injection Pressure Sensor Bank 2 parameters increase between 5 - 13 kPa (0.7 - 1.9 psi) when the Secondary Air Injection System is commanded On with a scan tool.

- **If not within the specified range**

Refer to Circuit/System Testing - Secondary Air Injection System Pressure Not In Range.

- **If within the specified range**

9. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

10. Verify the DTC does not set.

- **If the DTC sets**

- **If the DTC does not set**

11. All OK.

Circuit/System Testing

Secondary Air Injection Pump Malfunction

1. Ignition Off, disconnect the KR25 Secondary Air Injection Pump relay.
2. Verify a test lamp illuminates between the B+ circuit terminal 87 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 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.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Disconnect the harness connector at the G21 Secondary Air Injection Pump.
 4. Test for infinite resistance between the control circuit terminal A and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 5. Test or replace the G21 Secondary Air Injection Pump.
3. Disconnect the harness connector at the G21 Secondary Air Injection Pump.
4. Ignition Off, test for less than 10 Ω between the G21 Secondary Air Injection Pump ground circuit terminal B and ground.
 - **If 10 Ω or greater**
 1. Ignition Off.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 10 Ω**
5. Connect the harness connector at the G21 Secondary Air Injection Pump.
6. Connect a 40 A **EL 36169-HD** between the B+ circuit terminal 87 or 5 and the control circuit terminal 30 or 3.

NOTE: To prevent the secondary air injection pump from overheating, do not operate the pump consecutively for greater than 2 minutes. The pump is provided with a thermal protector that will automatically reset when allowed to cool.

7. Verify the G21 Secondary Air Injection Pump is activated.
 - **If the pump does not activate**
 1. Ignition Off, disconnect the harness connector at the G21 Secondary Air Injection Pump.
 2. Test for less than 2 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 ,
 3. Replace the G21 Secondary Air Injection Pump.
 - **If the pump activates**

8. Test or replace the KR25 Secondary Air Injection Pump relay.

Secondary Air Injection System Pressure Not In Range

1. Ignition Off, verify the conditions listed below do not exist:
 - Restricted or blocked secondary air injection system hoses/pipes.
 - Leaking or disconnected secondary air injection system hoses/pipes.
 - Damaged secondary air injection shutoff and check valve.
 - Restricted or blocked cylinder head secondary air injection inlet ports and passages.
 - Restricted or blocked exhaust system. Refer to [Restricted Exhaust](#).
 - **If a condition is located**

Repair or replace the affected component as necessary.
 - **If all components test normal**
2. Disconnect the secondary air injection hoses/pipe from the Q29 Secondary Air Injection Solenoid Valve.
3. Ignition On, command the Secondary Air Injection Pump Relay On with a scan tool.
4. Verify airflow to the Q29 Secondary Air Injection Solenoid Valve.
 - **If no airflow**

Replace the G21 Secondary Air Injection Pump.
 - **If airflow**
5. Test or replace the Q29 Secondary Air Injection Solenoid Valve.

Component Testing

KR25 Secondary Air Injection Pump Relay Test

1. Ignition Off, disconnect the KR25 Secondary Air Injection Pump Relay.
2. Test for 70 - 110 Ω between terminals 85 - 86 or 1 - 2.
 - **If less than 70 Ω or greater than 110 Ω**

Replace the KR25 Secondary Air Injection Pump Relay.
 - **If between 70 - 110 Ω**
3. Test for infinite resistance between the terminals listed below:
 - 30 - 86 or 1 - 3
 - 30 - 87 or 3 - 5
 - 30 - 85 or 2 - 3
 - 85 - 87 or 2 - 5
 - **If less than infinite resistance**

Replace the KR25 Secondary Air Injection Pump Relay.
 - **If infinite resistance**
4. Install a 15 A fused jumper wire between relay terminal 85 or 2 and 12 V. Install a jumper wire between relay terminal 86 or 1 and ground.
5. Test for less than 2 Ω between terminals 30 - 87 or 3 - 5.
 - **If 2 Ω or greater**

Replace the KR25 Secondary Air Injection Pump Relay.
 - **If less than 2 Ω**
6. All OK.

Q29 Secondary Air Injection Solenoid Valve Static Test

1. Ignition Off, disconnect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
2. Test for 4 - 15 Ω between the voltage supply terminal 5 and the ground circuit terminal 4 at the valve.
 - **If less than 4 Ω or greater than 15 Ω**

Replace the Q29 Secondary Air Injection Solenoid Valve.

- **If between 4 - 15 Ω**

3. All OK

Q29 Secondary Air Injection Solenoid Valve Dynamic Test

1. Ignition Off, disconnect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
2. Install a 15 A fused jumper wire between the voltage supply terminal 5, at the valve, and 12 V. Install a jumper wire to the ground circuit terminal 4 at the valve.
3. Verify the valve opens and closes when connecting and disconnecting the jumper wire to ground.
 - **If the valve does not open and close**

Replace the Q29 Secondary Air Injection Solenoid Valve.

- **If the valve opens and closes**

4. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Relay Replacement \(Attached to Wire Harness\)](#) [Relay Replacement \(Within an Electrical Center\)](#)
- [Secondary Air Injection Pump Replacement](#)
- [Secondary Air Injection Bypass Valve Replacement - Bank 2](#) for secondary air injection solenoid valve replacement - Bank 2
- [Secondary Air Injection Bypass Valve Replacement - Bank 1](#) for secondary air injection solenoid valve replacement - Bank 1
- [Secondary Air Injection Pipe Replacement](#)

DTC P2432, P2433, P2437, OR P2438: SECONDARY AIR INJECTION SYSTEM 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 P2432

Secondary Air Injection System Pressure Sensor Circuit Low Voltage Bank 1

DTC P2433

Secondary Air Injection System Pressure Sensor Circuit High Voltage Bank 1

DTC P2437

Secondary Air Injection System Pressure Sensor Circuit Low Voltage Bank 2

DTC P2438

Secondary Air Injection System Pressure Sensor Circuit High Voltage Bank 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Secondary Air Injection Pressure Sensor 5 V Reference Bank 1	P0335, P2432	P2432	P2433*	P2431
Secondary Air Injection Pressure Sensor Signal Bank 1	P2432	P2432	P2433*	P2431
Secondary Air Injection Pressure Sensor Low Reference Bank 1	-	P2433	-	P2431
Secondary Air Injection Pressure Sensor 5 V Reference Bank 2	P0335, P2437	P2437	P2438*	P2436
Secondary Air Injection Pressure Sensor Signal Bank 2	P2437	P2437	P2438*	P2436
Secondary Air Injection Pressure Sensor Low Reference Bank 2	-	P2438	-	P2436
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Secondary Air Injection Pressure Sensor Bank 1 and Bank 2

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: BARO			
Operating Conditions: Ignition On, Engine Off			
5-Volt Reference	41 kPa (6 psi)	41 kPa (6 psi)	149 kPa (21.6 psi)
Secondary Air Pressure Sensor Signal	40 kPa (5.8 psi)	40 kPa (5.8 psi)	149 kPa (21.6 psi)
Low Reference	-	149 kPa (21.6 psi)	-

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. The Secondary air injection pressure sensors, which are integral to the shutoff and check valves, are used to monitor the air flow from the secondary air injection pump. The engine control module (ECM) supplies voltage to the 5 V reference circuits and provides a ground for the low reference circuits. The sensors provide a signal voltage to the ECM relative to the pressure changes within the secondary air injection system.

Conditions for Running the DTC

- DTC P0606, P0641, or P0651 is not set.
- The ignition is On, or the engine is running.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P2432 or P2437

The ECM detects that a secondary air injection pressure sensor signal is less than 0.3 V for greater than 6 s.

P2433 or P2438

The ECM detects that a secondary air injection pressure sensor signal is greater than 4.7 V for greater than 6 s.

Action Taken When the DTC Sets

DTCs P2432, P2433, P2437 and P2438 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2432, P2433, P2437 and P2438 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

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Description and Operation

Secondary Air Injection System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On
2. Verify that DTC P0641 or P0651 is not set.
 - **If a DTC is set**
Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If the DTC is not set.**
3. Verify the scan tool BARO pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure (With LFX)** table.
 - **If not within the specified range**
Refer to **DTC P2227-P2230 (LFX)**.
 - **If within the specified range**
4. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 (left hand) and Bank 2 (right hand) pressure parameters are within 3 kPa (0.4 psi) of BARO.
 - **If not within the specified range**
Refer to Circuit/System Testing
 - **If within the specified range**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

6. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing

- **If the DTC does not set**

7. All OK

Circuit/System Testing

1. Ignition Off and all vehicle systems Off. It may take up to 2 min, for all vehicle systems to power down. Disconnect the harness connector at the appropriate Q29 Secondary Air Injection Solenoid Valve.

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/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If less than 5 Ω**

3. Ignition On.

4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.

- **If less than 4.8 V**

1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the 5 V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the 5 V reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On.

2. Test for less than 1 V between the 5 V reference circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8 - 5.2 V**

5. Verify the scan tool Secondary Air Injection Pressure Sensor parameter is less than 0.5 V.

- **If 0.5 V or greater**

1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On

2. Test for less than 1 V between the signal circuit terminal 2 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K20 Engine Control Module.

- **If less than 0.5 V**

6. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the 5 V reference circuit terminal 1.

7. Verify the scan tool Secondary Air Injection Pressure Sensor parameter is greater than 4.8 V.

- **If 4.8 V or less**

1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the signal circuit terminal 1 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 4.8 V**
 8. Test or replace the Q29 Secondary Air Injection Solenoid Valve.

Component Testing

Q29 Secondary Air Injection Solenoid Valve Static Test

1. Ignition Off, disconnect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
2. Test for 4 - 15 Ω between the voltage supply terminal 5 and the ground circuit terminal 4 at the valve.

- **If less than 4 Ω or greater than 15 Ω**

Replace the Q29 Secondary Air Injection Solenoid Valve.

- **If between 4 - 15 Ω**

3. All OK

Q29 Secondary Air Injection Solenoid Valve Dynamic Test

1. Ignition Off, disconnect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
2. Install a 15 A fused jumper wire between the voltage supply terminal 5, at the valve, and 12 V. Install a jumper wire to the ground circuit terminal 4 at the valve.
3. Verify the valve opens and closes when connecting and disconnecting the jumper wire to ground.

- **If the valve does not open and close**

Replace the Q29 Secondary Air Injection Solenoid Valve.

- **If the valve opens and closes**

4. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Secondary Air Injection Bypass Valve Replacement - Bank 1](#) for secondary air injection solenoid valve replacement - Bank 1.
- [Secondary Air Injection Bypass Valve Replacement - Bank 2](#) for secondary air injection solenoid valve replacement - Bank 2.
- [Control Module References](#) for ECM replacement, programming and setup.

DTC P2440: SECONDARY AIR INJECTION SYSTEM CUT-OFF VALVE STUCK OPEN

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptor

DTC P2440

Secondary Air Injection System Cut-Off Valve Stuck Open

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. A pressure sensor in each bank is used to monitor the air flow from the secondary air injection pump. The engine control module (ECM) supplies voltage to the 5-volt reference circuits and supplies a ground to the low reference circuits. The sensors provide a signal voltage to the ECM relative to the pressure changes within the secondary air injection system.

Ignition voltage is supplied to the secondary air injection pump relay and the secondary air injection solenoid valve (shutoff and check valve) relay. The ECM activates the relays by grounding the control circuits. When the relay contacts close, voltage is supplied to the pump and the valves, which turns the pump on and opens the valves.

The diagnostic uses 3 phases to test the secondary air injection system:

- DTCs P0411, P2430 and P2435 run during Phase 1
- DTCs P2430, P2435 and P2440 run during Phase 2
- DTC P2444 runs during Phase 3

During phase 1, both the secondary air injection pump and the secondary air injection solenoid valves are activated. Normal secondary air function occurs. Expected system pressure is 5 - 13 kPa (0.7 - 1.9 psi) above BARO.

During phase 2, only the secondary air injection pump is activated. The solenoid valves are closed. Pressure sensor performance and solenoid valve deactivation are tested. Expected system pressure is 14 - 22 kPa (2.0 - 3.2 psi) above BARO.

During phase 3, neither the secondary air injection pump nor the secondary air injection solenoid valves are activated. Secondary air injection pump deactivation is tested. Expected system pressure equals BARO.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300, P0351, P0352, P0353, P0354, P0355, P0356, P0412, P0418, P0420, P0430, P0606, P0641, P0651, P124A, P124B, P124C, P124D, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2227, P2228, P2229, P2230, P2430, P2431, P2432, P2433, P2435, P2436, P2437, or P2438 is not set.
- Greater than 60 min has elapsed since the last cold start.
- Ignition voltage is between 10 - 32 V.
- Engine speed is less than 5,000 RPM.
- Intake air temperature (IAT) is greater than -10°C (+14°F).
- Engine coolant temperature (ECT) is between -10 and +56°C (14 - 133°F).
- Barometric pressure (BARO) is greater than 74 kPa (10.7 psi).
- Manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- Mass air flow (MAF) is less than 50 g/s.
- Secondary air injection pump is commanded ON.
- Secondary air injection diagnostic test Phase 1 has run and passed.
- DTC P2440 runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that average difference between the predicted system pressure and the actual system pressure is less than a calibrated threshold for greater than 8 s.

Action Taken When the DTC Sets

DTC P2440 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2440 is a Type B DTC.

Diagnostic Aids

Ice buildup due to condensation/water in the air passages or pump may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0411, P0412, P0418, P041F, P044F, P2257, P2258, P2430, P2431, P2432, or P2433 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If none of the DTCs are set.**
3. Verify the scan tool BARO pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure (With LFX)** table.
 - **If not within the specified range**

Refer to **DTC P2227-P2230 (LFX)**.
 - **If within the specified range**
4. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 (left hand) and Bank 2 (right hand) pressure parameters are within 3 kPa (0.4 psi) of BARO.
 - **If not within the specified range**

Replace the appropriate Q29 Secondary Air Injection Solenoid valve or valves
 - **If within the specified range**
5. Engine running
6. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 (left hand) and Bank 2 (right hand) parameters increase between 14 - 25 kPa (2.0 - 3.6 psi) when the Secondary Air Injection

Pump Relay is commanded ON with a scan tool.

- **If not within the specified range**

Refer to Circuit/System Testing

- **If within the specified range**

7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

- **If the DTC sets**

Refer to Circuit/System Testing

- **If the DTC does not set**

8. All OK

Circuit/System Testing

1. Ignition Off, disconnect harness connector at the Q29 Secondary Air Injection Solenoid Valve, ignition On.

2. Verify a test lamp does not illuminate between the control circuit terminal 5 and ground.

- **If the test lamp illuminates**

1. Ignition Off, disconnect the X3 harness connector at the X50A Fuse Block-Underhood, ignition On.

2. Verify a test lamp does not illuminate between terminal X3-16 at the X50A Fuse Block-Underhood and ground.

- If the test lamp illuminates

Replace the X50A Fuse Block-Underhood.

- If the test lamp does not illuminate

Repair the short to voltage on the control circuit.

- **If the test lamp does not illuminate**

3. Verify the conditions listed below do not exist:

- Hoses/pipes restricted or blocked upstream of valve
- Hoses/pipes leaking or disconnected
- Damaged or restricted secondary air injection pump
- Damaged secondary air injection check valve
- **If a condition exists**

Repair or replace the component as necessary.

- **If none of the conditions exist**

NOTE: Leave the harness connector and secondary air injection pipe connected or reconnect them after disconnecting the solenoid valve.

4. Ignition Off, disconnect the Q29 Secondary Air Injection Solenoid Valve, ignition On.

5. Verify there is no airflow through the valve when commanding the Secondary Air Injection Pump Relay On with a scan tool.

- **If airflow**

Test or replace the Q29 Secondary Air Injection Solenoid Valve.

- **If no airflow**

6. Replace the G21 Secondary Air Injection Pump.

Q29 Secondary Air Injection Solenoid Valve Static Test

1. Ignition Off, disconnect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
2. Test for 4 - 15 Ω between the voltage supply terminal 5 and the ground circuit terminal 4 at the valve.

- **If less than 4 Ω or greater than 15 Ω**

Replace the Q29 Secondary Air Injection Solenoid Valve.

- **If between 4 - 15 Ω**

3. All OK

Q29 Secondary Air Injection Solenoid Valve Dynamic Test

1. Ignition Off, disconnect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
2. Install a 15 A fused jumper wire between the voltage supply terminal 5, at the valve, and 12 V. Install a jumper wire to the ground circuit terminal 4 at the valve.
3. Verify the valve opens and closes when connecting and disconnecting the jumper wire to ground.

- **If the valve does not open and close**

Replace the Q29 Secondary Air Injection Solenoid Valve.

- **If the valve opens and closes**

4. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Fuse Block Replacement](#) .
- [Secondary Air Injection Pump Replacement](#)
- [Secondary Air Injection Bypass Valve Replacement - Bank 2](#) for secondary air injection solenoid valve replacement - Bank 2
- [Secondary Air Injection Bypass Valve Replacement - Bank 1](#) for secondary air injection solenoid valve replacement - Bank 1

DTC P2444: SECONDARY AIR INJECTION SYSTEM PUMP STUCK ON

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptor

DTC P2444

Secondary Air Injection System Pump Stuck On

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. A pressure sensor in each bank is used to monitor the air flow from the secondary air injection pump. The engine control module (ECM) supplies voltage to the 5-volt reference circuits and supplies a ground to the low reference circuits. The sensors provide a signal voltage to the ECM relative to the pressure changes within the secondary air injection system.

Ignition voltage is supplied to the secondary air injection pump relay and the secondary air injection solenoid valve (shutoff and check valve) relay. The ECM activates the relays by grounding the control circuits. When the relay contacts close, voltage is supplied to the pump and the valves, which turns the pump on and opens the valves.

The diagnostic uses 3 phases to test the secondary air injection system:

- DTCs P0411, P2430 and P2435 run during Phase 1
- DTCs P2430, P2435 and P2440 run during Phase 2
- DTC P2444 runs during Phase 3

During phase 1, both the secondary air injection pump and the secondary air injection solenoid valves are activated. Normal secondary air function occurs. Expected system pressure is 5 - 13 kPa (0.7 - 1.9 psi) above BARO.

During phase 2, only the secondary air injection pump is activated. The solenoid valves are closed. Pressure sensor performance and solenoid valve deactivation are tested. Expected system pressure is 14 - 22 kPa (2.0 - 3.2 psi) above BARO.

During phase 3, neither the secondary air injection pump nor the secondary air injection solenoid valves are activated. Secondary air injection pump deactivation is tested. Expected system pressure equals BARO.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300, P0351, P0352, P0353, P0354, P0355, P0356, P0412, P0418, P0420, P0430, P0606, P0641, P0651, P124A, P124B, P124C, P124D, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2227, P2228, P2229, P2230, P2430, P2431, P2432, P2433, P2435, P2436, P2437, or P2438 is not set.
- Greater than 60 min has elapsed since the last cold start.
- Ignition voltage is between 10 - 32 V.
- Engine speed is less than 5,000 RPM.
- Intake air temperature (IAT) is greater than -10°C ($+14^{\circ}\text{F}$).
- Engine coolant temperature (ECT) is between -10 and $+56^{\circ}\text{C}$ ($14 - 133^{\circ}\text{F}$).
- Barometric pressure (BARO) is greater than 74 kPa (10.7 psi).
- Manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- Mass air flow (MAF) is less than 50 g/s.
- Secondary air injection pump is commanded ON.
- Secondary air injection diagnostic test Phase 1 and Phase 2 have run and passed.
- DTC P2444 runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that average difference between the predicted system pressure and the actual system pressure is greater than or less than calibrated thresholds for greater than 8 s.

Action Taken When the DTC Sets

DTC P2444 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P2444 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On
2. Verify that DTC P0412, P0418, P041F, P044F, P2257, P2258, P2432 or P2433 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set.**

NOTE: To prevent the secondary air injection pump from overheating, do not operate the pump consecutively for greater than 2 minutes. The pump is provided with a thermal protector that will automatically reset when allowed to cool.

3. Verify the G21 Secondary Air Injection Pump turns On and Off when commanding the Secondary Air Injection Pump Relay On and Off with a scan tool.

- **If the pump does not turn On and Off**

Refer to Circuit/System Testing

- **If the pump turns On and Off**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

5. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing

- **If the DTC does not set**

6. All OK

Circuit/System Testing

1. Ignition Off, disconnect the KR25 Secondary Air Injection Pump Relay. Ignition On.
2. Verify a test lamp does not illuminate between the control circuit terminal 30 or 3 and ground.
 - **If the test lamp illuminates**

Repair the short to voltage on the circuit.

- **If the test lamp does not illuminate**

3. Test or replace the KR25 Secondary Air Injection Pump Relay.

Component Testing

KR25 Secondary Air Injection Pump Relay Test

1. Ignition Off, disconnect the KR25 Secondary Air Injection Pump Relay.
2. Test for 70 - 110 Ω between terminals 85 - 86 or 1 - 2.

- **If less than 70 Ω or greater than 110 Ω**

Replace the KR25 Secondary Air Injection Pump Relay.

- **If between 70 - 110 Ω**

3. Test for infinite resistance between the terminals listed below:

- 30 - 86 or 1 - 3
- 30 - 87 or 3 - 5
- 30 - 85 or 2 - 3
- 85 - 87 or 2 - 5

- **If less than infinite resistance**

Replace the KR25 Secondary Air Injection Pump Relay.

- **If infinite resistance**

4. Install a 15 A fused jumper wire between relay terminal 85 or 2 and 12 V. Install a jumper wire between relay terminal 86 or 1 and ground.

5. Test for less than 2 Ω between terminals 30 - 87 or 3 - 5.

- **If 2 Ω or greater**

Replace the KR25 Secondary Air Injection Pump Relay.

- **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)

DTC P2544: TRANSMISSION TORQUE REQUEST CIRCUIT MESSAGE COUNTER INCORRECT

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for a overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptors

DTC P2544

Transmission Torque Request Circuit Message Counter Incorrect

Circuit/System Description

To improve shift feel, the transmission control module (TCM) is constantly sending the engine control module (ECM) serial data messages with requests to modify engine speed or torque. These serial data

messages are sent through two circuits which are part of a communication network called the controller area network (CAN). The ECM sets DTC P2544 when it detects a discrepancy in the structure of the message causing the integrity of the message to be questioned.

Conditions for Running the DTC

- The engine run time is greater than 0.5 s.
- No other CAN errors are present.

Conditions for Setting the DTC

The ECM detects that the engine speed and torque modification messages from the TCM are either corrupted or intermittently missing for greater than 4 s.

Action Taken When the DTC Sets

- DTC P2544 is a Type B DTC.
- The TCM commands maximum line pressure during shifts, which results in harsh shifts.
- The TCM freezes adaptive functions.

Conditions for Clearing the DTC

DTC P2544 is a Type B DTC.

Diagnostic Aids

An intermittent fault in the CAN circuits will cause the ECM to set DTC P2544.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

NOTE:

- DTC P2544 is an informational DTC.
- Diagnose all other engine control module DTCs prior to DTC P2544.

1. Verify that no other DTCs are set except for DTC P2544.

- **If any other DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .

- **If only DTC P2544 is set**

2. Replace the K71 Transmission Control Module.

3. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

4. Verify the DTC does not set.

- **If DTC sets**

Replace the K20 Engine Control Module.

- **If DTC does not set**

5. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

DTC P25A5-P25A7: FUEL MODE SELECTOR SWITCH

Diagnostic 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 P25A5

Fuel Mode Selector Switch Performance

DTC P25A6

Fuel Mode Selector Switch Circuit Low

DTC P25A7

Fuel Mode Selector Switch Circuit High

Circuit/System Description

The engine control module (ECM) receives an input from the fuel mode selector switch. The ECM uses the fuel mode information to determine which mode (gasoline or CNG) the driver is requesting.

Conditions for Running the DTC

P25A5

Ignition is ON

Fuel Selector Switch Voltage is between 1.40-4.44V

P25A6 or P25A7

Ignition is ON

Conditions for Setting the DTC

P25A5

The engine control module detects the fuel mode selector switch input signal is outside the acceptable range of either 1.499V-3.30V or 3.65V-4.39V for greater than 2s.

P25A6

The engine control module detects the fuel mode selector switch input signal is less than 1.40V for greater than 2s.

P25A7

The engine control module detects the fuel mode selector switch input signal is greater than 4.44V for greater than 2s.

Action Taken When the DTC Sets

DTCs P25A5, P25A6 and P25A7 are Type B DTCs.

The ECM will not change fuel modes.

Conditions for Clearing the DTC

DTCs P25A5, P25A6 and P25A7 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description (LFX)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P25A5, P25A6, or P25A7 is not set.
 - **If the DTC is set**

Refer to Circuit/System Testing.
 - **If the DTC is not set**
3. Operate the Fuel Selector Switch between modes several times.
4. Verify DTC P25A5, P25A6, or P25A7 is not set.
 - **If the DTC is set**

Refer to Circuit/System Testing.
 - **If the DTC is not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the harness connector at the S48A Fuel Selector Switch. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the S48A Fuel Selector Switch ground circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 10 Ω**
3. Ignition ON, Test for 4.8-5.2 V between the S48A Fuel Selector Switch 5 V signal circuit terminal 5 (-UD7) or terminal 10 (UD7) and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than infinite resistance between the S48A Fuel Selector Switch 5 V signal circuit terminal 5 (-UD7) or terminal 10 (UD7) and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 10 Ω is the signal circuit end to end.

- If 10 Ω or greater, repair the open/high resistance in the circuit.
- If less than 10 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.
3. Test for less than 1 V between the between the S48A Fuel Selector Switch 5 V signal circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

4. Replace the S48A Fuel Selector Switch.
5. Ignition ON, verify DTC P25A5, P25A6, or P25A7 does not set.

- **If DTC P25A5, P25A6, or P25A7 is set.**

Replace the K20 Engine Control Module.

- **If DTC P25A5, P25A6, or P25A7 does not set.**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- S48A Fuel Selector Switch replacement
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P2635: FUEL PUMP FLOW PERFORMANCE (CHASSIS CONTROL MODULE)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P2635

Fuel Pump Flow Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0231	P023F	P0232	P023F, P2635
Low Reference	-	P023F	-	P023F, P2635

Circuit/System Description

The engine control module (ECM) supplies voltage to the chassis control module when the ECM detects that the ignition is on. The voltage from the ECM to the chassis control module remains active for two seconds, unless the engine is in crank or run. While this voltage is being received, the chassis control module closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC

- DTC P018B, P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.
- DTC P0641 has not failed this ignition cycle.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The system voltage is greater than 11 V.
- The engine has been running for more than 30 seconds.
- Low fuel level warning not present.

Conditions for Setting the DTC

This DTC sets when the chassis control module detects a predetermined fuel pressure performance degradation between the desired fuel pressure and the current fuel pressure.

Action Taken When the DTC Sets

DTC P2635 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2635 is a Type B DTC.

Diagnostic Aids

Using the failure records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the failure records can help determine how many miles since the DTC set. The fail counter and pass counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

On vehicles equipped with a high pressure mechanical pump on direct injection engines, the vehicle may continue to run even though the pump in the fuel tank is not operating.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description (LFX)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

[Control Module References](#) for scan tool information

Circuit/System Testing

NOTE: Do not replace the chassis control module based on a history DTC P2635. The DTC P2635 may be stored but that does not indicate a failure of the chassis control module. Refer to [Strategy Based Diagnosis](#) for further history DTC diagnostics.

1. Ignition ON.
2. Verify DTC P018B, P018C, P018D, P0231, P0232 or P023F is not set.
 - **If any of the DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If none of the DTCs are set**
3. Verify the proper fuel system pressure. Perform the fuel system pressure test, refer to [Fuel System Diagnosis \(LFX\)](#).
 - **If the fuel system pressure test is not normal**

Replace the A7 Fuel Pump and Level Sensor Assembly.
 - **If the fuel system pressure test is normal**
4. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor Assembly. It may take up to 2 minutes for all vehicle systems to power down.
5. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If less than 10 Ω**
6. Connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
7. Ignition ON.
8. Verify the test lamp turns On and Off when commanding the fuel pump On and Off using the scan tool ECM fuel pump enable control function.
 - **If the test lamp is always Off**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If the test lamp is always On**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K38 Chassis Control Module.
 - **If the test lamp turns On and Off**
9. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

[Control Module References](#) for chassis control module replacement, programming, and setup.

DTC P2668, P26E2, OR P26E3: FUEL MODE INDICATOR CONTROL

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptor

DTC P2668

Fuel Mode Indicator Control Circuit

DTC P26E2

Fuel Mode Indicator Control Circuit Low

DTC P26E3

Fuel Mode Indicator Control Circuit High

Circuit/System Description

The body control module (BCM) supplies voltage to the signal circuit to the fuel mode indicator lamp. The fuel mode indicator lamp control circuit is grounded by the engine control module (ECM). When in CNG mode the ECM grounds the control circuit which illuminates the fuel mode indicator.

Conditions for Running the DTC

Ignition is ON

Conditions for Setting the DTC

P2668

The engine control module detects that the commanded state of the driver and the actual state of the control circuit do not match.

P26E2

The engine control module detects the fuel mode indicator control circuit open or shorted to ground.

P26E3

The engine control module detects the fuel mode indicator control circuit is shorted to voltage.

Action Taken When the DTC Sets

DTCs P2668, P26E2 and P26E3 are Type B DTCs.

The ECM will not change fuel modes.

Conditions for Clearing the DTC

DTCs P2668, P26E2 and P26E3 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description (LFX)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC B0987, B1011, or B2625 is not set.
 - **If the DTC B0987, B1011, or B2625 is set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If the DTC B0987, B1011, or B2625 is not set**
3. Verify DTC P2668, P26E2 or P26E3 is not set.
 - **If the DTC is set**
Refer to Circuit/System Testing.
 - **If the DTC is not set**
4. Operate the Fuel Selector Switch between modes several times.
5. Verify DTC P2668, P26E2 or P26E3 is not set.
 - **If the DTC is set**
Refer to Circuit/System Testing.
 - **If the DTC is not set**
6. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the harness connector at the S48A Fuel Selector Switch. It may take up to 2 min for all vehicle systems to power down.
2. Connect a test lamp between battery voltage and the fuel mode indicator control circuit terminal 4 (UD7) or terminal 6 (-UD7), Ignition ON.
3. Verify a test lamp turns ON and OFF when commanding the Fuel Mode Indicator ON and OFF with a scan tool.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
 2. Test for infinite resistance between the fuel mode indicator control circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp is always OFF**

1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the fuel mode indicator control circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V
3. Ignition OFF.
4. Test for less than 2 Ω in the fuel mode indicator control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **If the test lamp turns ON and OFF**
4. Replace the S48A Fuel Selector Switch.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- S48A Fuel Selector Switch replacement
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup

SYMPTOMS - ENGINE CONTROLS

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides 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.

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.

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.

Fuel Odor

A noticeable smell of unburned gasoline.

Hard Start

The engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stall.

Hesitation, Sag, Stumble

A momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

Lack of Power, Sluggishness, or Sponginess

The engine delivers less than expected power. Little or no increase in vehicle speed when the accelerator pedal is pushed down part way.

Poor Fuel Economy

Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

Rough, Unstable, or Incorrect Idle and Stalling

The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle speed may vary. Either condition may be severe enough to stall the engine.

Surges/Chuggles

An engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

Symptoms Verification

Before using the Symptom tables, perform the following verifications:

- Verify that 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 that the scan tool data is within a normal operating range. Refer to [Control Module References](#) for scan tool information.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.

Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

- Moisture and water intrusion in connectors, terminals, and components
- Incomplete connector mating
- Poor terminal contact
- High circuit or component resistance - High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Wiring harness that is too short or tight

- Wire insulation that is chaffed or cut
- High or low ambient temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surfaces
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of aftermarket, add on accessories

Visual/Physical Check

- Verify that the control module grounds are clean, tight, and correctly located.
- Verify that the vacuum hoses are not split or kinked, and are properly connected.
- Verify that the air filter is clean and free from restrictions.
- Verify that there is no water intrusion in connectors terminals and components.
- Inspect the air intake ducts for the following conditions:
 - Collapsed
 - Damaged areas
 - Looseness
 - Incorrect installation
 - Leaking

If any condition listed above has allowed non-metered air to enter the air induction system, the **Throttle or Idle Learn** procedure must be performed after the repair is complete.

- Inspect for air leaks at the throttle body mounting area, the mass air flow (MAF) sensor and intake manifold sealing surfaces.
- Inspect the wiring harness for the following conditions:
 - Poor connections
 - Pinches
 - Cuts
- Inspect for loose, damaged, unseated, or missing sensors/components.
- Inspect the terminals for corrosion and correct contact.

Symptoms Testing

Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Engine Control Module (ECM) Commanded Reduced Engine Power, Fuel Odor, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges/Chuggles

- Test/inspect the fuel system for the following conditions:
 - Incorrect system operation or fuel pressure - Refer to **Fuel System Diagnosis (LFX)**.
 - Leaking or incorrectly operating fuel injectors - Refer to **Fuel Injector Solenoid Coil Test (LFX)**.
 - Contaminated or poor quality fuel - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Test/inspect the ignition system for the following conditions:
 - 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 - Refer to [Coolant in Combustion Chamber](#) , or [Oil Consumption Diagnosis](#) for diagnosis.
- Secondary ignition system susceptible to moisture. Wet down the secondary ignition system with water from a spray bottle to help locate damaged or deteriorated components. Engine running, look/listen for arcing or misfiring as the water is applied.
- Weak spark using the J 26792 HEI spark tester - Refer to [Electronic Ignition System Diagnosis](#).
- Test/inspect for the following conditions:
 - Non-metered air flow into the air induction system. If a leak is found, repair as necessary. The [Throttle or Idle Learn](#) procedure must be performed when the repair is complete.
 - Incorrectly operating transmission torque converter clutch (TCC) - The scan tool should indicate an engine speed drop when the TCC is commanded ON. Refer to [Torque Converter Diagnosis](#) .
 - Incorrectly operating A/C compressor
 - An engine that runs lean or rich. Observe the Fuel Trim parameters with a scan tool.
 - Slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to different throttle positions.

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 (MAF) sensor installation. A MAF sensor that is incorrectly installed may cause a hard start. Install the MAF in the proper direction. Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) .
- Incorrect MAF sensor connections.
- Engine oil contaminated by fuel
- Split or kinked vacuum hoses - Verify that the routing and connections are correct.
- Excessive knock sensor system spark retard activity - Observe the scan tool Knock Retard parameter for activity greater than 0°.
- Electromagnetic interference (EMI) on reference circuits, which can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition control circuit if a condition exists.
- Incorrectly operating crankcase ventilation valve - Refer to [Crankcase Ventilation System Inspection/Diagnosis](#) .
- A stuck open evaporative emission (EVAP) canister purge solenoid.
- A crankshaft position (CKP) sensor with an intermittent condition - Observe the scan tool Crankshaft Position Resync Counter parameter. The parameter should remain at 0 during all operating conditions, and when moving the related harnesses and connectors between the crankshaft position sensor and the ECM.
- Test/inspect the engine cooling system for the following conditions:
 - A thermostat with an 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 following conditions:
 - Physical damage or possible internal failure
 - Restricted three-way catalytic converters

For additional information, refer to [Symptoms - Engine Exhaust](#) .

- An engine mechanical condition. Test/inspect for the following conditions:
 - Excessive oil in the combustion chamber or leaking valve seals
 - Oil consumption
 - Incorrect cylinder compression
 - Sticking or leaking valves
 - Worn camshaft lobes
 - Incorrect valve timing
 - Worn rocker arms
 - Broken valve springs
 - Excessive carbon buildup in the combustion chambers - Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.
 - Incorrect engine parts

For additional information, refer to [Symptoms - Engine Mechanical](#) .

- If the above conditions do not address the symptom, refer to the additional symptoms tests.

Additional Symptoms Tests

Detonation/Spark Knock

- Test for an engine overheating condition. Refer to [Engine Overheating](#) .
- 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.
- Inspect for excessive carbon buildup in the combustion chambers. Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.
- If there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicle minimum octane requirements.

Engine Control Module (ECM) Commanded Reduced Engine Power

Under certain conditions the 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 oil or coolant to overheat. Refer to [Cooling Fan Description and Operation](#) , and [Cooling System Description and Operation](#) to verify

correct operation of the cooling fan.

- Temporarily reduced engine power. Under extremely cold ambient temperatures some SIDI equipped vehicles may experience ECM commanded reduced engine power for a few minutes during engine warm-up. This would be a normal condition, noticeable only at wide open throttle, and the reduced engine power lamp would not be illuminated.
- Fuel temperature out of range too high.
- A high pressure fuel system condition. Refer to [Fuel System Diagnosis \(LFX\)](#), and [Fuel System Description \(LFX\)](#) to verify high pressure fuel system pressure and operation.
- Intake air temperature out of range too high. Engine running, observe the scan tool IAT sensor parameter. The readings should be between -40Â° C and +149Â° C (-40Â° F and +300Â° F. Refer to [DTC P0112, P0113, or P0114](#) for additional information.
- Reduced engine power due to OnStar® remote command. Verify the vehicle is not in the OnStar® initiated Stolen Vehicle Slowdown mode. Refer to [OnStar Stolen Vehicle Slowdown Active](#) , and [Remote Vehicle Speed Limiting Description and Operation](#) for additional information.
- If equipped with MH7 (6T45) or MHH (6T40) automatic transmission, an incorrect learned brake pedal position (BPP) sensor. Verify the following actions have not occurred:
 - An engine control module has been replaced
 - A BPP sensor has been replaced
 - A BPP sensor is misaligned or incorrectly installed

If any of the above actions have occurred, the [Brake Pedal Position Sensor Learn](#) procedure must be performed.

Fuel Odor

- Inspect for a saturated EVAP canister - Refer to [Evaporative Emission Control System Description](#) .
- Inspect for a condition with the internal components of the fuel tank assembly - Refer to [Fuel System Description \(LFX\)](#) .
- Inspect for leaking, damaged, or deteriorated fuel lines.

Hard Start

- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and clean, if necessary. Refer to [Throttle Body Inspection and Cleaning](#) .
- Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within $\pm 3\text{Â}^{\circ}\text{C}$ ($5\text{Â}^{\circ}\text{F}$). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to [Temperature Versus Resistance - 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.
- Verify that the fuel system has adequate pressure for engine start-up. Observe the scan tool Fuel Pressure Sensor parameter and refer to [Fuel System Diagnosis \(LFX\)](#) for correct pressure specifications.
- Inspect for excessive crankshaft endplay that will cause the crankshaft position (CKP) sensor reluctor wheel to move out of alignment with the CKP 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 \(LFX\)](#).
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) .
- Test the generator. Refer to [Symptoms - Engine Electrical](#) . Repair the charging system if the generator output voltage is less than 9 volts or more than 16 volts.

- Verify that each injector harness is connected to the correct injector.
- Inspect for excessive crankshaft endplay that will cause the crankshaft position (CKP) sensor reluctor wheel to move out of alignment with the CKP sensor. Refer to [Crankshaft and Bearing Cleaning and Inspection](#) , and [Engine Mechanical Specifications](#) .
- Test the manifold absolute pressure (MAP) sensor. Refer to [DTC P0106 \(LFX\)](#) .

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 actuator for each cylinder bank from 0 degrees to 20 degrees and back to zero while observing the appropriate 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 Timing Drive Components Cleaning and Inspection](#) , and [Camshaft Actuator System Description](#) for additional information.

Poor Fuel Economy

- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and clean, if necessary. Refer to [Throttle Body Inspection and Cleaning](#) .
- Inspect for heavy loads being carried or towed
- Inspect for acceleration rate too much or too often
- Inspect the brake system for brake drag.
- 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 the parameter listed in 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.
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) .

Rough, Unstable, or Incorrect Idle and Stalling

- An excessively high idle may be due to the floor mat interfering with the accelerator pedal. With this condition present, it may not be possible to shift the transmission into gear. Inspect the accelerator pedal for binding and verify that the floor mat is not interfering with the accelerator pedal movement.
- Engine idle speed may be unstable or the engine may stall if the ECM has learned an incorrect idle/airflow compensation value. A DTC may also set. Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. If the throttle body needs cleaning, refer to [Throttle Body Inspection and 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 or Idle Learn** procedure must be performed.

- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**.
- Inspect the engine mounts. Refer to **Engine Mount Inspection**
- Inspect the intake and exhaust manifolds for casting flash.

NOTE: The ECM uses the bank 1 exhaust camshaft position sensor to determine camshaft to crankshaft relationship in order to control fuel injector and ignition system synchronization. If the bank 1 exhaust camshaft position sensor signal to the ECM is intermittent, a stalling condition will occur and a DTC will not set.

- Inspect all bank 1 exhaust camshaft position sensor wiring for poor connections. Start the engine and observe for engine stalling while wiggling the bank 1 exhaust camshaft position sensor wiring harness. Refer to **Inducing Intermittent Fault Conditions** for further diagnosis.

Surges/Chuggles

- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**.
- Inspect for slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The PCM reduces the amount of fuel delivered to the engine, causing a driveability condition.
- Verify that each injector harness is connected to the correct injector.

POOR FUEL FILL QUALITY

Problem	Causes
DEFINITION: During the fueling process a continual, occasional, or no-fuel nozzle shut-off condition has occurred.	
Difficult to fill	• Fuel fill limiter vent valve stuck closed • Evaporative emission (EVAP) canister restricted • EVAP vent valve stuck closed • Hose between canister and canister vent solenoid twisted or kinked if applicable • High fuel temperature • Fuel filler hose is kinked • Faulty dispensing nozzle • Ignition switch ON, vent valve closed
Over fill	• Fill limiter vent valve stuck open or leaking • Fuel inlet check valve stuck open
Pre-mature shut-off of the fuel dispensing nozzle occurs immediately after engaging dispensing nozzle, tank empty	• Restricted vapor lines or fuel fill pipe • High fuel temperature • Inlet check valve at tank stuck closed, fill pipe full of fuel • Fuel tank full, gauge not accurate

Problem	Causes
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

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 Schematics \(LFX\)](#)
- [Instrument Cluster Schematics](#)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

NOTE: Any MIL requesting DTCs that may be set should be diagnosed first.

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the MIL On and Off with a scan tool.
 - MIL Control Circuit Low Voltage Test Status
 - MIL Control Circuit Open Test Status
 - MIL Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing
 - **If Malfunction is not displayed**
3. Engine running.
4. Verify the parameters listed below do not display Malfunction when commanding the MIL On and Off with a scan tool.
 - MIL Control Circuit Low Voltage Test Status
 - MIL Control Circuit Open Test Status
 - MIL Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing
 - **If Malfunction is not displayed**
5. Verify the malfunction indicator lamp turns ON and OFF when commanding the MIL On and Off with a scan tool.
 - **If the MIL does not turn ON and OFF**

Refer to Circuit/System Testing
 - **If the MIL turns ON and OFF**
6. All OK.

Circuit/System Testing

1. Ignition OFF.
2. Disconnect the X1 harness connector at the K20 Engine Control Module.
3. Ignition ON, verify the MIL does not illuminate.
 - **If the MIL illuminates**
 1. Test for infinite resistance between the control circuit terminal 46 and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - If infinite resistance, replace the P16 Instrument Cluster.
 - **If the MIL does not illuminate**
4. Connect a 3 A fused jumper wire between the control circuit terminal 46 and ground.
5. Verify the MIL illuminates.
 - **If the MIL illuminates**

Replace the K20 Engine Control Module.
 - **If the MIL does not illuminate**
 1. Test for less than 1 V between the control circuit terminal 46 and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V
 2. Ignition OFF.
 3. Test for less than 2 Ω in the control circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω .
6. Ignition OFF, disconnect the X1 harness connector at the instrument cluster.
 7. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal 8 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - **If the test lamp illuminates**
 8. Replace the P16 Instrument Cluster.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Instrument Cluster Replacement](#)
- [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 diagnostic is an organized approach to identify a condition which causes the engine to crank but not start. This diagnostic directs the technician to the appropriate system diagnosis.

Diagnostic Aids

Inspect for any of the conditions listed below:

- If equipped with a key type ignition system, a partially retracted or folded over ignition key. When attempting to start the engine, the mechanical portion of the vehicle key must be locked in the fully extended position with the fob parallel to the key. Leaving the key partially retracted or folded over when starting may interrupt transponder authentication and result in an intermittent no-start condition. In such instances, DTC B3055 may also be set. If an intermittent no-start complaint is received, it may be necessary to discuss with the customer their starting habits and verify they are locking the key in the fully extended position, fob parallel to the key, before starting.
- Insufficient fuel. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.
- An in-tank fuel pump condition. 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).
- Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid. Refer to [Fuel Injector Solenoid Coil Test \(LFX\)](#) for diagnosis.

- Fuel injector ON time inadequate. When this condition is present, there may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Check all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle.
- A crankshaft position sensor condition. When this condition is present, the engine control module (ECM) uses the camshaft position sensors to determine engine speed and position. If the condition exists in the signal circuit of the sensor, the engine will go into a limp home mode after a hard restart. The ECM then calculates engine speed from one of the camshaft position sensors. However, the engine will operate with a crankshaft position sensor condition only if the ECM has stored the learned reference position of the camshafts in memory.
- Loose unsecured engine electrical grounds. Inspect the engine for good secure electrical grounds.
- Water or foreign material in the fuel, which can cause either a no start or a engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 min in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.
- An ignition system that is susceptible to moisture. An engine that starts and runs after being brought into a warm, dry repair shop may be susceptible to moisture. Spray water on the ignition system components and wiring while cranking the engine in order to check for an engine starting or will not stay running concern.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 26792 HEI Spark Tester

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)** .

Circuit/System Verification

NOTE: This diagnostic assumes the following:

- The battery is completely charged.
- The engine cranking speed is acceptable.

- There is adequate fuel in the fuel tank.

1. Crank the engine for up to 15 s.
2. Verify that DTC P0116, P0118, P0201, P202, P203, P204, P205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0335, P0336, P0513, P0601, P0602, P0603-P0606, P062B, P0627, P0628, P0629, P0633, P069E, P1631, P1649, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F or U0109 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. Ignition ON.
4. Verify the Security Indicator on the instrument cluster illuminates momentarily.

- **If the security indicator stays ON or is flashing**

Review the [Diagnostic Trouble Code \(DTC\) List - Vehicle](#), for immobilizer system DTCs. For additional information, refer to [Immobilizer Description and Operation](#).

- **If the security indicator does not stay ON and is not flashing**

5. Verify the scan tool Engine Speed parameter displays greater than 0 RPM while cranking the engine.

- **If 0 RPM**

Refer to [DTC P0335 or P0336](#).

- **If greater than 0 RPM**

NOTE: A MAF sensor circuit condition may cause an Engine Cranks But Does Not Run condition without setting a DTC.

6. Verify that the scan tool Mass Airflow Sensor parameter displays greater than 0 Hz while cranking the engine.

- **If 0 Hz**

Refer to [DTC P0102 or P0103](#).

- **If greater than 0 Hz**

7. Ignition OFF, connect the EL 26792 HEI Spark Tester between the spark plug boot of a T8 Ignition Coil and ground.

NOTE:

- Perform the spark test on at least 3 of the cylinders.
- An erratic or weak spark is considered a no spark condition.

8. Verify the spark tester sparks while cranking the engine.

- **If the spark tester does not spark**

Refer to [Electronic Ignition System Diagnosis](#).

- **If the spark tester sparks**

9. Ignition ON, engine OFF.

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 down to less than 60°C (150°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.

10. Command the Fuel Pump Enable On several times with a scan tool.
11. Verify the Chassis Control Module Fuel Pressure Sensor parameter is between 345 - 690 kPa (50 - 100 psi) while the fuel pump is running.
 - **If not within the specified range**

Refer to [Fuel System Diagnosis \(LFX\)](#).

- **If within the specified range**

NOTE: The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.

12. Verify the Chassis Control Module Fuel Pressure Sensor parameter, after the fuel pump has turned OFF, decreases to 500 - 599 kPa (72 - 87 psi), and does not decrease greater than 34 kPa (5 psi) in 1 minute from that point.
 - **If not within the specified range**

Refer to [Fuel System Diagnosis \(LFX\)](#).

- **If within the specified range**

13. Verify the Fuel Rail Pressure Sensor parameter is between 1.9 - 2.1 MPa (279 - 305 psi) while cranking the engine.

- **If not within the specified range**

Perform the Circuit/System Testing section of the [Fuel Injector Circuit Diagnosis](#).

- **If within the specified range**

14. Verify none of the conditions listed below exist:

- Collapsed air intake duct to the throttle body
- Restricted air filter element
- Gas or coolant fouled spark plugs
- A skewed engine coolant temperature (ECT) sensor - Refer to [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#).
- 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](#).

- **If a condition exists**

Repair as necessary.

- **If no conditions exist**

15. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

FUEL SYSTEM DIAGNOSIS (LFX)

Diagnostic 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 Chassis Control Module when the ECM detects that the ignition is ON. The voltage from the ECM to the Chassis Control Module remains active for 2 s, unless the engine is in Crank or Run. While this voltage is being received, the Chassis Control Module closes the ground switch of the Fuel Pump and also supplies a varying voltage to the Fuel Tank Fuel Pump Module in order to maintain the desired fuel 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 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. The check valve maintains fuel pressure in the fuel feed pipe in order to prevent long cranking times.

Diagnostic Aids

Observe the Misfire Counters or perform the fuel injector balance test to help identify a leaking Fuel Injector. Refer to [Fuel Injector Balance Test](#).

Reference Information

Description and Operation

Fuel System Description (LFX)

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

J-37287-FF 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 before performing this diagnostic.
- Inspect the fuel system for damage or external leaks before proceeding.
- Verify that adequate fuel is in the fuel tank before proceeding.
- The Fuel Pump Enable may need to be commanded On a few times in order to obtain the highest possible fuel pressure.
- DO NOT perform the Fuel System Diagnosis if the engine coolant temperature is above 60Â°C (150Â°F). High fuel pressure readings

may result due to hot soak fuel boiling. With the engine OFF, the fuel pressure may increase beyond the pressure relief regulator valve's setting point of 690 kPa (100 PSI) $\pm$ 5 percent.

1. Ignition ON, engine OFF, command the Fuel Pump Enable On several times with a scan tool.
2. Verify the Chassis Control Module Fuel Pressure Sensor parameter is between 345-690 kPa (50-100 PSI) with the fuel pump running.

- **If less than 345 kPa (50 PSI)**

Refer to Circuit/System Testing - Fuel Pressure Low.

- **If greater than 690 kPa (100 PSI)**

Replace the G12 Fuel Pump.

- **If between 345-690 kPa (50-100 PSI)**

NOTE: The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.

3. Verify that the Chassis Control Module Fuel Pressure Sensor parameter decreases to 500-599 kPa (72-87 PSI) after the fuel pump is turned off.

- **If the fuel pressure does not decrease to 500-599 kPa (72-87 PSI)**

Replace the G12 Fuel Pump.

- **If the fuel pressure decreases to 500-599 kPa (72-87 PSI)**

4. Verify the Chassis Control Module Fuel Pressure Sensor parameter does not decrease greater than 34 kPa (5 PSI) in 1 min.

- **If the fuel pressure decreases greater than 34 kPa (5 PSI)**

Refer to Circuit/System Testing - Fuel Pressure Leaks Down.

- **If the fuel pressure does not decrease greater than 34 kPa (5 PSI)**

5. Engine idling.

6. Verify that the Chassis Control Module Fuel Pressure Sensor parameter is between 300-400 kPa (43-58 PSI)

- **If less than 300 kPa (43 PSI)**

Refer to Circuit/System Testing - Fuel Pressure Low.

- **If greater than 400 kPa (58 PSI)**

Replace the G12 Fuel Pump.

7. Verify the scan tool Chassis Control Module Short Term Fuel Pump Trim and the Long Term Fuel Pump Trim when multiplied together are less than 1.5.

- **If greater than 1.5**

Refer to Circuit/System Testing - Fuel Pressure Low.

- **If less than 1.5**

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.

8. Verify the scan tool Chassis Control Module Fuel Pressure Sensor and the Desired Fuel Pressure are within 45 kPa (6.5 PSI) at 300 kPa (43.5 PSI) request or 60 kPa (8.7 PSI) at 400 kPa (58 PSI) request of each other while operating the vehicle through varying loads.

- **If greater than 45 kPa (6.5 PSI) / 60 kPa (8.7 PSI)**

Refer to Circuit/System Testing - Fuel Pressure Drops OFF.

- **If less than 45 kPa (6.5 PSI) / 60 kPa (8.7 PSI)**

9. If the fuel system components test normal, refer to [Symptoms - Engine Controls](#), [Fuel Injector Solenoid Coil Test \(LFX\)](#), and [Fuel Injector Balance Test](#).

Circuit/System Testing

Fuel Pressure Low

1. Verify none of the conditions listed below exist:

- Restricted fuel feed pipe
- Restricted or plugged strainer
- Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
- **If a condition exist**

Repair as necessary.

- **If a condition does not exist**

2. Test or replace the G12 Fuel Pump.

Fuel Pressure Leaks Down

1. Ignition OFF, relieve the fuel pressure. Refer to [Fuel Pressure Relief \(Gasoline\)](#).
2. Install the **EN-37287** Fuel Line Shut-Off Adapters between the fuel feed pipe and the fuel rail.
3. Open the valve on the **EN-37287** Fuel Line Shut-Off Adapters.
4. Ignition ON, command the Fuel Pump Enable On with a scan tool.
5. Close the valve on the **EN-37287** Fuel Line Shut-Off Adapters.
6. Verify the Chassis Control Module Fuel Rail Fuel Pressure parameter does not decrease greater than 34 kPa (5 PSI) in 1 min.

- **If the fuel pressure drops**

Replace the G12 Fuel Pump.

- **If the fuel pressure does not drop**

7. Locate and replace the leaking Q17 Fuel Injector.

Fuel Pressure Drops OFF

1. Verify none of the conditions listed below exist:

- Restricted fuel feed pipe
- Restricted or plugged strainer
- Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
- **If a condition exist**

Repair as necessary.

- **If a condition does not exist**

2. Test or replace the G12 Fuel Pump.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Chassis Control Module Replacement](#)
- [Fuel Feed Front Pipe Replacement \(LFX\)](#)
- [Fuel Feed Hose Replacement \(Flex Sensor to Front Pipe\)](#) [Fuel Feed Hose Replacement \(Flex Sensor to Rear Pipe\)](#) [Fuel Feed Hose Replacement \(Without E-85\)](#)
- [Fuel Feed Pipe Replacement \(LFX\)](#)
- [Fuel Injection Fuel Rail Assembly Replacement - Bank 1 \(LFX\)](#)
- [Fuel Injection Fuel Rail Assembly Replacement - Bank 2 \(LFX\)](#)
- [Fuel Tank Fuel Pump Module Replacement \(NT5, NT7\)](#) [Fuel Tank Fuel Pump Module Replacement \(NU6\)](#) for G12 Fuel Pump replacement

FUEL INJECTOR SOLENOID COIL TEST (LFX)

Diagnostic 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 a separate high voltage supply circuit and a high voltage control circuit for each fuel injector. The fuel 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 a fuel injector, allowing for initial injector opening. The fuel injector is then held open with 12 V. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Component Testing

NOTE:

- The resistance test must be performed at the fuel injector or mis-diagnosis will occur.
- The DMM and test leads must be calibrated to 0 Ω in order to prevent mis-diagnosis.

1. Ignition OFF, all vehicle system OFF, disconnect the harness connector at the appropriate Q17 Fuel Injector.
2. Test for 1.9 - 2.3 Ω at 20 $^{\circ}$ C (68 $^{\circ}$ F) between the high voltage supply circuit terminal 2 and the high voltage control circuit terminal 1 at the Q17 fuel injector.
 - If not within the specified range

Replace the Q17 Fuel Injector.

- **If within the specified range**

3. Test for infinite resistance between each terminal at the Q17 Fuel Injector and the Q17 Fuel Injector housing/case.

- **If less than infinite resistance**

Replace the Q17 Fuel Injector.

- **If infinite resistance**

4. All OK, perform the **Fuel Injector Balance Test**.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LFX)**
- **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LFX)**

FUEL INJECTOR BALANCE 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.

Circuit/System Description

Two methods of testing fuel injector balance are available, the Active Fuel Injector Tester (AFIT) or a scan tool. The Active Fuel Injector Tester and SIDI adaptor connects to the engine control module harness connectors to test the high pressure fuel pump performance, fuel injector wiring, and fuel injector operation. The AFIT displays step by step instructions to precisely determine pressure drop of each fuel injector. The scan tool fuel injector balance test is performed while the engine is running at idle. The scan tool pressurizes the fuel rail to a predetermined pressure before each fuel injector is pulsed for a precise amount of time allowing a measured amount of the fuel to be injected. This causes a drop in the system fuel pressure that is recorded and used to compare each fuel injector.

Diagnostic Aids

- Monitoring the Current Misfire Counters may help to isolate the fuel injector that is causing the condition.
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description (LFX)

Scan Tool Reference

Control Module References for scan tool information

- **CH-47976** Active Fuel Injector Tester
- **CH-47976-500** Active Fuel Injection Tester (AFIT) SIDI Adapter Kit

For equivalent regional tools, refer to [Special Tools \(Diagnostic Tools\)](#) [Special Tools \(Mechanical Tools\)](#)

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Fuel Remaining parameter is greater than 10%.
 - **If the Fuel Remaining parameter is less than 10%** , add fuel to the fuel tank.
 - **If the Fuel Remaining parameter is 10% or greater**
3. Verify the scan tool ECT Sensor parameter is less than 60°C (140°F).
 - **If the ECT Sensor parameter is greater than 60°C (140°F)** , allow the engine temperature to cool.
 - **If the ECT Sensor parameter is 60°C (140°F) or less**
4. Verify the battery is fully charged and all accessories are Off.
 - **If the battery is not fully charged** , charge or repair battery as necessary.
 - **If the battery is fully charged**
5. Perform the appropriate Fuel Injector Balance Test in Circuit System Testing.

Circuit System Testing

Fuel Injector Balance Test with Active Fuel Injector Tester

1. Ignition OFF, all vehicle systems OFF. Install the **CH-47976** Active Fuel Injector Tester and the **CH-47976-500** Active Fuel Injection Tester (AFIT) SIDI Adapter Kit, refer to the Active Fuel Injector Tester User Guide. It may take up to 2 minutes for all vehicle systems to power down.
2. Turn ON the Active Fuel Injector Tester and select the vehicle.
3. Ignition ON, perform the Injector Test with the Active Fuel Injector Tester.
 - **If the Active Fuel Injector Tester aborts testing due to fuel pressure or fuel leak down**
Refer to [Fuel System Diagnosis \(LFX\)](#).
 - **If the Active Fuel Injector Tester does not abort testing**
4. Compare the test results with the appropriate recommended tolerance.
 - **If any fuel injector exceeds the recommended tolerance**
Replace the appropriate Q17 Fuel Injector(s).
 - **If all fuel injectors are within the recommended tolerance**
5. Perform [Fuel Injector Circuit Diagnosis](#).

Fuel Injector Balance Test with Scan Tool

1. Ignition ON.
2. Command the Fuel Pump Enable ON with a scan tool.
3. Verify the fuel pressure is between 345 - 690 kPa (50 - 100 PSI) with the fuel pump running.
 - **If not within 345 - 690 kPa (50 - 100 PSI)**
Refer to [Fuel System Diagnosis \(LFX\)](#).
 - **If within 345 - 690 kPa (50 - 100 PSI)**

NOTE: The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure

should stabilize and remain constant.

4. Verify the fuel pressure does not decrease greater than 34 kPa (5 PSI) within 1 minute.

- **If greater than the specified value**

Refer to [Fuel System Diagnosis \(LFX\)](#).

- **If less than the specified value**

5. Engine idling.

6. Verify the scan tool Fuel Rail Pressure Sensor 1 parameter is between 1.9 - 5.0 MPa (276 - 725 PSI).

- **If not between 1.9 - 5.0 MPa (276 - 725 PSI)**

Refer to [Fuel System Diagnosis \(LFX\)](#).

- **If between 1.9 - 5.0 MPa (276 - 725 PSI)**

NOTE: The engine speed must be between 600 - 1, 000 RPM to perform this test.

7. Select the Fuel Injector Balance function within the Control Functions menu of a scan tool.

8. Select and test a Q17 Fuel Injector. Repeat for each Q17 Fuel Injector.

9. Obtain and record a pressure drop value for each Q17 Fuel Injector.

10. Add all of the individual pressure drop values except for the fuel injector suspected of being faulty. This is the total pressure drop.

11. Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop.

12. Multiply the average pressure drop by 0.20. This is the acceptable variance from the average pressure drop, 20%.

13. Verify the difference between any individual pressure drop and the average pressure drop is not greater than the acceptable variance.

- **If greater than the acceptable variance**

Replace the Q17 Fuel Injector.

- **If within the acceptable variance**

14. Perform [Fuel Injector Circuit Diagnosis](#).

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Fuel Injection Fuel Rail Assembly Replacement - Bank 1 \(LFX\)](#)
- [Fuel Injection Fuel Rail Assembly Replacement - Bank 2 \(LFX\)](#)

FUEL INJECTOR CIRCUIT DIAGNOSIS

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Injector 1 Control +	P2147	P0201	P2148	P1248
Fuel Injector 1 Control -	P0261	P0201	P0262	P1248

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Injector 2 Control +	P2150	P0202	P2151	P1249
Fuel Injector 2 Control -	P0264	P0202	P0265	P1249
Fuel Injector 3 Control +	P2153	P0203	P2154	P124A
Fuel Injector 3 Control -	P0267	P0203	P0268	P124A
Fuel Injector 4 Control +	P2156	P0204	P2157	P124B
Fuel Injector 4 Control -	P0270	P0204	P0271	P124B
Fuel Injector 5 Control +	P216B	P0205	P216C	P124C
Fuel Injector 5 Control -	P0273	P0205	P0274	P124C
Fuel Injector 6 Control +	P216E	P0206	P216F	P124D
Fuel Injector 6 Control -	P0276	P0206	P0277	P124D

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 Solenoid Coil Test (LFX)**.
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description (LFX)

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.

- Engine idling.
- Verify the scan tool Cylinder 1 - 6 Current Misfire Counter parameters do not increment.
 - If the Cylinder 1 - 6 Current Misfire Counters increment**
Refer to Circuit/System Testing.
 - If the Cylinder 1 - 6 Current Misfire Counters do not increment**
- Verify the scan tool Cylinder 1 - 6 Injector Control Circuit Status parameters display OK.

- If the Cylinder 1 - 6 Injector Control Circuit Status parameters do not display OK

Refer to Circuit/System Testing.

- If the Cylinder 1 - 6 Injector Control Circuit Status parameters display OK

4. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF. Disconnect the X3 harness connector at the K20 Engine Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for infinite resistance between the appropriate Q17 Fuel Injector control + circuit and ground.
 - **If less than infinite resistance**
 1. Disconnect the harness connector of the Q17 Fuel Injector.
 2. Test for infinite resistance between the Q17 Fuel Injector control + circuit and ground.
 - If infinite resistance
 3. Test for infinite resistance between the Q17 Fuel Injector control - circuit and ground.
 - If less than infinite, repair the short to ground in the circuit.
 - If infinite, replace the Q17 Fuel Injector.
 - **If infinite resistance**
3. Ignition ON.
4. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
 - **If 1 V or greater**
 1. Disconnect the harness connector of the Q17 Fuel Injector, ignition ON.
 2. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, repair the short to voltage on the control - circuit.
 - **If less than 1 V**
5. Ignition OFF.
6. Test for less than 3 Ω between the Q17 Fuel Injector control + circuit and control - circuit.
 - **If 3 Ω or greater**
 1. Disconnect the harness connector of the Q17 Fuel Injector.
 2. Test for less than 2 Ω on the control + circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 3. Test for less than 2 Ω on the control - circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the Q17 Fuel Injector.
 - **If less than 3 Ω**
7. Replace the K20 Engine Control Module.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Fuel Injector Replacement \(LFX\)](#)
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup

ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.

- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

Circuit/System Description

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10% in non-blended gasoline or greater than 85% with E85 blended gasoline for flexible fuel applications can cause driveability conditions such as hesitation, lack of power, stalling, or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

Reference Information

Special Tools

CH 44175 - A Alcohol Tester Kit, if available

For equivalent regional tools, refer to [Special Tools \(Diagnostic Tools\)](#) [Special Tools \(Mechanical Tools\)](#) .

Circuit/System Verification

1. Remove a sample of fuel from the bottom of the fuel tank and place in a clean, clear container.
2. Place the sample on a level surface for 2 minutes.
3. Verify the sample is clear and bright in color.

- **If the sample appears cloudy, or contaminated with water, as indicated by a water layer at the bottom of the sample**

Refer to Circuit/System Testing - Particulate Contaminants in Fuel.

- **If alcohol contamination is suspected**

Refer to Circuit/System Testing - Alcohol in Fuel Testing.

- **If the sample remains clear and bright**

4. All OK.

Circuit/System Testing

Alcohol in Fuel Testing with Special Tool, If Available

1. Test the fuel composition using **CH 44175 - A** and Instruction Manual.
2. Verify no water appears in the fuel sample.
 - **If water appears in the fuel sample**
Clean the fuel system.
 - **If no water appears in the fuel sample**
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.
4. Verify the non-blended gasoline fuel sample does not measure greater than 15% or an E85 blended gasoline fuel sample does not measure greater than 91% ethanol.
 - **If greater than the specified value**
 1. Add fresh regular gasoline to the vehicle's fuel tank.
 2. Remove a new sample of fuel from the tank.
 3. Test the fuel composition using **CH 44175 - A** and Instruction Manual.
 4. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.

5. Verify the non-blended gasoline fuel sample does not measure greater than 15% or an E85 blended gasoline fuel sample does not measure greater than 91% ethanol.
 - If additional testing indicates that the ethanol percentage is still above 15% for a non-blended gasoline sample, drain and replace the vehicle's fuel. Refer to [Fuel Tank Draining](#).
 - If additional testing indicates that the E85 blended gasoline sample still measures above 91%, continue adding fresh, regular gasoline until the ethanol content is 85% or less.
- **If the specified value or less**

5. All OK.

Alcohol in Fuel Testing without Special Tool

NOTE: This procedure is for non-blended gasoline only. If excessive alcohol content is suspected with E85 fuel add 15% tank volume of fresh, regular gasoline to the fuel tank.

1. Using a 100 ml (3.38 oz) specified cylinder with 1 ml (0.034 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.
2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.38 oz) and install a stopper.
3. Shake the cylinder vigorously for 10 - 15 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 minutes to allow adequate liquid separation. If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be more than 10 ml (0.34 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5% alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.
7. Verify the non-blended gasoline fuel sample does not measure greater than 15%.
 - **If greater than the specified value**
 1. Add fresh regular gasoline to the vehicle's fuel tank.
 2. Remove a new sample of fuel from the tank.
 3. Test the fuel composition of the new sample.
 4. Verify the non-blended gasoline fuel sample does not measure greater than 15%.
 - If greater than the specified value, drain and replace the vehicle's fuel. Refer to [Fuel Tank Draining](#).
 - If the specified value or less, all OK.
 - **If the specified value or less**
8. All OK.

Particulate Contaminants in Fuel

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel from the bottom of the fuel tank.
2. Place the container on a level surface for approximately 5 minutes in order to allow settling of the particulate contamination. Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles.
3. Verify there are no physical contaminants or water present in the fuel sample.
 - **If any physical contaminants or water are present**

Clean the fuel system.
 - **If no physical contaminants or water are present**

4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Fuel System Cleaning
- Fuel Tank Draining

EVAPORATIVE EMISSION SYSTEM DIAGNOSIS

Special Tools

EN-41413-VLV EVAP Service Port Vent Fitting

Operating Instructions for the Evaporative Emission System Tester

Vehicle Setup

WARNING: Refer to Fuel and Evaporative Emission Pipe Warning .

CAUTION: Refer to Clean, Dry, Low Pressure Gas Source Caution .

NOTE: When servicing the evaporative emission (EVAP) system, test pressure must not exceed 13 in H₂O (0.5 PSI) as pressure in excess of this could cause system components to perform inaccurately.

NOTE: A large difference between the vehicle temperature and shop temperature will seriously affect the accuracy of the tests. Always allow at least 15 min for the vehicle temperature to adjust to the shop temperature. Refer to Temperature Variation Instructions for more information about vehicle versus shop temperatures.

1. Engine OFF, open the hood. Position a large fan to blow air under the vehicle onto the fuel tank area.
2. Connect the red battery clip from the tester to the positive battery terminal.

NOTE: The vehicle battery must be fully charged for optimum tester performance.

3. Connect the black battery clip from the tester to chassis ground.

Flow Meter Test - Leak Detection

CAUTION: Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .

1. Open the Nitrogen tank valve and turn the NITROGEN / SMOKE valve on the front control panel to NITROGEN.
2. Connect the hose to the correct test orifice on the bottom front of the tester. For orifice size, refer to the vehicle specific information found in service procedures for DTCs that relate to EVAP system leaks.
3. Press and release the remote switch to activate the tester.

NOTE: The tester will time out after about 15 min. You may press the remote switch to reactivate the tester as desired.

4. Position the sliding red flag on the flow meter to align with the floating indicator. When the red flag is set, press and release the remote switch to deactivate the tester.
5. Remove the hose from the test orifice and install the hose onto the vehicle. For proper connection location, and the special tool numbers for any adapters that may be required, refer to the service

procedures for DTCs that relate to EVAP system leaks.

6. Ignition ON, seal the EVAP system per instructions in the service procedures for DTCs that relate to EVAP system leaks. Most systems can be sealed using a scan tool output control for the EVAP Vent Solenoid Valve, other systems require that the vent system be plugged.

NOTE:

- **Larger volume fuel tanks, and/or those with lower fuel levels, may require several minutes to fill with nitrogen.**
- **Static buildup may cause the float indicator to stick. It may be necessary to tap on the flow meter to free up the float.**
- **If fuel level is 90% or greater it will take longer to fill the system with smoke because the fuel fill tube check valve will be closed and force any smoke to pass through the on-board refueling vapor recovery pipe and orifice.**

7. Press and release the remote switch to activate the nitrogen flow and fill the system.

8. Verify the stable floating indicator position to the red flag.

- **Above the red flag, result is unacceptable - fail**

Go to the Smoke Procedure

- **Below the red flag - pass. Test complete**

9. Press and release the remote switch to deactivate the tester.

Smoke Procedure - Locate the Leak

NOTE:

It is not recommended to use the tester in an outside repair bay area because wind and sunlight may affect temperature and your ability to see the smoke.

1. Turn OFF any fans that may cause air movement around or near the vehicle.

NOTE:

Completely unwind the nitrogen/smoke hose from the bracket to optimize the tester's performance.

2. Connect the nitrogen/smoke hose to the vehicle as directed in the service procedures. Some vehicles require that the nitrogen/smoke hose be connected at the front of the EVAP system at the EVAP service port. An adapter may be necessary. Other vehicles require the connection be made at the rear of the system using an adapter at the fuel fill cap or capless fuel fill. Consult the service procedures for DTCs that relate to EVAP system leaks for vehicle specific instructions regarding connection location and adapters.
3. Open the Nitrogen tank valve and turn the nitrogen/smoke valve on the control panel to smoke.

NOTE:

The remote switch operates on a push ON, push OFF fashion.

4. Press and release the remote switch to activate the tester and inject smoke into the EVAP system.
5. Verify smoke has filled the EVAP system by opening the system opposite the end where smoke is injected.

NOTE:

- **When injecting smoke at the service port, remove the fuel fill cap until smoke is observed. Then close the system and continue testing.**
- **If using a special tool fuel fill cap adapter at the filler neck, vent the system at the service port, with special tool EN-41413-VLV until smoke is observed then remove the vent fitting tool and close the system to continue with the test.**
- **Inject smoke in less than 2 min cycles for optimum tester performance.**

6. Press and release the remote switch to deactivate the tester.

NOTE: For optimum visual smoke performance, deactivate the smoke flow and allow the system pressure to drop. Allowing the smoke to exit small holes at a low flow rate greatly enhances visibility.

7. Introduce smoke into the system for an additional 60 s. Continue introducing smoke at 15 s intervals, as necessary until leak source is identified.
8. Using a high-intensity white light, inspect the entire EVAP system path, and look for the source of the leak indicated by the exiting smoke.

- **Smoke seen leaking**

Repair or replace the affected component.

- **No smoke seen leaking**

9. All OK

Temperature Variation Instructions

The Concern

Ideal circumstances for conducting the EVAP flow meter test require equal temperatures between the Nitrogen gas and the vehicle EVAP system. Significant differences in temperature between them can result in a flow or pressure change during testing, causing misleading results. Typically, the evaporative emission system tester is stored indoors, approximately 21°C (70°F). Vehicles brought in for diagnosis may have an EVAP system at significantly different temperatures.

For Example

NOTE: With no temperature difference between the Nitrogen gas and EVAP system, the resulting vehicle EVAP system pressure will remain stable at 13 in. H₂O (0.5 PSI) once pressurized, providing no leaks are present.

When the EVAP flow meter tests are performed with significant differences in temperature between the Nitrogen gas and the vehicle EVAP system, the following results can occur:

- An increase in flow during the flow meter test can be caused by a vehicle's warm EVAP system cooling down.
- A decrease in flow during the flow meter test can be caused by a vehicle's cool EVAP system warming up.

The Solution

When working on a vehicle with significant temperature differences between the vehicle EVAP system and the Nitrogen gas, allow the vehicle EVAP system temperature to stabilize as close as possible to the temperature of the Nitrogen gas before conducting the flow meter test.

ELECTRONIC IGNITION SYSTEM DIAGNOSIS

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

Circuit/System Description

This ignition system uses an individual ignition coil for each cylinder. The Engine Control Module (ECM) controls the spark events by transmitting the timing pulses on the ignition control circuits to the individual ignition coil in firing order sequence.

Diagnostic Aids

- This engine application may use 2 fuses, one for each bank, to supply ignition voltage to the ignition module/coil assemblies. A good indication that a fuse is open is that all misfire counters are incrementing on one side of the engine.
- An open/high resistance on the low reference circuit to the ignition coil may cause a misfire.
- An erratic or weak spark is considered a no spark condition.

Reference Information

Schematic Reference

Engine Controls Schematics (LFX)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

Control Module References

Special Tools

EL 26792 HEI Spark Tester

For equivalent regional tools, refer to [Special Tools \(Diagnostic Tools\)](#) [Special Tools \(Mechanical Tools\)](#).

Circuit/System Testing

NOTE: Do not perform this diagnostic procedure unless you were sent here from a misfire DTC or the Engine Cranks But Does Not Run diagnostic.

1. Ignition OFF and all vehicle systems OFF. Disconnect the harness connector at the appropriate T8 Ignition Coil. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the ground circuit terminal 1/A and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 5 Ω**
3. Test for less than 5 Ω between the low reference circuit terminal 2/B and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **If less than 5 Ω**
4. Ignition ON.
5. Verify a test lamp illuminates between the ignition circuit terminal 4/D and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp illuminates**
6. Ignition OFF, exchange the suspect T8 Ignition Coil with the T8 Ignition Coil of a known functioning cylinder.
7. Engine Running.
8. Verify the scan tool Cylinder 1 - 6 Current Misfire Counter does not increment for the same cylinder that the suspect T8 Ignition Coil was removed from.
 - **If increments**
Replace the K20 Engine Control Module.
 - **If does not increment**
9. Test or replace the T8 Ignition Coil.

Component Testing

NOTE: You must perform the Circuit/System Testing before proceeding with Component Testing.

1. Ignition OFF, connect the EL 26792 to the appropriate T8 Ignition Coil.
2. Engine Running.
3. Verify the spark output of the T8 Ignition Coil.
 - **If no output or the output is weak**
Replace the T8 Ignition Coil
 - **If the output is good**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition Coil Replacement - Bank 1**
- **Ignition Coil Replacement - Bank 2**
- **Control Module References** for engine control module replacement, programming, and setup.

INSPECTION/MAINTENANCE SYSTEM CHECK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **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, such as engine control modules (ECMs), transmission control modules (TCMs), fuel pump control modules, etc. An I/M Test DTC will not be stored or erased from the electronic control unit 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 Status indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has 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 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 41 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 or exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following; if equipped:

- The air conditioning system
- The catalytic converter efficiency
- Comprehensive component monitoring - Emission related inputs and outputs
- The evaporative emission (EVAP) system
- The fuel delivery system
- Heated catalyst monitoring
- Misfire monitoring
- The oxygen sensor system (O2S or HO2S)
- The oxygen sensor heater system (HO2S heater)

For the specific DTCs required for each system, refer to **Inspection/Maintenance (I/M) System DTC Table**. Systems such as misfire and comprehensive components may not be listed in a system status list. These tests run continuously and do not require an I/M System Status indicator.

Diagnostic Aids

The Inspection/Maintenance System Status or Data display provides an indication of when the control module has completed the required tests. This does not necessarily mean that the test has passed, only that a decision was made. If the diagnostic fails, a DTC will indicate the failure. If a failure indication is present for a DTC associated with one of the I/M regulated systems, it may prevent other required tests from running. For example, a DTC for the control circuit of the EVAP purge solenoid may not be listed in the Inspection/Maintenance System DTC Table because it is a continuous test. If this DTC is set, the Active Tests for the EVAP system may not run.

The Inspection/Maintenance System Status or Data information may be useful for a technician to determine if diagnostics have run when verifying repairs.

Circuit/System Verification

1. Verify that all Inspection/Maintenance System Status or Data indicators report YES, and that no I/M Test DTCs are present.

- **If any I/M Test DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.

- **If no I/M Test DTCs are set**

2. All OK.

Circuit/System Testing

NOTE: Many DTC related repairs will instruct the technician to clear the DTC information. Clearing the DTC will reset the Inspection/Maintenance System Status or Data indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.

1. Verify no I/M DTCs are present.
 - **If an I/M DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing.**

Refer to **Inspection/Maintenance (I/M) System DTC Table**.

- **If no I/M DTCs are set**
- 2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.
 - **If a control module re-program or other repair is required,**
Perform the [Inspection/Maintenance Complete System Set Procedure](#) after repair.
 - **If no repair is required**
- 3. Observe the 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](#).
 - **If no Inspection/Maintenance System Status or Data indicators report NO**
- 4. All OK.

INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

Description

The purpose of the Inspection/Maintenance (I/M) complete system set procedure is to satisfy the enable criteria necessary to execute all of the I/M readiness diagnostics and complete the trips 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 (I/M) Complete System Set Procedure if any I/M System Status indicators are set to NO.

Conditions for Meeting a Cold Start

- The ignition voltage between 10 and 15 V.
- The barometric pressure (BARO) is more than 75 kPa (10.9 PSI).
- The engine coolant temperature (ECT) at start-up is less than 42Â°C (108Â°F).
- The intake air temperature (IAT) is between 2 - 32Â°C (36-90Â°F).
- The engine is OFF for greater than 6 hours or the following conditions must be met:
 - The start-up IAT minus start-up ECT are within 12Â°C (22Â°F).
 - The start-up ECT minus start-up IAT are within 50Â°C (90Â°F).
- Fuel level is between 25 and 75%.

Circuit/System Verification

1. Verify that all I/M System Status indicators report YES, and that no I/M Test DTCs are present.
 - **If any I/M Test DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If no I/M Test DTCs are set**
2. All OK.

Inspection/Maintenance (I/M) System Set Procedure

1. Ensure that the vehicle meets the conditions for a cold start listed above.
 - If the EVAP I/M System Status indicator displays NO, perform the EVAP Service bay test if applicable.

2. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc., and open the hood.
3. Set the vehicle parking brake and ensure the vehicle is in park for automatic transmission or neutral for manual transmission.
4. Start and idle the engine for 2 min.

WARNING: Refer to [Road Test Warning](#) .

5. Close the hood, release the parking brake and Accelerate at part throttle to 72 - 80 km/h (45 - 50 MPH) with this speed maintained until the engine reaches operating temperature, 8 - 10 min.
6. Continue operation under these conditions for an additional 6 min.
7. Accelerate at part throttle to 90 km/h (55 MPH) with this speed maintained for 2 min.
8. Release the accelerator pedal for at least 10 s. This will allow the vehicle to enter the decel fuel cut off.

NOTE: Do NOT touch the accelerator pedal until told to do so. A change in throttle position or an increase in engine speed may invalidate this portion of the test.

9. Safely stop the vehicle, with the engine in drive for automatic or neutral with the clutch pedal depressed and parking brake applied for manual. Allow the vehicle to idle for 2 min.
10. Shift the vehicle to park for automatic and neutral for manual. Turn OFF the ignition and exit the vehicle. Do NOT disturb the vehicle for 45 min.
11. Observe the Inspection/Maintenance (I/M) System Status with a scan tool. All of the I/M System Status indicators should display YES.
 - If the EVAP I/M System Status indicator displays NO, turn OFF the ignition, ensure that the vehicle meets the conditions for a cold start, and repeat steps 6 - 11 three more times, or until the EVAP I/M System Status indicator transitions to YES. If the indicator continues to display NO, refer to the [Inspection/Maintenance \(I/M\) System DTC Table](#) to identify the DTCs that did not run.
 - If any of the I/M System Status indicators display NO, refer to the [Inspection/Maintenance \(I/M\) System DTC Table](#) for the indicator which did not display YES. The I/M System DTC Table identifies the DTCs associated with each I/M System Status Indicator.

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.

12. 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](#).
13. Observe the engine DTC information with a scan tool. Verify no DTCs are present.
 - If a DTC is set, diagnose using the [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) . After repairs, perform the [Inspection/Maintenance Complete System Set Procedure](#) to verify no further DTCs are set.

INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE

System	DTCs Required to Set System Status to YES
If an I/M System Status indicator did NOT update to YES during the Inspection/Maintenance Complete System Set Procedure , review each indicator and reference this table to determine each DTC associated with the I/M System Status Indicator. Each DTC listed below has specific conditions that must be met for the diagnostic to run. Included within the conditions are additional DTCs, which if set, may inhibit the DTCs listed below from running. Reviewing and operating the vehicle within the Conditions for Running for each DTC listed below will allow the I/M System Status Indicators to transition to YES.	
Camshaft System	DTC P0011, P0014, P0021, or P0024
Catalyst	DTC P0420 or P0430

System	DTCs Required to Set System Status to YES
EVAP	• <u>DTC P0442</u> • <u>DTC P0446</u> • <u>DTC P0455 or P0497</u>
Exhaust Gas Recirculation/Camshaft Position	<u>DTC P05CC-P05CF</u>
Fuel System	<u>DTC P219A or P219B (LFX)</u>
Oxygen Sensor	<u>DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D, or P2270-P2273</u>
Oxygen Sensor Heater	<u>DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, or P0161</u>

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2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 3.6L (LFX) - Repair Instructions - Impala

REPAIR INSTRUCTIONS

BRAKE PEDAL POSITION SENSOR LEARN

Calibration Criteria

NOTE: Do not apply the brake pedal during the brake pedal position sensor calibration procedure. Any movement of the brake pedal during this procedure will cause the calibration procedure to fail. If this occurs, the brake pedal position sensor calibration must be repeated.

Brake pedal position sensor calibration must be performed after the brake pedal position sensor, body control module (BCM), or engine control module (ECM) have been serviced. The calibration procedure will set the brake pedal position sensor home value. This value is used by the BCM and ECM to determine the action of the driver applying the brake system and to provide this information to the vehicle subsystems via serial data.

Calibration Procedure

1. Apply the parking brake.
2. Ignition ON, engine OFF, place the transmission in the PARK position for automatic transmission or NEUTRAL position for manual transmission.
3. Install a scan tool.
4. Clear all DTCs before proceeding.
5. Navigate to the Configuration/Reset Functions menu of the BCM.
6. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.
7. Navigate to the Configuration/Reset Functions menu of the ECM.
8. Select the Learn Functions menu.
9. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.

CRANKSHAFT POSITION VARIATION LEARN

The Crankshaft Position Variation Learn procedure is required when the following service procedures have been performed, regardless of whether DTC P0315 is set:

- An engine replacement.
- A engine control module (ECM) replacement.
- A crankshaft balancer replacement.
- A crankshaft replacement.
- A crankshaft position sensor replacement.
- Any engine repairs which disturb the crankshaft to crankshaft position sensor relationship.

The ECM monitors certain component signals to determine if all the conditions are met to continue with the Crankshaft Position Variation Learn procedure. The scan tool only displays the condition that inhibits the procedure. The scan tool displays the signals of the components listed below:

- Crankshaft position sensors activity: If there is a crankshaft position sensor condition, refer to the applicable DTC set.

- Camshaft position sensor signal activity: If there is a camshaft position sensor signal condition, refer to the applicable DTC set.
- Engine coolant temperature (ECT): If the engine coolant temperature is not warm enough, idle the engine until the engine coolant temperature reaches the correct temperature.

1. Verify no DTCs are set.

- **If any DTCs other than P0300 - P0308, or P0315 are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .

- **If DTC P0300 - P0308, P0315, or no DTCs are set**

NOTE: **The Crankshaft Position Variation Learn may have to be repeated up to 5 times before the procedure is successful.**

2. Engine Running at normal operating temperature, perform the scan tool Crankshaft Position Variation Learn procedure and follow the on screen instructions.

3. Verify the scan tool displays Test Passed Successfully when completed.

- **If Test Passed Successfully is not displayed**

Verify that none of the conditions listed below exist:

- The ignition switch is in the ON position until there is insufficient system voltage.
- An ECM power disconnect with the ignition ON that may have erased the crankshaft position system variation values and set DTC P0315.
- Interference in the signal circuit of the crankshaft position sensor.
- Debris between the crankshaft position sensor and the reluctor wheel.
- A damaged or misaligned reluctor wheel.
- Worn crankshaft main bearings.
- Excessive crankshaft runout.
- A damaged crankshaft.
- If a condition exists, repair or replace as necessary.
- If no conditions exist, replace the K20 Engine Control Module.
- **If Test Passed Successfully is displayed**

4. Clear all DTCs.

5. Engine Running.

6. Verify a DTC is not set.

- **If a DTC is set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .

- **If a DTC is not set**

7. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

[Control Module References](#) for engine control module replacement, programming, and setup.

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)

WARNING: In order to reduce the risk of personal injury, loss of high voltage isolation to ground and higher system impedance, do not attempt to repair any HV wiring, connector, or terminal that is damaged. High voltage coaxial type cables are not repairable. Never attempt to repair a coaxial type cable. The entire cable/harness or component must be replaced. In order to maintain system integrity and personal safety, never attempt to repair any high voltage wiring, cables, or terminals. Performing this procedure on high voltage circuits may result in serious injury or death.

NOTE: If the wiring harness internal to the transmission is damaged, the wiring harness must be replaced. The use of splice sleeves in an attempt to repair the internal transmission wires, connectors, or terminals could result in performance issues.

NOTE: Do not splice wires in Door Harness Grommets.

NOTE: The DuraSeal splice sleeves have the following 2 critical features:

- A special heat shrink sleeve environmentally seals the splice. The heat shrink sleeve contains a sealing adhesive inside.
- A cross hatched (knurled) core crimp provides the necessary low resistance contact integrity for these sensitive, low energy circuits.

Use only DuraSeal splice sleeves to form a one-to-one splice on all types of insulation except high voltage and specialty cables. Use DuraSeal splice sleeves where there are special requirements such as moisture sealing. Follow the instructions below in order to splice copper wire using DuraSeal splice sleeves.

Splice Sleeve Selection

Splice Sleeve Color	Crimp Tool Nest Color		Wire Gauge mm ² / (AWG)
	3 Crimp Nests	4 Crimp Nests	
Salmon (Yellow-Pink) 19300089	Red (1) or Red/Green (1)	Red (2)	0.22 - 0.8/(18 - 26)
Blue 19168447	Blue (2)	Blue (3)	1.0 - 2.0/(14 - 16)
Yellow 19168448	Yellow (3)	Yellow (4)	3.0 - 5.0/(10 - 12)

NOTE: You must perform the following procedures in the listed order. Repeat the procedure if any wire strands are damaged. You must obtain a clean strip with all of the wire strands intact.

1. Open the harness by removing any tape:
 - Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in order to avoid wire insulation damage.
 - Use the DuraSeal splice sleeves on all types of insulation except Tefzel and coaxial.
 - Do not use the crimp and DuraSeal splice sleeve to form a splice with more than 2 wires coming together.
2. Cut as little wire off the harness as possible. You may need the extra length of wire in order to change the location of a splice.

Adjust splice locations so that each splice is at least 40 mm (1.5 in) away from the other splices, harness branches, or connectors.

3. Strip the insulation:

- When adding a length of wire to the existing harness, use the same size wire as the original wire.
 - Perform one of the following items in order to find the correct wire size:
 - Find the wire on the schematic and convert to regional wiring gauge size.
 - If you are unsure of the wire size, begin with the largest opening in the wire stripper and work down until achieving a clean strip of the insulation.
 - Strip approximately 5.0 mm (0.20 in) of insulation from each wire to be spliced.
 - Do not nick or cut any of the strands. Inspect the stripped wire for nicks or cut strands.
 - If the wire is damaged, repeat this procedure after removing the damaged section.
4. For high temperature wiring, slide a section of high temperature SCT1 shrink tubing down the length of wire to be spliced. Ensure that the shrink tubing will not interfere with the splice procedure.
 5. Select the proper DuraSeal splice sleeve according to the wire size. Refer to the above table at the beginning of the repair procedure for the color coding of the DuraSeal splice sleeves and the crimp tool nests.

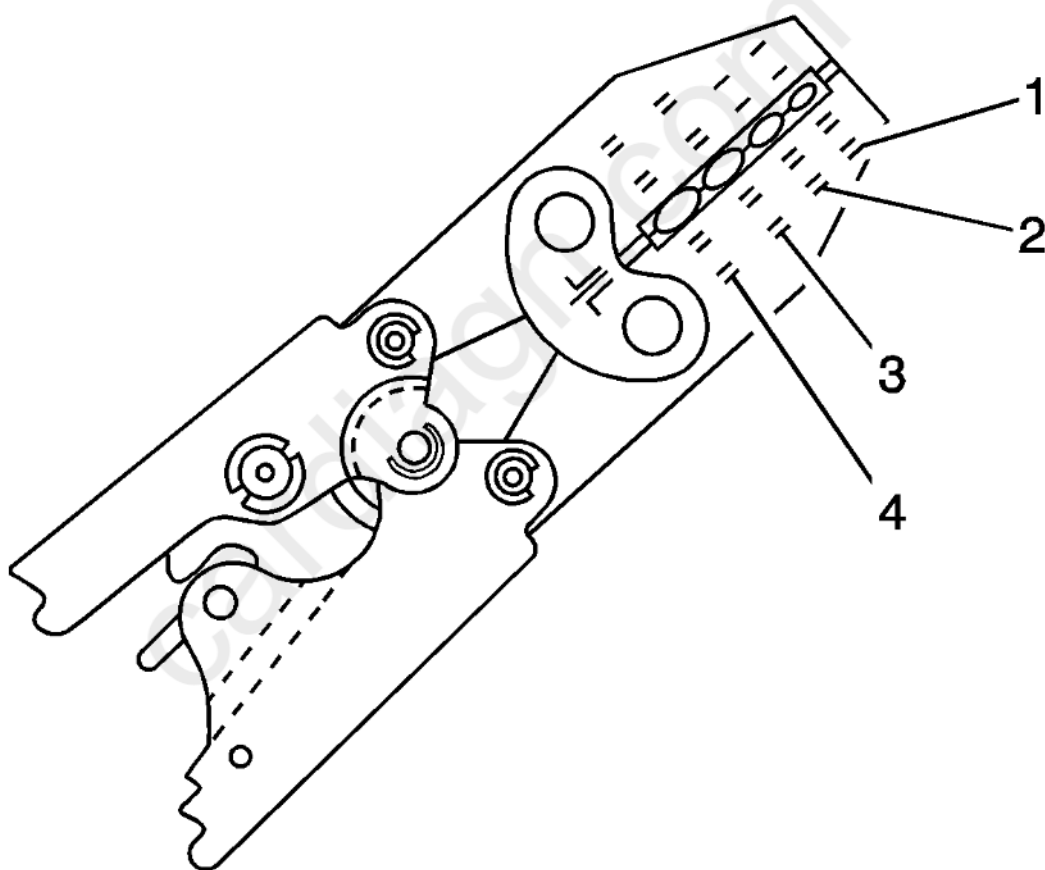


Fig. 1: Splice Sleeve Crimping Tool With 4 Crimp Nests
Courtesy of GENERAL MOTORS COMPANY

6. The **EL-38125-10** splice sleeve crimping tool has four crimp nests. The largest crimp nest (4) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (3) is used for crimping 14 and 16 gauge wires. The third largest crimp nest (2) is used for crimping 18 and 20 gauge wires. The smallest crimp nest (1) is used for crimping 22 to 26 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.

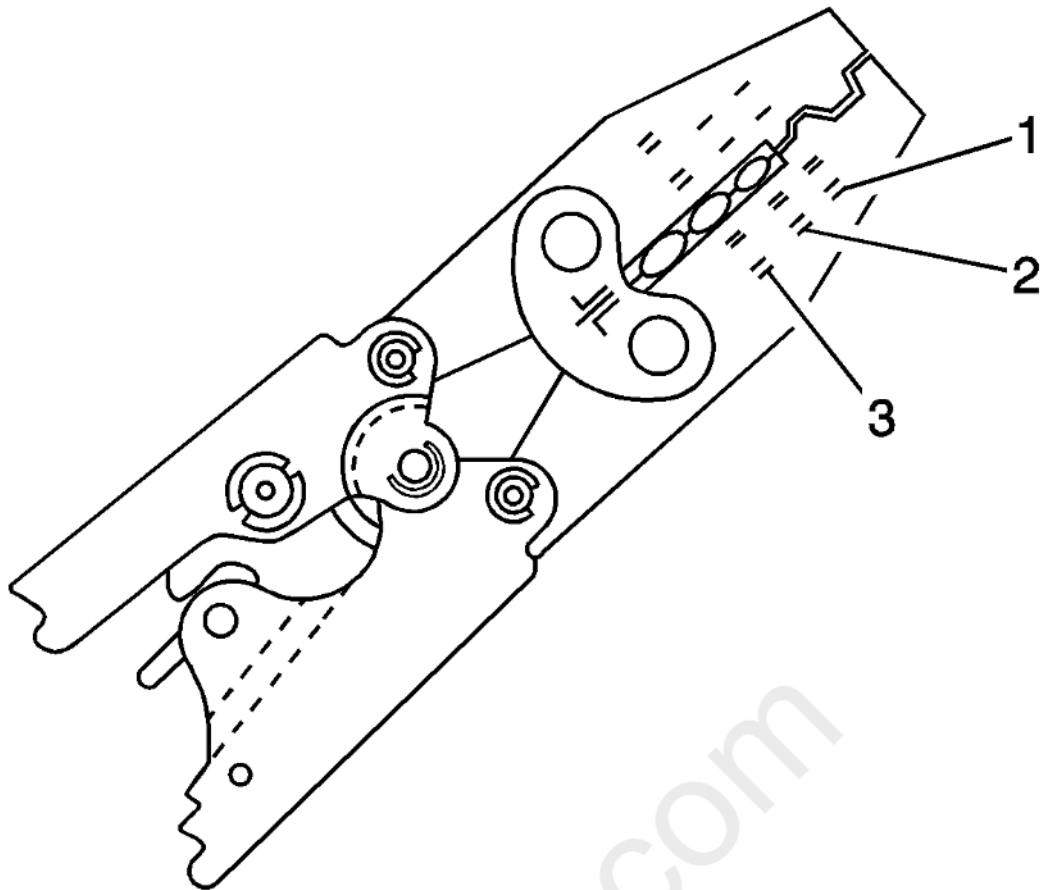


Fig. 2: Splice Sleeve Crimping Tool With 3 Crimp Nests
Courtesy of GENERAL MOTORS COMPANY

7. The **J-38125-8** splice sleeve crimping tool has three crimp nests. The largest crimp nest (3) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (2) is used for crimping 14 and 16 gauge wires. The smallest crimp nest (1) is used for crimping 18 to 20 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.
8. Use the splice sleeve crimp tool in order to position the DuraSeal splice sleeve in the proper color nest of the splice sleeve crimp tool. For the four crimp nest tool, use the three largest crimp nests to crimp the splice sleeves. For the three crimp nest tool, use all three crimp nests to crimp the splice sleeves. Use the four and three crimp tool diagrams (above) and the table (farther above) to match the splice sleeve with the correct crimp nest. The crimp tool diagram callout numbers match the numbers in the table (under crimp tool nest color).

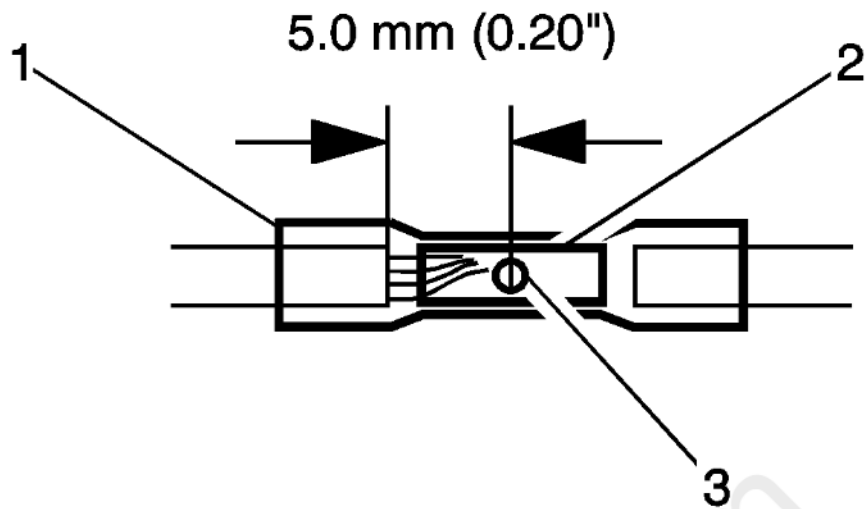


Fig. 3: Identifying Duraseal Splice Sleeve

Courtesy of GENERAL MOTORS COMPANY

9. Place the DuraSeal splice sleeve in the nest. Ensure that the crimp falls midway between the end of the barrel and the stop. The sleeve has a stop (3) in the middle of the barrel (2) in order to prevent the wire (1) from going further. Close the hand crimper handles slightly in order to firmly hold the DuraSeal splice sleeve in the proper nest.



Fig. 4: Crimped Duraseal Splice Sleeve

Courtesy of GENERAL MOTORS COMPANY

10. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different gauges.
11. Tightly close the handles of the crimp tool until the crimper handles open when released.

The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Repeat steps 4 and 6 for the opposite end of the splice.



Fig. 5: 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.

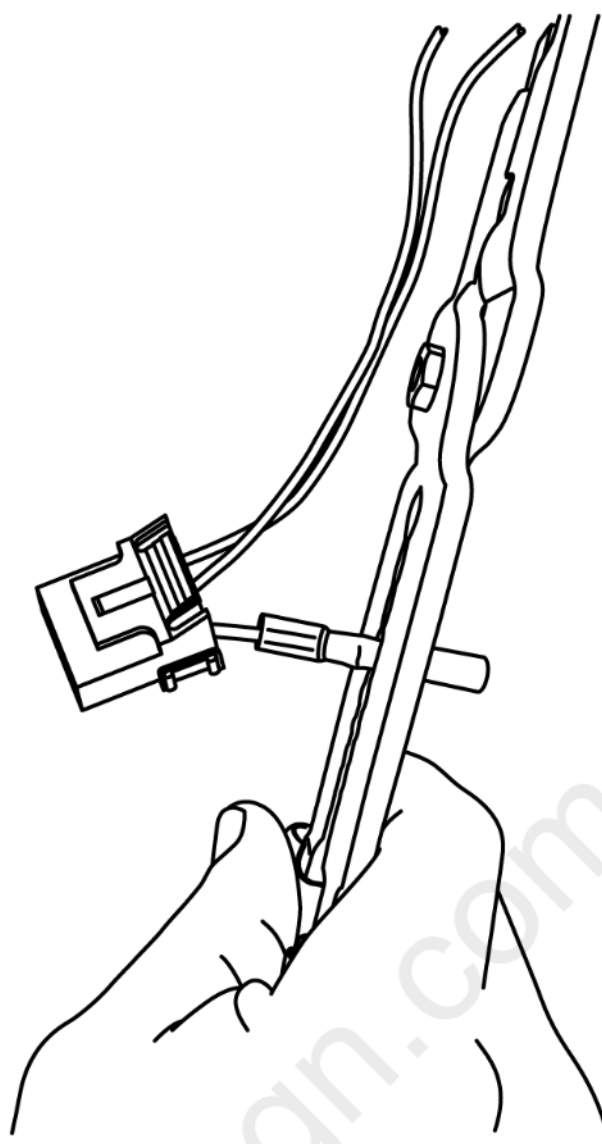


Fig. 6: Tightly Close Handles Of Crimp Tool

Courtesy of GENERAL MOTORS COMPANY

2. Tightly close the handles of the crimp tool until the crimper handles open when released.

The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Holding the DuraSEAL with one hand gently tug on the wire to ensure it is crimped in the DuraSeal.

3. Using the heat torch, apply heat to the crimped area of the barrel.

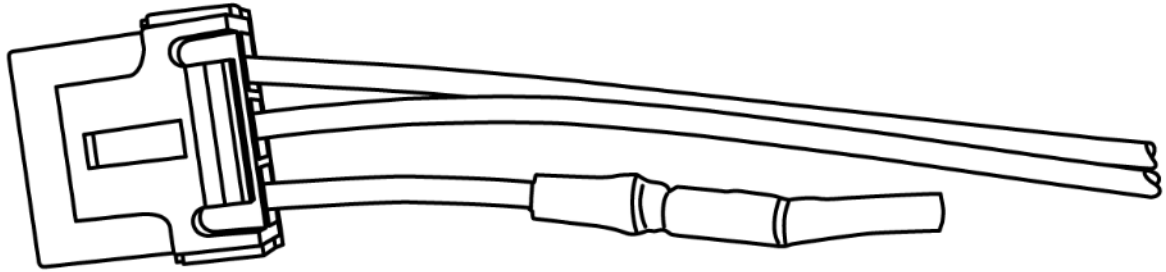


Fig. 7: Heat To Crimped Area Of Barrel

Courtesy of GENERAL MOTORS COMPANY

4. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.



Fig. 8: Taping Extra Terminated Leads Back Into Harness
Courtesy of GENERAL MOTORS COMPANY

5. Tape the extra terminated lead(s) back into the harness.

High Temperature Wiring Repairs

Use the following procedures to perform high temperature wiring repairs:

1. Center the high temperature SCT1 shrink tube over the DuraSeal splice sleeve.
2. Using the heat torch, apply heat to the high temperature heat shrink tubing.
3. Gradually move the heat from the center to the open end of the tubing:
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.
4. Replace any reflective tape and clips that may have been removed during the repair.

CONNECTOR RECONNECTION - ENGINE CONTROLS AND FUEL

Special Tools

EL-35616 Terminal Test Probe Kit

For equivalent regional tools, refer to [Special Tools](#) .

When the condition is not currently present, but is indicated in DTC history, the cause may be intermittent. An intermittent may also be the cause when there is a customer complaint, but the symptom cannot be duplicated. Refer to the Symptom Table of the system that is suspect of causing the condition before trying to locate an intermittent condition.

Most intermittent conditions are caused by faulty electrical connections or wiring. Inspect for the following items:

- Loose, corroded, or painted terminal stud/fastener
- Wiring broken inside the insulation
- Poor connection between the male and female terminal at a connector
- A terminal not seated all the way into the connector body
- Poor terminal to wire connection - Some conditions which fall under this description are poor crimps, poor solder joints, crimping over the wire insulation rather than the wire itself, and corrosion in the wire to terminal contact area, etc.
- Pierced or damaged insulation can allow moisture to enter the wiring causing corrosion. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.
- Wiring which has been pinched, cut, or its insulation rubbed through may cause an intermittent open or short as the bare area touches other wiring or parts of the vehicle.
- Wiring that comes in contact with hot or exhaust components
- Refer to [**Inducing Intermittent Fault Conditions**](#) in order to duplicate the conditions required, in order to verify the customer concern.
- Refer to [**Testing for Electrical Intermittents**](#) for test procedures to detect intermittent open, high resistance, short to ground, and short to voltage conditions.
- Refer to [**Scan Tool Snapshot Procedure**](#) for advanced intermittent diagnosis and Vehicle Data Recorder operation.

Testing for Terminal Fretting

Some intermittent conditions can be caused by wire terminal fretting corrosion. Fretting corrosion is a build-up of insulating, oxidized wear debris that can form when there is a small motion between electrical contacts. The oxidized wear debris can pile up enough at the electrical contact spots that the electrical resistance across the connection increases. Movement between the contacting surfaces as small as 10 to 100 microns can cause fretting. To put this in perspective, a sheet of paper is about 100 microns thick, so fretting motion is small and hard to see. Vibration and thermal expansion/contraction are the main sources that create fretting motion. Since vehicles vibrate and can experience large temperature swings, they are a good source for fretting motion. Tin, copper, nickel, and iron surfaces are all susceptible to fretting corrosion. Fretting corrosion can be difficult to see but it looks like small, dark smudges on the terminals contact surface.

To correct a fretting condition disconnect the suspect connector and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to both sides of the connector terminals. Then reconnect the connector and wipe away any excess lubricant. This will correct the additional terminal contact resistance due to the terminal fretting corrosion.

Testing for Proper Terminal Contact

It is important to test terminal contact at the component and any inline connectors before replacing a suspect component. Mating terminals must be inspected to ensure good terminal contact. A poor connection between the male and female terminal at a connector may be the result of contamination or deformation.

Contamination may be caused by the connector halves being improperly connected. A missing or damaged connector seal, damage to the connector itself, or exposing the terminals to moisture and dirt can also cause contamination. Contamination, usually in the underhood or underbody connectors, leads to terminal corrosion, causing an open circuit or intermittently open circuit.

Deformation is caused by probing the mating side of a connector terminal without the proper adapter. Always use the **EL-35616** kit when probing connectors. Other causes of terminal deformation are improperly joining the connector halves, or repeatedly separating and joining the connector halves. Deformation, usually to the female terminal contact tang, can result in poor terminal contact causing an open or intermittently open circuit.

Testing for Proper Terminal Contact in Bussed Electrical Centers

It is very important to use the correct test adapter when testing for proper terminal contact of fuses and relays in a bussed electrical center. Use the **EL-35616** kit to test for proper terminal contact. Failure to use the **EL-35616** kit can result in improper diagnosis of the bussed electrical center.

Follow the procedure below in order to test terminal contact:

1. Separate the connector halves.
2. Visually inspect the connector halves for contamination. Contamination may result in a white or green build-up within the connector body or between terminals. This causes high terminal resistance, intermittent contact, or an open circuit. An underhood or underbody connector that shows signs of contamination should be replaced in its entirety: terminals, seals, and connector body.
3. Using an equivalent male terminal/terminated lead, verify that the retention force is significantly different between a known good terminal and the suspect terminal. Replace the female terminal in question.

Flat Wire Connectors

There are no serviceable parts for flat wire connectors on the harness side or the component side.

Follow the procedure below in order to test terminal contact:

1. Remove the component in question.
2. Visually inspect each side of the connector for signs of contamination. Avoid touching either side of the connector as oil from your skin may be a source of contamination as well.
3. Visually inspect the terminal bearing surfaces of the flat wire circuits for splits, cracks, or other imperfections that could cause poor terminal contact. Visually inspect the component side connector to ensure that all of the terminals are uniform and free of damage or deformation.
4. Insert the appropriate adapter into the flat wire harness connector in order to test the circuit in question.

Control Module/Component Voltage and Grounds

Poor voltage or ground connections can cause widely varying symptoms.

- Test all control module voltage supply circuits. Many vehicles have multiple circuits supplying voltage to a control module. Other components in the system may have separate voltage supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the voltage source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Operate the component to test the ability of the circuit to carry sufficient current. Refer to [Circuit Testing](#) , and [Power Distribution Schematics](#) .
- Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point (screw or stud). Inspect the connections at the component and in splice packs, where applicable. Operate the component to test the ability of the circuit to carry sufficient current. Refer to [Circuit Testing](#) , and [Ground Distribution Schematics](#) .

Temperature Sensitivity

- An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/connection is cold, or only when the component/connection is hot.
- Freeze Frame, Failure Records, Snapshot, or Vehicle Data Recorder data may help with this type of intermittent condition, where applicable.
- If the intermittent is related to heat, review the data for a relationship with the following:
 - High ambient temperatures
 - Underhood/engine generated heat
 - Circuit generated heat due to a poor connection, or high electrical load

- Higher than normal load conditions, towing, etc.
- If the intermittent is related to cold, review the data for the following:
 - Low ambient temperatures - In extremely low temperatures, ice may form in a connection or component. Inspect for water intrusion.
 - The condition only occurs on a cold start.
 - The condition goes away when the vehicle warms up.
- Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
- If temperature is suspected of causing an intermittent fault condition, attempt to duplicate the condition. Refer to [Inducing Intermittent Fault Conditions](#) in order to duplicate the conditions required.

Electromagnetic Interference and Electrical Noise

Some electrical components/circuits are sensitive to electromagnetic interference or other types of electrical noise. Inspect for the following conditions:

- A mis-routed harness that is too close to high voltage/high current devices such as secondary ignition components, motors, generator etc. - These components may induce electrical noise on a circuit that could interfere with normal circuit operation.
- Electrical system interference caused by a malfunctioning relay, or a control module driven solenoid or switch - These conditions can cause a sharp electrical surge. Normally, the condition will occur when the malfunctioning component is operating.
- Installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. - These accessories may create interference in other circuits while operating and the interference would disappear when the accessory is not operating. Refer to [Checking Aftermarket Accessories](#).
- Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode.
- The generator may be allowing AC noise into the electrical system.

Incorrect Control Module

- There are only a few situations where reprogramming a control module is appropriate:
 - A new service control module is installed.
 - A control module from another vehicle is installed.
 - Revised software/calibration files have been released for this vehicle.

NOTE: **DO NOT re-program the control module with the SAME software/calibration files that are already present in the control module. This is not an effective repair for any type of concern.**

- Verify that the control module contains the correct software/calibration. If incorrect programming is found, reprogram the control module with the most current software/calibration. Refer to [Control Module References](#) for replacement, setup, and programming.

ENGINE CONTROL MODULE REPLACEMENT (LFX)

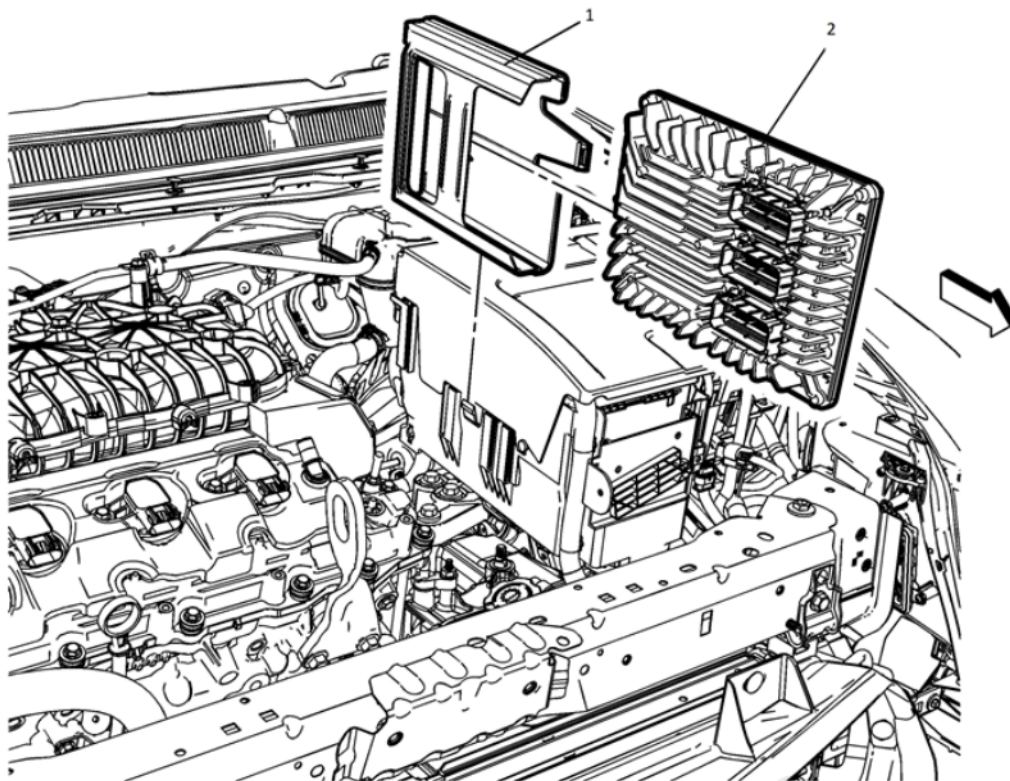


Fig. 9: Engine Control Module (LFX)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .	
1	Engine Control Module Bracket Procedure Release the retaining tab.

Callout	Component Name
2	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 not touch the connector pins or the soldered components on the circuit board. • Remove any debris from around the control module connector surfaces before servicing the control module. Inspect the control module connector gaskets when diagnosing or replacing the control module. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the control module. • The replacement control module must be programmed. Procedure 1. Disconnect the electrical connectors. 2. Release the retaining tab. 3. If replacing, program the ECM. Refer to Control Module References . NOTE: Before removing the engine control module (ECM), record the oil life percentage remaining. Use the scan tool to reset the Engine Oil Life remaining back to the original percentage recorded.

THROTTLE OR IDLE LEARN

Description

The engine control module (ECM) learns the airflow through the throttle body to ensure the correct idle. The learned airflow values are stored within the ECM. These values are learned to adjust for production variation and will continuously learn during the life of the vehicle to compensate for reduced airflow due to throttle body coking. Anytime the throttle body airflow rate changes, for example due to cleaning or replacing, the values must be relearned.

An engine that had a heavily coked throttle body that has been cleaned or replaced may take several drive cycles to unlearn the coking. To accelerate the process, the scan tool has the ability to reset all learned values back to zero. A new ECM will also have values set to zero.

The idle may be unstable or a DTC may set if the learned values do not match the actual airflow.

Conditions for Running the Throttle Learn Procedure

Scan tool Idle Learn or Idle Learn Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P0697, P06A3, P06D2, P1248, P1249, P124A, P124B, P1516, P16A0-P16A2, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2176, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, or P2322 are not set.
- Ignition ON, engine OFF.
- The vehicle speed sensor (VSS) is 0 km/h (0 MPH).

Service Bay/On Road Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P0697, P06A3, P06D2, P1248, P1249, P124A, P124B, P1516, P16A0-P16A2, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2176, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, or P2322 are not set.
- The engine speed is between 450 - 4,000 RPM.
- The manifold absolute pressure (MAP) is greater than 5 kPa.
- The mass air flow (MAF) is greater than 2 g/s.
- The ignition voltage is greater than 10 volts.

Diagnostic Aids

A un-metered air leak in the induction system or a small vacuum leak may not set a DTC. If the condition goes undetected, the ECM may learn an incorrect Throttle Body Idle Airflow Compensation value over time. The incorrectly learned value may cause various symptoms to occur such as rough or unstable idle speeds, and/or engine stall. If this condition is detected and repaired it will be necessary perform the Idle Learn procedure to ensure any symptoms are corrected.

Throttle Learn

Scan Tool Idle Learn or Idle Learn Reset Procedure - Performed after the throttle body is cleaned or replaced

1. Ignition ON, engine OFF, perform the Idle Learn or Idle Learn Reset in Configuration/Reset or Module Setup.
2. Engine idling, verify the scan tool Throttle Body Idle Airflow Compensation value is equal 0% and the engine is idling at a normal idle speed.
3. Clear the DTCs and return to the diagnostic that referred you here.

Service Bay/On Road Idle Learn Procedure - Performed after the ECM is programmed or replaced

NOTE: Do NOT perform this procedure if any DTCs are set.

1. Engine idling for 3 min.
2. The ECM will start to learn the new idle cells and the scan tool Desired Idle Speed should start to decrease.

3. Ignition OFF for 60 s.
4. Start and idle the engine for 3 min.
5. Verify the engine is idling normally.
 - **If the engine idle is not correct**

NOTE: During the drive cycle the check engine light may come on with idle speed DTCs. If idle speed codes are set, clear codes so the ECM can continue to learn.

1. Operate the vehicle at speeds above 70 km/h (44 mph) with several decelerations and extended idles.
2. Verify the engine is idling normally.
 - If the engine idle is not correct.

Ignition OFF for 60 s, repeat step 5.1.

 - If the engine idle is correct.
3. Clear any DTCs and return to the diagnostic that referred you here.
 - **If the engine idle is correct**
6. Clear any DTCs and return to the diagnostic that referred you here.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

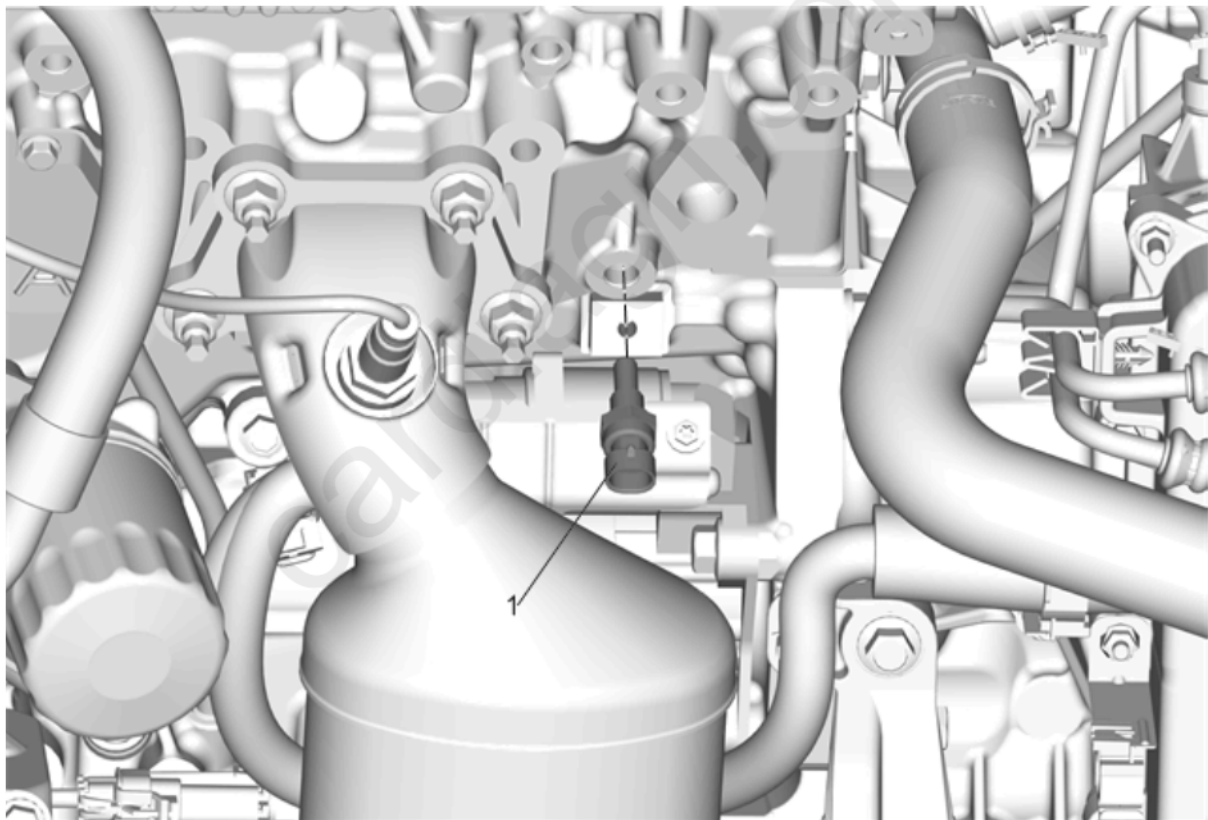


Fig. 10: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
1. Remove the front compartment front sight shield. Refer to Front Compartment Front Sight Shield Replacement . 2. Partially drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill) Cooling System Draining and Filling (Static) .	

Callout	Component Name
1	Engine Coolant Temperature Sensor CAUTION: Refer to Component Fastener Tightening Caution . Procedure 1. Disconnect the ECT sensor harness connector. Tighten 20 N.m (15 lb ft)

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

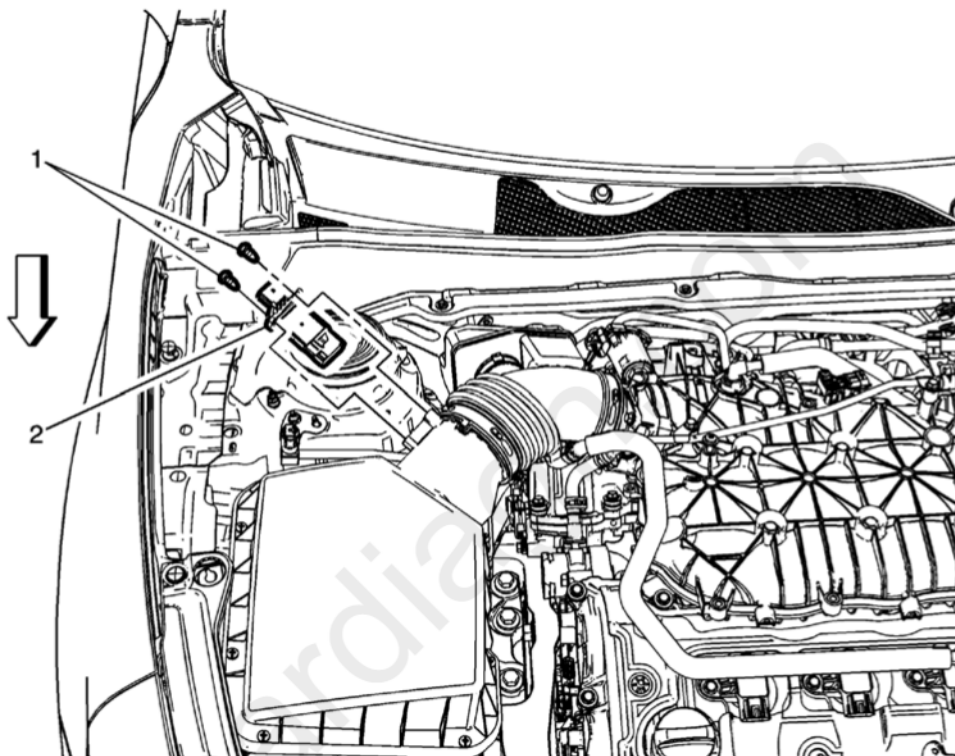


Fig. 11: Mass Airflow Sensor with Intake Air Temperature Sensor
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Mass Air Flow Sensor Fasteners (Qty :2) CAUTION: Refer to Fastener Caution .
2	Mass Air Flow Sensor Procedure Disconnect the electrical connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

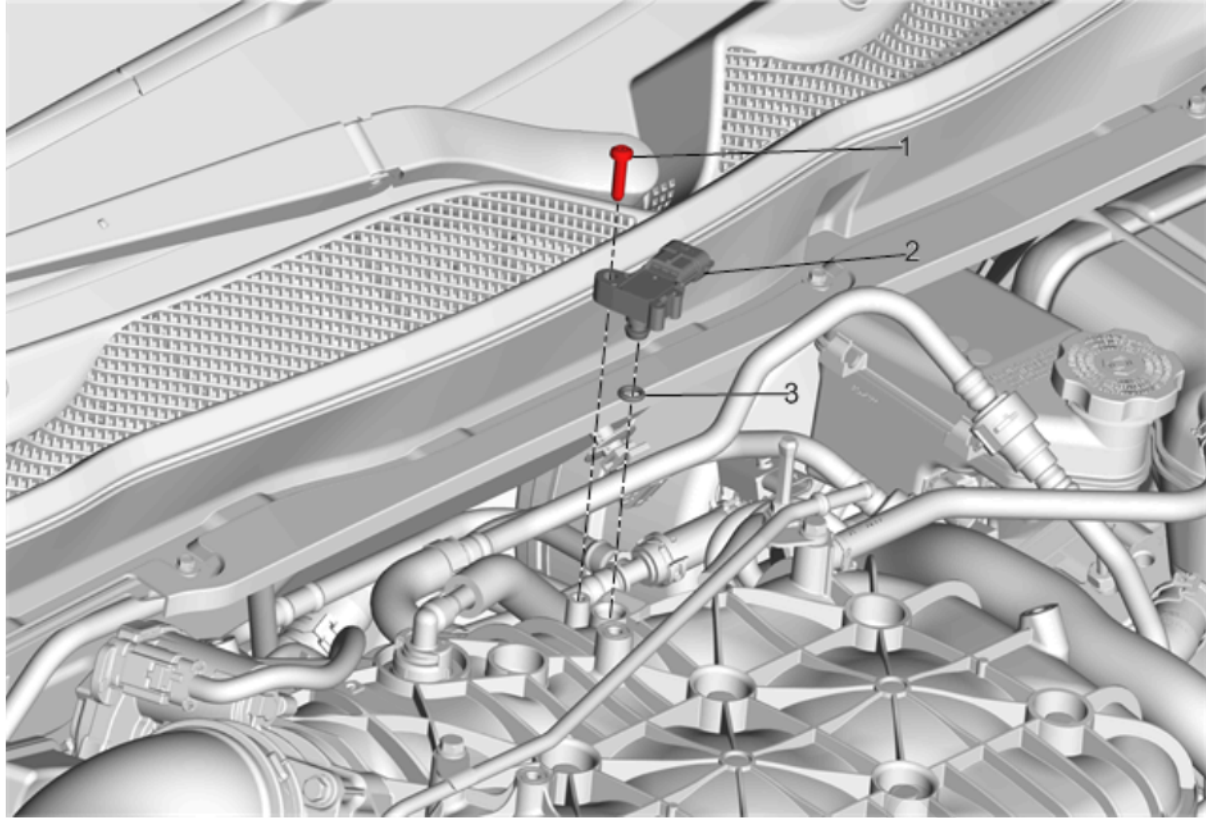


Fig. 12: Manifold Absolute Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX) .	
1	Manifold Absolute Pressure Sensor Fastener CAUTION: Refer to Fastener Caution . Tighten 4 N.m (35 lb in)
2	Manifold Absolute Pressure Sensor Procedure Disconnect the electrical connector.
3	Manifold Absolute Pressure Seal Procedure If re-installing the sensor, inspect the sensor seal for damage and replace as necessary.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1

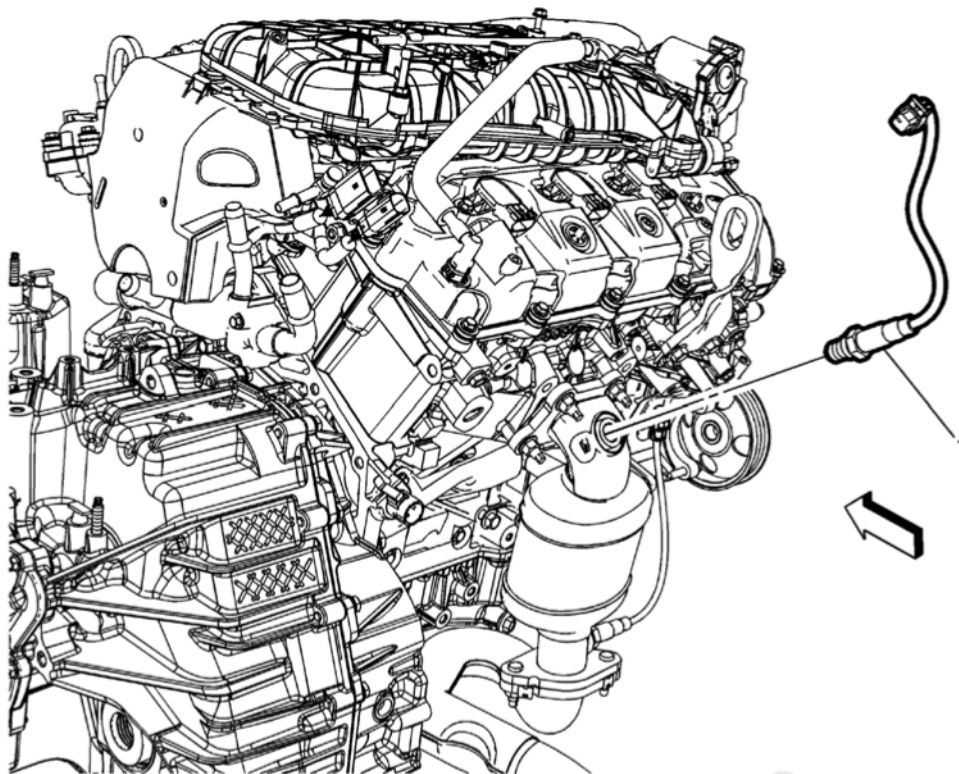


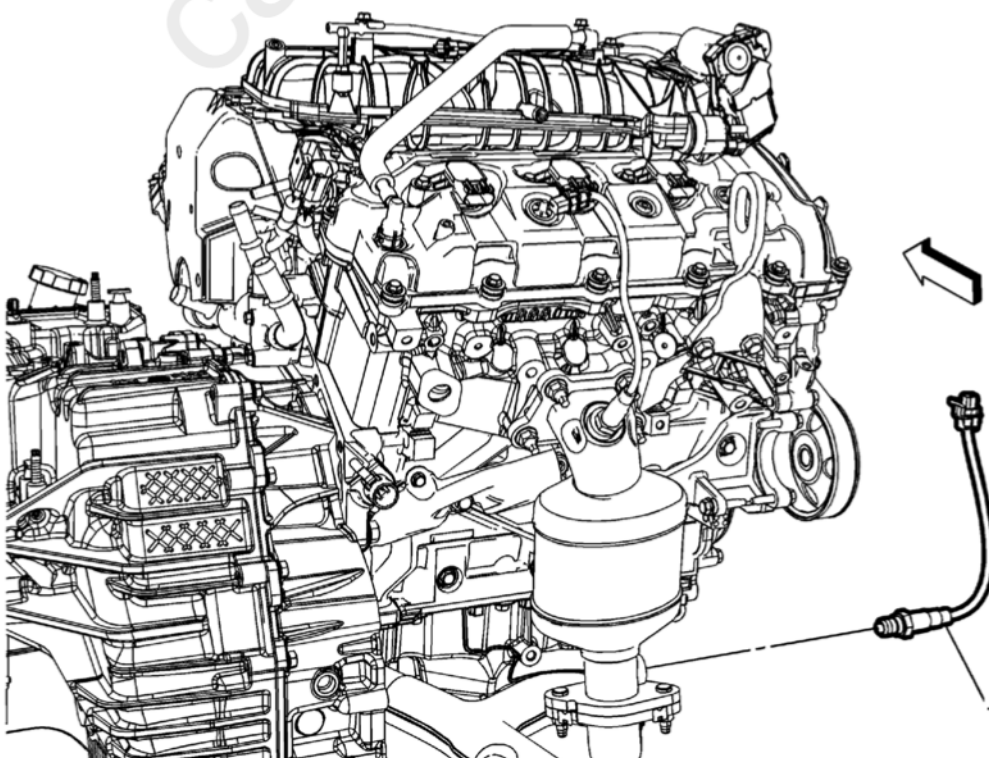
Fig. 13: Heated Oxygen Sensor - Bank 1 Sensor 1 (FWD)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
<u>Intake Manifold Cover Replacement (LFX)</u>	

Callout	Component Name
1	Heated Oxygen Sensor CAUTION: Refer to Component Fastener Tightening Caution . CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution . Procedure Disconnect the electrical connector. 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 48°C (120°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)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2



Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Lifting and Jacking the Vehicle	
1	Heated Oxygen Sensor CAUTION: Refer to Component Fastener Tightening Caution . CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution . Procedure Disconnect the electrical connector. 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 48°C (120°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)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1

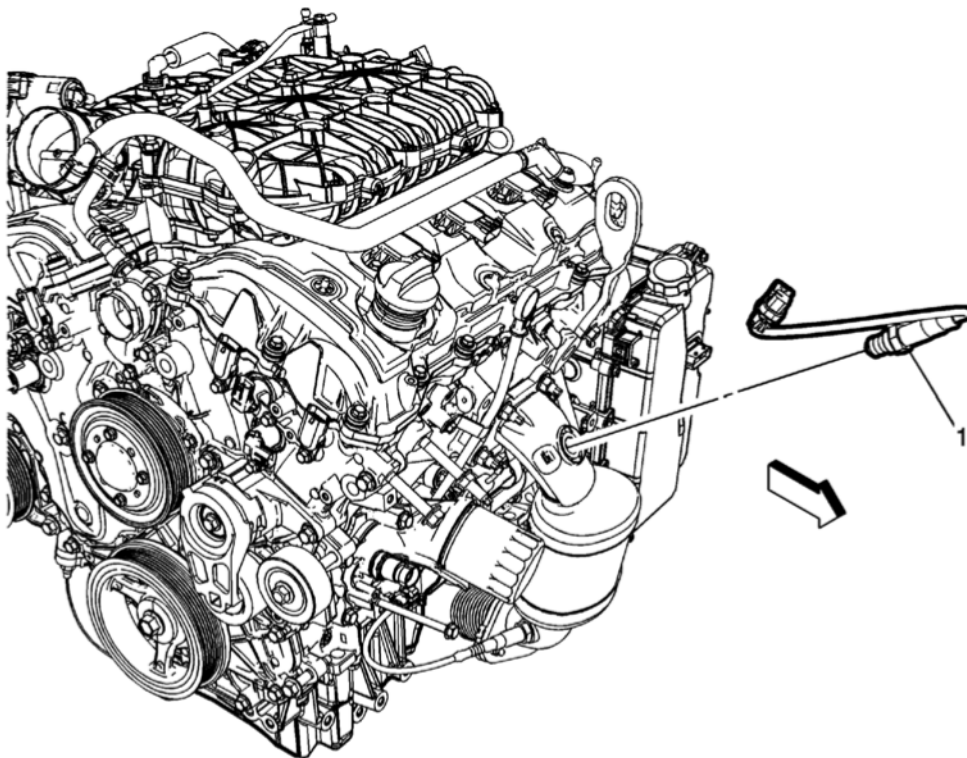


Fig. 15: Heated Oxygen Sensor - Bank 2 Sensor 1 (LFX)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
1. Remove the front compartment front sight shield. Refer to Front Compartment Front Sight Shield Replacement .	

Callout	Component Name
	Heated Oxygen Sensor CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution . CAUTION: Refer to Component Fastener Tightening Caution . CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution . Procedure 1. Disconnect the heated oxygen sensor harness connector. NOTE: • The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F). • A special anti-seize compound is used on the HO2S threads. The compound consists of 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 replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason is to be reinstalled, the threads must have anti-seize compound applied before reinstallation. Refer to Adhesives, Fluids, Lubricants, and Sealers . Tighten 42 N.m (31 lb ft) Special Tools J 39194 Oxygen Sensor Wrench For equivalent regional tools, refer to Special Tools .
1	

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2

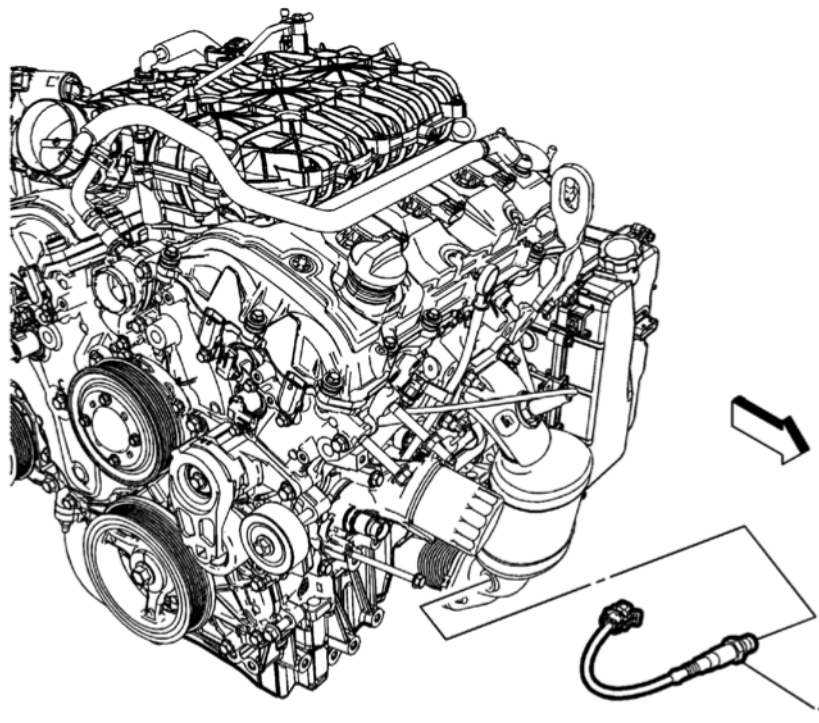


Fig. 16: Heated Oxygen Sensor - Bank 2 Sensor 2 (LFX)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Lifting and Jacking the Vehicle	

Callout	Component Name
1	Heated Oxygen Sensor CAUTION: Refer to Component Fastener Tightening Caution . CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution . Procedure Disconnect the electrical connector. 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 48°C (120°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)

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

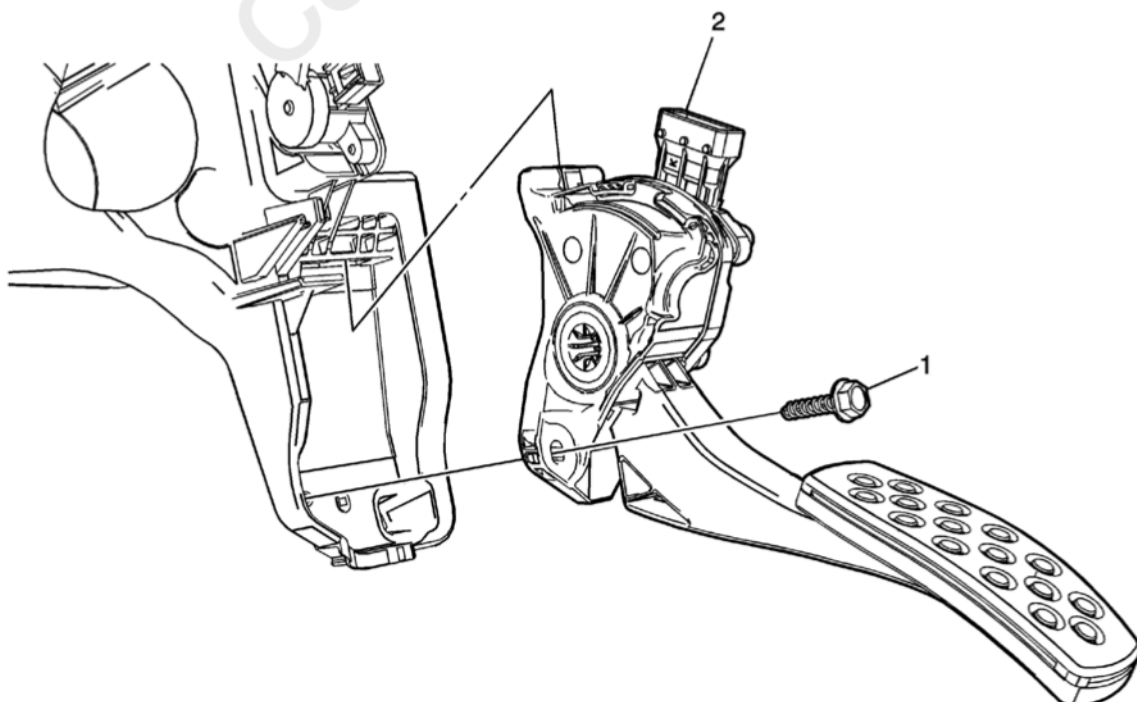


Fig. 17: Identifying Accelerator Pedal With Position Sensor Assembly
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Accelerator Pedal Position Sensor Bolt CAUTION: Refer to Fastener Caution . Tighten 3.5 N.m (31 lb in)
2	Accelerator Pedal Position Sensor Procedure Disconnect electrical connector.

THROTTLE BODY ASSEMBLY REPLACEMENT

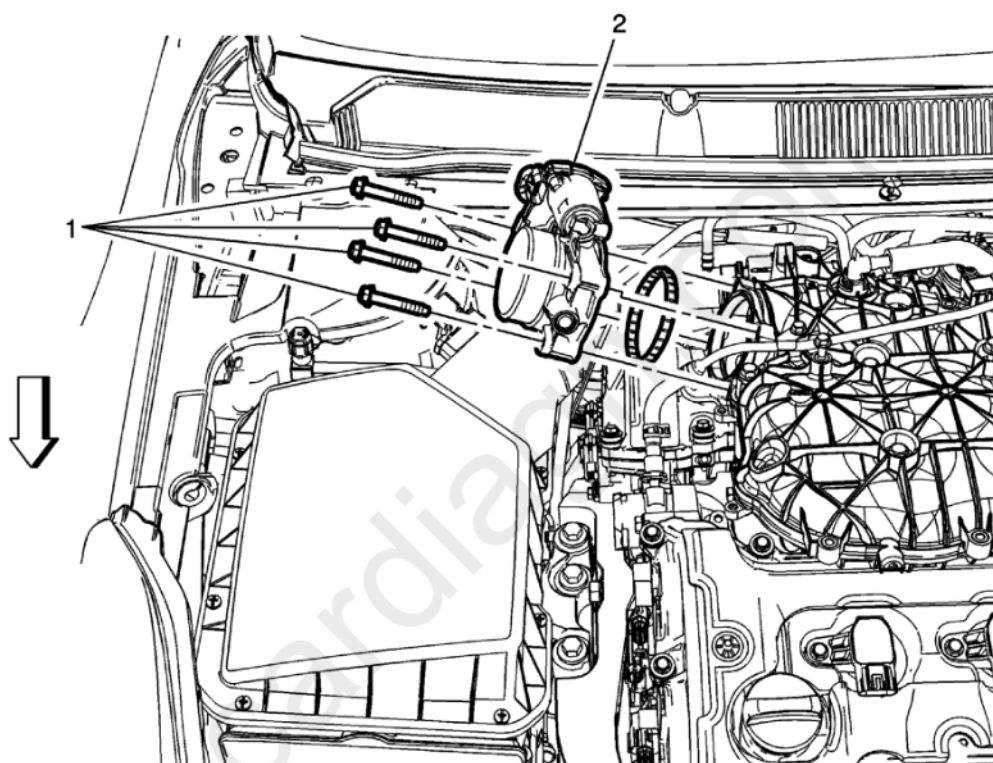


Fig. 18: Throttle Body Assembly (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Intake Manifold Cover Replacement (LFX) 2. Air Cleaner Outlet Duct Replacement	
1	Throttle Body Bolt (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)

Callout	Component Name
2	Throttle Body Procedure 1. Disconnect the electrical connector. 2. Install a NEW throttle body gasket. 3. Perform the throttle or idle learn. Throttle or Idle Learn

THROTTLE BODY INSPECTION AND CLEANING

NOTE: Over extended time and mileage, deposits may accumulate on the back of the throttle valve plate. Typically these deposits pose no problem. Occasionally the deposit may accumulate to a point where perceived pedal effort or throttle valve movement is effected.

1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

WARNING: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

CAUTION: Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

2. Inspect the throttle body bore and the throttle valve plate for deposits. You will need to open the throttle valve in order to inspect all surfaces.

CAUTION: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

3. Clean the throttle body bore and the throttle valve plate using a clean shop towel with GM Top Engine Cleaner. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
4. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
5. Perform the Throttle/Idle Learn procedure. Refer to [Throttle or Idle Learn](#).

FUEL PRESSURE RELIEF (GASOLINE)

WARNING: Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.

1. Remove the fuel pump control module 20A fuse from the underhood electrical center. Refer to [Electrical Center Identification Views](#).
2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 20 - 30 seconds.
3. Turn the ignition OFF.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

Special Tools

CH 48027 Digital Pressure Gauge

For equivalent regional tools, refer to [Special Tools \(Diagnostic Tools\)](#) [Special Tools \(Mechanical Tools\)](#)

Installation Procedure

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#).

WARNING:

Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

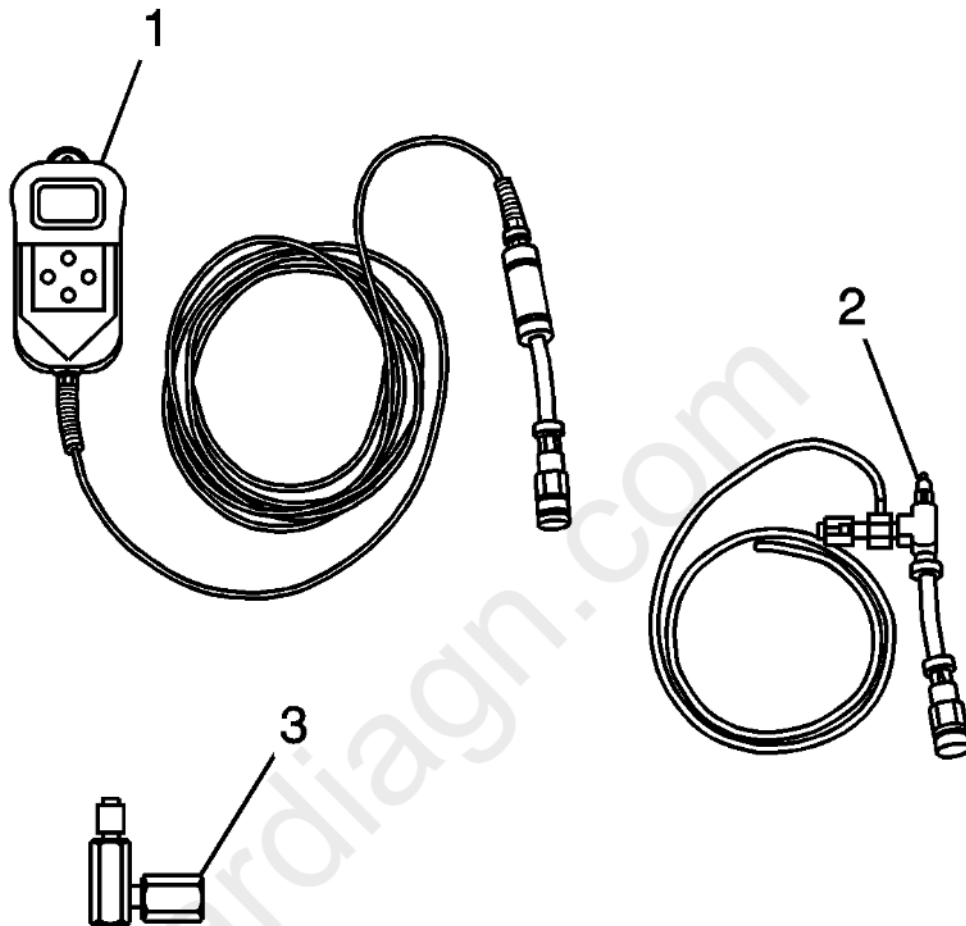


Fig. 19: Identifying Digital Pressure Gage & Components

Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief \(Gasoline\)](#).
2. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement \(LFX\)](#).
3. Connect the **CH 48027** gauge (1) to the **CH 48027** adapter (2).
4. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
5. Perform any tests and/or diagnostics as needed. For the proper usage of the **CH 48027** gauge (1), refer to the manufacture's directions.

Removal Procedure

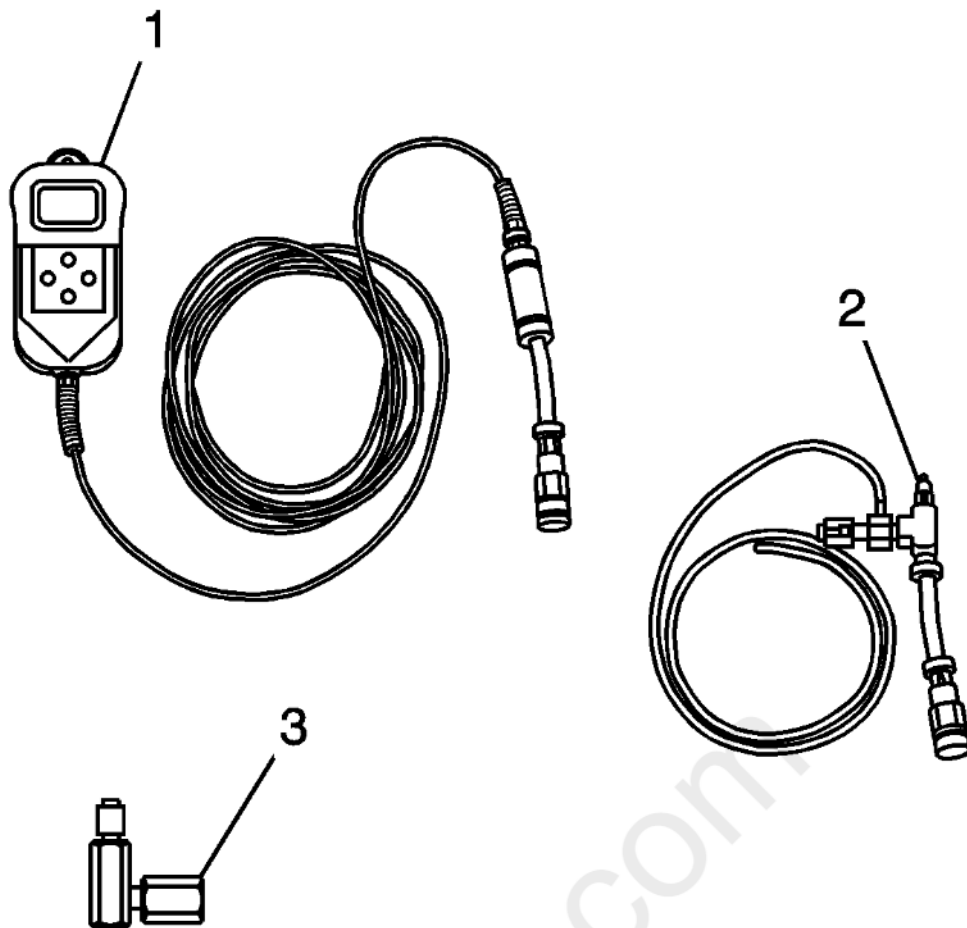


Fig. 20: Identifying Digital Pressure Gauge & Components

Courtesy of GENERAL MOTORS COMPANY

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.

1. Relieve the fuel system pressure, if required. Perform the following steps:
 1. Wrap a shop towel around the fuel rail service port.
 2. Place the hose on the **CH 48027** adapter (2) into an approved gasoline container.
 3. Open the valve on the **CH 48027** adapter (2) in order to bleed any fuel from the fuel rail.
 4. Close the valve on the **CH 48027** adapter (2).
 5. Remove the hose on the **CH 48027** adapter (2) from the approved gasoline container.
 6. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.

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

2. Disconnect the **CH 48027** gauge (1) from the **CH 48027** gauge (2).
3. Disconnect the **CH 48027** adapter (2) from the **CH 48027** adapter (3).

4. Disconnect the **CH 48027** adapter (3) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement \(LFX\)](#) .
7. Tighten the fuel fill cap.

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 [Gasoline/Gasoline Vapors Warning](#) .

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief \(Gasoline\)](#).

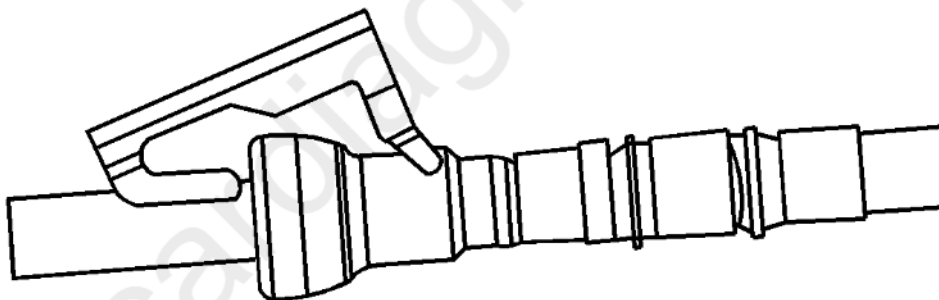


Fig. 21: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Remove the retainer from the quick-connect fitting.

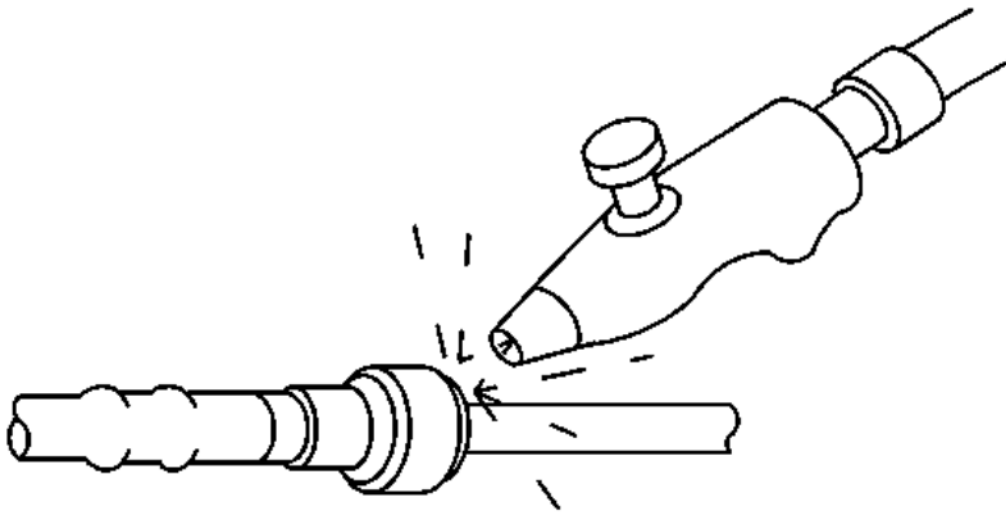


Fig. 22: Blowing Dirt Out Of Fitting.(Metal Collar)

Courtesy of GENERAL MOTORS COMPANY

WARNING: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

3. Blow dirt out of the fitting using compressed air.

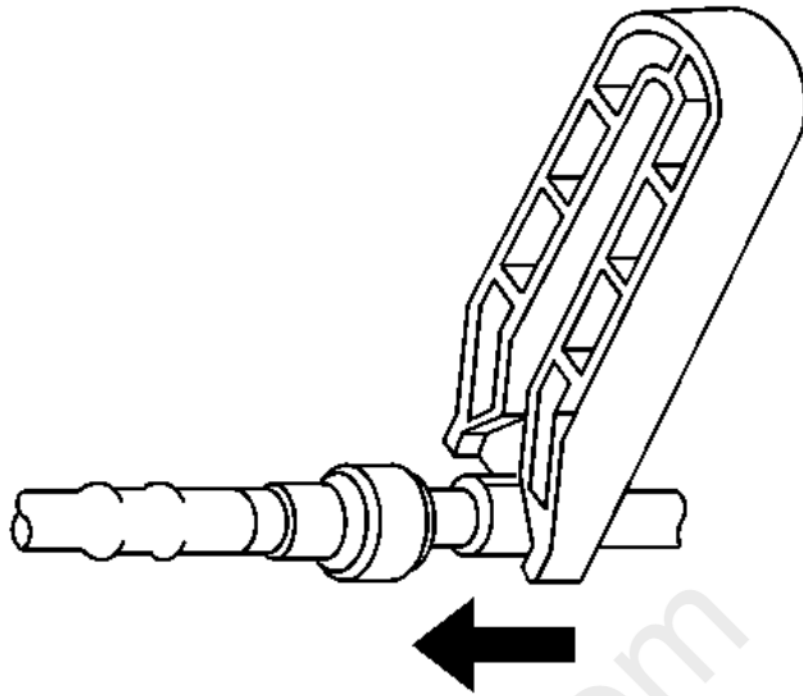


Fig. 23: View Of Quick Connect Locking Tabs (Metal Collar)

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.

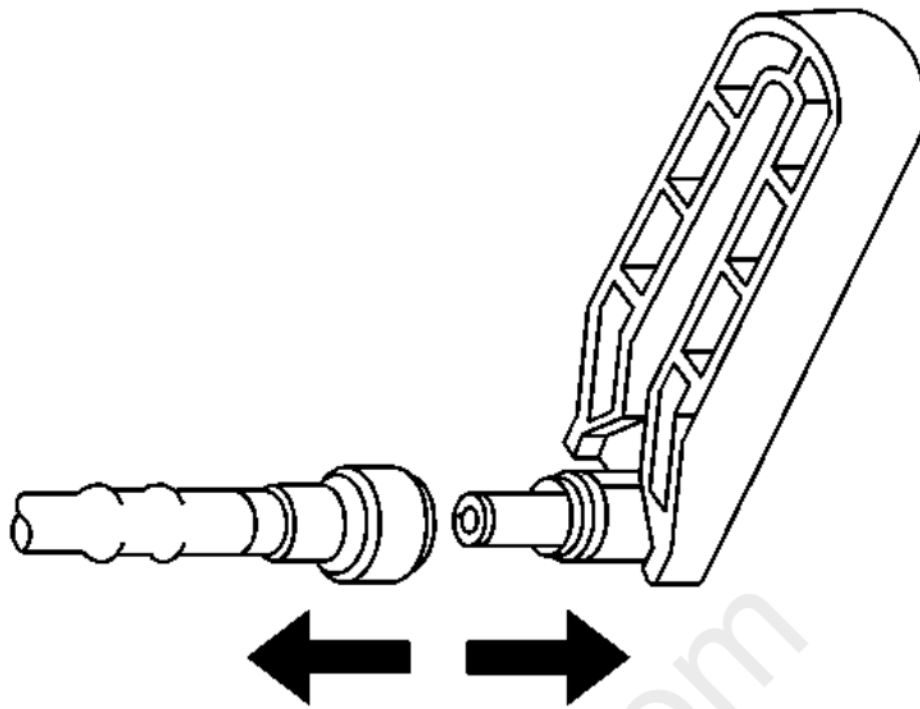


Fig. 24: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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

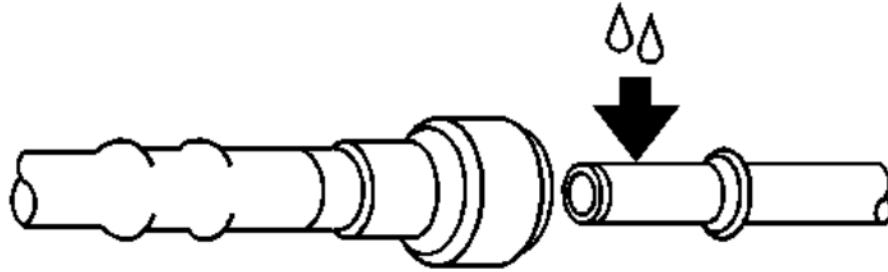


Fig. 25: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends.

This will ensure proper reconnection and prevent a possible fuel leak.

During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

1. Apply a few drops of clean engine oil to the male pipe end.

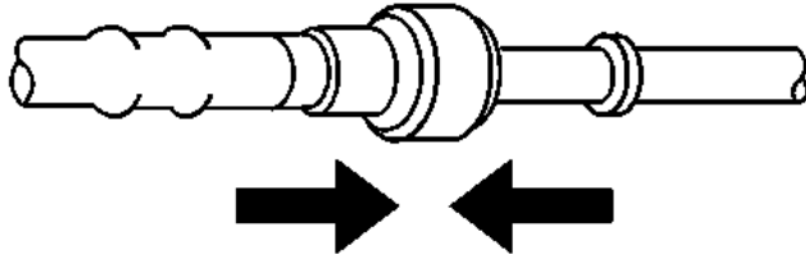


Fig. 26: View Of Connectors (Metal Collar)

Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the quick-connect fitting together to cause the retaining tabs to snap into place.

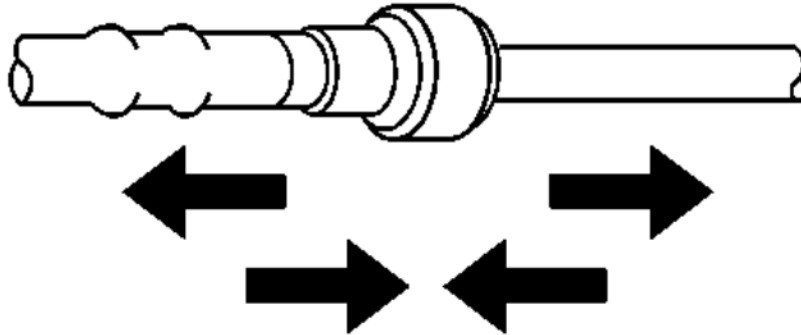


Fig. 27: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

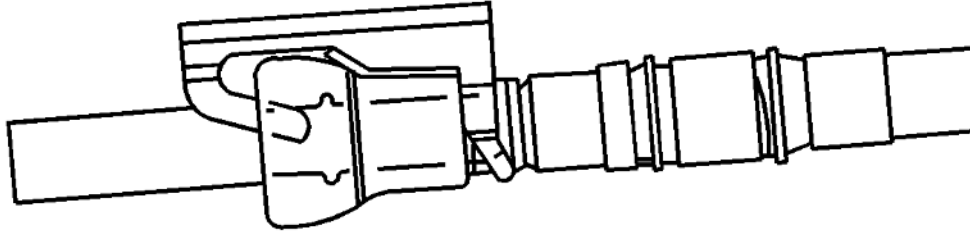


Fig. 28: View Of Fuel Pipe Retainer

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 [Gasoline/Gasoline Vapors Warning](#) .

NOTE: If servicing a fuel system, insure the fuel pressure has been relieved.

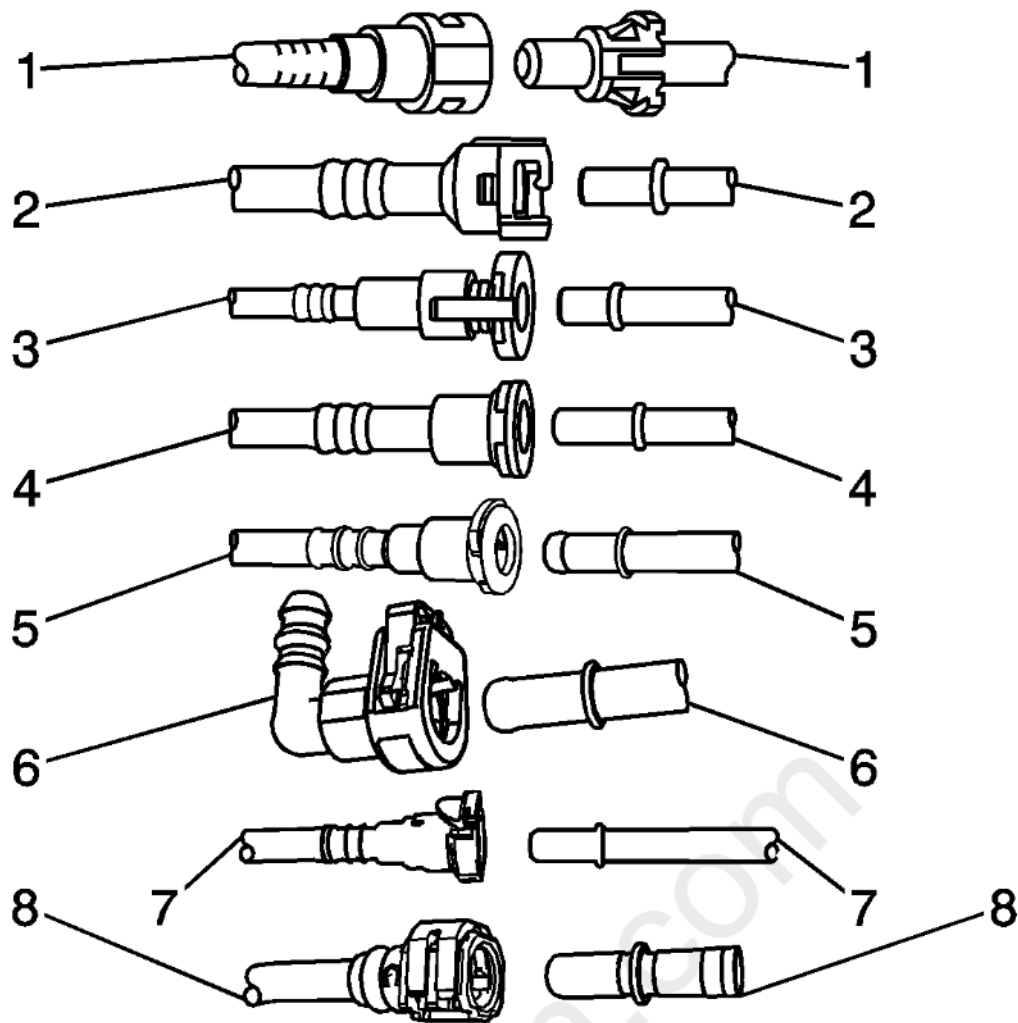


Fig. 29: Plastic Collar Quick Connect Fitting Service

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.

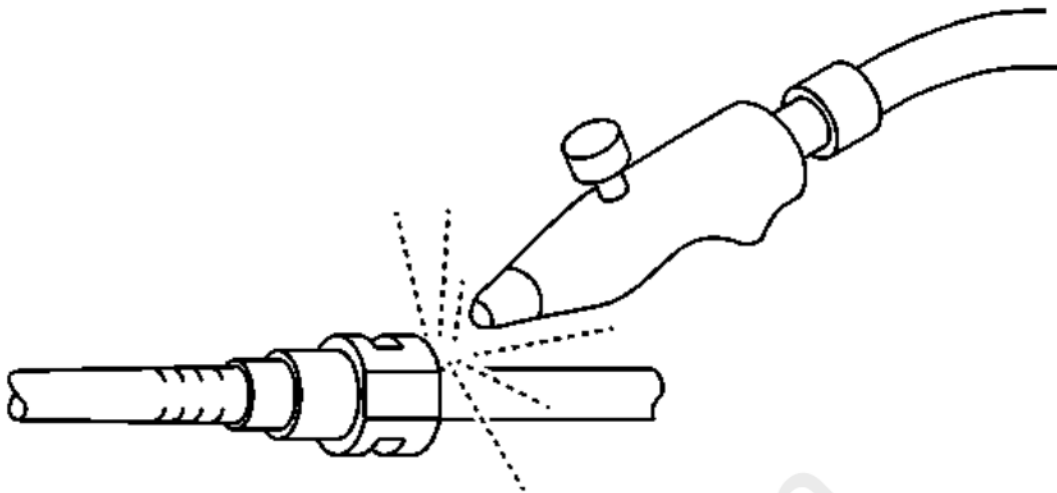


Fig. 30: Blowing Dirt Out Of Fitting (Plastic Collar)

Courtesy of GENERAL MOTORS COMPANY

WARNING: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.

1. Using compressed air, blow any dirt out of the quick-connect fitting.

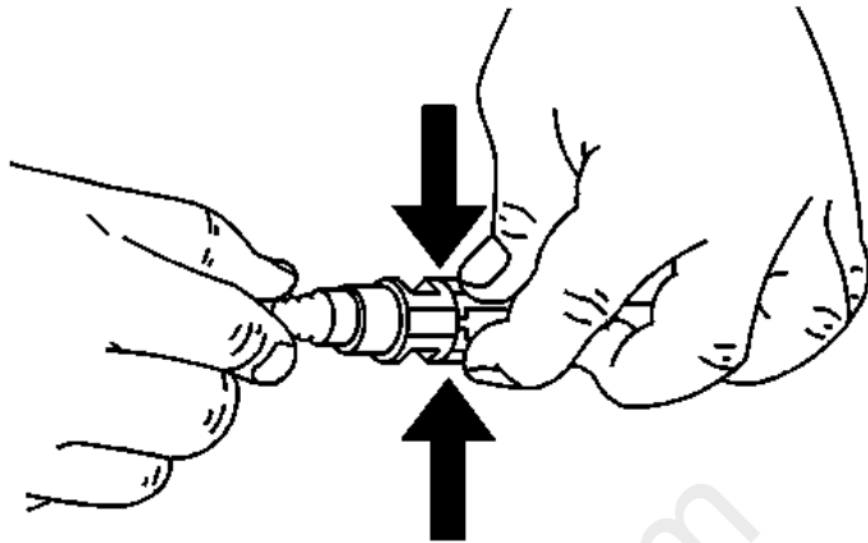


Fig. 31: View Of Quick Connect Fitting Release Tabs (Plastic Collar)

Courtesy of GENERAL MOTORS COMPANY

2. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick-connect fitting release tabs.

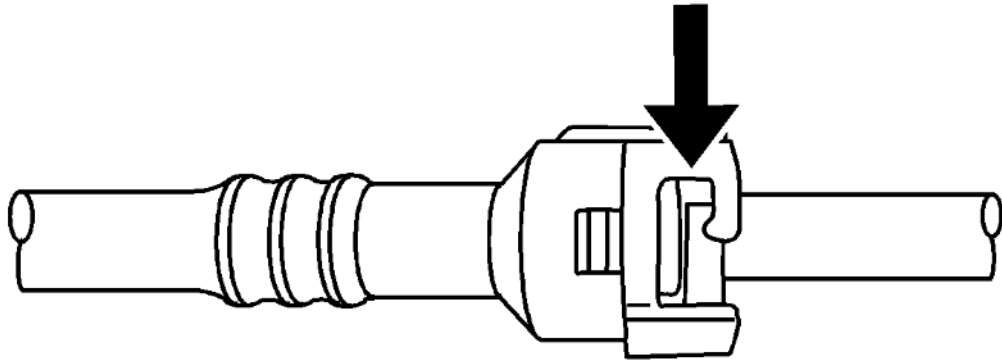


Fig. 32: Releasing Q Release Style Connectors (Plastic Collar)

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.

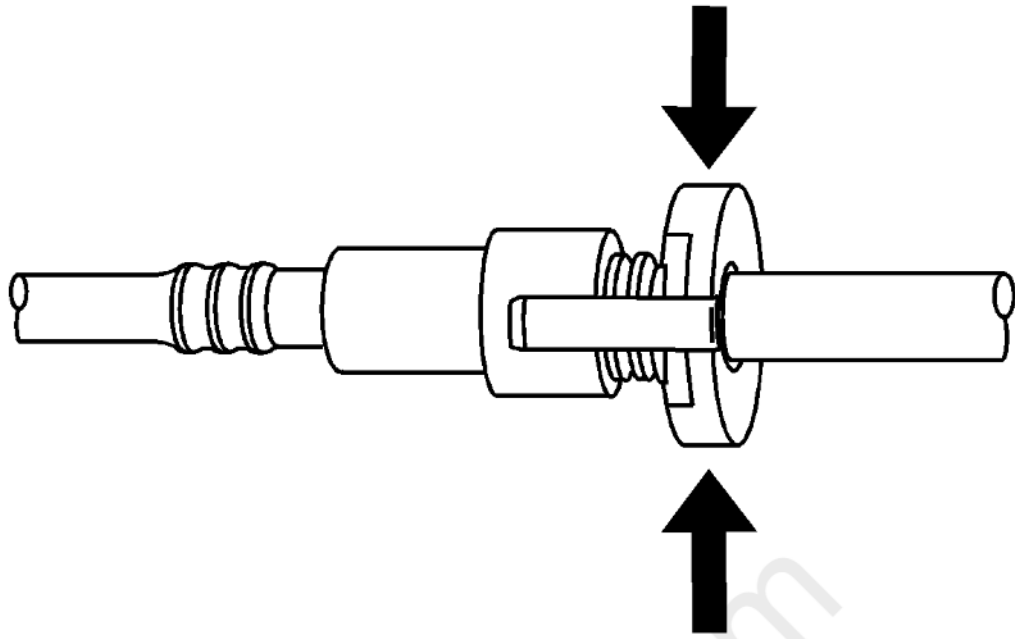


Fig. 33: Disengaging Quick Connect Fitting (Plastic Collar)

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.

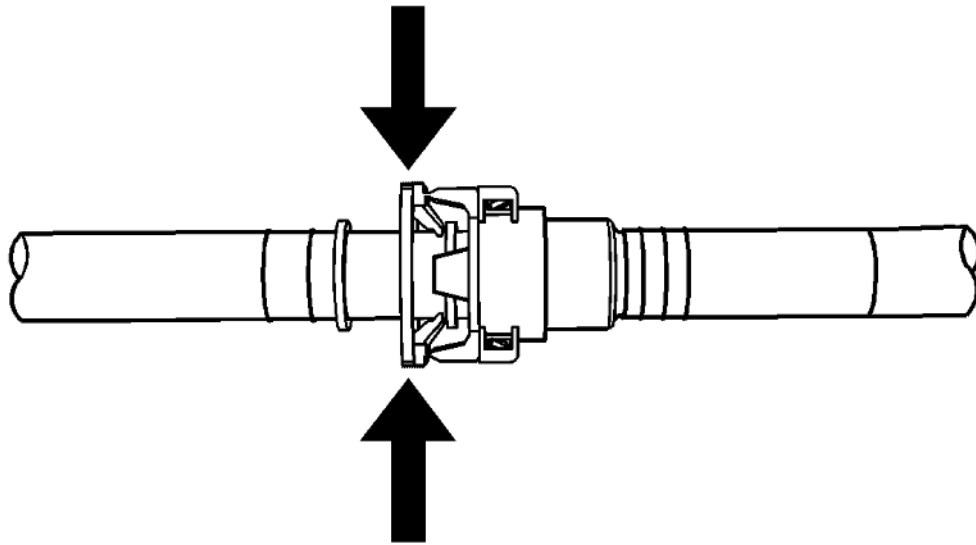


Fig. 34: Pushing In Male Side Of Connector
 Courtesy of GENERAL MOTORS COMPANY

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.

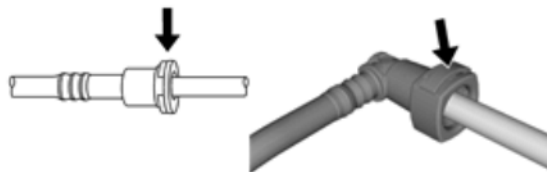


Fig. 35: Variants Of Sliding Retainer Style Connectors
 Courtesy of GENERAL MOTORS COMPANY

NOTE: There are two variants of sliding retainer style connectors shown above, both have the same release and installation procedure.

6. This step applies to Sliding Retainer style connectors ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab doesn't move try pressing the tab in from the opposite side. The tab will only move in one direction.

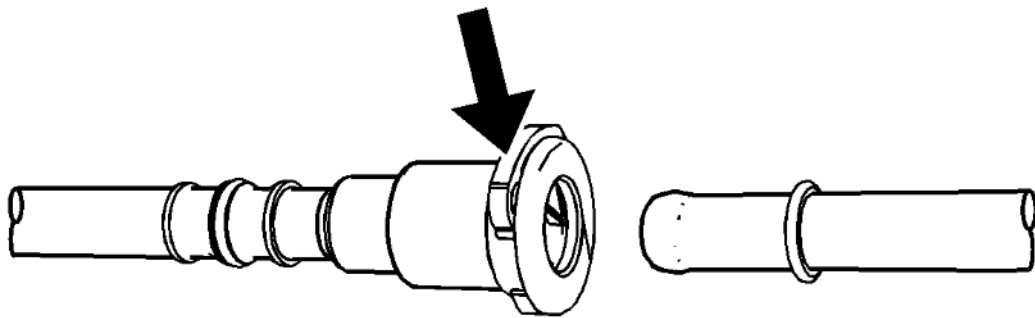


Fig. 36: Global Connector Style

Courtesy of GENERAL MOTORS COMPANY

7. This step applies to the Global Connector style only. Push the connector toward the tube in order to release the pressure. Press and hold down the release mechanism, and pull the connector straight out.

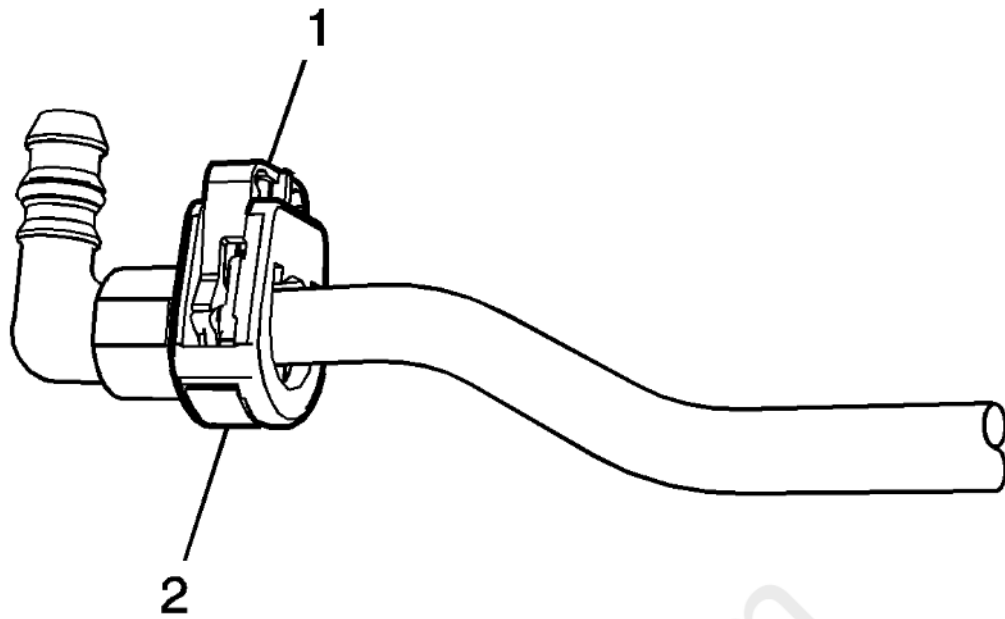


Fig. 37: TI Loc style

Courtesy of GENERAL MOTORS COMPANY

8. This step applies to the TI Loc style only. Push the connector toward the tube in order to release the pressure. Release the redundant latch (1) with two fingers or a flat bladed tool. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.

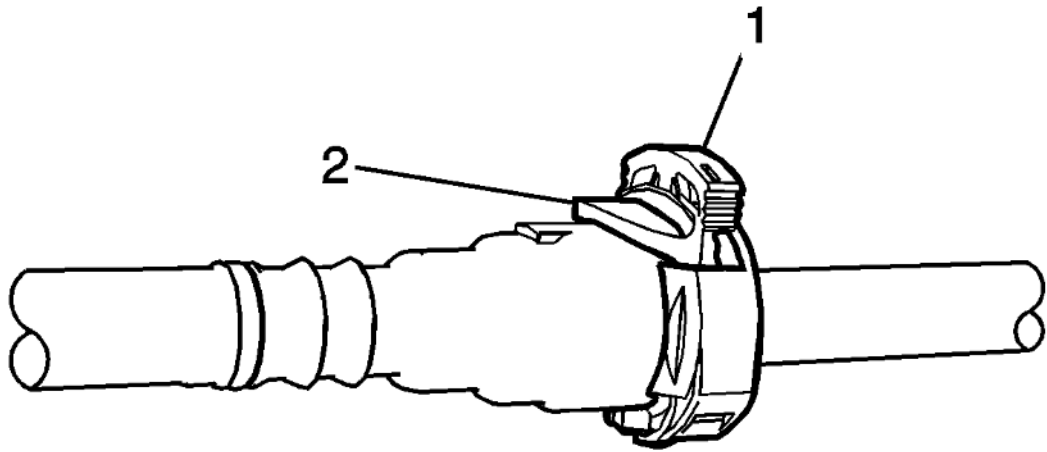


Fig. 38: Safe Lock Style

Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to [Relieving Fuel Pressure Warning](#) .

9. This step applies to the Safe Lock style only. Push the connector toward the tube in order to release the pressure. Release the second latch (1) with two fingers. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.

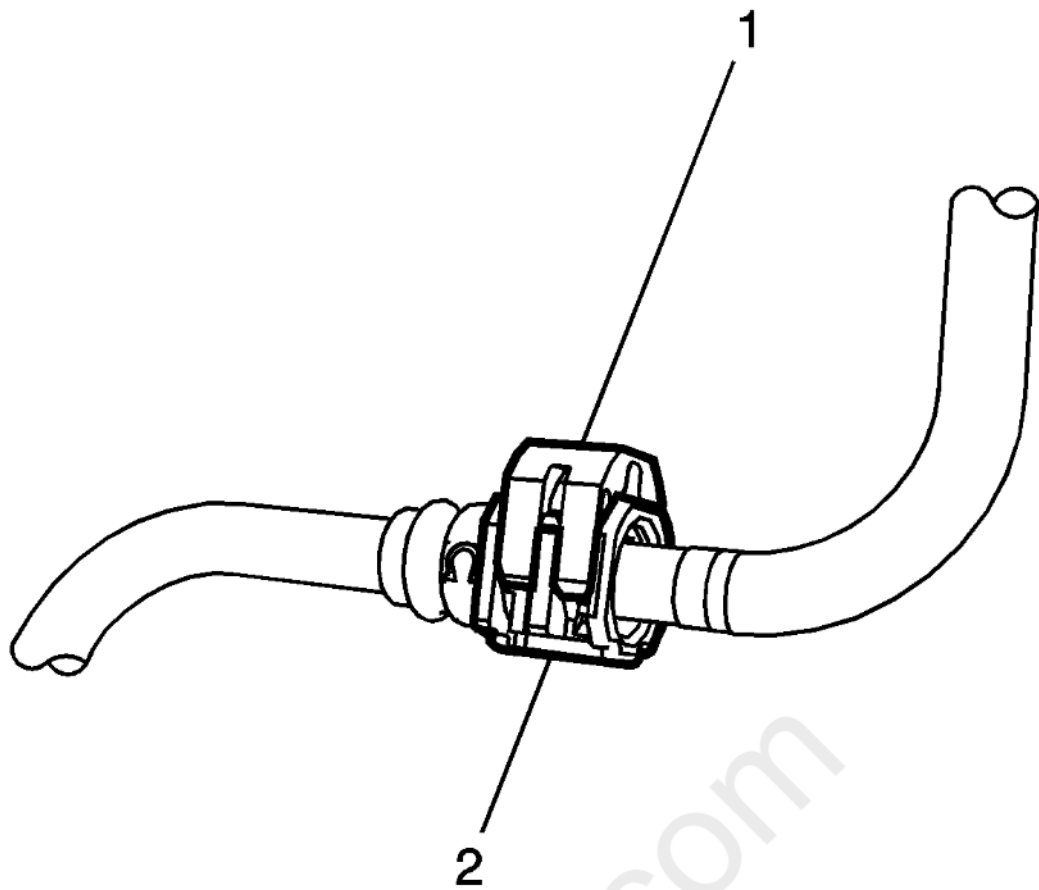


Fig. 39: Latch And Connector Straight Out

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

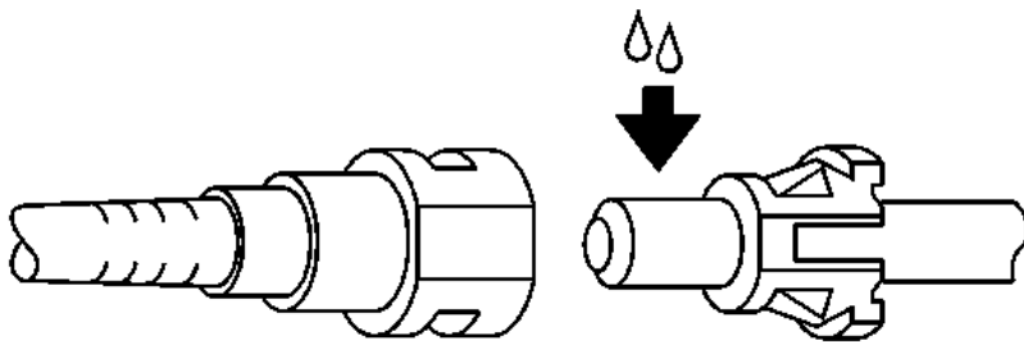


Fig. 40: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS COMPANY

WARNING: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.

1. Apply a few drops of clean engine oil to the male pipe end.

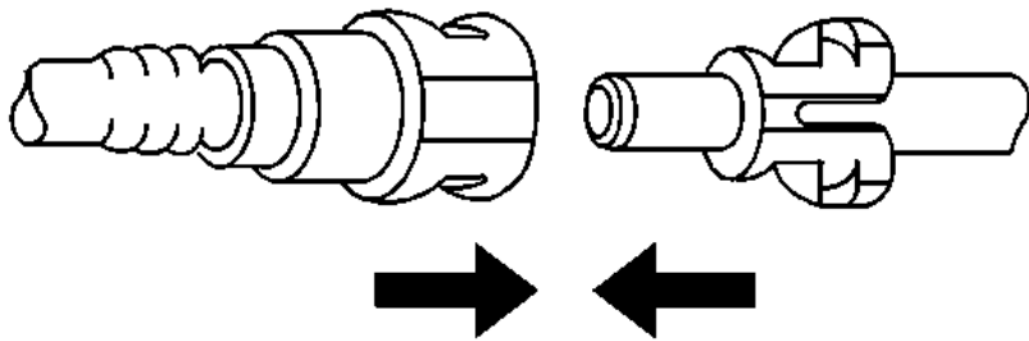


Fig. 41: Connecting Quick-Connect Fittings

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.

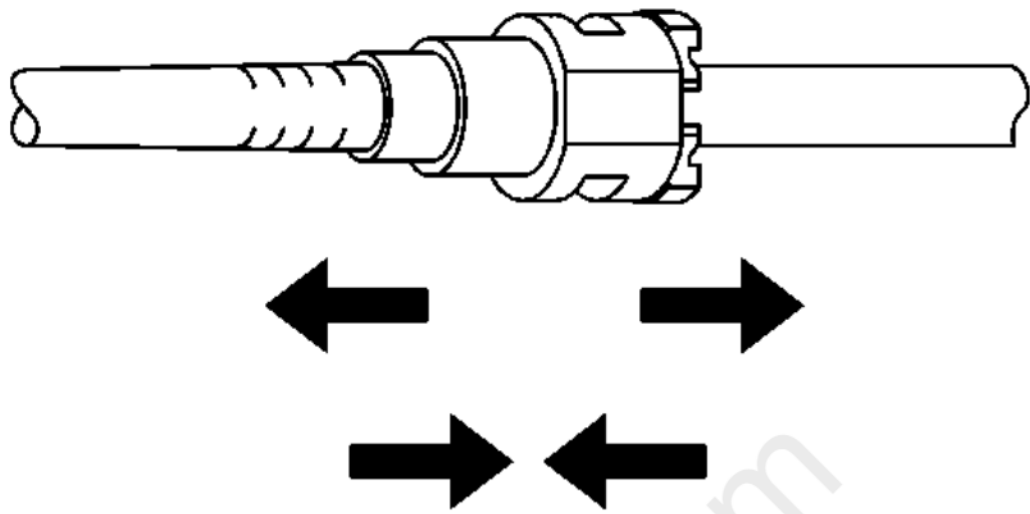


Fig. 42: View Of Quick-Connect Fitting

Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

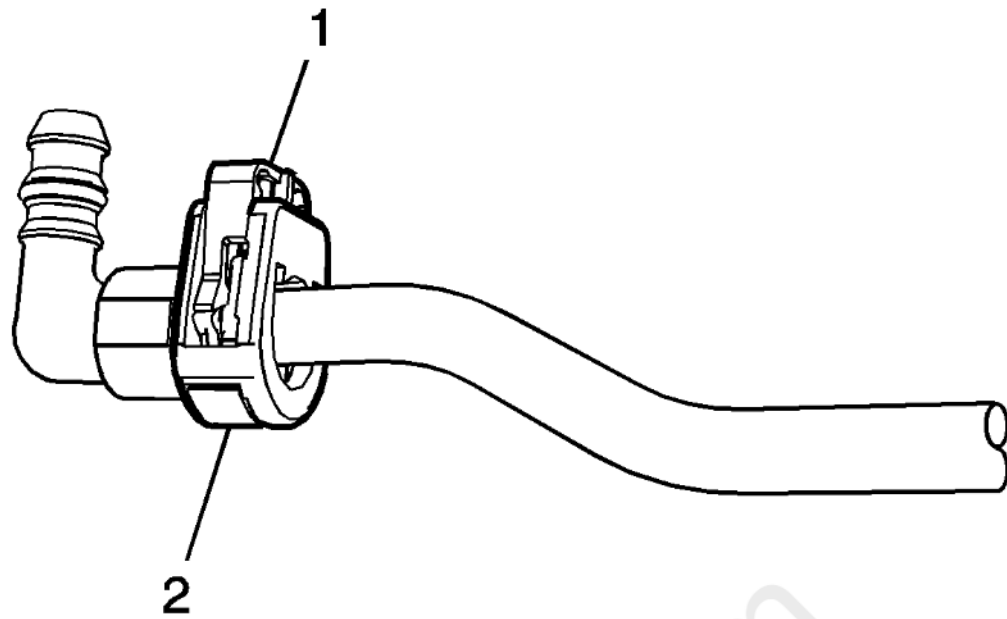


Fig. 43: TI Loc style

Courtesy of GENERAL MOTORS COMPANY

4. Insert the tube in the connector until the retainer snaps in place.
5. Push down on the redundant latch (1) until it is fully engaged and snapped into position.

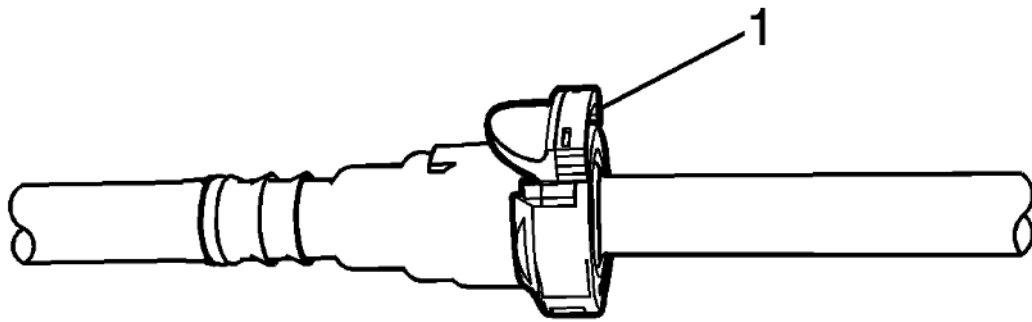


Fig. 44: Redundant Latch

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.

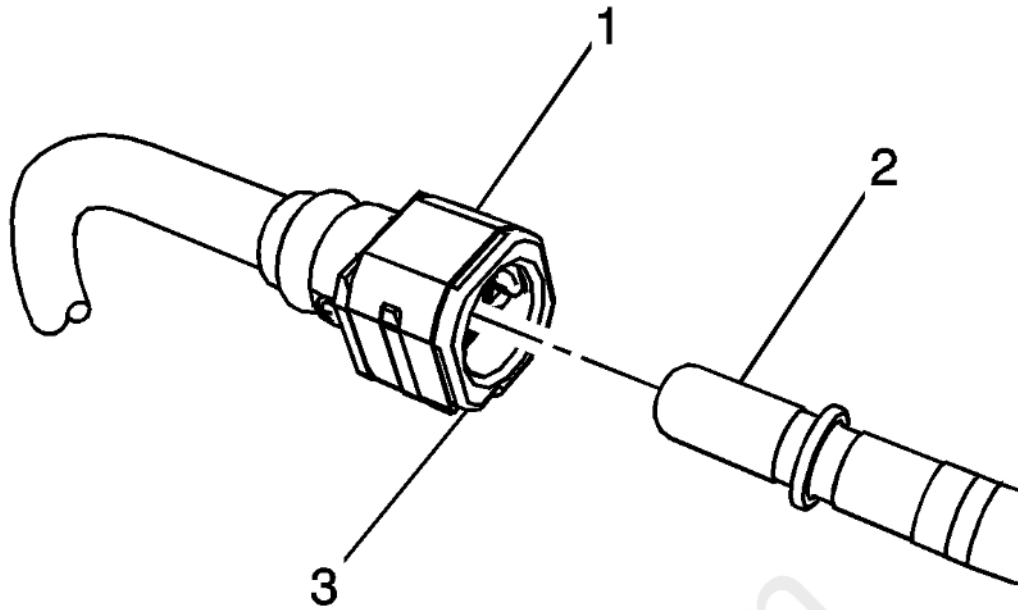


Fig. 45: Latch And Connector

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

Special Tools

- DT 36850 Transjel Lubricant
- CH 45004 Fuel Tank Drain Hose

WARNING: Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

WARNING: Place a dry chemical (Class B) fire extinguisher nearby before performing any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.

1. Raise and Support the Vehicle. Refer to [Lifting and Jacking the Vehicle](#)

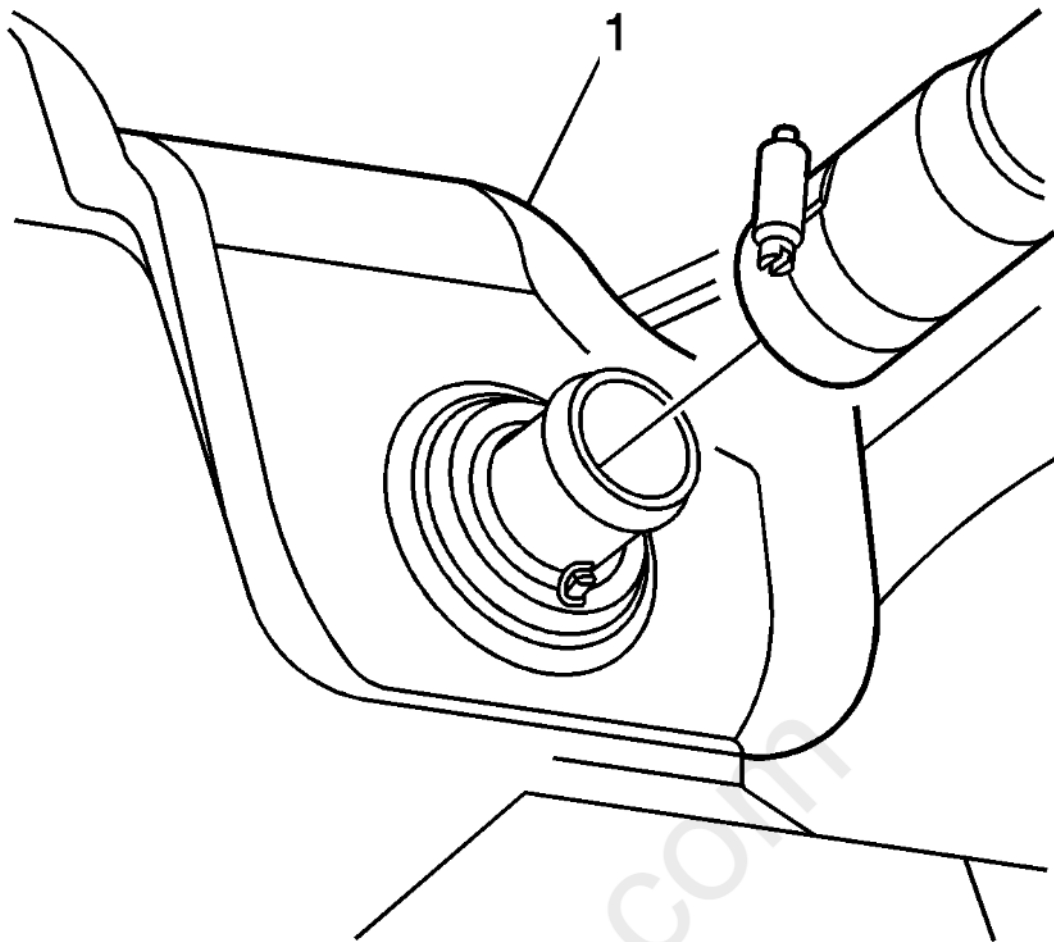


Fig. 46: Inserting Fuel Tank Drain Hose Into Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

NOTE: Lubricate the fuel drain hose with DT 36850 Transjel Lubricant or equivalent to aid in hose insertion. Do not use an unapproved lubricant.

2. Loosen the lower fill hose clamp in order to separate the fill hose from the fuel tank (1).
3. Insert the **CH 45004** Fuel Tank Drain Hose into the fuel tank (1) until the hose reaches the bottom of the fuel tank.
4. Use a hand or air operated pump device in order to drain as much fuel from the fuel tank as possible.

FUEL TANK PROTECTOR REPLACEMENT

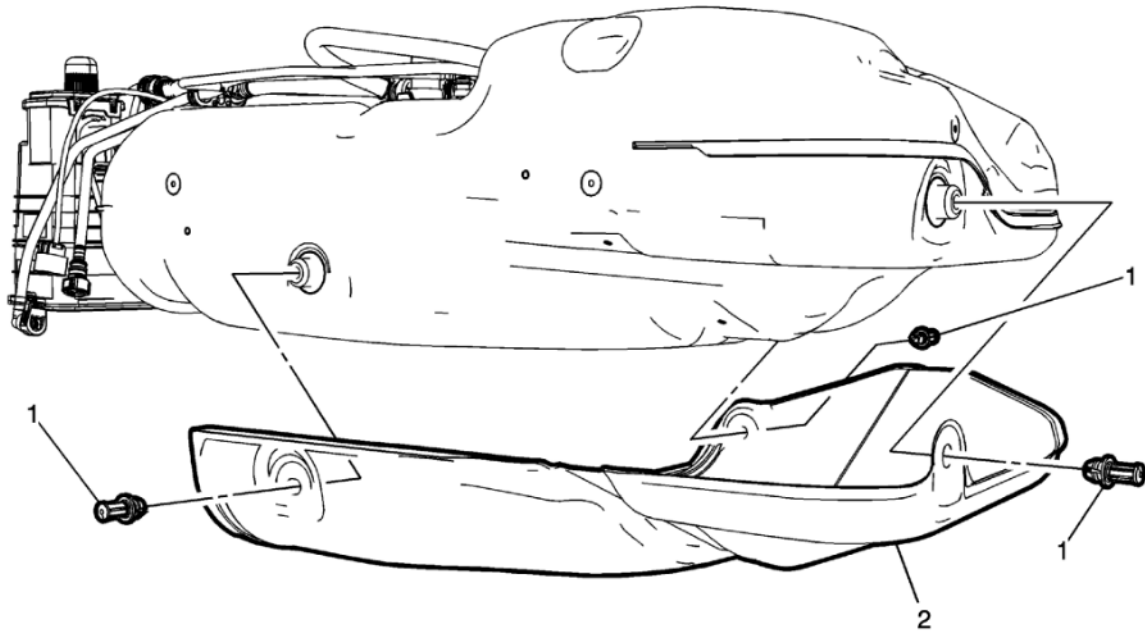


Fig. 47: Fuel Tank Protector & Retainers
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove the left fuel tank strap and partially lower the tank on the left side. Refer to Fuel Tank Replacement .	
1	Fuel Tank Protector Retainers (Qty: 3)
2	Fuel Tank Protector

FUEL TANK REPLACEMENT

Removal Procedure

WARNING: To avoid any vehicle damage, serious personal injury or death:

- When major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.
- When performing work in the engine compartment or under the vehicle, ensure that the hood is fully open, or opened to its secondary latch. When the hood is opened to the secondary latch, the vehicle will disable the remote start features from the key fob and OnStar mobile app. Failure to open the hood, or open the hood to the secondary latch while doing a repair in the engine compartment or under the vehicle can result in inadvertent vehicle starting which could result in personal injury or damage to a vehicle.

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

WARNING: Refer to [Safety Glasses Warning](#) .

1. Relieve the system fuel pressure. Refer to [Fuel Pressure Relief \(Gasoline\)](#)
2. Drain the fuel tank. Refer to [Fuel Tank Draining](#).
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .

4. Remove the exhaust muffler. Refer to [Exhaust Muffler with Resonator, Exhaust, and Tail Pipe Replacement](#) .
5. Remove the left rear underbody air deflector. Refer to [Underbody Rear Air Deflector Replacement - Left Side](#) .
6. Remove the right rear underbody air deflector. Refer to [Underbody Rear Air Deflector Replacement - Right Side](#) .

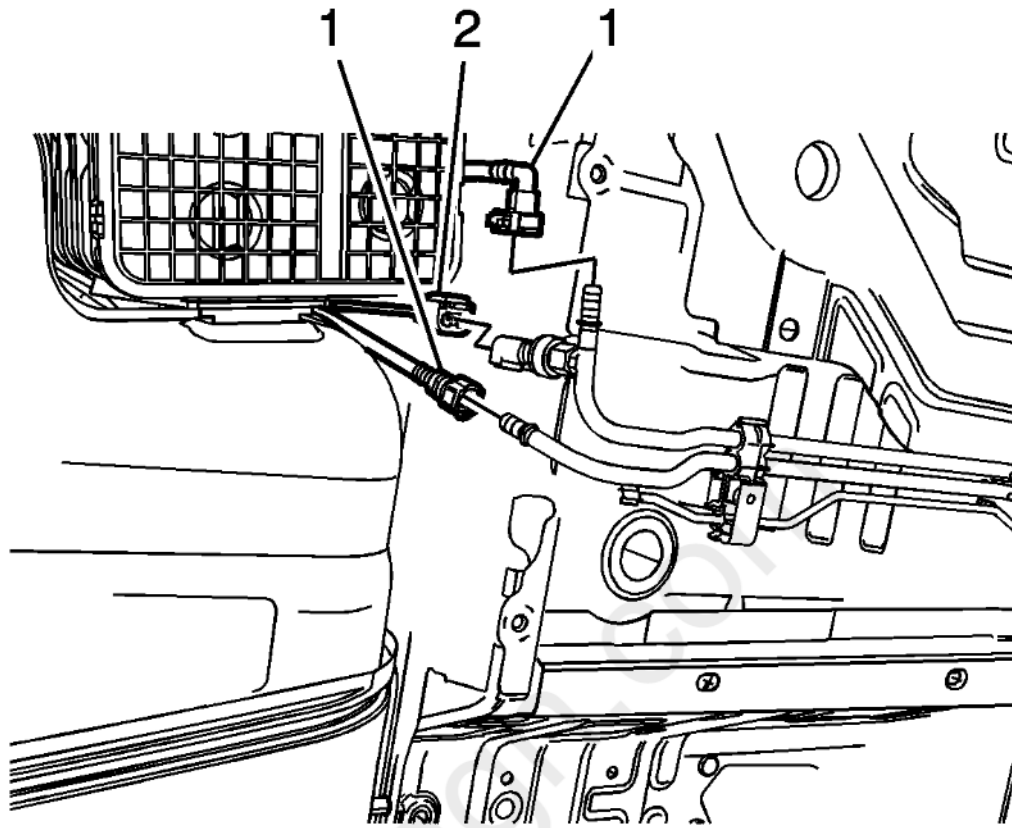


Fig. 48: Evaporative Emission, Fuel Pipes And Fuel Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the evaporative emission and fuel pipes (1). Refer to [Plastic Collar Quick Connect Fitting Service](#).
8. Disconnect the fuel pressure sensor electrical connector (2).

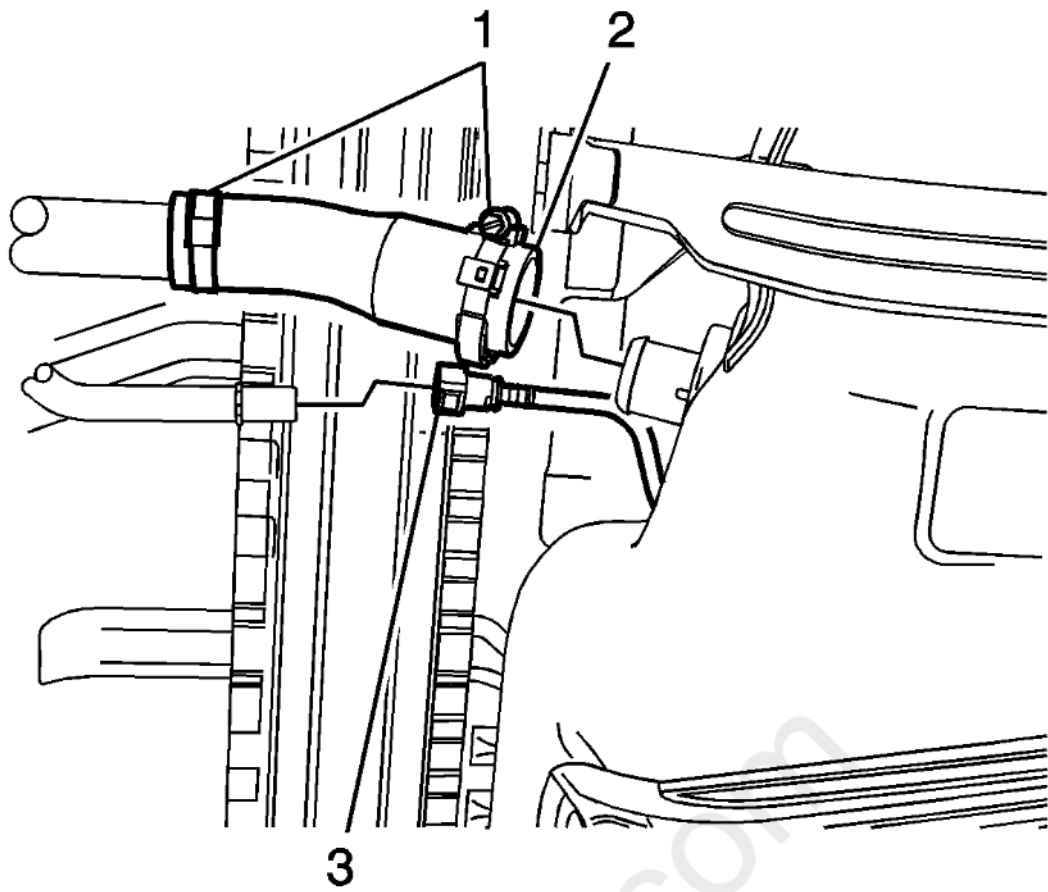


Fig. 49: Hose Clamps And Filler Tube

Courtesy of GENERAL MOTORS COMPANY

9. Loosen the hose clamps (1) and remove the filler tube (2).
10. Disconnect the evaporative emission line (3) from the filler pipe assembly. Refer to [**Plastic Collar Quick Connect Fitting Service**](#).

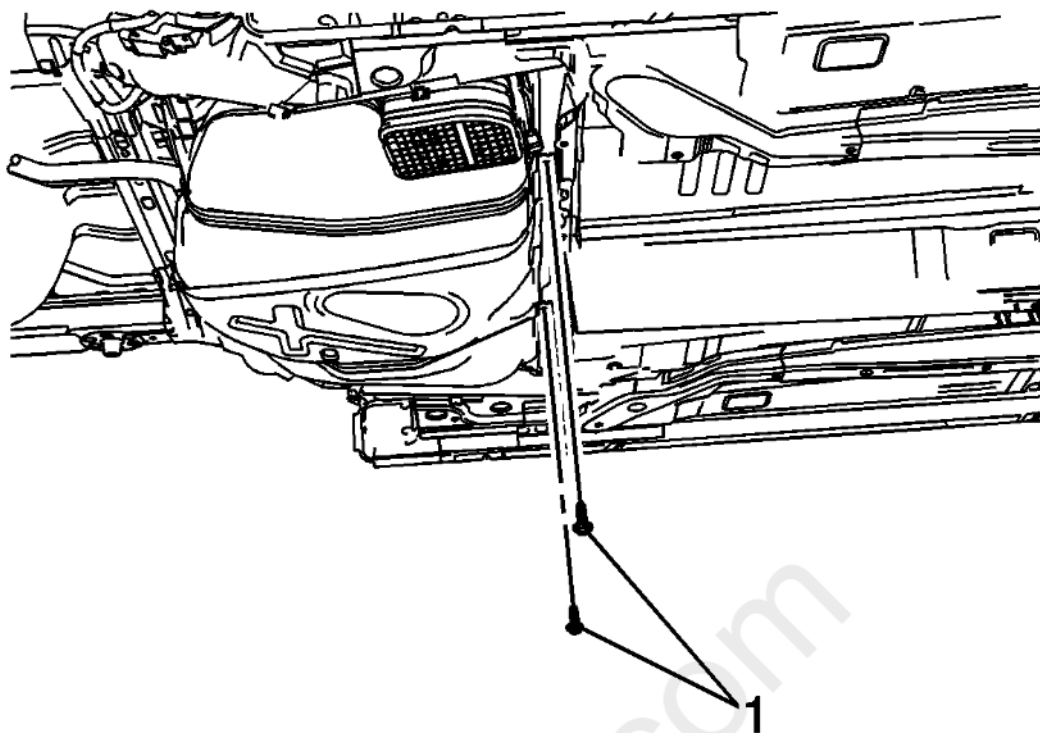


Fig. 50: Fuel Tank Strap Bolts

Courtesy of GENERAL MOTORS COMPANY

11. Support the fuel tank with a suitable jack.
12. Remove the fuel tank strap bolts (1).

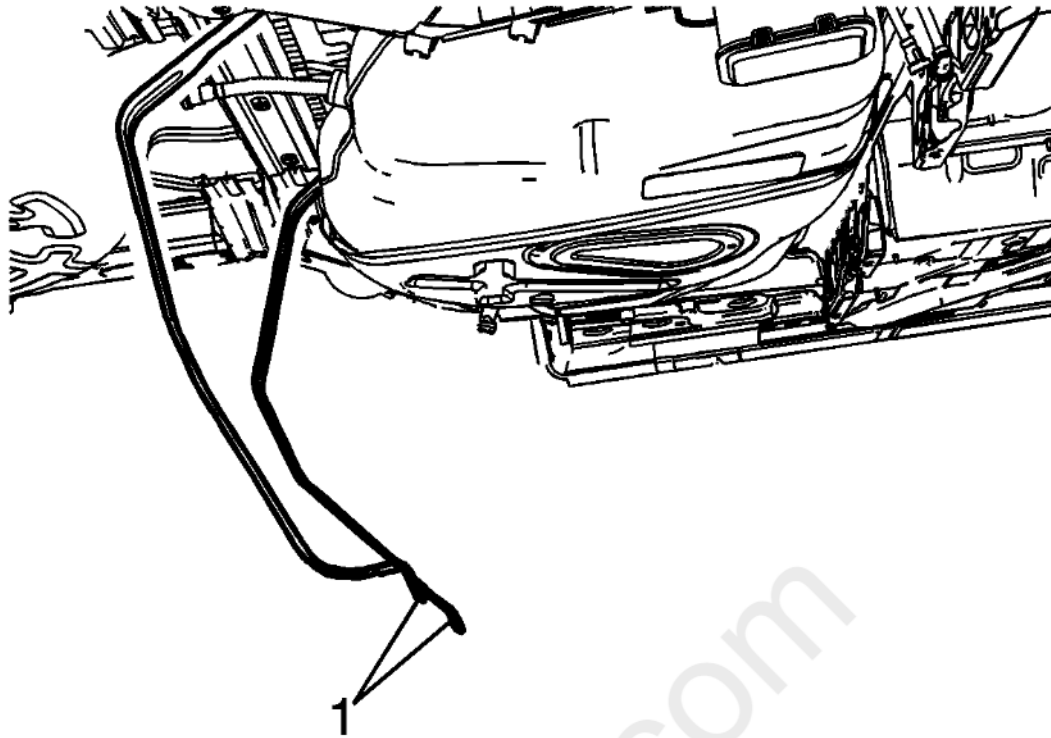


Fig. 51: Fuel Tank Straps

Courtesy of GENERAL MOTORS COMPANY

13. Swing the fuel tank straps (1) out of the way.

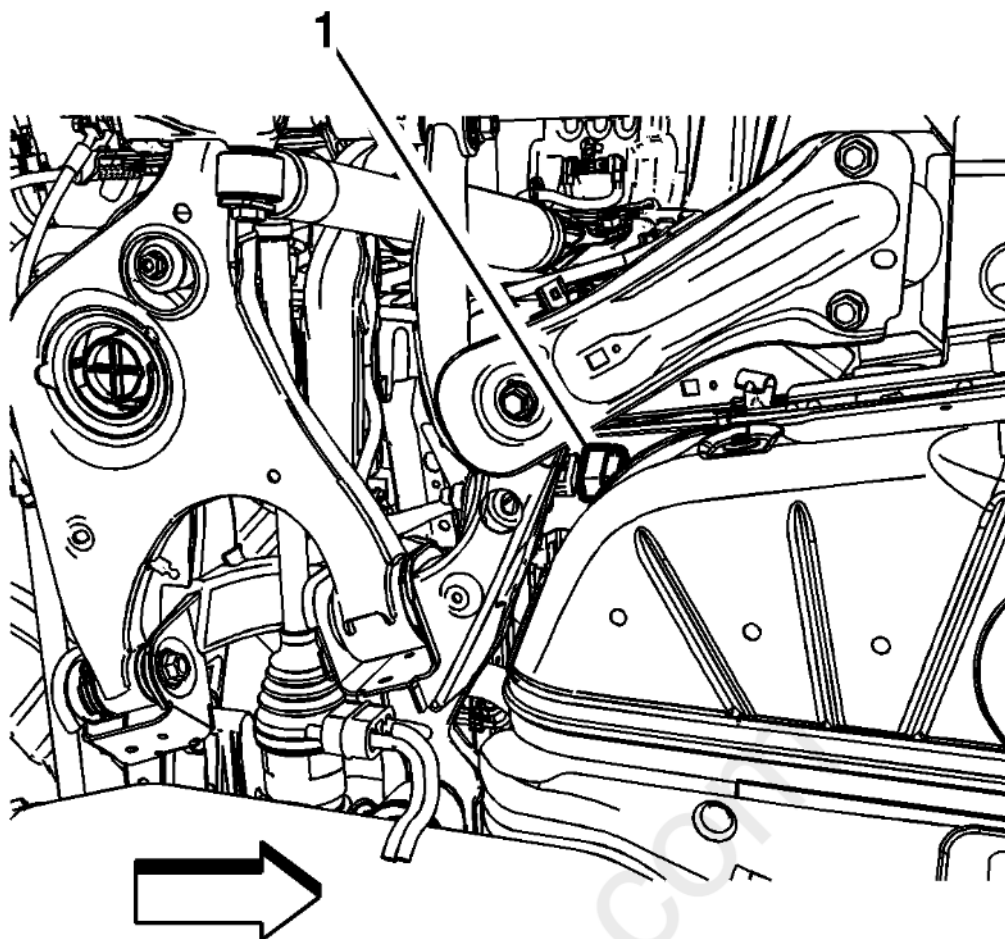


Fig. 52: Fuel Pump Module Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect the fuel tank harness electrical connector (1).

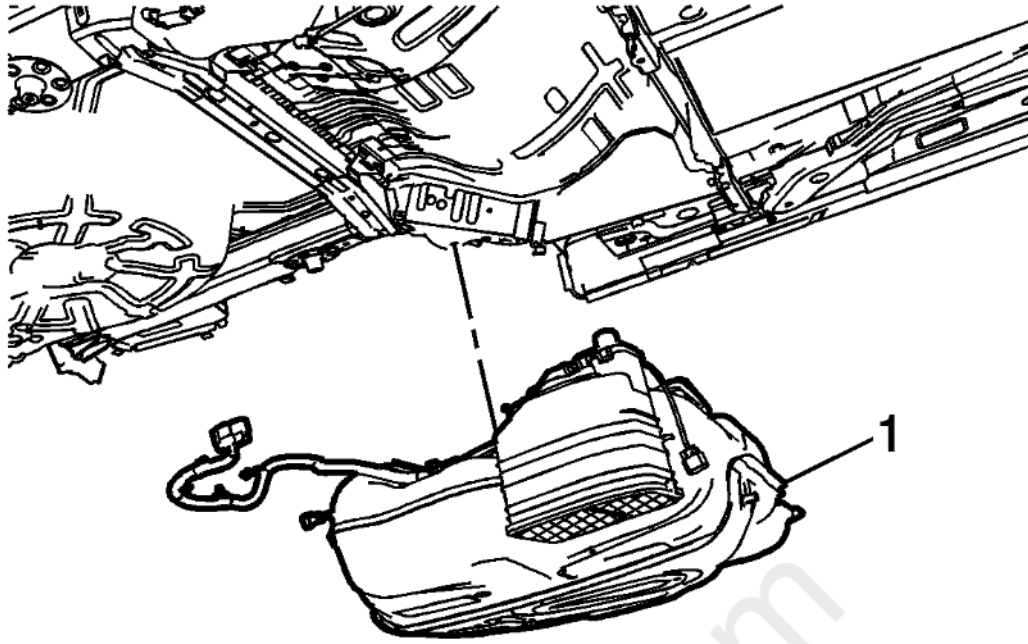


Fig. 53: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

15. Remove the fuel tank (1).
16. Remove the following components if replacing just the fuel tank.
 1. Fuel tank fuel pump module. Refer to [Fuel Tank Fuel Pump Module Replacement \(NT5, NT7\)](#)[Fuel Tank Fuel Pump Module Replacement \(NU6\)](#).
 2. Evaporative emission carbon canister. Refer to [Evaporative Emission Canister Replacement](#).
 3. Transfer components as necessary.

Installation Procedure

1. Install the following components if fuel tank replacement was necessary:
 1. Fuel tank fuel pump module. Refer to [Fuel Tank Fuel Pump Module Replacement \(NT5, NT7\)](#)[Fuel Tank Fuel Pump Module Replacement \(NU6\)](#).
 2. Evaporative emission carbon canister. Refer to [Evaporative Emission Canister Replacement](#).

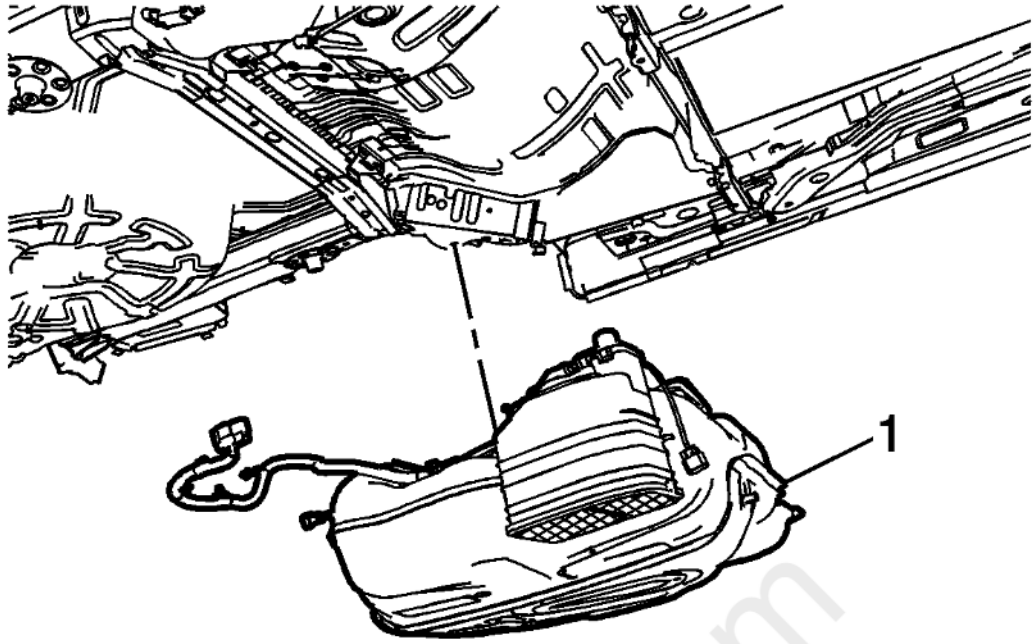


Fig. 54: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

2. Use a suitable jack and install the fuel tank (1).

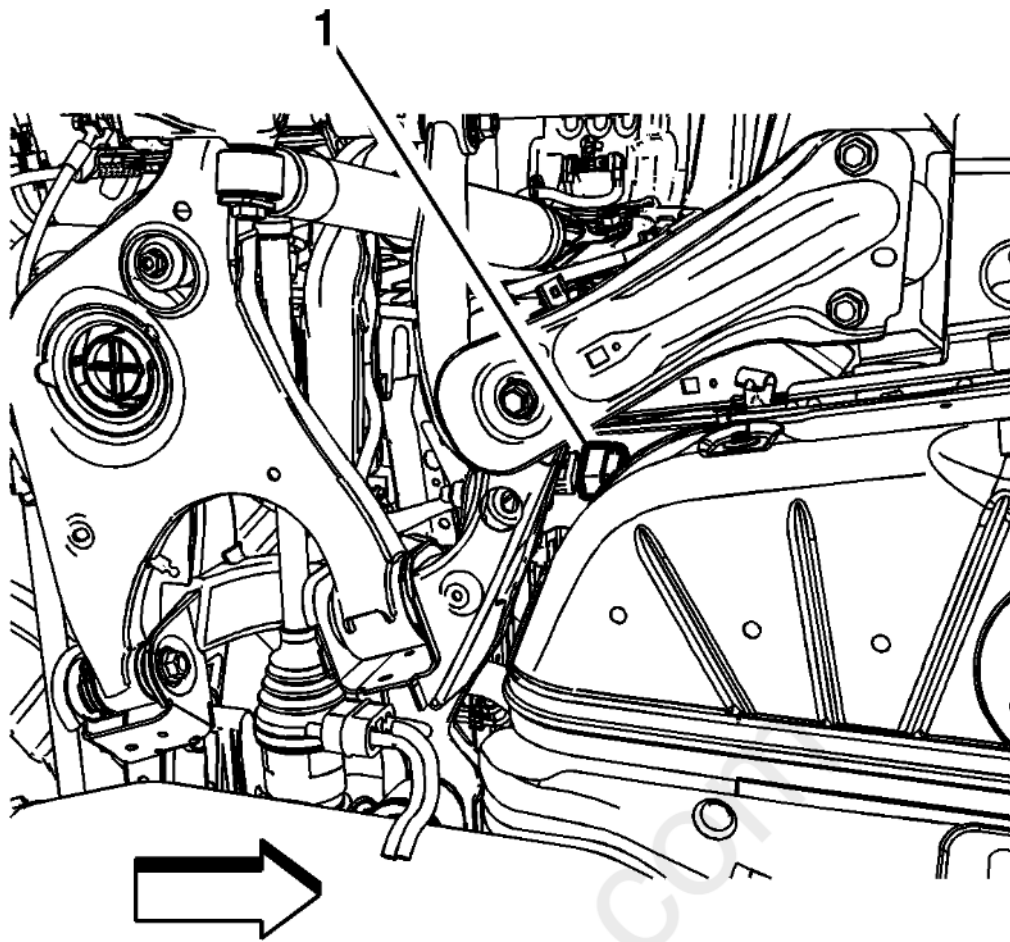


Fig. 55: Fuel Pump Module Wiring Harness

Courtesy of GENERAL MOTORS COMPANY

3. Connect the fuel tank harness electrical connector (1).

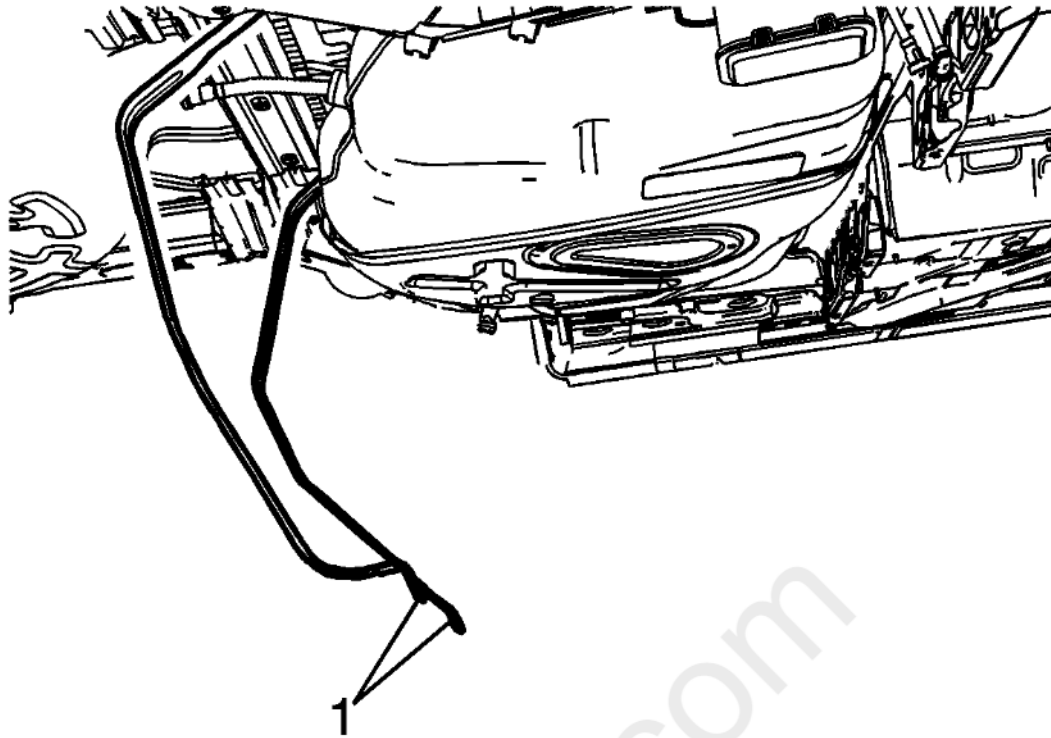


Fig. 56: Fuel Tank Straps

Courtesy of GENERAL MOTORS COMPANY

4. Reposition the fuel tank straps (1).

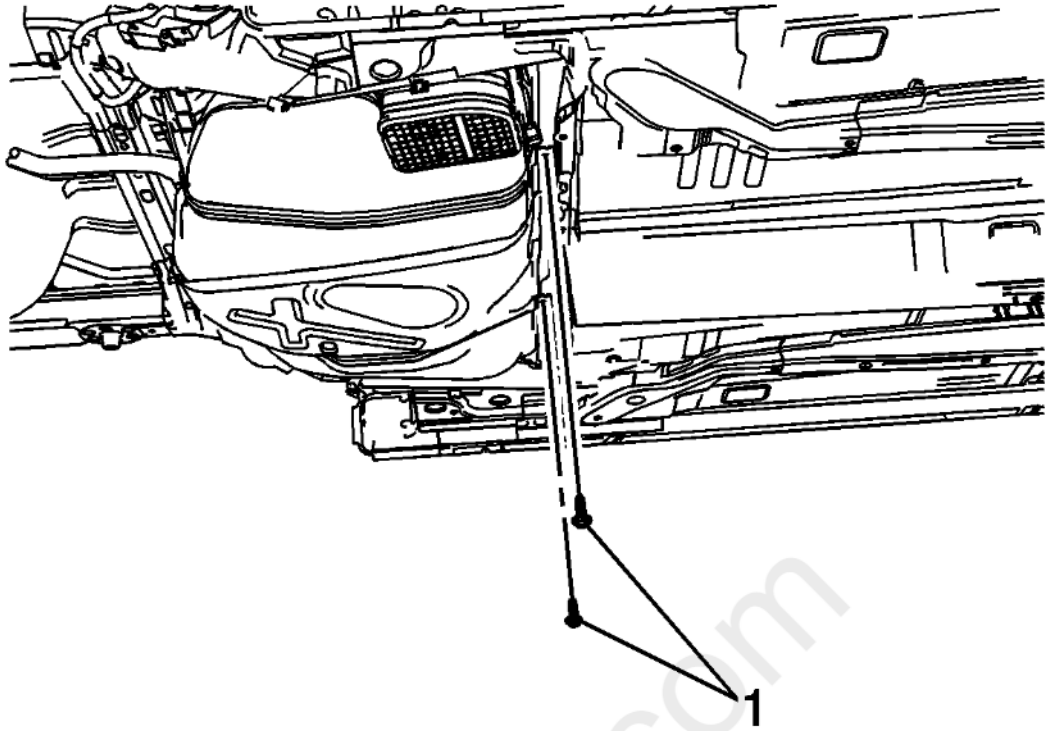


Fig. 57: Fuel Tank Strap Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

5. Install the fuel tank strap bolts (1) and tighten to 27 N.m (20 lb ft).

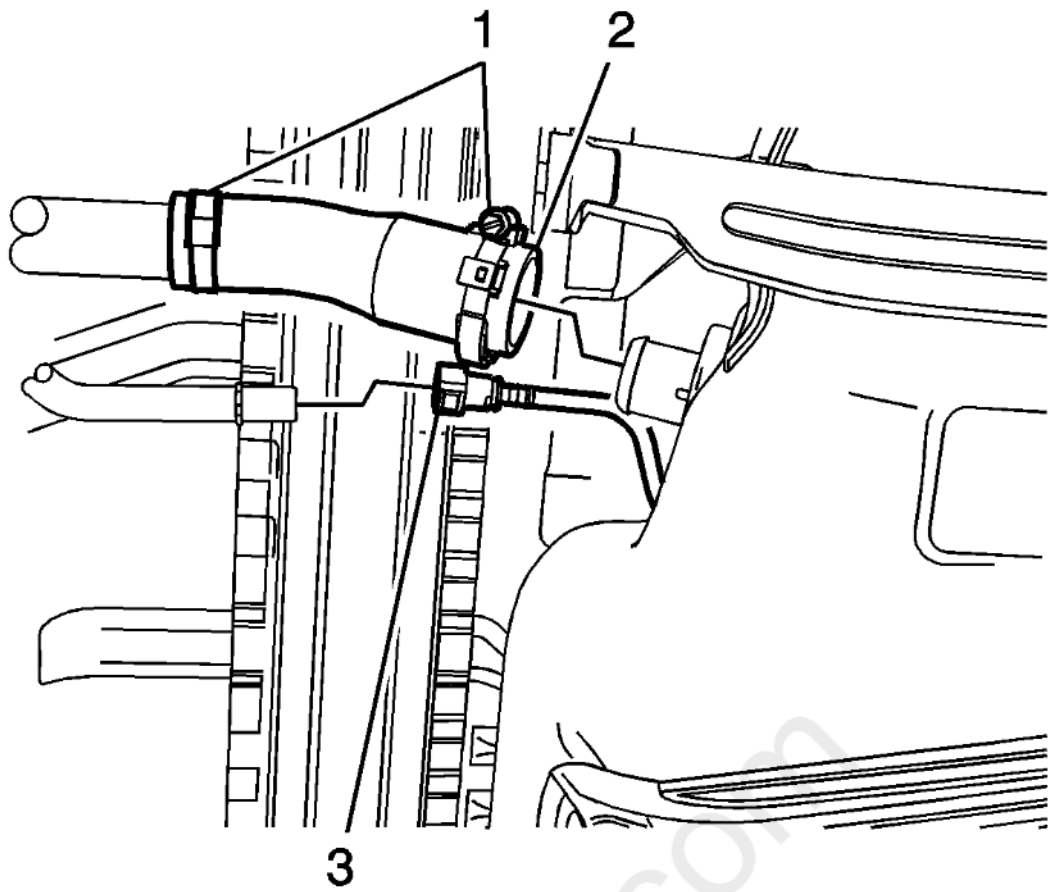


Fig. 58: Hose Clamps And Filler Tube

Courtesy of GENERAL MOTORS COMPANY

6. Install the filler tube (2) and tighten the hose clamps (1) to 4 N.m (35 lb in).
7. Connect the evaporative emission line (3). Refer to **Plastic Collar Quick Connect Fitting Service**.

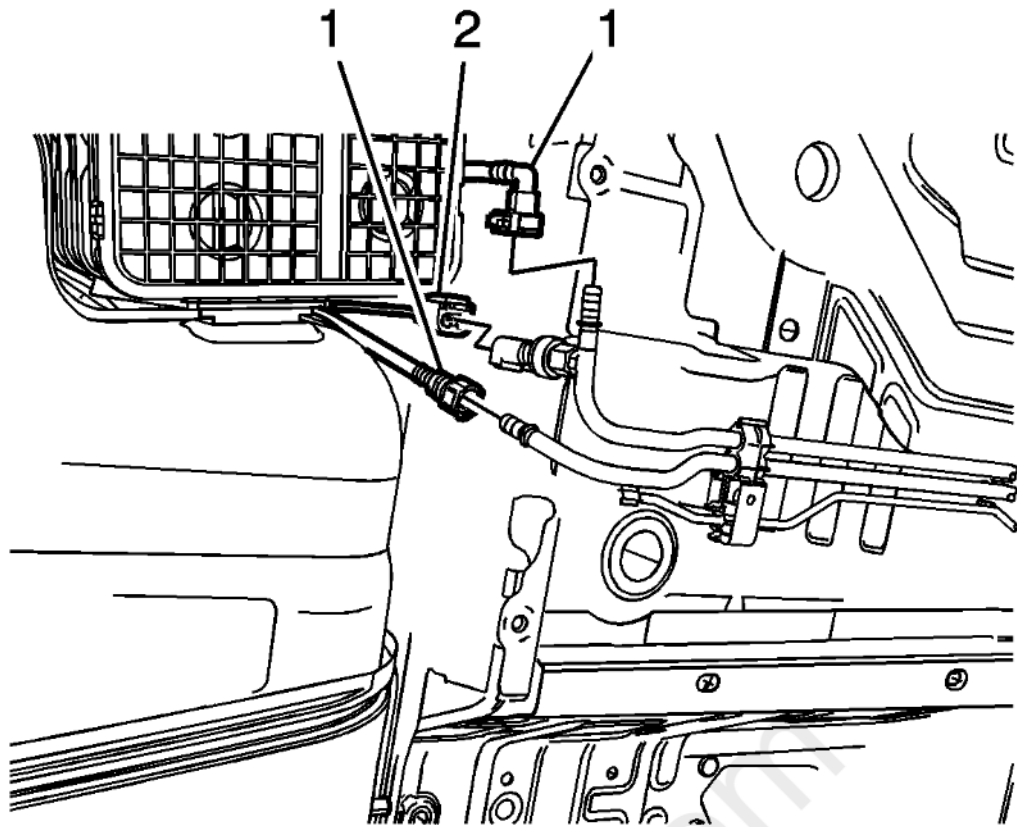


Fig. 59: Evaporative Emission, Fuel Pipes And Fuel Pressure Sensor Electrical Connector
 Courtesy of GENERAL MOTORS COMPANY

8. Connect the evaporative emission and fuel pipes (1). Refer to [Plastic Collar Quick Connect Fitting Service](#).
9. Connect the fuel pressure sensor electrical connector (2).
10. Install the left rear underbody air deflector. Refer to [Underbody Rear Air Deflector Replacement - Left Side](#).
11. Install the right rear underbody air deflector. Refer to [Underbody Rear Air Deflector Replacement - Right Side](#).
12. Install the exhaust muffler. Refer to [Exhaust Muffler with Resonator, Exhaust, and Tail Pipe Replacement](#).
13. Lower the vehicle.
14. Refill the fuel tank.
15. Inspect for fuel leaks.

FUEL TANK FUEL PUMP MODULE REPLACEMENT (NT5, NT7)

Special Tools

CH 45722 Fuel Sender Lock Ring Wrench

For equivalent regional tools, refer to [Special Tools \(Diagnostic Tools\)](#) [Special Tools \(Mechanical Tools\)](#)

Removal Procedure

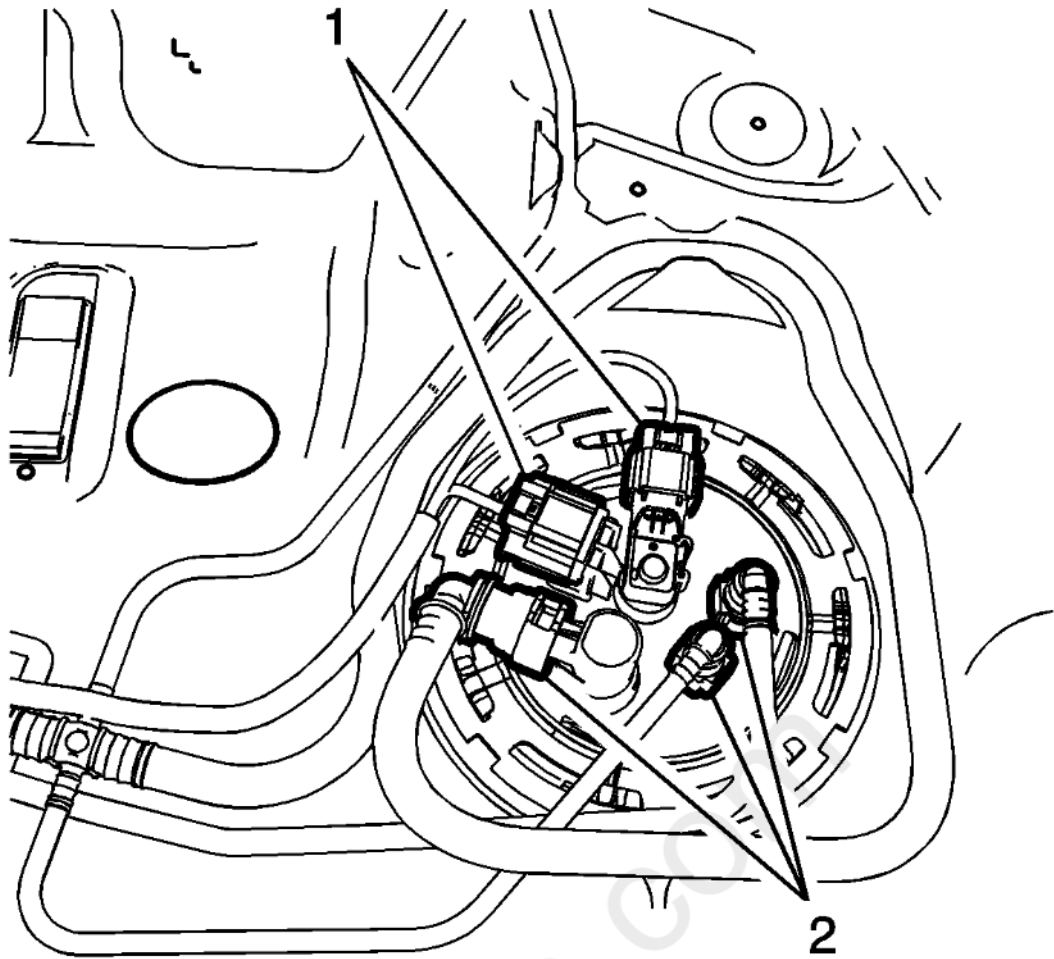


Fig. 60: Fuel Pump Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

1. Remove the fuel tank. Refer to [Fuel Tank Replacement](#).
2. Disconnect the fuel pump electrical connector (1) and the quick connects (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).

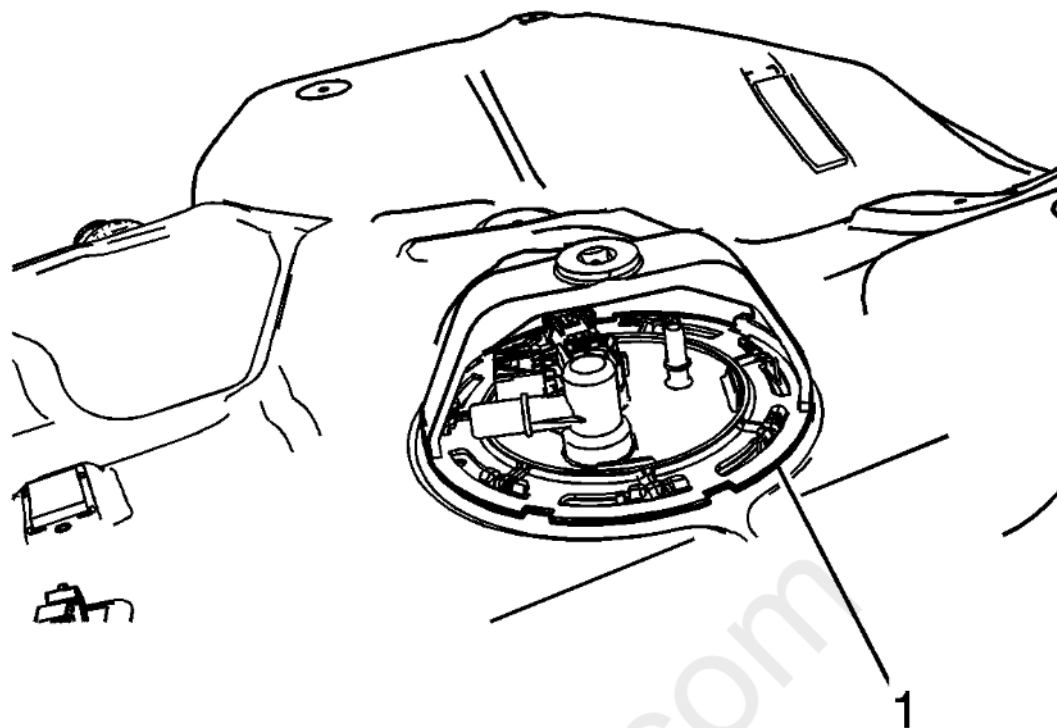


Fig. 61: Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning counter clockwise and remove the lock ring (1).

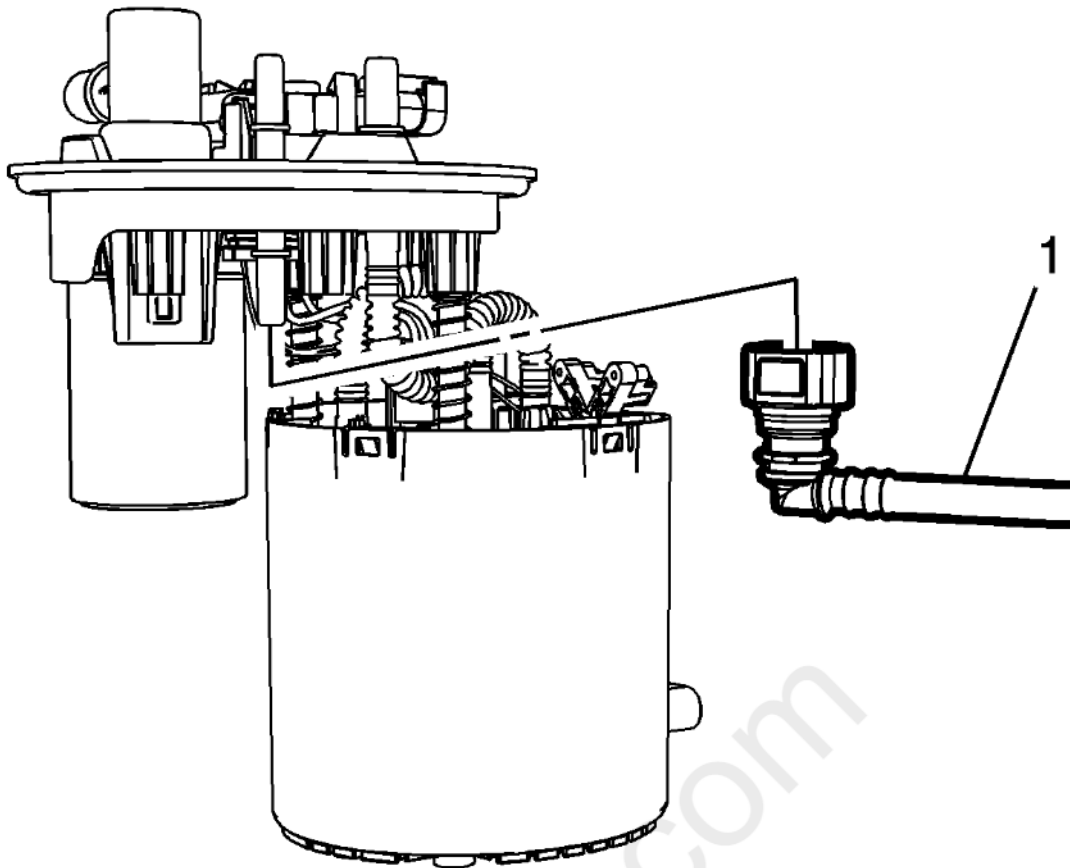


Fig. 62: Fuel Pump Vent Hose

Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel pump vent hose from the fuel tank fuel pump module. Refer to **Plastic Collar Quick Connect Fitting Service**.

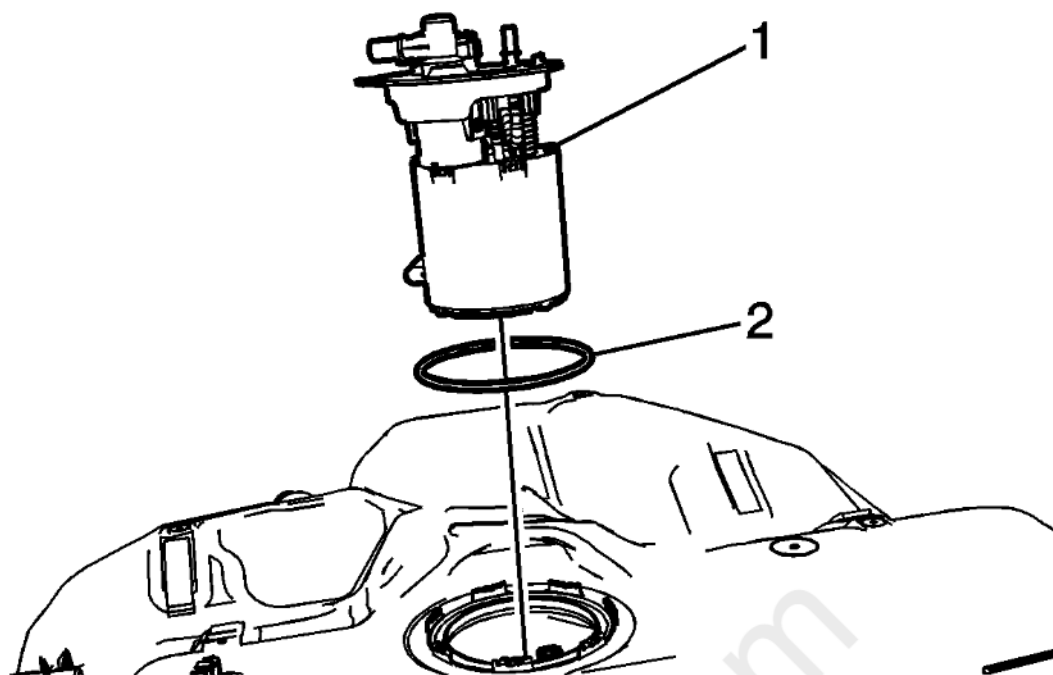


Fig. 63: Fuel Tank Module & O-Ring

Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel tank module (1) and the O-ring (2).

Installation Procedure

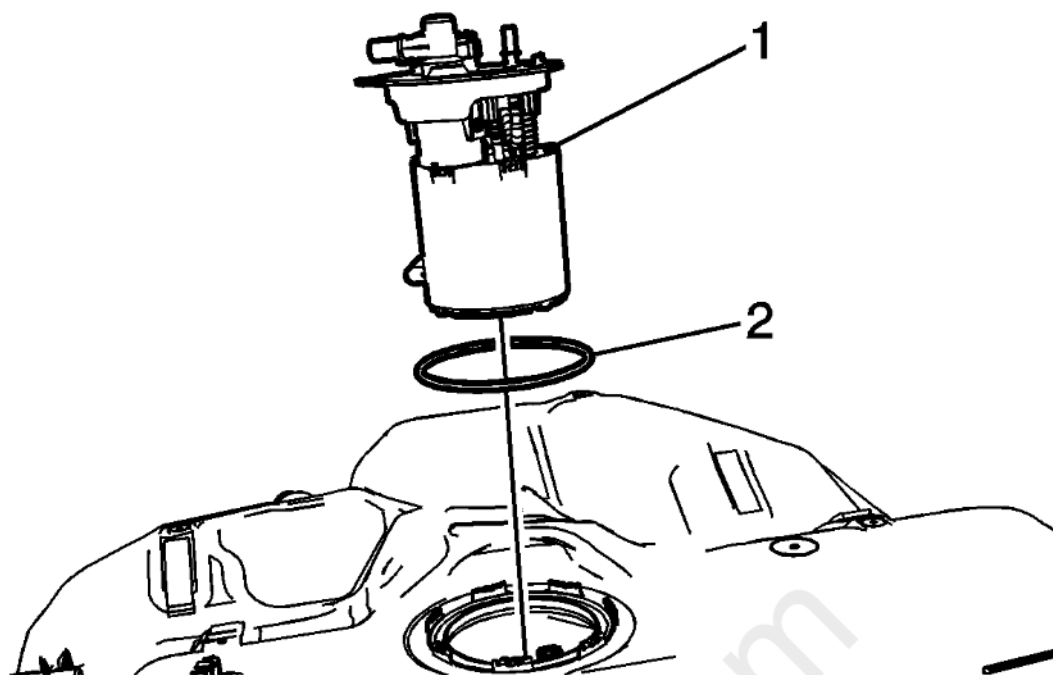


Fig. 64: Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW seal (2) and the fuel tank module (1).

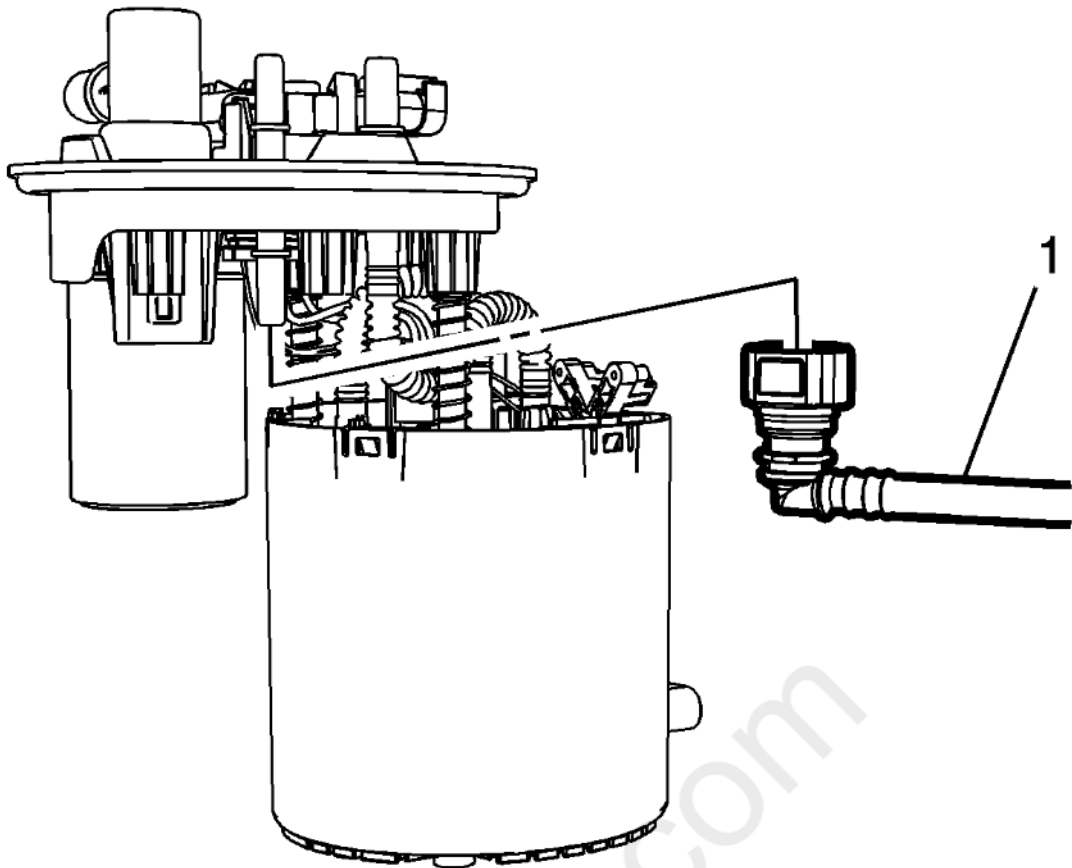


Fig. 65: Fuel Pump Vent Hose

Courtesy of GENERAL MOTORS COMPANY

2. Connect the fuel pump vent hose to the fuel tank fuel pump module. Refer to [**Plastic Collar Quick Connect Fitting Service**](#).

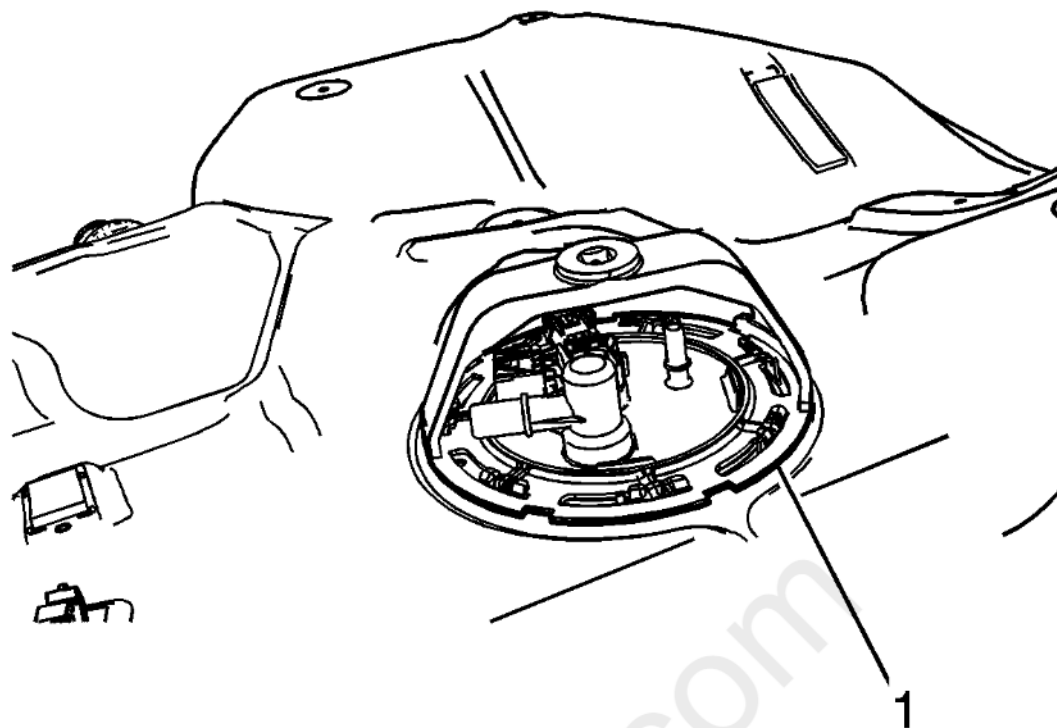


Fig. 66: Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning clockwise and install the lock ring (1).

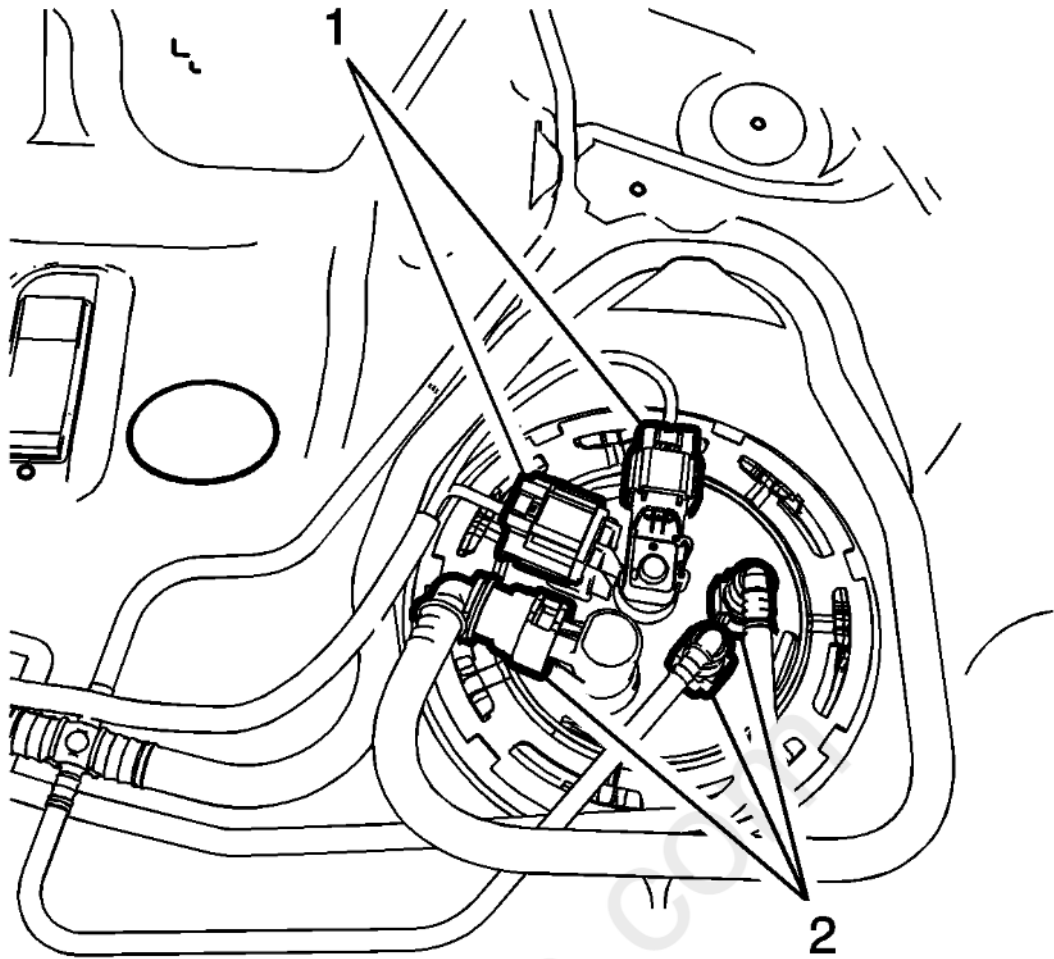


Fig. 67: Fuel Pump Electrical Connectors

Courtesy of GENERAL MOTORS COMPANY

4. Connect the fuel pump electrical connector (1) and the quick connects (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).
5. Install the fuel tank. Refer to [Fuel Tank Replacement](#).

FUEL TANK FUEL PUMP MODULE REPLACEMENT (NU6)

Special Tools

CH 45722 Fuel Sender Lock Ring Wrench

For equivalent regional tools, refer to [Special Tools \(Diagnostic Tools\)](#) [Special Tools \(Mechanical Tools\)](#)

Removal Procedure

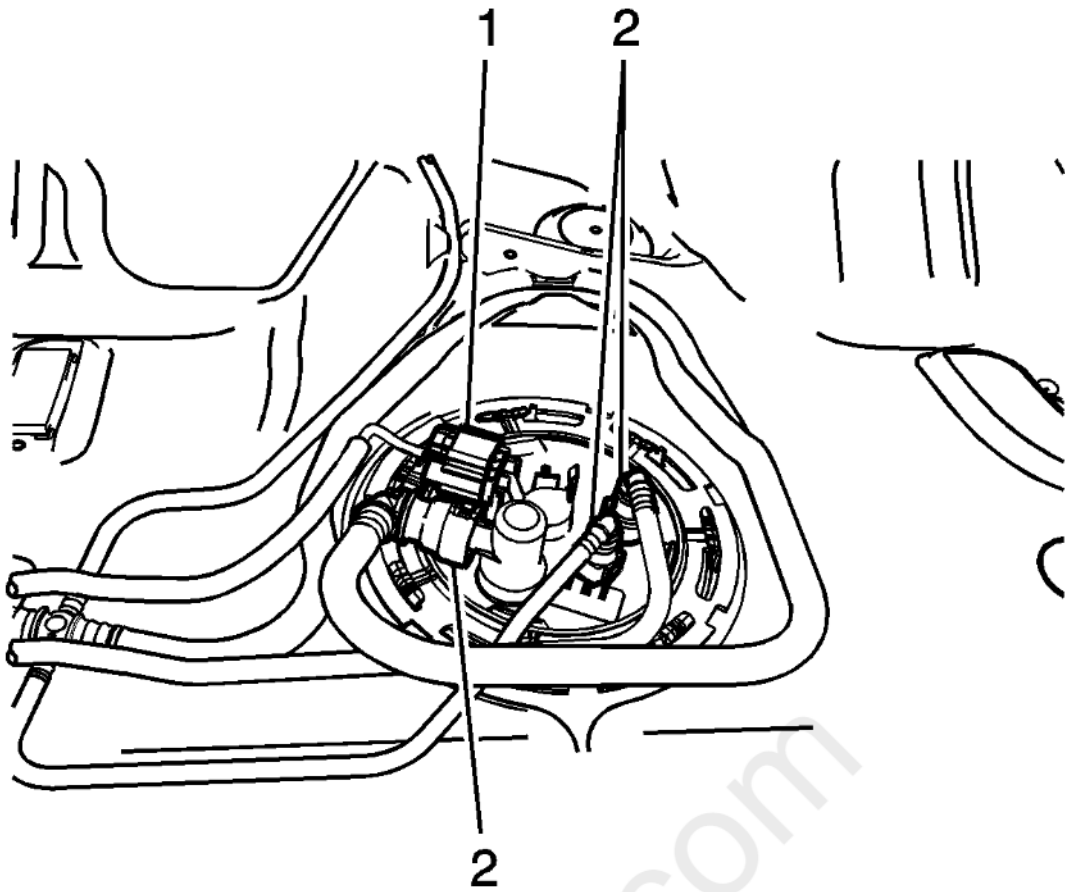


Fig. 68: Fuel Pump Electrical Connector & Quick Connects
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

1. Remove the fuel tank. Refer to [Fuel Tank Replacement](#).
2. Disconnect the fuel pump electrical connector (1) and the quick connects (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).

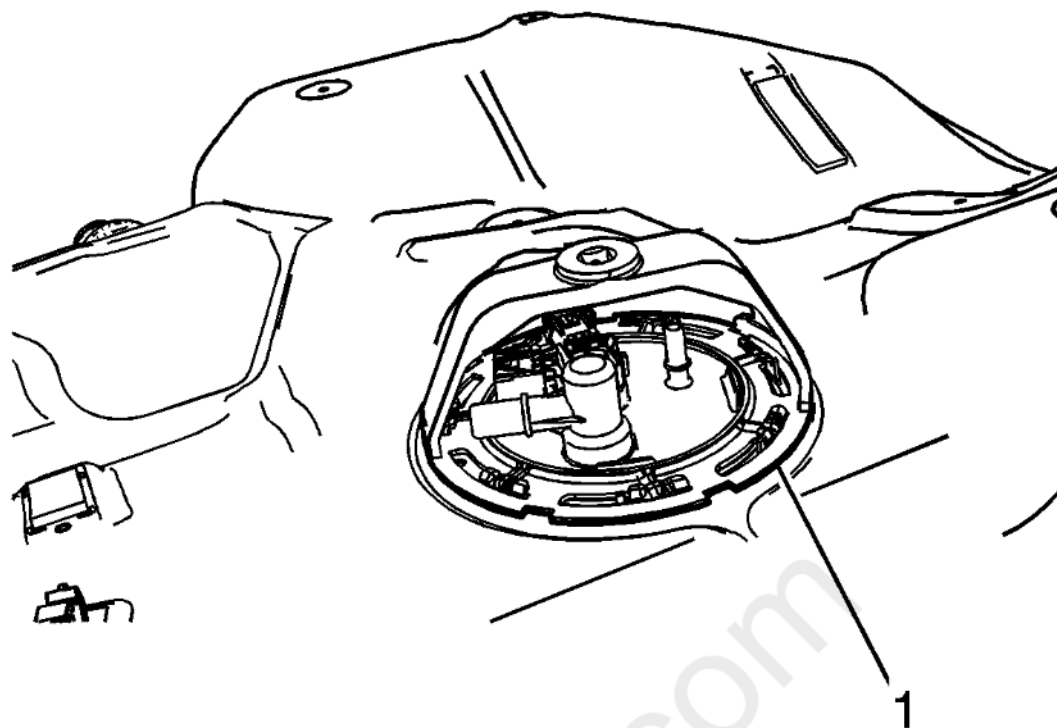


Fig. 69: Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning counter clockwise and remove the lock ring (1).

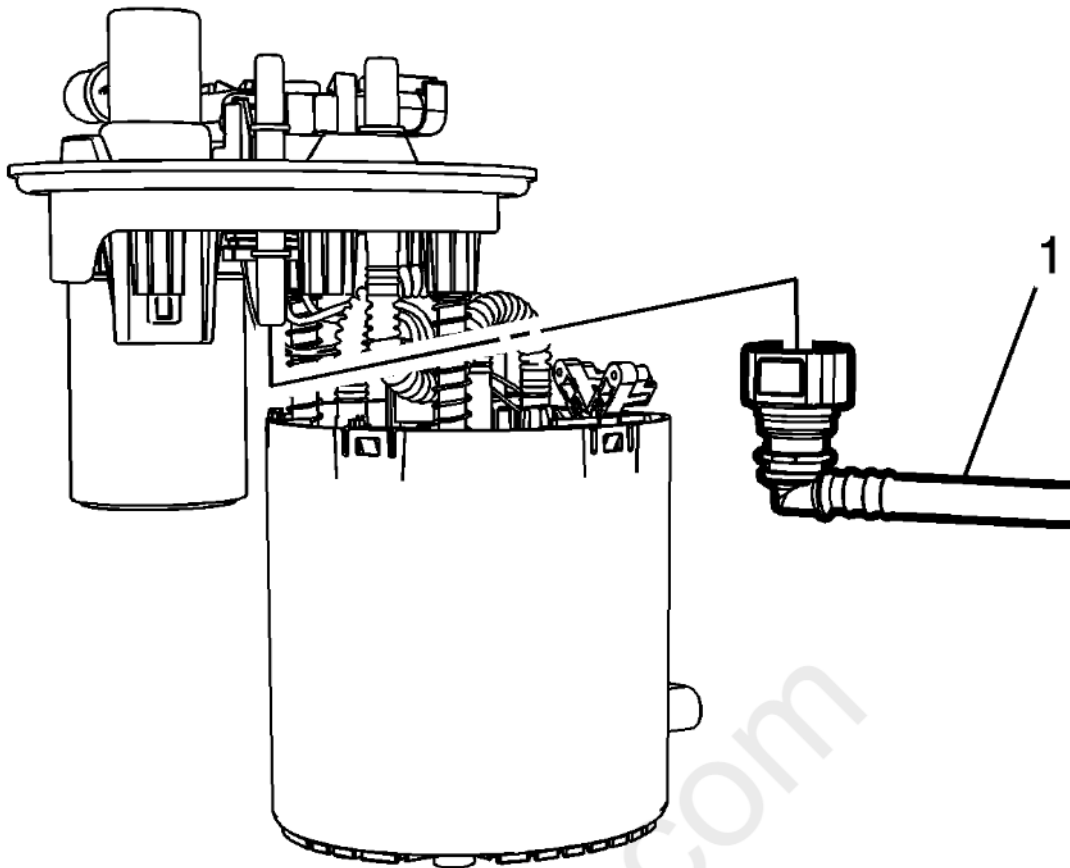


Fig. 70: Fuel Pump Vent Hose

Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel pump vent hose from the fuel tank fuel pump module. Refer to **Plastic Collar Quick Connect Fitting Service**.

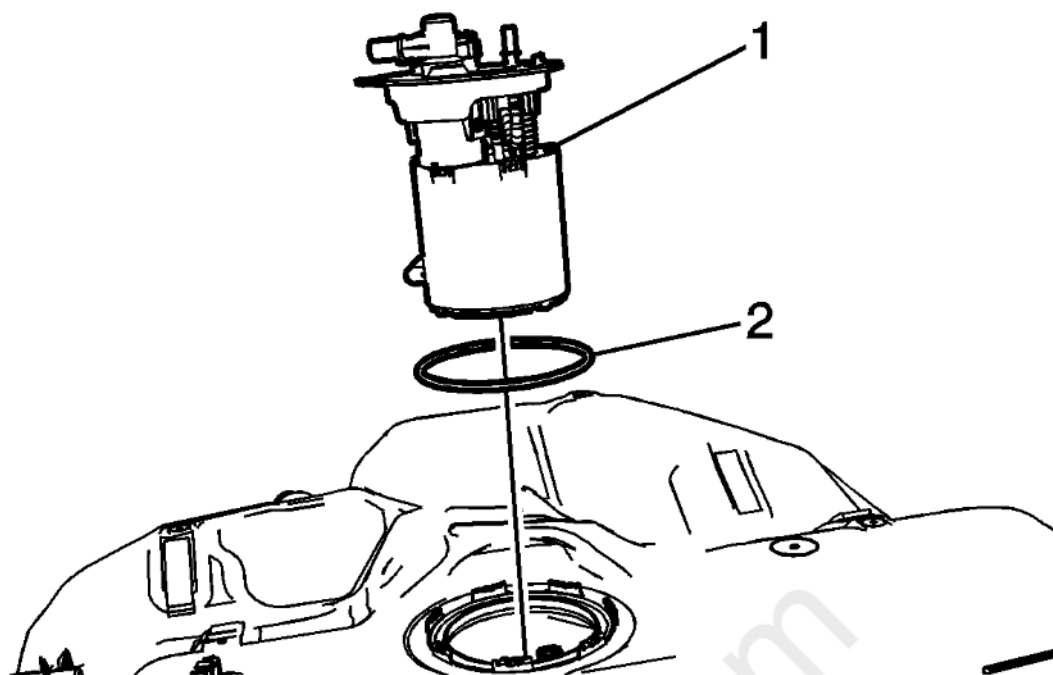


Fig. 71: Fuel Tank Module & O-Ring

Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel tank module (1) and the O-ring (2).

Installation Procedure

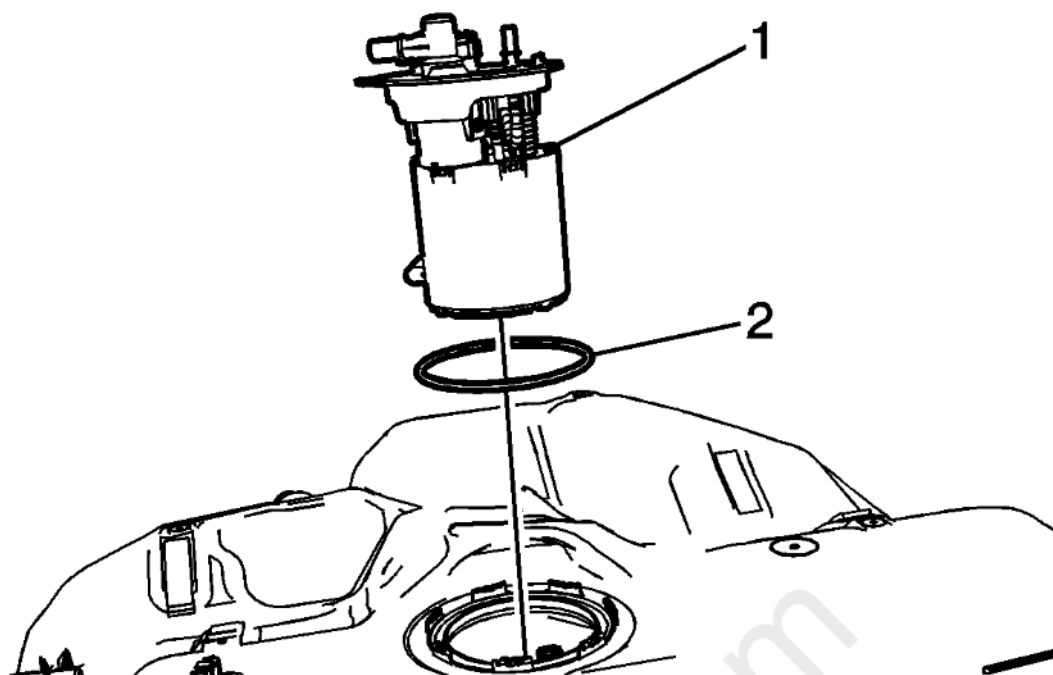


Fig. 72: Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW seal (2) and the fuel tank module (1).

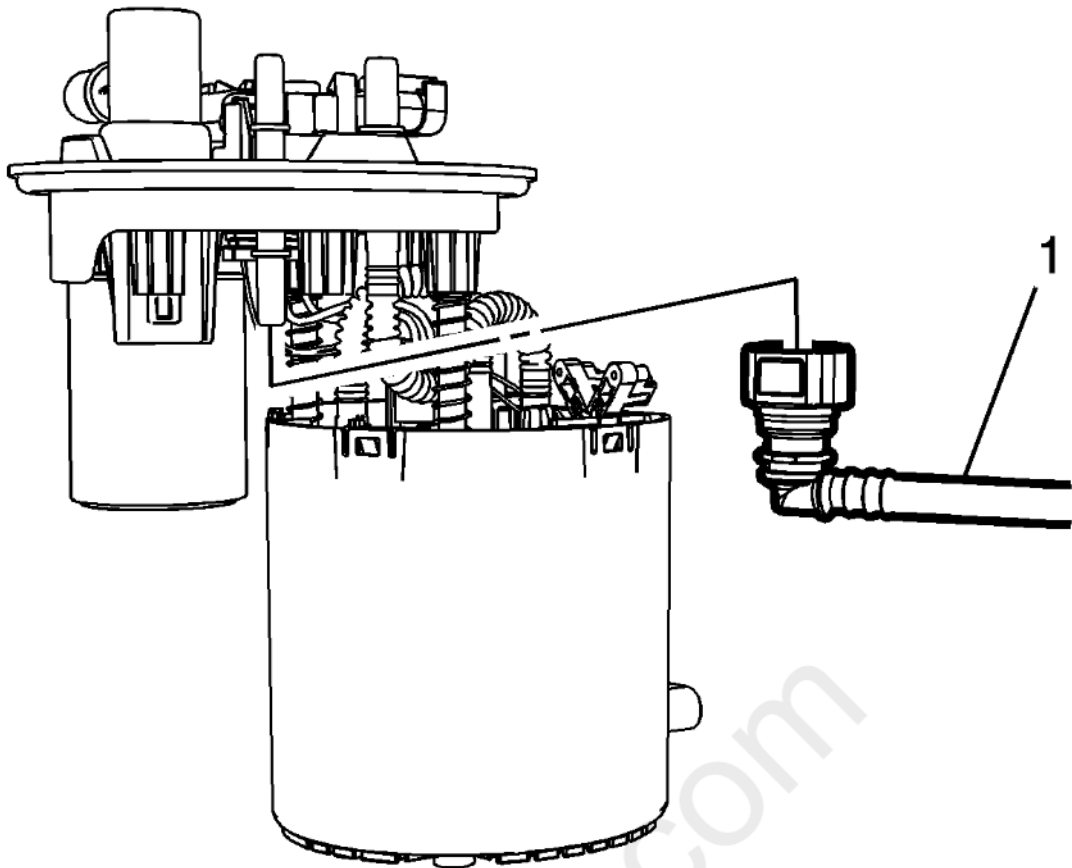


Fig. 73: Fuel Pump Vent Hose

Courtesy of GENERAL MOTORS COMPANY

2. Connect the fuel pump vent hose to the fuel tank fuel pump module. Refer to [**Plastic Collar Quick Connect Fitting Service**](#).

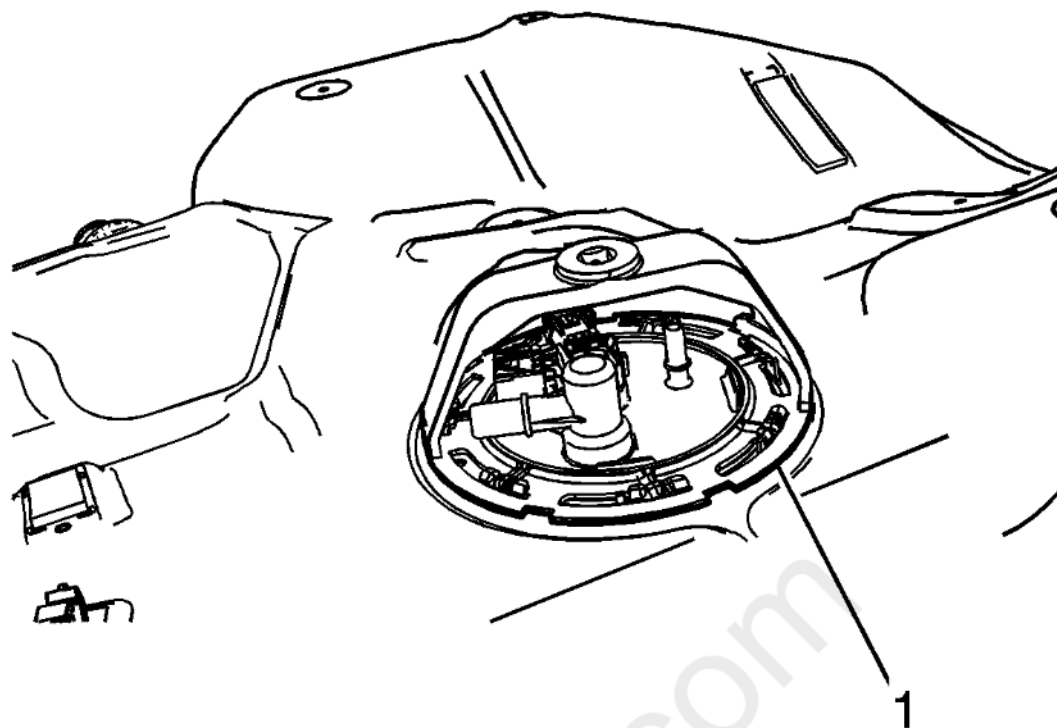


Fig. 74: Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning clockwise and install the lock ring (1).

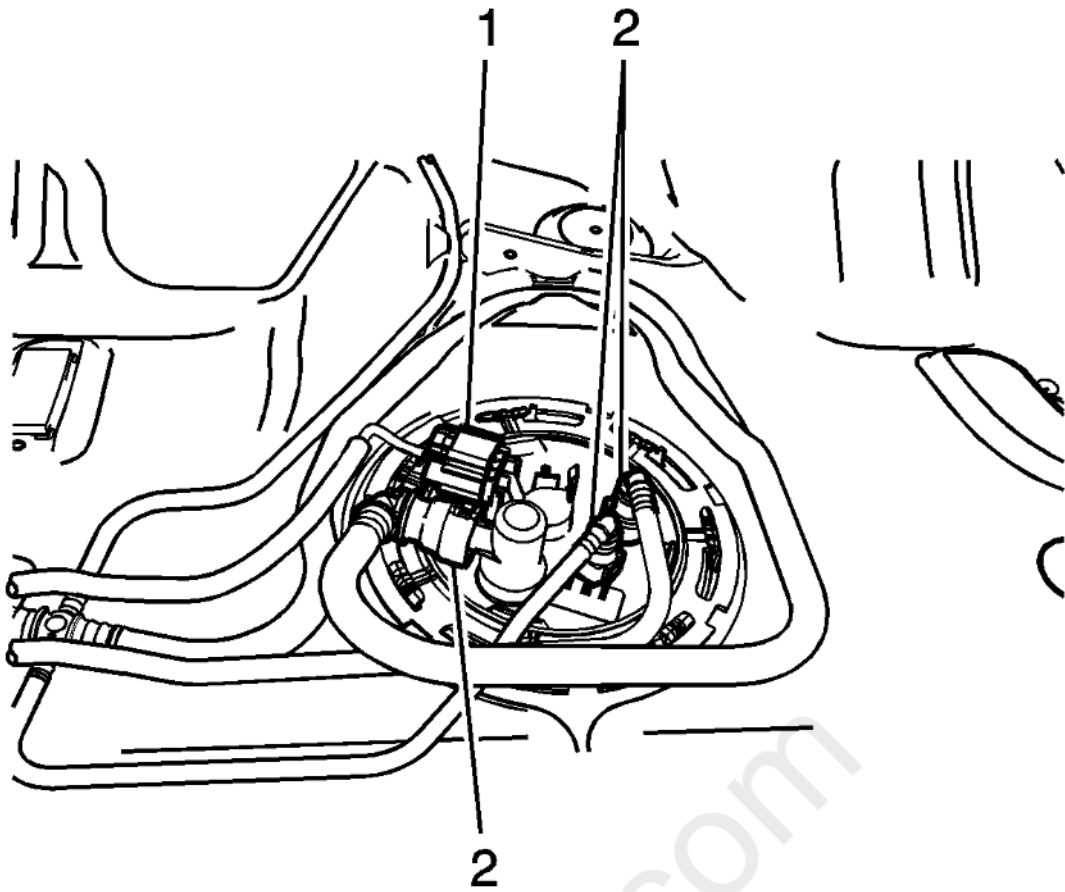


Fig. 75: Fuel Pump Electrical Connector & Quick Connects

Courtesy of GENERAL MOTORS COMPANY

4. Connect the fuel pump electrical connector (1) and the quick connects (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).
5. Install the fuel tank. Refer to [Fuel Tank Replacement](#).

CHASSIS CONTROL MODULE REPLACEMENT

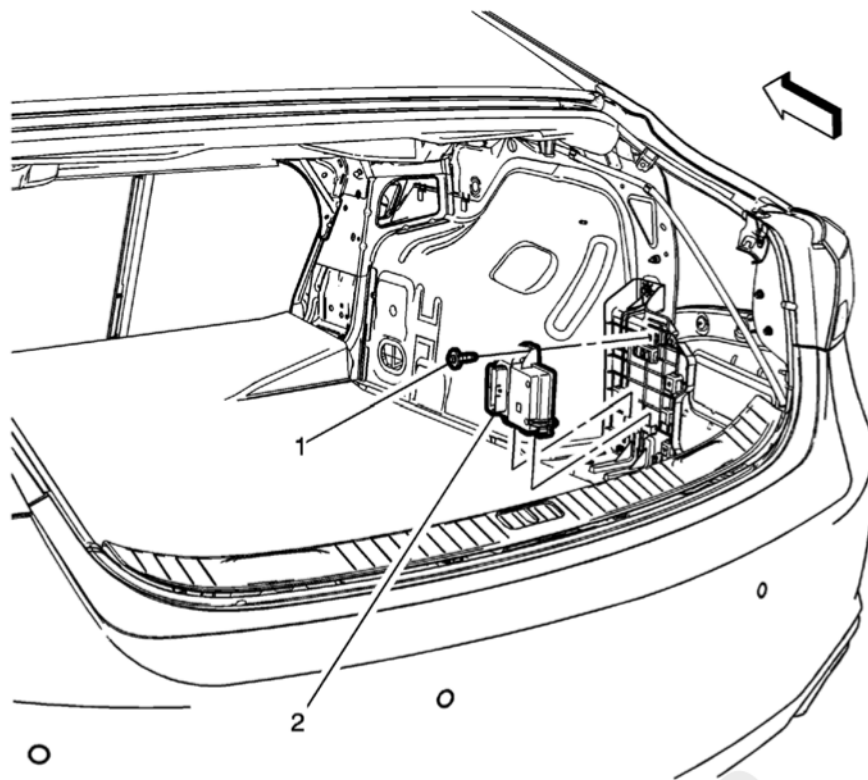


Fig. 76: Chassis Control Module

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Reposition the passenger rear side trim panel. Refer to Rear Compartment Side Trim Replacement - Right Side .	
1	Chassis Control Module Fastener (Qty: 1) CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Chassis Control Module Procedure 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Refer to Control Module References .

FUEL TANK PRESSURE SENSOR REPLACEMENT (NT5, NT7)

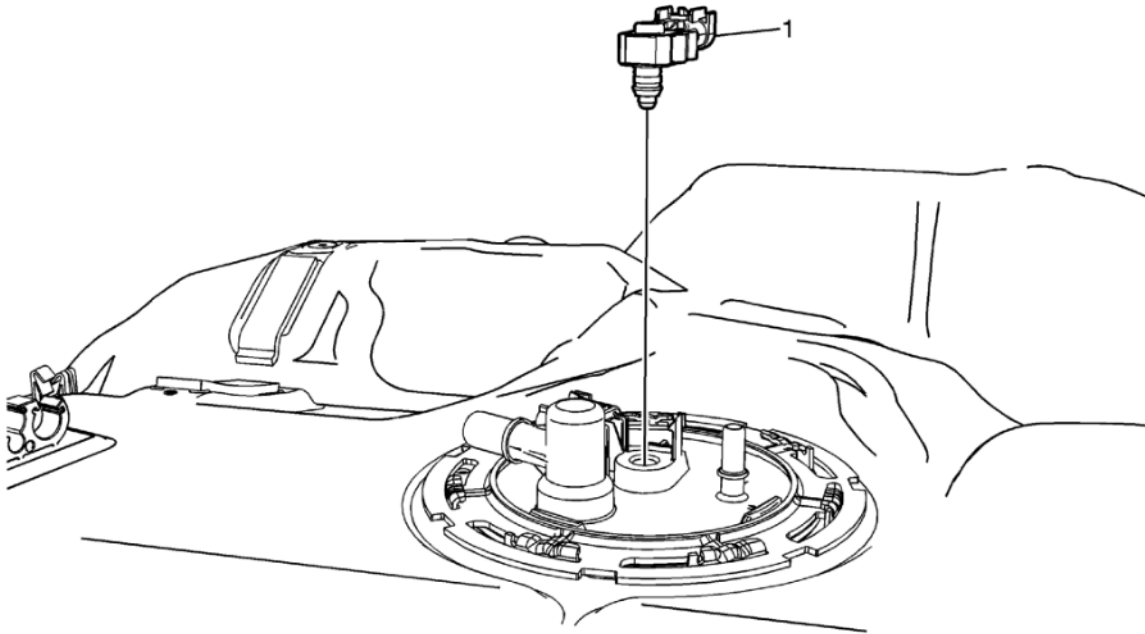


Fig. 77: Fuel Tank Pressure Sensor

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement .	
1	Fuel Tank Pressure Sensor Procedure 1. Disconnect the electrical connector. 2. Release the retaining tab.

FUEL TANK PRESSURE SENSOR REPLACEMENT (NU6)

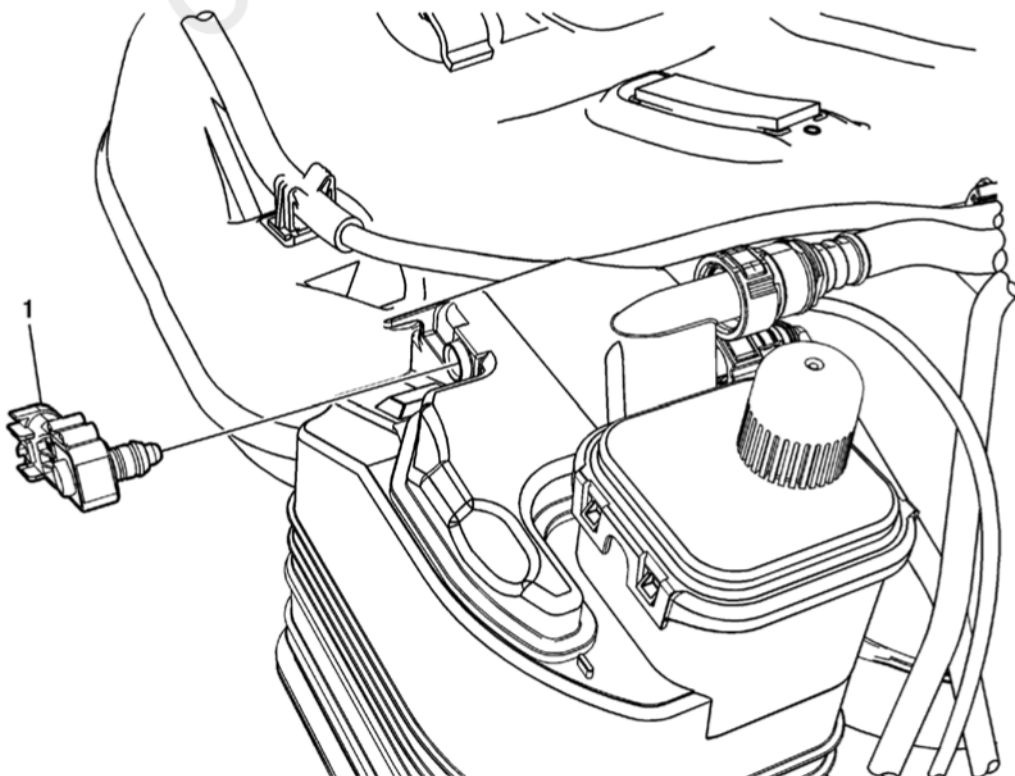


Fig. 78: Fuel Tank Pressure Sensor
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement .	
1	Fuel Tank Pressure Sensor Procedure 1. Disconnect the electrical connector. 2. Release the retaining tab.

FUEL TANK FILLER PIPE REPLACEMENT (LFX)

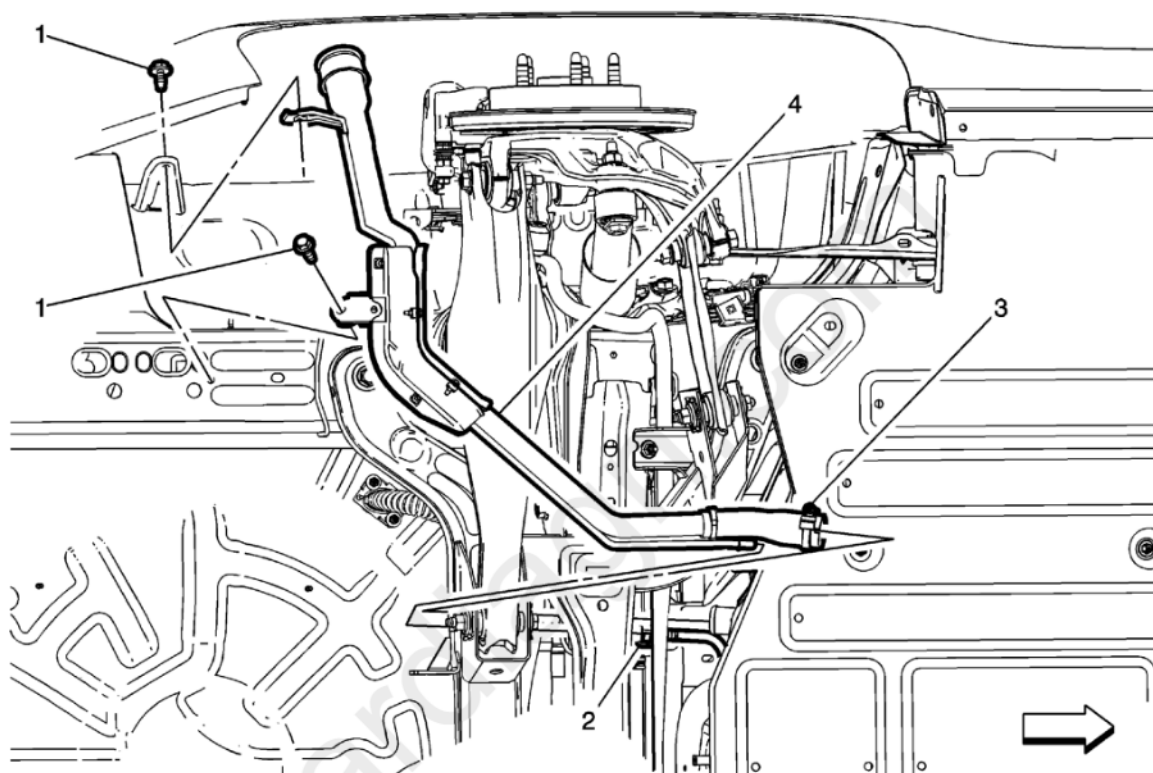


Fig. 79: Fuel Tank Filler Pipe
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the filler pipe housing. Refer to Fuel Tank Filler Pipe Housing Replacement .	
1	Filler Pipe Fastener (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Rear Evaporative Emission Pipe Procedure Disconnect the quick connect fitting. Refer to Plastic Collar Quick Connect Fitting Service .
3	Hose Clamp Tighten 4 N.m (35 lb in)

Callout	Component Name
Preliminary Procedure Remove the filler pipe housing. Refer to Fuel Tank Filler Pipe Housing Replacement .	
4	Fuel Tank Filler Pipe

FUEL LEVEL SENSOR REPLACEMENT

Removal Procedure

WARNING: Fuel Vapors can collect while servicing fuel system parts in enclosed areas such as a trunk. To reduce the risk of fire and increased exposure to vapors:

- Use forced air ventilation such as a fan set outside of the trunk.
- Plug or cap any fuel system openings in order to reduce fuel vapor formation.
- Clean up any spilled fuel immediately.
- Avoid sparks and any source of ignition.
- Use signs to alert others in the work area that fuel system work is in process.

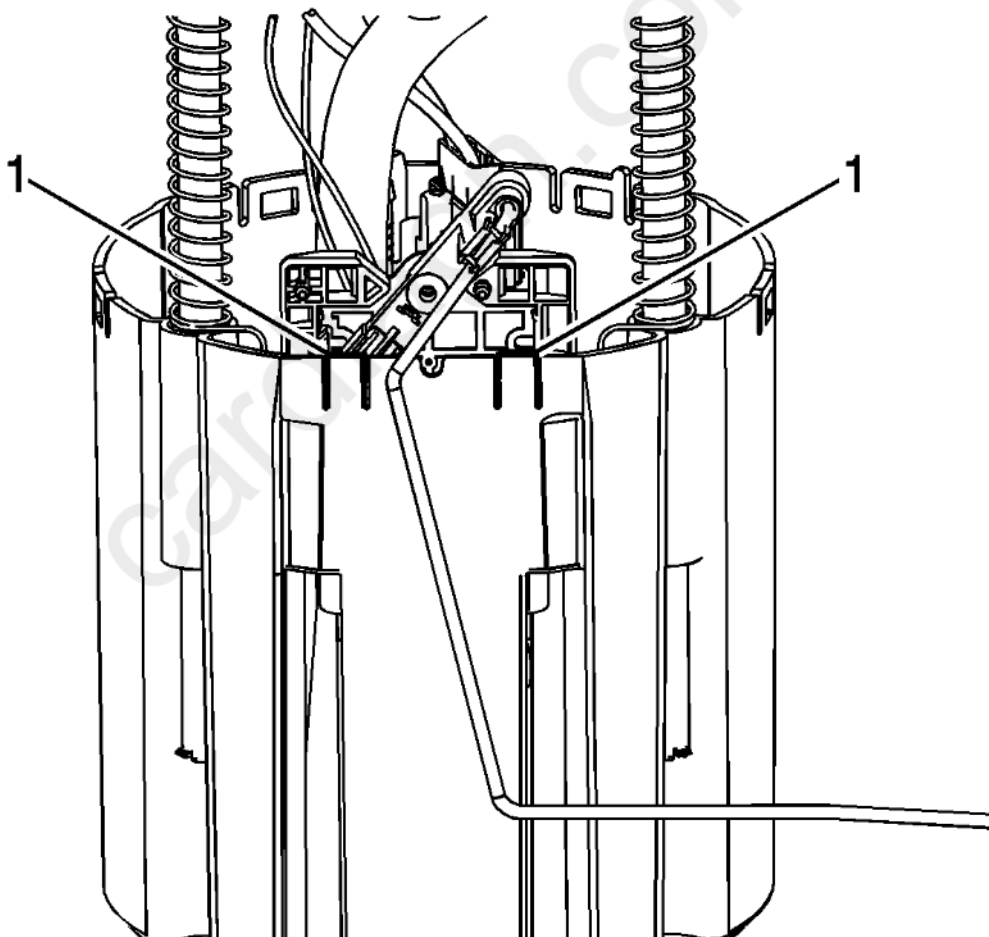


Fig. 80: Identifying Locking Tabs

Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel tank pump module. Refer to [Fuel Tank Fuel Pump Module Replacement \(NT5, NT7\)](#) [Fuel Tank Fuel Pump Module Replacement \(NU6\)](#).
2. Using two flat-bladed tools, carefully pull both locking tabs (1) outward while simultaneously lifting the level sensor.

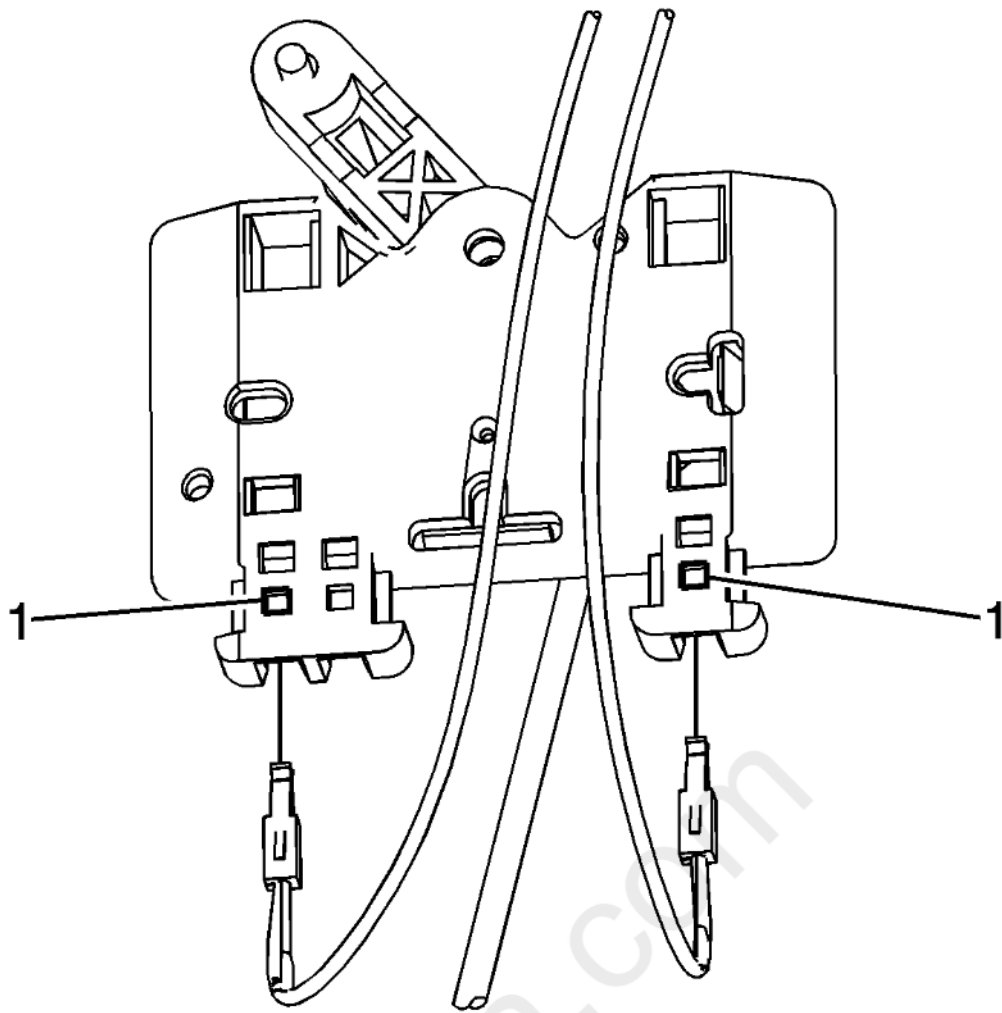


Fig. 81: Identifying Electrical Terminals

Courtesy of GENERAL MOTORS COMPANY

3. Using a small bladed tool, gently release the retaining tabs on the electrical terminals (1) while simultaneously pulling the terminals out.
4. Inspect the terminals for bending and reposition as necessary.

Installation Procedure

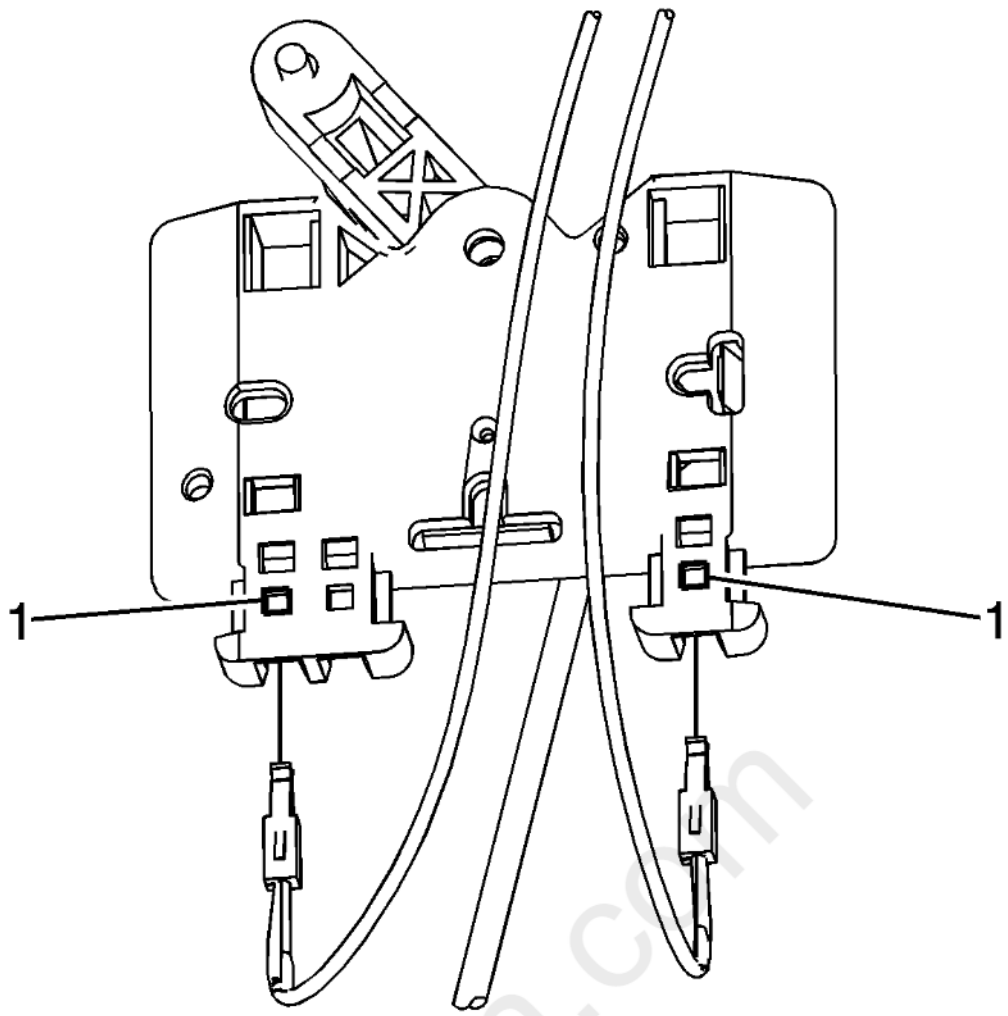


Fig. 82: Identifying Electrical Terminals

Courtesy of GENERAL MOTORS COMPANY

1. Push in the electrical terminals (1) and ensure the terminals are secure.

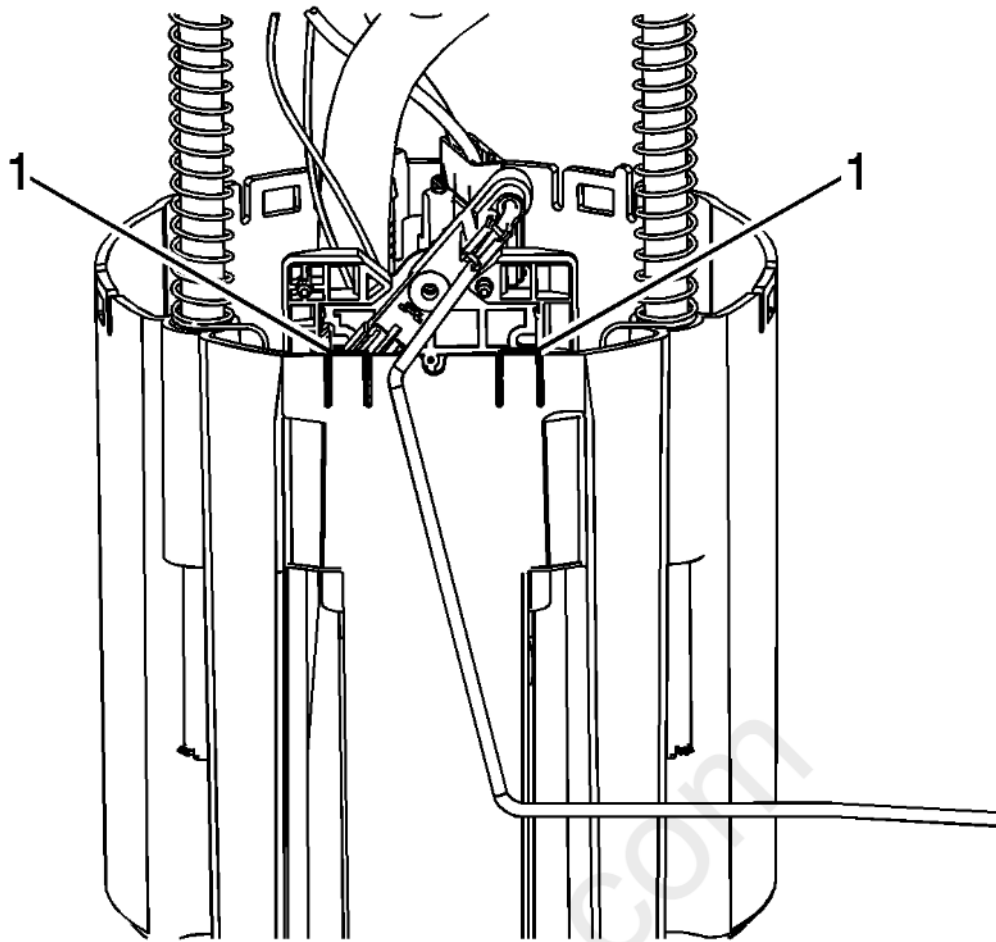


Fig. 83: Identifying Locking Tabs

Courtesy of GENERAL MOTORS COMPANY

2. Carefully insert the level sensor until the locking tabs (1) snap into the locking position.
3. Install the fuel tank pump module. Refer to **Fuel Tank Fuel Pump Module Replacement (NT5, NT7)****Fuel Tank Fuel Pump Module Replacement (NU6)**

FUEL FEED FRONT PIPE REPLACEMENT (LFX)

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)** .
2. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Gasoline)**.

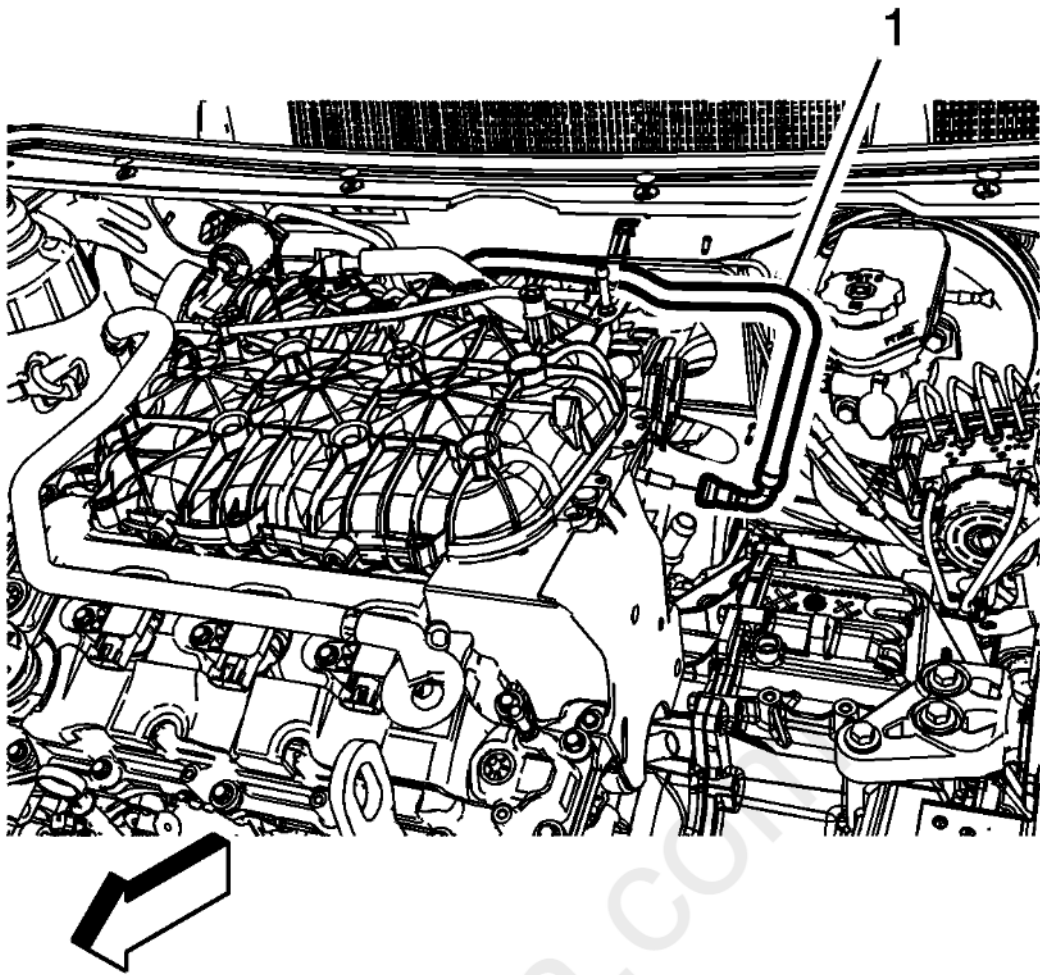


Fig. 84: Fuel Feed Hose (LFX)

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the fuel feed front pipe (1) from the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).
4. Unclip the 3 feed pipes from the pipe retainers.
5. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
6. Lower the rear of the drivetrain and front suspension frame 51 mm (2 in). Refer to [Drivetrain and Front Suspension Frame Replacement](#).
7. Unclip the fuel feed pipe from the line retainer on the cowl panel.

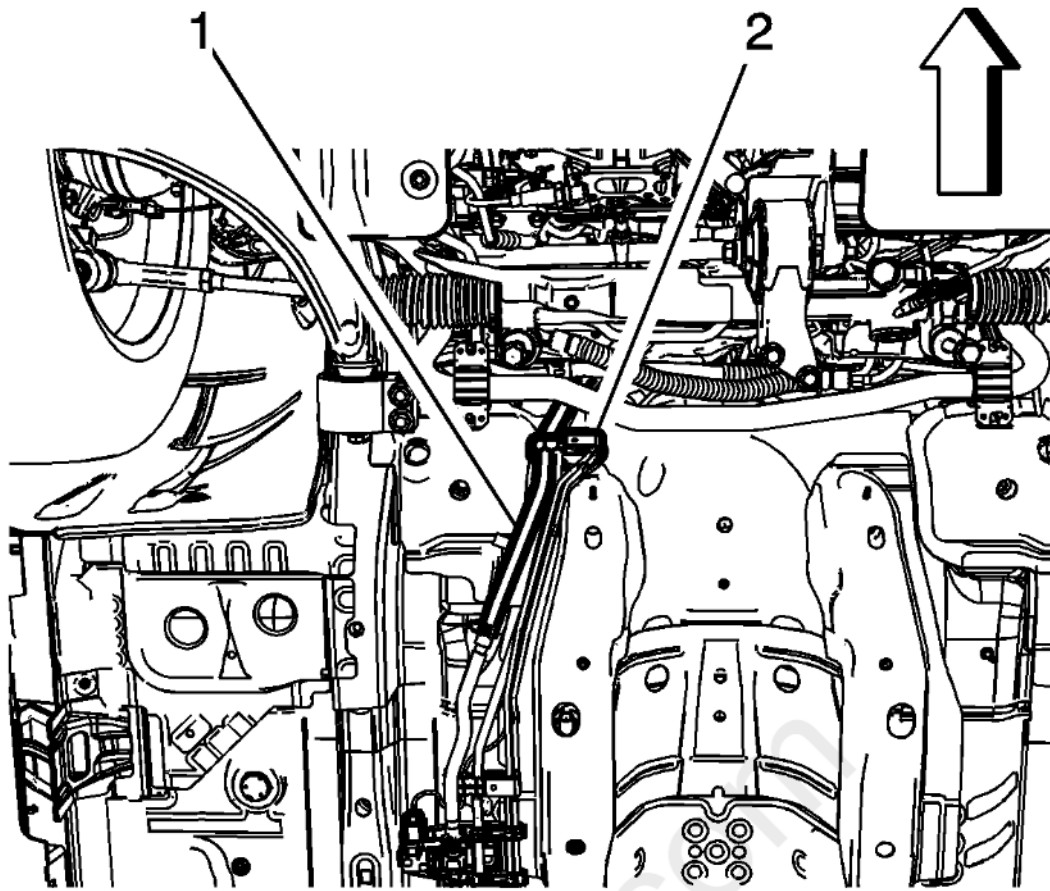


Fig. 85: Fuel Feed Front Pipe & Retainers

Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the fuel feed front pipe (1) from the fuel feed hose. Refer to [**Plastic Collar Quick Connect Fitting Service**](#).
9. Remove the fuel feed front pipe (1) from the retainers (2).
10. Remove the fuel feed front pipe (1) from the vehicle.

Installation Procedure

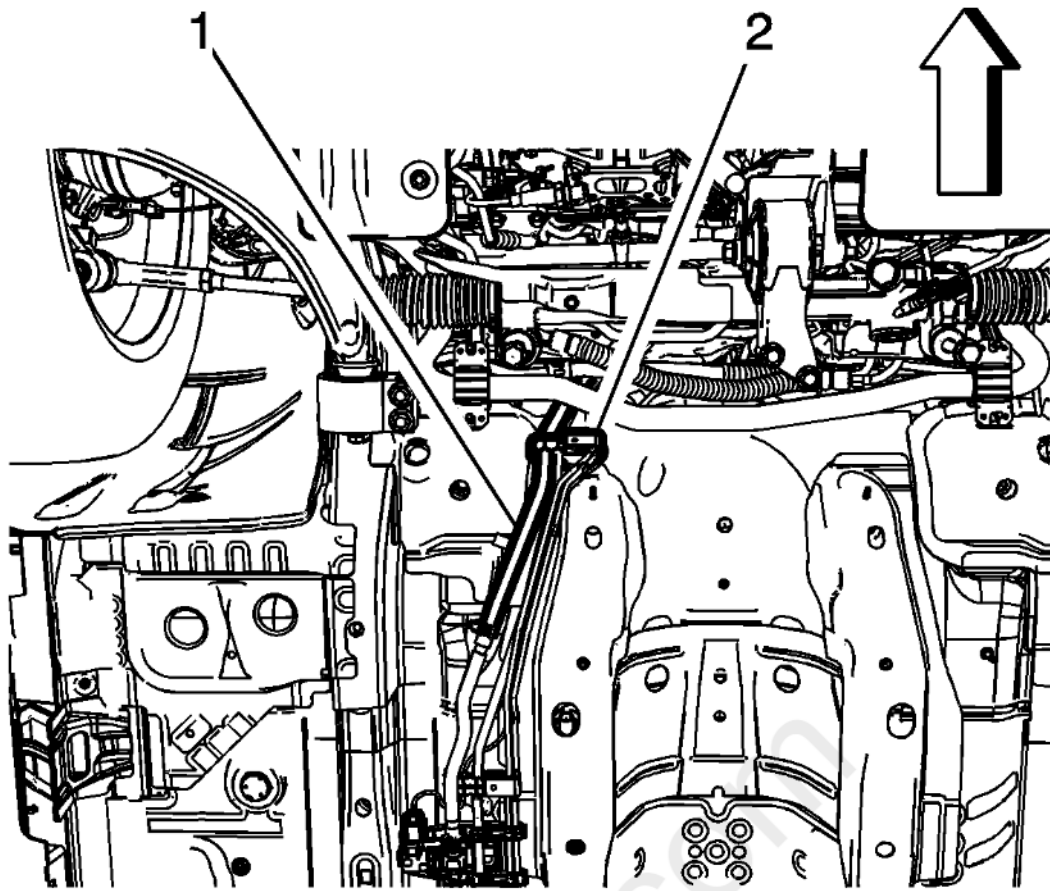


Fig. 86: Fuel Feed Front Pipe & Retainers

Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel feed front pipe (1) to the vehicle.
2. Install the fuel feed front pipe (1) to the retainers (2).
3. Connect the fuel feed front pipe (1) to the fuel feed hose. Refer to [**Plastic Collar Quick Connect Fitting Service**](#).
4. Install the drivetrain and front suspension frame. Refer to [**Drivetrain and Front Suspension Frame Replacement**](#).
5. Lower the vehicle.

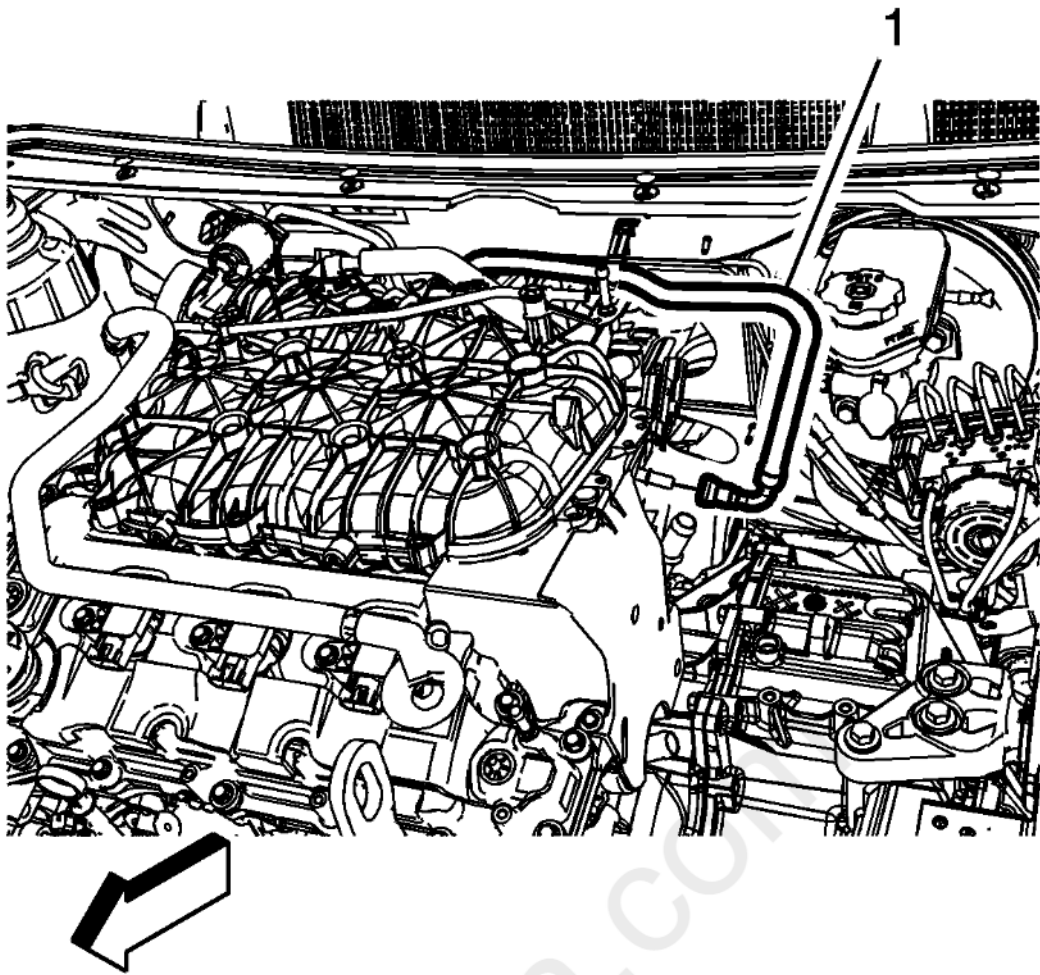


Fig. 87: Fuel Feed Hose (LFX)

Courtesy of GENERAL MOTORS COMPANY

6. Connect the fuel feed front pipe (1) to the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).
7. Clip the feed pipe into the 3 retainers.
8. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement \(LFX\)](#) .

FUEL FEED HOSE REPLACEMENT (FLEX SENSOR TO FRONT PIPE)

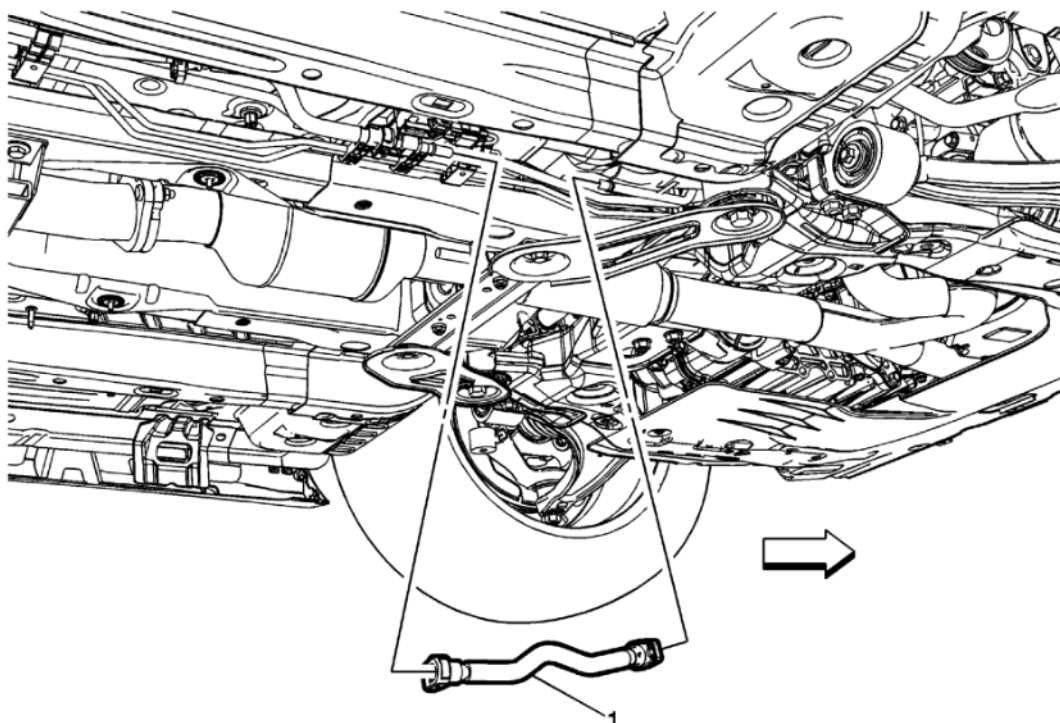


Fig. 88: Fuel Feed Hose (Flex Sensor to Front Pipe FWD)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief (Gasoline). 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 3. Remove the right front underbody air deflector. Refer to Underbody Front Air Deflector Replacement - Right Side (Tire) Underbody Front Air Deflector Replacement - Right Side (XFE).	
1	Fuel Feed Hose Procedure Disconnect the fuel feed hose quick connects. Refer to Plastic Collar Quick Connect Fitting Service .

FUEL FEED HOSE REPLACEMENT (FLEX SENSOR TO REAR PIPE)

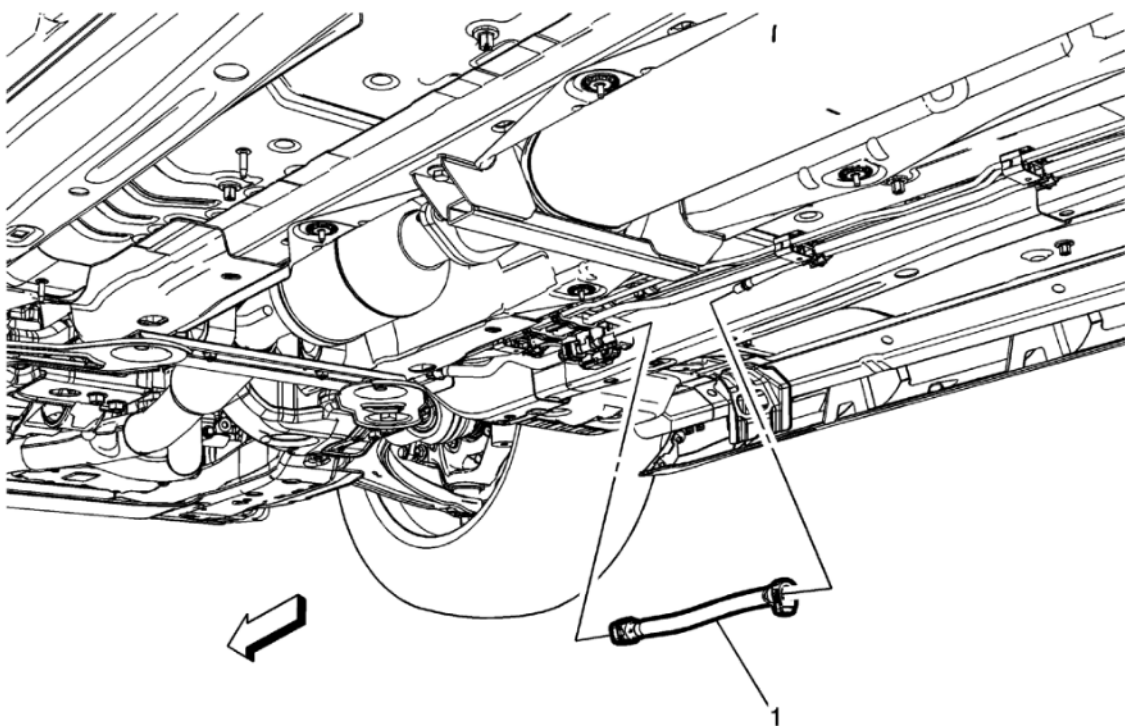


Fig. 89: Fuel Feed Hose (Flex Sensor to Rear Pipe FWD)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief (Gasoline). 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 3. Remove the right front underbody air deflector. Refer to Underbody Front Air Deflector Replacement - Right Side (Tire) Underbody Front Air Deflector Replacement - Right Side (XFE).	
1	Fuel Feed Hose Procedure Disconnect the fuel feed hose quick connects. Refer to Plastic Collar Quick Connect Fitting Service .

FUEL FEED HOSE REPLACEMENT (WITHOUT E-85)

Removal Procedure

1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement \(LFX\)](#).
2. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief \(Gasoline\)](#).

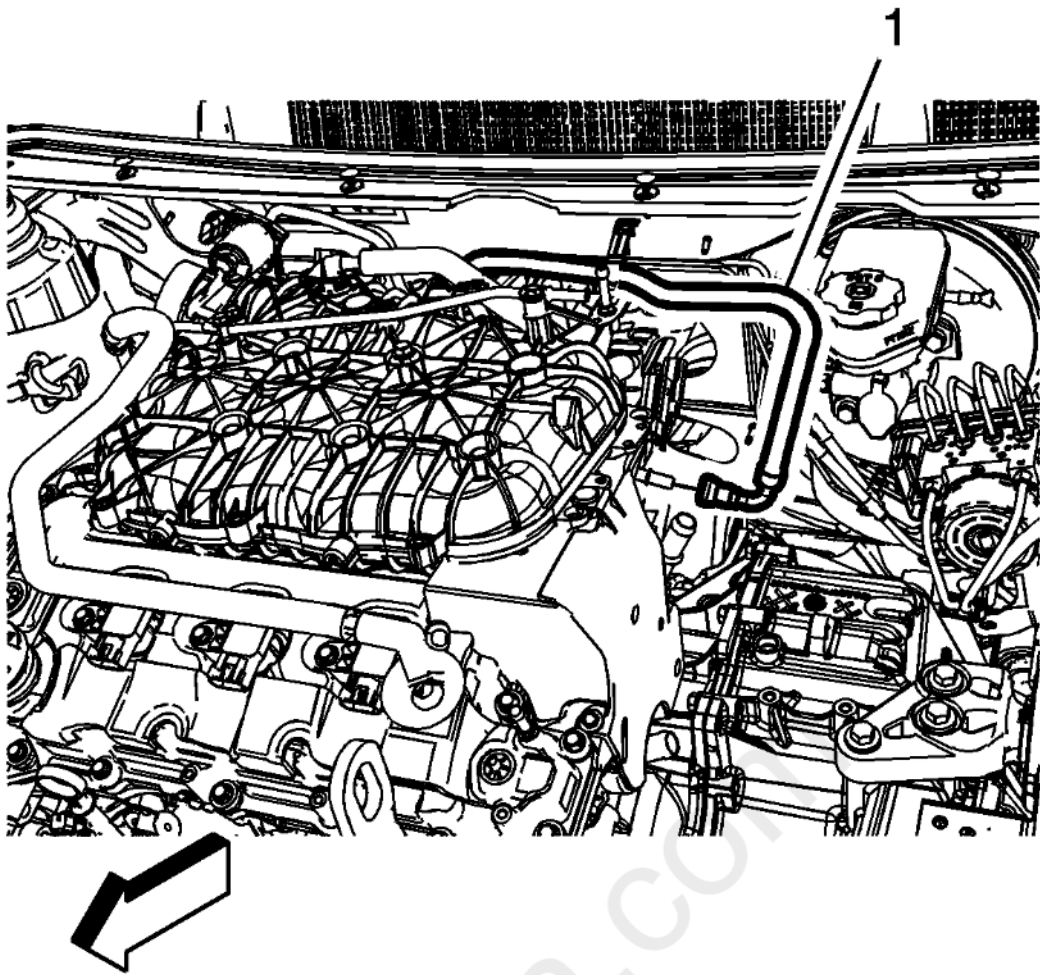


Fig. 90: Fuel Feed Hose (LFX)

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the fuel feed hose (1) from the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).
4. Unclip the fuel feed hose from the retainers.
5. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
6. Lower the rear of the drivetrain and front suspension frame 51 mm (2 in). Refer to [Drivetrain and Front Suspension Frame Replacement](#).
7. Unclip the fuel feed hose from the line retainer on the cowl panel.

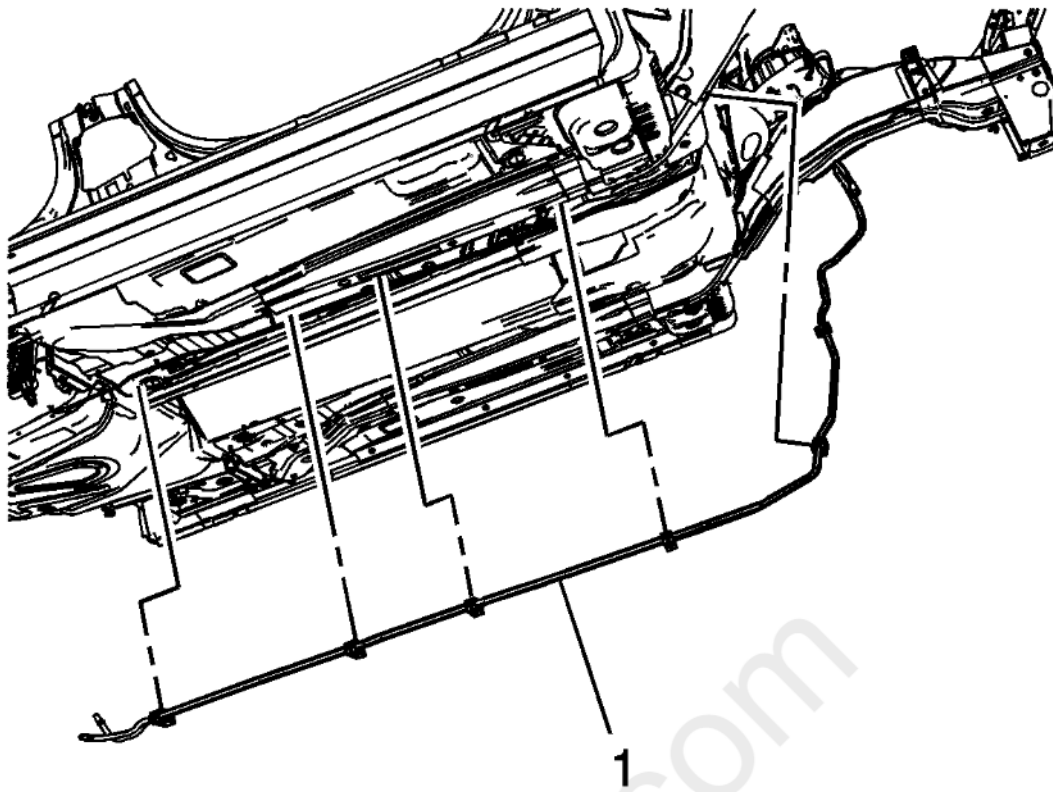


Fig. 91: Fuel Feed And Evaporative Emission Pipes

Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the fuel feed hose (1) from the fuel feed pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
9. Disconnect fuel pressure sensor electrical connector.
10. Remove the fuel feed hose (1) from the retainers.
11. Remove the fuel feed hose (1) from the vehicle.

Installation Procedure

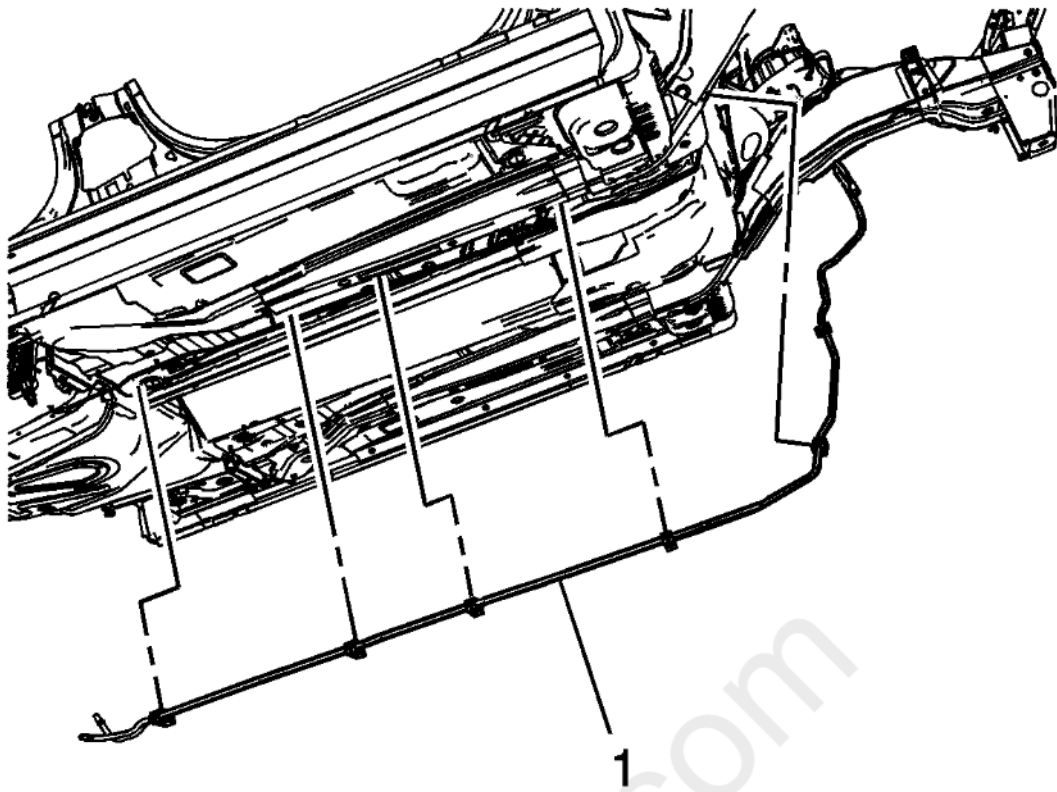


Fig. 92: Fuel Feed And Evaporative Emission Pipes

Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel feed hose (1) to the vehicle.
2. Install the fuel feed hose (1) to the retainers.
3. Connect fuel pressure sensor electrical connector.
4. Connect the fuel feed hose (1) to the fuel feed pipe. Refer to [**Plastic Collar Quick Connect Fitting Service**](#).
5. Install the drivetrain and front suspension frame. Refer to [**Drivetrain and Front Suspension Frame Replacement**](#).
6. Lower the vehicle.

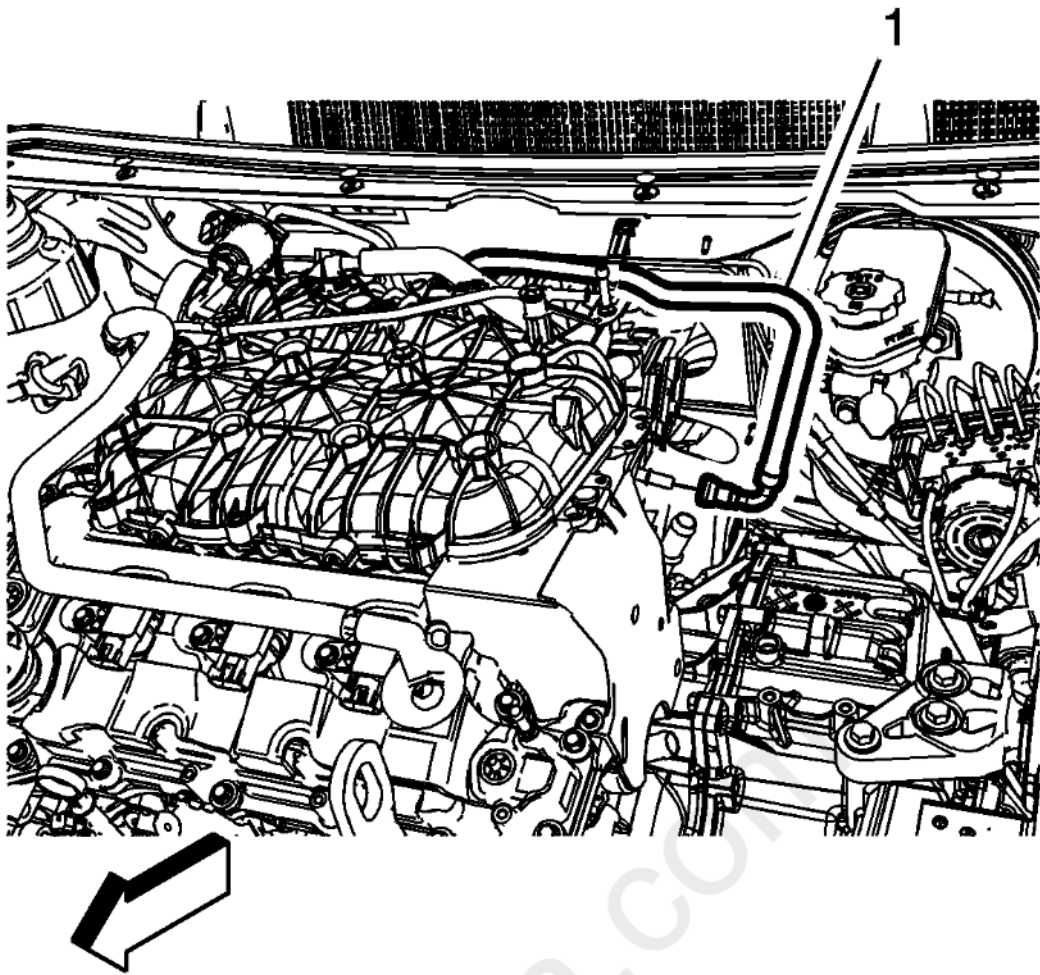


Fig. 93: Fuel Feed Hose (LFX)

Courtesy of GENERAL MOTORS COMPANY

7. Connect the fuel feed hose (1) to the fuel rail. Refer to [**Metal Collar Quick Connect Fitting Service**](#).
8. Clip the fuel feed hose to the retainers.
9. Install the intake manifold cover. Refer to [**Intake Manifold Cover Replacement \(LFX\)**](#) .

FLEXIBLE FUEL SENSOR REPLACEMENT

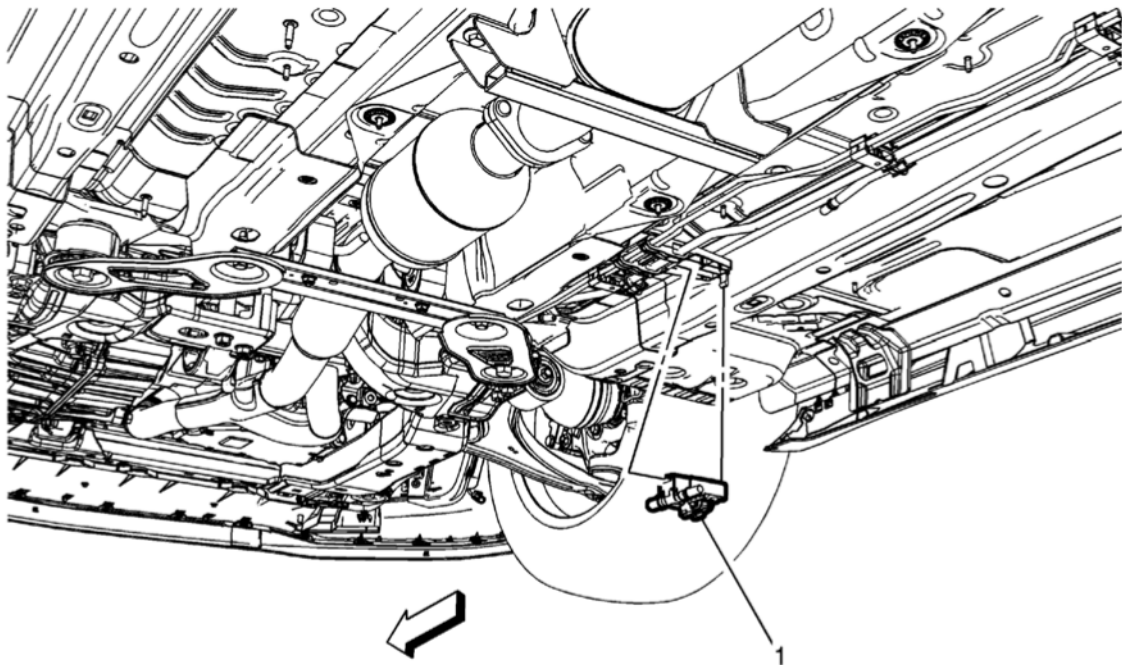


Fig. 94: Flexible Fuel Sensor (FWD)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief (Gasoline). 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 3. Remove the right front underbody air deflector. Refer to Underbody Front Air Deflector Replacement - Right Side (Tire) Underbody Front Air Deflector Replacement - Right Side (XFE). 4. Remove the fuel feed hoses from the sensor. Refer to Fuel Feed Hose Replacement (Flex Sensor to Front Pipe) Fuel Feed Hose Replacement (Flex Sensor to Rear Pipe) Fuel Feed Hose Replacement (Without E-85).	
1	Flex Fuel Sensor Procedure 1. Disconnect the electrical connector. 2. Unclip sensor from bracket to remove.

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE

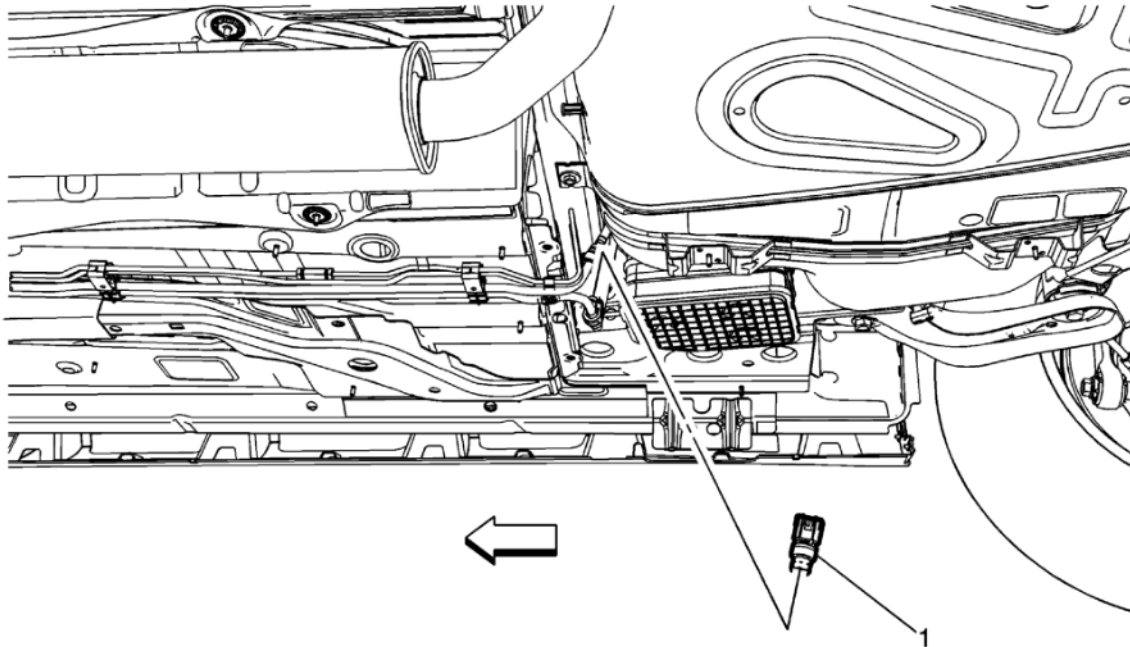


Fig. 95: Fuel Pressure Sensor - Fuel Feed Pipe (FWD)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief (Gasoline). 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 3. Remove the right rear underbody air deflector. Refer to Underbody Rear Air Deflector Replacement - Right Side.	
1	Fuel Pressure Sensor CAUTION: Refer to Component Fastener Tightening Caution . Procedure 1. Disconnect the electrical connector. 2. Use a NEW O-ring whenever the sensor is removed. Tighten 15 N.m (11 lb ft)

FUEL FEED PIPE REPLACEMENT (LFX)

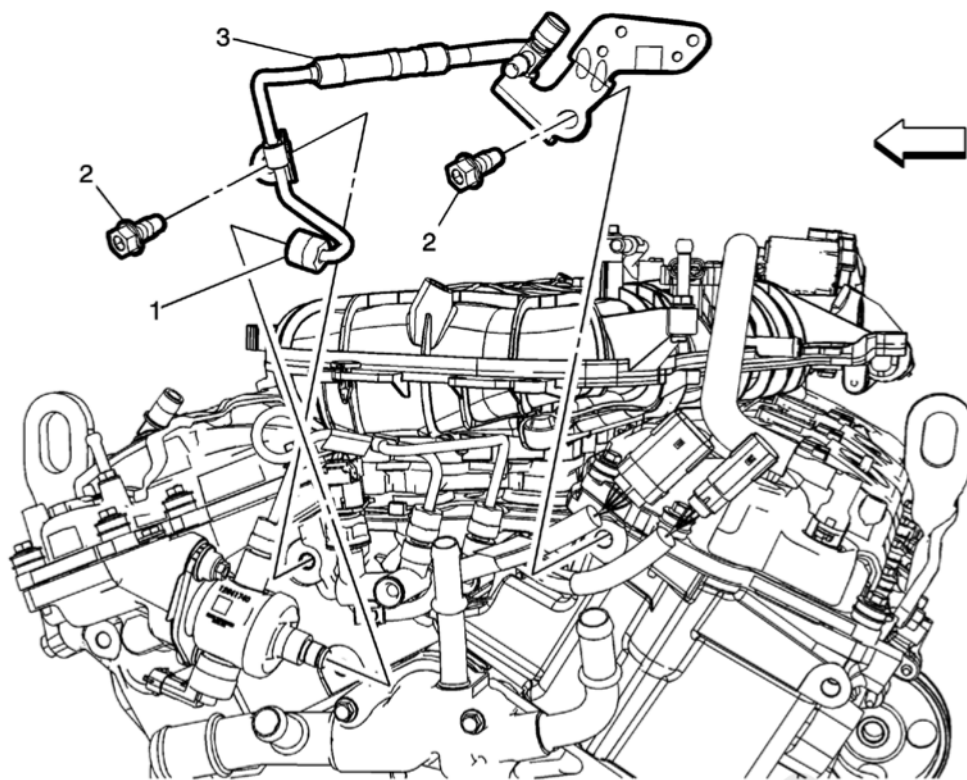


Fig. 96: Fuel Feed Pipe & Mounting Components (LFX At Engine)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief (Gasoline). 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX). 3. Remove the fuel pipe shield. Refer to Fuel Pipe Shield Replacement. 4. Disconnect the fuel feed line quick connect. Refer to Metal Collar Quick Connect Fitting Service.	
1	Fuel Feed Pipe Fitting (Qty: 1) CAUTION: Refer to Fastener Caution . Tighten 28 N.m (21 lb ft)
2	Fuel Feed Pipe Bolt (Qty: 2) Tighten 50 N.m (37 lb ft)
3	Fuel Feed Pipe Procedure 1. Unclip the electrical harness from the feed pipe bracket. 2. DISCARD the pipe when removed, and install a NEW pipe. 3. Ensure that the high pressure fuel pipe, and fuel pump fittings are clean and dry prior to assembly. 4. Pressure up the fuel system and check for leaks.

FUEL SYSTEM CLEANING

NOTE: When flushing the fuel tank, treat the fuel and water mixture as a hazardous material. Handle the material in accordance with all local, state and federal laws and regulations.

NOTE: Whenever the fuel tank is cleaned, inspect the fuel pump fuel strainer. If the fuel pump fuel strainer is contaminated, replace the fuel pump fuel strainer and inspect the fuel pump.

NOTE: Always maintain cleanliness when servicing fuel system components.

1. Remove the fuel tank fuel pump module. Refer to [Fuel Tank Fuel Pump Module Replacement \(NT5, NT7\)](#) [Fuel Tank Fuel Pump Module Replacement \(NU6\)](#) .
2. Inspect the fuel pump inlet for dirt and debris. If dirt and debris are found, replace the fuel pump.
3. Flush fuel tank with hot water.
4. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to ensure that the removal of the water from the fuel tank is complete.
5. Allow tank to dry completely before reassembly.
6. Install the fuel tank fuel pump module. Refer to [Fuel Tank Fuel Pump Module Replacement \(NT5, NT7\)](#) [Fuel Tank Fuel Pump Module Replacement \(NU6\)](#) .

FUEL PRESSURE SENSOR REPLACEMENT - FUEL INJECTION FUEL RAIL

Removal Procedure

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief \(Gasoline\)](#).
2. Remove Fuel Pipe Shield. [Fuel Pipe Shield Replacement](#)

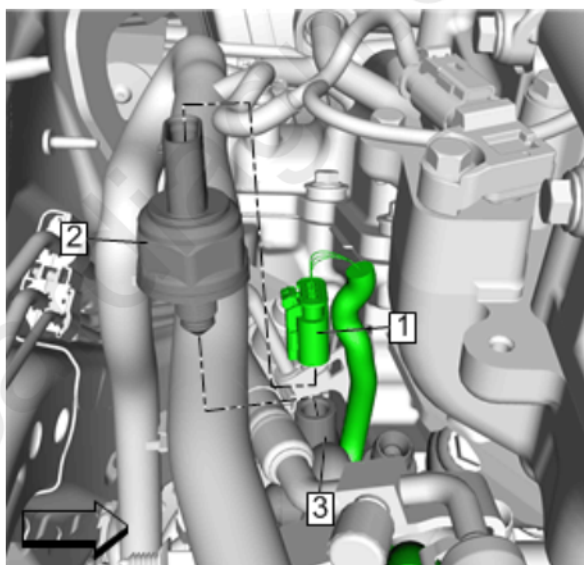


Fig. 97: Fuel Rail Pressure Sensor - Fuel Injection Fuel Rail (LFX)

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution](#) .

NOTE: Applying force to the plastic housing of the sensor may damage the sensor. To tighten or loosen, apply force only to the attached hexagon.

3. Disconnect Electrical Connector (1) @Fuel Injection Fuel Rail Fuel Pressure Sensor (2)

NOTE: Some fuel may leak from the fuel injection fuel rail fuel pressure sensor orifice after the sensor is removed. Dry the area around this orifice after the removal of the sensor using a lint free cloth and inspect the fuel injection fuel rail fuel pressure sensor sealing surface. The surface should be free of fuel, debris, and burrs.

4. Remove Fuel Injection Fuel Rail Fuel Pressure Sensor (2) @Fuel Injection Fuel Rail (3) and DISCARD

Installation Procedure

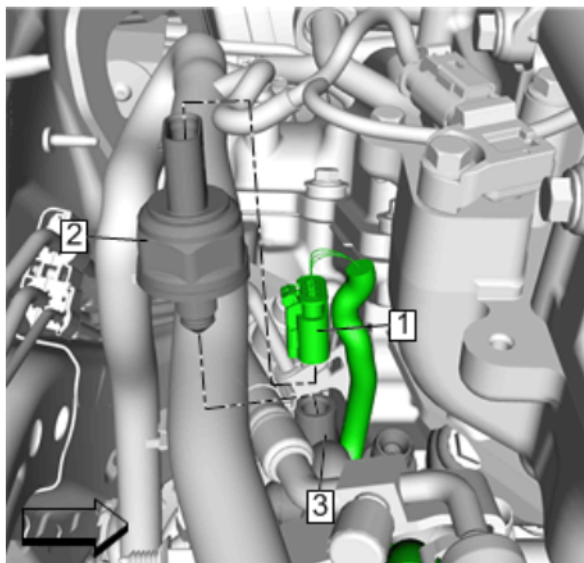


Fig. 98: Fuel Rail Pressure Sensor - Fuel Injection Fuel Rail (LFX)

Courtesy of GENERAL MOTORS COMPANY

NOTE: Applying force to the plastic housing of the sensor may damage the sensor. To tighten or loosen, apply force only to the attached hexagon.

NOTE: Ensure the fuel rail threads are clean and free of any excess fuel, or the fuel injection fuel rail fuel pressure sensor will NOT seal properly.

1. Lubricate the threads and sealing surface of the NEW fuel injection fuel rail fuel pressure sensor with one drop of clean engine oil.
2. Install the NEW fuel injection fuel rail fuel pressure sensor (2) and hand tighten.
3. Fuel Injection Fuel Rail Fuel Pressure Sensor (2) @Fuel Injection Fuel Rail (3) - Remove and re-lubricate with one drop of clean engine oil.

CAUTION: Refer to **Component Fastener Tightening Caution** .

4. Install Fuel Injection Fuel Rail Fuel Pressure Sensor (2) @Fuel Injection Fuel Rail (3) and tighten 33N.m (24 lb ft)
5. Connect Electrical Connector (1) @Fuel Injection Fuel Rail Fuel Pressure Sensor (2)

NOTE: If a fuel leak occurs at the fuel rail, the fuel rail will need to be replaced.

6. Pressurize the fuel system and inspect for leaks.
7. Install Fuel Pipe Shield.**Fuel Pipe Shield Replacement**

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 1 (LFX)

Special Tools

EN-49248 Injector Rail Assembly Remover

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)** .

Removal Procedure

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief \(Gasoline\)](#).
2. Remove the fuel pipe shield. Refer to [Fuel Pipe Shield Replacement](#).
3. Remove the intake manifold. Refer to [Intake Manifold Replacement](#).
4. Remove the fuel feed intermediate pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#).
5. Remove the fuel injection fuel rail noise shield from the fuel rails.

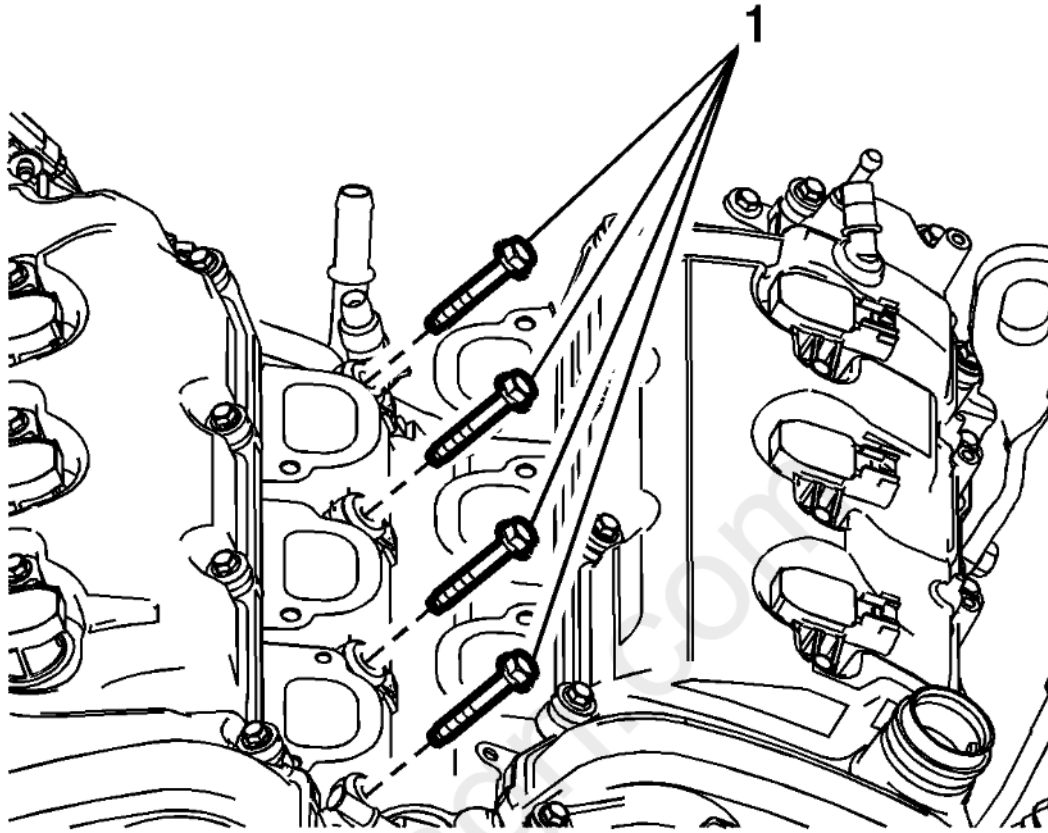


Fig. 99: Right Side Fuel Rail Fasteners

Courtesy of GENERAL MOTORS COMPANY

6. Remove the bank 1 fuel rail fasteners (1).

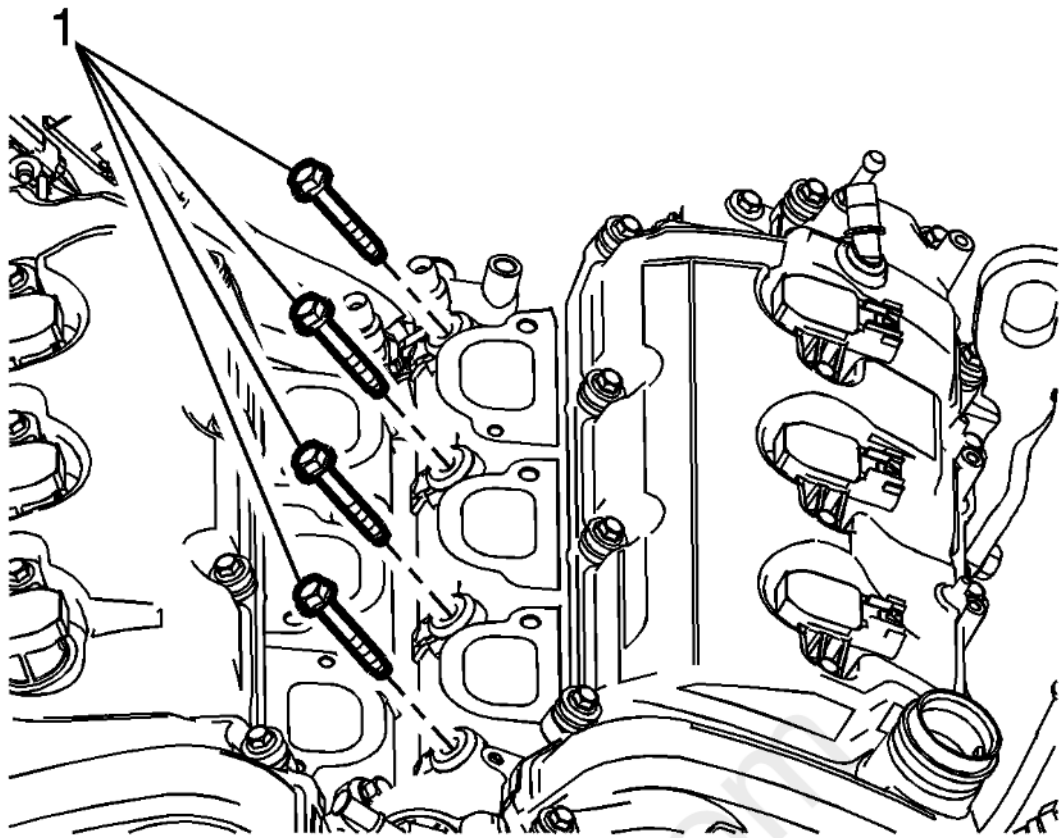


Fig. 100: Left Side Fuel Rail Fasteners

Courtesy of GENERAL MOTORS COMPANY

7. Remove the bank 2 fuel rail fasteners (1) for clearance purposes.

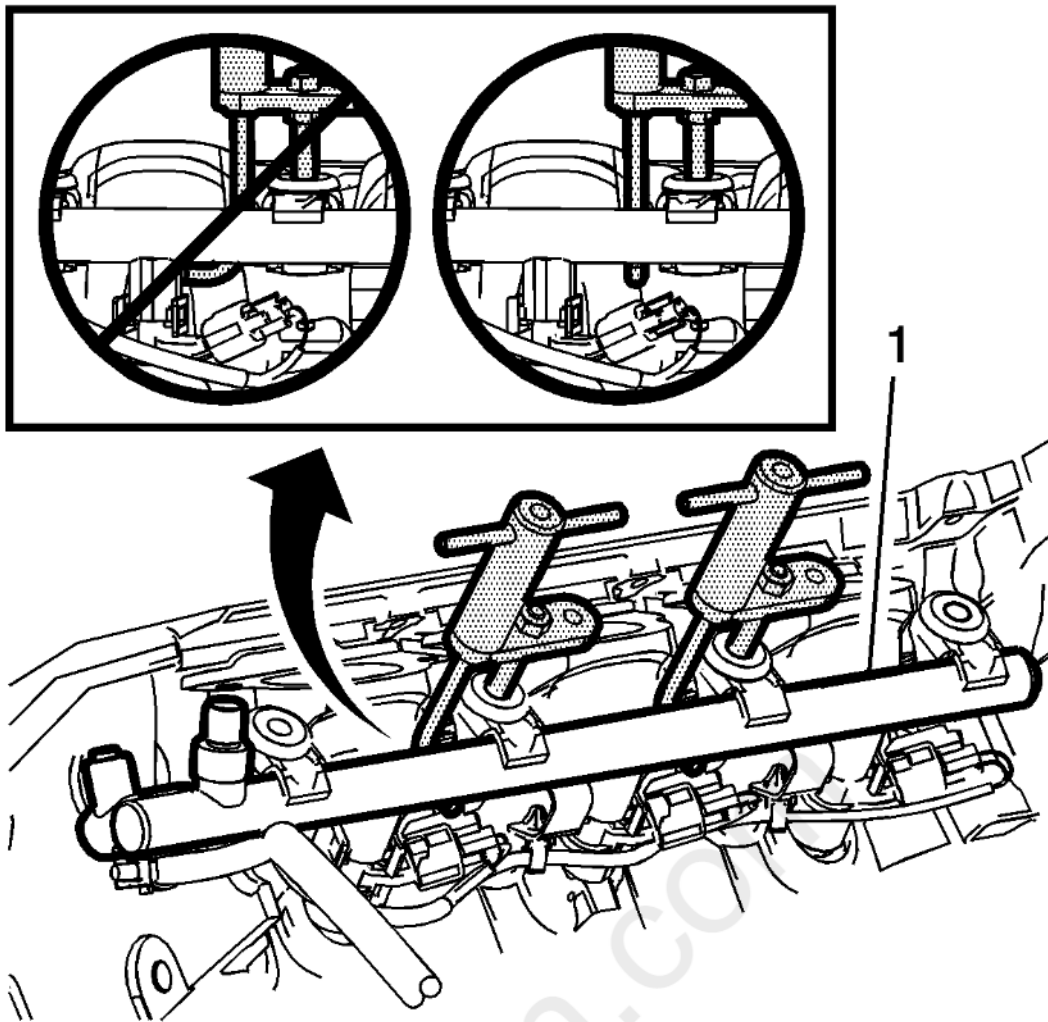


Fig. 101: Raising Fuel Rail With Special Tool

Courtesy of GENERAL MOTORS COMPANY

8. Using the **EN-49248-4** hook, raise the fuel rail (1) as an assembly.
9. Once the fuel rail is free, remove the **EN-49248** remover.

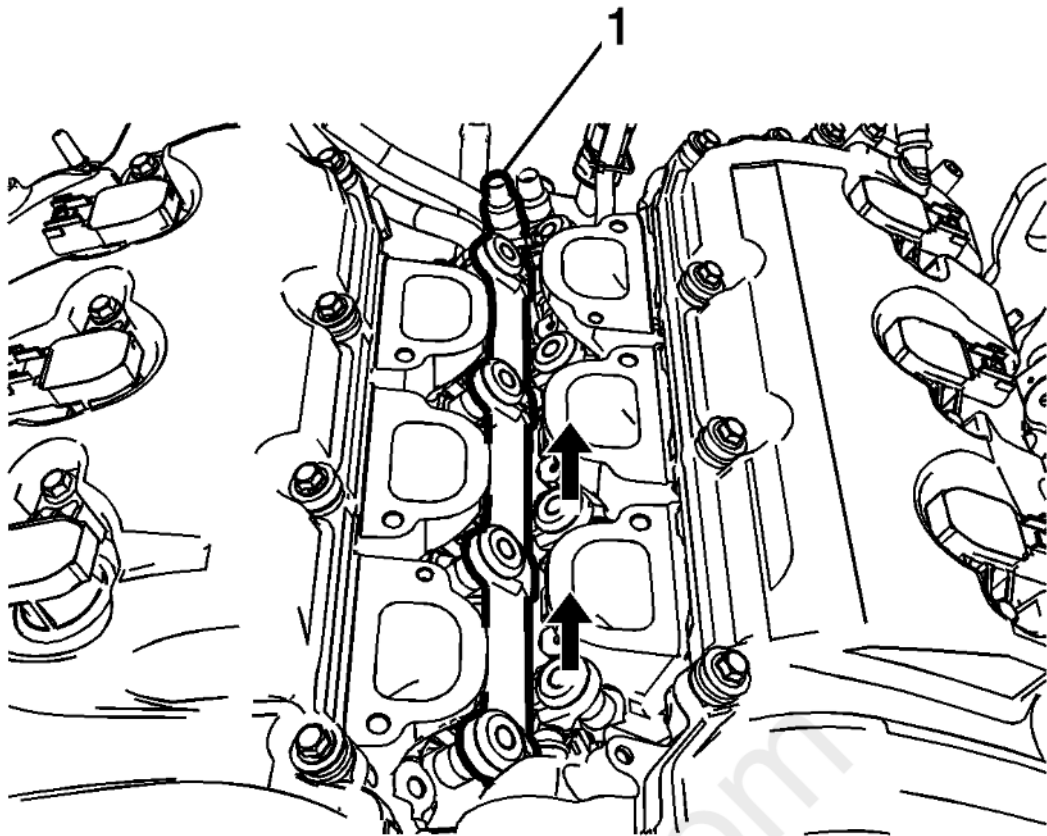


Fig. 102: Sliding Fuel Rail Toward Rear Of Engine

Courtesy of GENERAL MOTORS COMPANY

10. Slide the fuel rail (1) toward the rear of the engine approximately 1 inch (25.4mm), in order to clear the center injector bore.

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

11. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to [**Fuel Rail and Injectors Cleaning and Inspection**](#) .

Installation Procedure

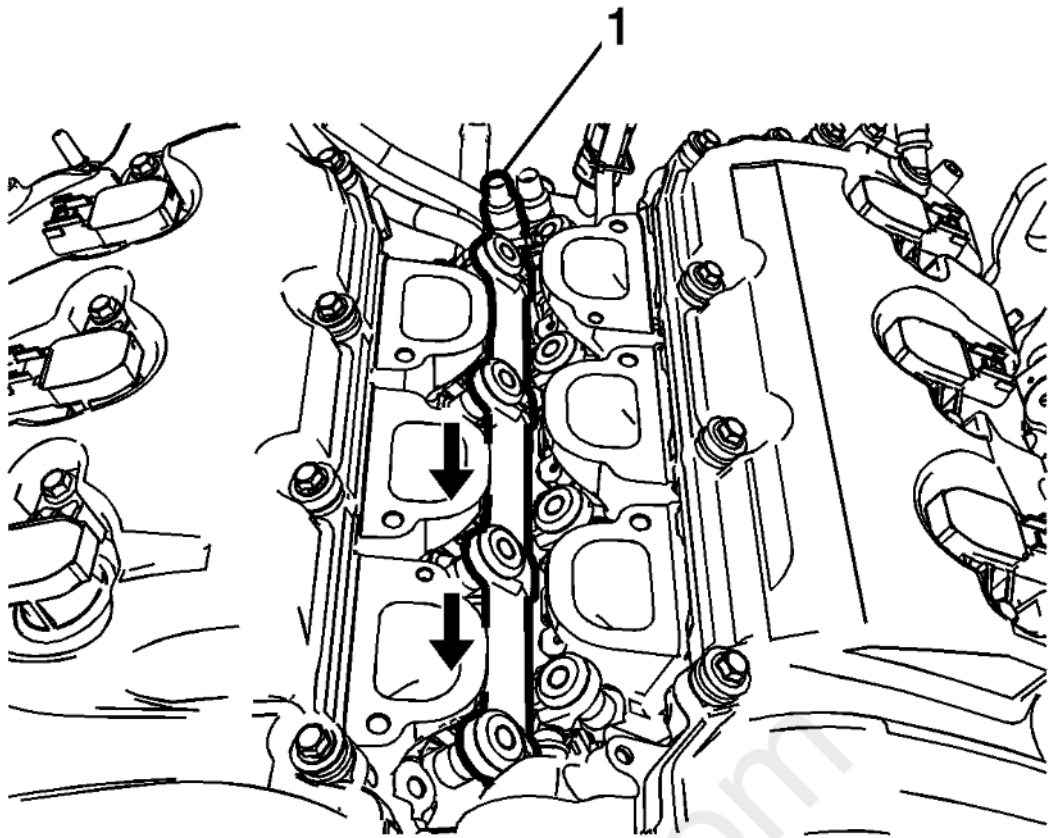


Fig. 103: Sliding Fuel Rail Toward Front Of Engine

Courtesy of GENERAL MOTORS COMPANY

1. Slide the fuel rail (1) toward the front of the engine approximately 1 inch (25.4mm), in order to align the center injector bore.

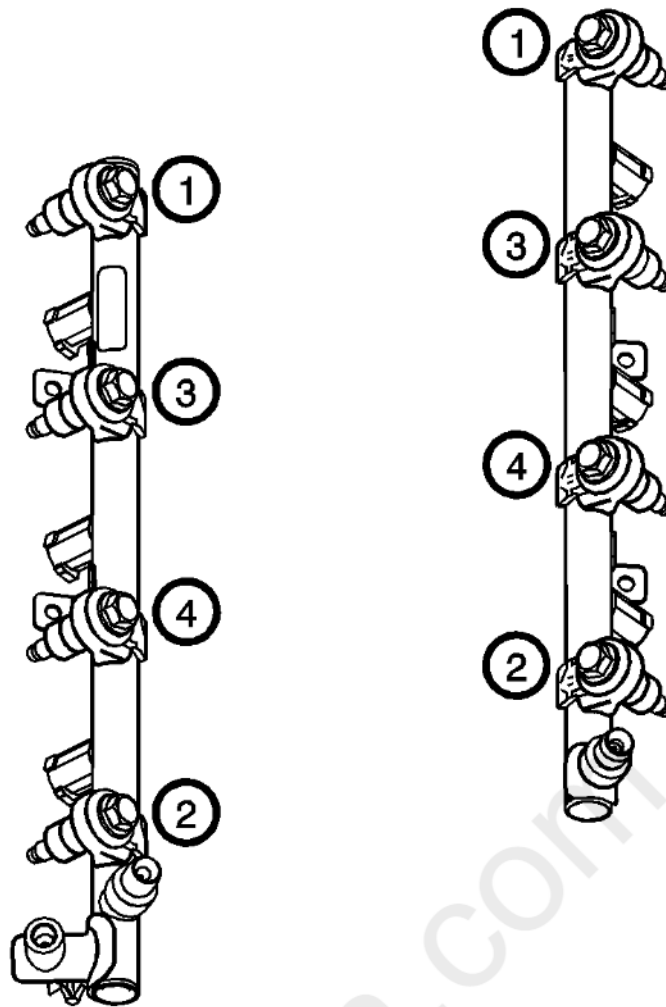


Fig. 104: Identifying Fuel Rail Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

2. Hand tighten the two outer fuel rail fasteners to seat the injectors.
3. Start and hand tighten the remaining fuel rail fasteners.
4. Tighten the fuel rail fasteners in the sequence shown above:
 1. Tighten the fuel rail bolts first pass to 12 N.m (106 lb in).
 2. Tighten the fuel rail bolts a final pass to 23 N.m (17 lb ft).
5. Install the fuel feed intermediate pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#).
6. Inspect for fuel 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.
7. Install the fuel injection fuel rail noise shield to the fuel rails.
8. Install the intake manifold. Refer to [Intake Manifold Replacement](#) .
9. Install the fuel pipe shield. Refer to [Fuel Pipe Shield Replacement](#).
10. Install the low side fuel pressure service port cap.
11. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 2 (LFX)

Special Tools

For equivalent regional tools, refer to [Special Tools \(Diagnostic Tools\)](#) [Special Tools \(Mechanical Tools\)](#) .

Removal Procedure

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief \(Gasoline\)](#).
2. Remove the fuel pipe shield. Refer to [Fuel Pipe Shield Replacement](#).
3. Remove the intake manifold. Refer to [Intake Manifold Replacement](#) .
4. Remove the fuel feed intermediate pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#).
5. Remove the fuel injection fuel rail noise shield from the fuel rails.

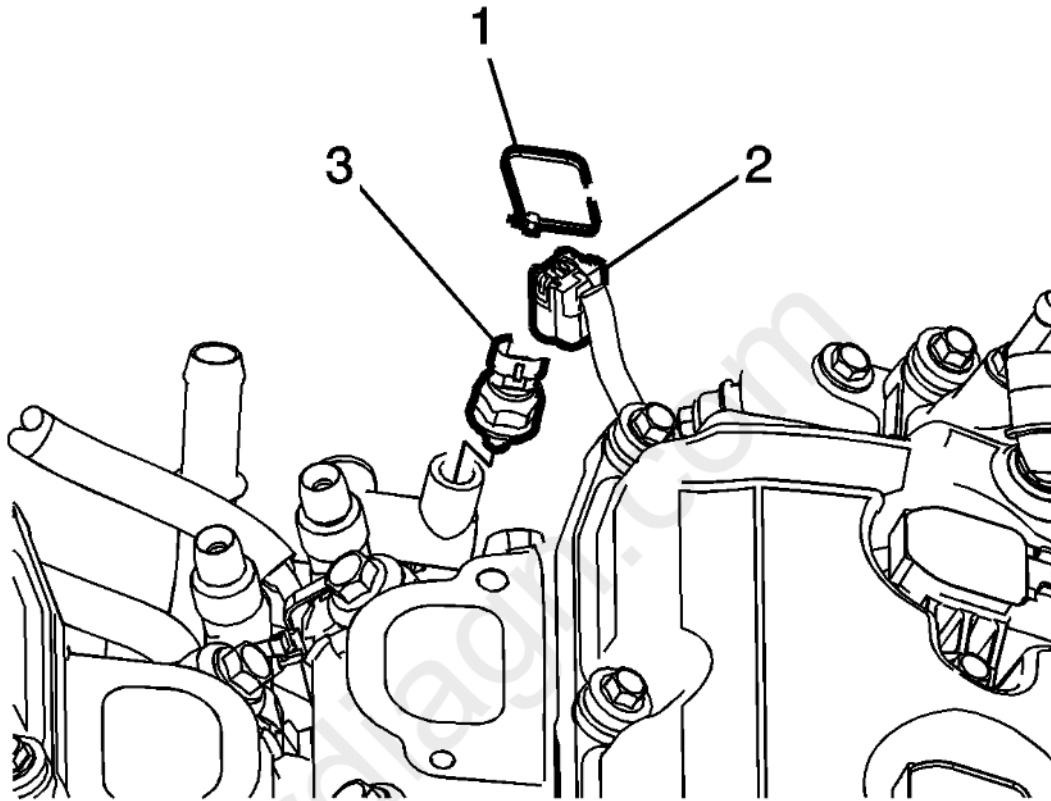


Fig. 105: Fuel Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Cut the plastic tie strap (1).
7. Disconnect the fuel pressure sensor electrical connector (2).
8. Remove the fuel pressure sensor (3).

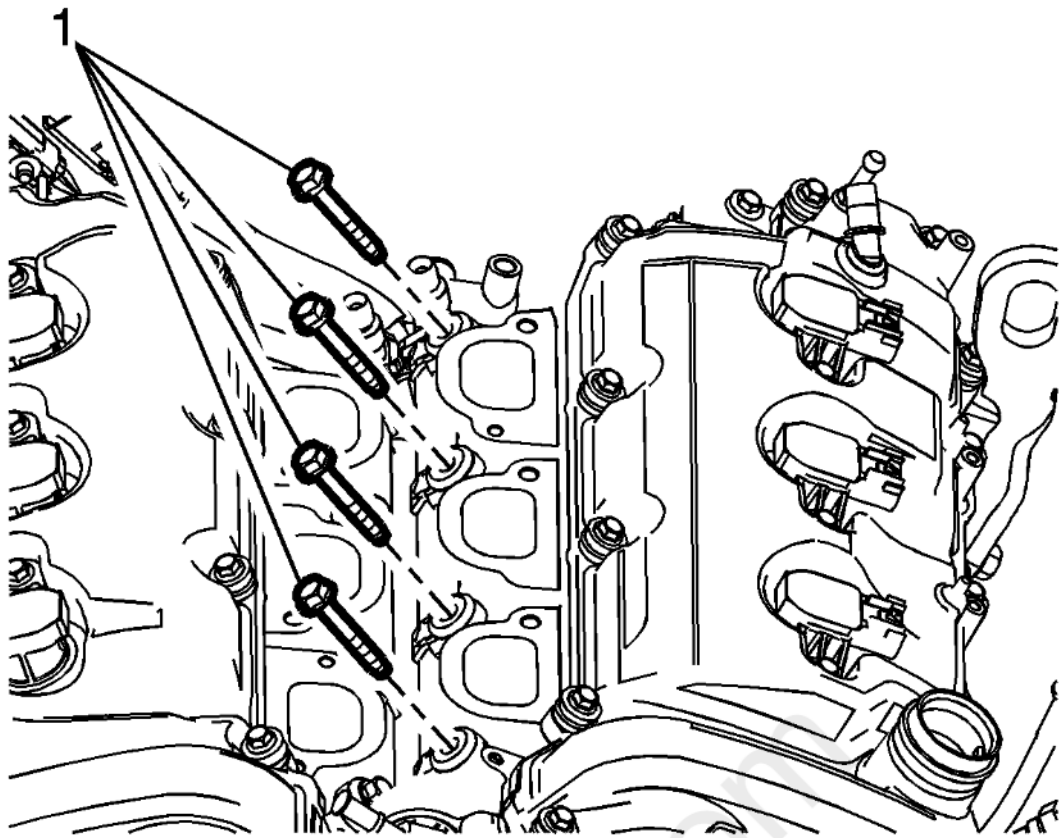


Fig. 106: Left Side Fuel Rail Fasteners

Courtesy of GENERAL MOTORS COMPANY

9. Remove the bank 2 fuel rail fasteners (1).

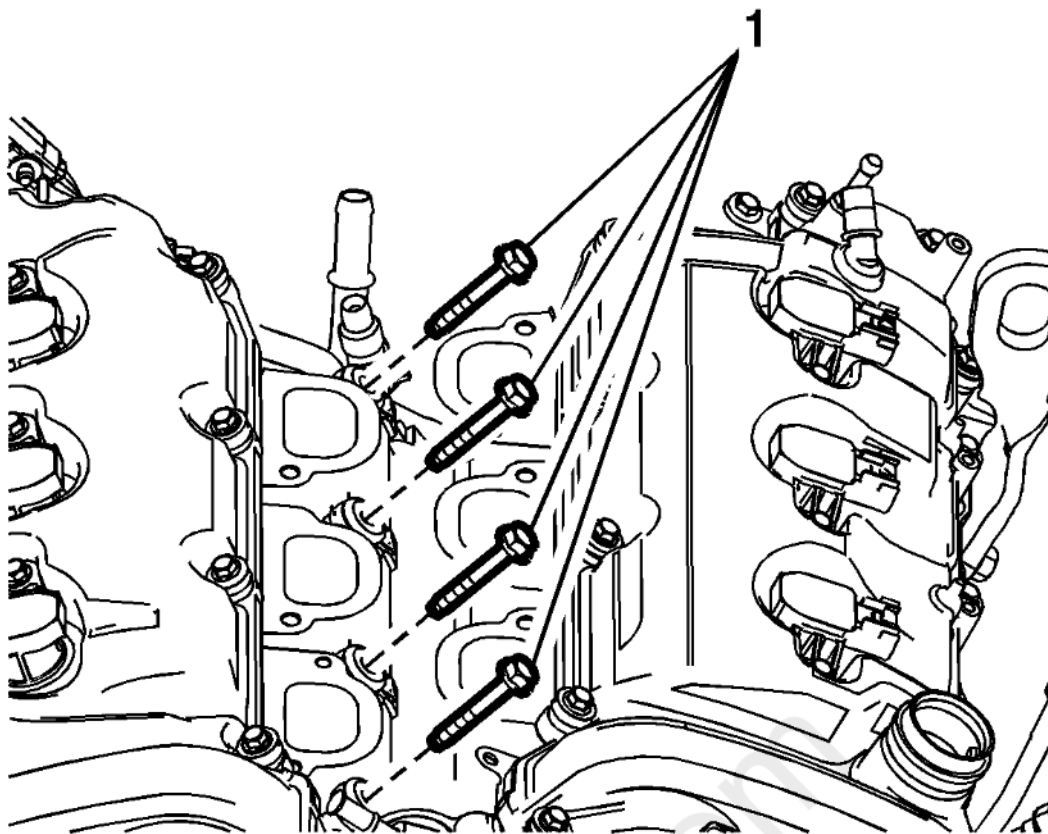


Fig. 107: Right Side Fuel Rail Fasteners

Courtesy of GENERAL MOTORS COMPANY

10. Remove the bank 1 fuel rail fasteners (1) for clearance purposes.

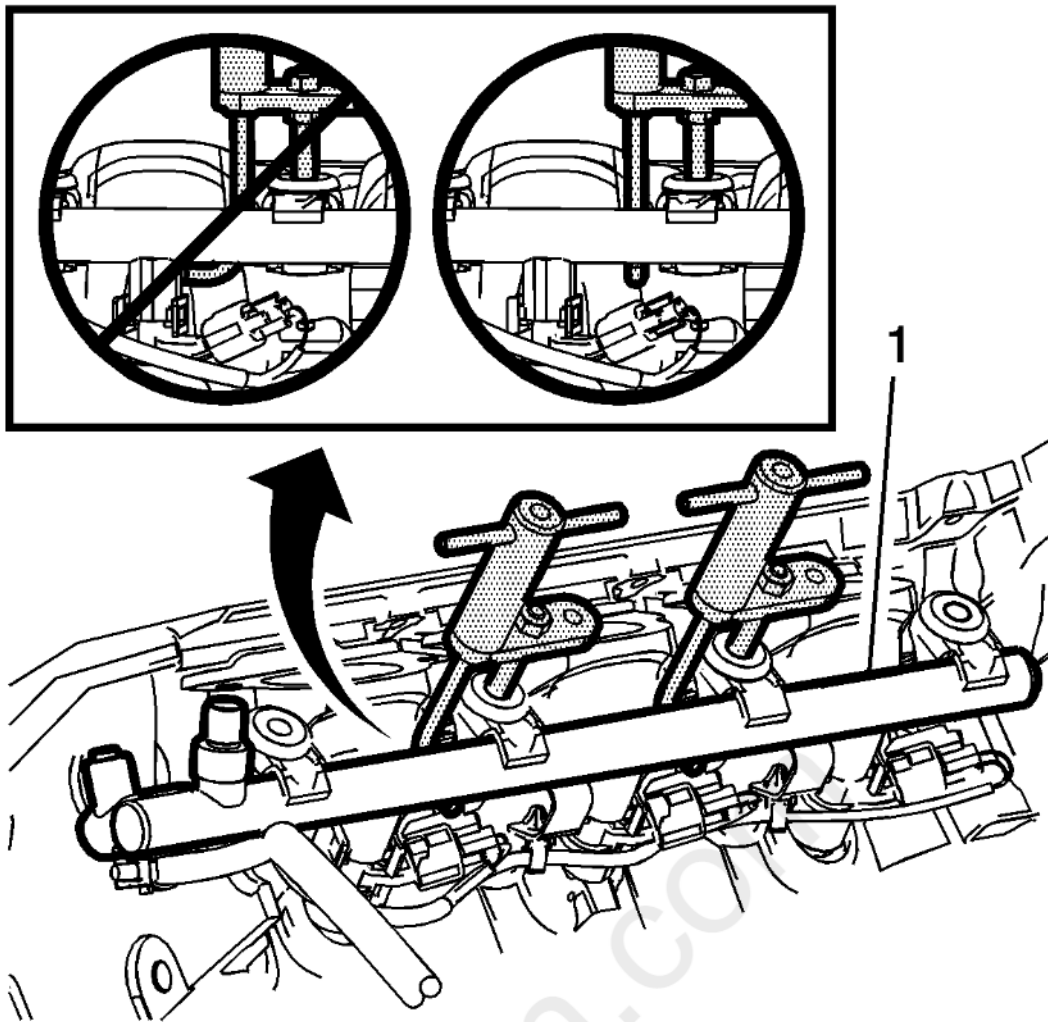


Fig. 108: Raising Fuel Rail With Special Tool

Courtesy of GENERAL MOTORS COMPANY

11. Using the **EN-49248 - 4** hook, raise the fuel rail (1) as an assembly.
12. Once the fuel rail is free, remove the **EN-49248** special tool.

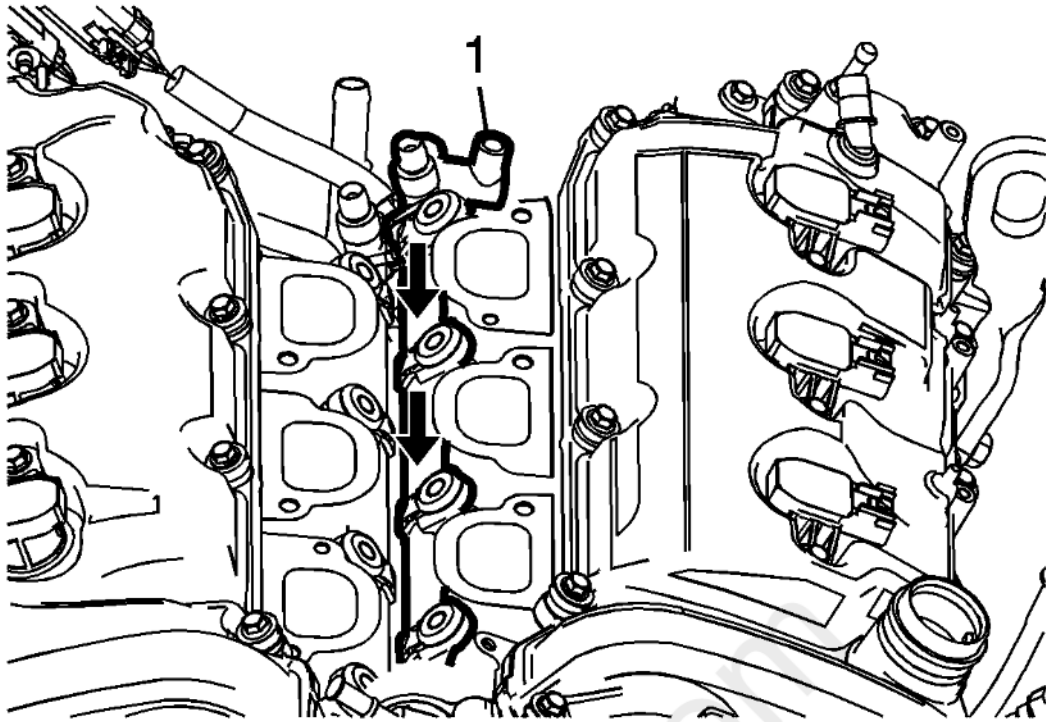


Fig. 109: Sliding Fuel Rail Toward Front Of Engine

Courtesy of GENERAL MOTORS COMPANY

13. Slide the fuel rail (1) toward the rear of the engine approximately 1 inch (25.4 mm), in order to clear the center injector bore.

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

14. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Rail and Injectors Cleaning and Inspection** .

Installation Procedure

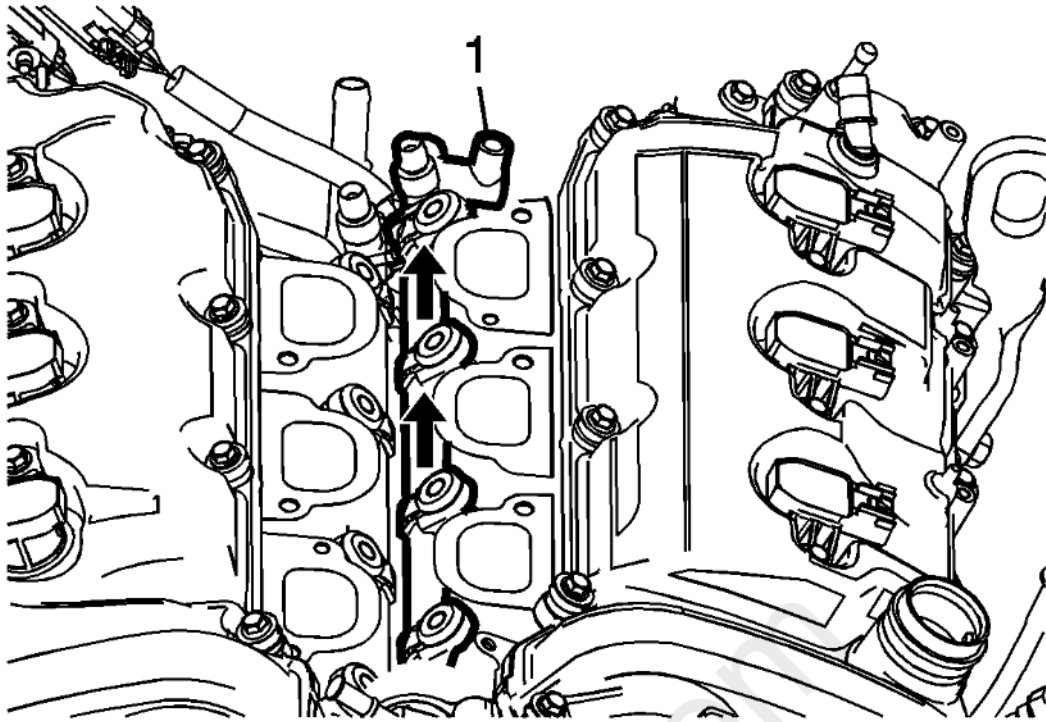


Fig. 110: Sliding Fuel Rail Toward Rear Of Engine

Courtesy of GENERAL MOTORS COMPANY

1. Slide the fuel rail (1) toward the front of the engine approximately 1 inch (25.4 mm), in order to align the center injector bore.

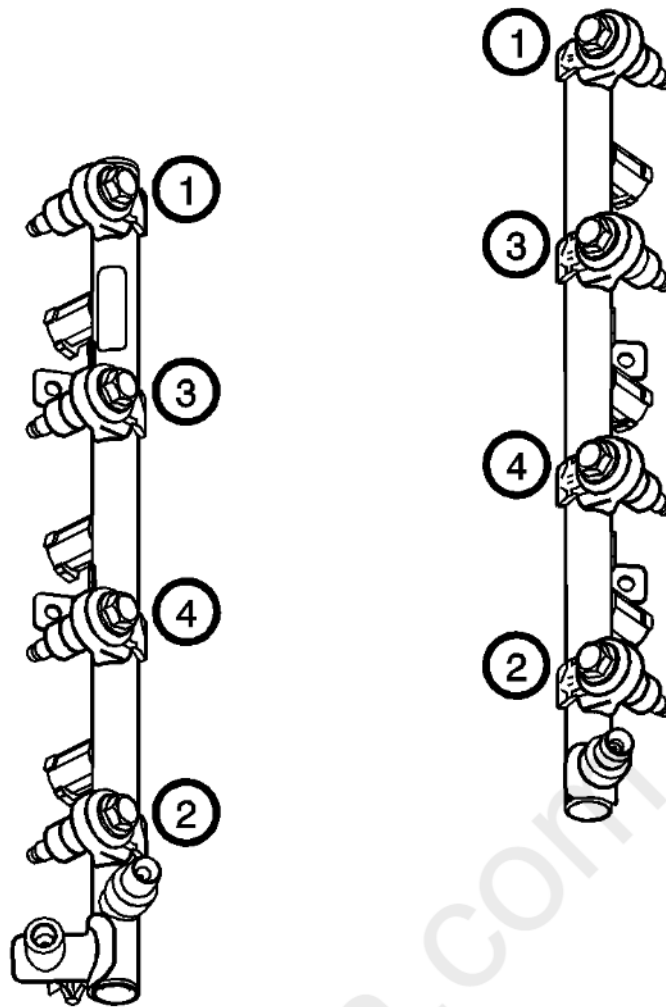


Fig. 111: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

2. Hand tighten the two outer fuel rail fasteners to seat the injectors.
3. Start and hand tighten the remaining fuel rail fasteners.
4. Tighten the fuel rail fasteners in the sequence shown above:
 1. First pass 12 N.m (106 lb in).
 2. Final pass 23 N.m (17 lb ft).

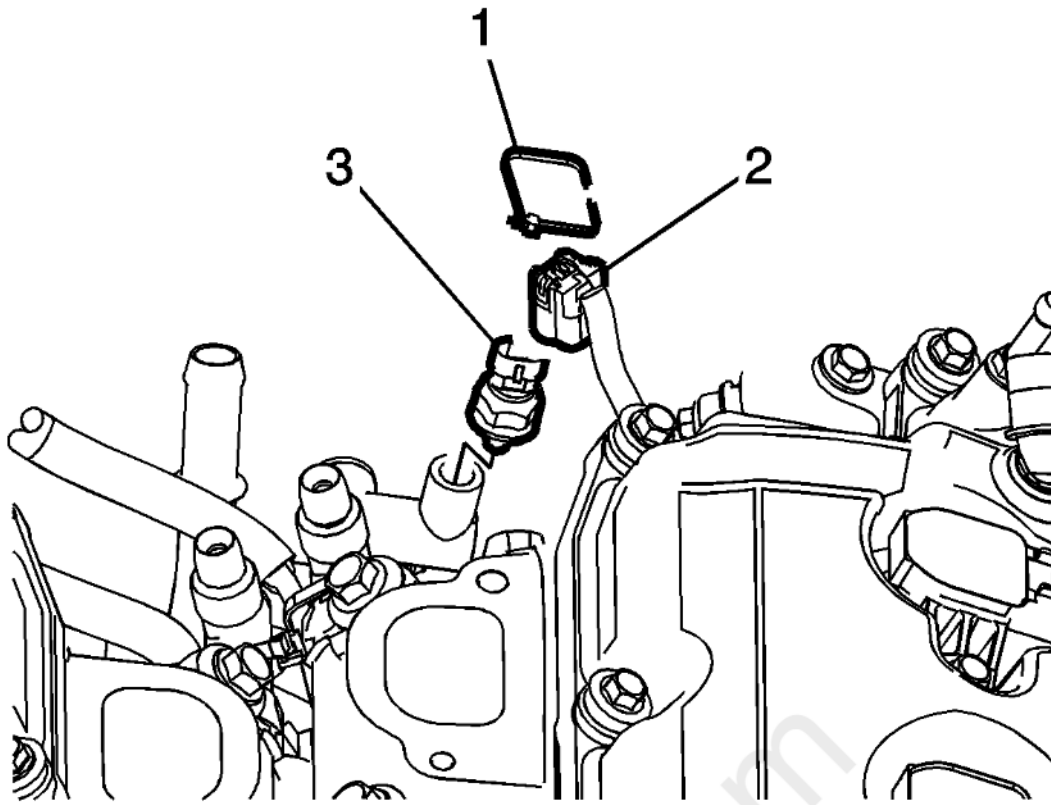


Fig. 112: Fuel Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Component Fastener Tightening Caution](#) .

5. Tighten the fuel pressure sensor (3) to 33 N.m (24 lb ft).
6. Connect the fuel pressure sensor electrical connector (2) and secure it with a new plastic zip tie.
7. Install the fuel feed intermediate pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#).
8. Inspect for fuel 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.
9. Install the fuel injection fuel rail noise shield to the fuel rails.
10. Install the intake manifold. Refer to [Intake Manifold Replacement](#) .
11. Install the fuel pipe shield. Refer to [Fuel Pipe Shield Replacement](#).
12. Install the low side fuel pressure service port cap.
13. Install the fuel tank cap.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT

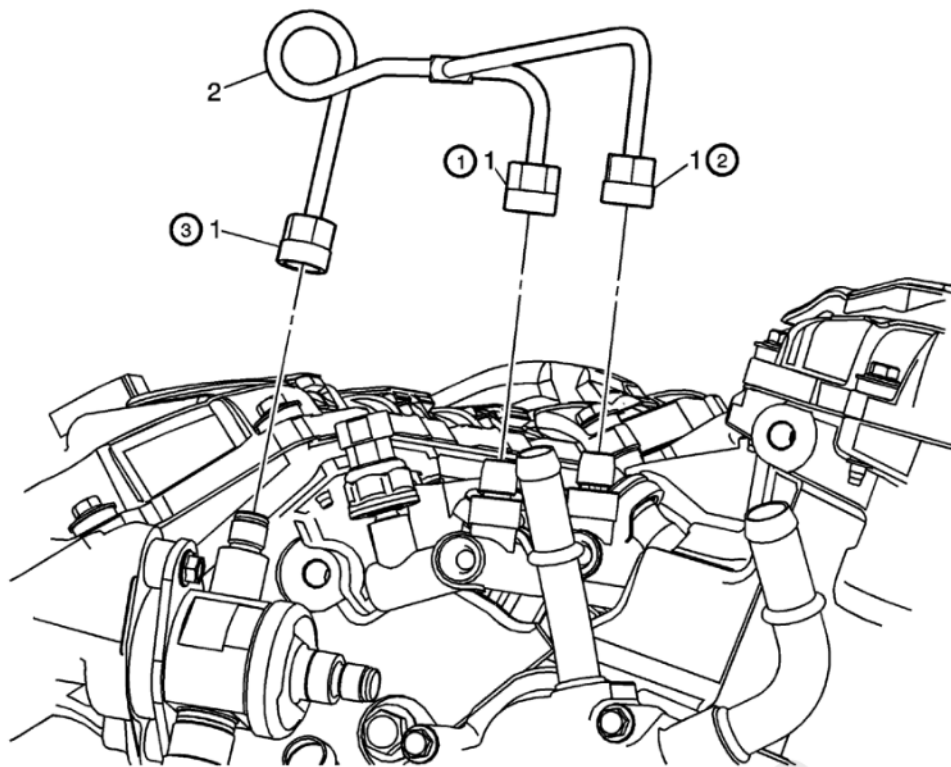


Fig. 113: View Of Fuel Feed Intermediate Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief (Gasoline). 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX). 3. Remove the fuel pipe shield. Refer to Fuel Pipe Shield Replacement.	
1	Fitting (Qty: 3) CAUTION: Refer to Component Fastener Tightening Caution . NOTE: Tighten the fittings in sequence as numbered: 1, 2, 3 Tighten 28 N.m (21 lb ft)
2	Fuel Feed Intermediate Pipe Procedure 1. Discard the pipe when removed and install a NEW pipe. 2. Lubricate the pipes with silicon free engine oil. Refer to Adhesives, Fluids, Lubricants, and Sealers . 3. Pressure up the fuel system and check for leaks.

FUEL PIPE SHIELD REPLACEMENT

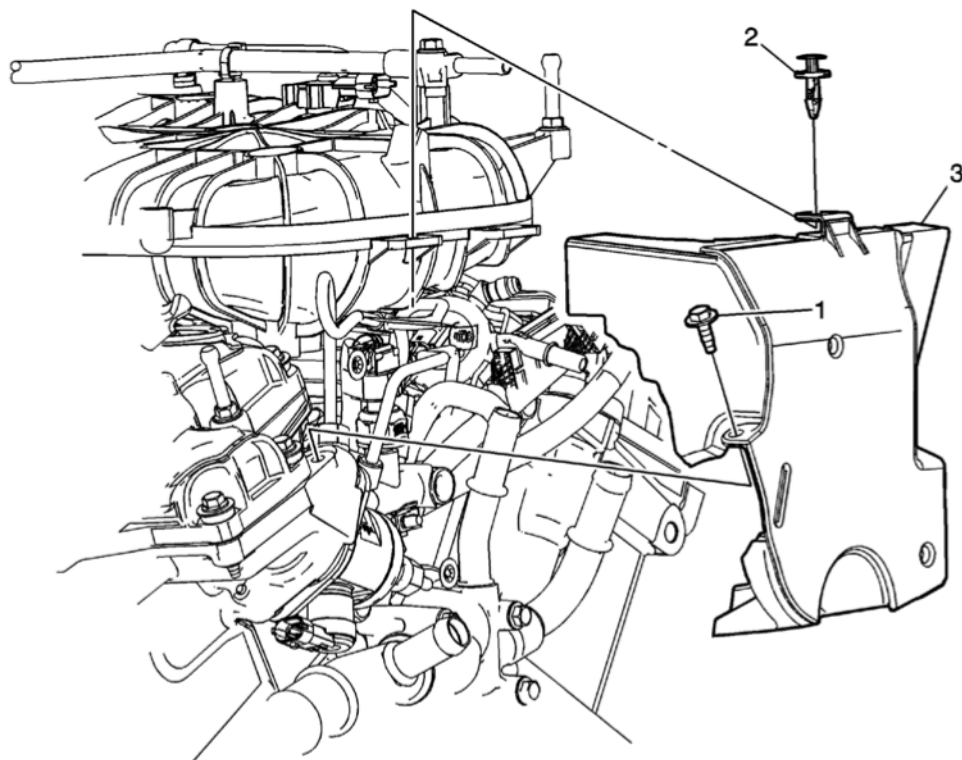


Fig. 114: Fuel Pipe Shield

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX) .	
1	Bolt CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Retainer
3	Fuel Pipe Shield

FUEL PUMP REPLACEMENT (LFX)

Special Tools

EN-48896 High Pressure Fuel Pump Installation Alignment Gauge

For equivalent regional tools, refer to [Special Tools \(Diagnostic Tools\)](#) [Special Tools \(Mechanical Tools\)](#) .

Removal Procedure

1. Relieve the low and high side fuel system pressure. Refer to [Fuel Pressure Relief \(Gasoline\)](#).
2. Remove the thermostat housing. Refer to [Engine Coolant Thermostat Housing Replacement \(LFX\)](#) .

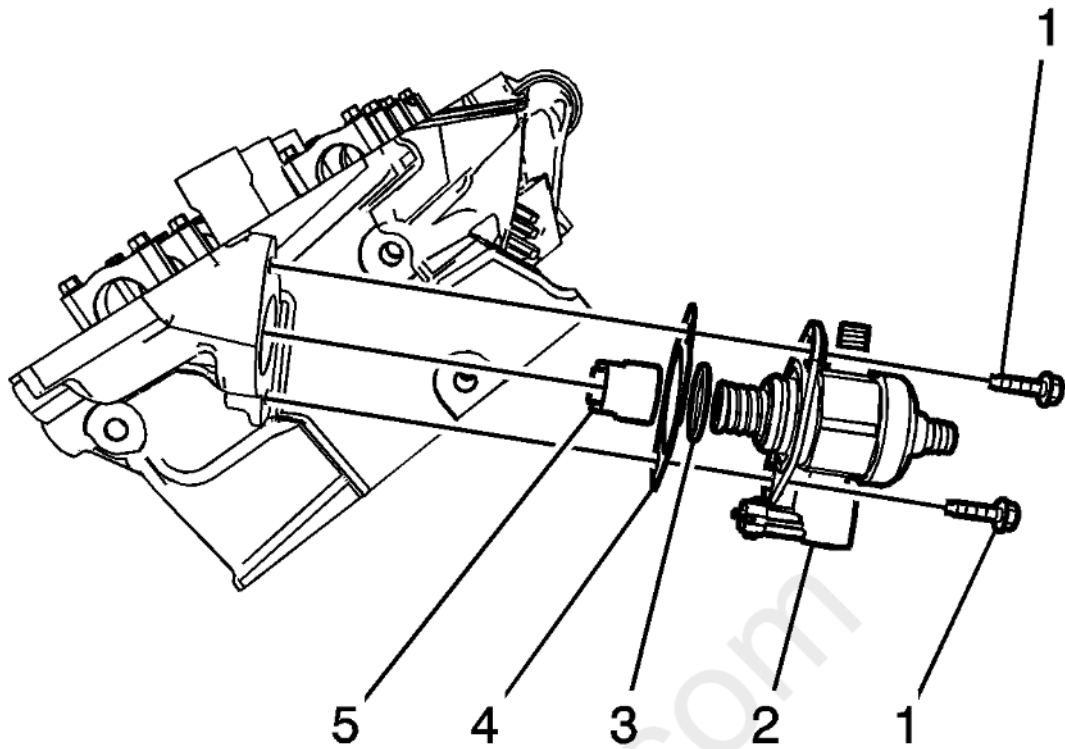


Fig. 115: Identifying High Pressure Fuel Pump Components

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.
4. Remove the low pressure feed pipe. **Fuel Feed Pipe Replacement (LFX)**
5. Remove the high pressure pipe. **Fuel Feed Intermediate Pipe Replacement**

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 high pressure fuel pump bolts (1).
7. Remove the high pressure fuel pump (2).
8. Remove and DISCARD the high pressure fuel pump O-ring (3).
9. Remove and DISCARD the high pressure fuel pump gasket (4).
10. Remove the high pressure fuel pump roller lifter (5).

Installation Procedure

NOTE: The camshaft must be in the base circle position before the high pressure fuel pump is installed.

1. Use the **EN-48896** alignment gauge to ensure that the camshaft lobe is in the base circle position. At base circle the tool will be flush with the head.
2. Lubricate the high pressure fuel pump cylinder head bore and roller lifter with camshaft prelube. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

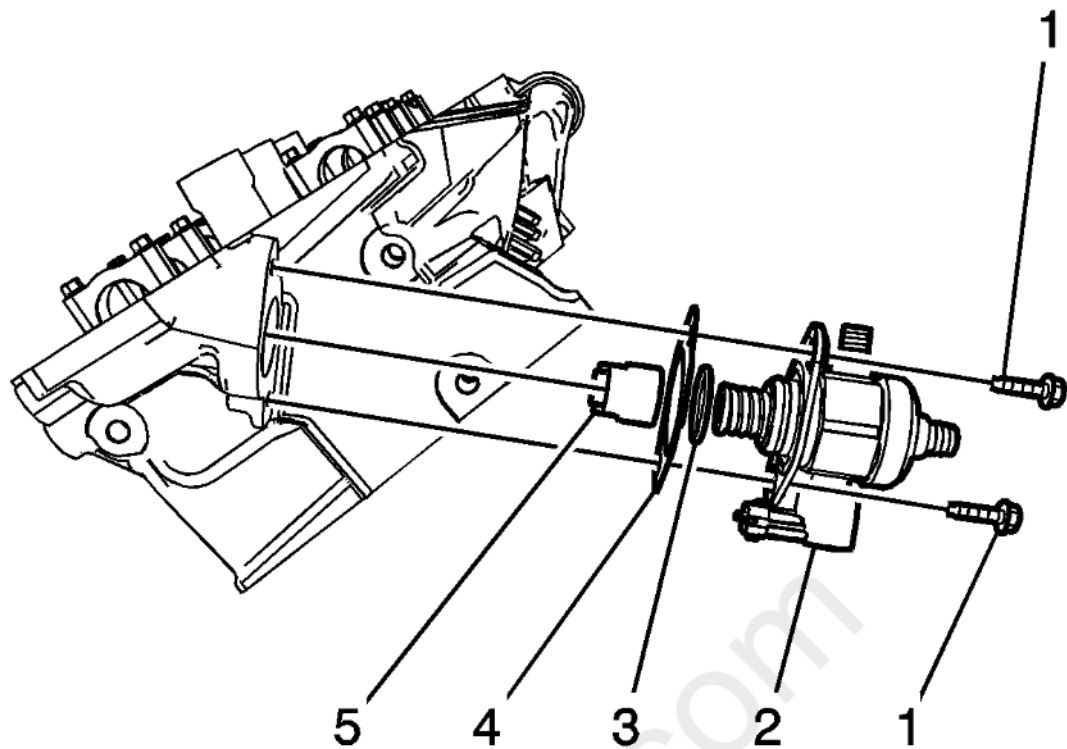


Fig. 116: Identifying High Pressure Fuel Pump Components

Courtesy of GENERAL MOTORS COMPANY

NOTE: The high pressure fuel pump gasket has a retaining feature to hold the pump retaining bolts in place.

3. Install the high pressure fuel pump roller lifter (5).

NOTE: Lubricate the NEW O-ring seals with clean engine oil.

4. Install a NEW high pressure fuel pump O-ring (3).

5. Position the NEW high pressure fuel pump gasket (4) and NEW bolts (1) to the fuel pump.

6. Install the high pressure fuel pump (2). Force will be required while hand tightening the bolts.

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.

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.

1. Start and hand-tighten the NEW high pressure fuel pump bolts (1) evenly.

2. Tighten the high pressure fuel pump retaining bolts (1) to 15 N.m (11 lb ft).

3. Tighten the fuel pump bolts (1) a final pass of an additional **60 degrees** .
7. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to assembly.
8. Install the high pressure fuel pipe. [Fuel Feed Intermediate Pipe Replacement](#)
9. Install the fuel feed pipe to the high pressure fuel pump. [Fuel Feed Pipe Replacement \(LFX\)](#)
10. Connect the high pressure fuel pump wiring harness.
11. Install the thermostat housing. Refer to [Engine Coolant Thermostat Housing Replacement \(LFX\)](#) .
12. Install the fuel tank cap.

NOTE: If a fuel leak occurs at the fuel rail, the fuel rail will need to be replaced.

13. 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.
14. Install the pressure relief cap to the fuel feed pipe.

FUEL INJECTOR REPLACEMENT (LFX)

Removal Procedure

1. Relieve the high side fuel system pressure. Refer to [Fuel Pressure Relief \(Gasoline\)](#).

NOTE: The fuel injectors have an alignment feature, note the position of the injectors alignment for installation.

2. Remove the fuel injection fuel rail assembly. Refer to [Fuel Injection Fuel Rail Assembly Replacement - Bank 1 \(LFX\)](#), or [Fuel Injection Fuel Rail Assembly Replacement - Bank 2 \(LFX\)](#).
3. For removal of the fuel injectors, refer to [Fuel Rail and Injectors Cleaning and Inspection](#) .

Installation Procedure

1. Prepare the fuel injectors for assembly, refer to [Fuel Rail and Injectors Cleaning and Inspection](#) .

NOTE: The fuel injectors have an alignment feature and must be reinstalled as noted during removal.

2. Install the fuel injection fuel rail assembly. Refer to [Fuel Injection Fuel Rail Assembly Replacement - Bank 1 \(LFX\)](#), or [Fuel Injection Fuel Rail Assembly Replacement - Bank 2 \(LFX\)](#).
3. Pressurize the fuel system and check for leaks.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

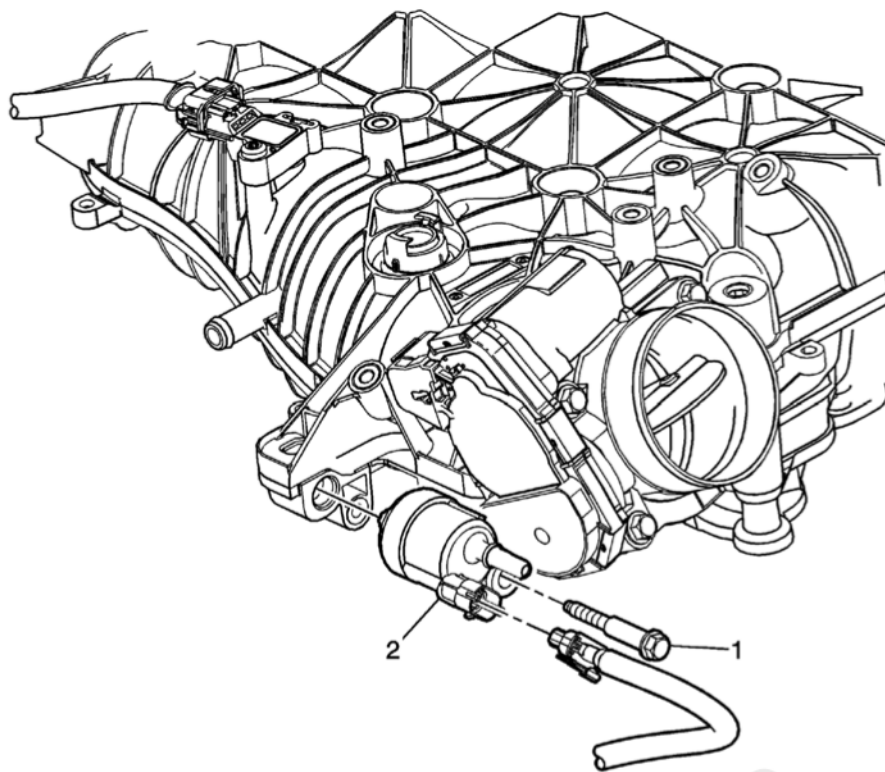


Fig. 117: Evaporative Emission Canister Purge Solenoid Valve
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX) . 2. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.	
1	Bolt CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Evaporative Emission Canister Purge Solenoid Valve Procedure 1. Disconnect the EVAP canister purge solenoid harness connector. 2. Install a NEW O-ring.

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

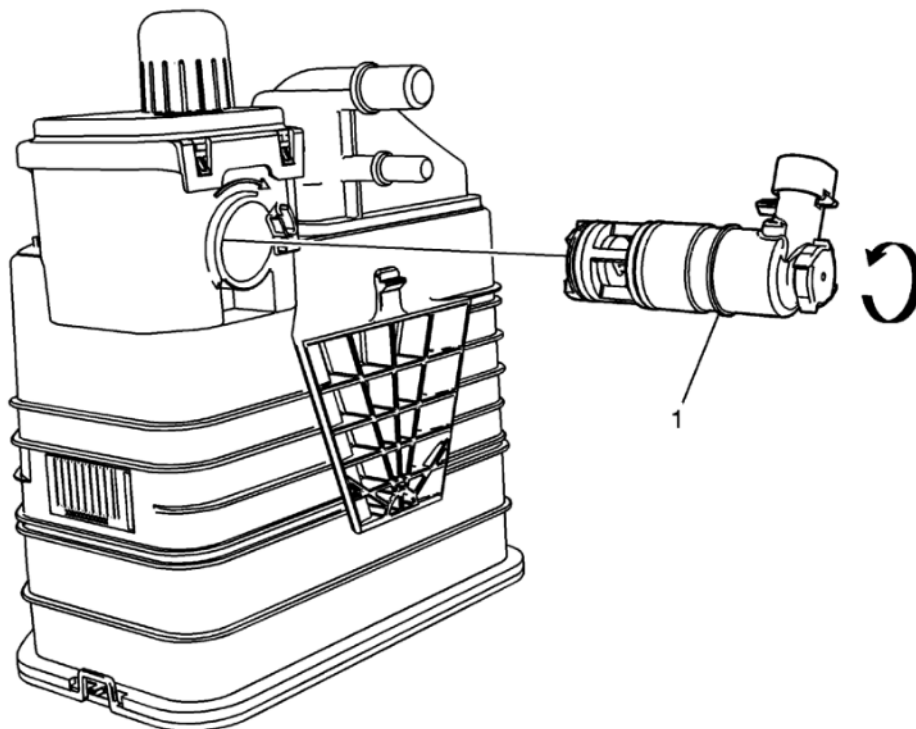


Fig. 118: Evaporative Emission Canister Vent Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove the carbon canister. Refer to Evaporative Emission Canister Replacement .	
1	Evaporative Emission Canister Vent Solenoid Valve
Procedure	
Disconnect the electrical connector.	

EVAPORATIVE EMISSION PIPE REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement \(LFX\)](#).

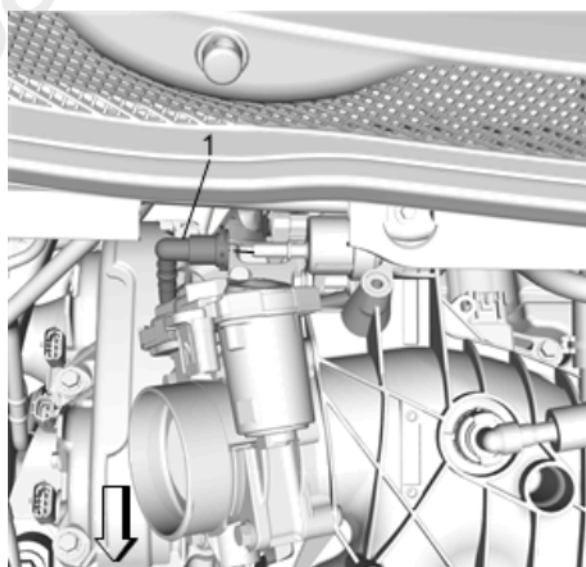


Fig. 119: EVAP Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the EVAP emission pipe (1) from the EVAP emission canister solenoid valve. Refer to [Plastic Collar Quick Connect Fitting Service](#).
3. Unclip the EVAP emission pipes from the pipe retainers.

4. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
5. Remove the drivetrain and front suspension frame rear support. Refer to [Drivetrain and Front Suspension Frame Rear Support Replacement](#) .

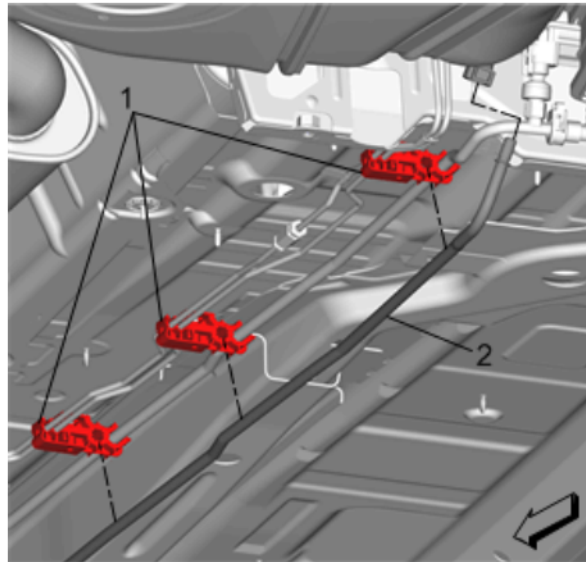


Fig. 120: EVAP Emission Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the EVAP emission pipe (2) from the EVAP emission canister purge pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
7. Remove the EVAP emission pipe (2) from the retainers (1).
8. Remove the EVAP emission pipe (2) from the vehicle.

Installation Procedure

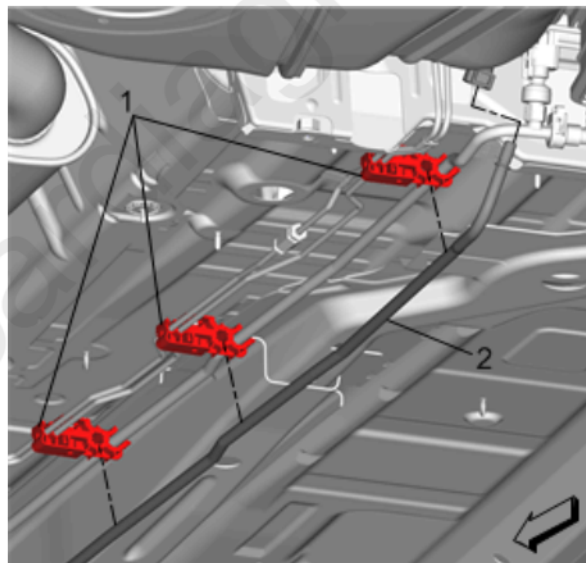


Fig. 121: EVAP Emission Pipe Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the EVAP emission pipe (2) to the vehicle.
2. Install the EVAP emission pipe (2) to the retainers (1).
3. Connect the EVAP emission pipe (2) to the EVAP emission canister purge pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
4. Install the drivetrain and front suspension frame rear support. Refer to [Drivetrain and Front Suspension Frame Rear Support Replacement](#) .
5. Lower the vehicle.

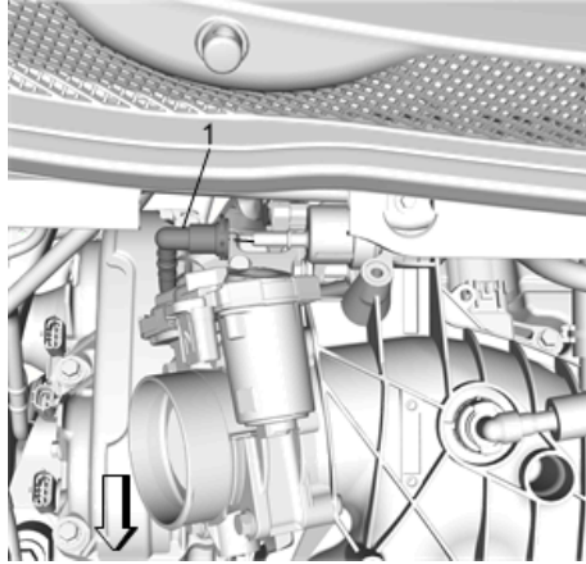


Fig. 122: EVAP Emission Pipe

Courtesy of GENERAL MOTORS COMPANY

6. Connect the EVAP emission pipe (1) to the EVAP emission canister solenoid valve. Refer to [Plastic Collar Quick Connect Fitting Service](#).
7. Clip the EVAP emission pipe into the retainers.
8. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement \(LFX\)](#).

EVAPORATIVE EMISSION CANISTER PURGE PIPE REPLACEMENT

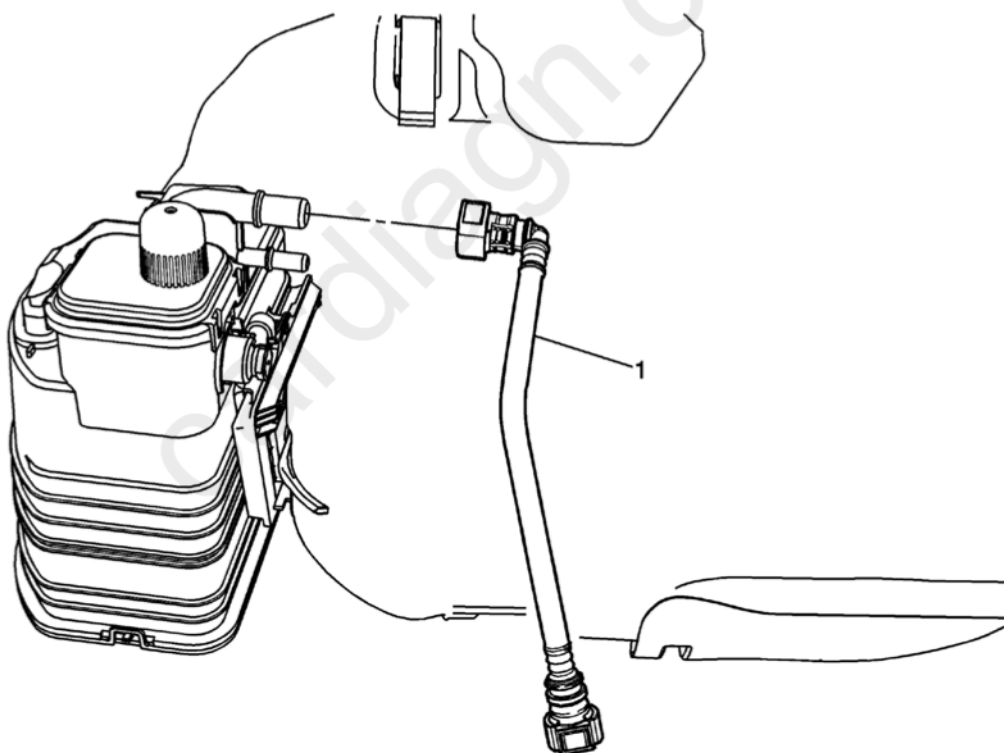


Fig. 123: Evaporative Emission Canister Purge Pipe

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement .	
1	Evaporative Emission Canister Purge Pipe Procedure Disconnect the evaporative emission quick connects. Refer to Plastic Collar Quick Connect Fitting Service .

EVAPORATIVE EMISSION CANISTER VENT FRONT PIPE REPLACEMENT

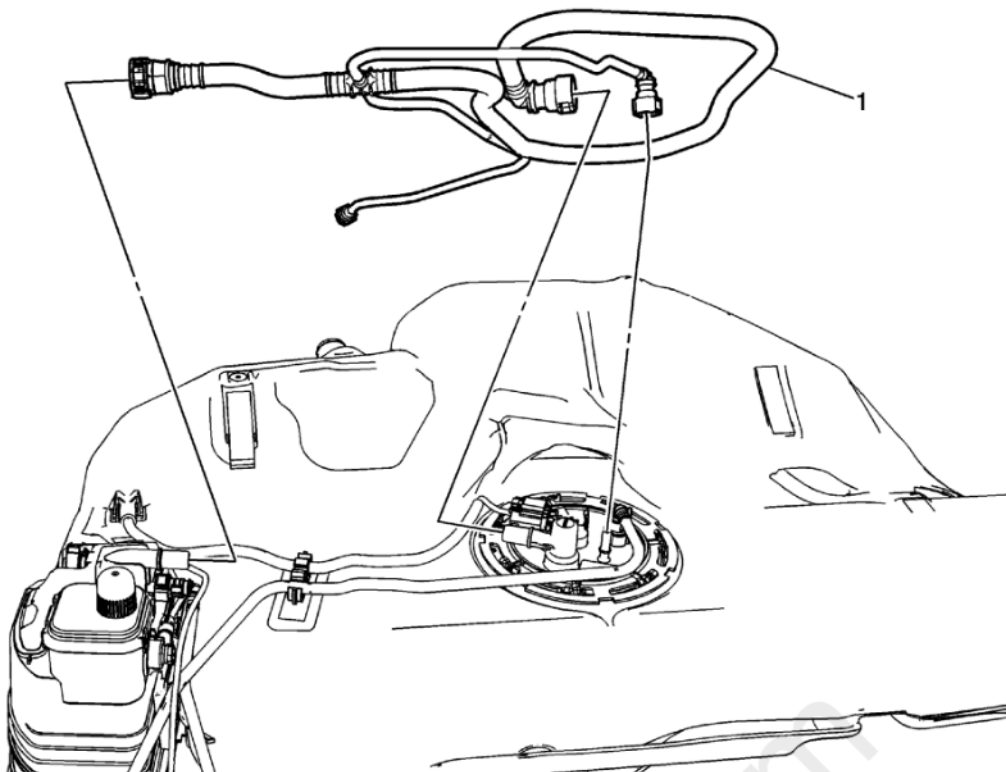
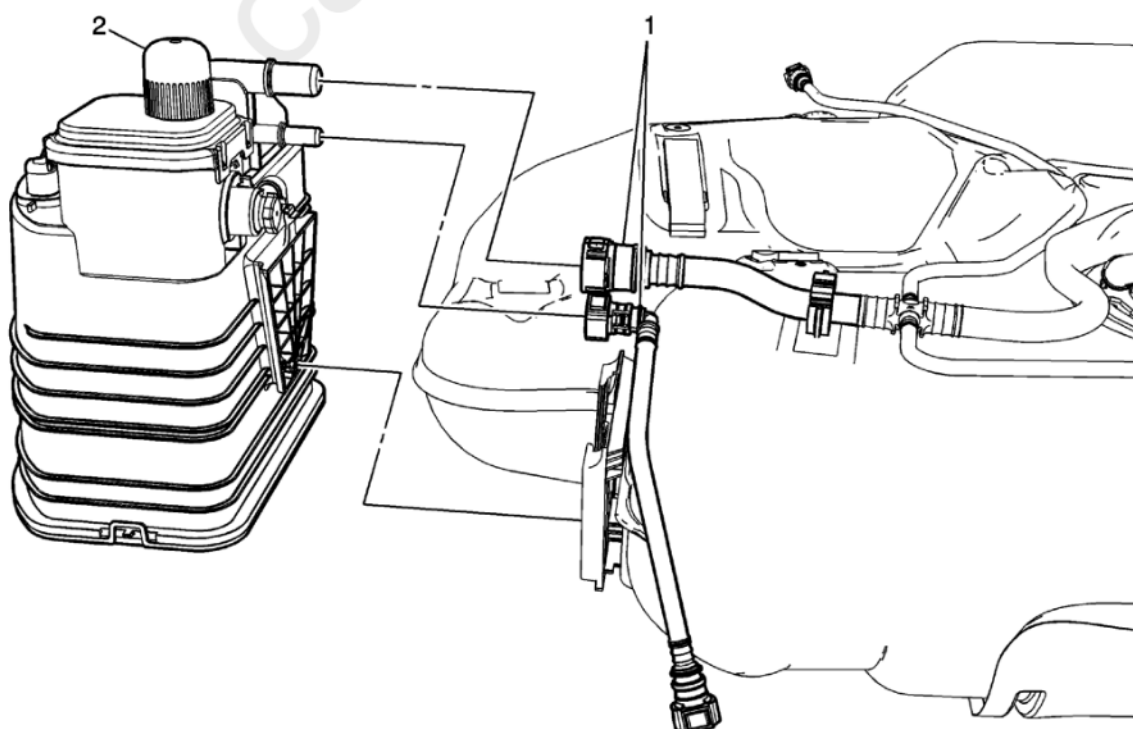


Fig. 124: Evaporative Emission Canister Vent Front Pipe

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement .	
1	Evaporative Emission Canister Vent Front Pipe Procedure Disconnect the evaporative emission quick connects. Refer to Plastic Collar Quick Connect Fitting Service .

EVAPORATIVE EMISSION CANISTER REPLACEMENT



Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement .	
1	Evaporative Emission Hose (Qty: 2) Procedure Disconnect the quick connects. Refer to Plastic Collar Quick Connect Fitting Service .
2	Evaporative Emission Canister Procedure 1. Disconnect the electrical connector. 2. Release the retaining tab.

EVAPORATIVE EMISSION SYSTEM CLEANING

Special Tools

GE 41413 - 200 Evaporative Pressure and Purge Station

For equivalent regional tools, refer to [Special Tools \(Diagnostic Tools\)](#) [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. Refer to [Evaporative Emission Canister Purge Solenoid Valve Replacement](#).
3. Lightly tap the EVAP canister purge valve on a hard surface.
4. Inspect for carbon particles exiting either of the vacuum ports.
 - If no carbon particles were detected, but a blockage was detected during a diagnostic procedure, install the original EVAP canister purge valve. Continue with the cleaning procedure.
 - If carbon particles are found during the inspection procedure, continue with the cleaning procedure.
 - If a diagnostic procedure directed you to replace the EVAP canister purge valve and no carbon particles were detected, replace the EVAP canister purge valve. Return to the published service procedure.

Cleaning Procedure

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
2. Remove the EVAP canister. Refer to [Evaporative Emission Canister Replacement](#).
3. Turn OFF the main valve on the **GE 41413 - 200** station.
4. Disconnect the hose from the diagnostic station pressure regulator.
5. Using a section of vacuum hose, connect one end onto the EVAP pressure/purge diagnostic station pressure regulator.

6. Connect the other end of the vacuum hose to the canister side of the purge pipe.
7. Turn ON the main nitrogen cylinder valve and continue to discharge nitrogen for 15 seconds.
8. If the nitrogen does not clear the blockage, replace the purge pipe.
9. Return the EVAP pressure/purge diagnostic station to the stations original condition.
10. Install a new EVAP canister. Refer to [Evaporative Emission Canister Replacement](#).
11. Lower the vehicle.
12. Install a new EVAP canister purge valve. Refer to [Evaporative Emission Canister Purge Solenoid Valve Replacement](#).
13. Return to the diagnostic table that sent you here.

IGNITION COIL REPLACEMENT - BANK 1

Removal Procedure

1. Remove the intake manifold. Refer to [Intake Manifold Replacement](#) .

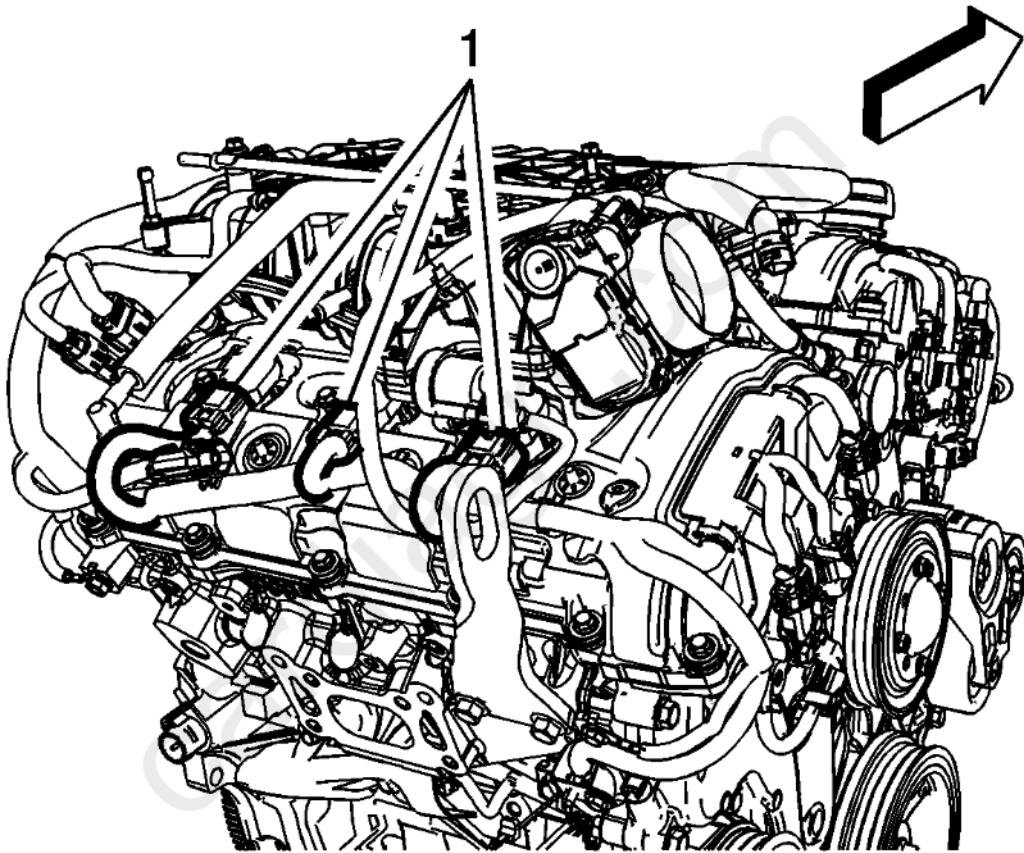


Fig. 126: Engine Wiring Harness Ignition Coil Electrical Connectors - Bank 1 (LFX)
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector(s) (1) from the ignition coil(s).

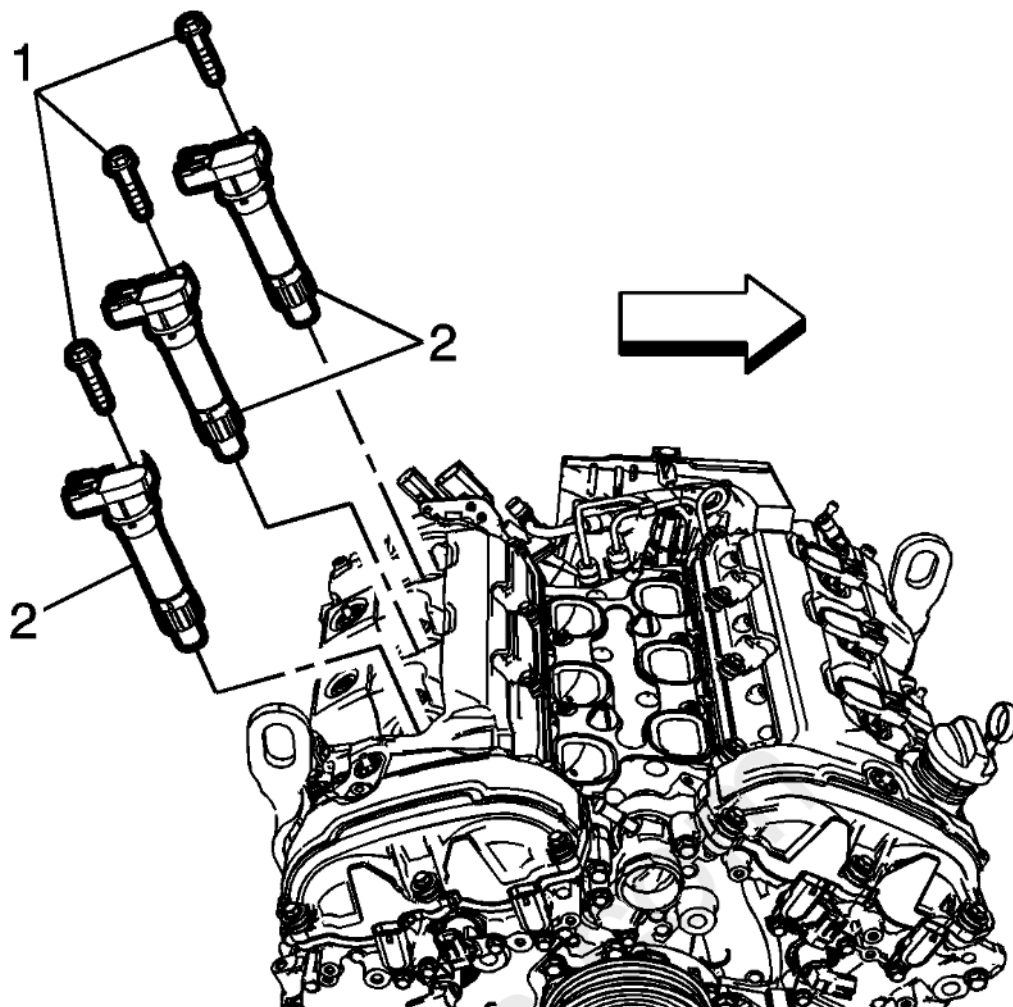


Fig. 127: Ignition Coil & Bolts - Bank 1

Courtesy of GENERAL MOTORS COMPANY

3. Remove the ignition coil bolt(s) (1).
4. Remove the ignition coil(s) (2).

Installation Procedure

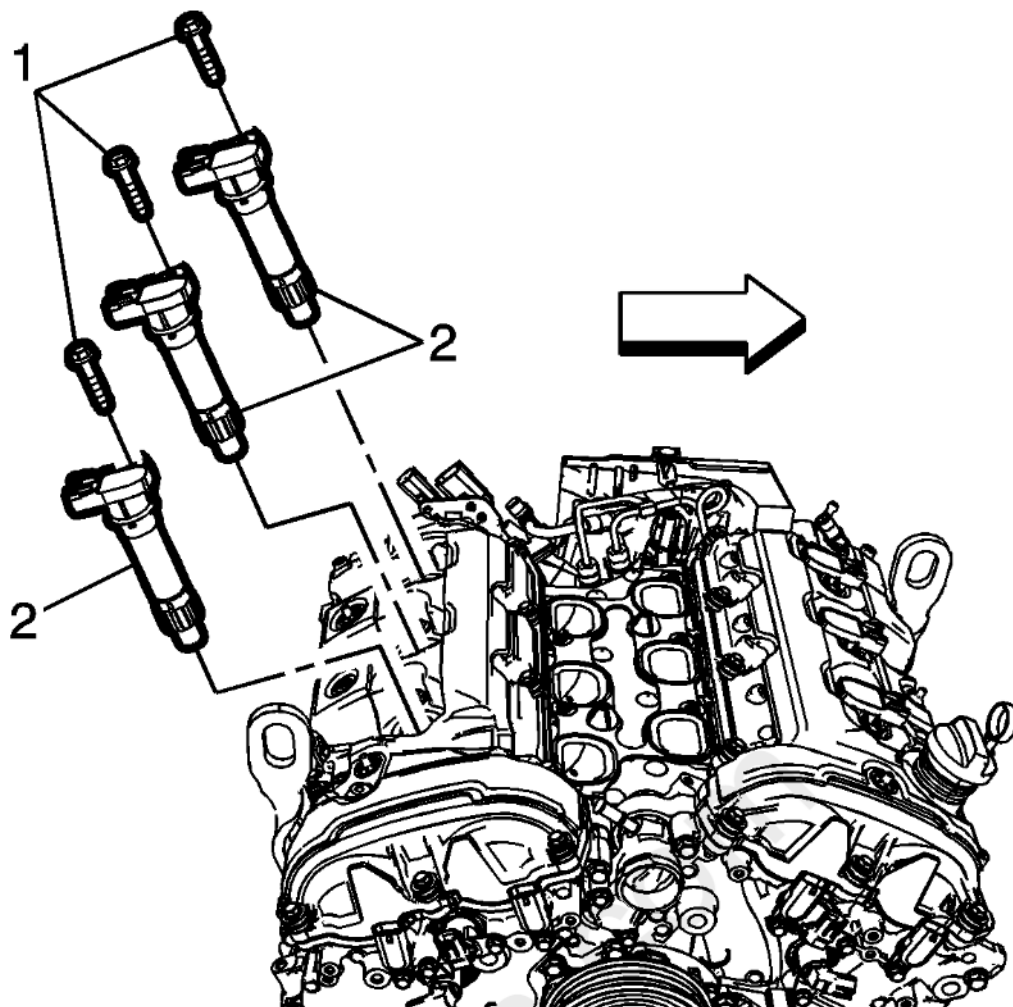


Fig. 128: Ignition Coil & Bolts - Bank 1

Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil(s) (2).

CAUTION: Refer to **Fastener Caution** .

2. Install the ignition coil bolt(s) (1).

Tighten

Tighten the bolt(s) to 10 N.m (89 lb in).

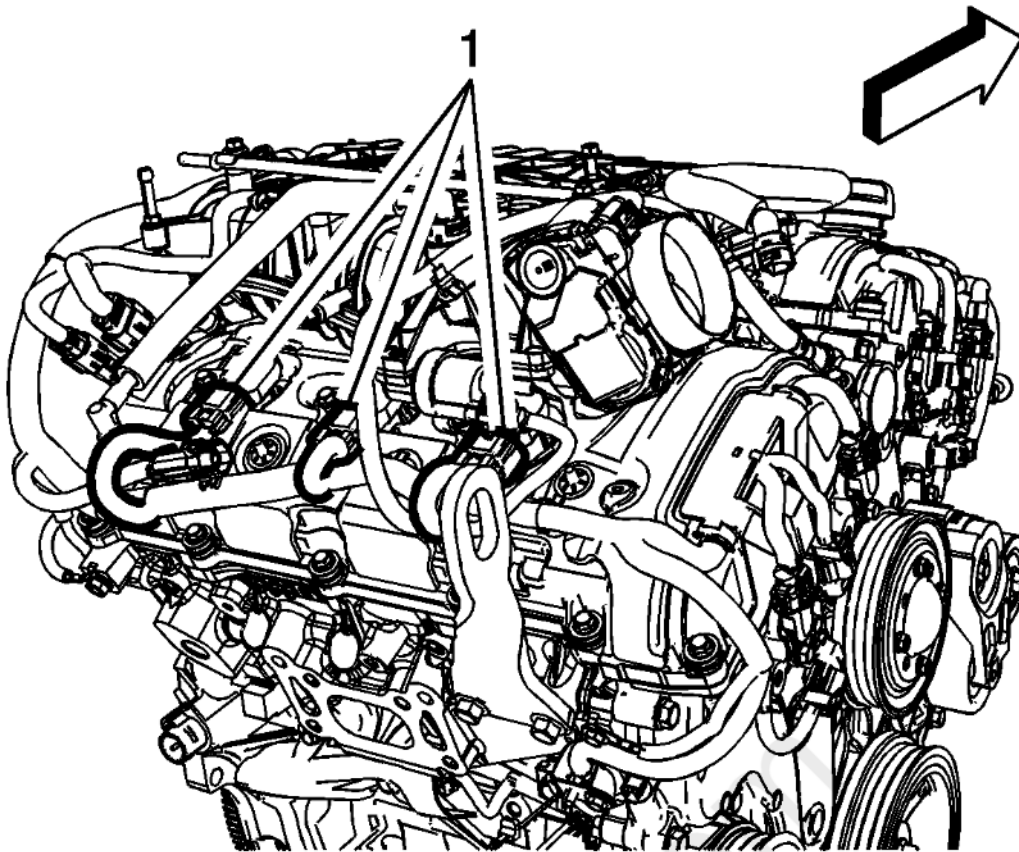


Fig. 129: Engine Wiring Harness Ignition Coil Electrical Connectors - Bank 1 (LFX)
Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine wiring harness electrical connector(s) (1) to the ignition coil(s).
4. Install the intake manifold. Refer to [Intake Manifold Replacement](#) .

IGNITION COIL REPLACEMENT - BANK 2

Removal Procedure

1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement \(LFX\)](#) .

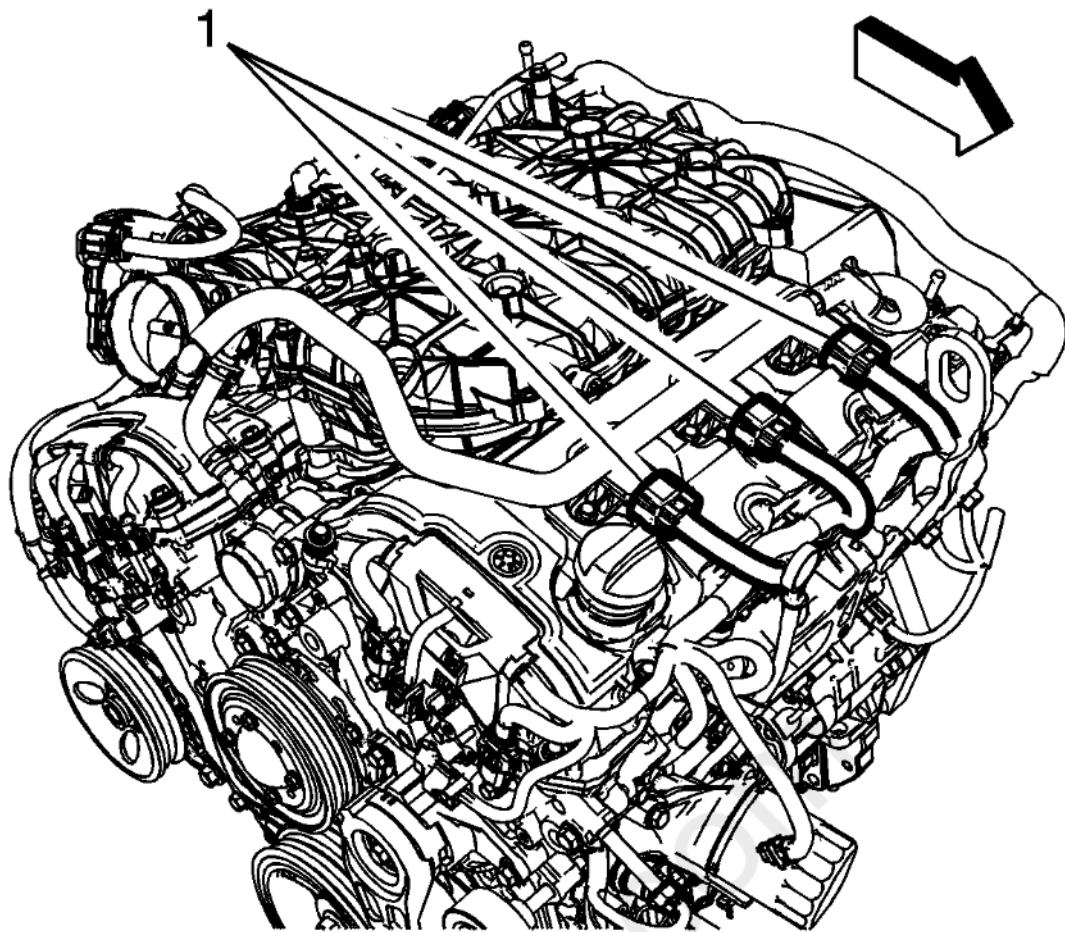


Fig. 130: Engine Wiring Harness Ignition Coil Electrical Connectors - Bank 2
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector(s) (1) from the ignition coil(s).

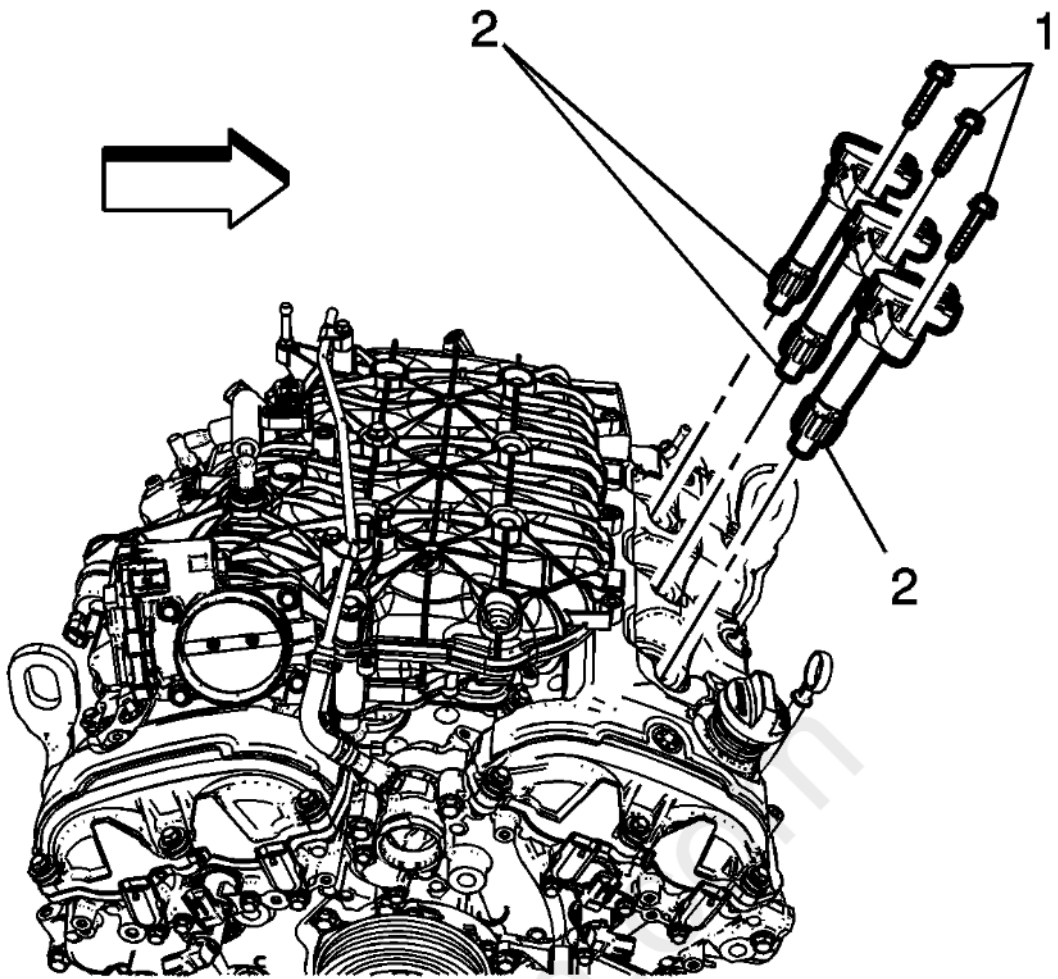


Fig. 131: Ignition Coil & Bolts - Bank 2

Courtesy of GENERAL MOTORS COMPANY

3. Remove the ignition coil bolt(s) (1).
4. Remove the ignition coil(s) (2).

Installation Procedure

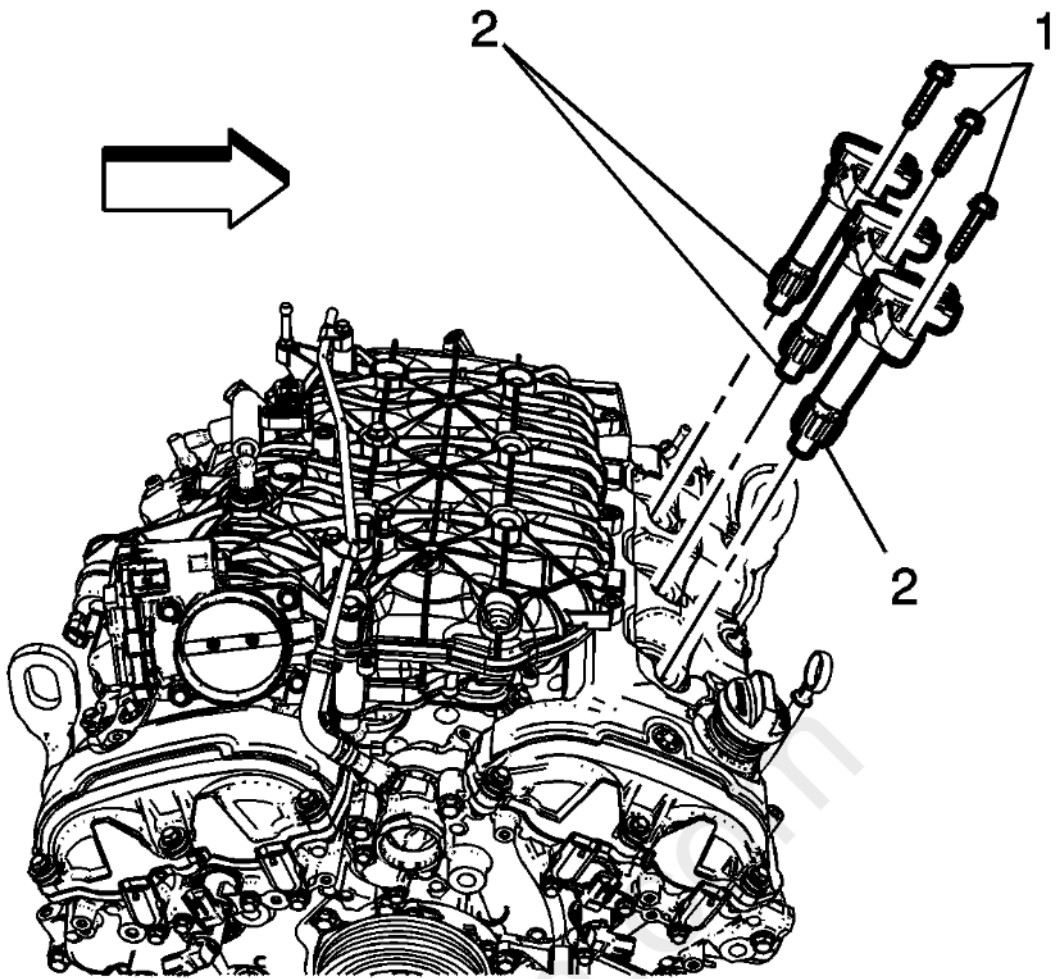


Fig. 132: Ignition Coil & Bolts - Bank 2

Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil(s) (2).

CAUTION: Refer to **Fastener Caution** .

2. Install the ignition coil bolt(s) (1).

Tighten

Tighten the bolt(s) to 10 N.m (89 lb in).

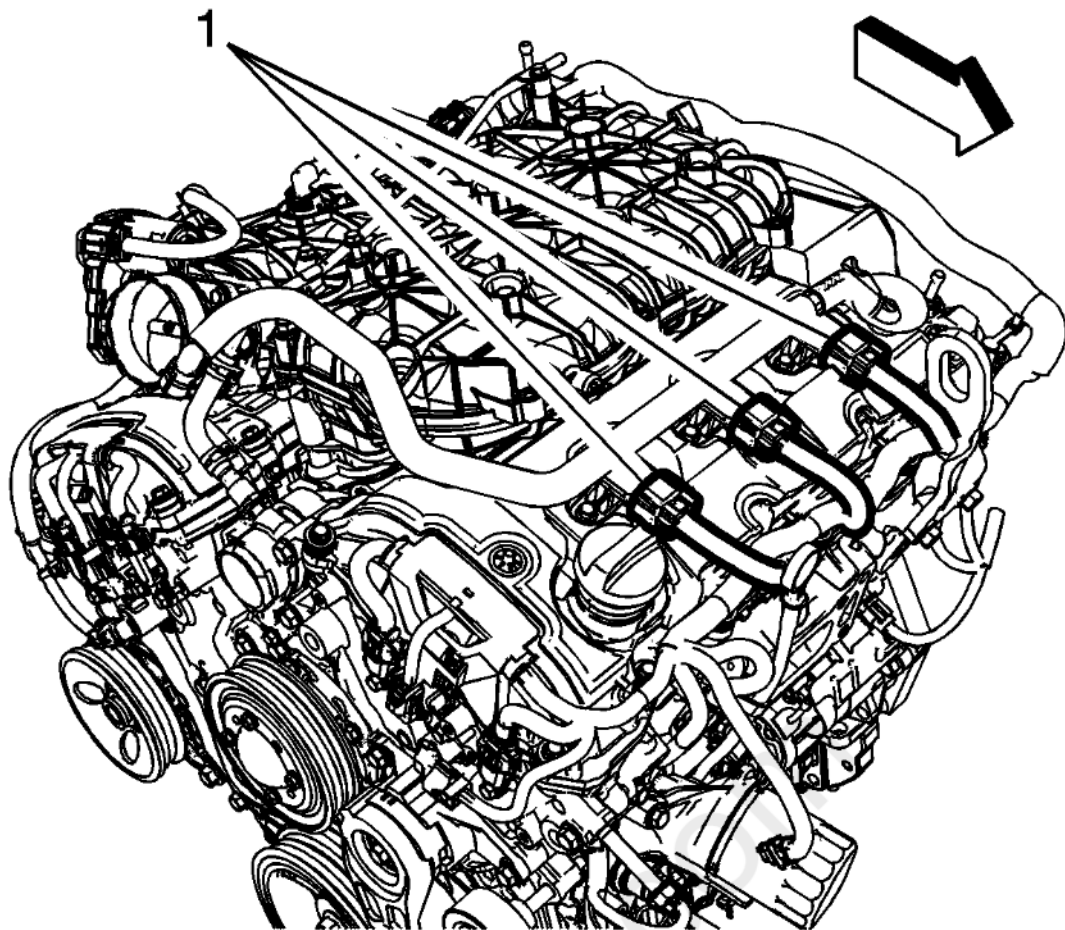


Fig. 133: Engine Wiring Harness Ignition Coil Electrical Connectors - Bank 2
Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine wiring harness electrical connector(s) (5) to the ignition coil(s) (4).
4. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement \(LFX\)](#) .

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

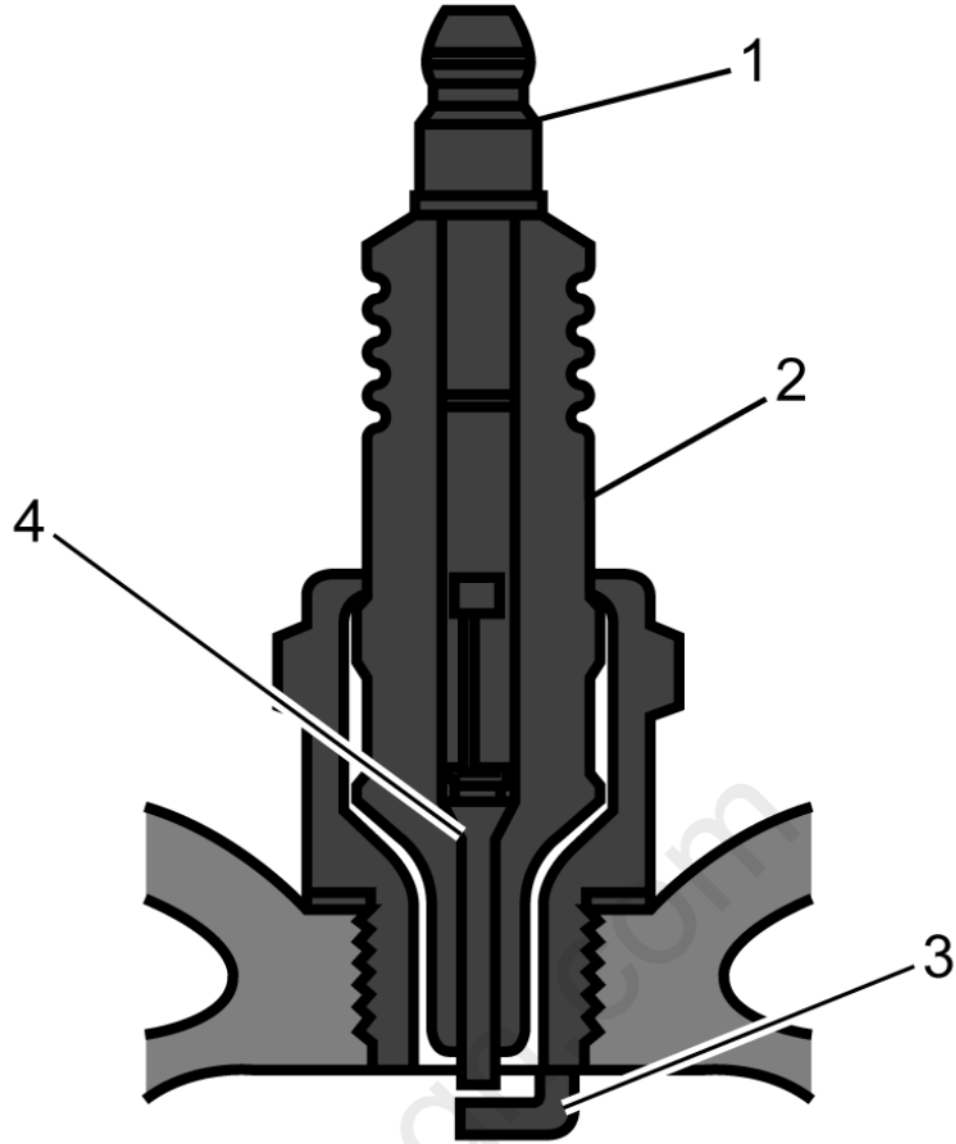


Fig. 134: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

- Inspect the terminal post (1) for damage.
 - Inspect for a bent or broken terminal post (1).
 - Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.
- Inspect the insulator (2) for flashover or carbon tracking, soot. This condition is often mistakenly identified as a cracked insulator. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
 - Inspect the spark plug boot for damage.
 - Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant, or water. A spark plug boot that is saturated causes arcing to ground.
- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).
- Inspect for evidence of improper arcing.
 - Measure the gap between the center electrode (4) and the side electrode (3) terminals. This must be done carefully in order to avoid damaging the small diameter Iridium center electrode. Refer to [Ignition System Specifications](#) . An excessively wide electrode gap can prevent correct spark plug operation.
 - Inspect for the correct spark plug torque. Refer to [Ignition System Specifications](#) . Insufficient torque can prevent correct spark plug operation. An over torqued spark plug, causes the insulator (2) to crack.
 - Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
 - Inspect for a broken or worn side electrode (3).

- Inspect for a broken, worn, or loose center electrode (4) by shaking the spark plug.
 - A rattling sound indicates internal damage.
 - A loose center electrode (4) reduces the spark intensity.
- Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
- Inspect for worn or missing platinum pads on the electrodes (3, 4) If equipped.
- Inspect for excessive fouling.
- Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

- Normal operation - Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives. Reddish orange deposits can indicate MMT fuel additive which is still used in some markets around the world (will cause misfire and cannot be burned off). MMT fuel additive use should be avoided.
- Carbon Fouled - Dry, fluffy black carbon, or soot caused by the following conditions:
 - Rich fuel mixtures
 - Leaking fuel injectors
 - Excessive fuel pressure
 - Restricted air filter element
 - Incorrect combustion
 - Reduced ignition system voltage output
 - Weak coils
 - Worn ignition wires
 - Incorrect spark plug gap
 - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
- Deposit Fouling - Oil, coolant, or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

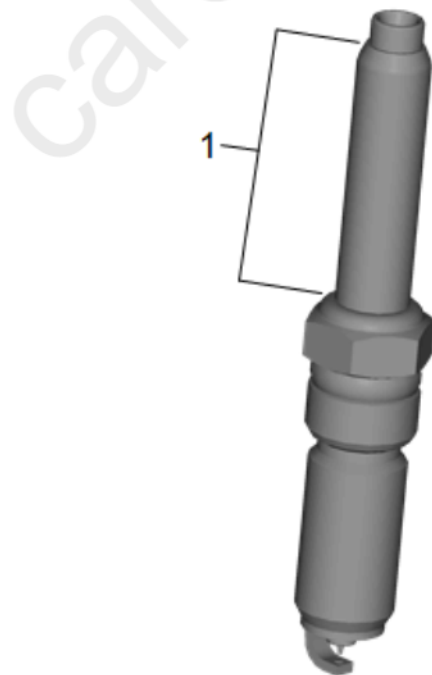


Fig. 135: Inspect For Carbon On Spark Plug Tower
 Courtesy of GENERAL MOTORS COMPANY

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.

SPARK PLUG REPLACEMENT

Removal Procedure

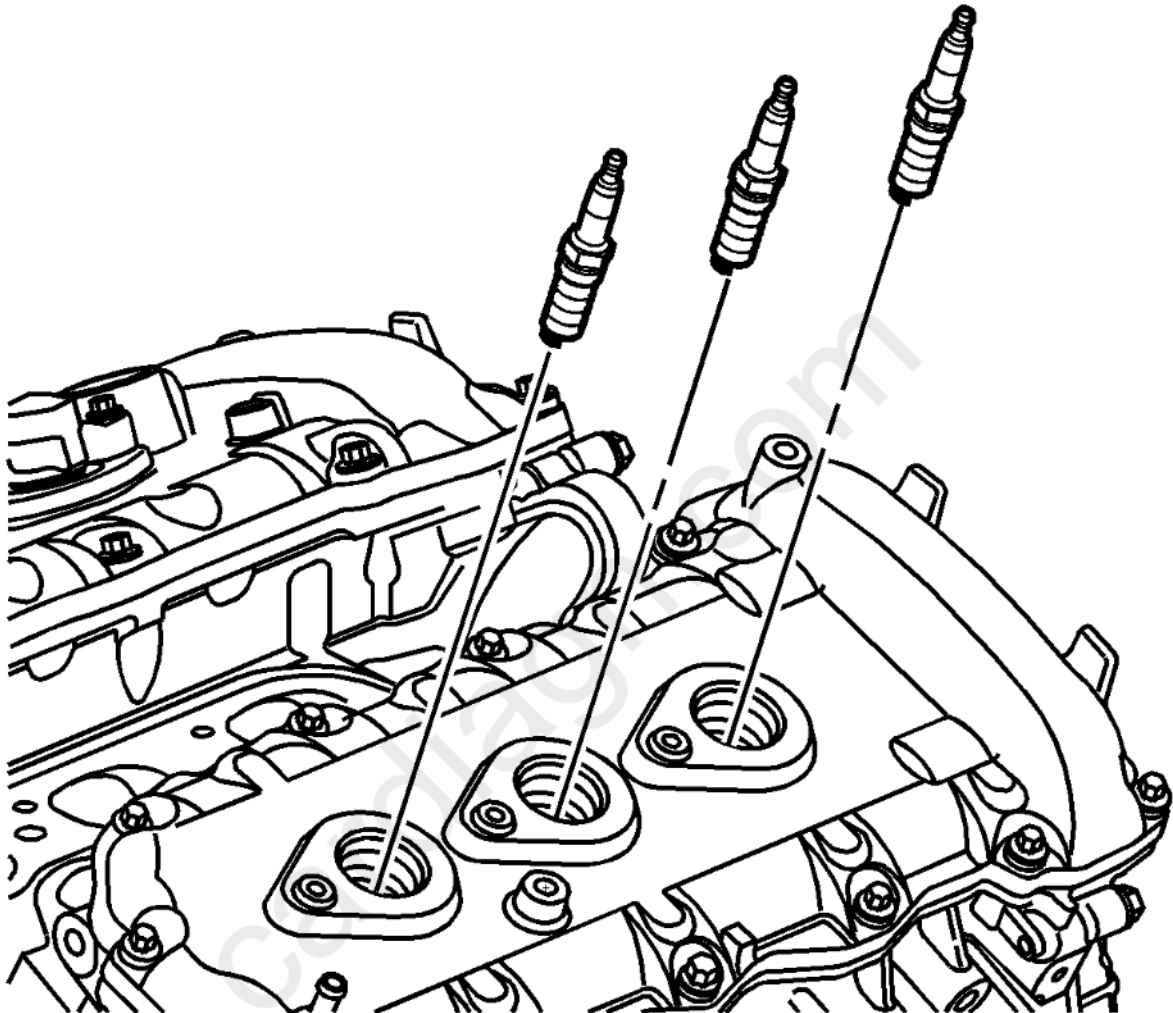


Fig. 136: View Of Spark Plugs

Courtesy of GENERAL MOTORS COMPANY

1. Remove the ignition coil(s). Refer to [Ignition Coil Replacement - Bank 1](#), and/or [Ignition Coil Replacement - Bank 2](#).

WARNING: Refer to [Safety Glasses and Compressed Air Warning](#) .

CAUTION: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.

2. Use compressed air in order to remove debris from the spark plug cavity.

CAUTION: Allow the engine to cool before removing the spark plugs. Attempting to remove the spark plugs from a hot engine may cause

the plug threads to seize, causing damage to cylinder head threads.

3. Remove the spark plug.

Installation Procedure

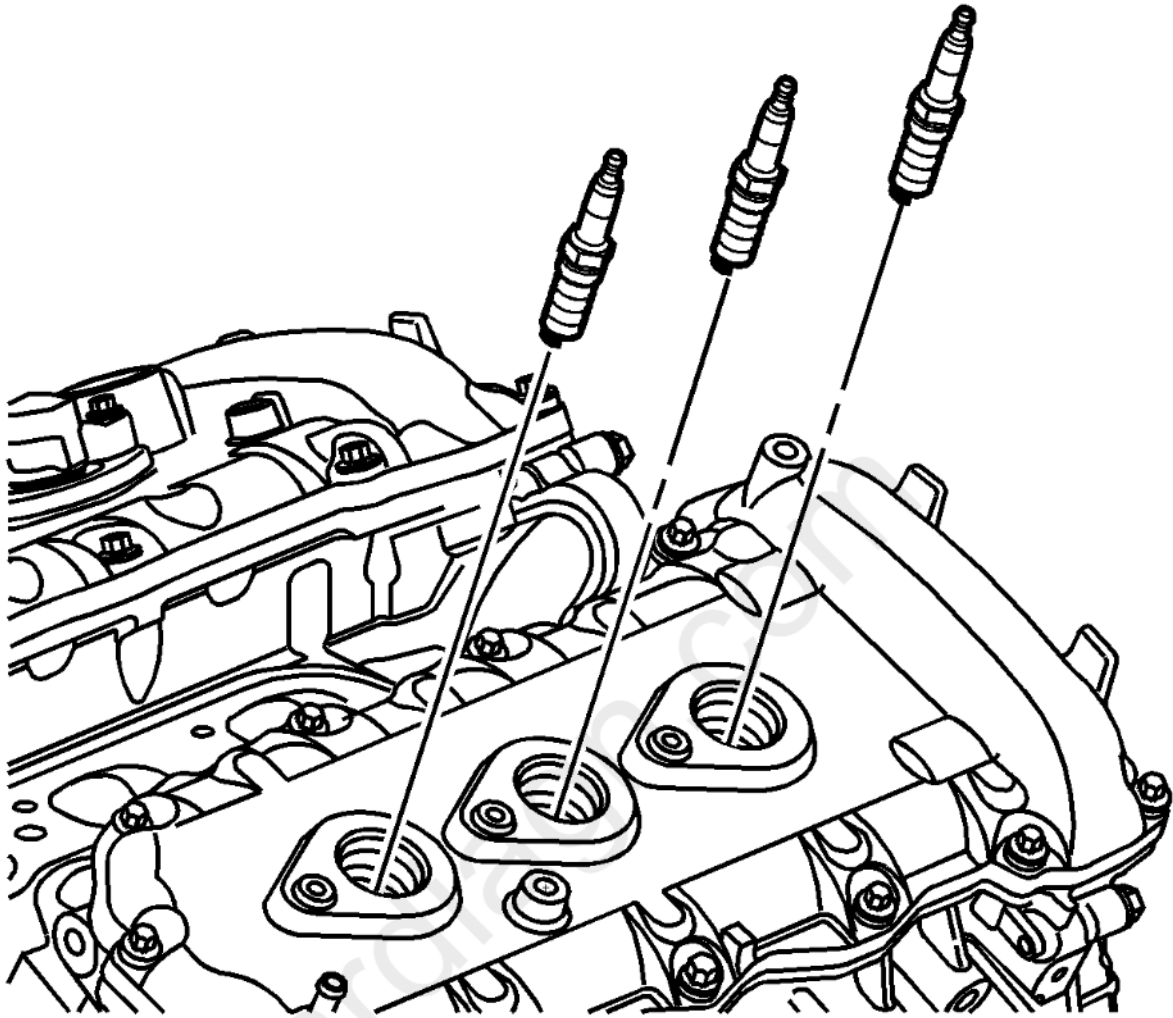


Fig. 137: View Of Spark Plugs

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use only the spark plugs specified for use in the vehicle. Do not install spark plugs that are either hotter or colder than those specified for the vehicle. Installing spark plugs of another type can severely damage the engine.

CAUTION: Check the gap of all new and reconditioned spark plugs before installation. The pre-set gaps may have changed during handling. Use a round feeler gauge to ensure an accurate check. Installing the spark plugs with the wrong gap can cause poor engine performance and may even damage the engine.

1. Ensure that the spark plug gap is equivalent to the spark plug gap specification. Refer to [Ignition System Specifications](#) .

CAUTION: Be sure that the spark plug threads smoothly into the cylinder head and the spark plug is fully seated. Use a thread chaser, if necessary, to clean threads in the cylinder head. Cross-threading or failing to fully seat the spark plug can cause overheating of the plug, exhaust blow-by, or thread damage.

CAUTION: Refer to [Fastener Caution](#) .

2. Install the spark plug and tighten to 18 N.m (13 lb ft)..

3. Install the ignition coil(s). Refer to [Ignition Coil Replacement - Bank 1](#), and/or [Ignition Coil Replacement - Bank 2](#).

CRANKSHAFT POSITION SENSOR REPLACEMENT

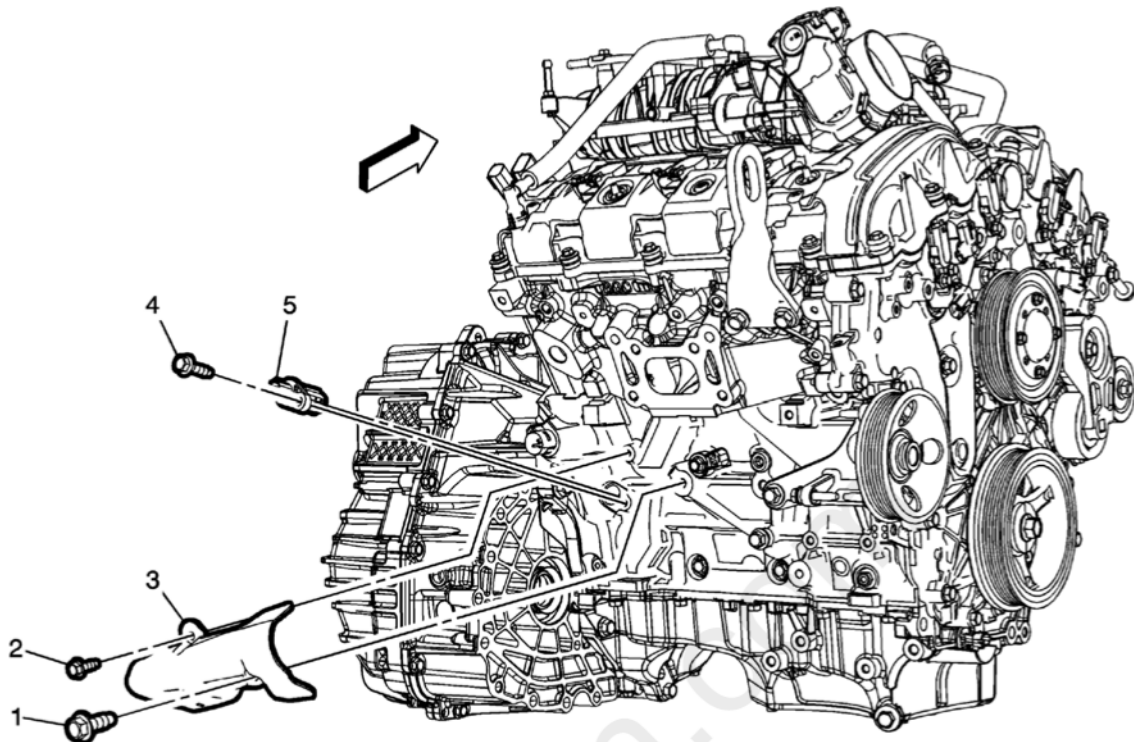


Fig. 138: Crankshaft Position Sensor (FWD)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Transmission Brace Replacement	
1	Knock Sensor Heat Shield Bolt CAUTION: Refer to Fastener Caution . Tighten 58 N.m (43 lb ft)
2	Knock Sensor Heat Shield Bolt Tighten 9 N.m (80 lb in)
3	Knock Sensor Heat Shield
4	Crankshaft Position Sensor Fastener Tighten 10 N.m (89 lb in)
5	Crankshaft Position Sensor Procedure 1. Disconnect the electrical connector. 2. Perform the crankshaft position system variation learn. Refer to Crankshaft Position Variation Learn .

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

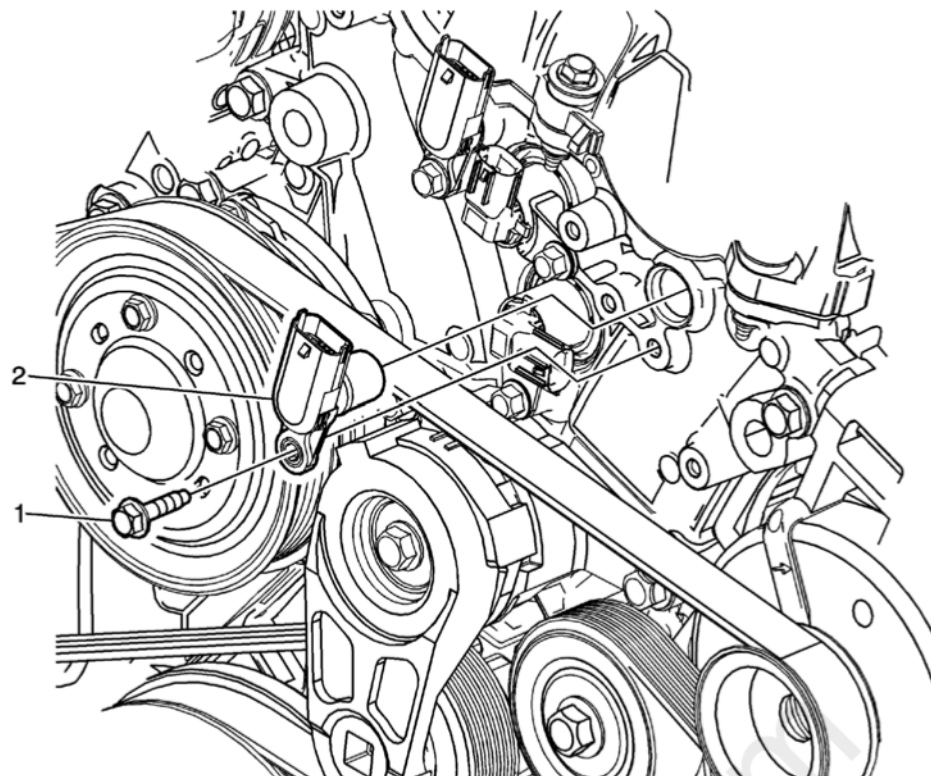


Fig. 139: Identifying Camshaft Position Sensor - Bank 2 (Left Side) Exhaust
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure Disconnect the electrical connector.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

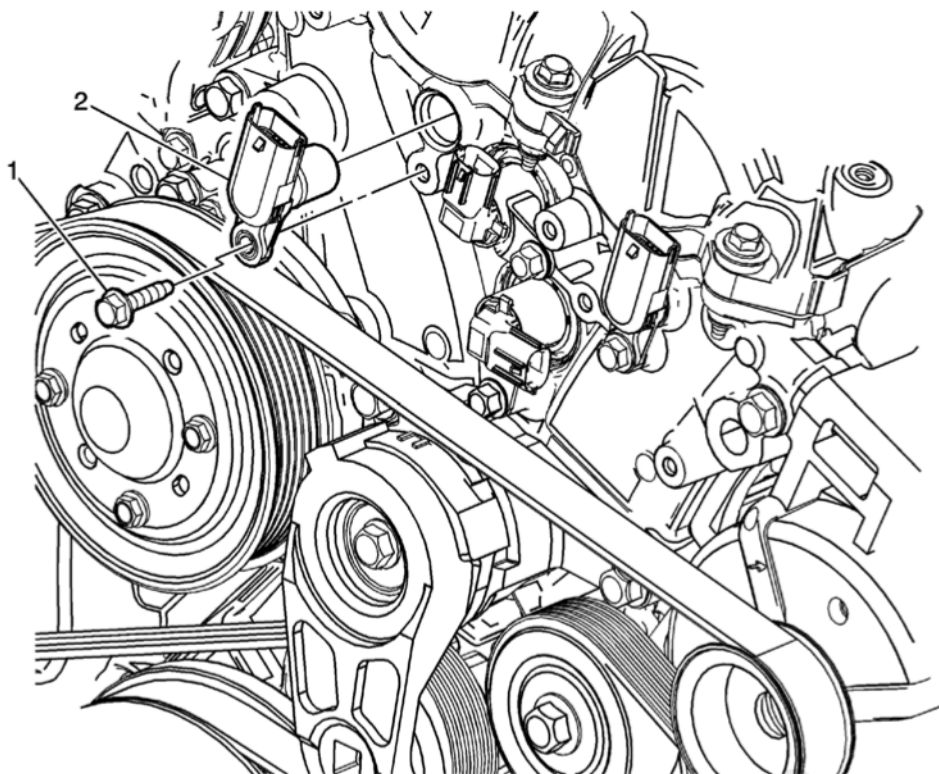


Fig. 140: Identifying Camshaft Position Sensor - Bank 2 (Left Side) Intake
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure Disconnect the electrical connector.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

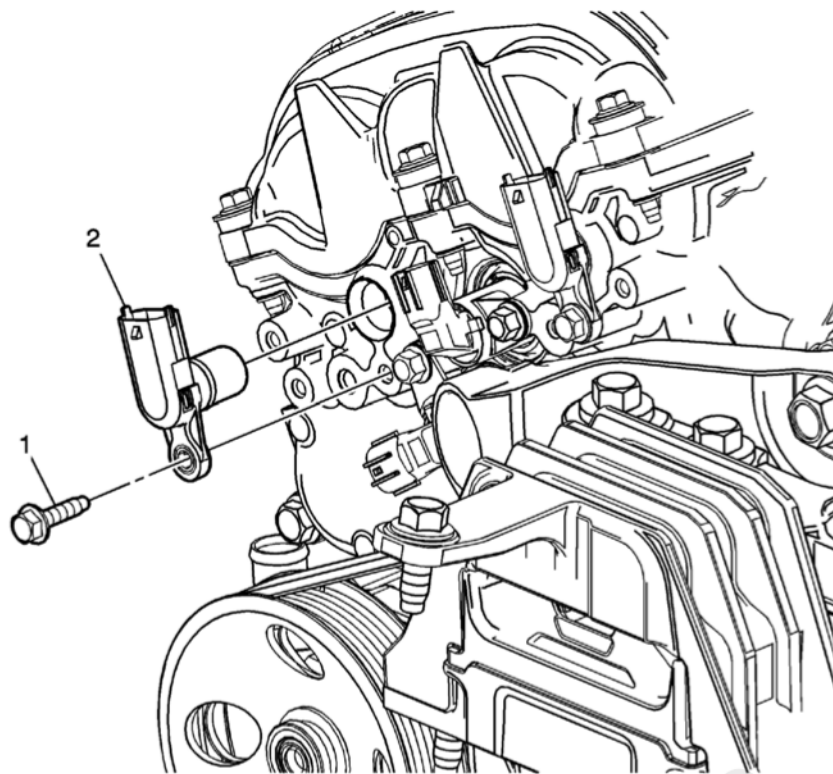


Fig. 141: Identifying Camshaft Position Sensor - Bank 1 (Right Side) Exhaust
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure <u>Air Cleaner Assembly Replacement</u>	
1	Camshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure Disconnect the electrical connector.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

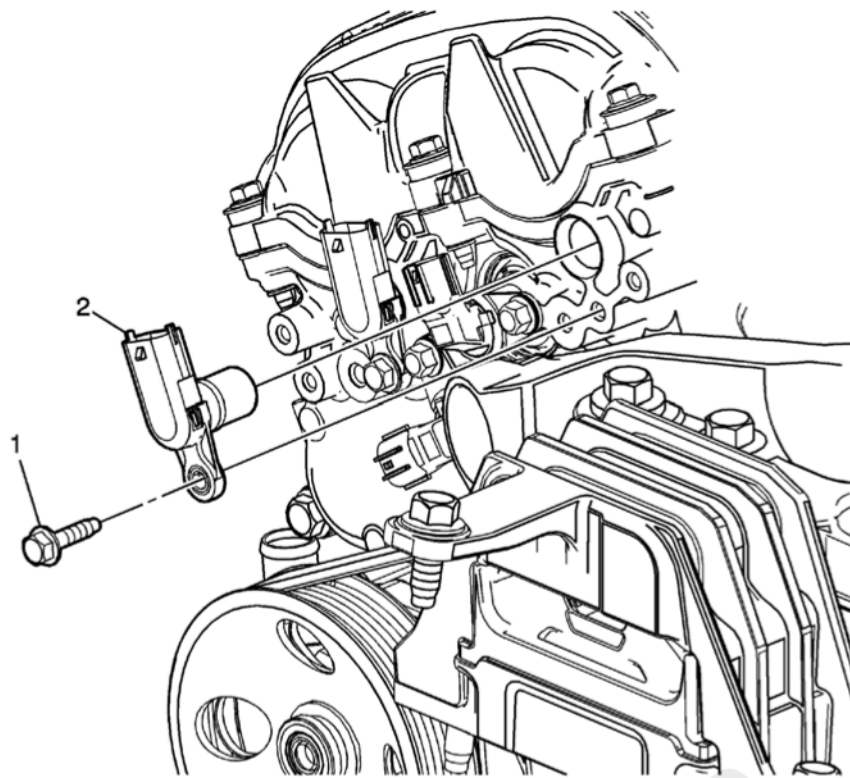


Fig. 142: Identifying Camshaft Position Sensor - Bank 1 (Right Side) Intake
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure <u>Air Cleaner Assembly Replacement</u>	
1	Camshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure Disconnect the electrical connector.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

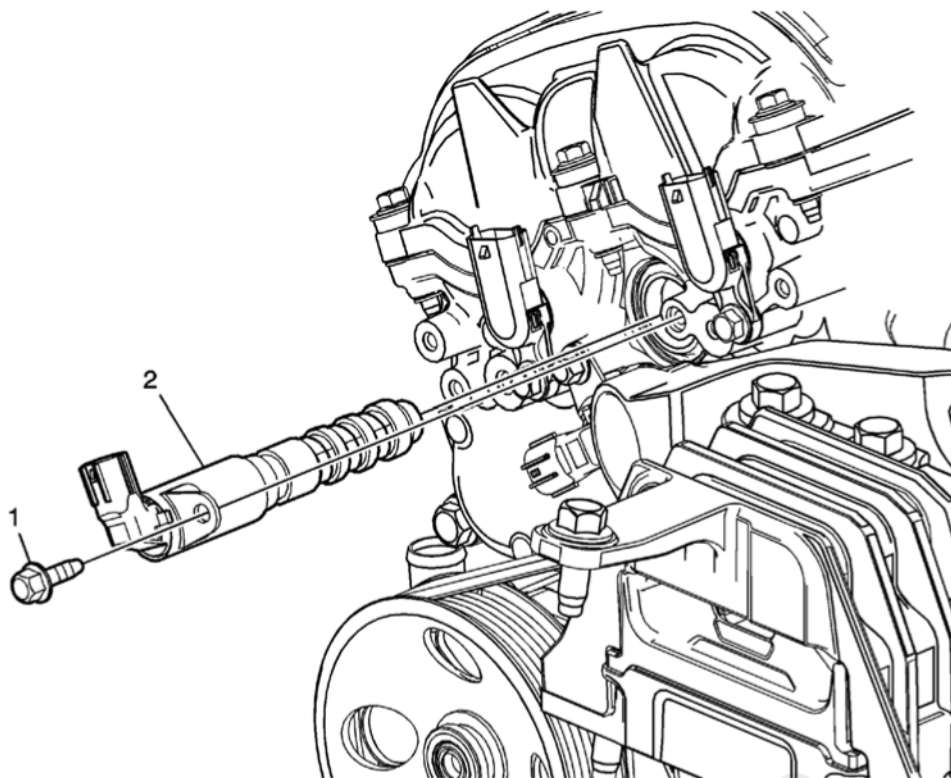


Fig. 143: Locating Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Intake

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure <u>Air Cleaner Assembly Replacement</u>	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve Procedure Disconnect the electrical connector.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

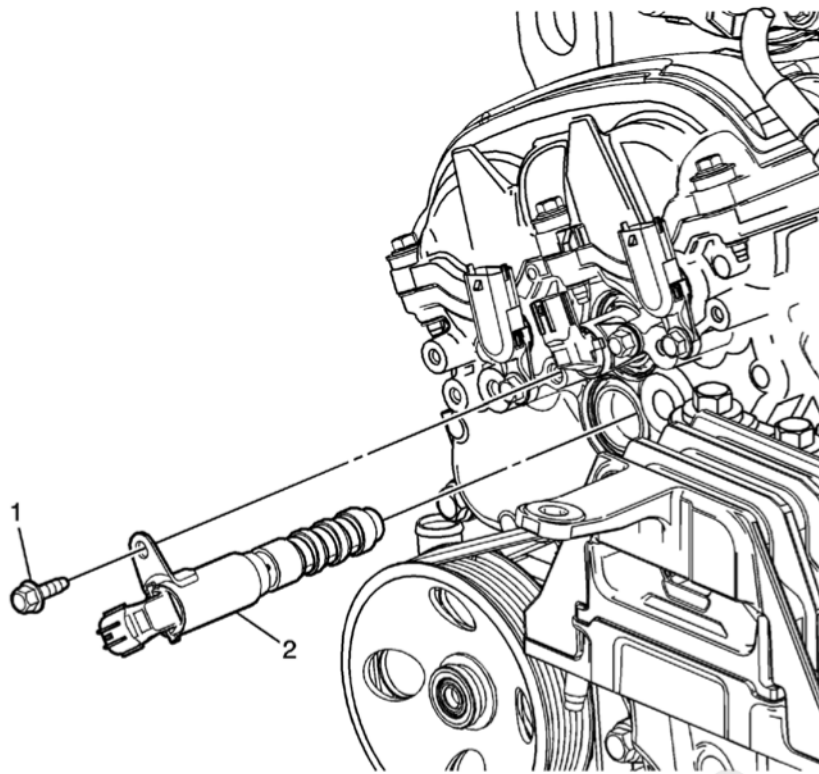


Fig. 144: Locating Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Exhaust

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure <u>Air Cleaner Assembly Replacement</u>	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve Procedure Disconnect the electrical connector.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

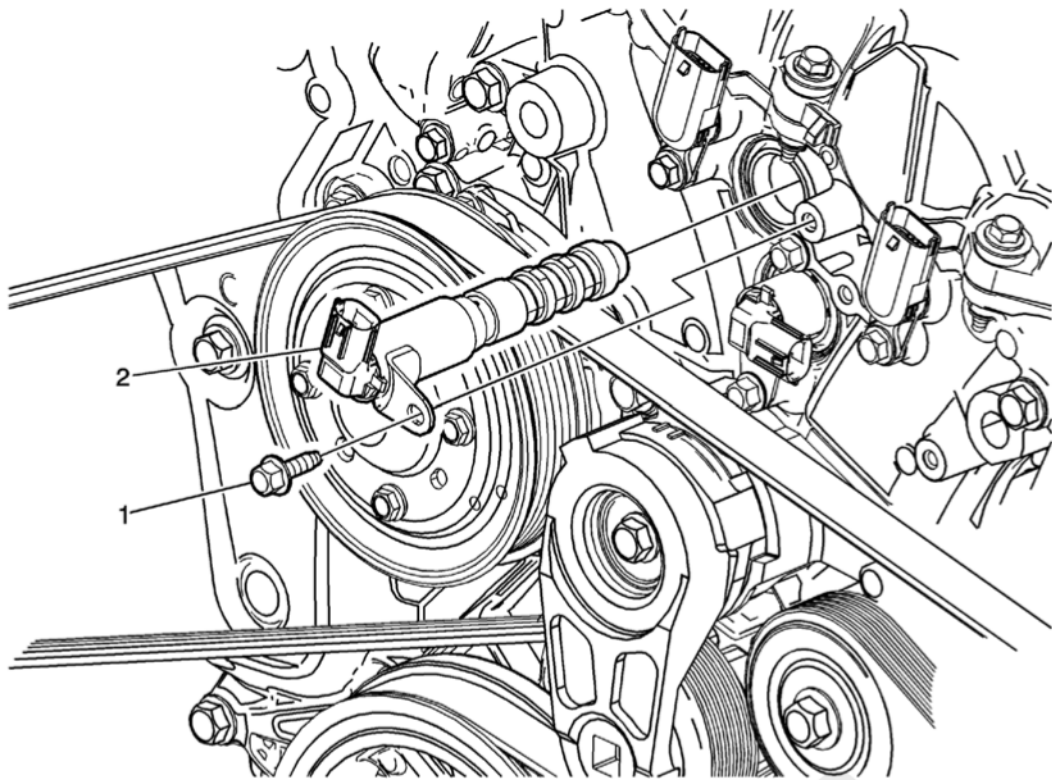


Fig. 145: Identifying Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Intake

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure <u>Engine Mount Bracket Replacement - Right Side</u>	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve Procedure Disconnect the electrical connector.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

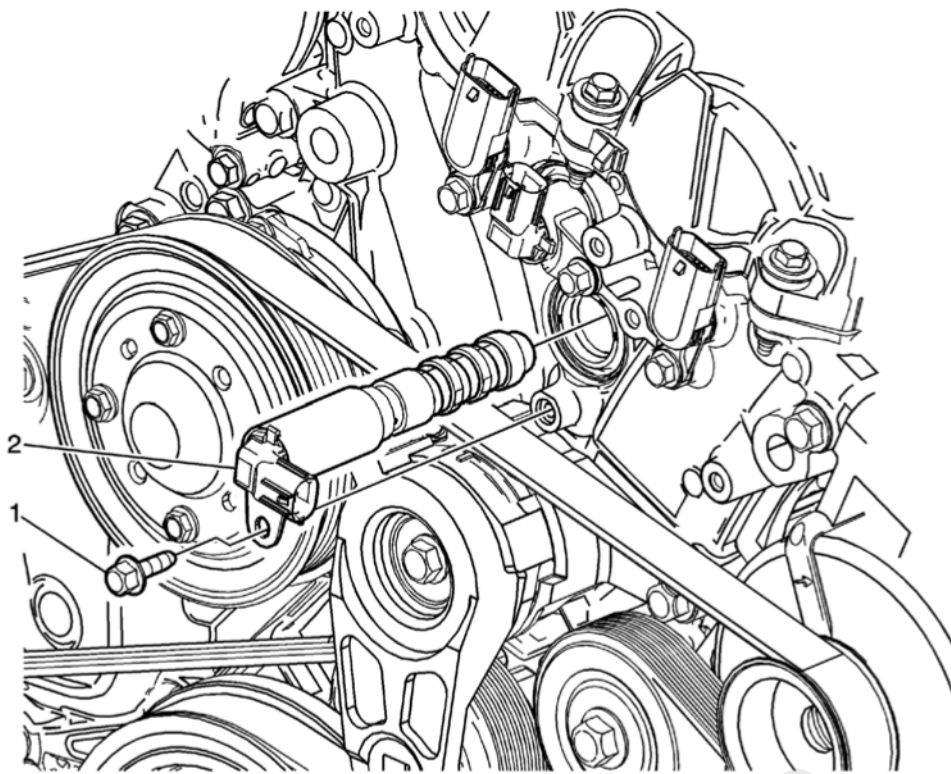


Fig. 146: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Exhaust
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure <u>Engine Mount Bracket Replacement - Right Side</u>	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve Procedure Disconnect the electrical connector.

KNOCK SENSOR REPLACEMENT - BANK 1

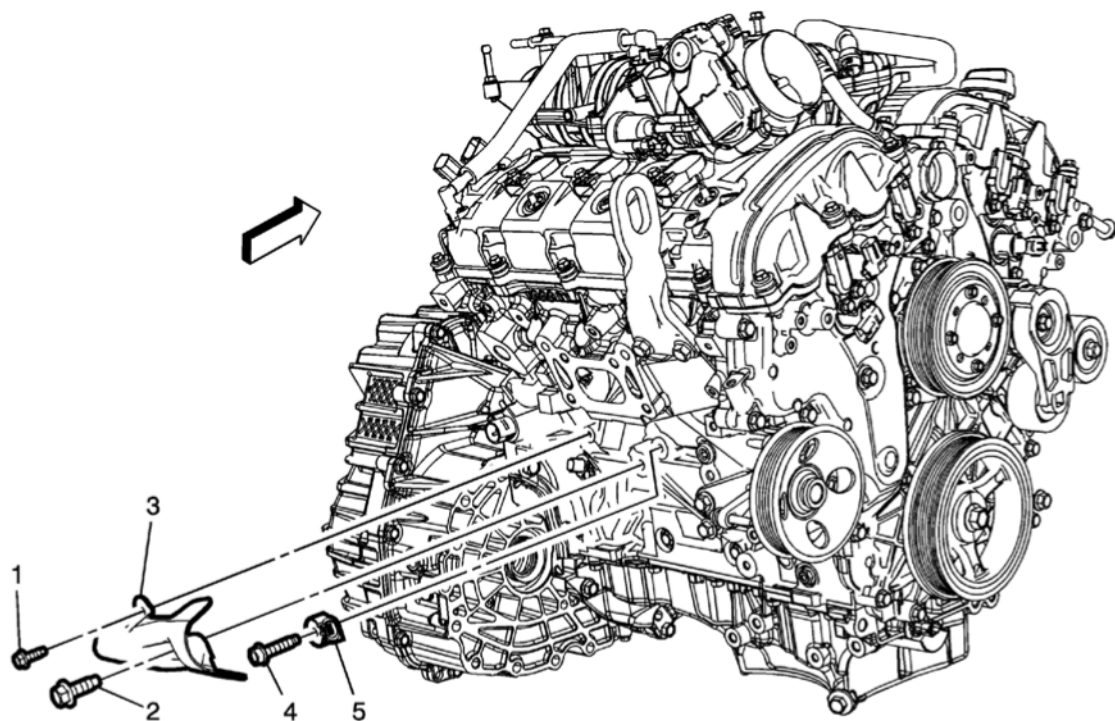


Fig. 147: Knock Sensor & Mounting Components - Bank 1 (FWD)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Lifting and Jacking the Vehicle 2. Transmission Brace Replacement	
1	Knock Sensor Heat Shield Bolt CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Knock Sensor Heat Shield Bolt Tighten 58 N.m (43 lb ft)
3	Knock Sensor Heat Shield
4	Knock Sensor Fastener Tighten 25 N.m (18 lb ft)
5	Knock Sensor Procedure Disconnect the electrical connector.

KNOCK SENSOR REPLACEMENT - BANK 2

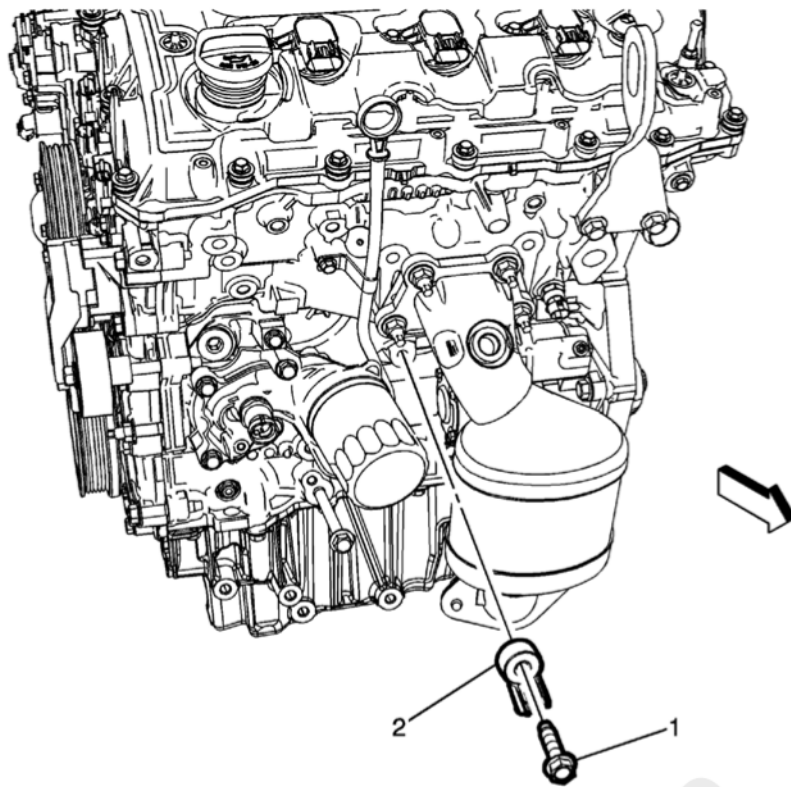


Fig. 148: Knock Sensor Replacement - Bank 2 (LFX, FWD)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection . 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 3. Remove the front compartment splash shield. Refer to Front Compartment Splash Shield Replacement .	
1	Knock Sensor Bolt CAUTION: Refer to Fastener Caution . Tighten 25 N.m (18 lb ft)
2	Knock Sensor Procedure Disconnect the electrical connector.

SECONDARY AIR INJECTION PIPE REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement \(LFX\)](#) .

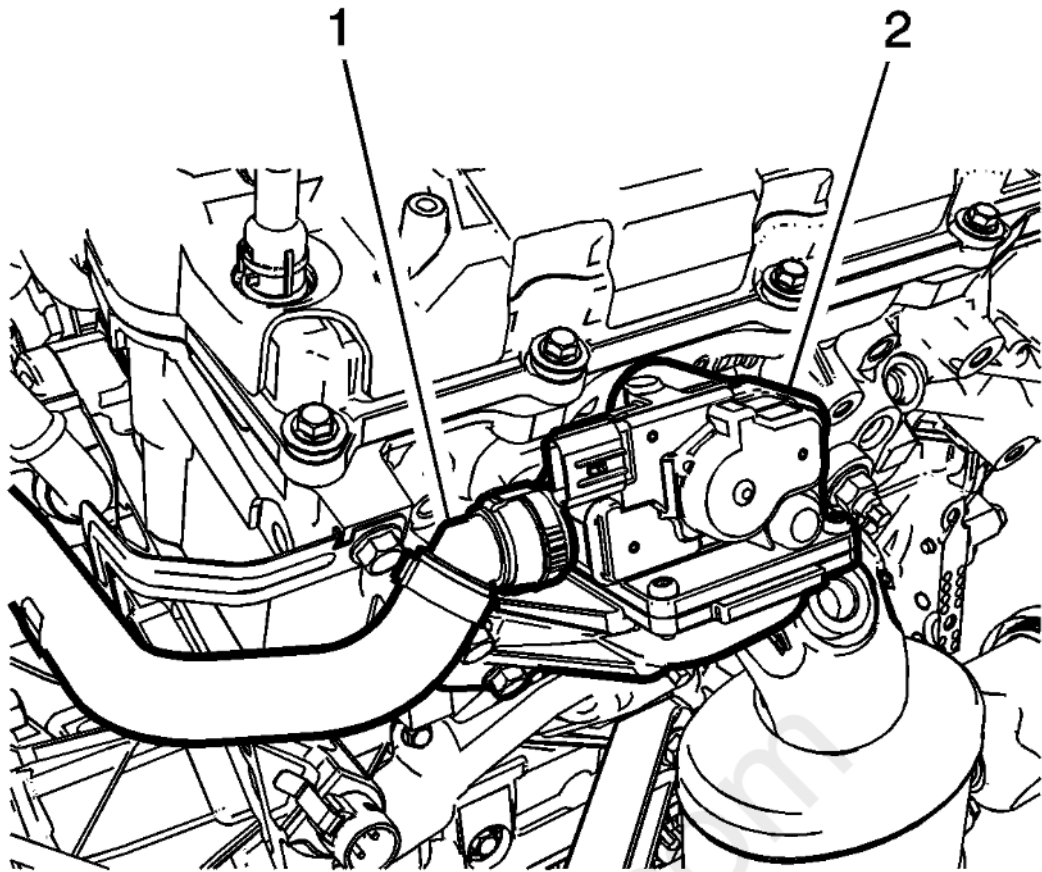


Fig. 149: Secondary Air Injection Pipe & Right Side Bypass Valve

Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the secondary air injection pipe (1) from the right side secondary air injection bypass valve (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

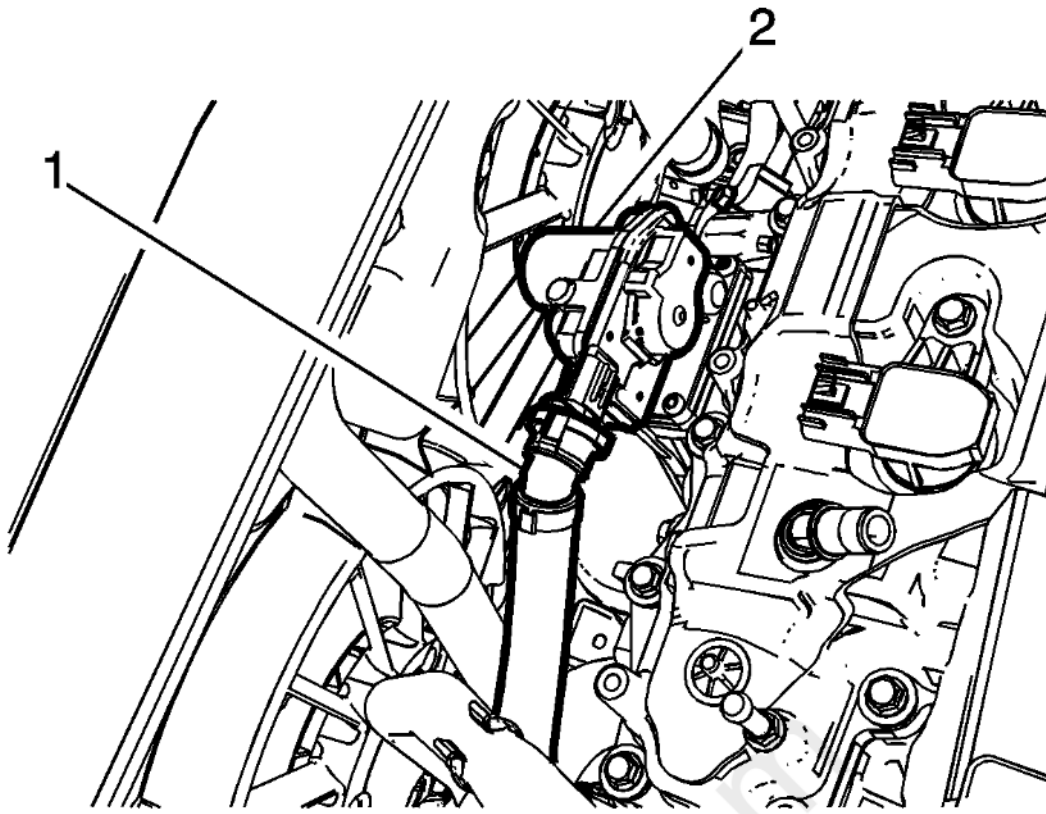


Fig. 150: Secondary Air Injection Pipe & Left Side Bypass Valve

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the secondary air injection pipe (1) from the left side secondary air injection bypass valve (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

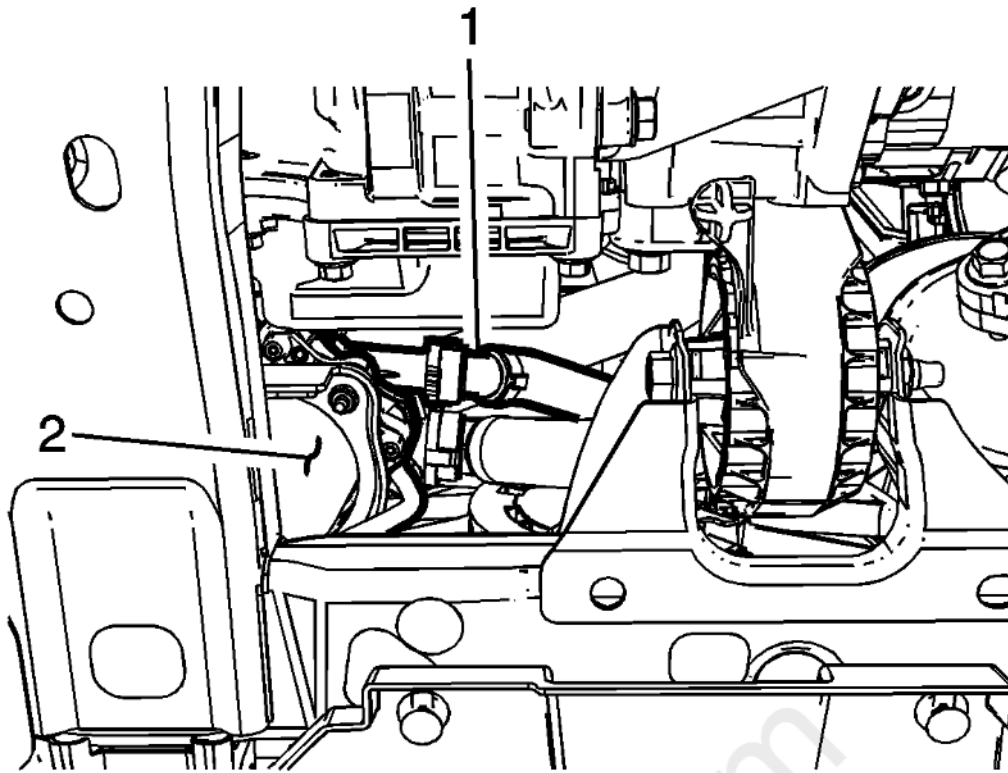


Fig. 151: Secondary Air Injection Pipe & Pump

Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the secondary air injection pipe (1) from the secondary air injection pump (2). Refer to [Plastic Collar Quick Connect Fitting Service](#) .

Installation Procedure

1. Reposition the secondary air injection pipe to the vehicle.

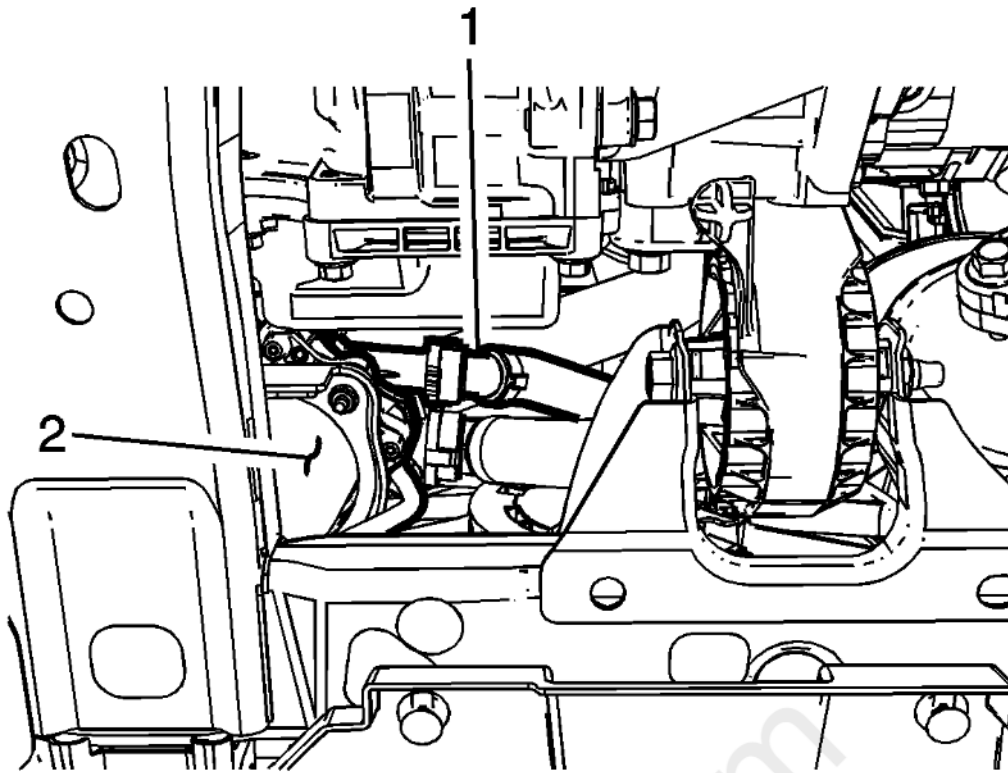


Fig. 152: Secondary Air Injection Pipe & Pump
Courtesy of GENERAL MOTORS COMPANY

2. Connect the secondary air injection pipe (1) to the secondary air injection pump (2). Refer to [Plastic Collar Quick Connect Fitting Service](#) .

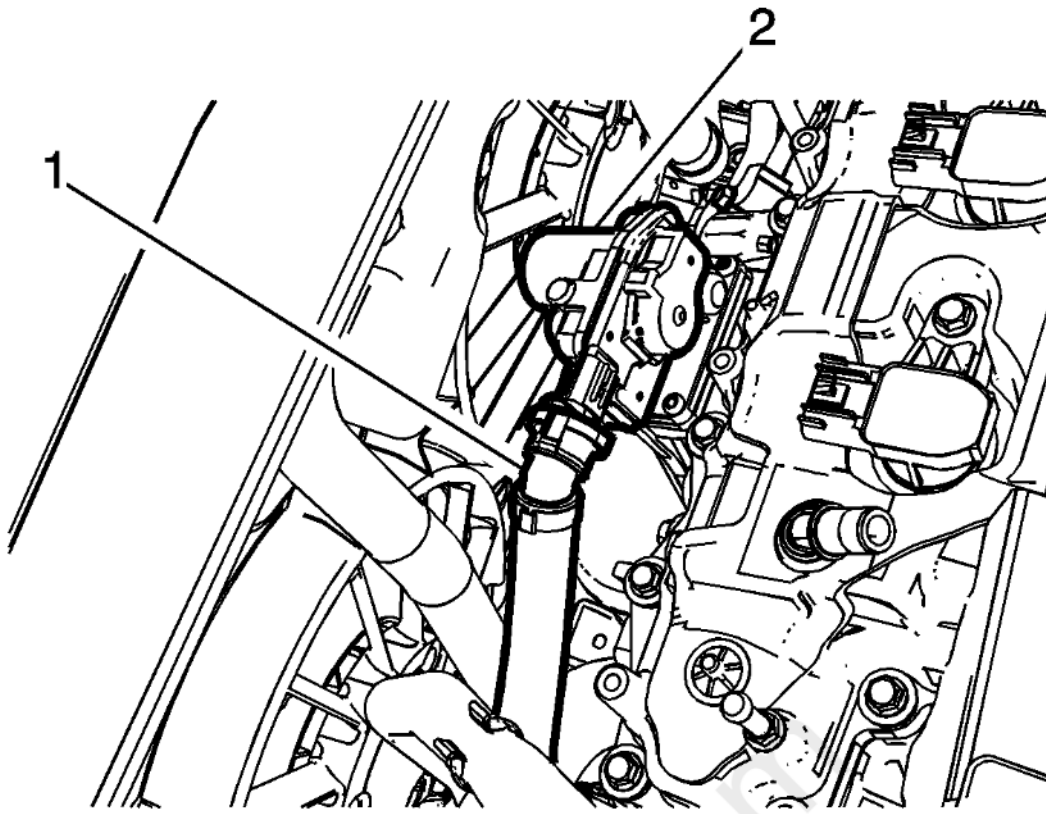


Fig. 153: Secondary Air Injection Pipe & Left Side Bypass Valve

Courtesy of GENERAL MOTORS COMPANY

3. Connect the secondary air injection pipe (1) to the left side secondary air injection bypass valve (2). Refer to [**Plastic Collar Quick Connect Fitting Service**](#) .

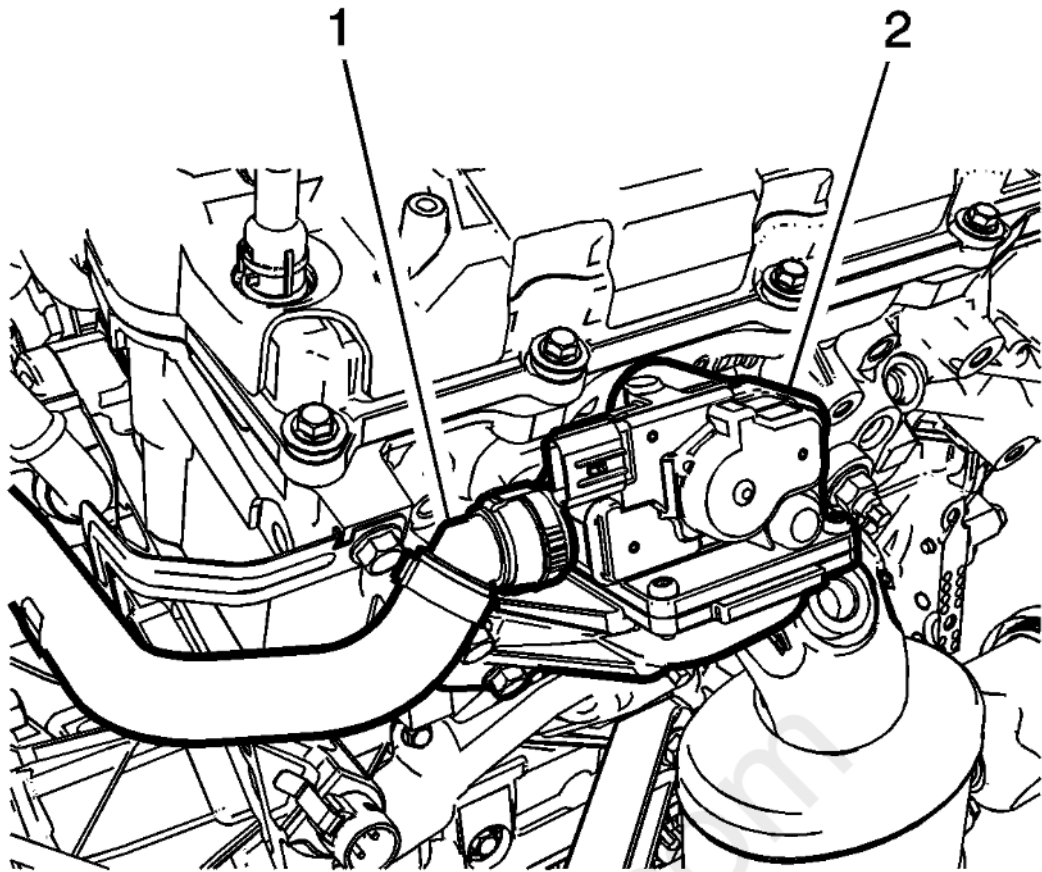


Fig. 154: Secondary Air Injection Pipe & Right Side Bypass Valve

Courtesy of GENERAL MOTORS COMPANY

4. Connect the secondary air injection pipe (1) to the right side secondary air injection bypass valve (2). Refer to [**Plastic Collar Quick Connect Fitting Service**](#) .
5. Install the intake manifold cover. Refer to [**Intake Manifold Cover Replacement \(LFX\)**](#) .

SECONDARY AIR INJECTION BYPASS VALVE REPLACEMENT - BANK 2

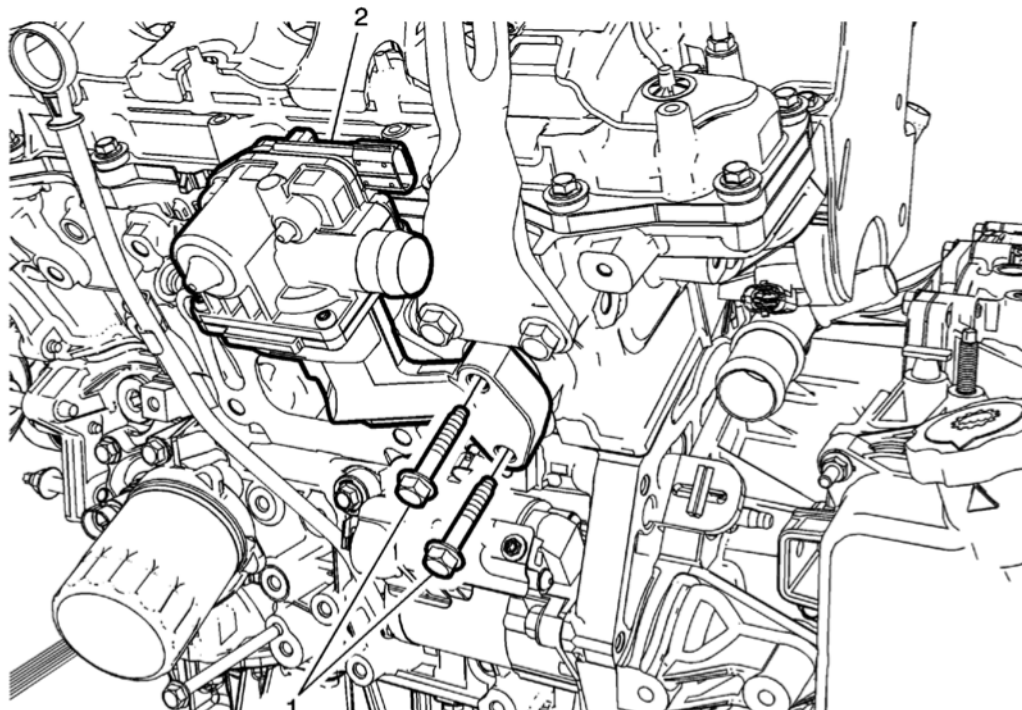


Fig. 155: Secondary Air Injection Bypass Valve - Bank 2

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement . 2. Disconnect the secondary air injection pipe from the secondary air injection bypass valve. Refer to Secondary Air Injection Pipe Replacement.	
1	Secondary Air Injection Check Valve Fasteners (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 22 N.m (16 lb ft).
2	Secondary Air Injection Bypass Valve Procedure Disconnect the electrical wiring harness connector from the secondary air injection check valve.

SECONDARY AIR INJECTION BYPASS VALVE REPLACEMENT - BANK 1

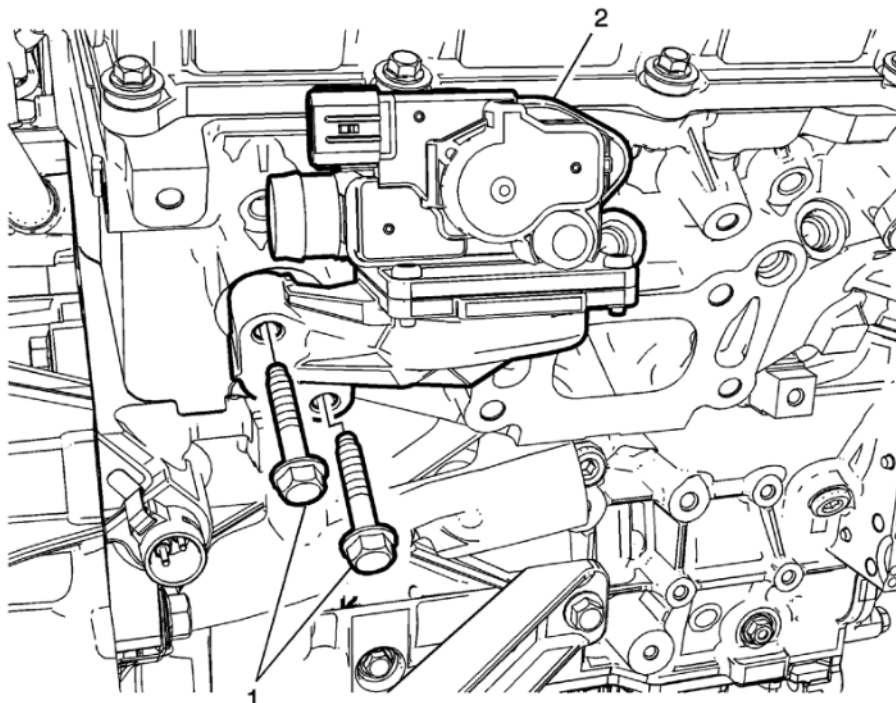


Fig. 156: Secondary Air Injection Bypass Valve - Bank 1

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement . 2. Disconnect the secondary air injection pipe from the secondary air injection bypass valve. Refer to Plastic Collar Quick Connect Fitting Service.	
1	Secondary Air Injection Bypass Valve Fasteners (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 22 N.m (16 lb ft).
2	Secondary Air Injection Bypass Valve Procedure Disconnect the electrical wiring harness connector from the secondary air injection check valve.

SECONDARY AIR INJECTION PUMP REPLACEMENT

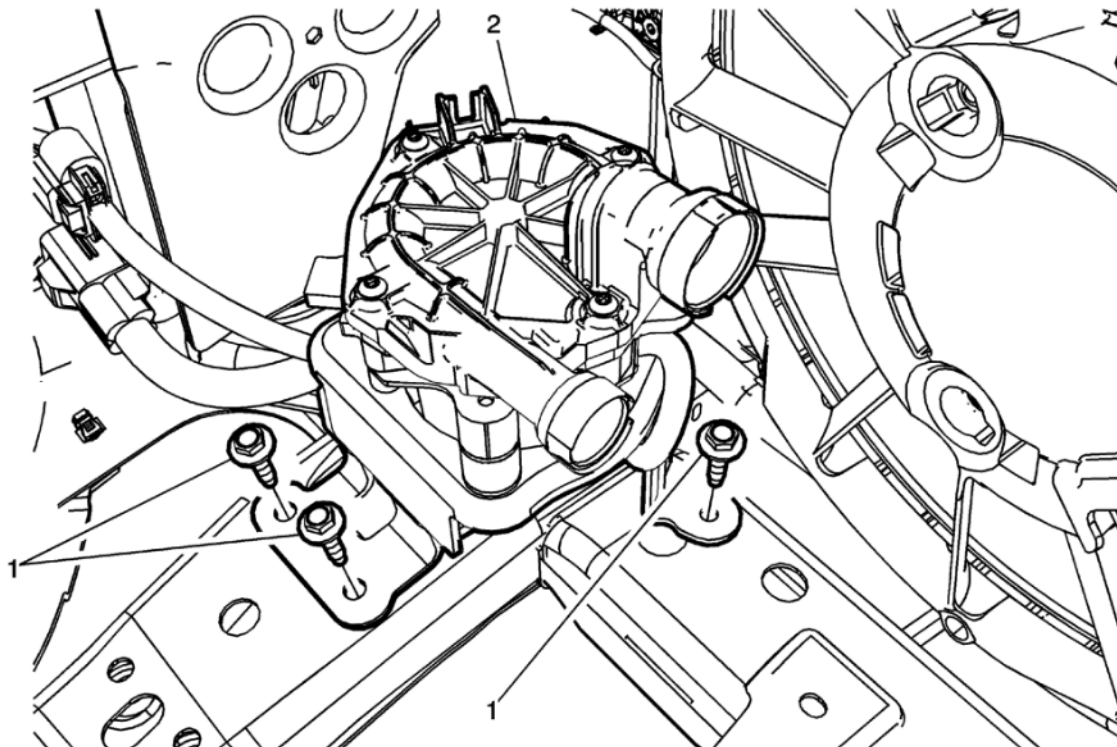


Fig. 157: Secondary Air Injection Pump
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX) . 2. Raise and properly support the vehicle. Refer to Lifting and Jacking the Vehicle . 3. Disconnect the secondary air injection pump hose. Refer to Secondary Air Injection Pump Hose Replacement. 4. Disconnect the secondary air injection pipe. Refer to Secondary Air Injection Pipe Replacement.	
1	Secondary Air Injection Pump Fasteners (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Secondary Air Injection Pump Procedure Disconnect the electrical wiring harness connectors from the secondary air injection pump.

SECONDARY AIR INJECTION PUMP HOSE REPLACEMENT

Removal Procedure

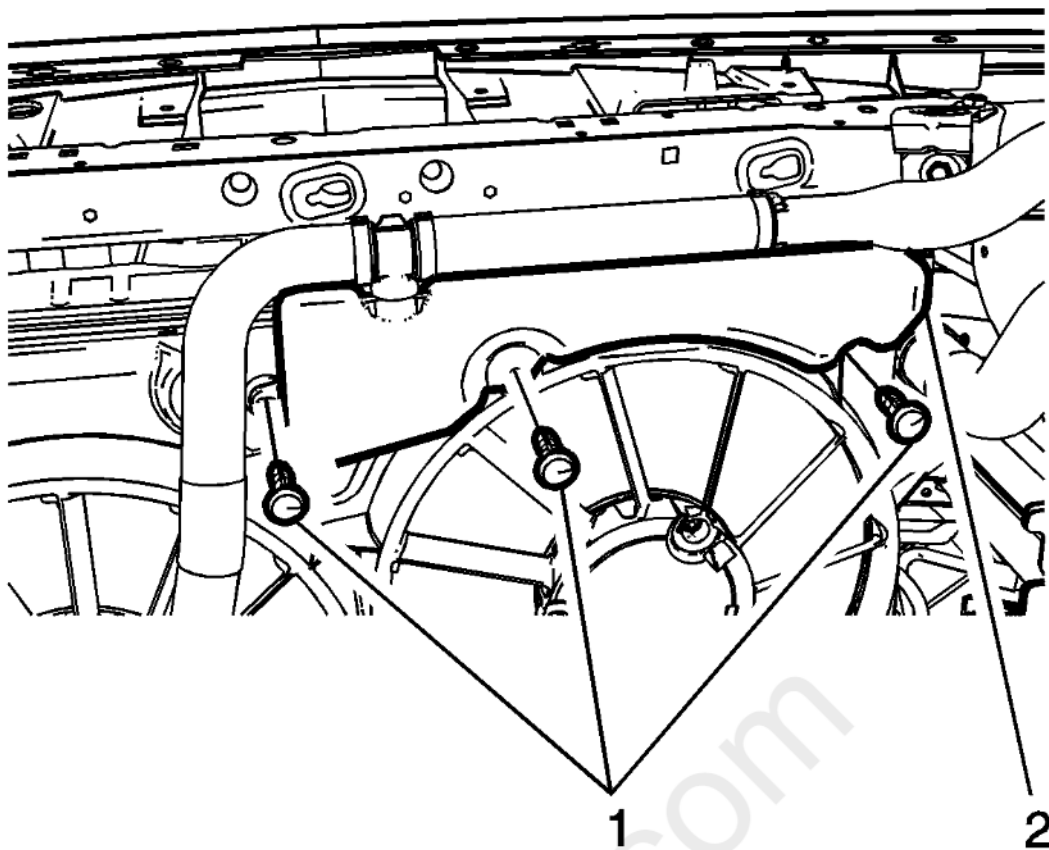


Fig. 158: Secondary Air Injection Pump Hose Assembly & Retainers

Courtesy of GENERAL MOTORS COMPANY

1. Remove the plastic retainers (1) securing the secondary air injection pump hose assembly (2) to the vehicle.

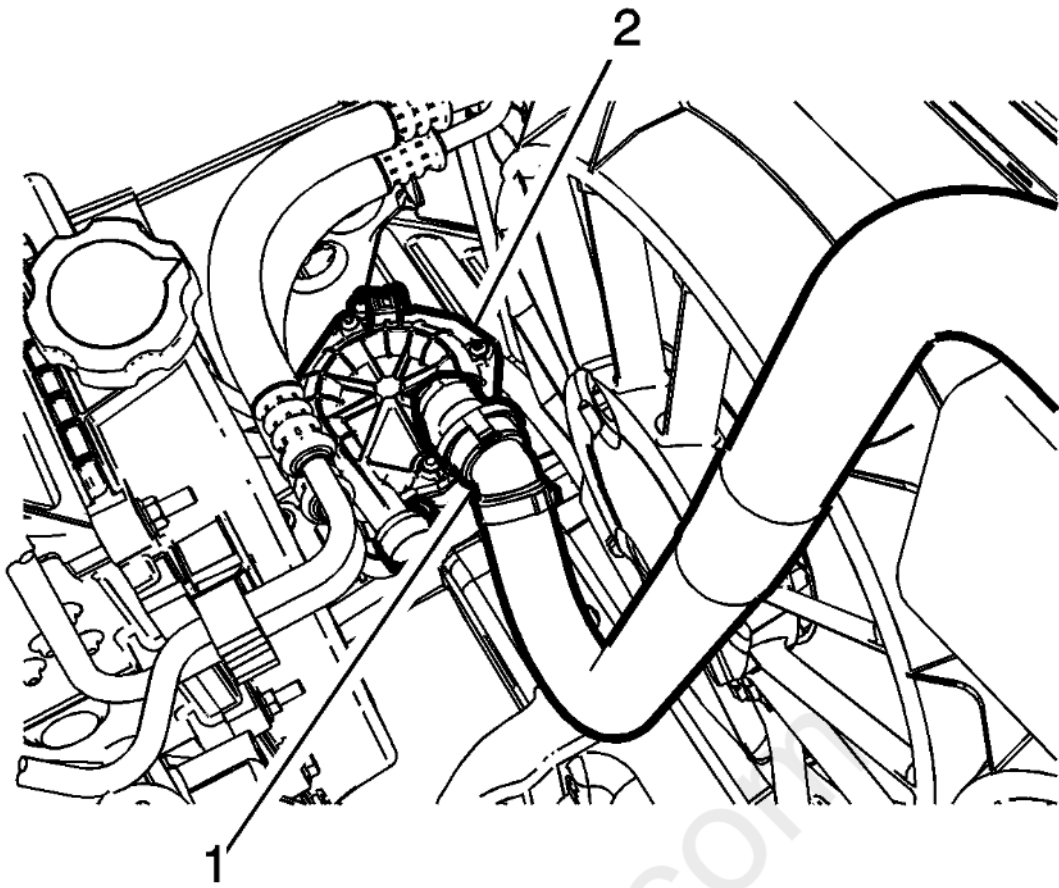


Fig. 159: Secondary Air Injection Pump & Hose

Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the secondary air injection pump hose (1) from the secondary air injection pump (2).
Refer to [Plastic Collar Quick Connect Fitting Service](#) .

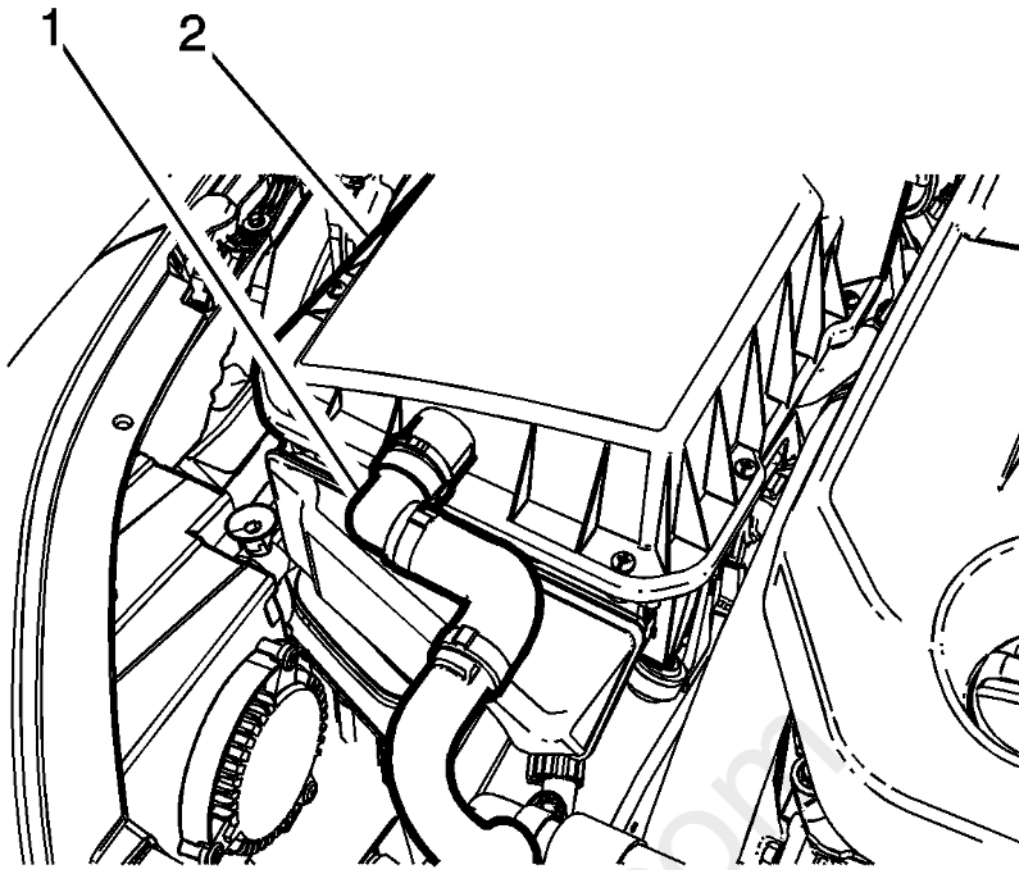


Fig. 160: Secondary Air Injection Pump Hose & Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the secondary air injection pump hose (1) from the air cleaner assembly (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

Installation Procedure

1. Reposition the secondary air injection pump hose to the vehicle.

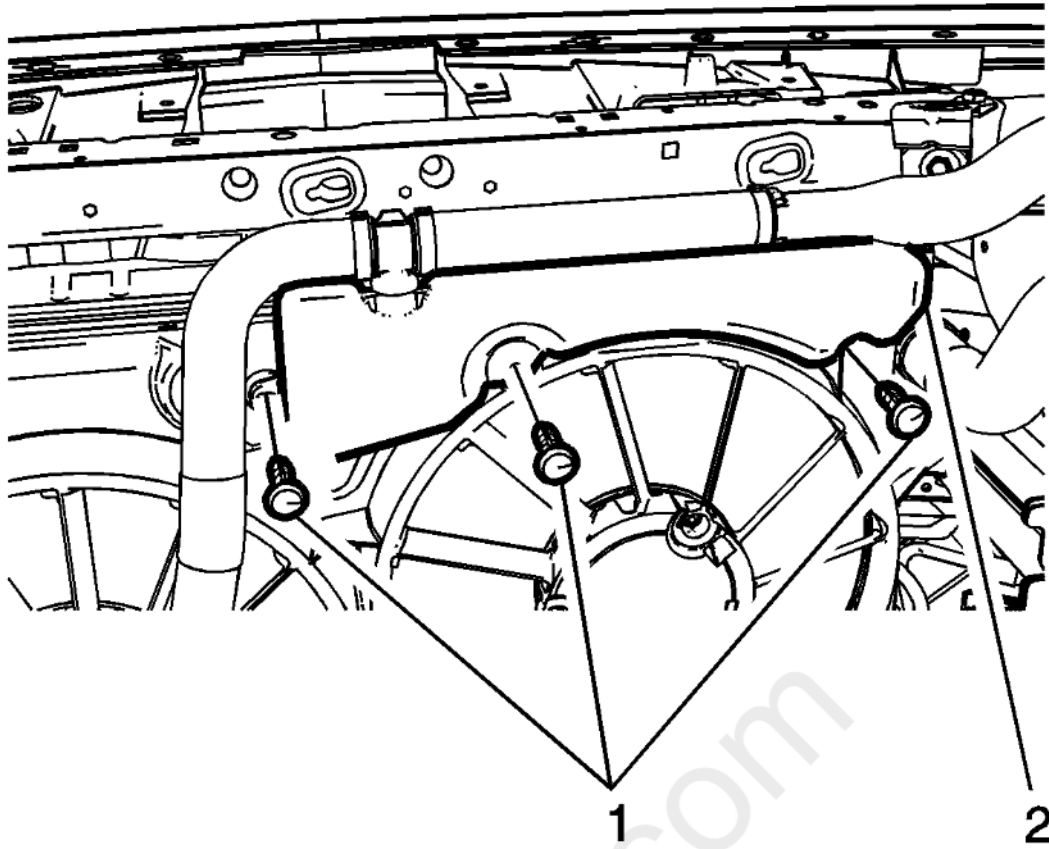


Fig. 161: Secondary Air Injection Pump Hose Assembly & Retainers

Courtesy of GENERAL MOTORS COMPANY

2. Install the plastic retainers (1) securing the secondary air injection pump hose assembly (2) to the vehicle.

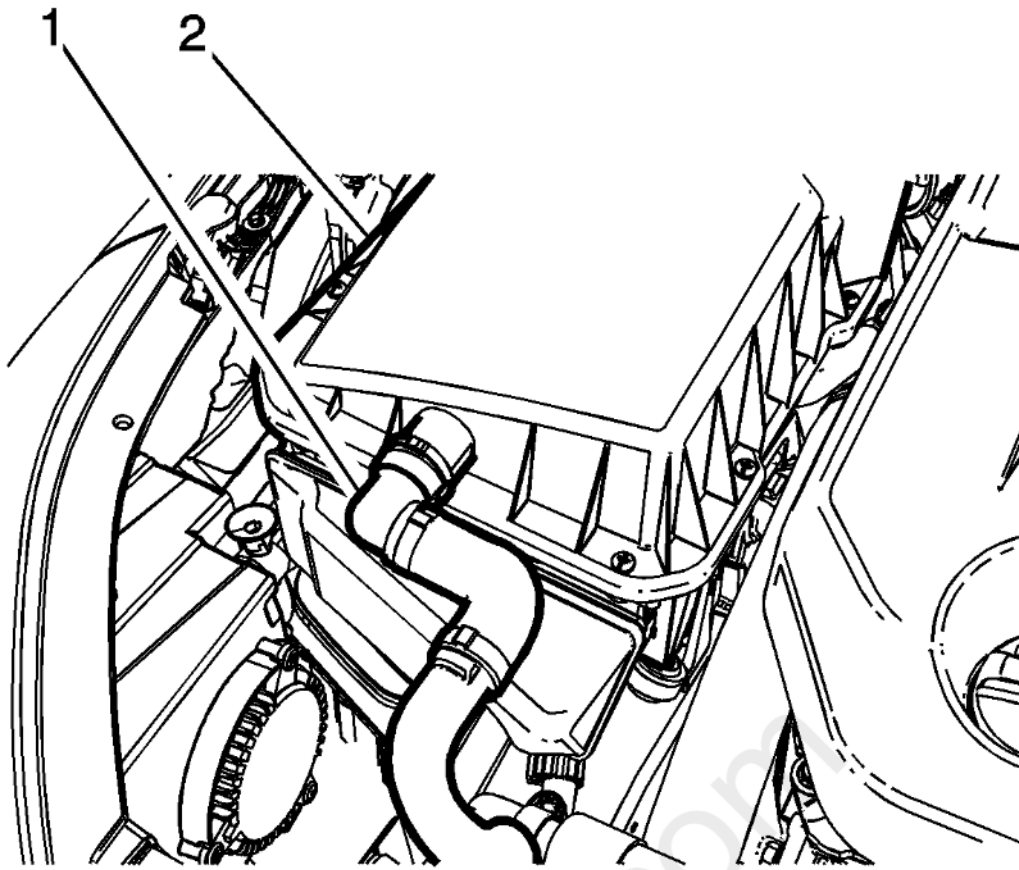


Fig. 162: Secondary Air Injection Pump Hose & Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

3. Connect the secondary air injection pump hose (1) to the air cleaner assembly (2). Refer to [**Plastic Collar Quick Connect Fitting Service**](#) .

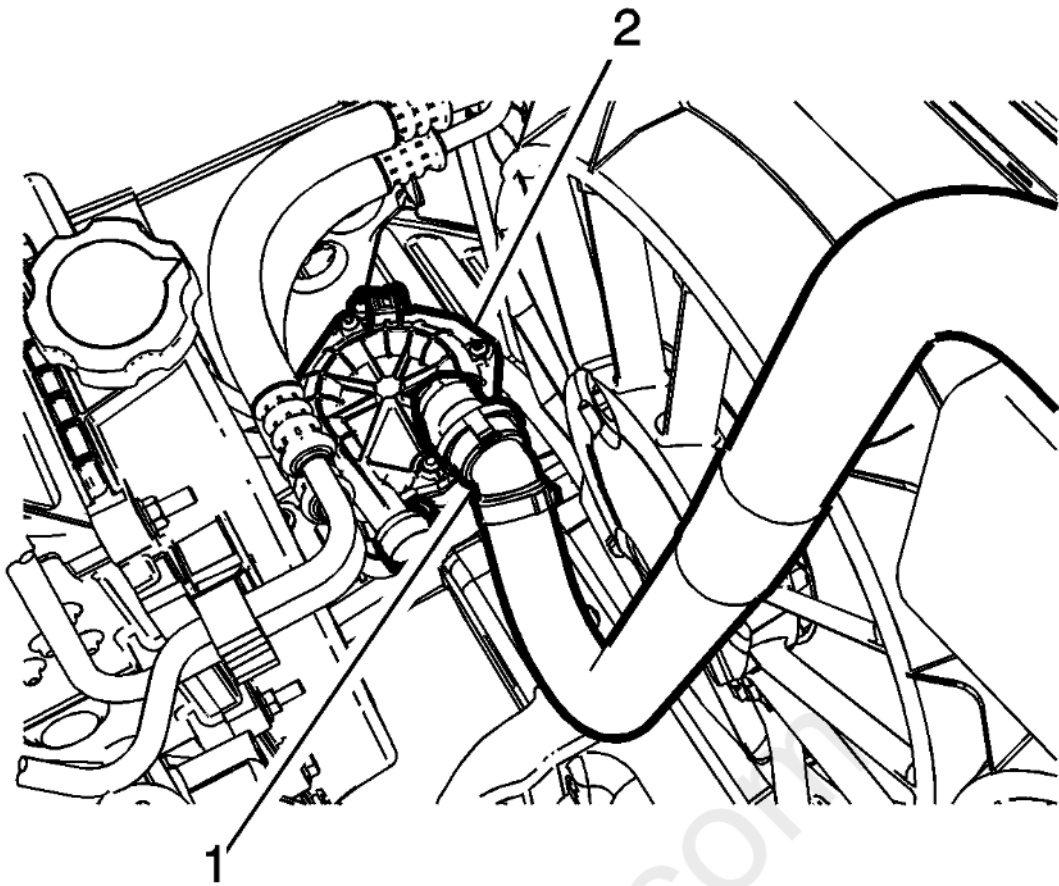


Fig. 163: Secondary Air Injection Pump & Hose
Courtesy of GENERAL MOTORS COMPANY

4. Connect the secondary air injection pump hose (1) to the secondary air injection pump (2). Refer to [Plastic Collar Quick Connect Fitting Service](#) .

AIR CLEANER ELEMENT REPLACEMENT

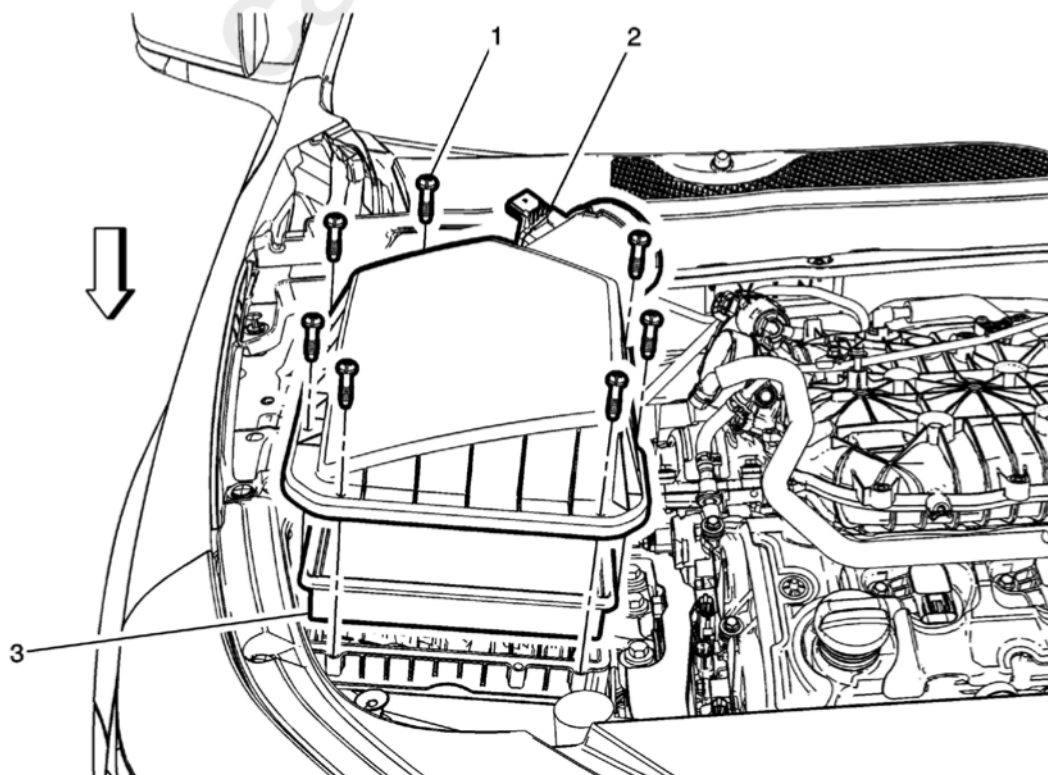


Fig. 164: Air Cleaner Element, Upper Cover & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	Air Cleaner Assembly Fasteners (Qty: 7) CAUTION: Refer to Fastener Caution .
2	Air Cleaner Upper Cover Procedure Disconnect the electrical connector.
3	Air Cleaner Element

AIR CLEANER ASSEMBLY REPLACEMENT

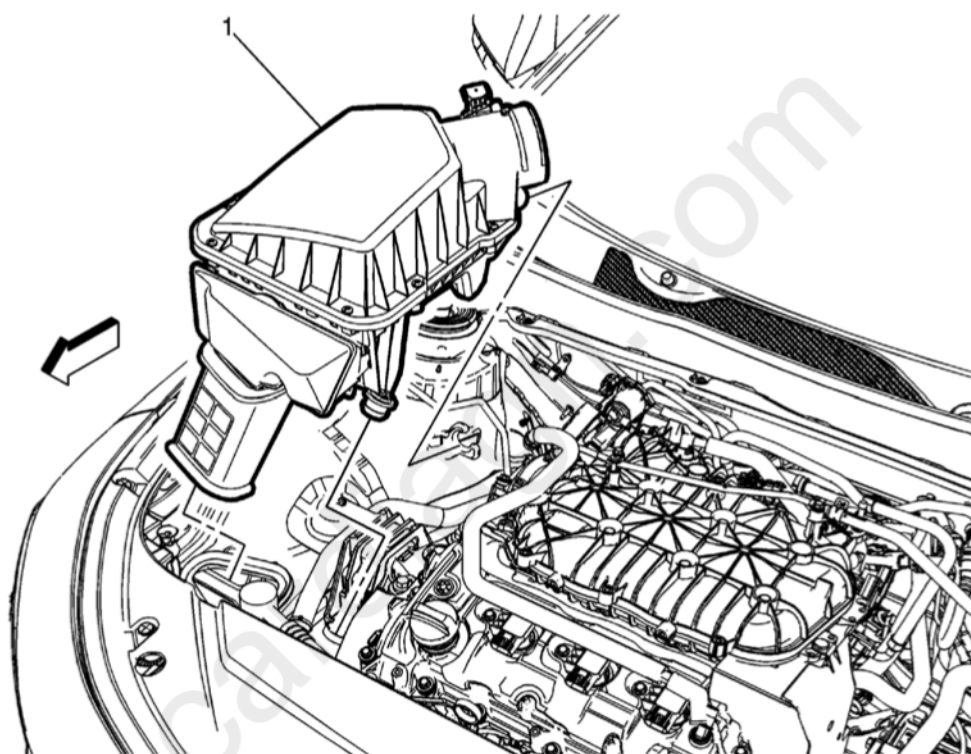


Fig. 165: Air Cleaner Assembly
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	Air Cleaner Assembly Procedure 1. Disconnect MAF sensor electrical connector. 2. Remove the air cleaner housing from the retainers, while guiding the housing out of the inlet duct. 3. Transfer parts as necessary.

AIR CLEANER OUTLET DUCT REPLACEMENT

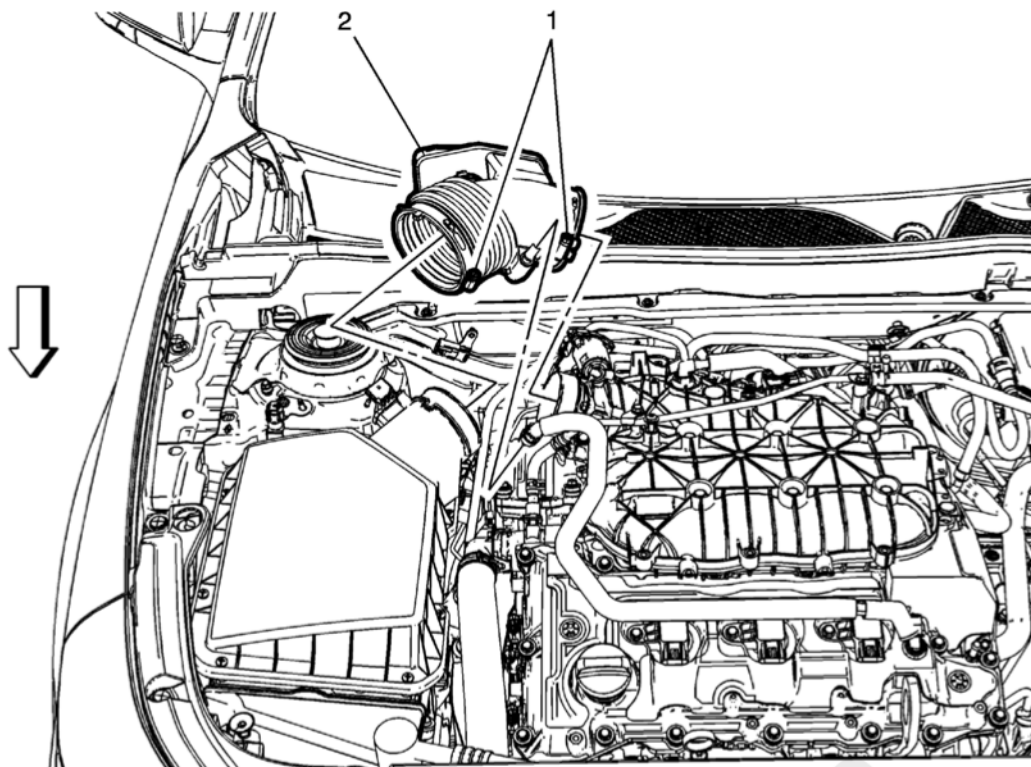


Fig. 166: Air Cleaner Outlet Duct

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX) .	
1	Air Cleaner Outlet Duct Clamps (Qty 2) CAUTION: Refer to Fastener Caution . NOTE: Ensure the outlet duct is fully seated to the mating surfaces before clamping. Verify that the cuff is not rolled under.
2	Air Cleaner Outlet Duct Procedure Disconnect the PCV tube from the air cleaner outlet duct.

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 3.6L (LFX) - Schematic and Routing Diagrams - Impala

SCHEMATIC WIRING DIAGRAMS

ENGINE CONTROLS WIRING SCHEMATICS (LFX)

Power, Ground, Serial Data, and MIL

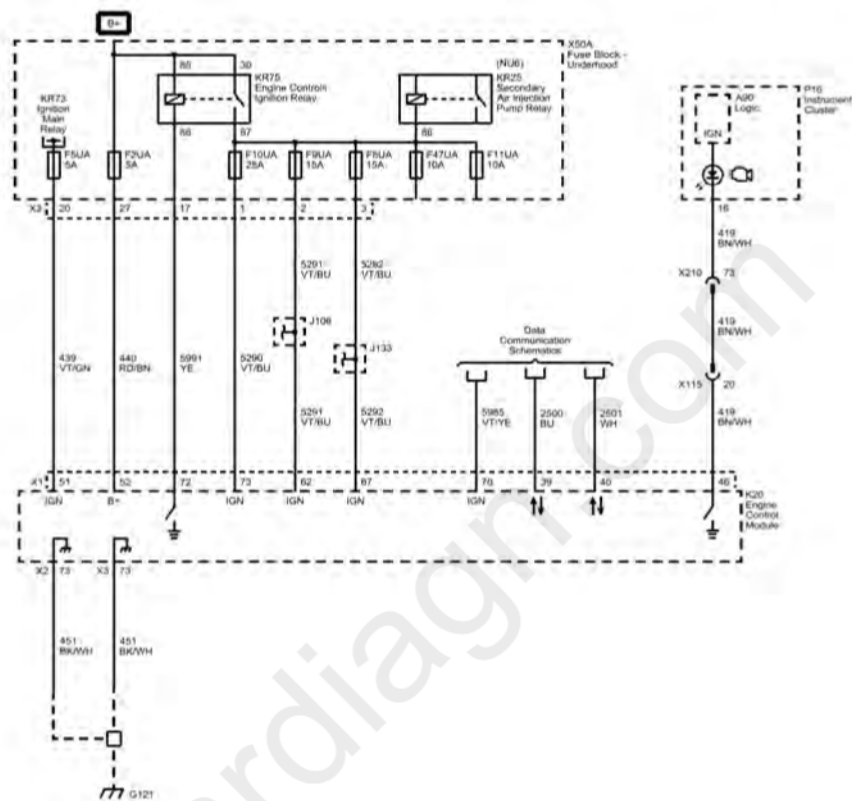


Fig. 1: Power, Ground, Serial Data, and MIL
Courtesy of GENERAL MOTORS COMPANY

5V1, and Low Reference Bus (1 of 3)

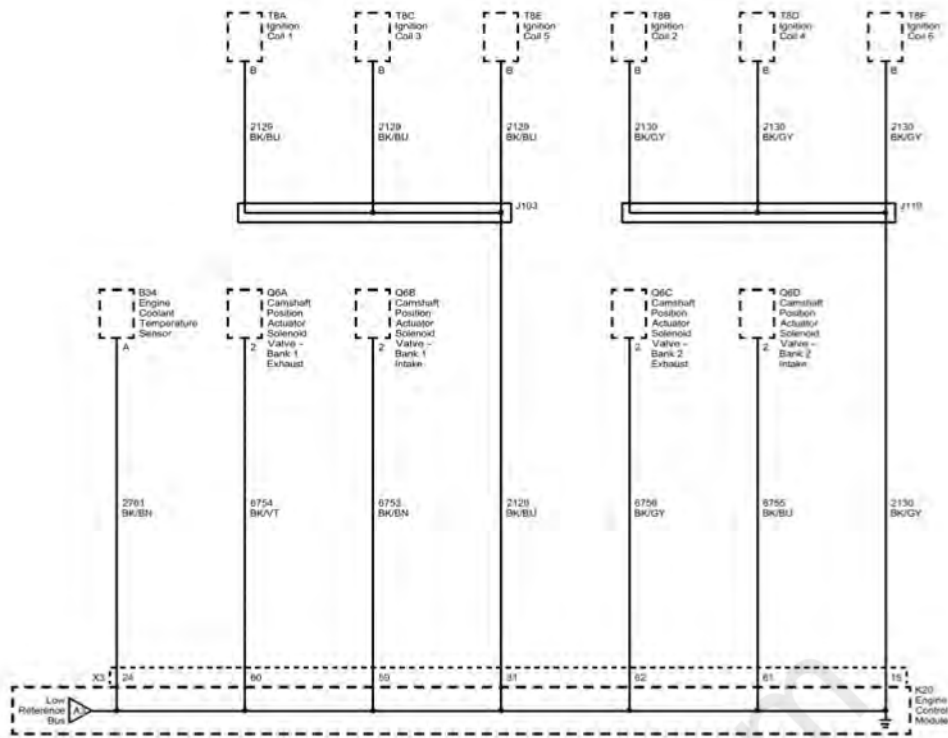


Fig. 4: Low Reference Bus (3 of 3)
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Pressure and Temperature

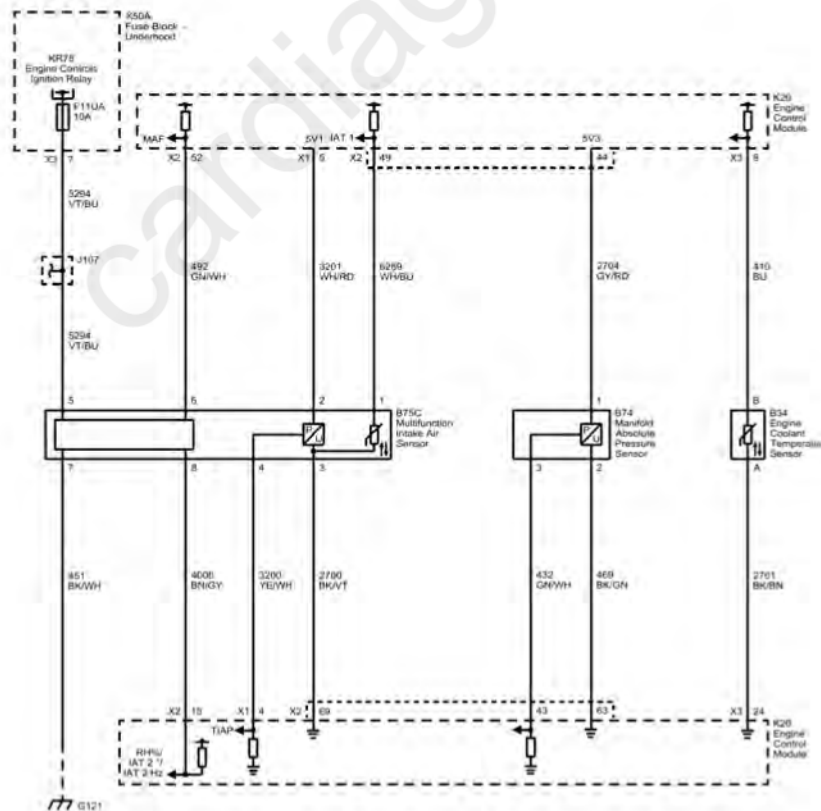


Fig. 5: Engine Data Sensors - Pressure and Temperature
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Oxygen Sensors

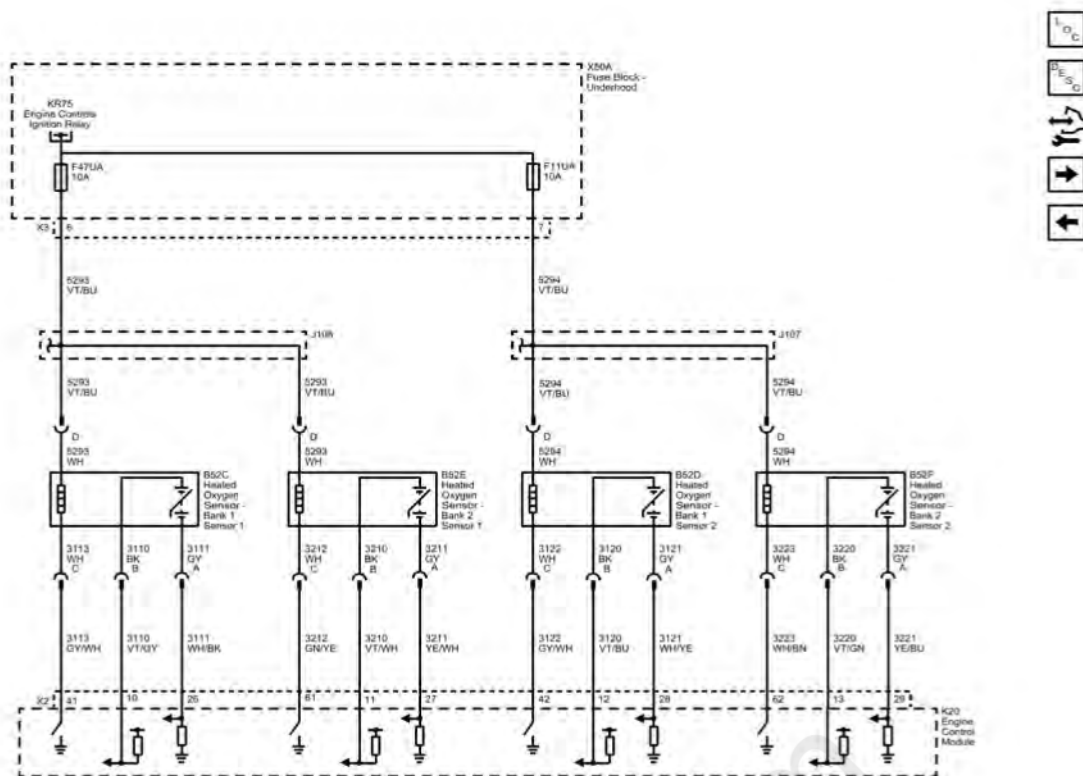


Fig. 6: Engine Data Sensors - Oxygen Sensors
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Throttle Controls and Override

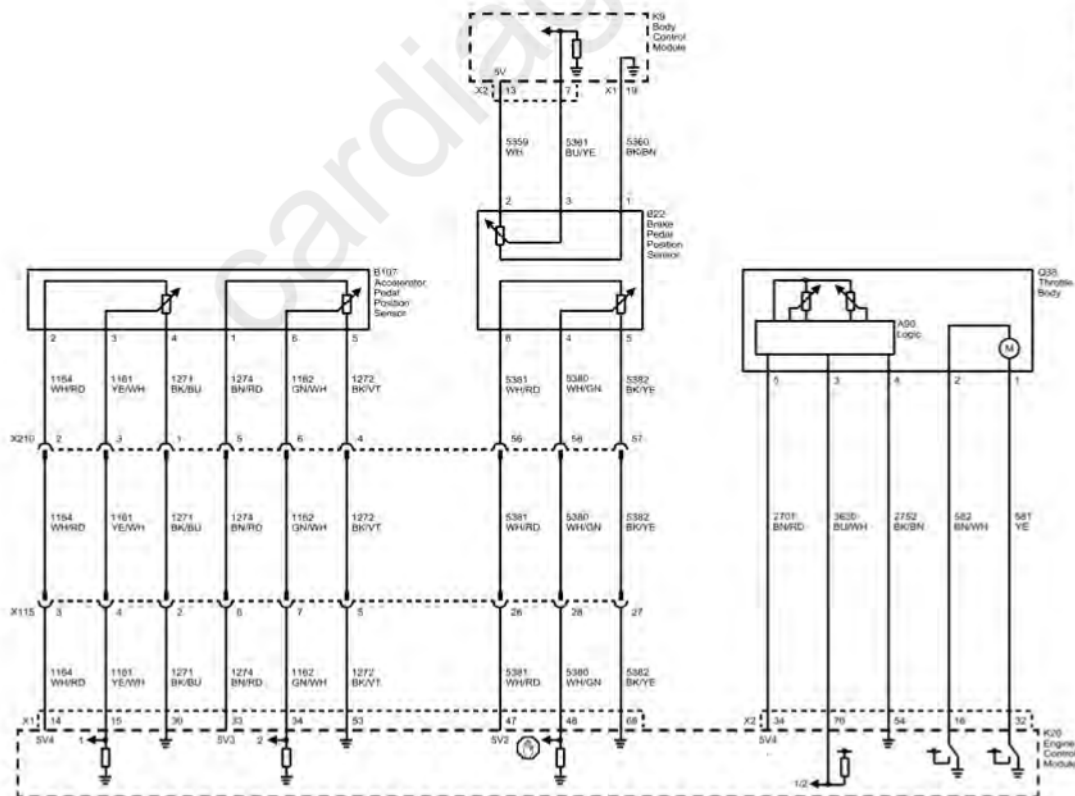


Fig. 7: Engine Data Sensors - Throttle Controls and Override
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Bank 1 Ignition System

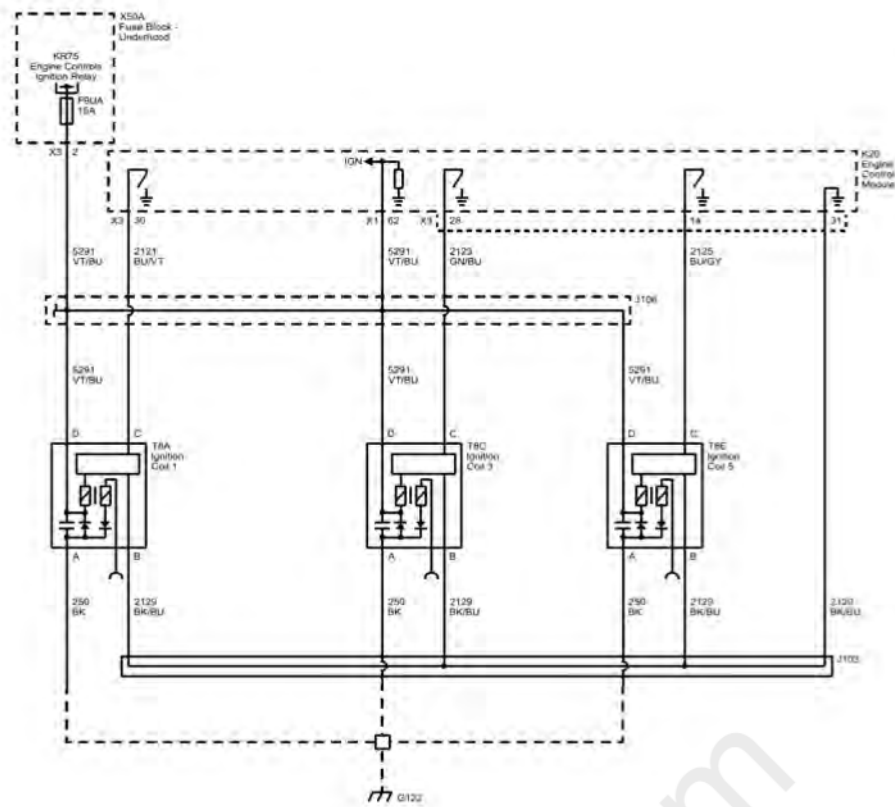


Fig. 8: Ignition Controls - Bank 1 Ignition System
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Bank 2 Ignition System

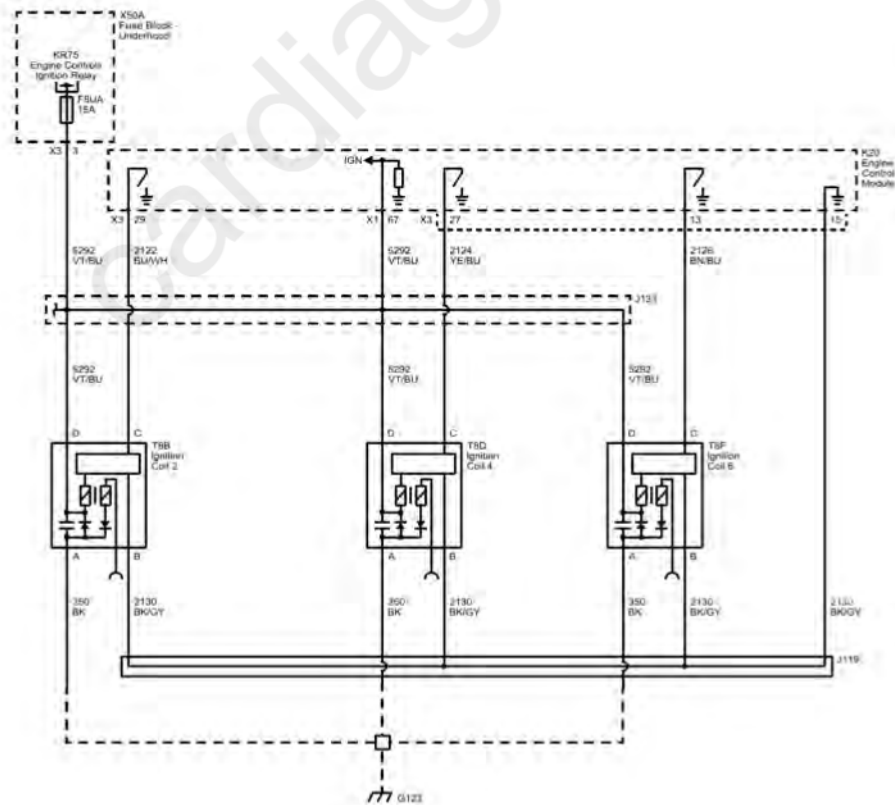


Fig. 9: Ignition Controls - Bank 2 Ignition System
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Camshaft Solenoids and Ignition Sensors

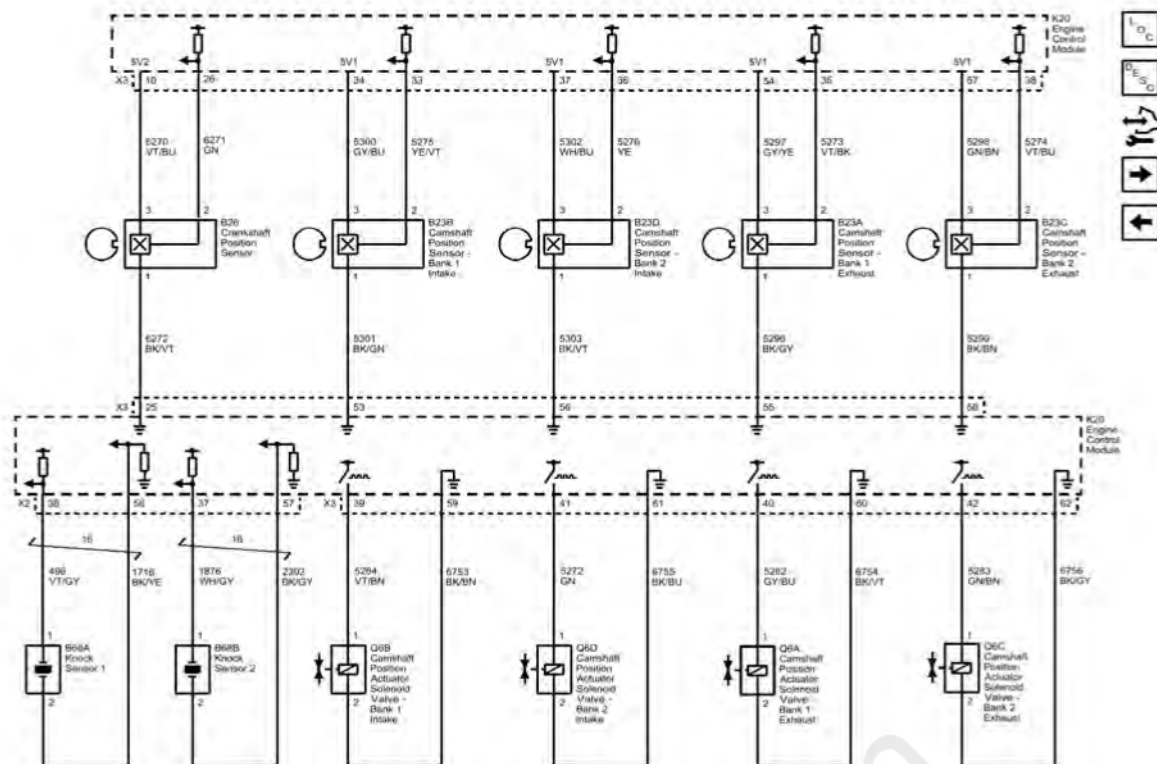


Fig. 10: Ignition Controls - Camshaft Solenoids and Ignition Sensors
 Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Injectors

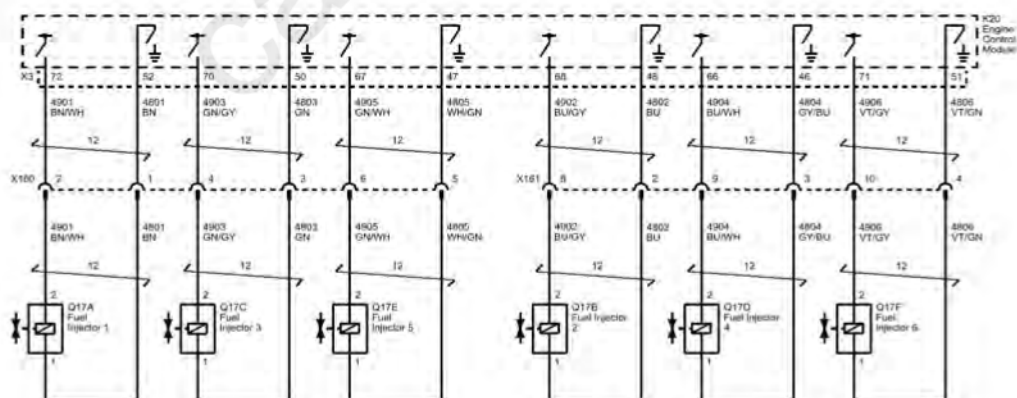


Fig. 11: Fuel Controls - Fuel Injectors
 Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Composition and Pressure

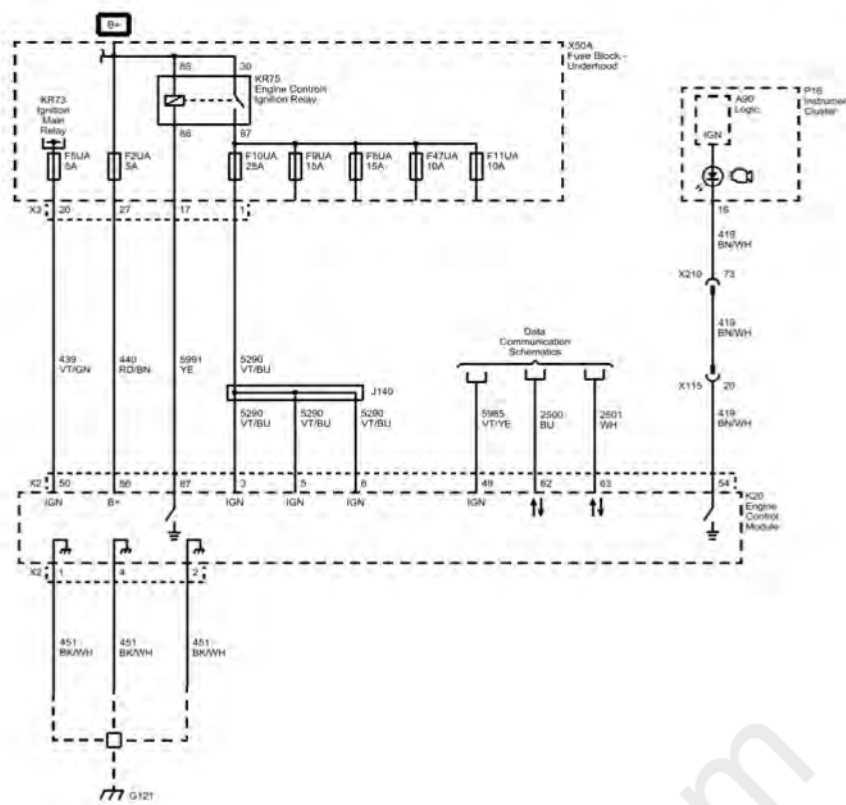


Fig. 16: Power, Ground, Serial Data, and MIL
Courtesy of GENERAL MOTORS COMPANY

5V1, and Low Reference Bus (1 of 3)

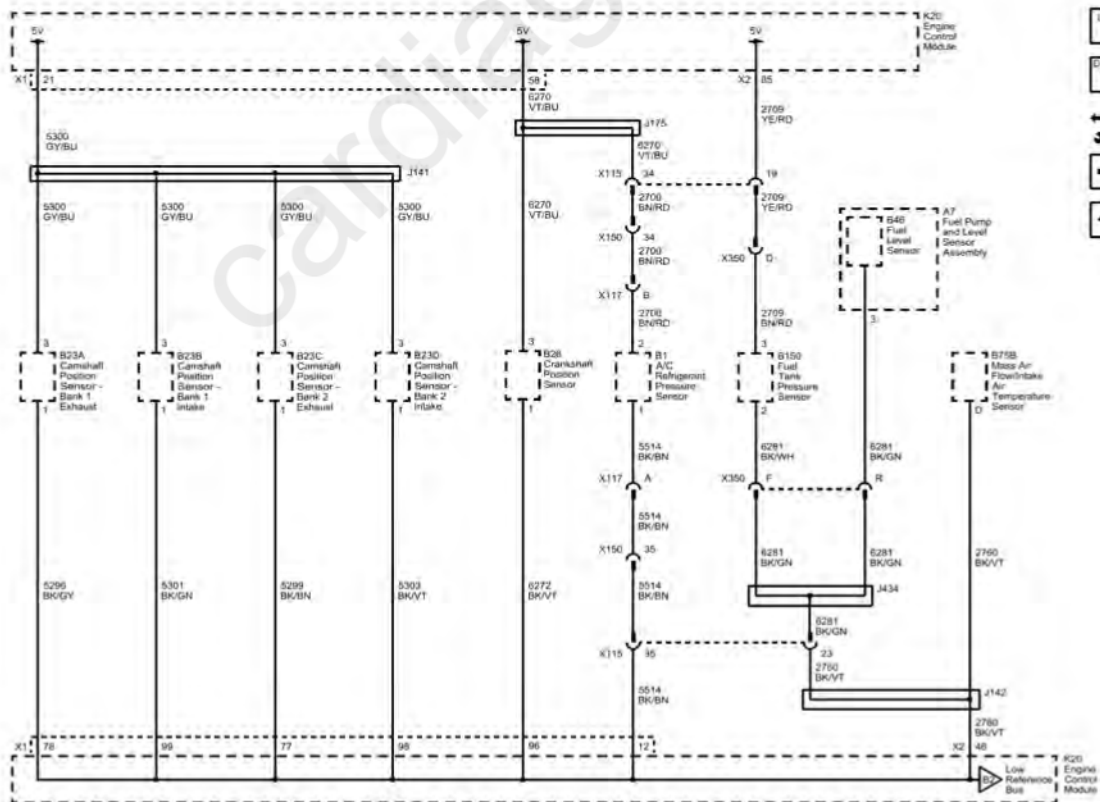


Fig. 17: 5V1, and Low Reference Bus (1 of 3)
Courtesy of GENERAL MOTORS COMPANY

5V2, 5V3, 5V4, and Low Reference Bus (2 of 3)

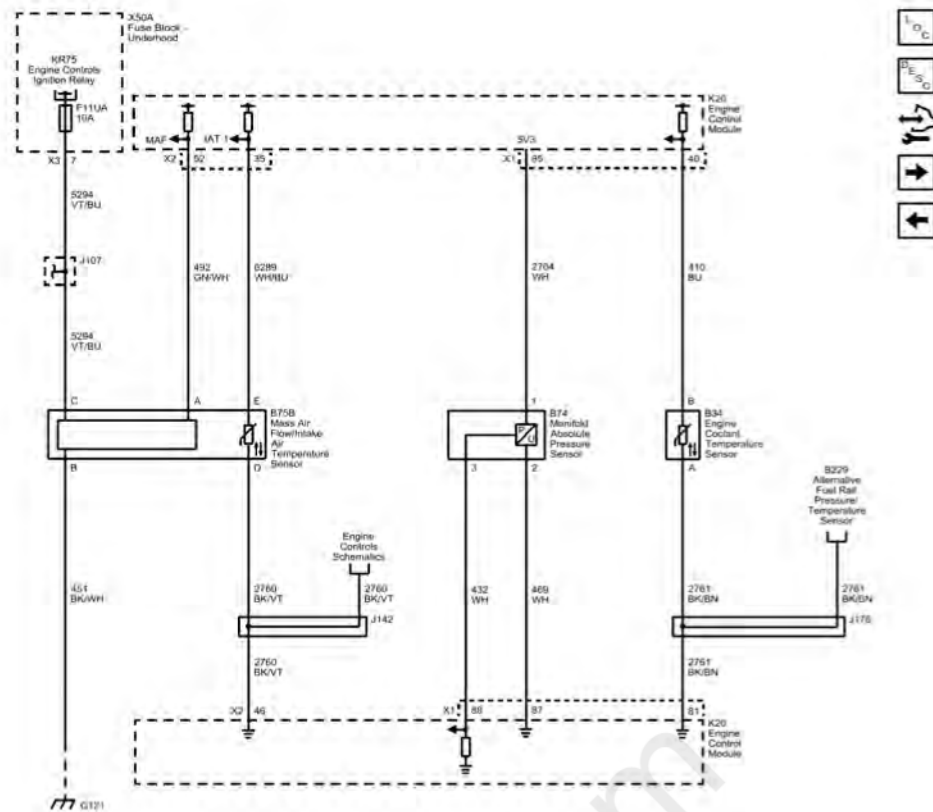


Fig. 20: Engine Data Sensors - Pressure and Temperature
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Oxygen Sensors

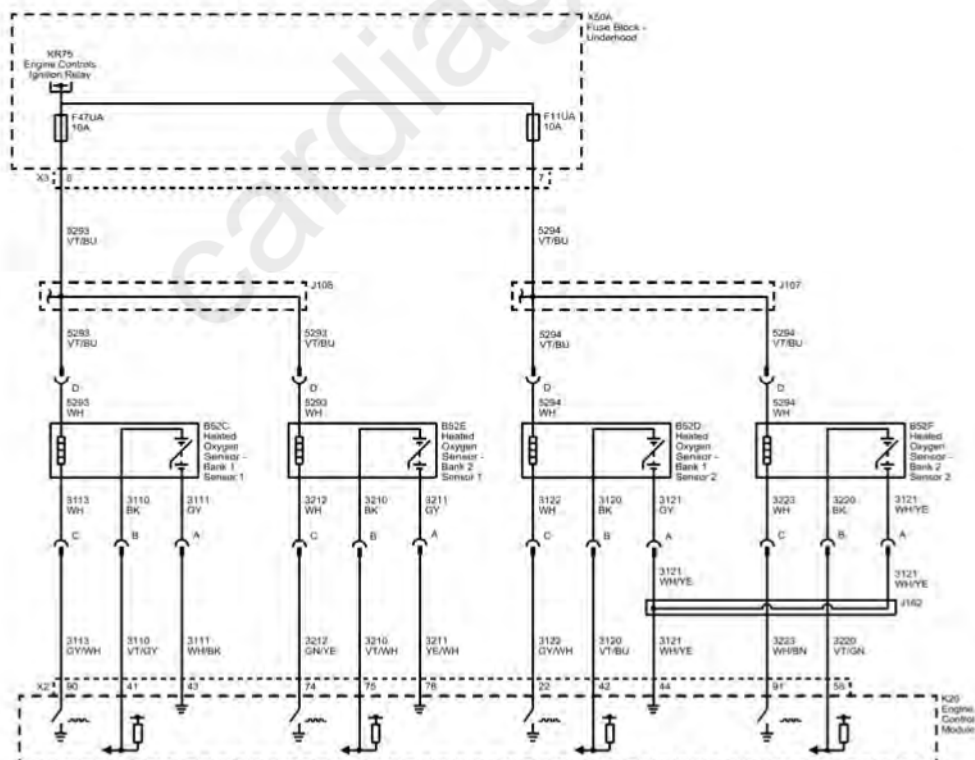


Fig. 21: Engine Data Sensors - Oxygen Sensors
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Throttle Controls and Override

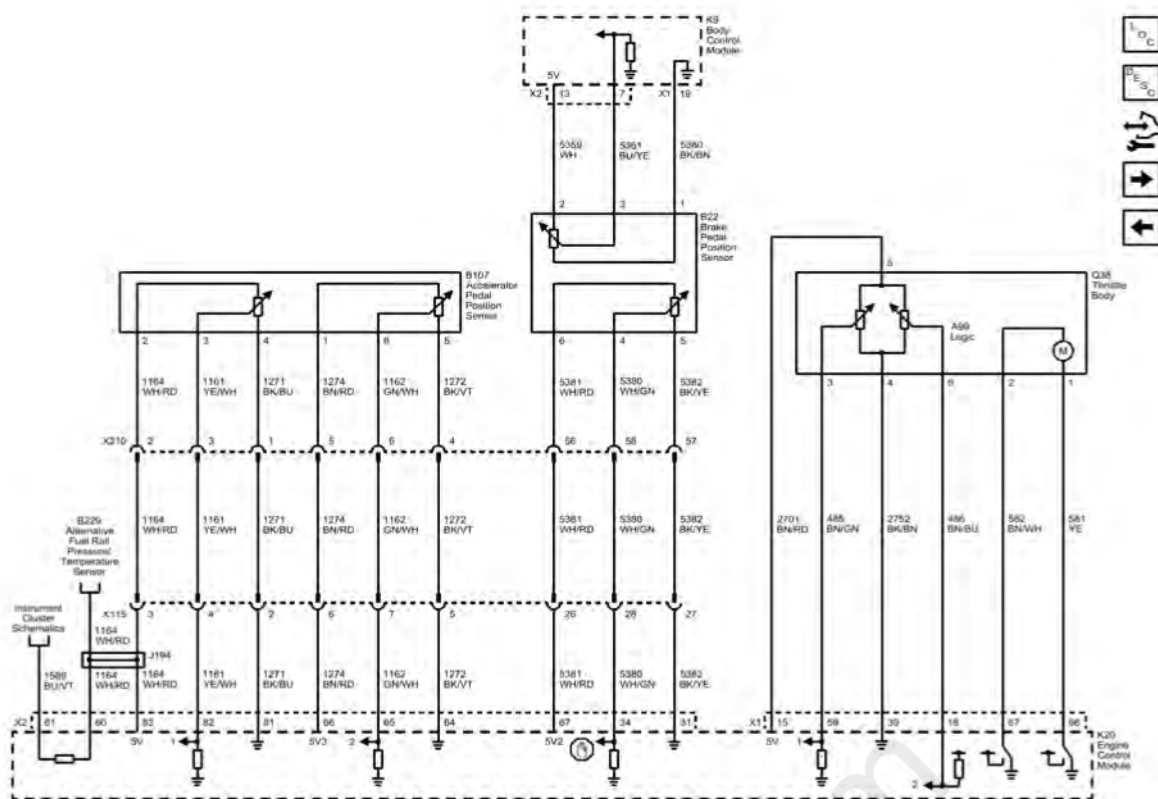


Fig. 22: Engine Data Sensors - Throttle Controls and Override
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Bank 1 Ignition System

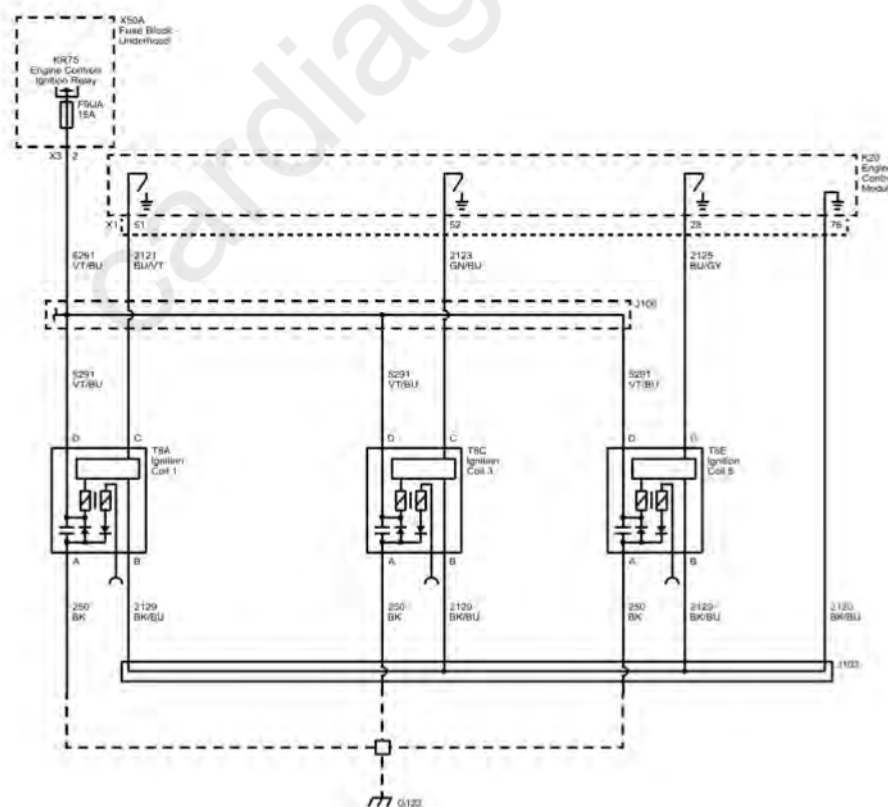


Fig. 23: Ignition Controls - Bank 1 Ignition System
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Bank 2 Ignition System

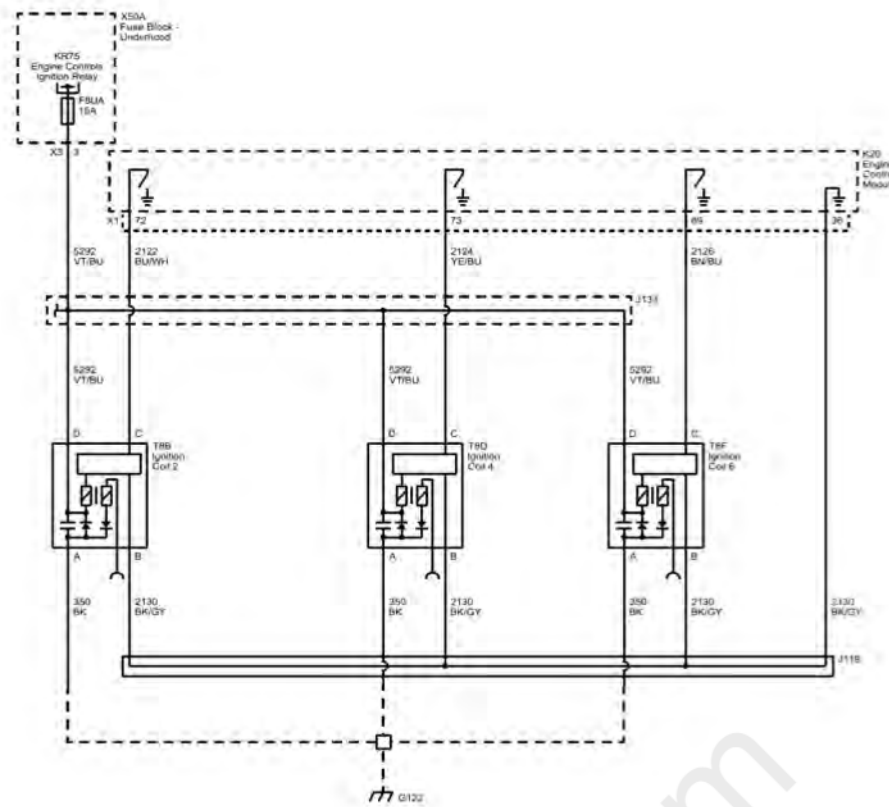


Fig. 24: Ignition Controls - Bank 2 Ignition System
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Camshaft Solenoids and Ignition Sensors

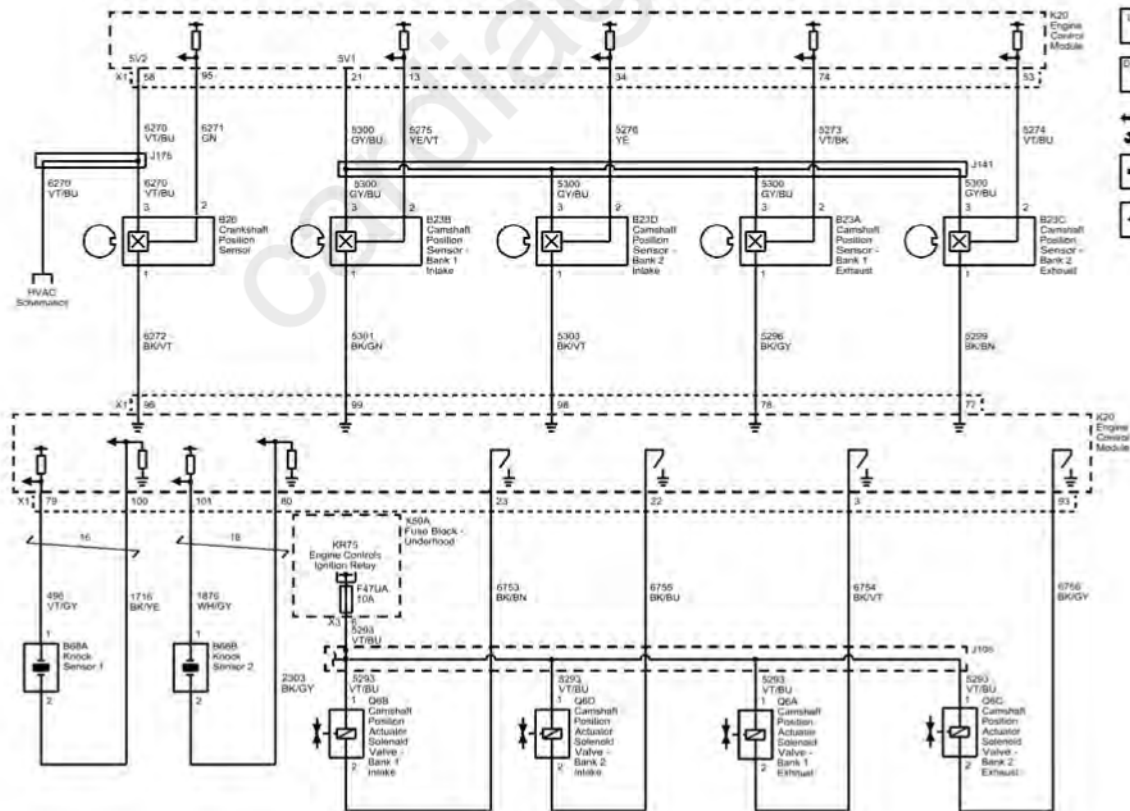


Fig. 25: Ignition Controls - Camshaft Solenoids and Ignition Sensors
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Injectors

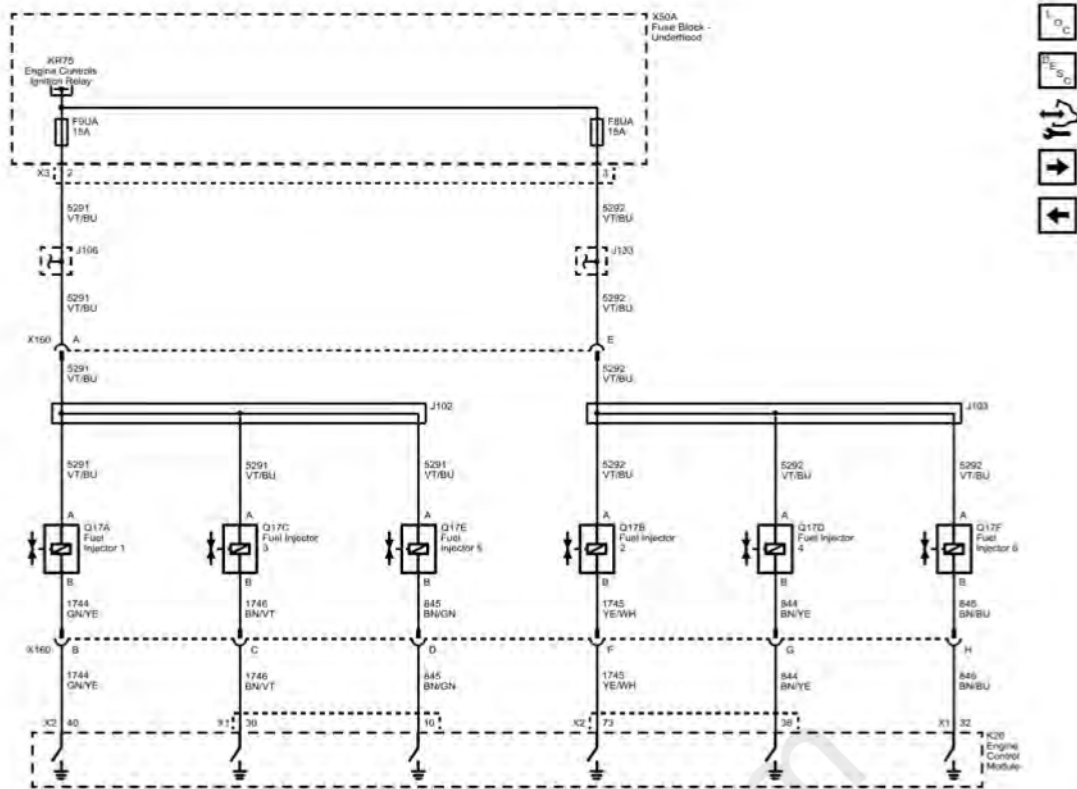
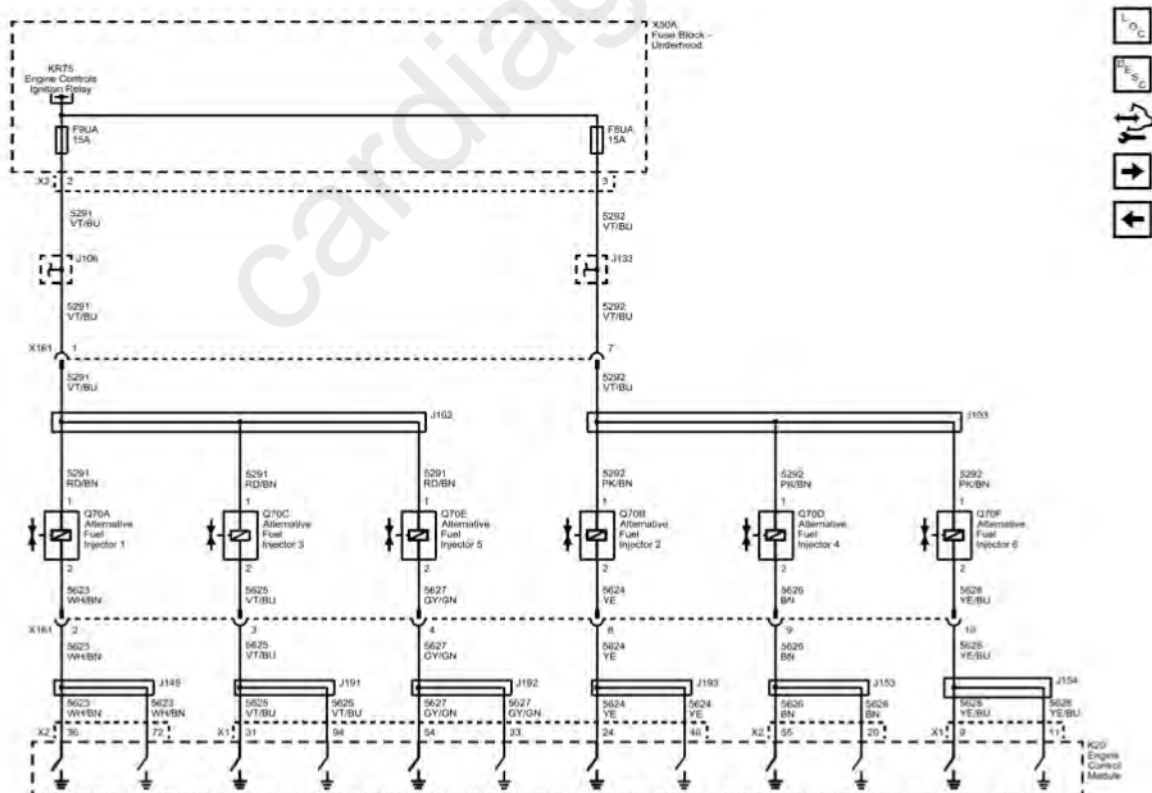


Fig. 26: Fuel Controls - Fuel Injectors
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - CNG Fuel Injectors



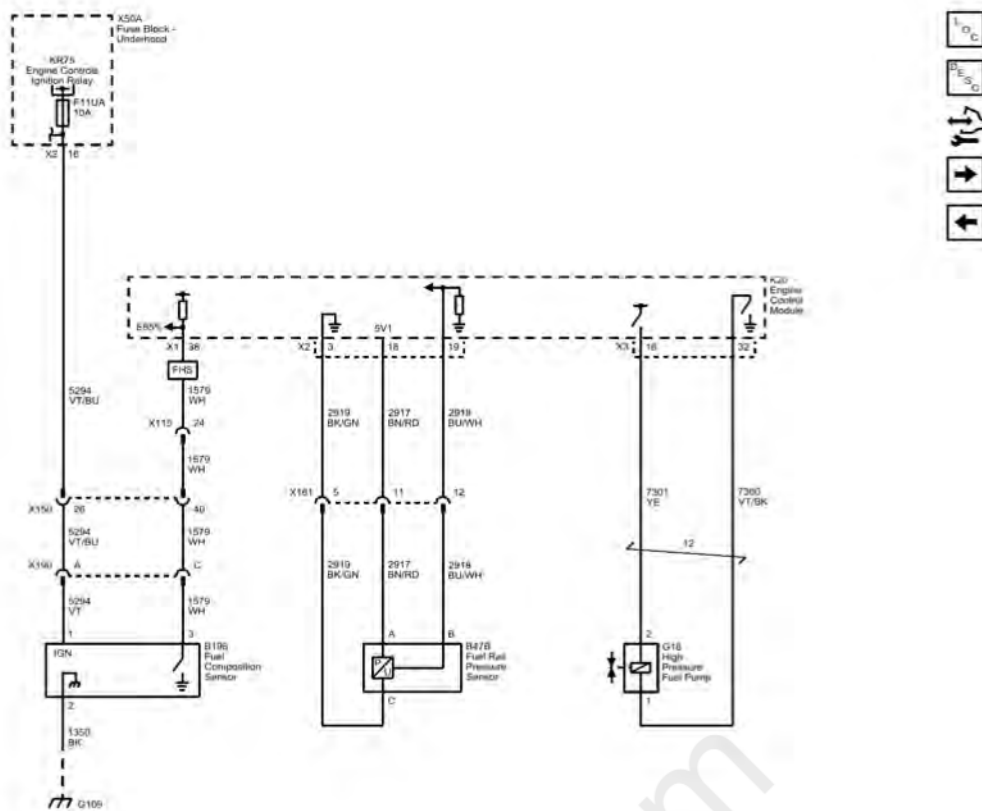


Fig. 28: Fuel Controls - Fuel Composition and Pressure
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - CNG Pressure and Temperature

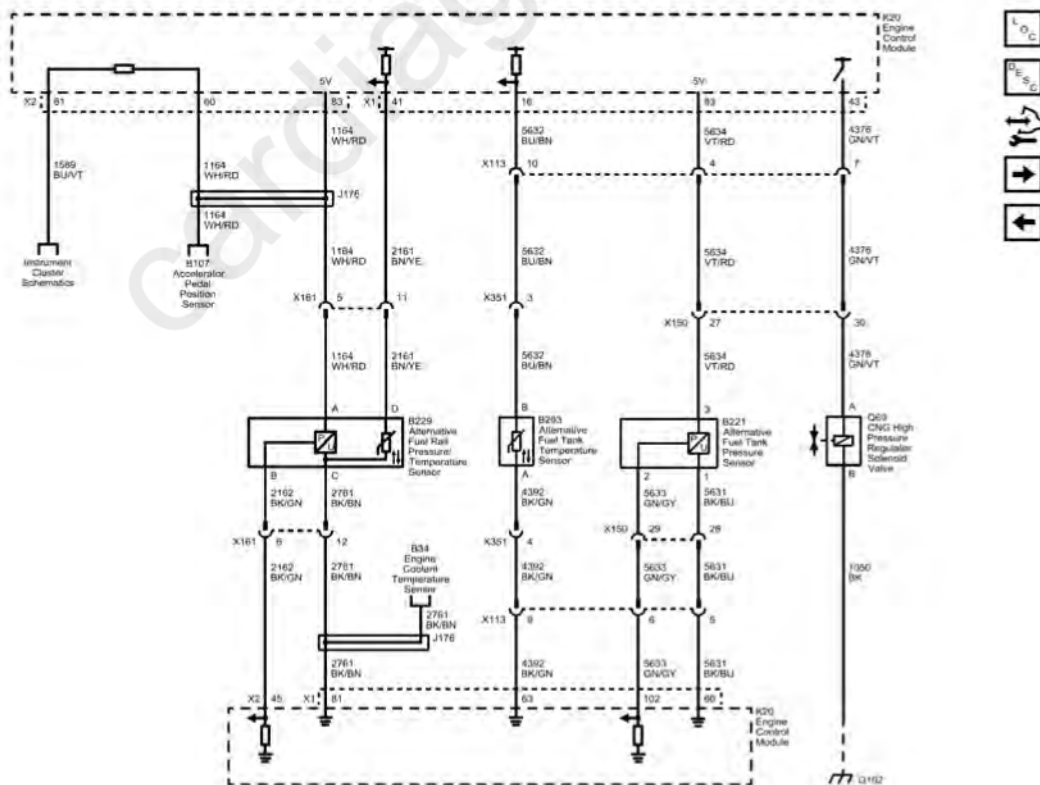
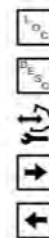
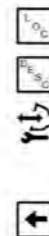


Fig. 29: Fuel Controls - CNG Pressure and Temperature
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - CNG Cut-Off



Controlled/Monitored Subsystem References



Courtesy of GENERAL MOTORS COMPANY

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 3.6L (LFX) - Special Tools and Equipment - Impala

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS (DIAGNOSTIC TOOLS)

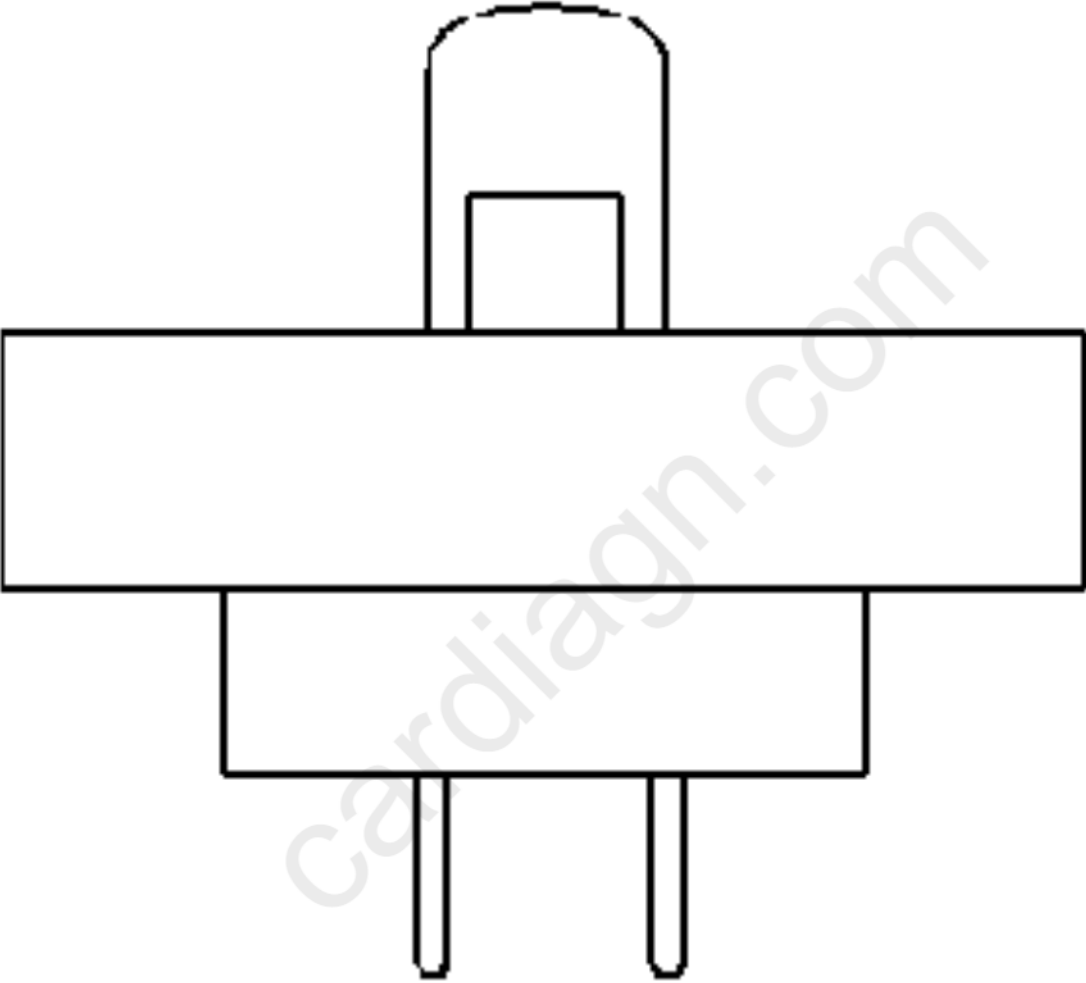
Illustration	Tool Number/Description
	CH-34730-2C J-34730-2C Injector Test Lamp

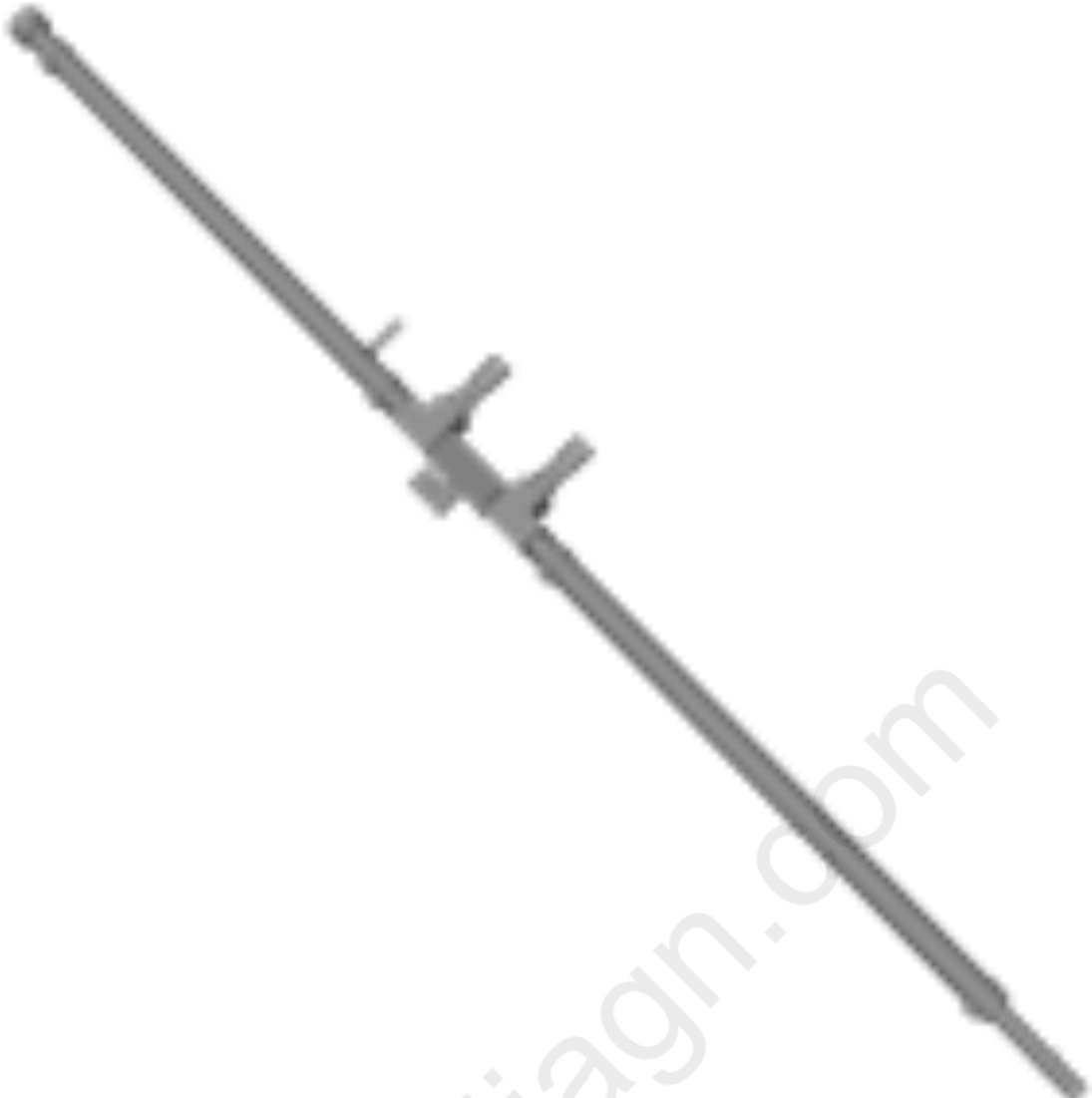
Illustration	Tool Number/Description
 A long, thin metal tool, likely a fuel pressure gauge adapter. It features a long, straight shaft with a threaded section in the middle, where a gauge or sensor would be attached. The tool is shown diagonally across the frame.	CH-37287-1A Fuel Pressure Gauge Adapter 3/8"
	CH-38641-B J-38641-B Diesel Fuel Quality Tester

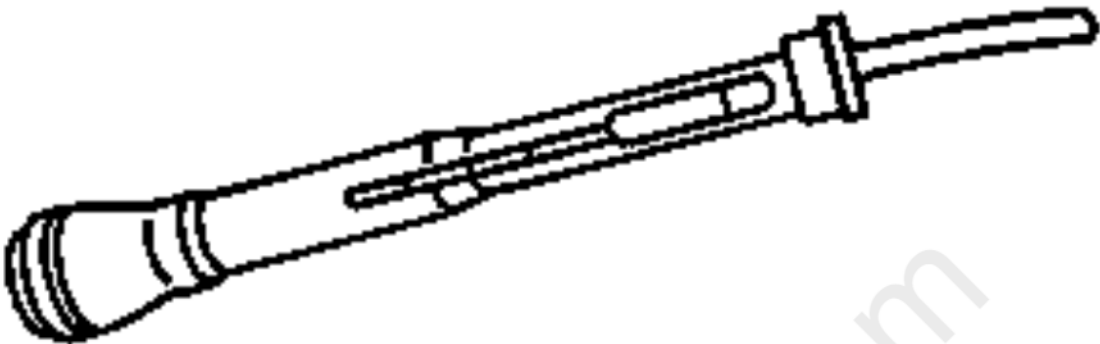
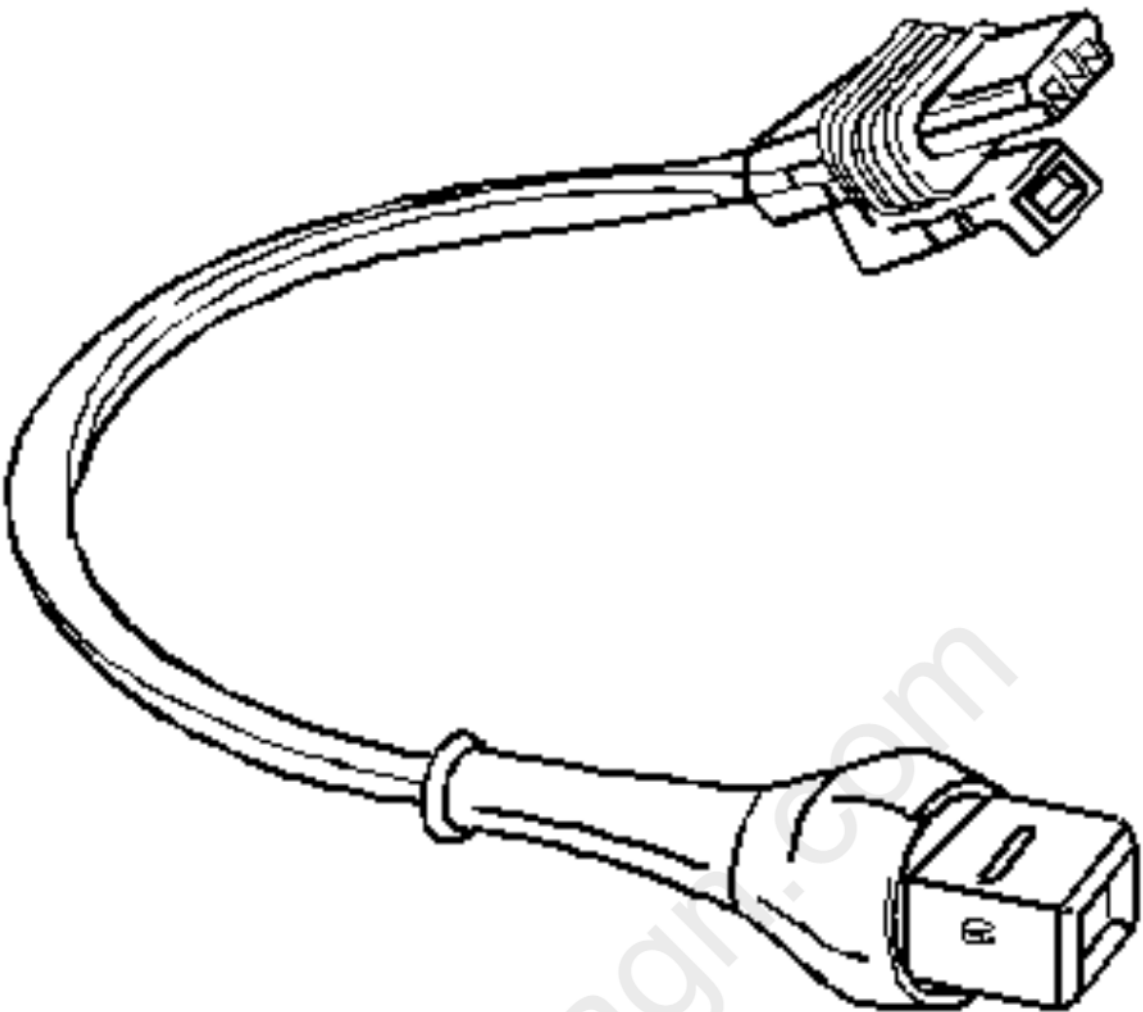
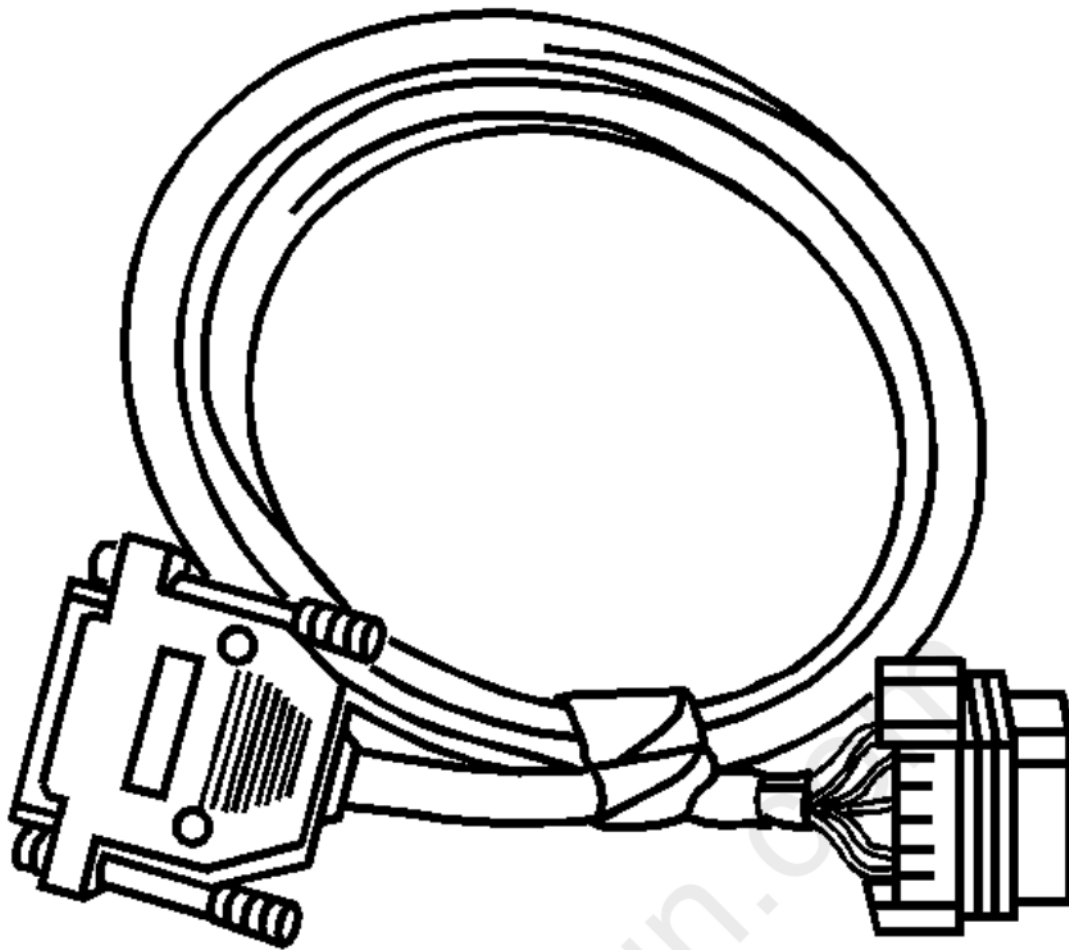
Illustration	Tool Number/Description
	

Illustration	Tool Number/Description
	CH-39021-301 J-39021-301 Fuel Injector Harness Adapter

Illustration

Tool
Number/Description



CH-39021-460
J-39021-460
Fuel Injector Test
Adapter

Illustration	Tool Number/Description
	CH-41415-30 GE-41415-30 J-41415-30 Fuel Tank Cap Adapter

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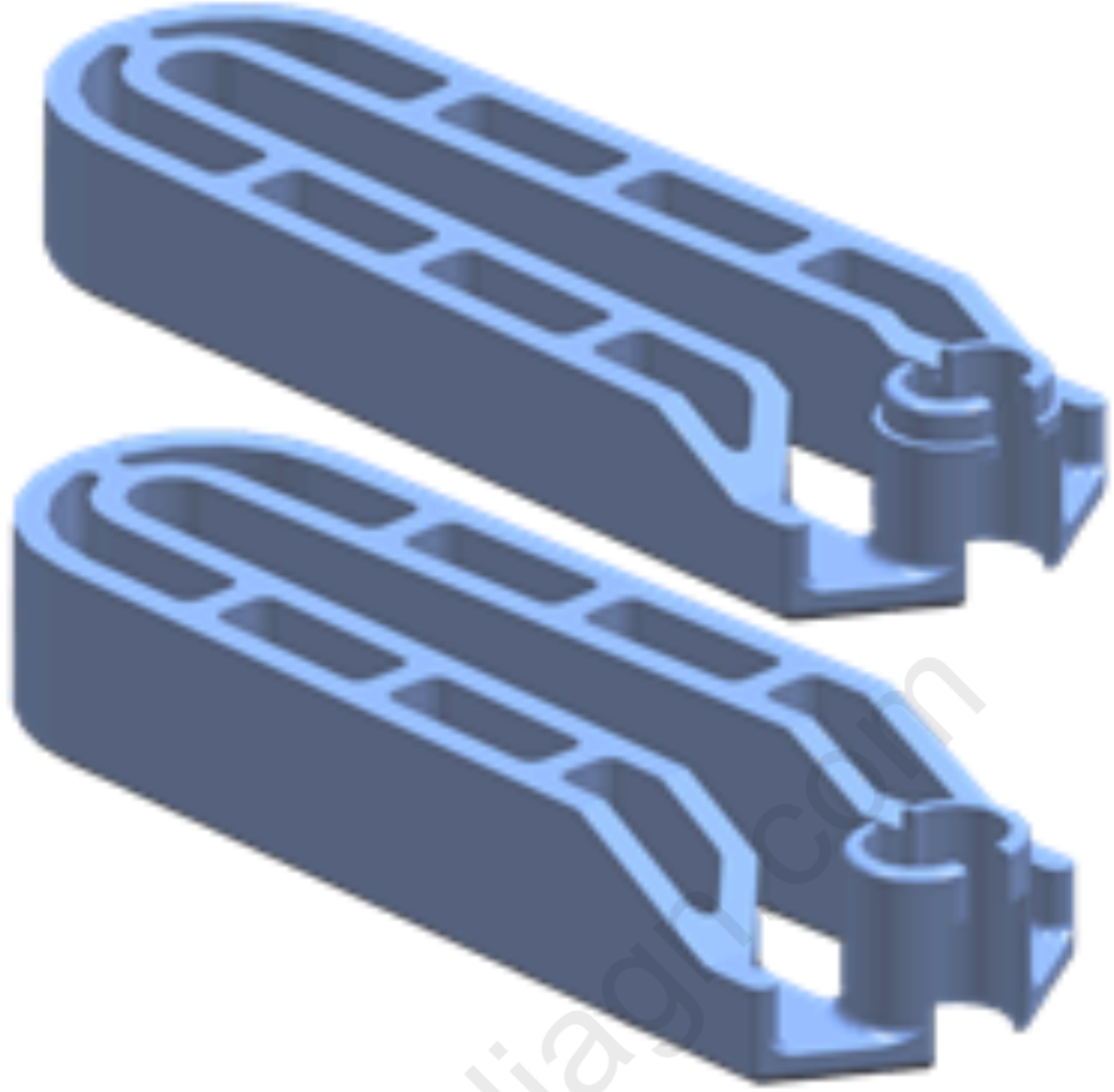
Illustration	Tool Number/Description
	CH-41769 J-41769 Fuel Line Quick Disconnect Tool
	CH-44284-2 J-44284-2 Fuel Flapper Door Holder

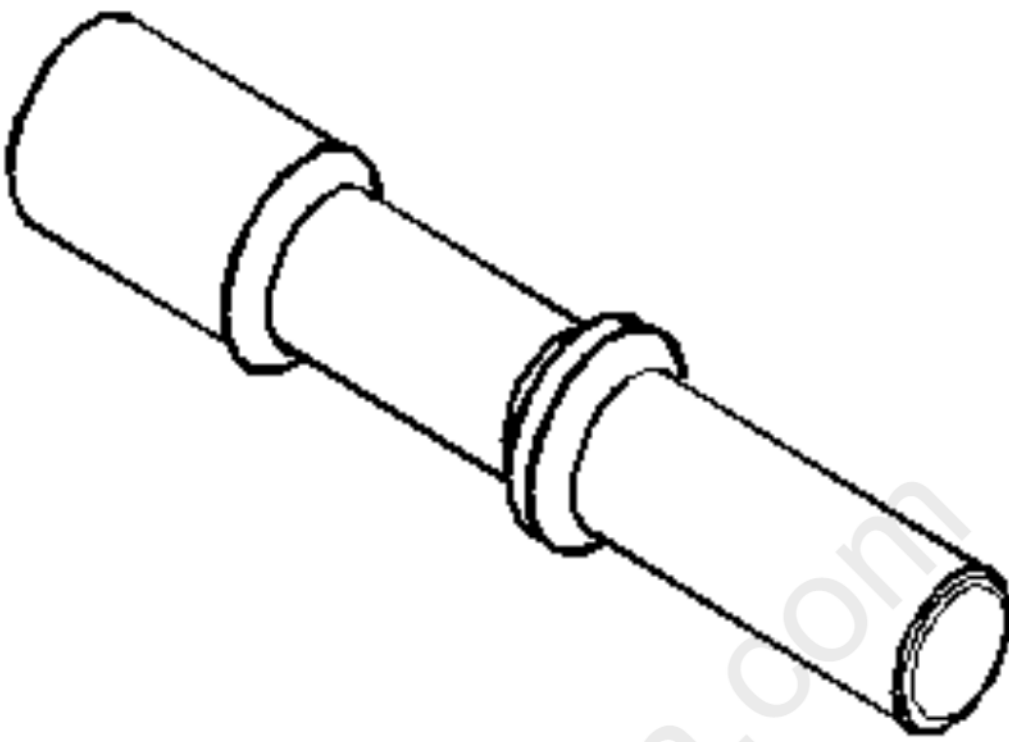
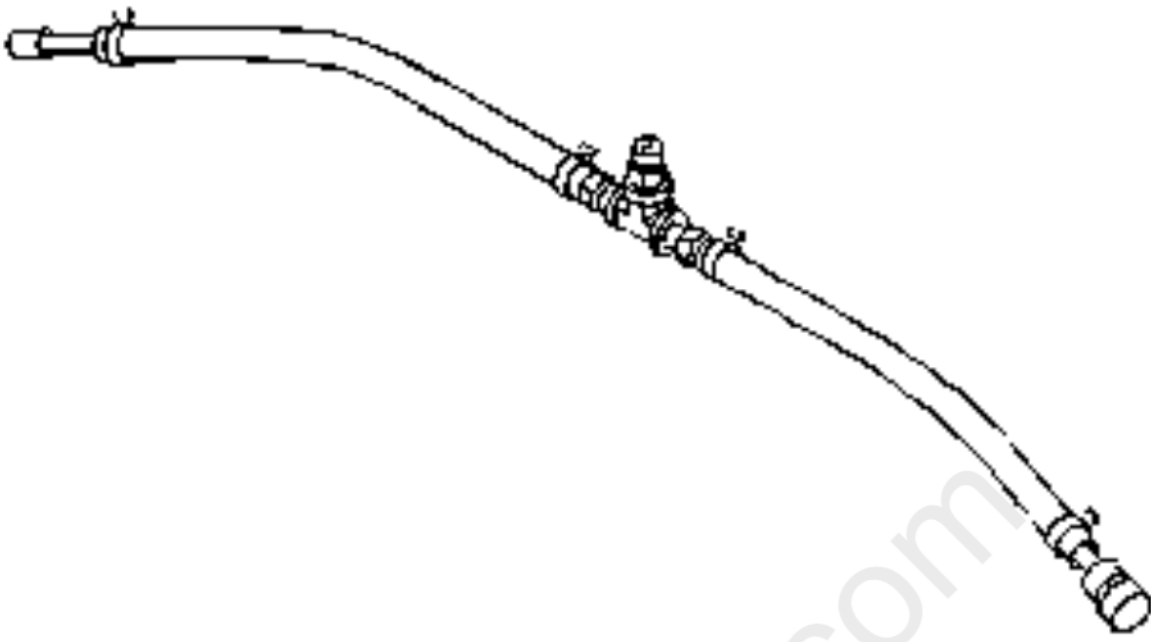
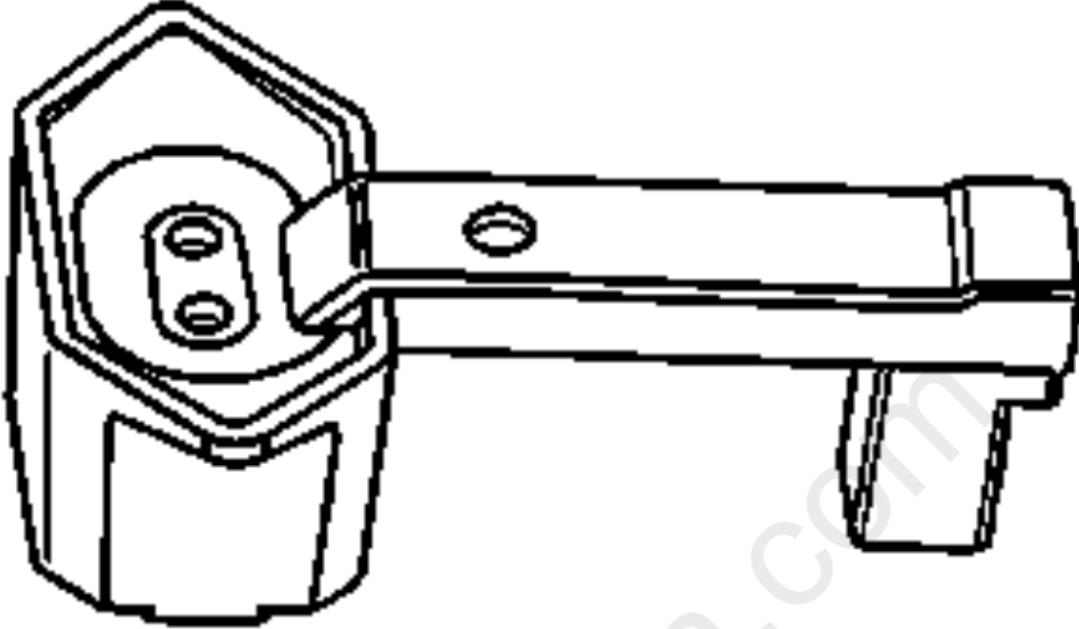
Illustration	Tool Number/Description
	

Illustration	Tool Number/Description
	CH-42982 J-42982 Fuel Pressure Gauge Adapter

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Illustration	Tool Number/Description
	CH-44175-A J-44175-A Fuel Composition Tester

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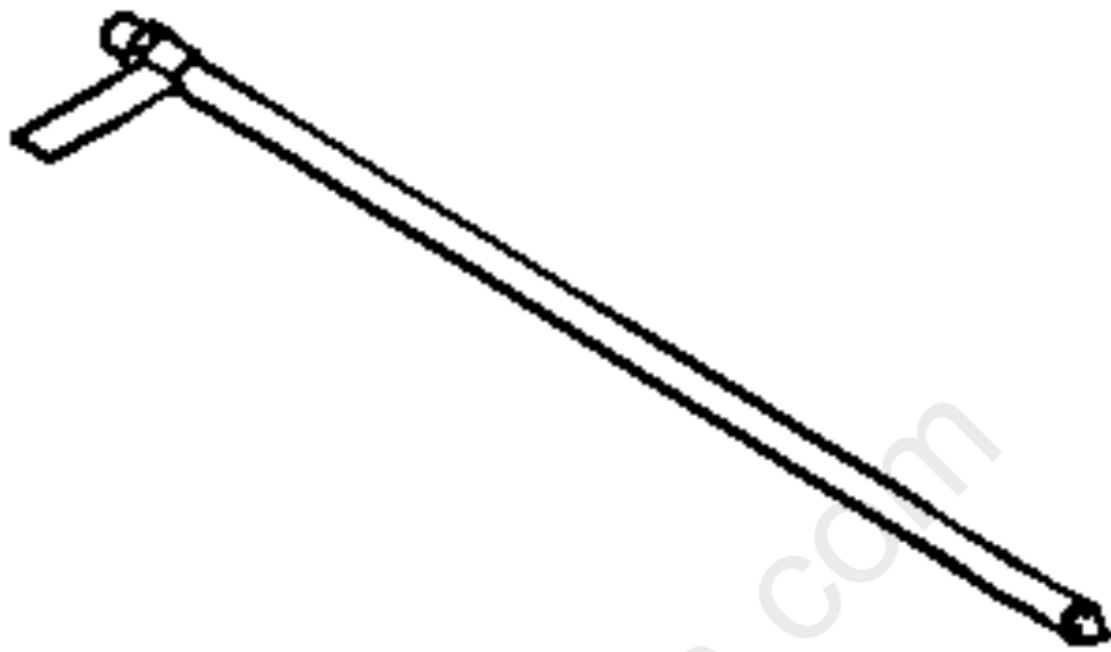
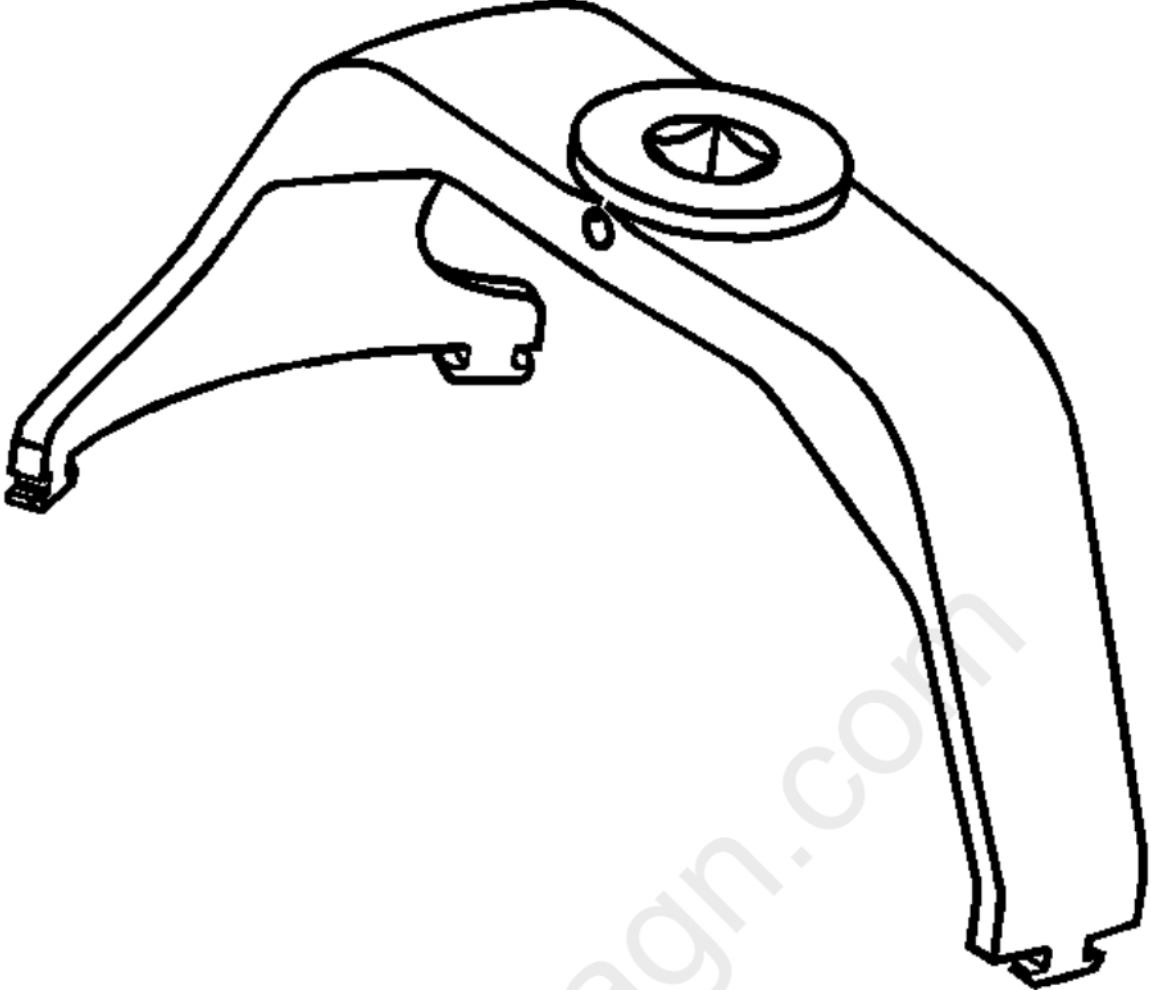
Illustration	Tool Number/Description
	CH-45004 J-45004 Fuel Tank Drain Hose

Illustration	Tool Number/Description
	CH-45722 J-45722 Fuel Sender Lock Ring Wrench

cardiagn.com

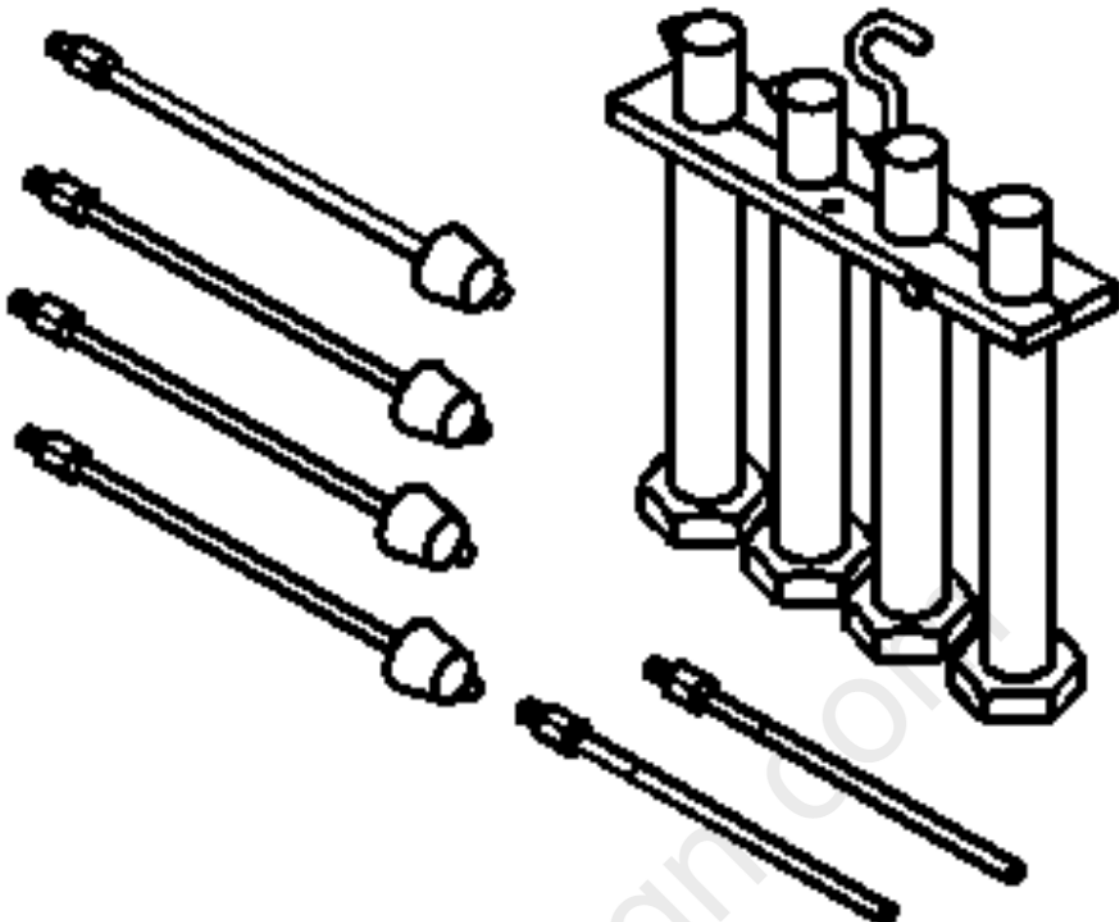
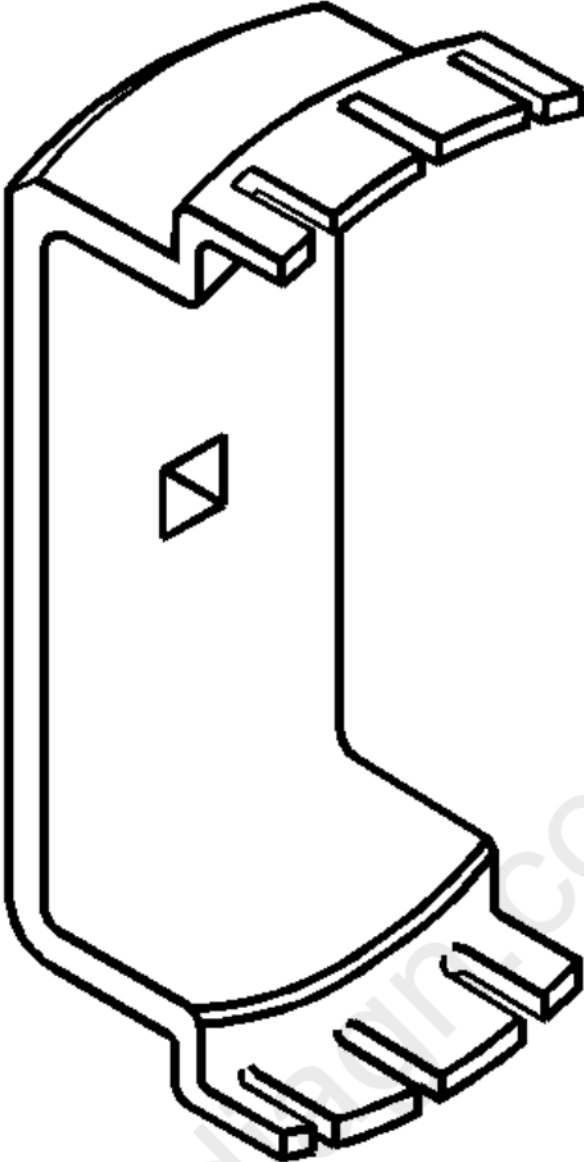
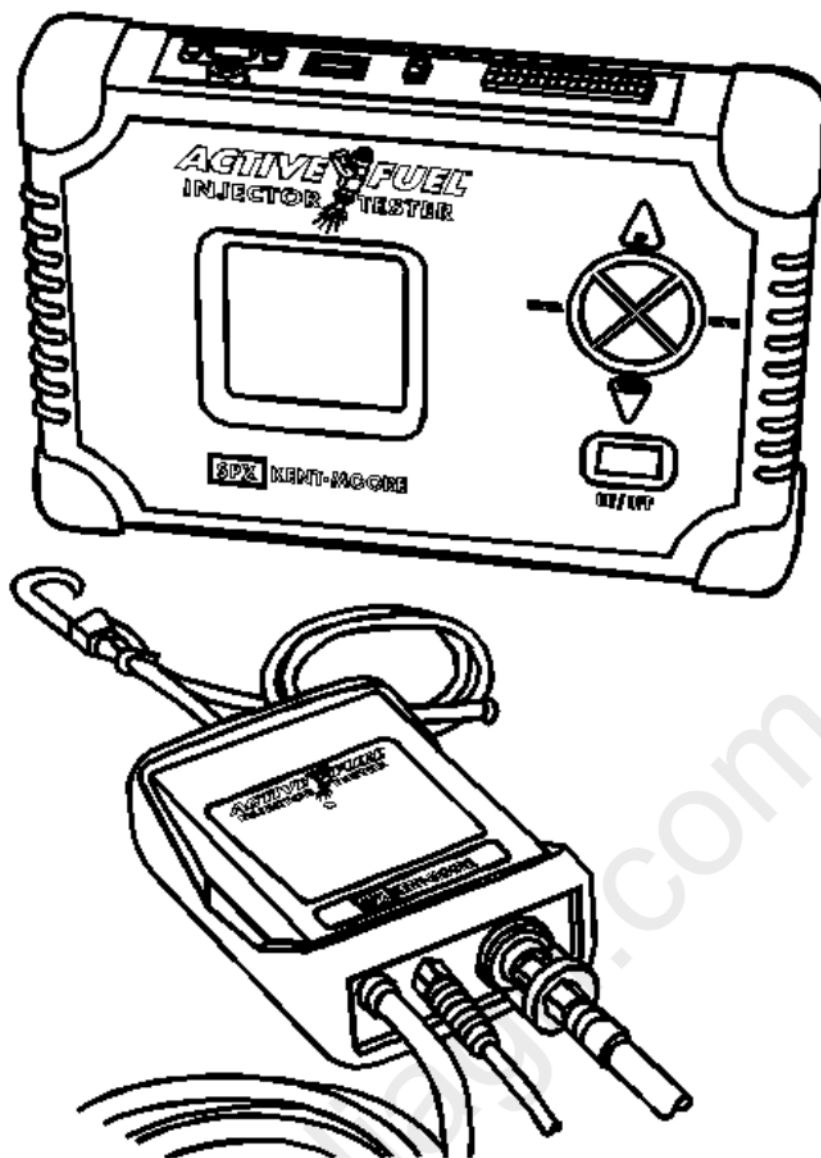
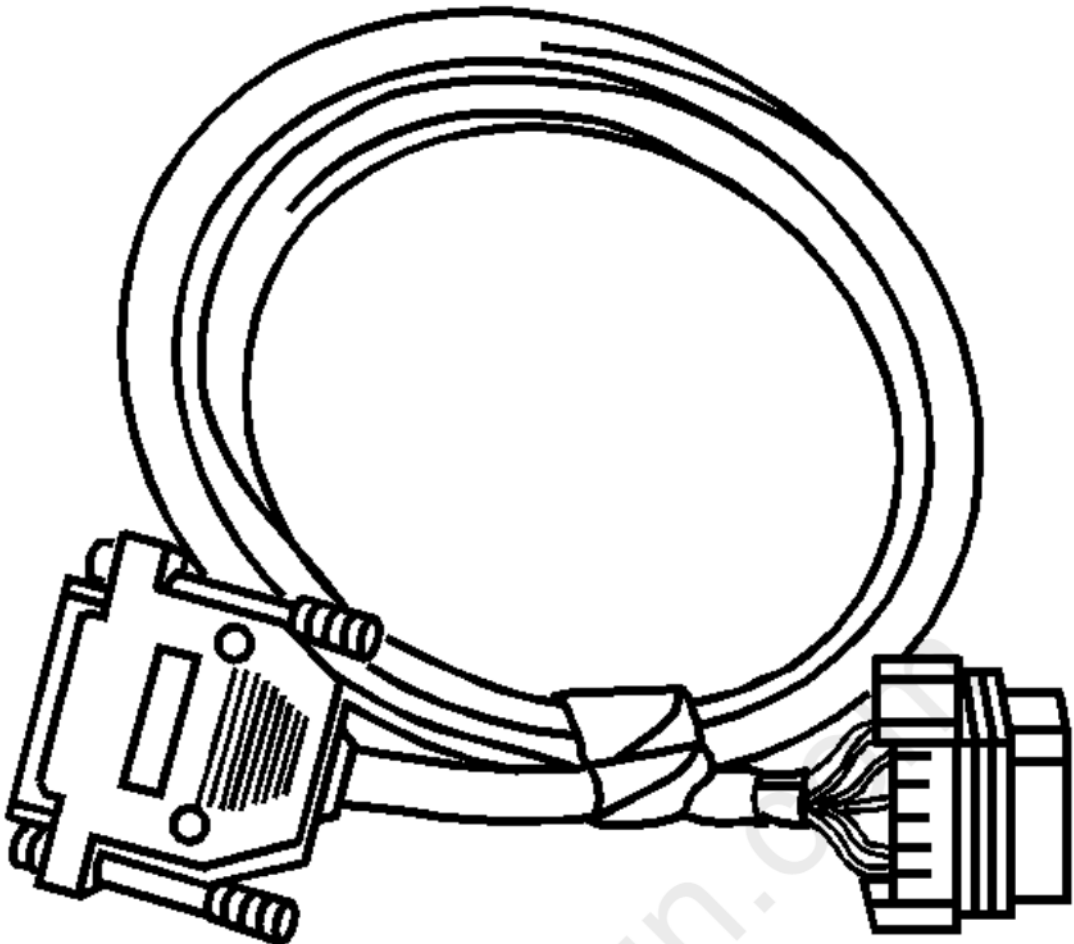
Illustration	Tool Number/Description
	CH-45873 J-45873 Fuel Return Volume Test Kit

Illustration	Tool Number/Description
	CH-47717 Lock Ring Wrench

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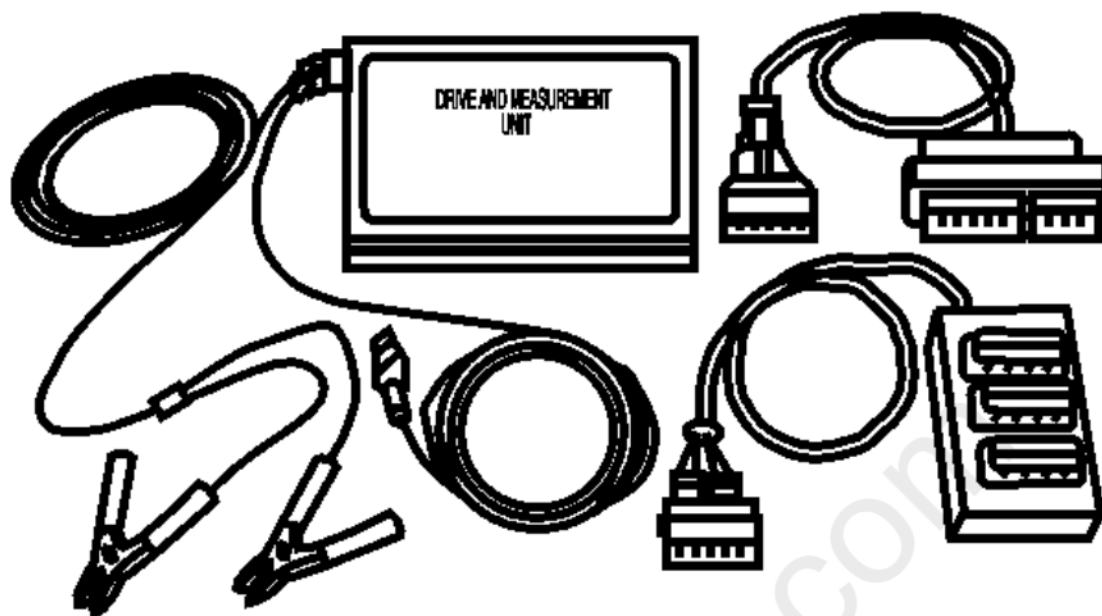
CH-47976
Active Fuel Injector
Tester (AFIT)

Illustration	Tool Number/Description
	CH-47976-75 Fuel Injector Harness Adapter

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Illustration

Tool Number/Description



CH-47976-500A
Active Fuel Injection
Tester (AFIT) SIDI
Adapter Kit

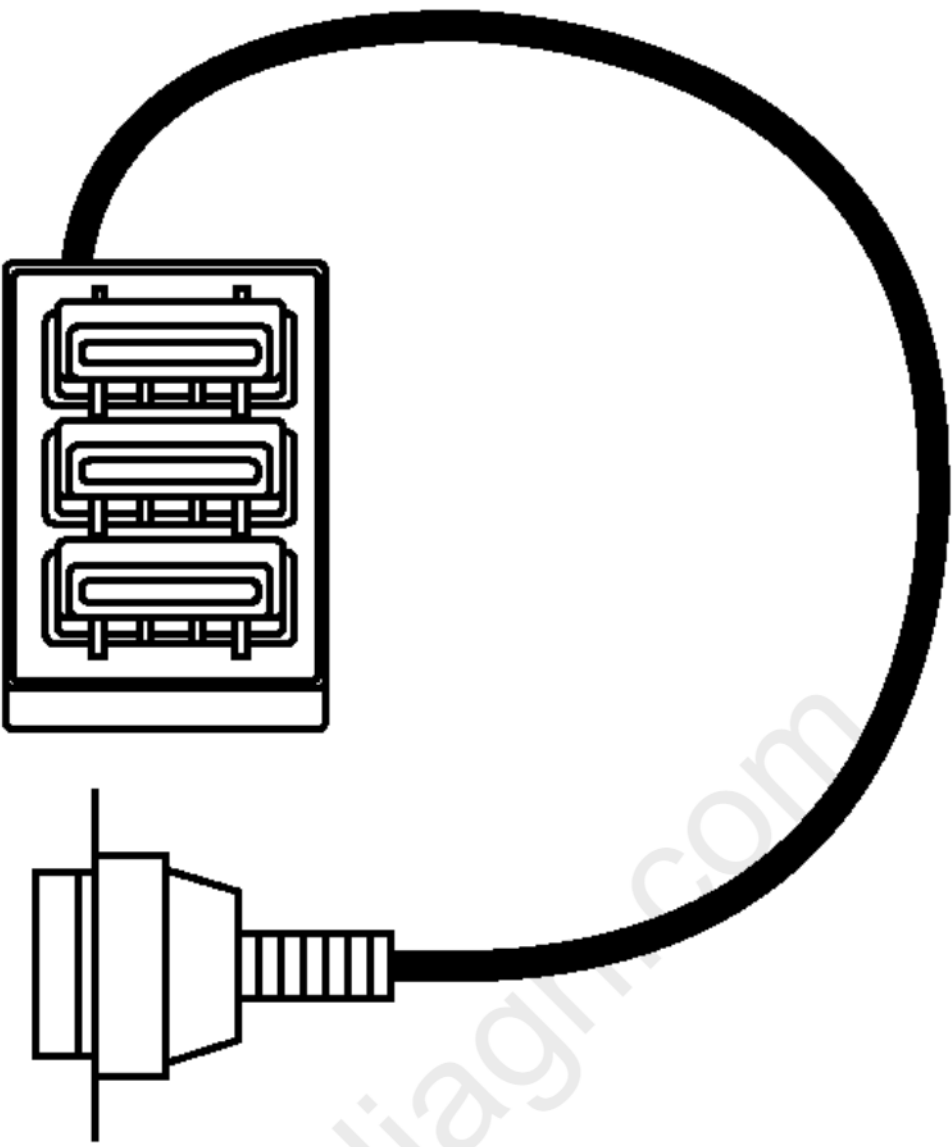
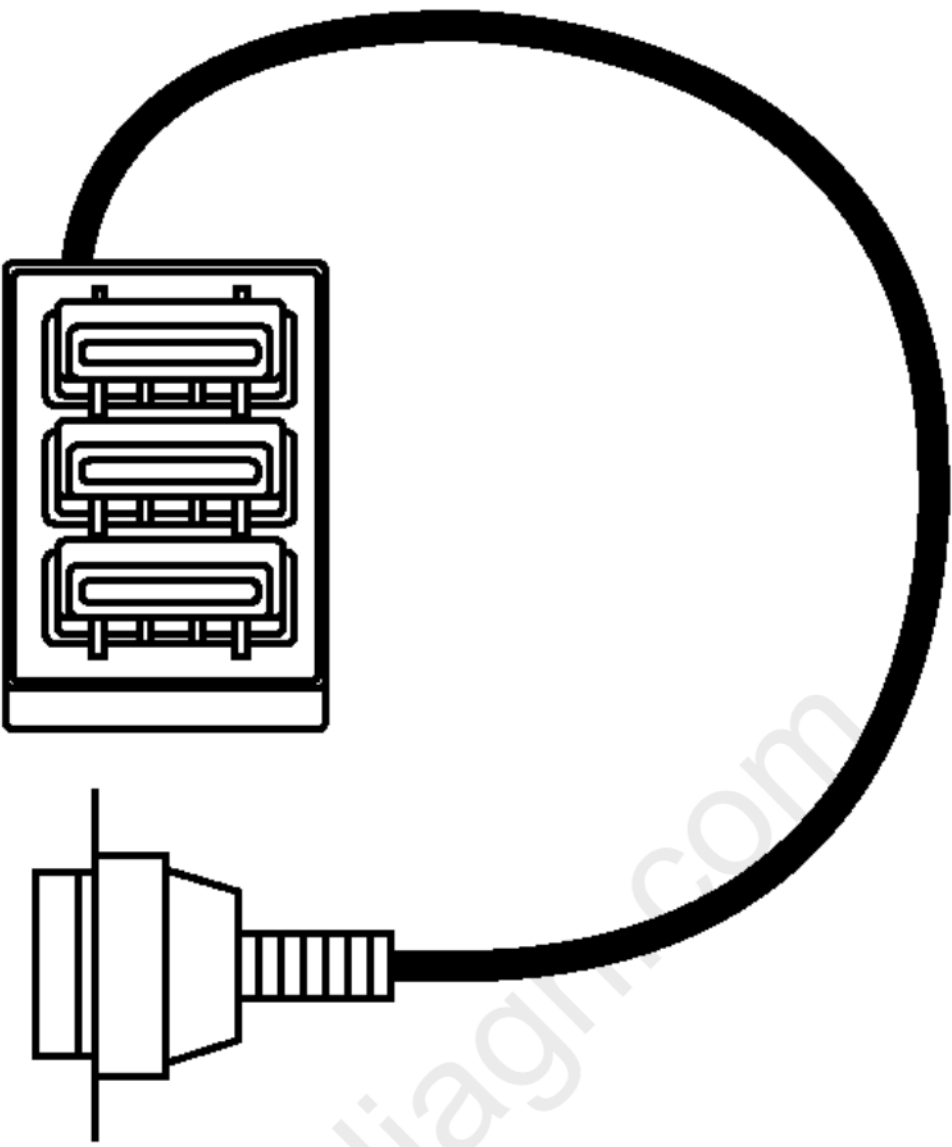
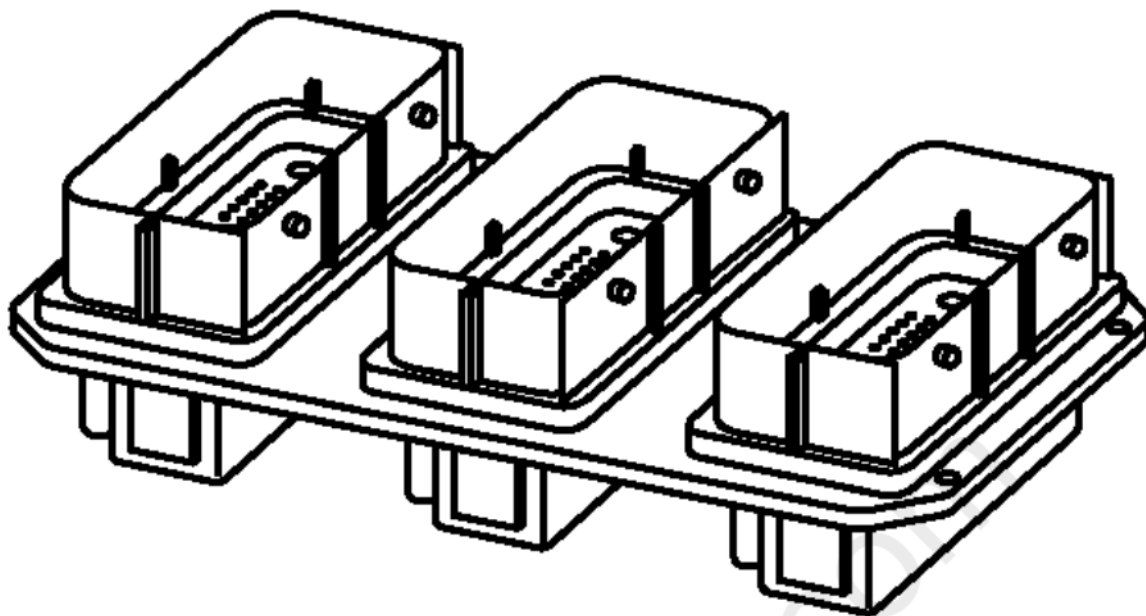
Illustration	Tool Number/Description
 The diagram shows a black cable forming a large loop. On the left side of the loop is a rectangular multi-pin connector with three rows of pins. On the bottom of the loop is a circular connector with a flange and a central pin. A diagonal watermark 'cardiagn.com' is visible across the lower half of the diagram.	CH-47976-502A AFIT SIDI E92 G2A Adapter Cable

Illustration	Tool Number/Description
	CH-47976-503 AFIT SIDI E80 G3 Adapter Cable

--

Illustration

Tool
Number/Description



CH-47976-504
E92/E39A G2B
Start/Stop Adapter

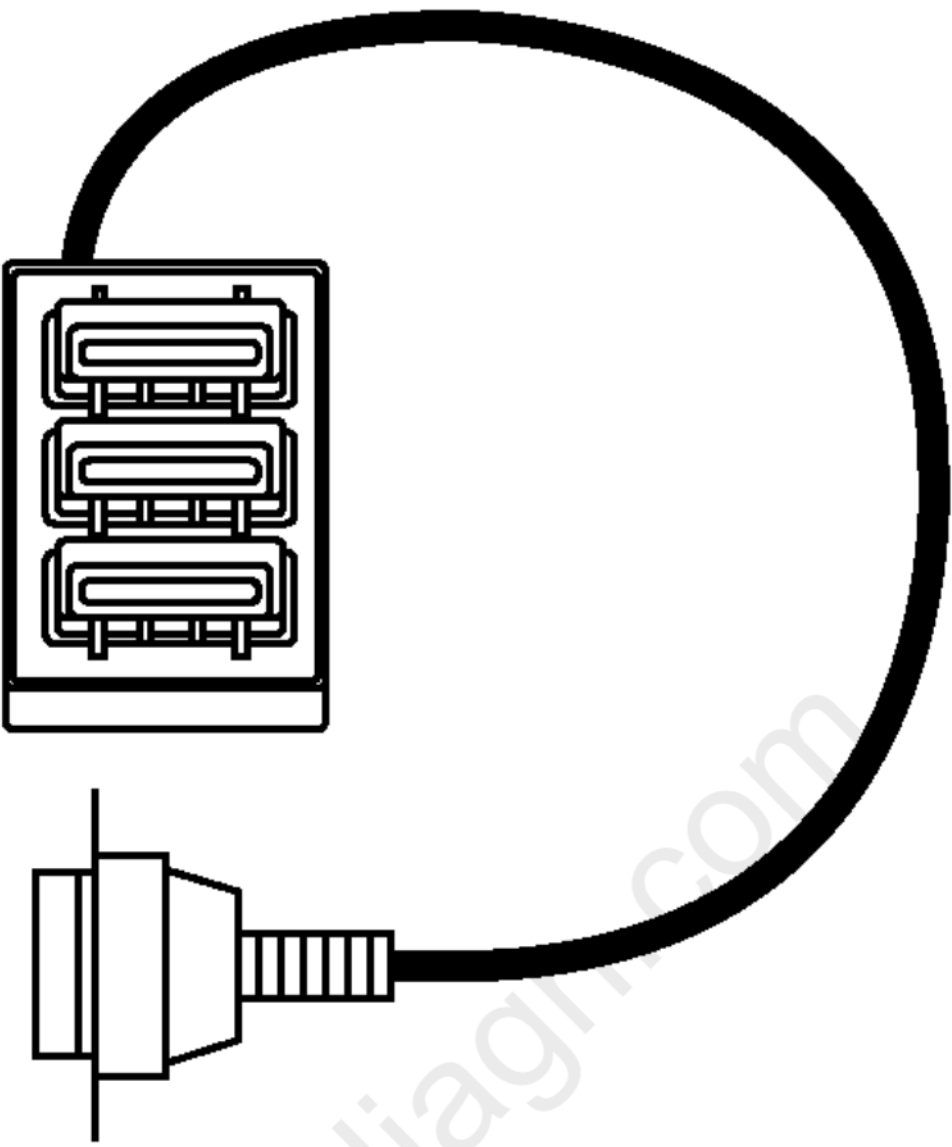
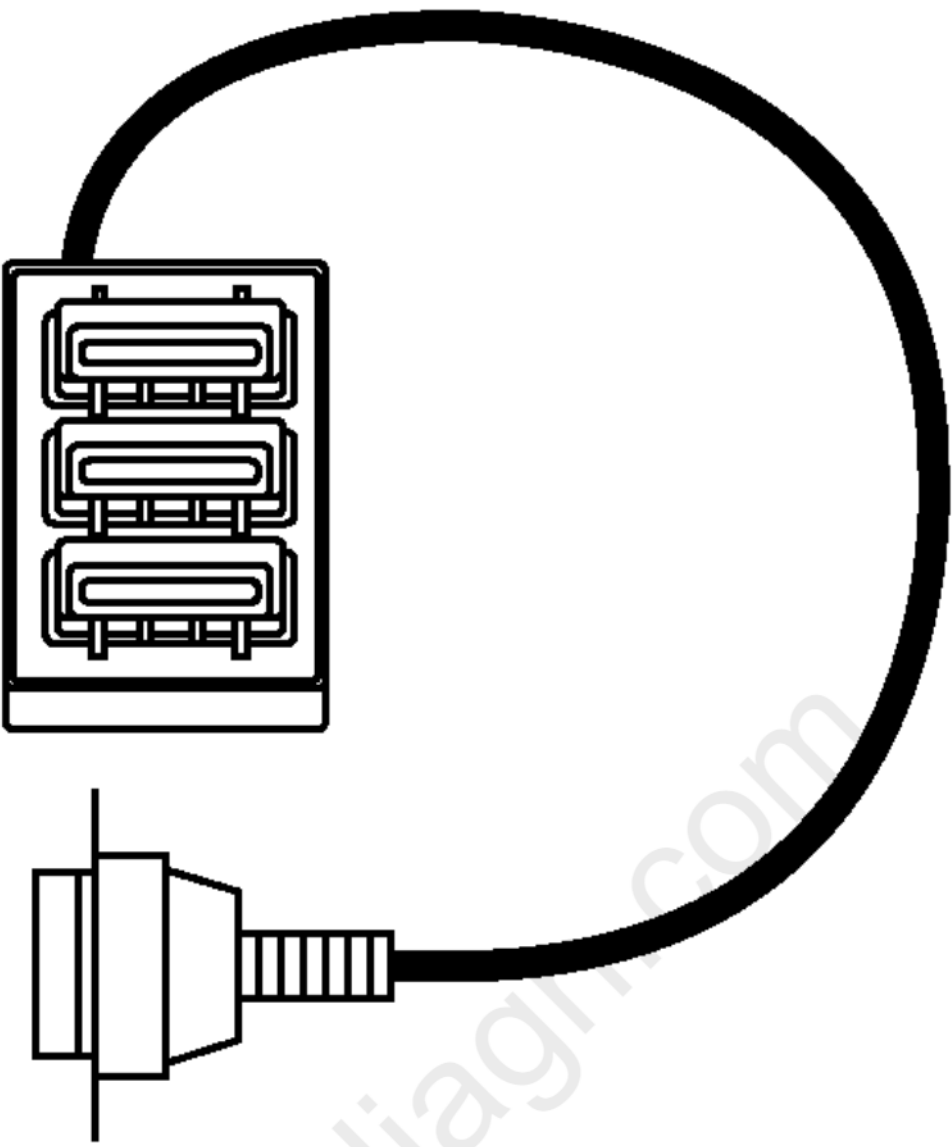
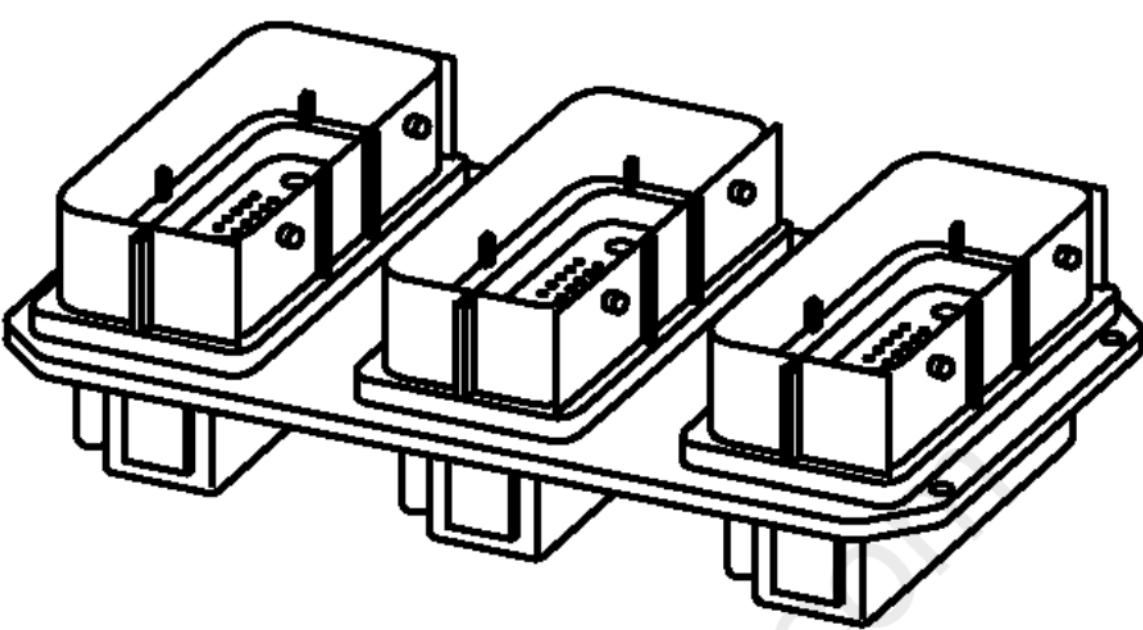
Illustration	Tool Number/Description
 The diagram shows an adapter cable. On the left is a rectangular connector with three horizontal slots, each containing a smaller rectangular component. On the right is a multi-pin connector with a series of vertical pins. A thick black cable connects the two connectors, forming a large loop. A faint watermark 'cardiagm.com' is visible across the diagram.	CH-47976-509 AFIT SIDI E81 G4 Adapter Cable

Illustration	Tool Number/Description
 The diagram shows an adapter cable. On the left is a rectangular connector with three horizontal slots, each containing a smaller rectangular component. On the right is a multi-pin connector with a series of vertical pins. A thick black cable connects the two connectors, forming a large loop.	CH-47976-511 AFIT SIDI E82 G5 Adapter Cable

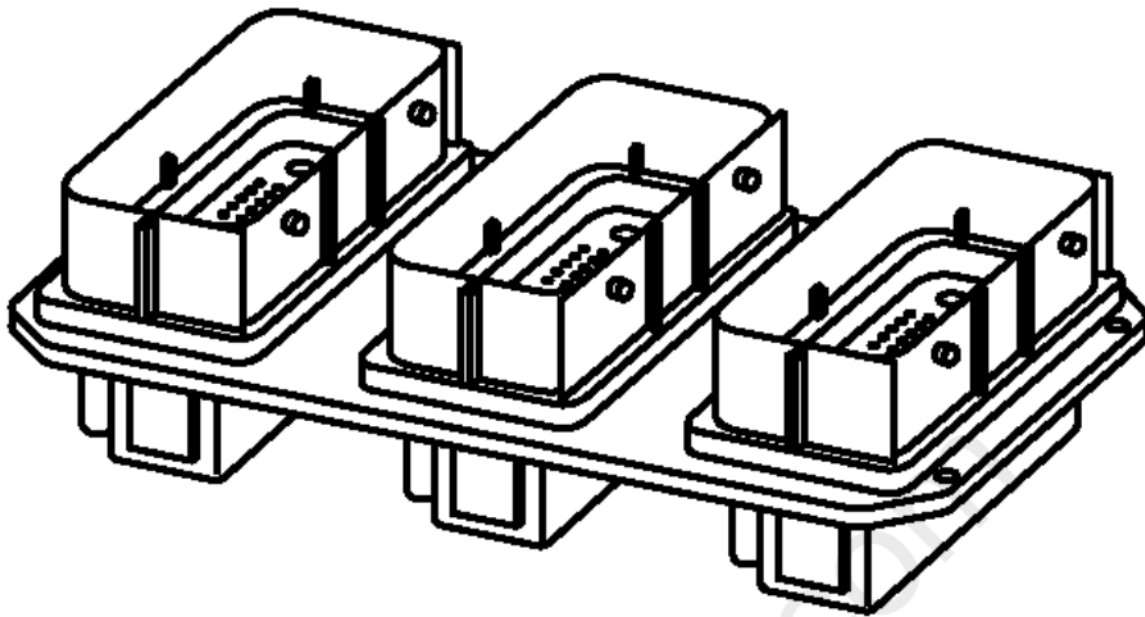
cardiagm.com

Illustration	Tool Number/Description
	CH-47976-512 E80 G3B Stop/Start Adapter

cardiagn.com

Illustration

Tool
Number/Description



CH-47976-513
E92 G2C Stop/Start
and SENT Adapter

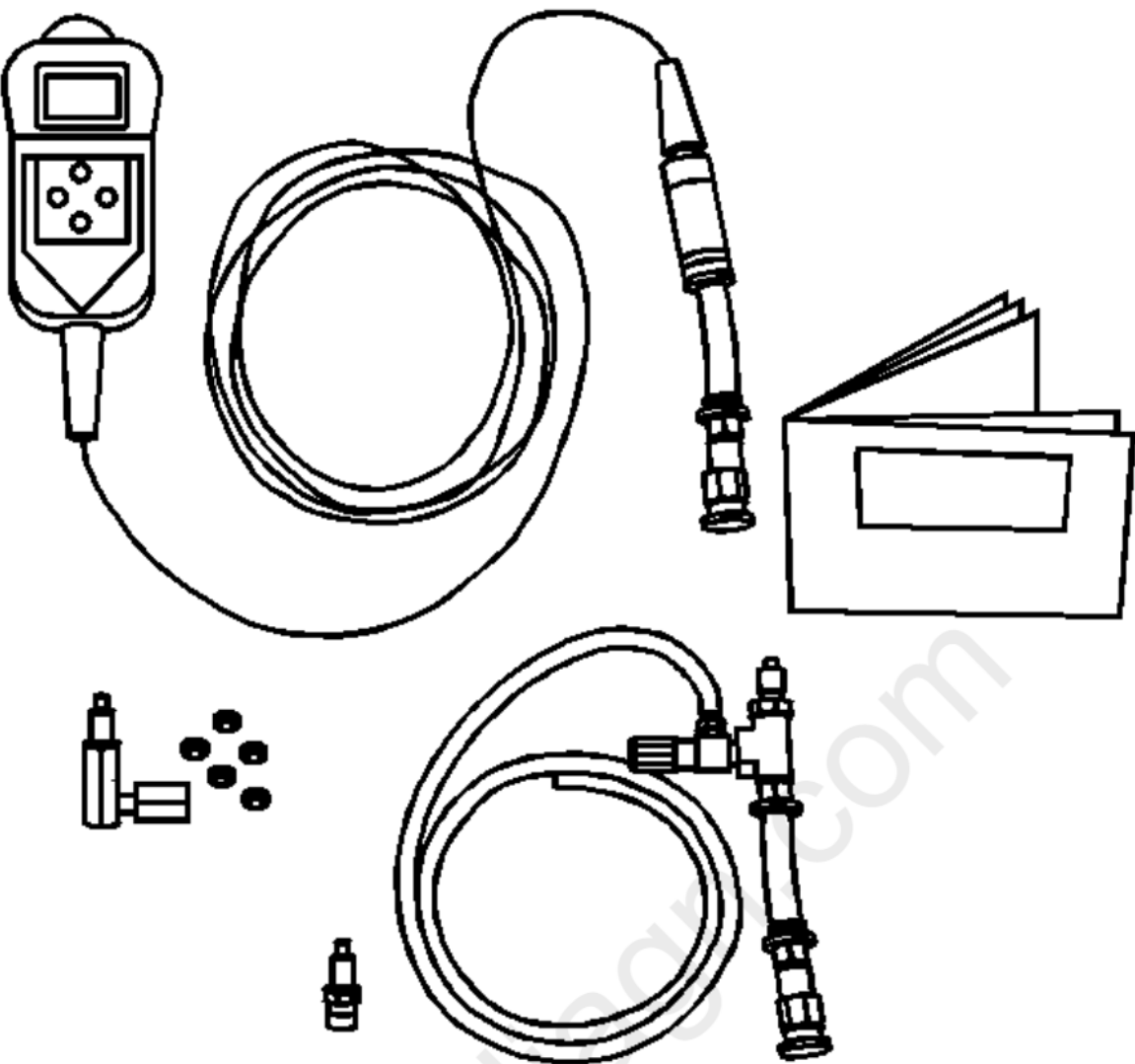
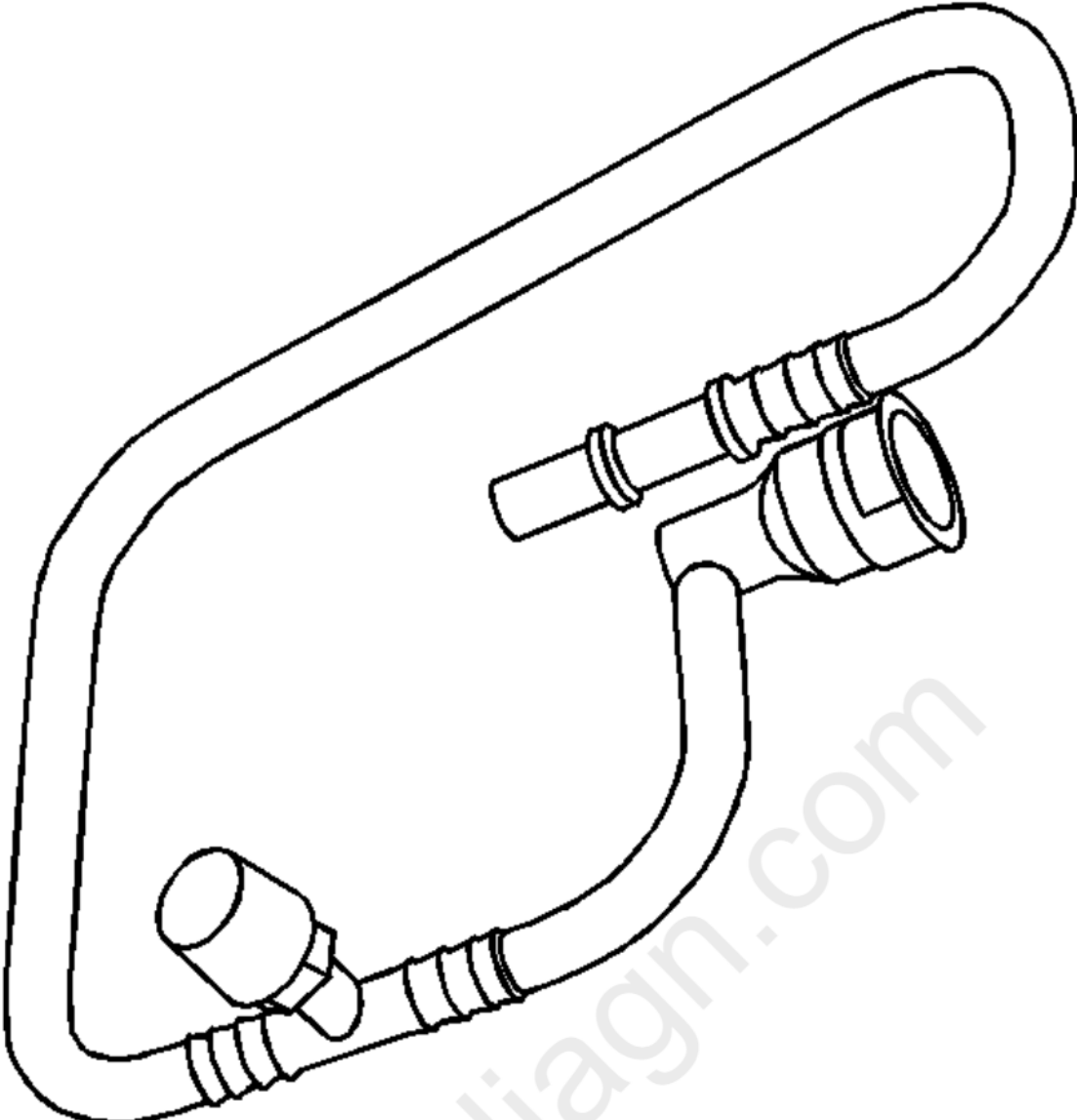
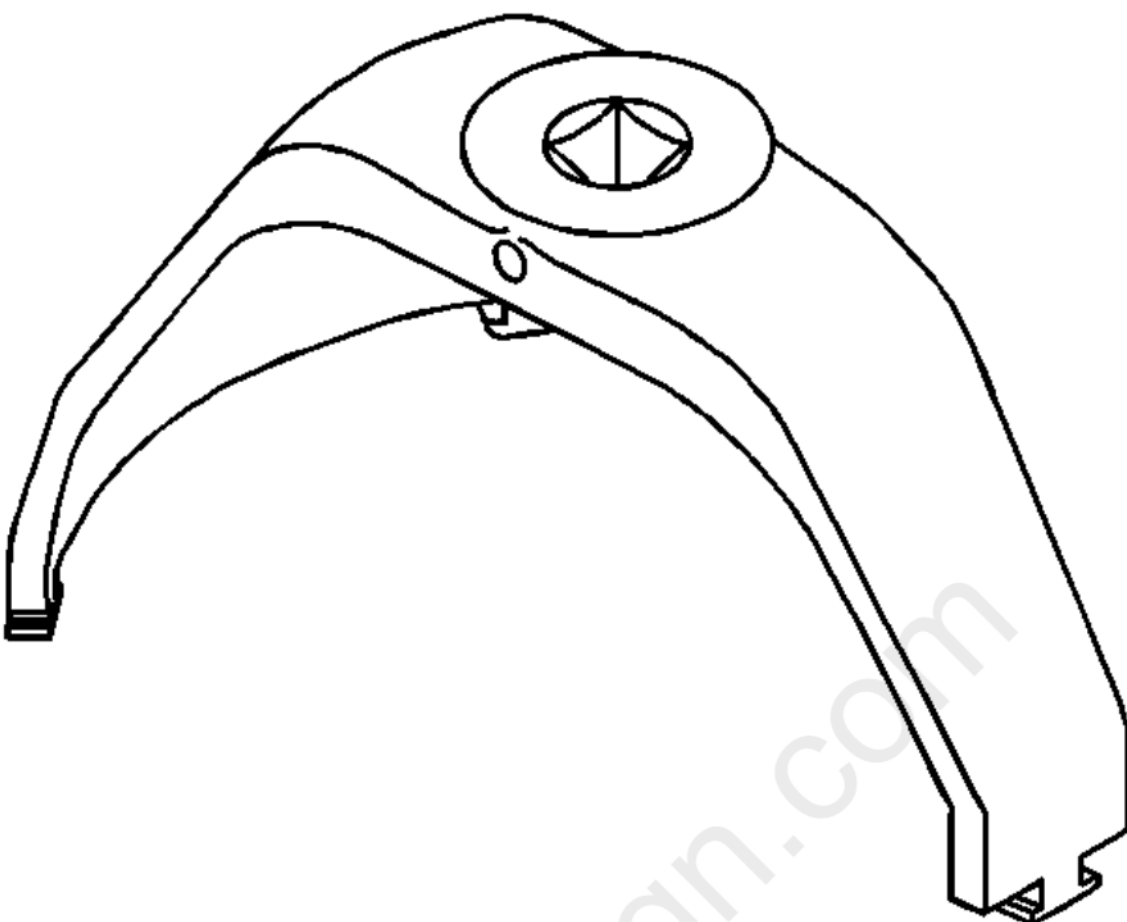
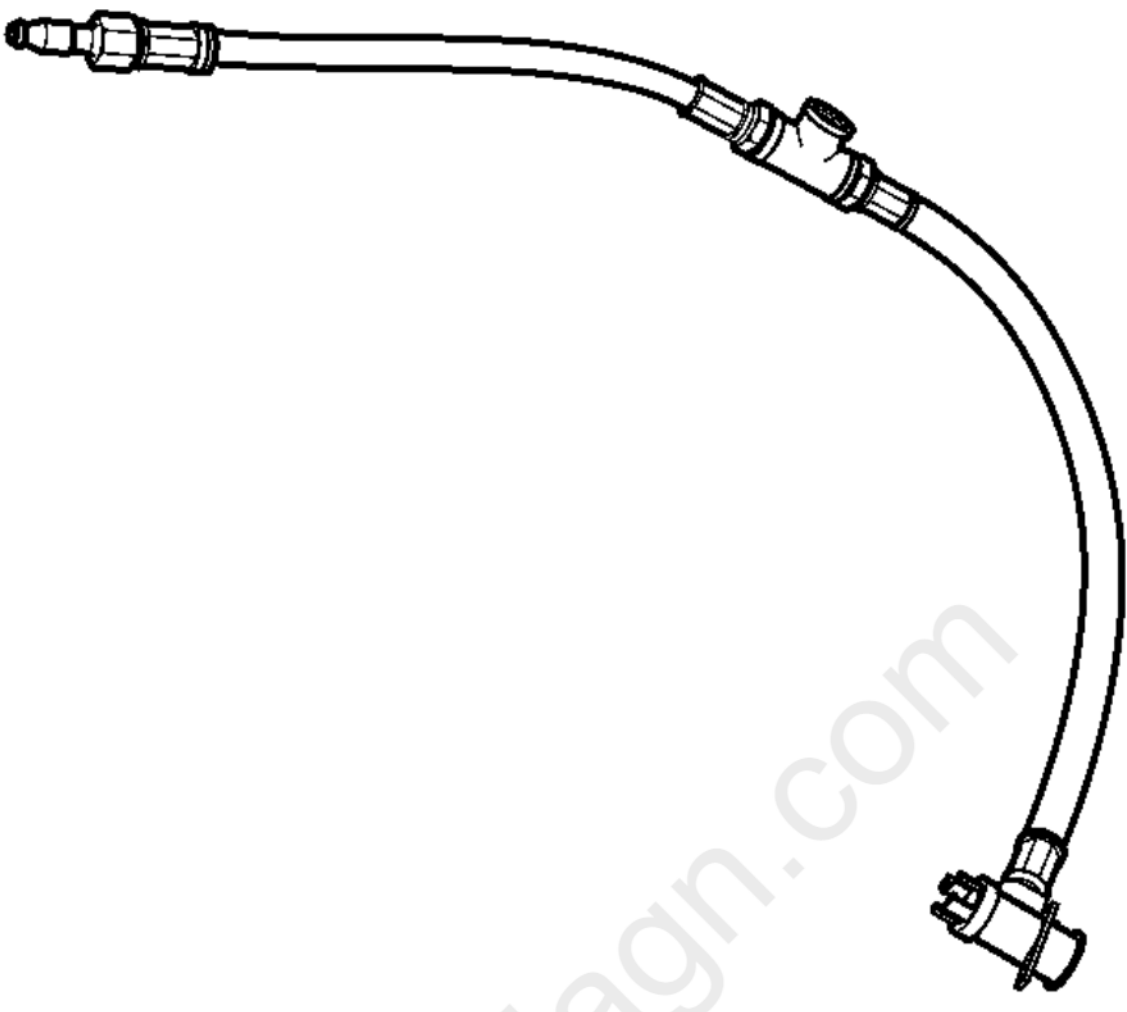
Illustration	Tool Number/Description
	CH-48027 Fuel Pressure Gauge

Illustration	Tool Number/Description
	CH-48096 EVAP Service Access Port Tool

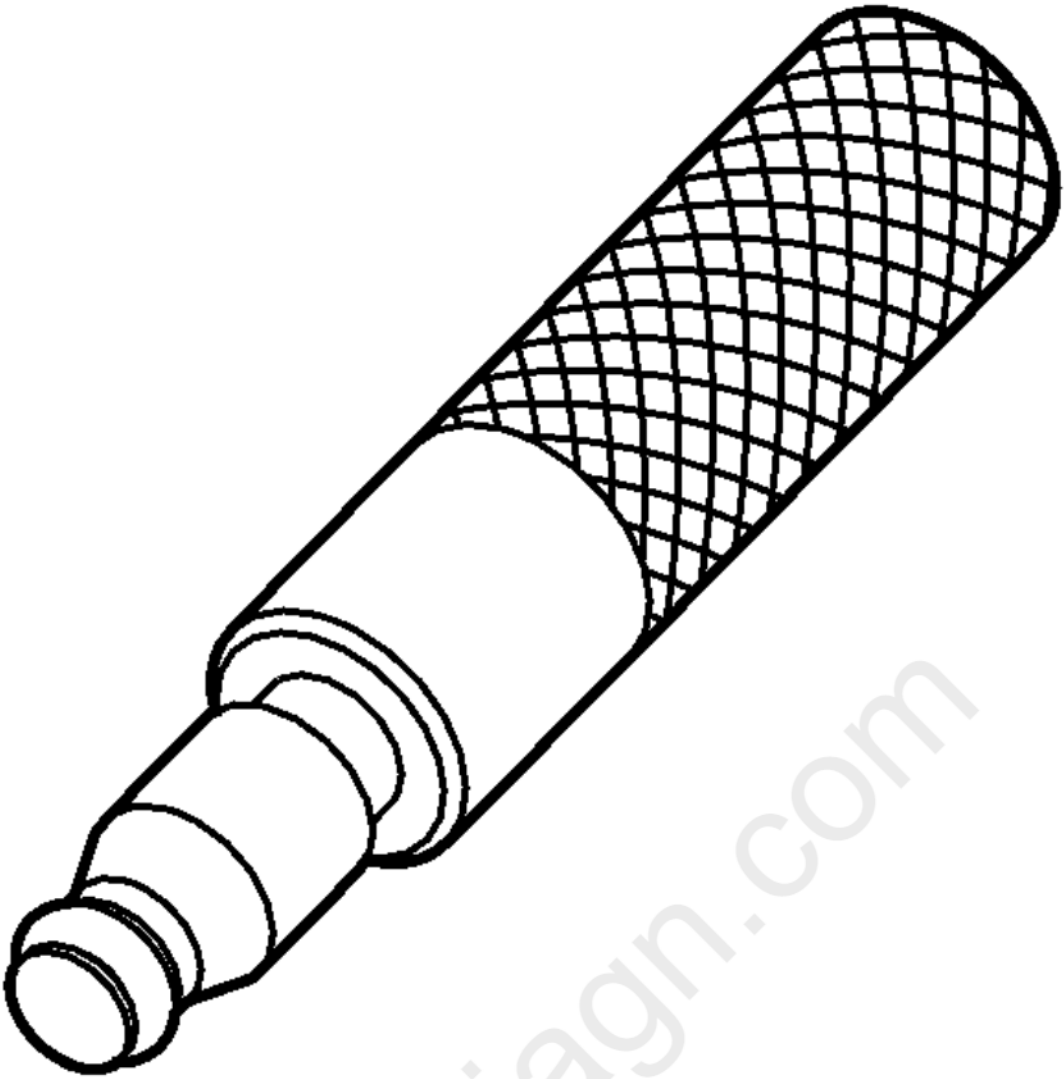
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Illustration	Tool Number/Description
	CH - 48482 Fuel Sender Lock Ring Wrench

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Illustration	Tool Number/Description
	CH-50375 Diesel Injector Return Line Pressure Adapter

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Illustration	Tool Number/Description
 The illustration shows a cylindrical tool, likely a cap or plug, oriented diagonally. The tool has a threaded section at the front (bottom left) and a knurled grip section at the back (top right). A watermark 'cardiagn.com' is visible across the center of the illustration.	CH-50377-A Injector Return Line Cap

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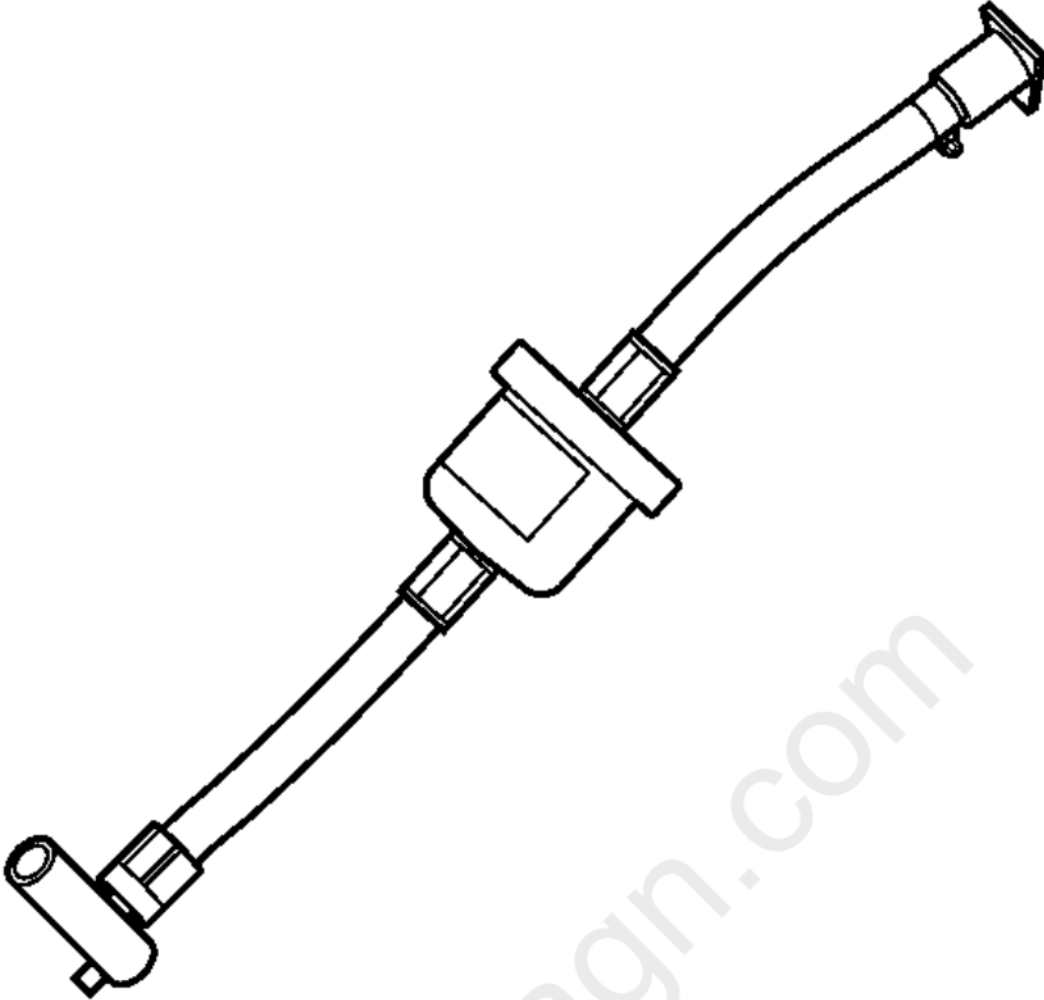
Illustration	Tool Number/Description
	CH-50378 Injector Return Leakage Test Adapter

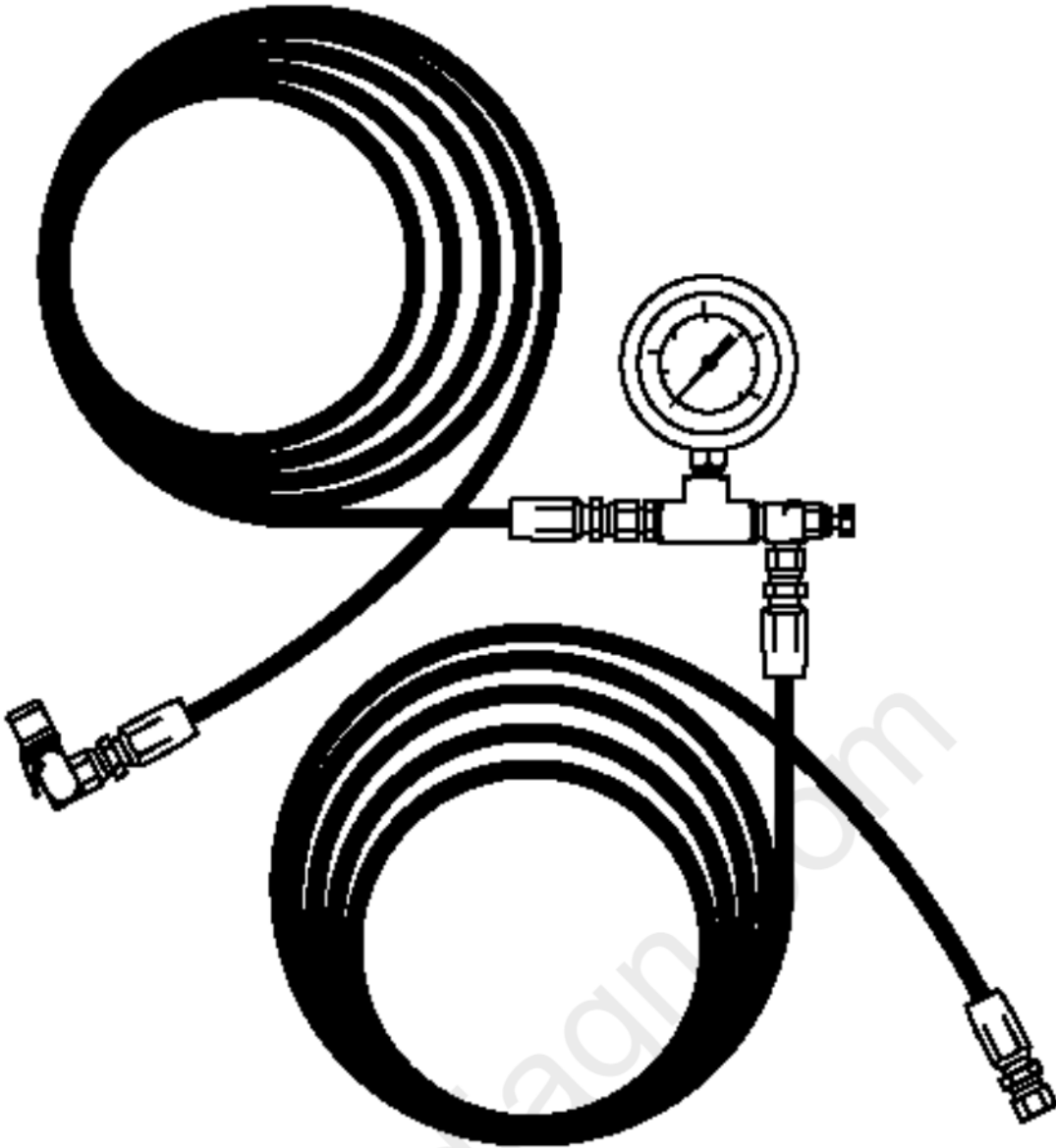
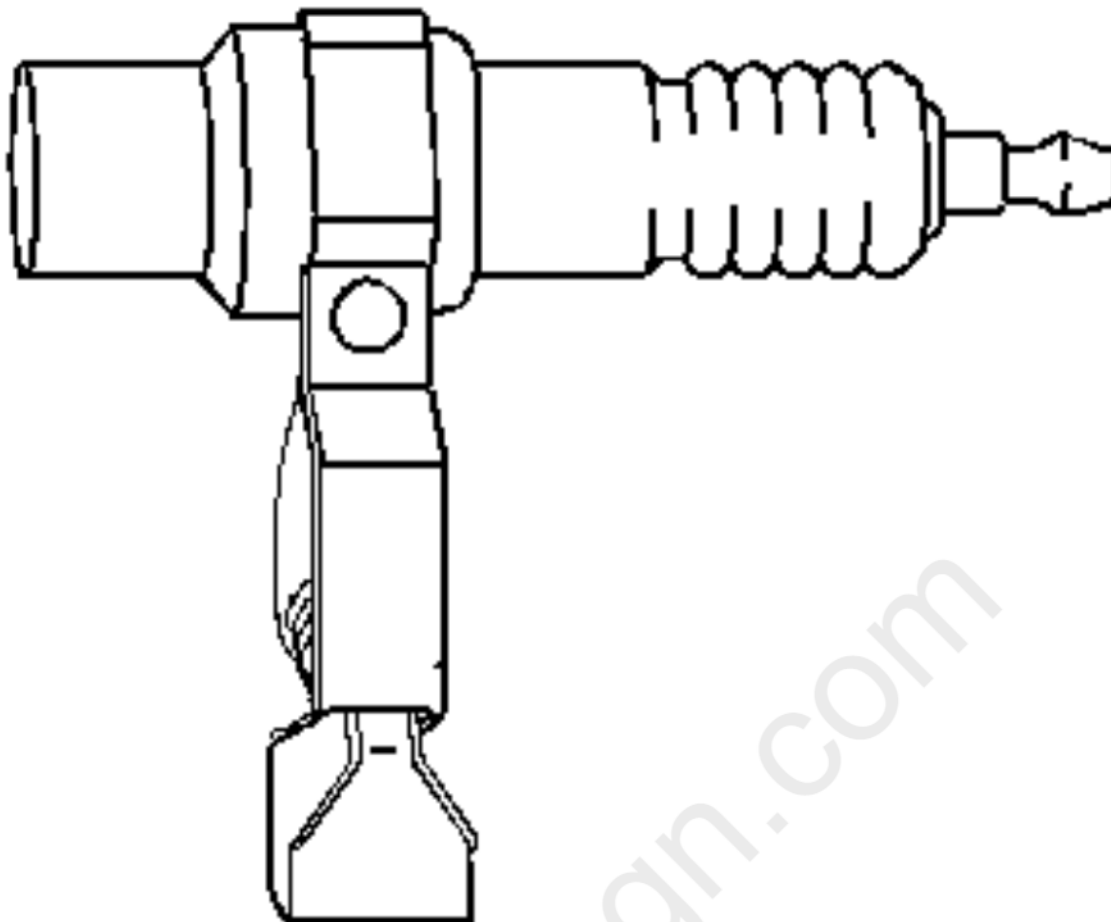
Illustration	Tool Number/Description
	CH-50933 Gauge Assembly, Liquid Propane Gas (LPG)
	EL-26792 J-26792 HEI Spark Tester

Illustration	Tool Number/Description
	
	EL-34730-405 J-34730-405 Injector Test Lamp

Illustration

Tool
Number/Description

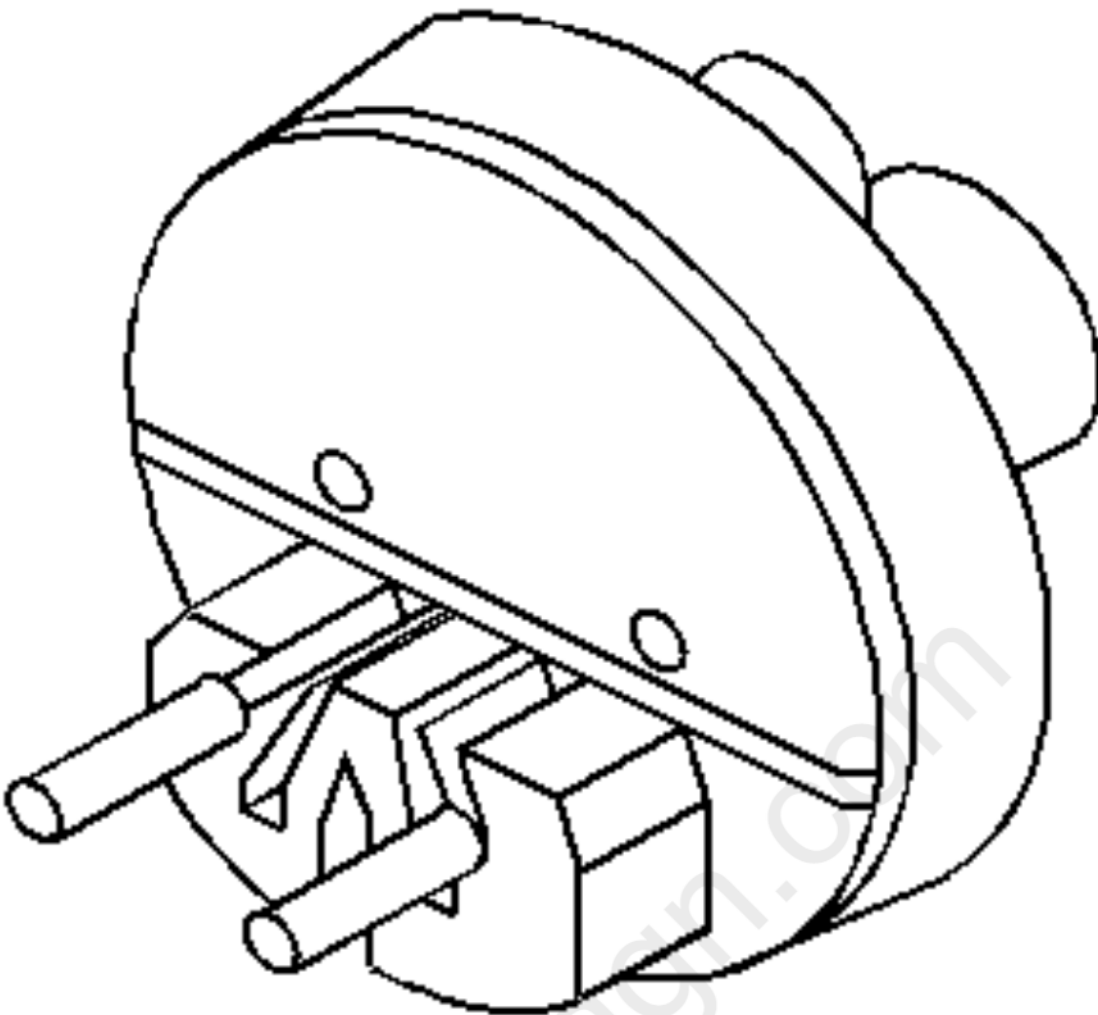


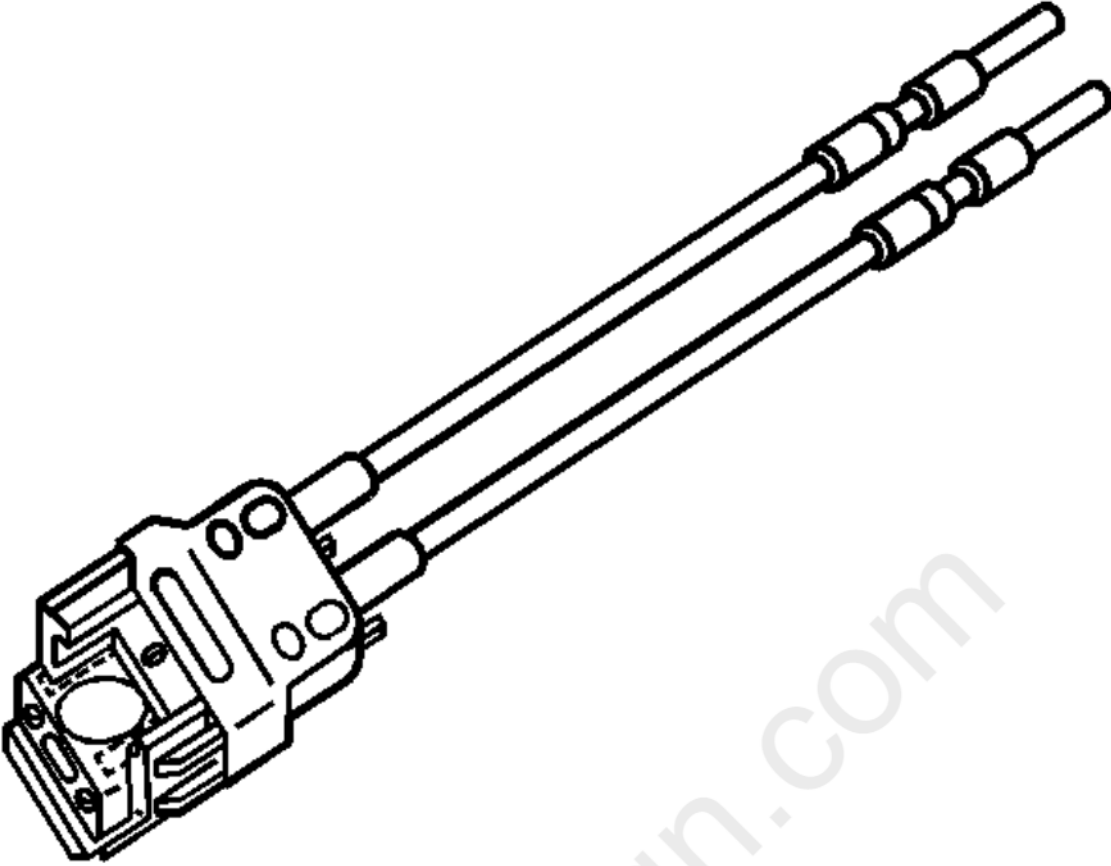
Illustration	Tool Number/Description
	EL-36169-HD Heavy Duty Fused Jumper
	EL-38522-A J-38522-A Variable Signal Generator

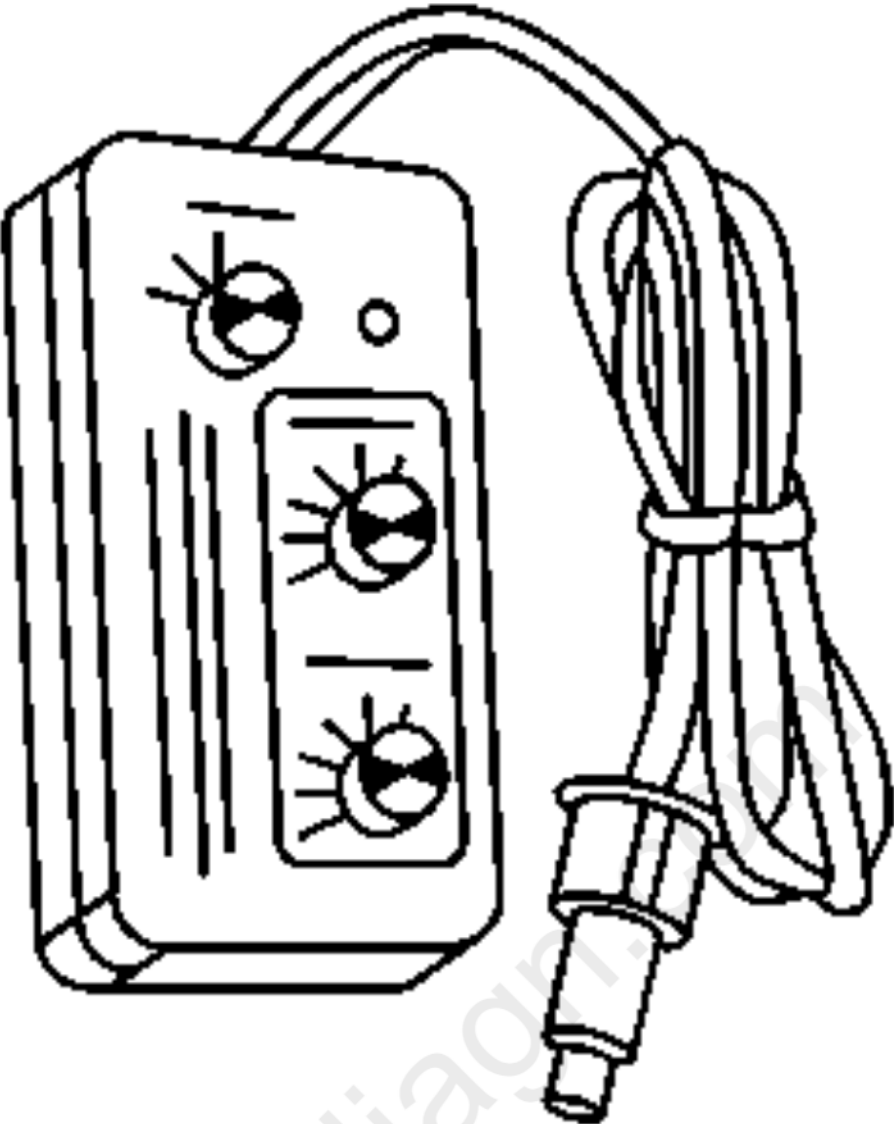
Illustration	Tool Number/Description
 A line drawing of a medical device, likely a defibrillator or resuscitator. The device has a rectangular control panel with three large, circular buttons arranged vertically. Each button has a symbol resembling a stylized 'E' or a lightning bolt. To the left of the buttons are several vertical lines, possibly representing a display or ventilation ports. A coiled cable is attached to the top of the device, ending in a specialized connector with a cylindrical base and a pointed tip. A faint watermark 'Cardiac' is visible across the image.	

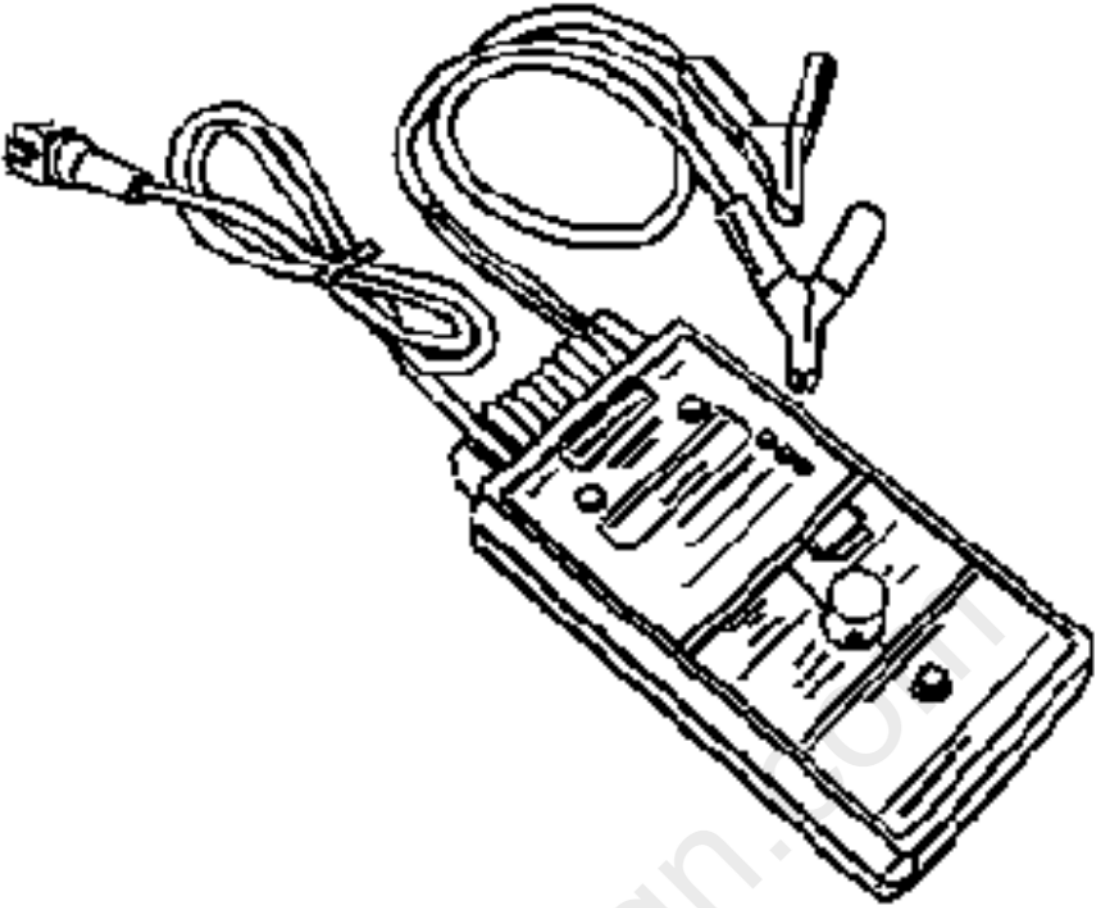
Illustration	Tool Number/Description
	EL-39021 J-39021 Fuel Injector Coil Balance Tester

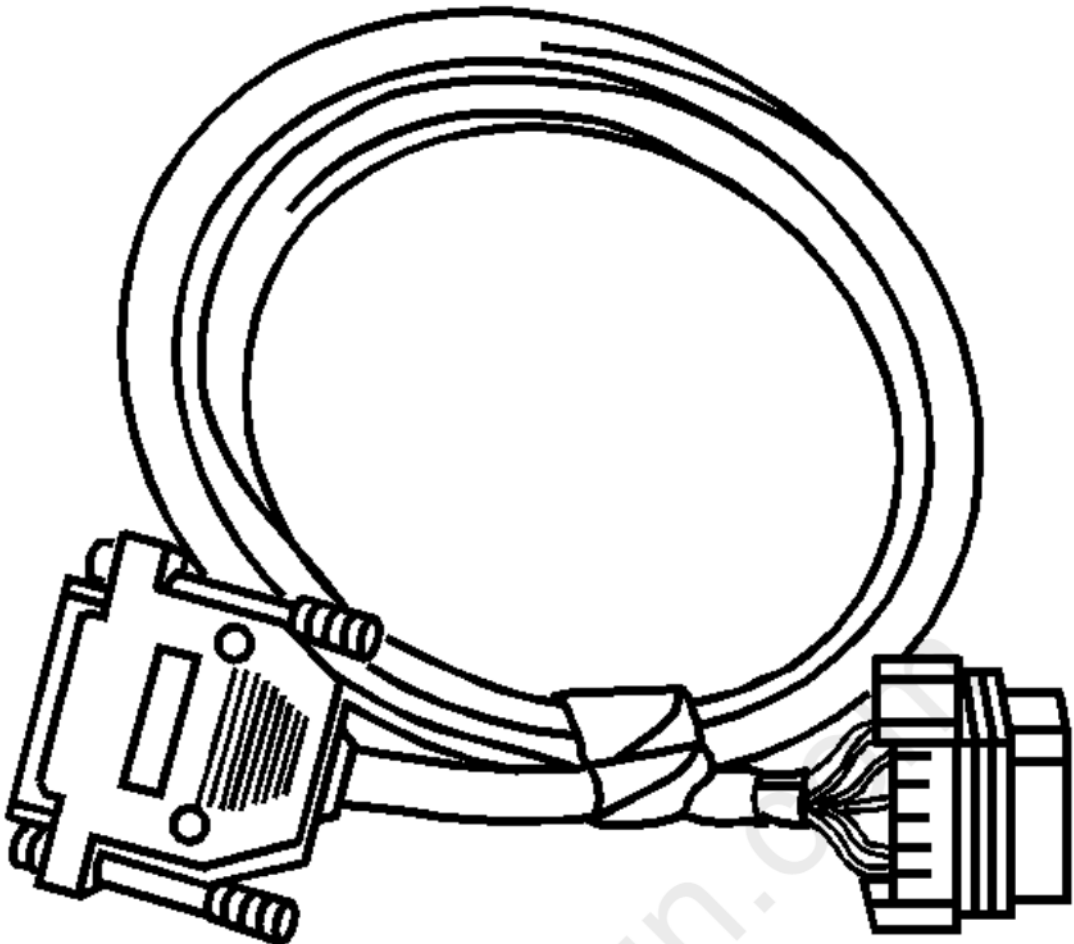
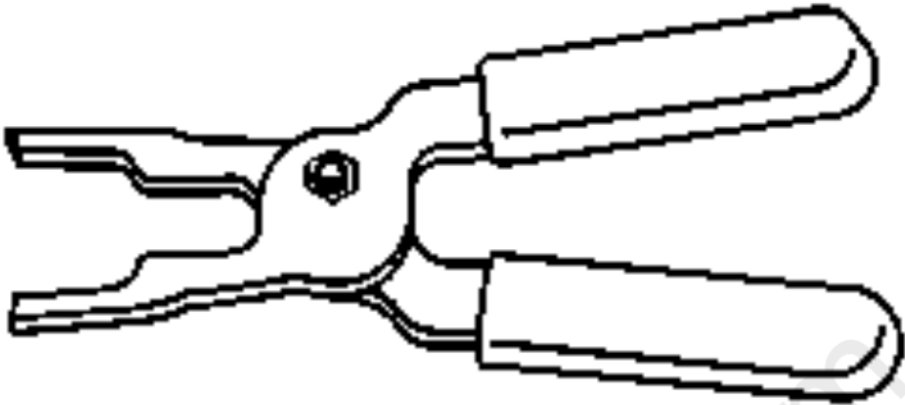
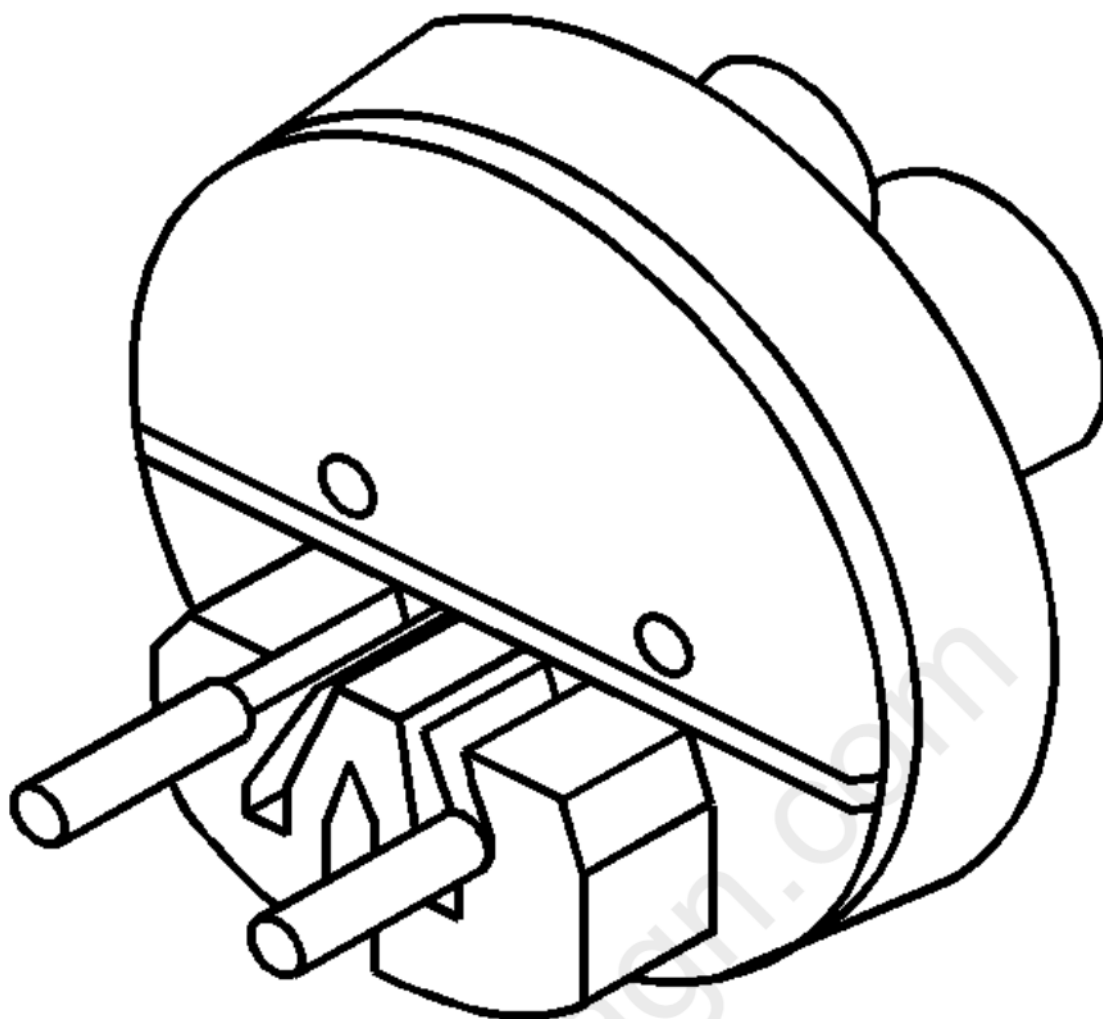
Illustration	Tool Number/Description
	EL-39021-460 J-39021-460 Fuel Injector Test Adapter

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

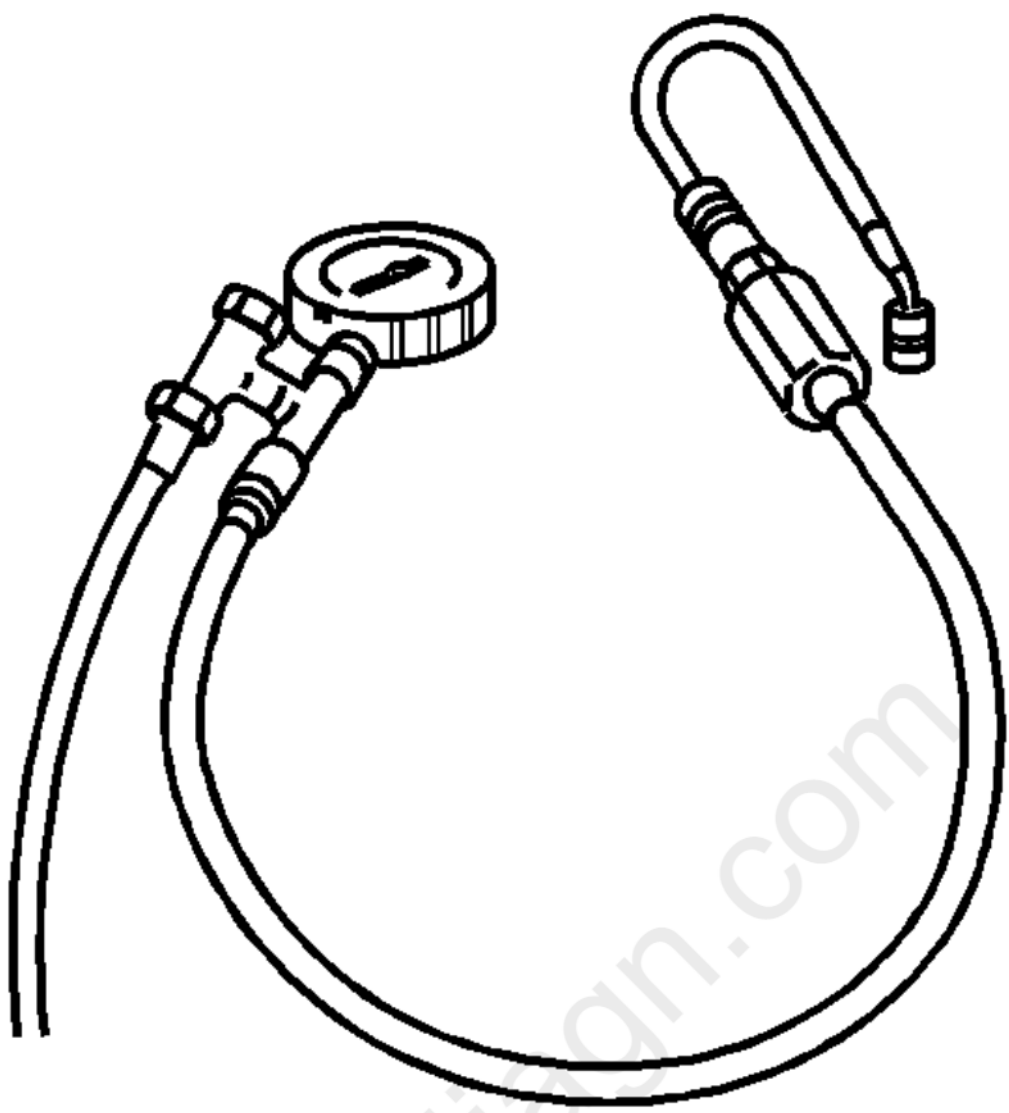
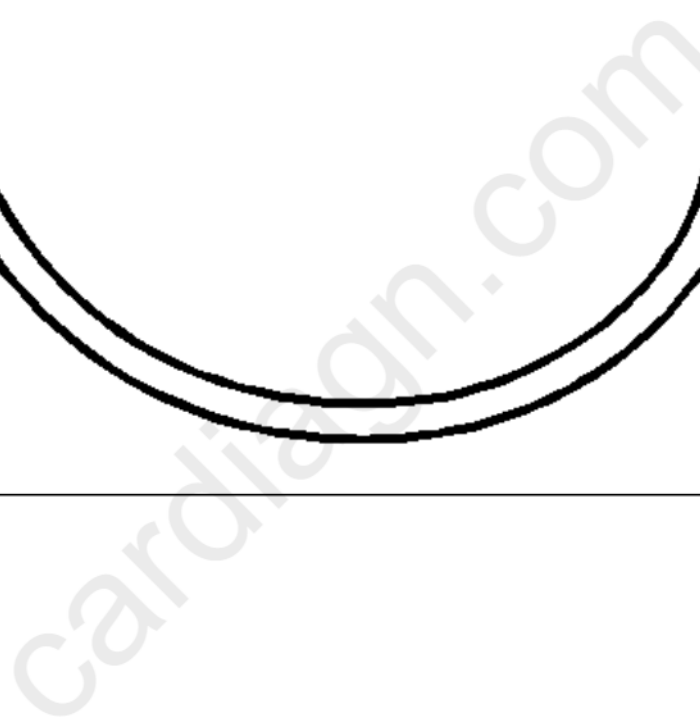
Illustration	Tool Number/Description
	EN-34730-91 J-34730-91 KM-J-34730-91 Pressure Tester
	EN-36012-A J-36012-A Ignition System Diagnosis Harness

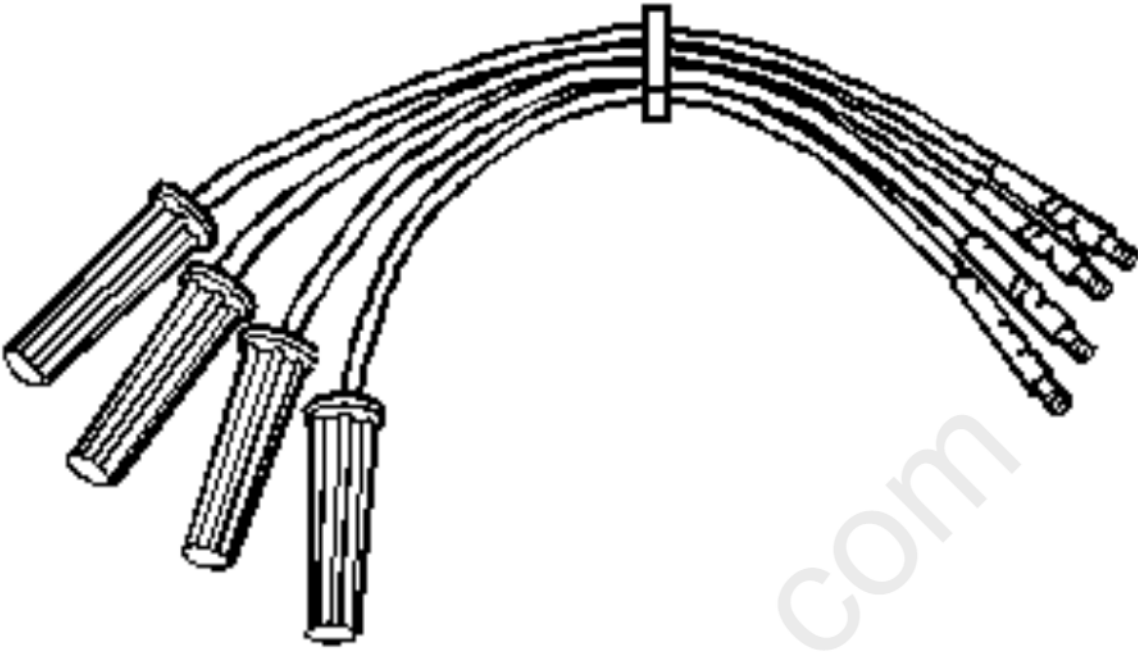
Illustration	Tool Number/Description
	
	EN-37287 J-37287 Fuel Line Shut-off Adapters

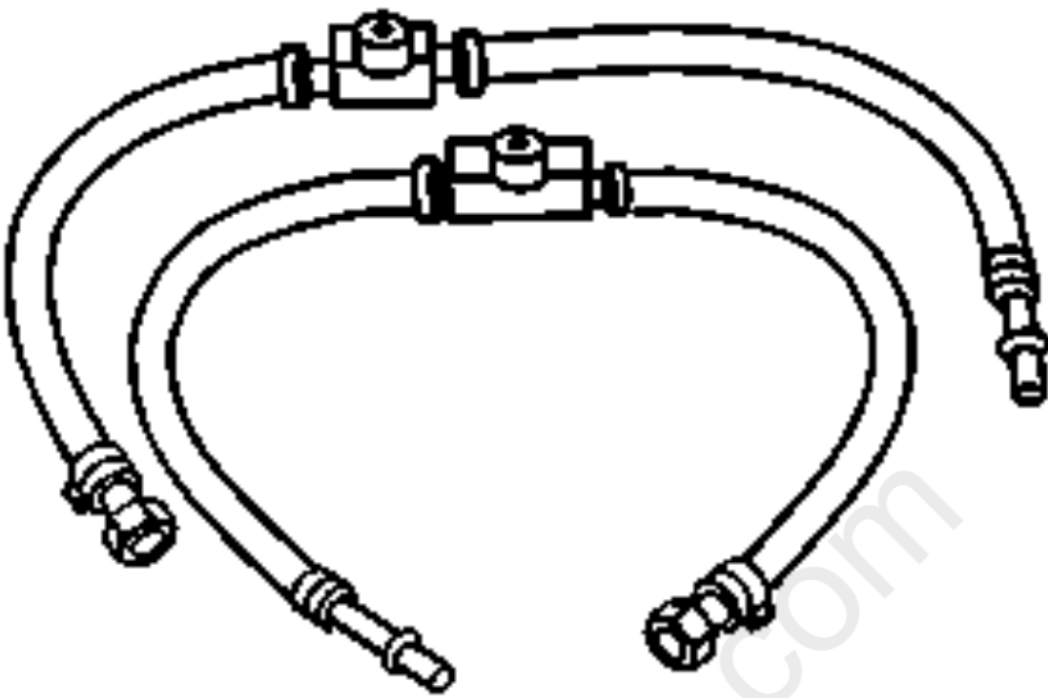
Illustration	Tool Number/Description
	

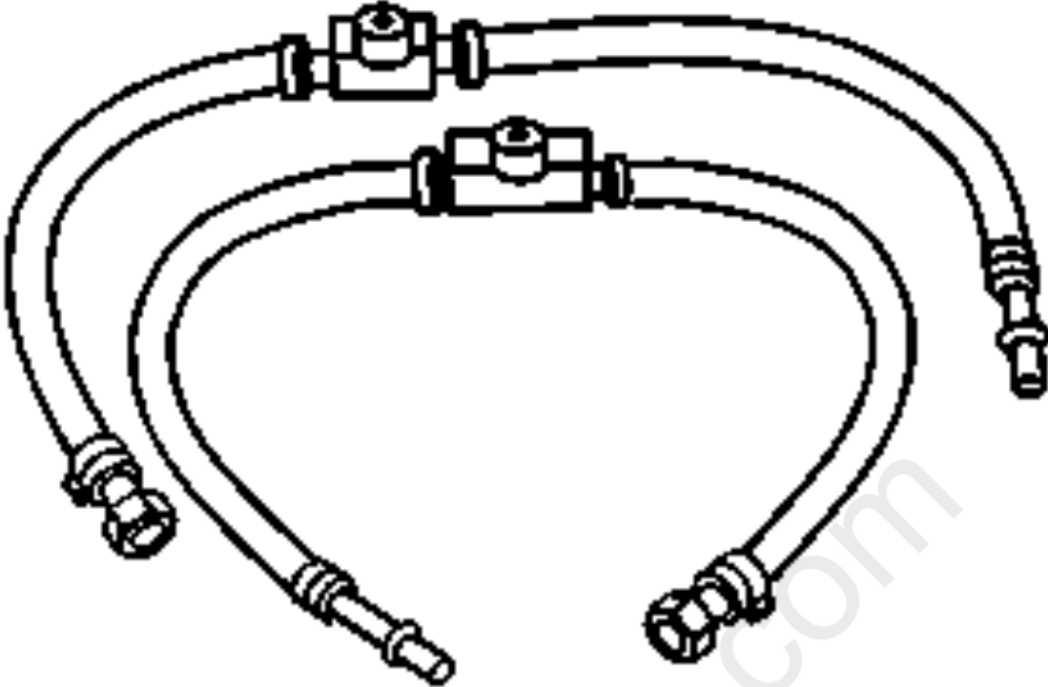
Illustration	Tool Number/Description
 The illustration shows two identical fuel line shut-off adapters. Each adapter is made of a flexible hose that is curved into a U-shape. In the center of each curve is a rectangular shut-off valve with a circular handle on top. At each end of the hose, there is a quick-connect fitting with a locking collar. The entire illustration is overlaid with a large, light gray diagonal watermark that reads 'cardiagn.com'.	EN-37287 - FF Fuel Line Shut-off Adapters

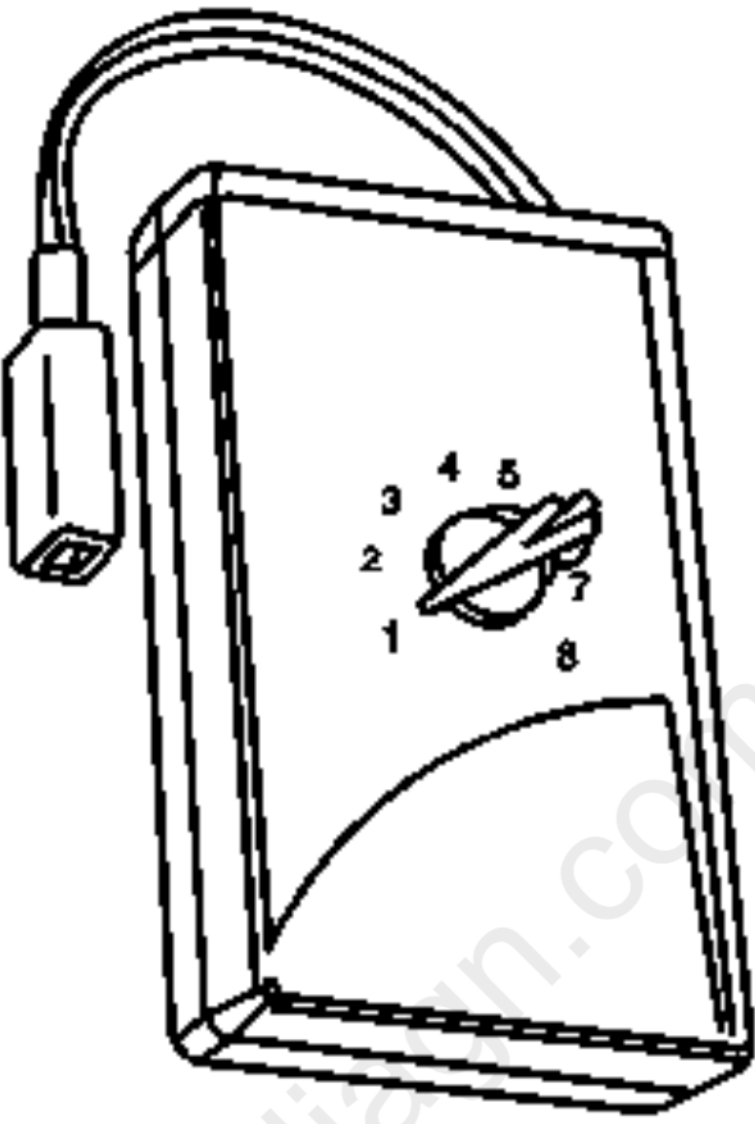
Illustration	Tool Number/Description
 A line drawing of a rectangular adapter box. On the front face, there is a circular dial with eight numbered positions (1 through 8) arranged in a circle. A sliding switch or lever is positioned over the dial, currently pointing towards the center. A cable is attached to the top of the box, extending upwards and then downwards to a multi-pin connector. The box is shown in a three-quarter perspective view.	EN-39021-210 J-39021-210 Injector Tester Adapter Box

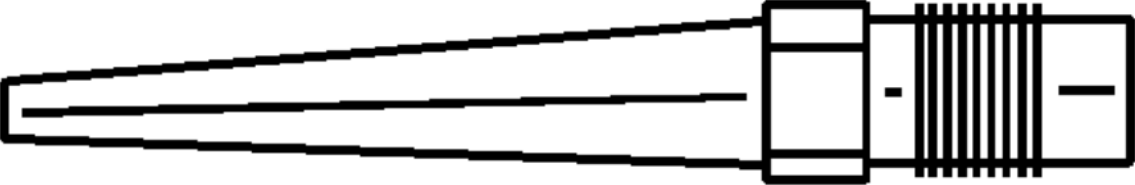
Illustration	Tool Number/Description
	EN-41413-311 J-41413-311 EVAP Plug
cardiagn.com	

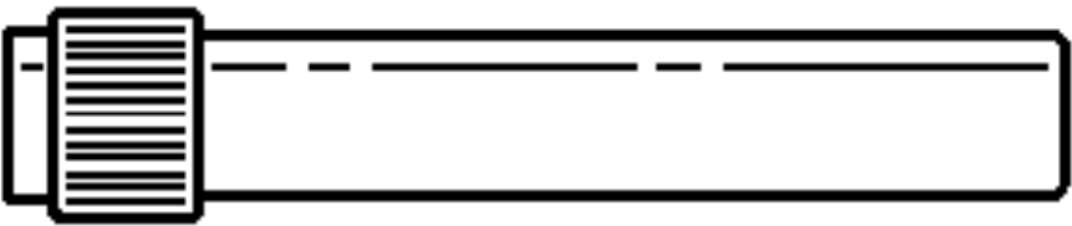
Illustration	Tool Number/Description
	EN-41413-VLV J-41413-VLV EVAP Service Port Vent Fitting
	EN-44602 J-44602 Injector Test Adapter

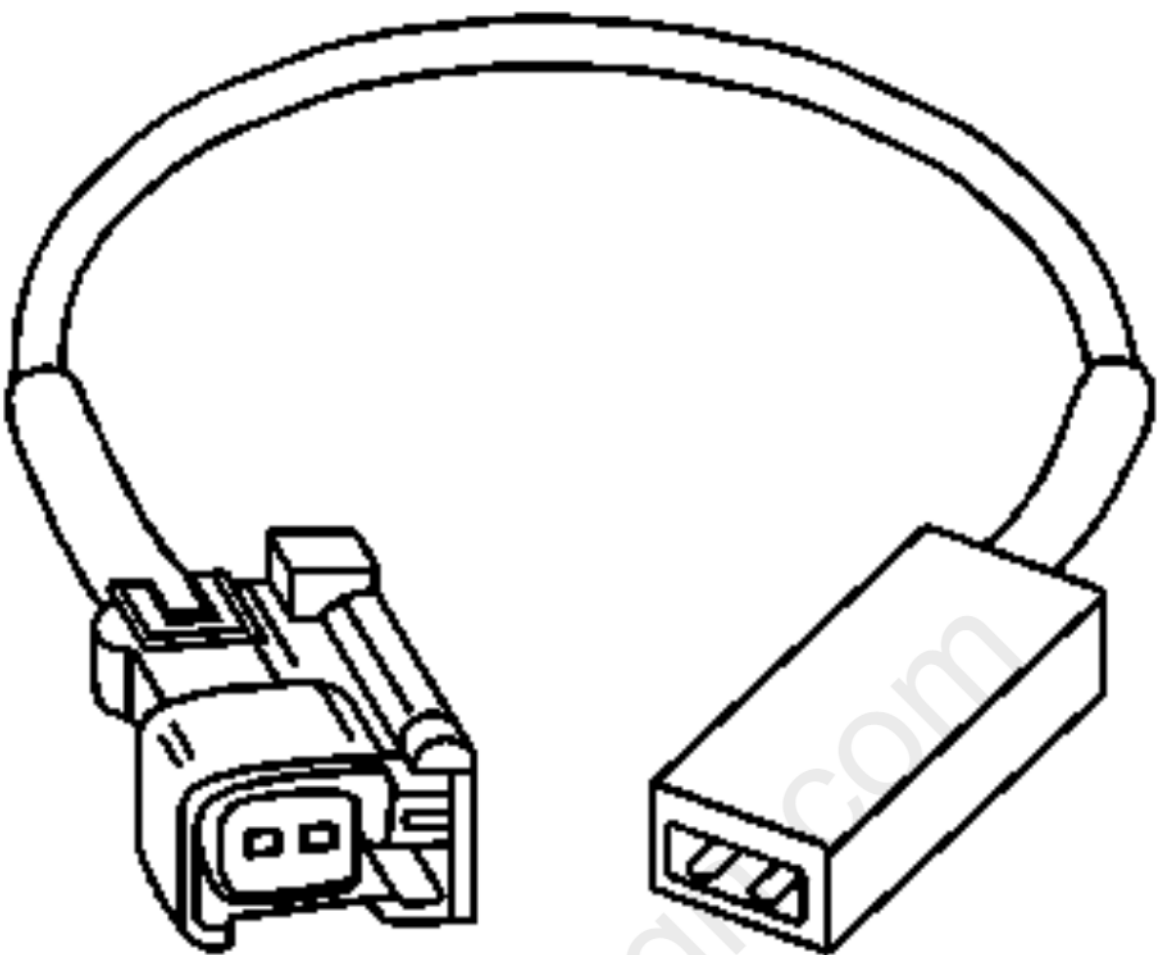
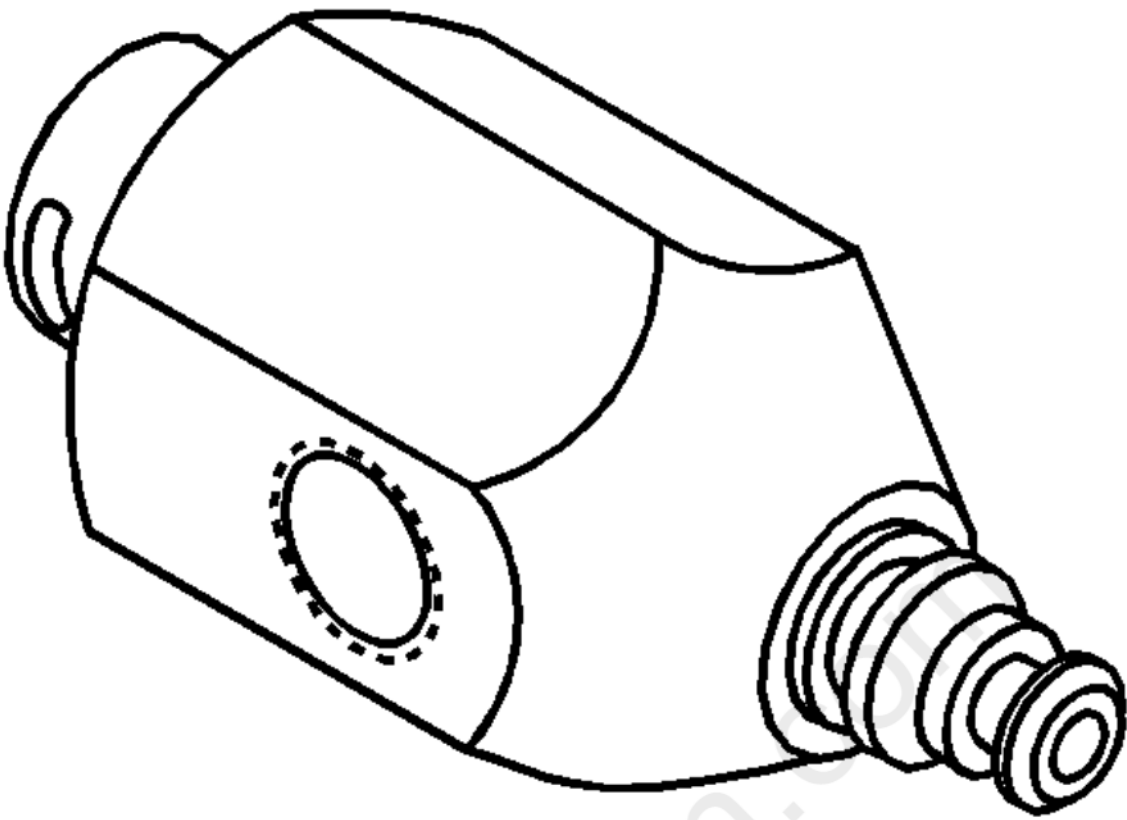
Illustration	Tool Number/Description
 A line drawing of a medical cable. The cable is shown in a loop. On the left side, there is a multi-pin connector with a complex, multi-part housing. On the right side, there is a rectangular probe connector with a slot on its front face. A faint watermark 'cardiagrad.com' is visible across the center of the image.	

Illustration	Tool Number/Description
	EN-45873-30 J-45873-30 Injector Flow Test Adapter

cardiagn.com

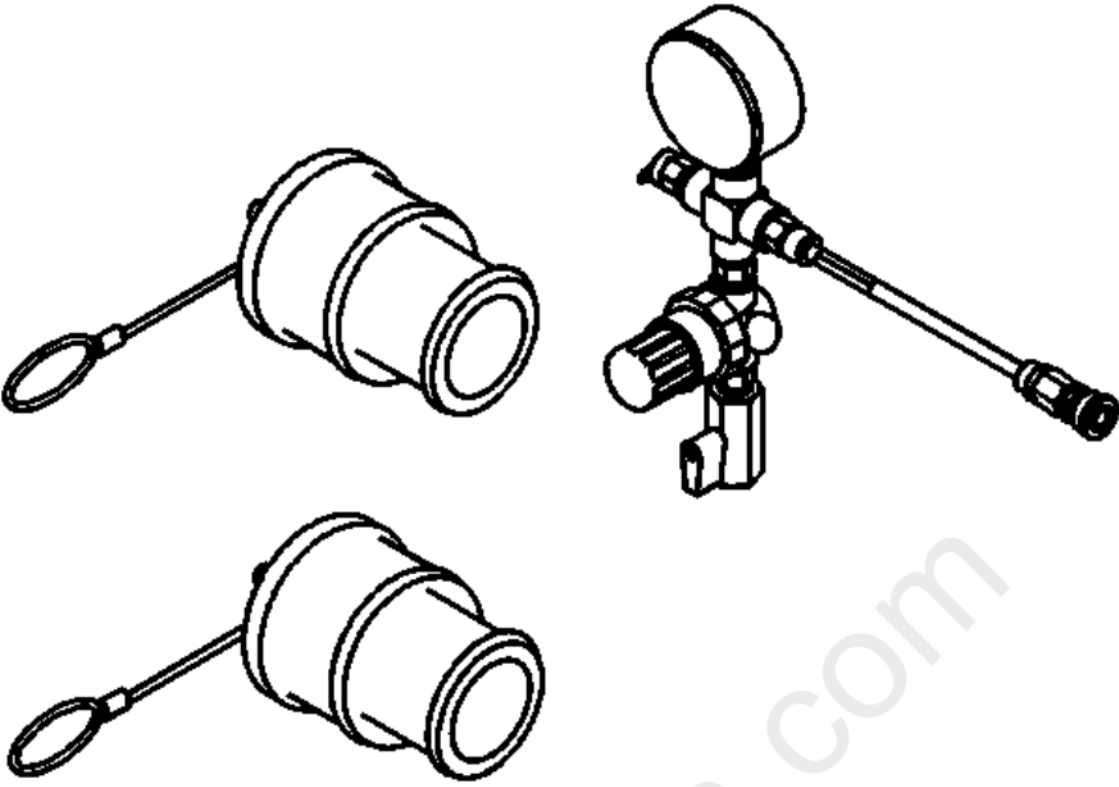
Illustration	Tool Number/Description
 The illustration shows three automotive tools. On the left and bottom left are two identical cylindrical pressure gauges, each with a ring handle and a threaded end. In the center is a manifold gauge, which features a pressure gauge at the top, a vacuum gauge on the left, and a service valve at the bottom. A long, thin hose is attached to the right side of the manifold gauge. A large, faint watermark 'cardiagn.com' is visible across the bottom half of the illustration area.	EN-46091 J-46091 Charge Air Cooler Tester

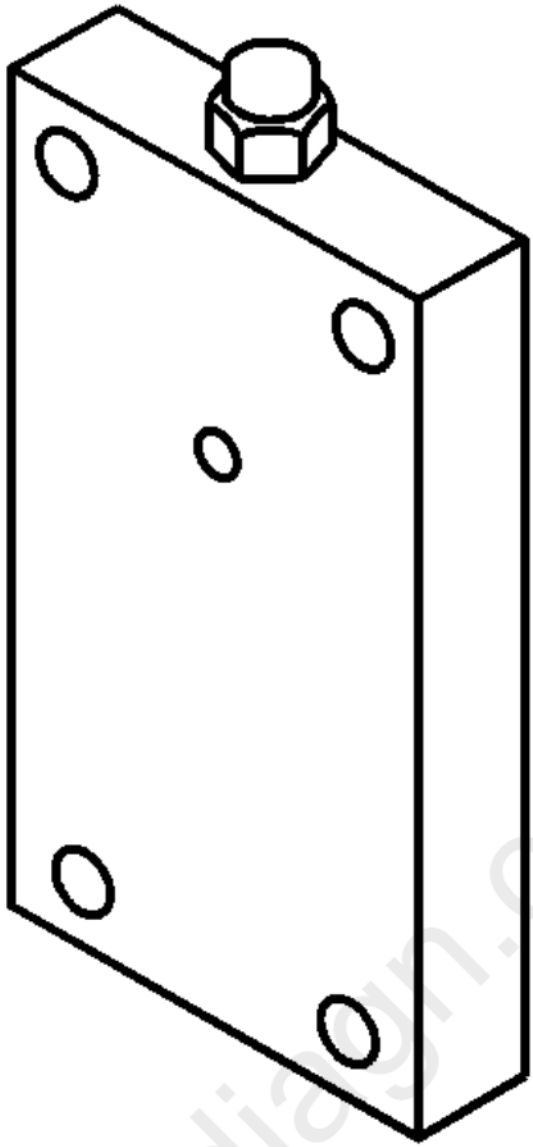
Illustration	Tool Number/Description
 The illustration shows a rectangular metal plate, likely a component of a charge air cooler. It features a hexagonal nut mounted on the top surface. The front face of the plate has six circular holes arranged in two columns of three. A diagonal watermark reading 'cardinal.com' is visible across the plate.	EN-46091-5 J-46091-5 Charge Air Cooler Tester Adapter

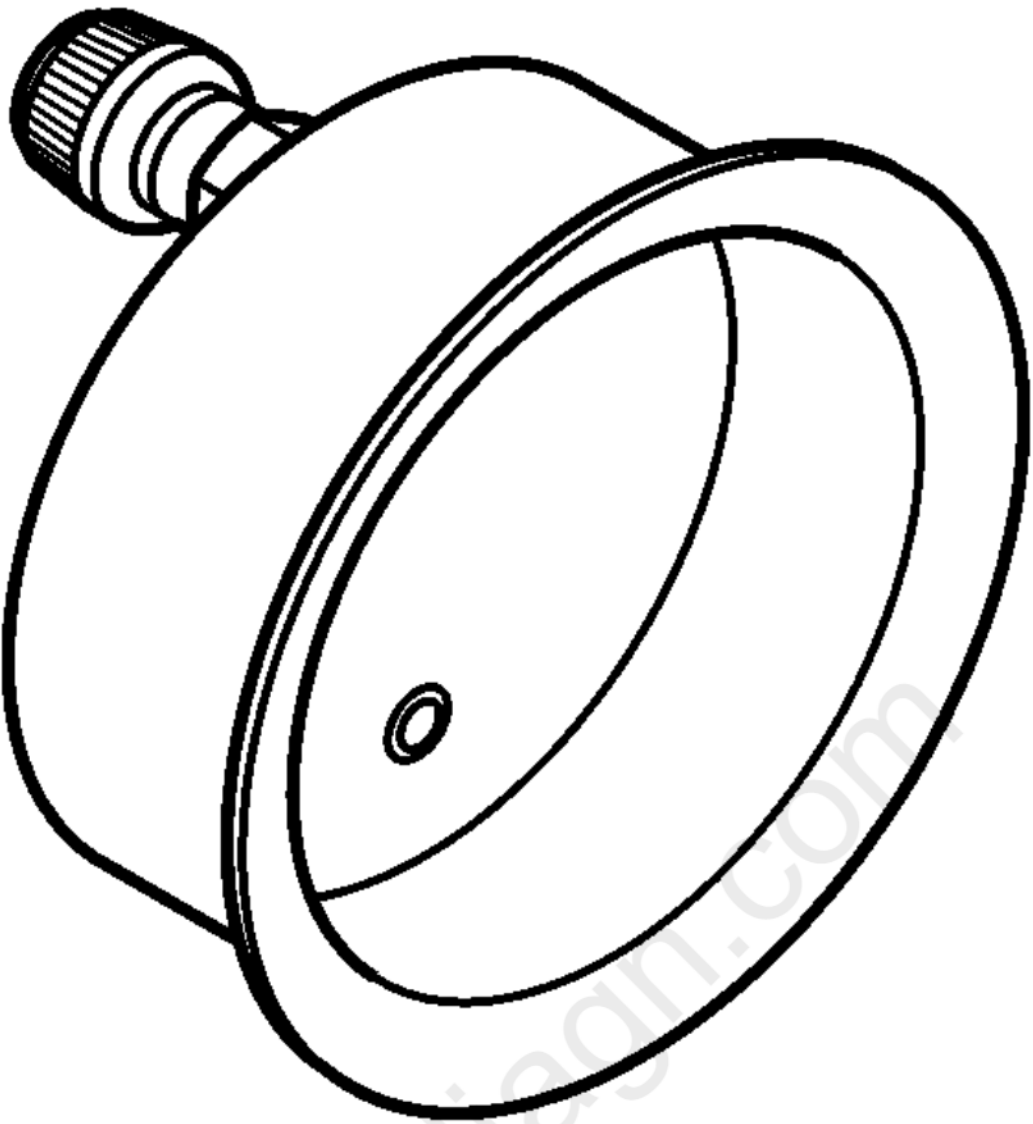
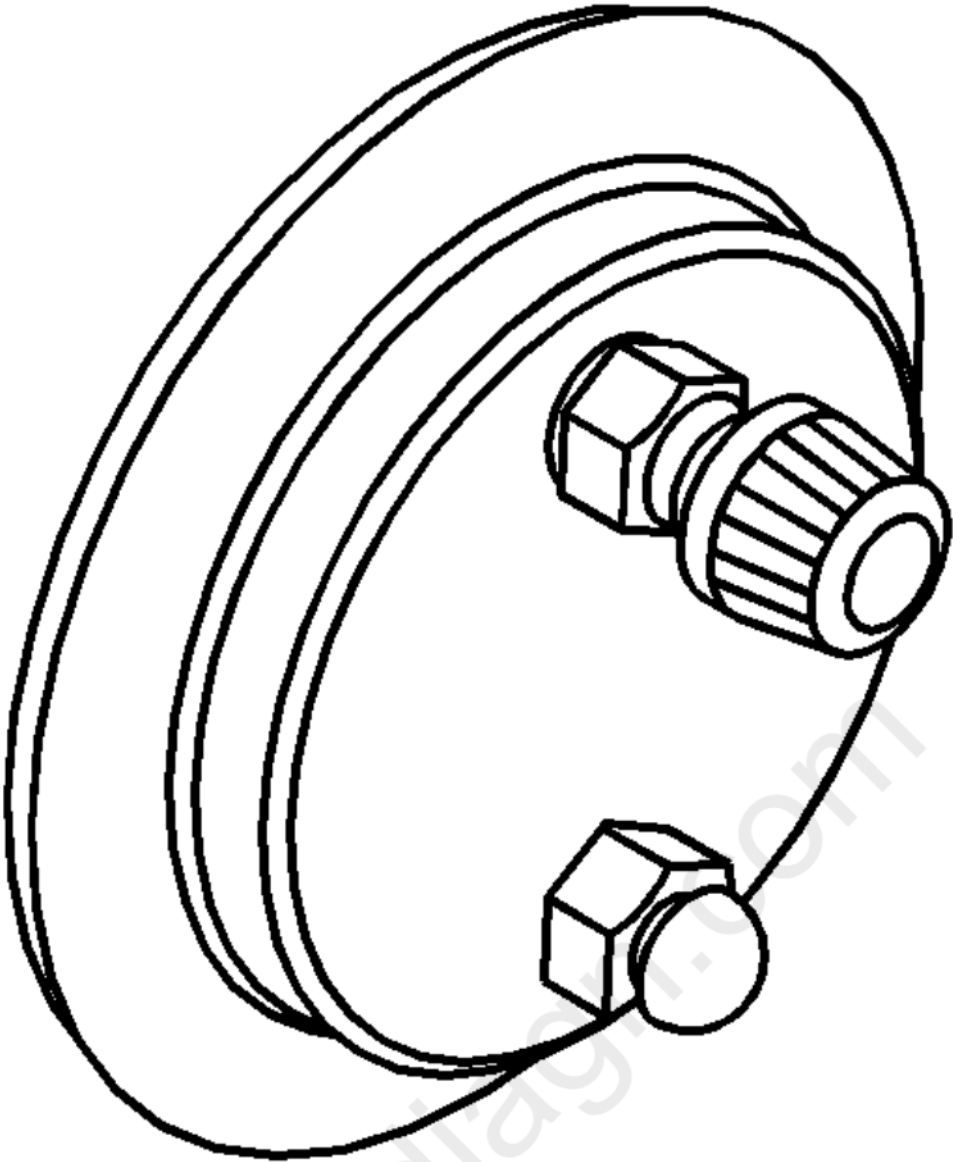
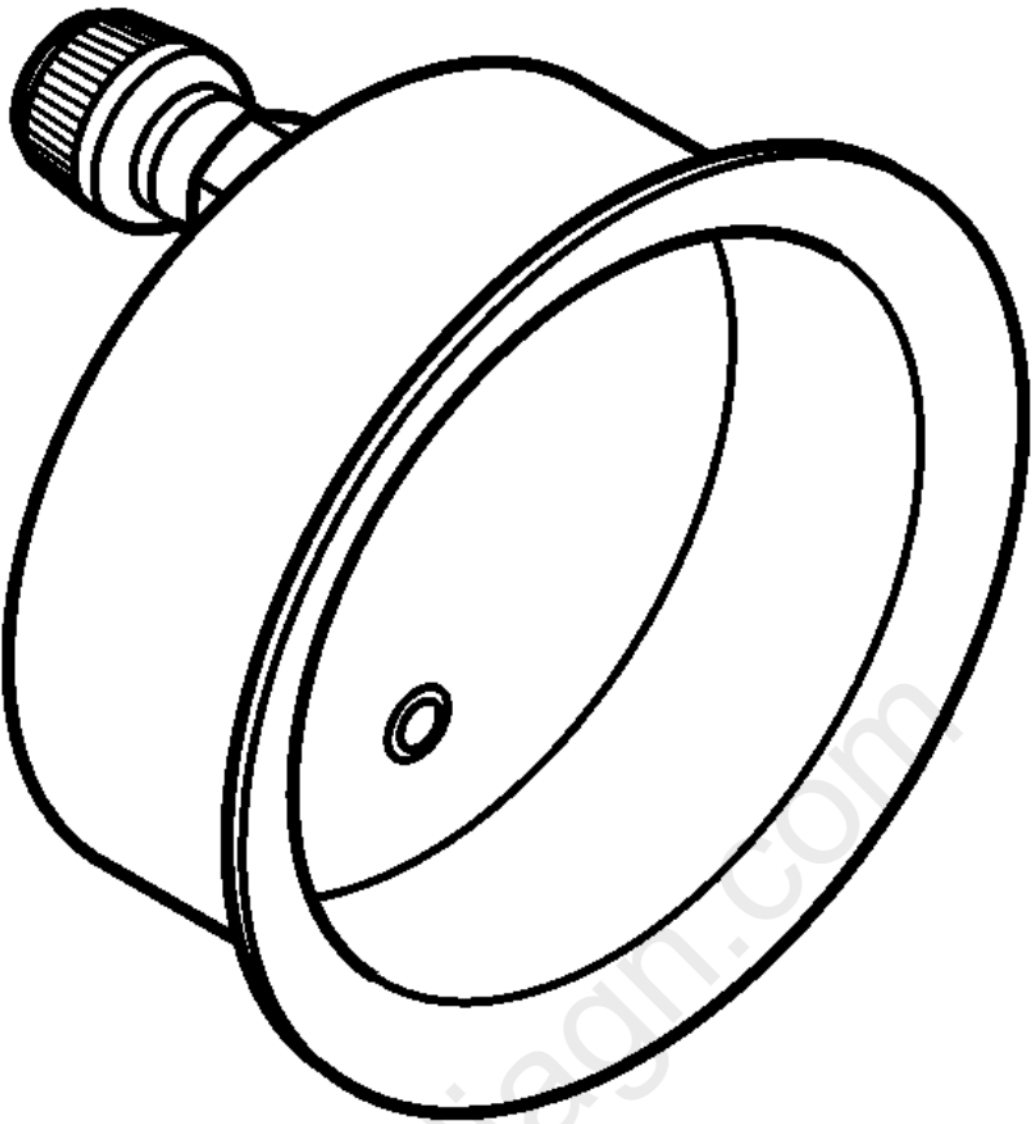
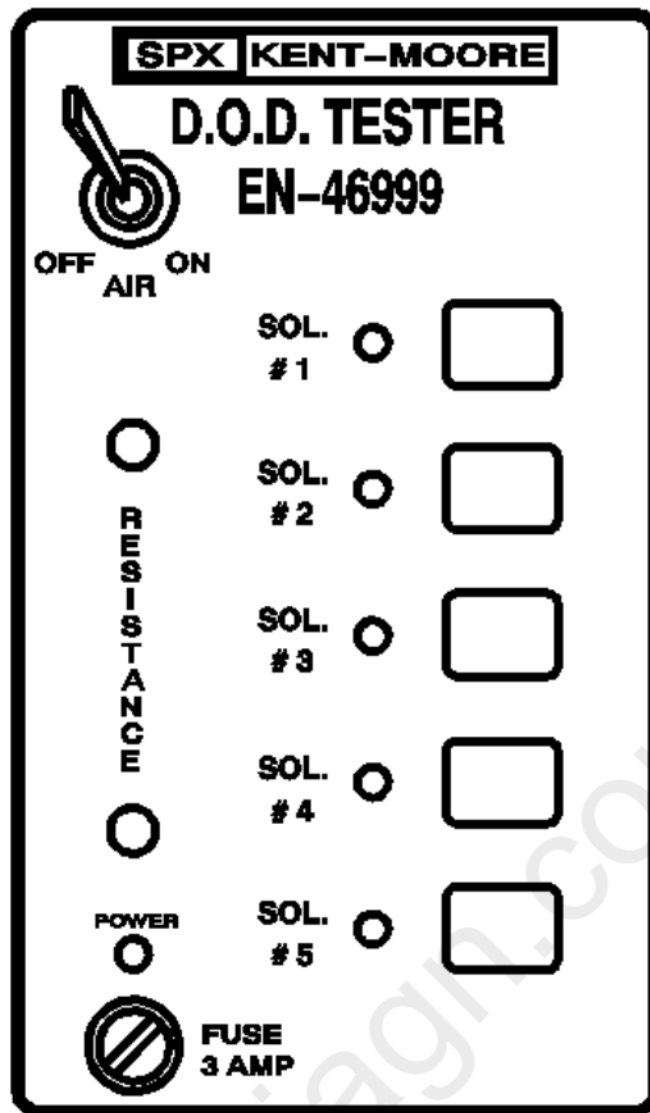
Illustration	Tool Number/Description
	EN-46091-10A Diesel Engine Pressure Test Adapter

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

cardiagri.com



EN-46999
Displacement On
Demand Tester

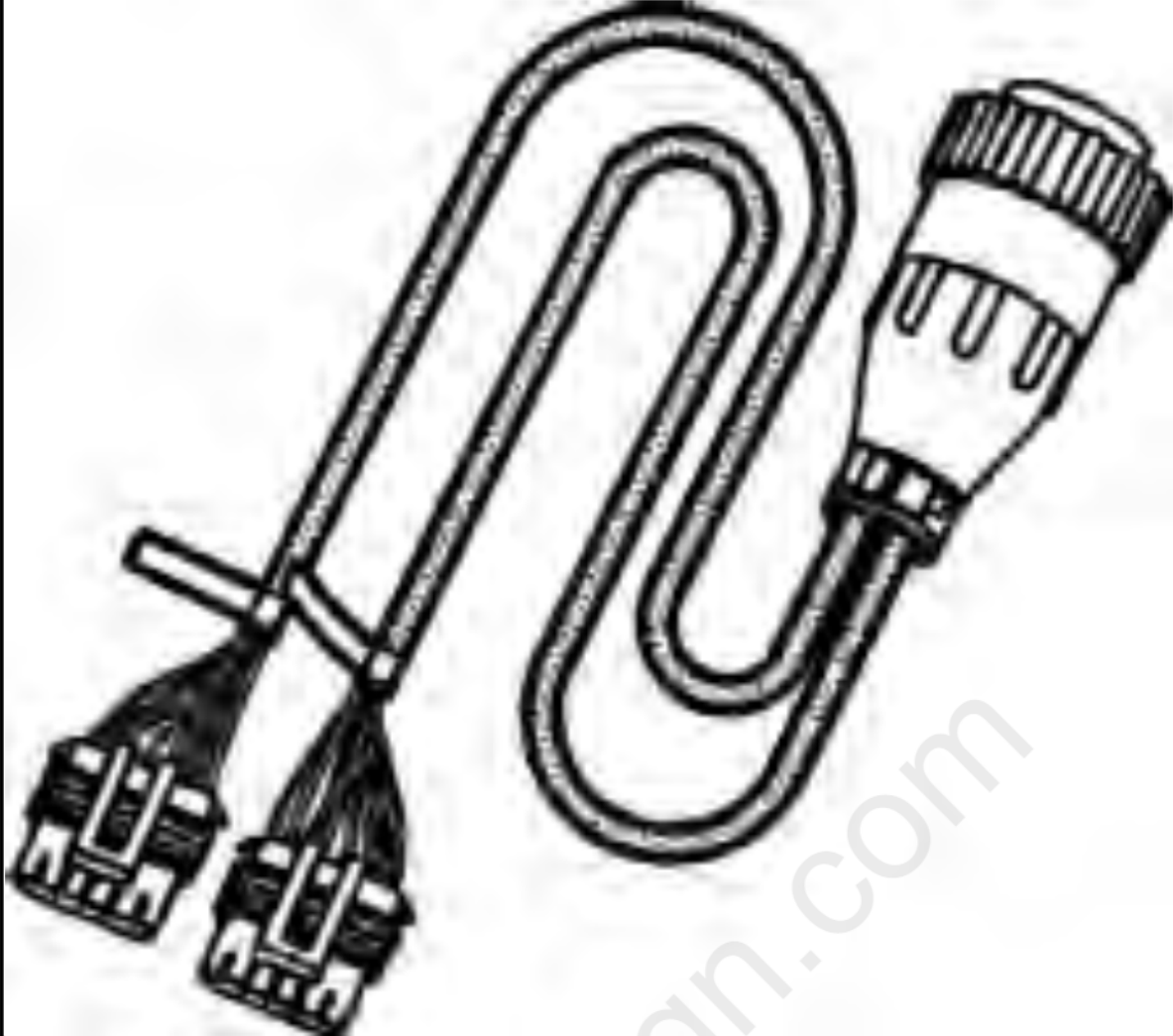
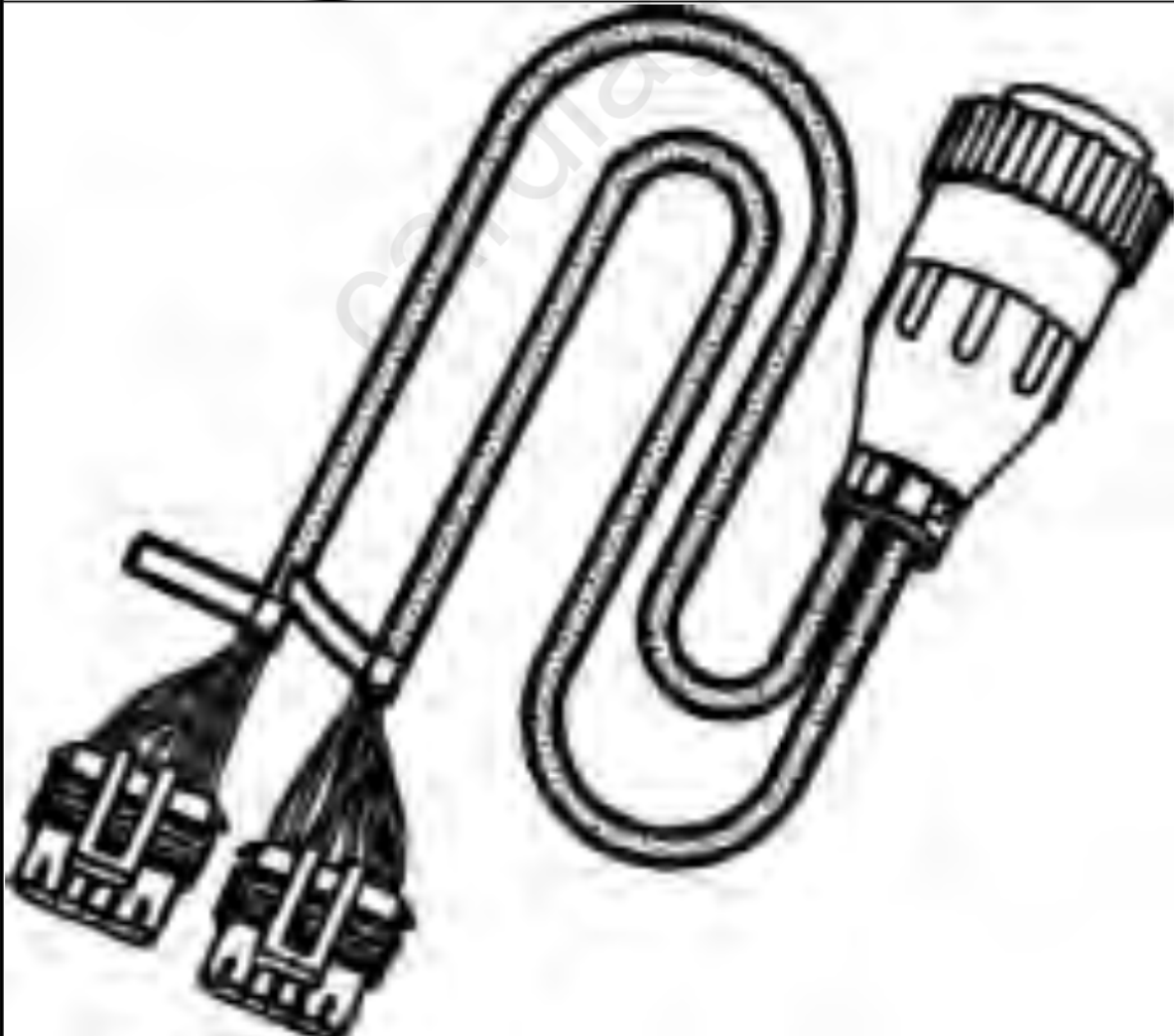
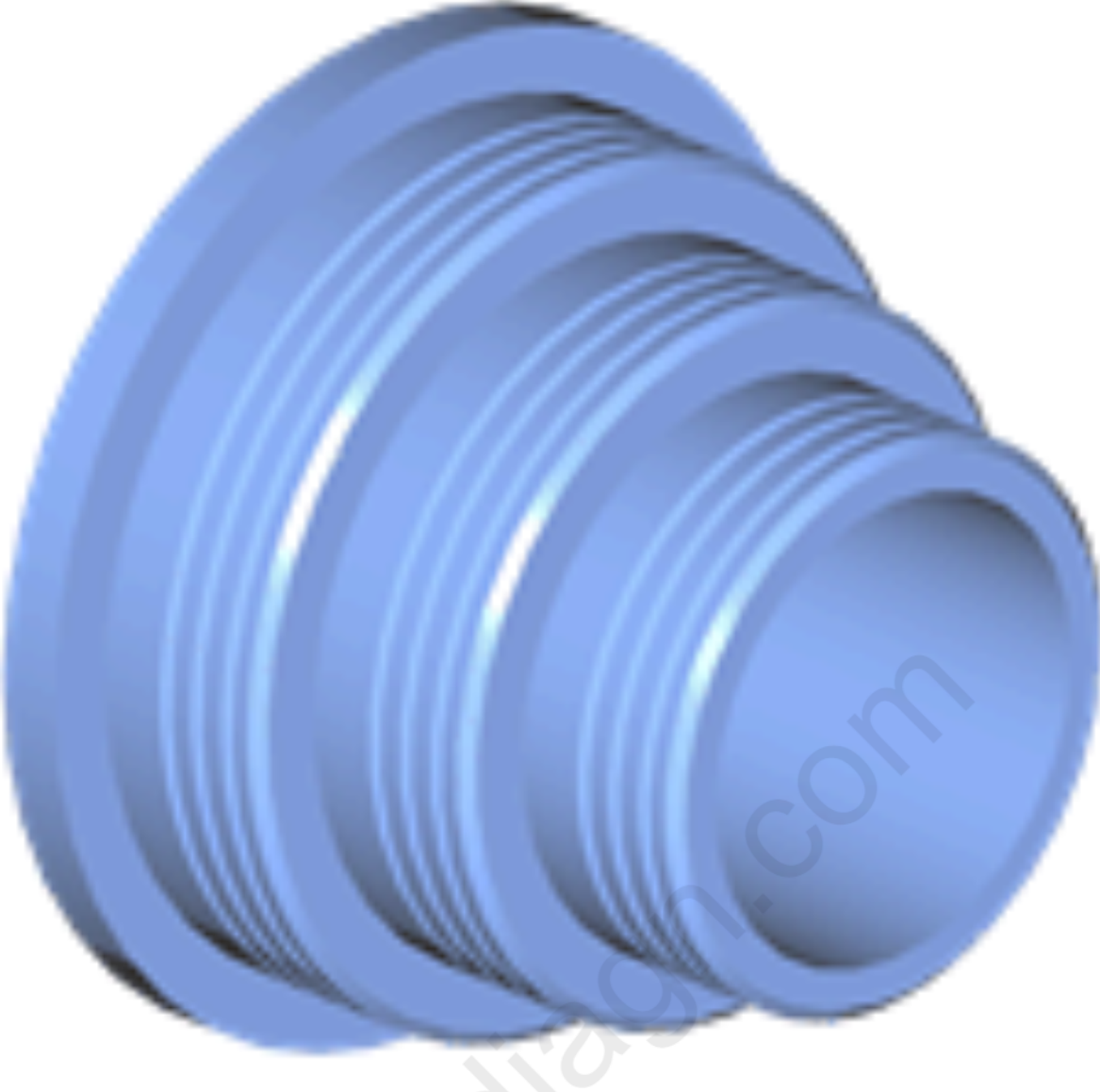
Illustration	Tool Number/Description
	EN-46999 - 15 Active Fuel Management Tester Harness - V6
	EN-46999 - 20 Active Fuel Management Tester Harness - Small Block V8

Illustration	Tool Number/Description
	EN-47603 Compression Gauge Adapter

Illustration	Tool Number/Description
	EN-47656 - NA Pressure Test Plugs
	GE-23738-A J-23738-A Vacuum Pump

Illustration

Tool
Number/Description

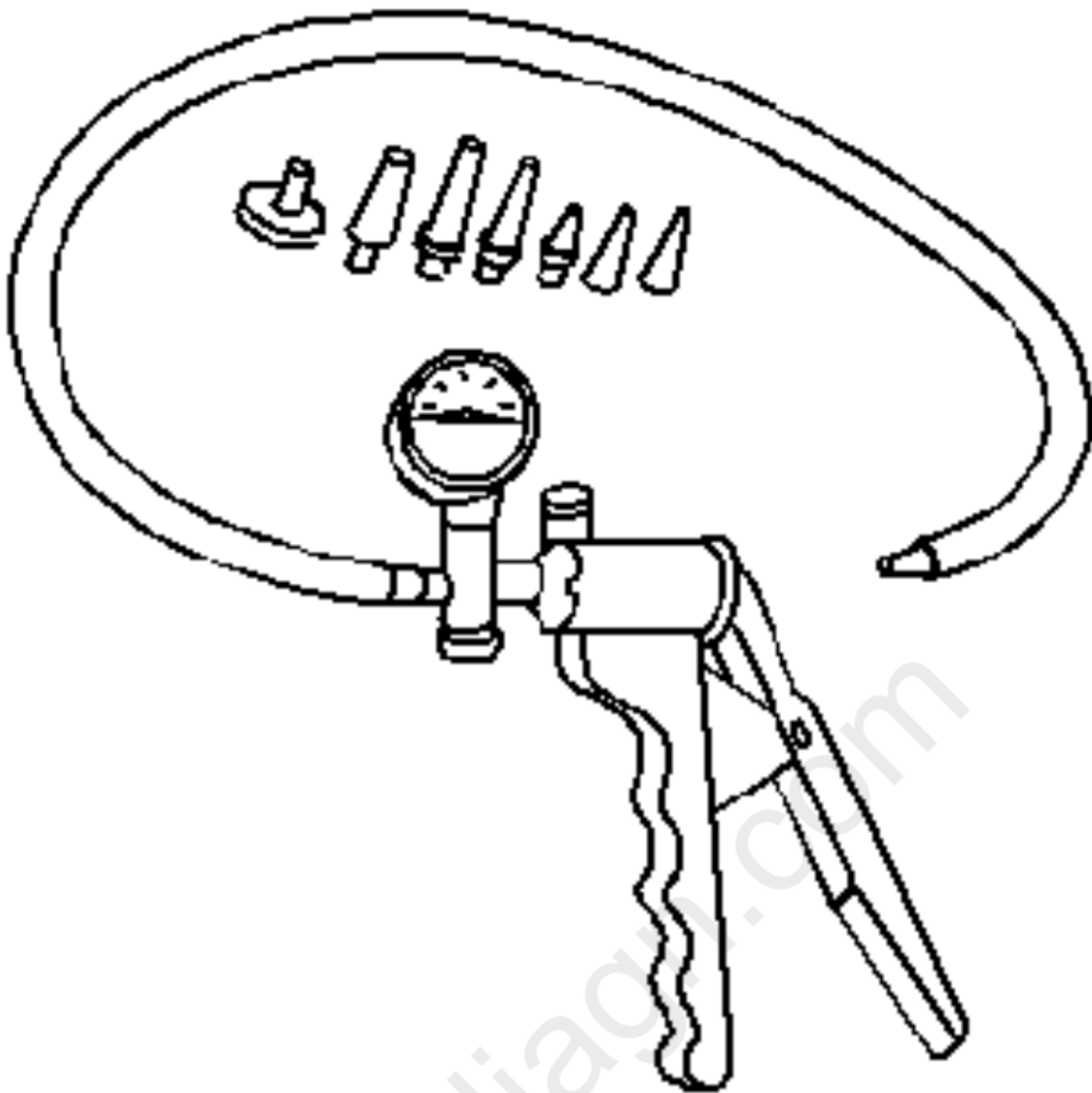
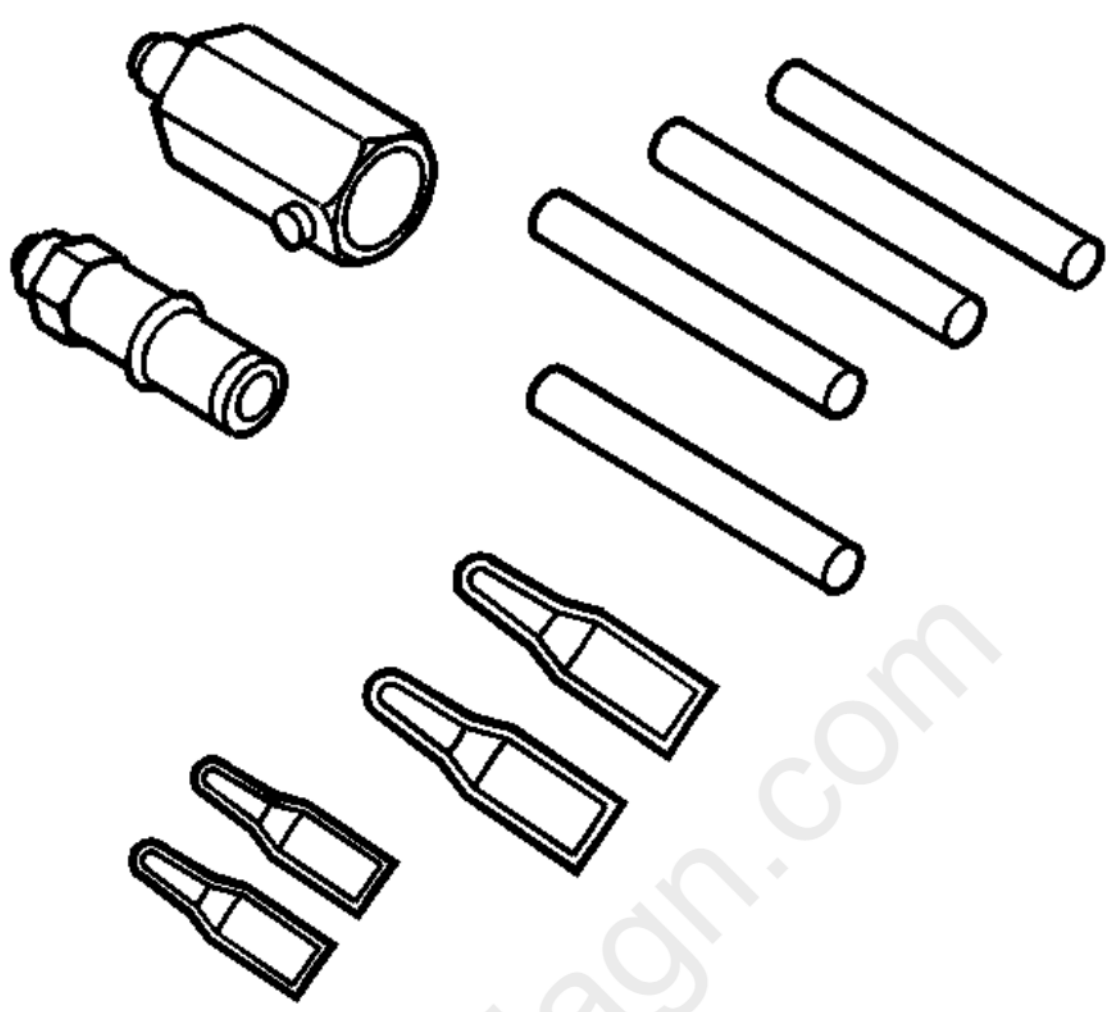


Illustration	Tool Number/Description
 The illustration shows a collection of tools for an EVAP system. At the top left is a large hexagonal cap with a small circular feature on its side. Below it is a smaller hexagonal plug. To the right of these are five long, thin, cylindrical rods of varying lengths. At the bottom are four L-shaped pry bars of different sizes. A large, light gray watermark 'cardiagn.com' is oriented diagonally across the entire illustration area.	GE-41413-300 EN-41413-300 J-41413-300 EVAP Cap and Plug Kit

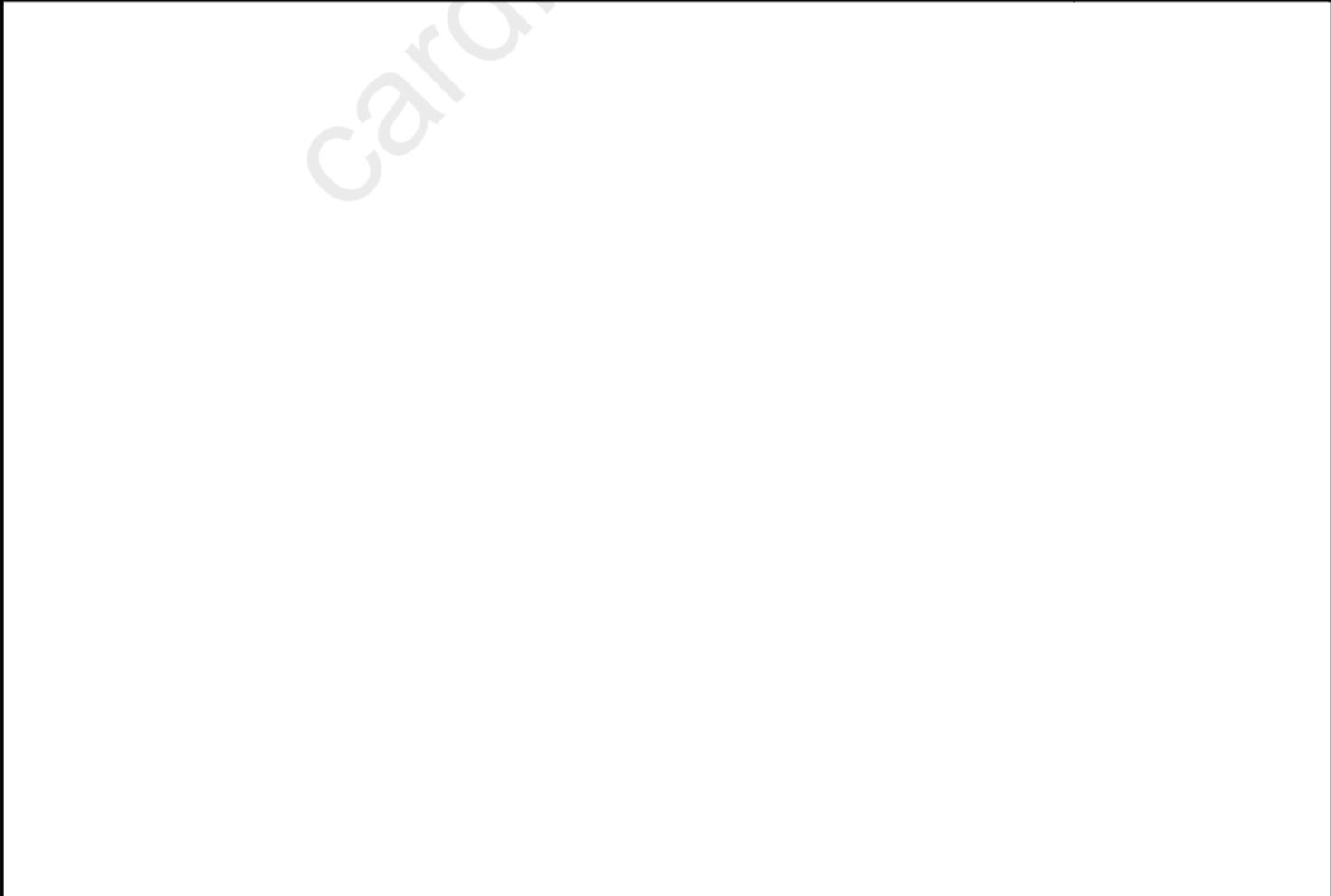


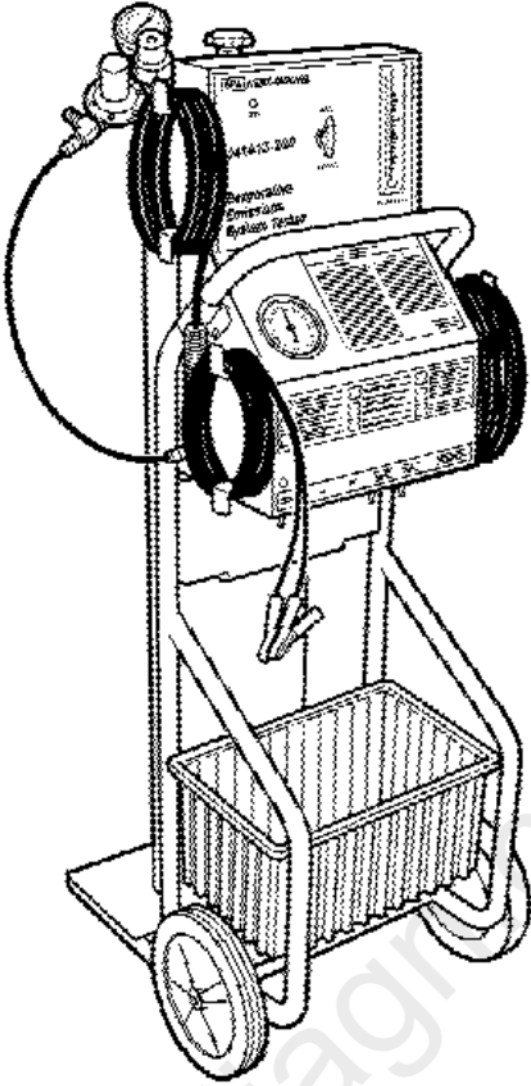
Illustration	Tool Number/Description
	GE-41413-A EN-41413-A J-41413-A Evaporative Emissions System Tester (EEST)
	GE-41413-SPT J-41413-SPT High Intensity White Light

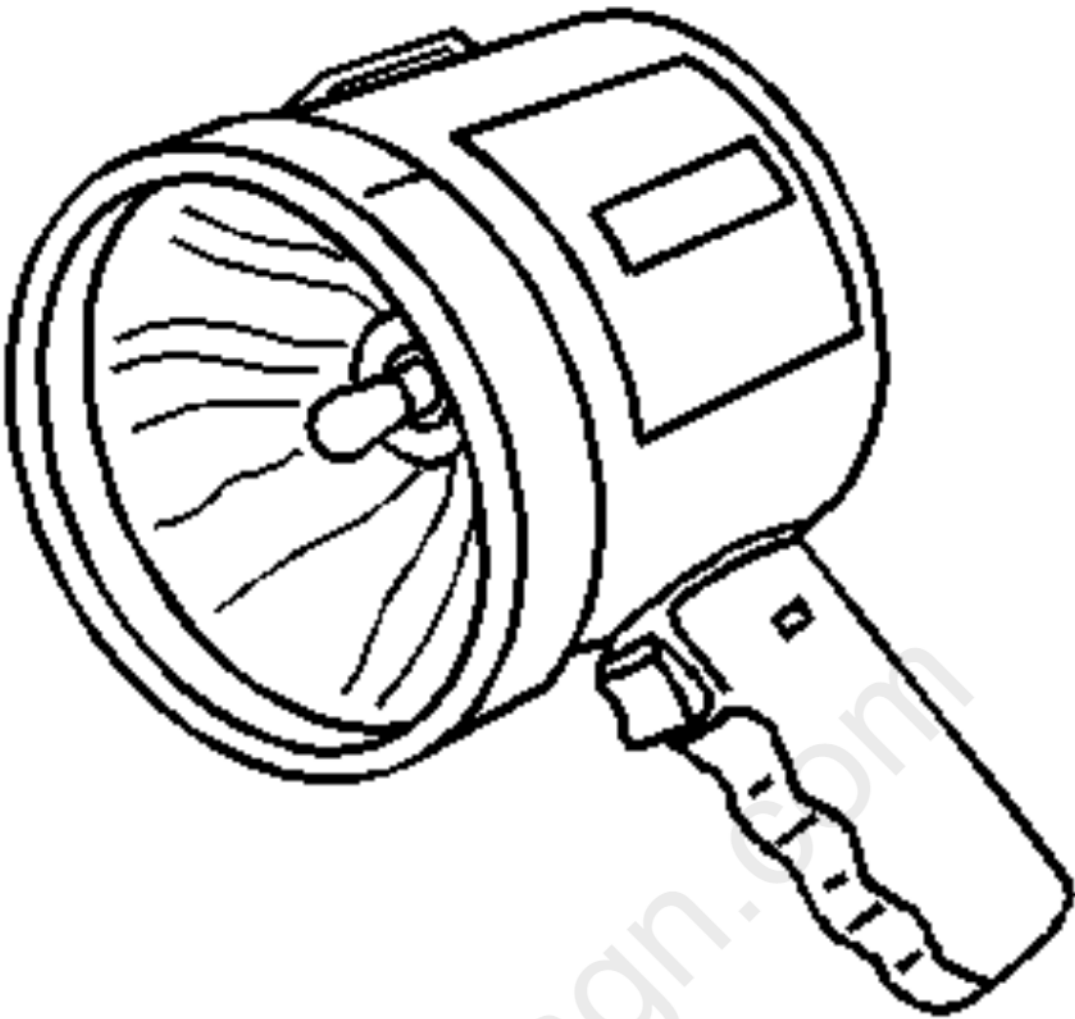
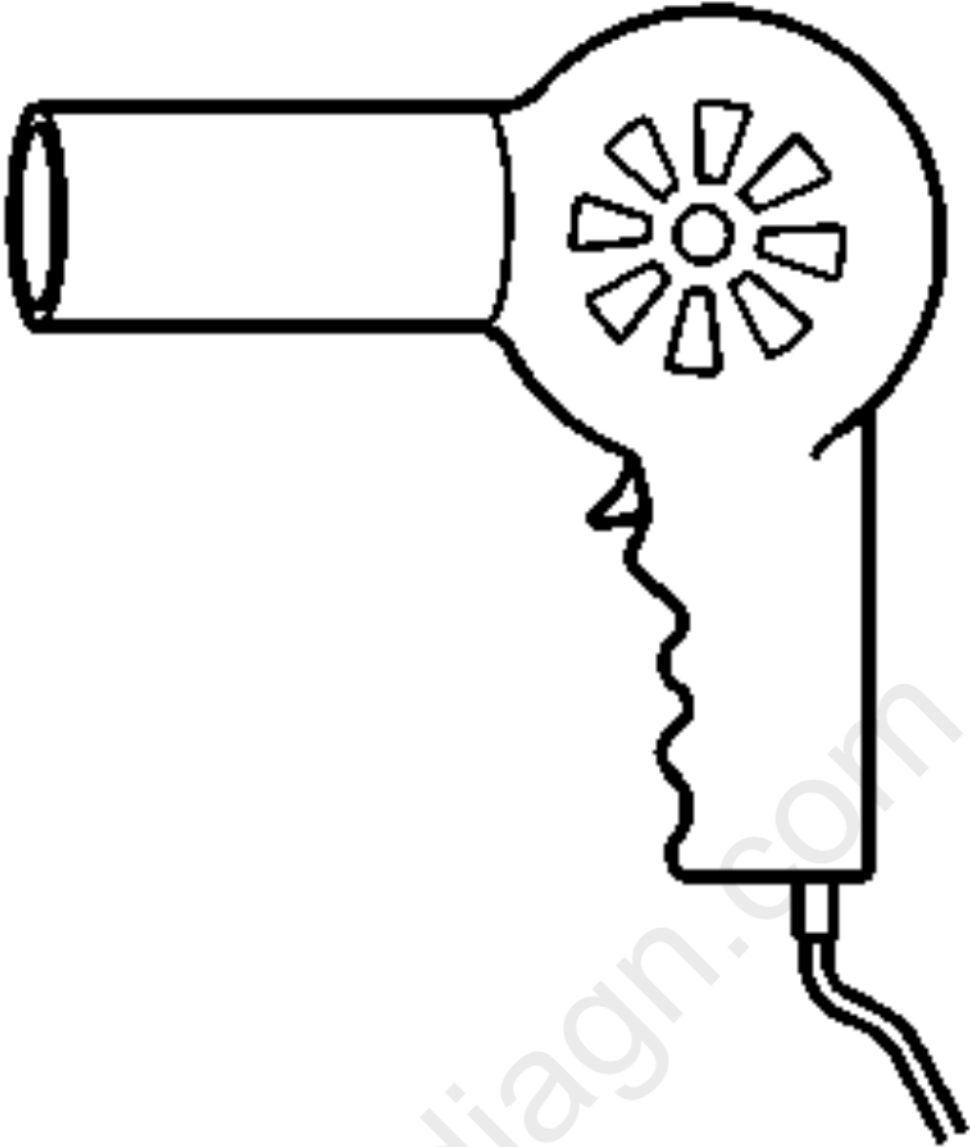
Illustration	Tool Number/Description
	

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)

Illustration	Tool Number/Description
	
	J-34730-375 Injector Test Lamp

Illustration

Tool
Number/Description

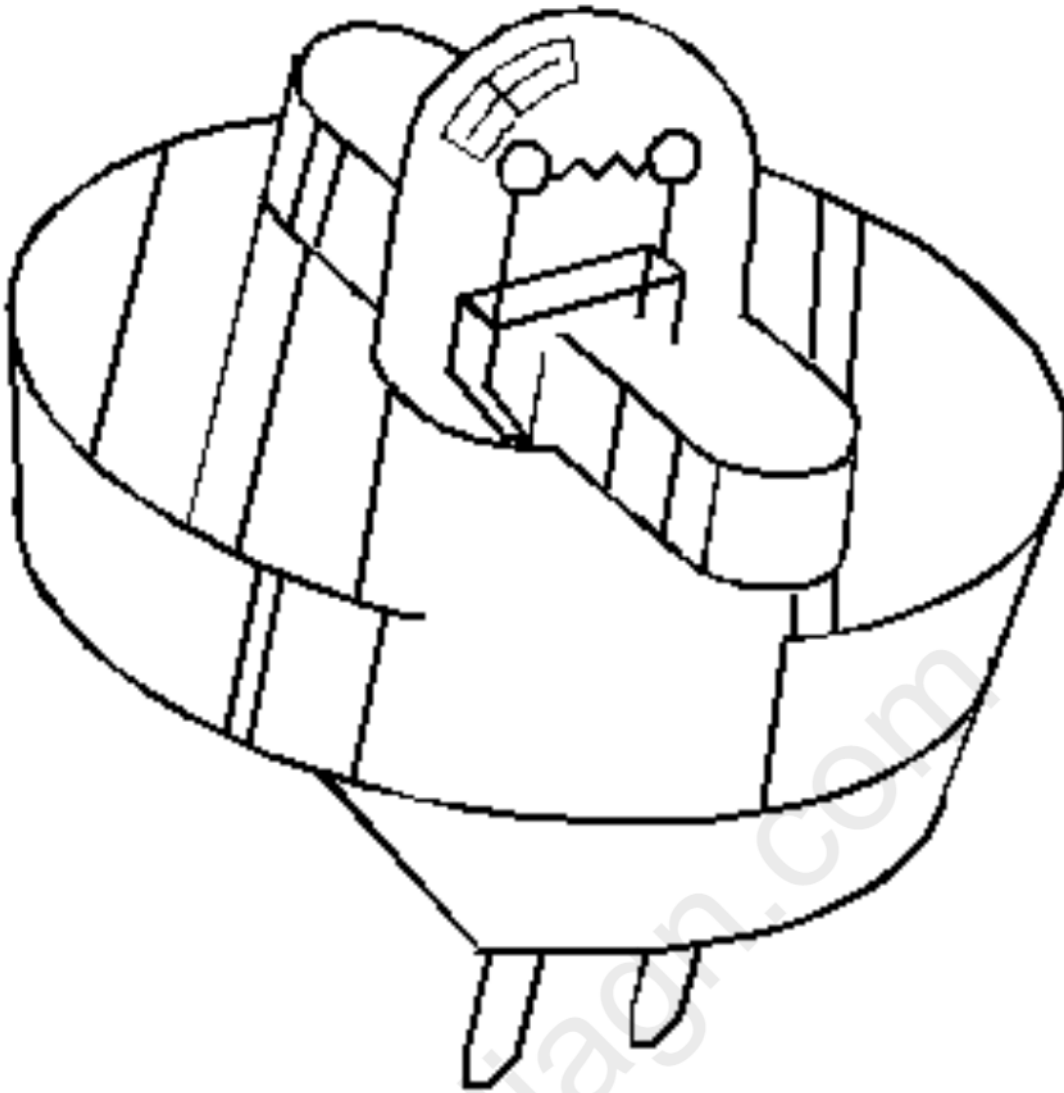


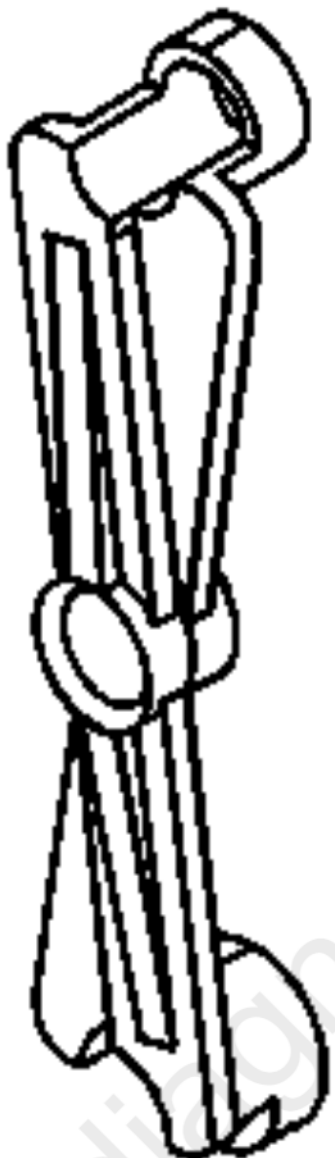
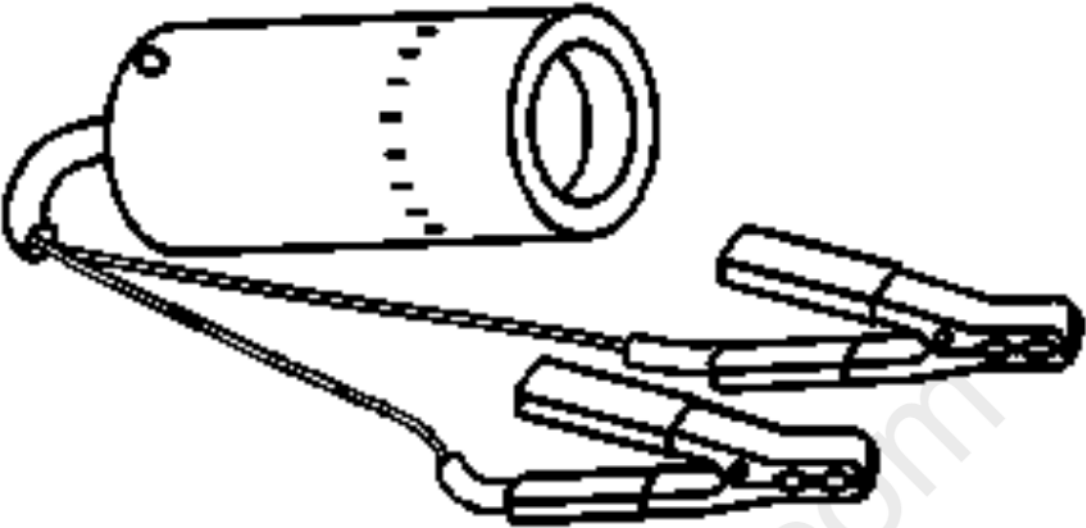
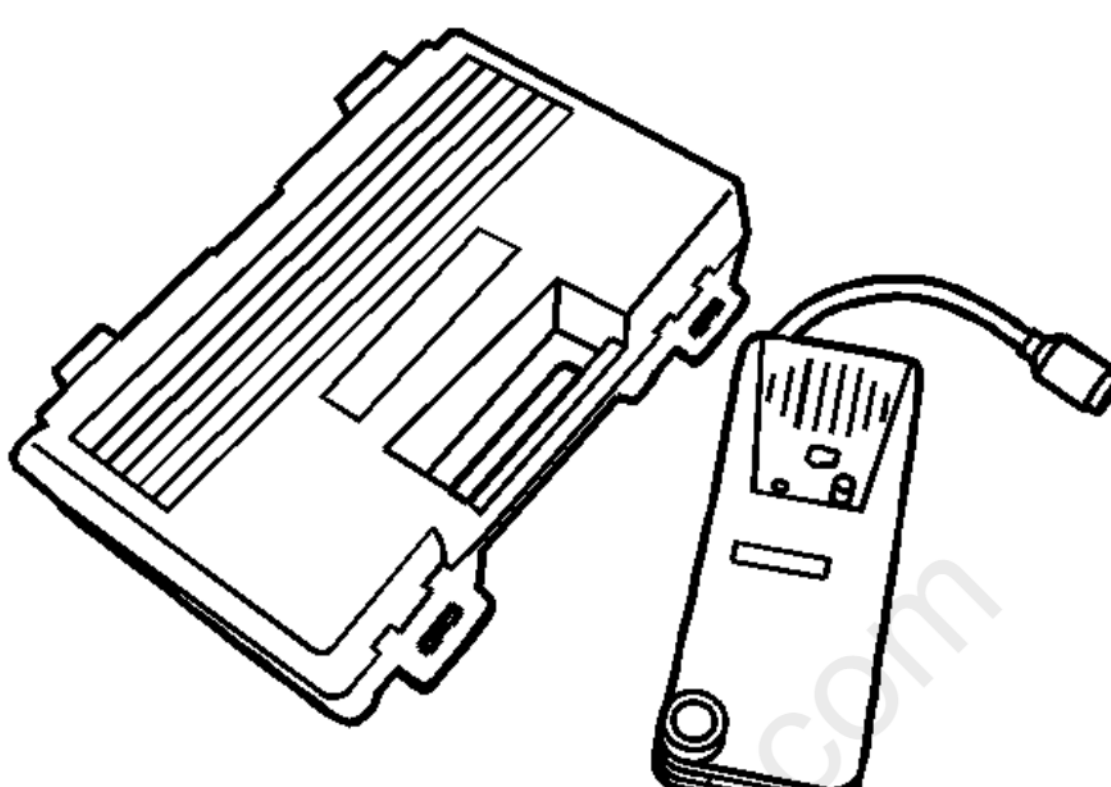
Illustration	Tool Number/Description
	J-44581 Fuel Line Disconnect Tool

Illustration	Tool Number/Description
	J-28428 - E J 42220 CH 42220 Universal 12-Volt Leak Detection Lamp

cardiagn.com

Illustration	Tool Number/Description
	J-45878 Combustible Gas Detector

SPECIAL TOOLS (MECHANICAL TOOLS)

Illustration	Tool Number/Description

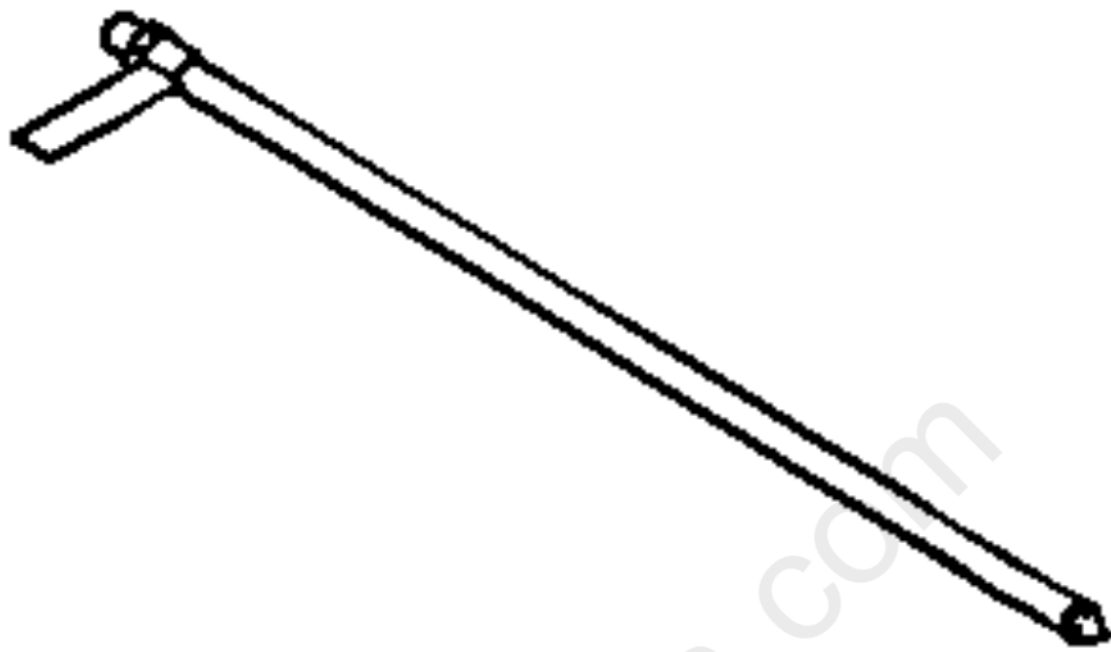
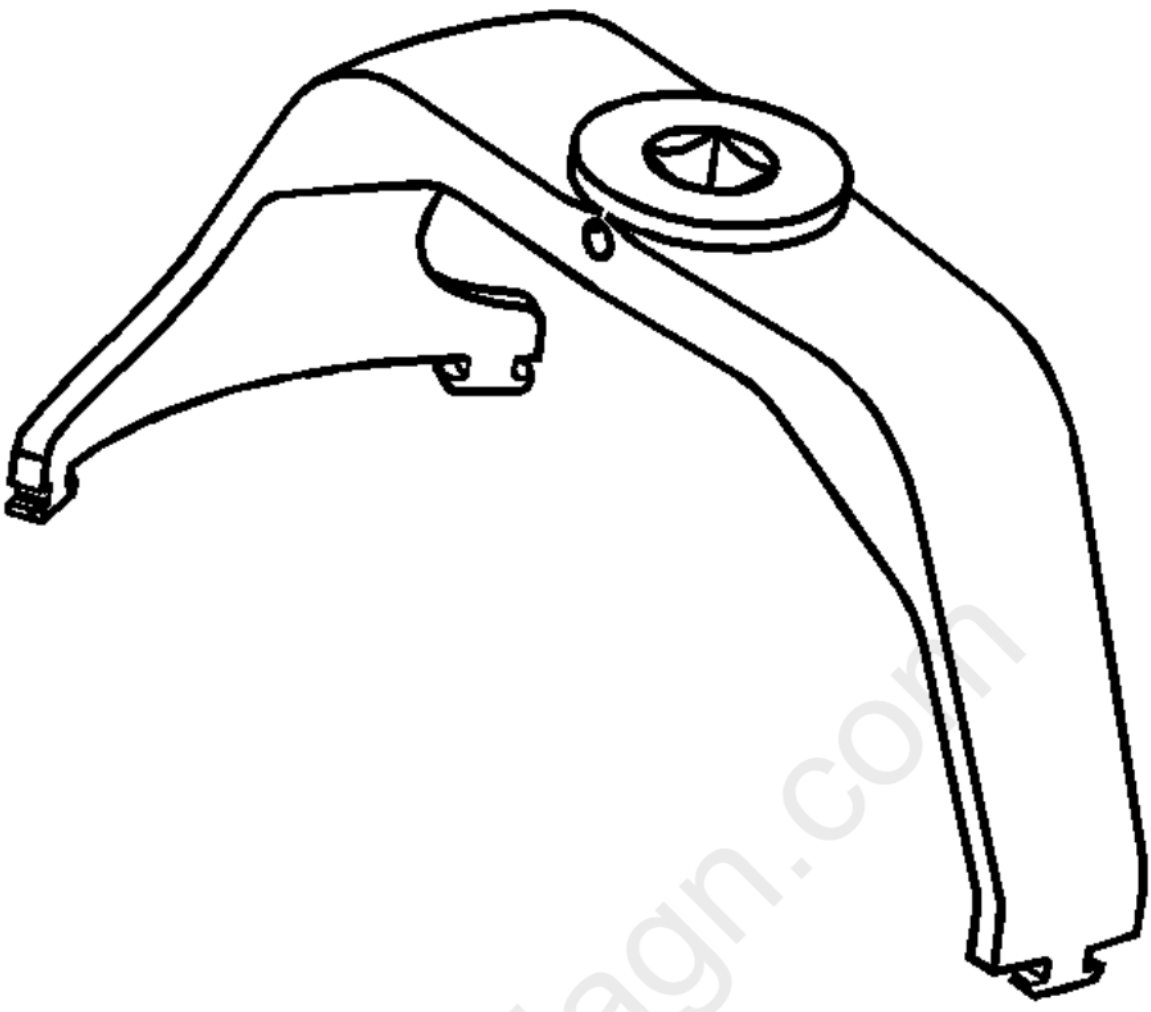
Illustration	Tool Number/Description
	CH-45004 J-45004 Fuel Tank Drain Hose South America - Use Local Equivalent

Illustration	Tool Number/Description
	CH-45722 Fuel Sender Lock Ring Wrench

cardiagn.com

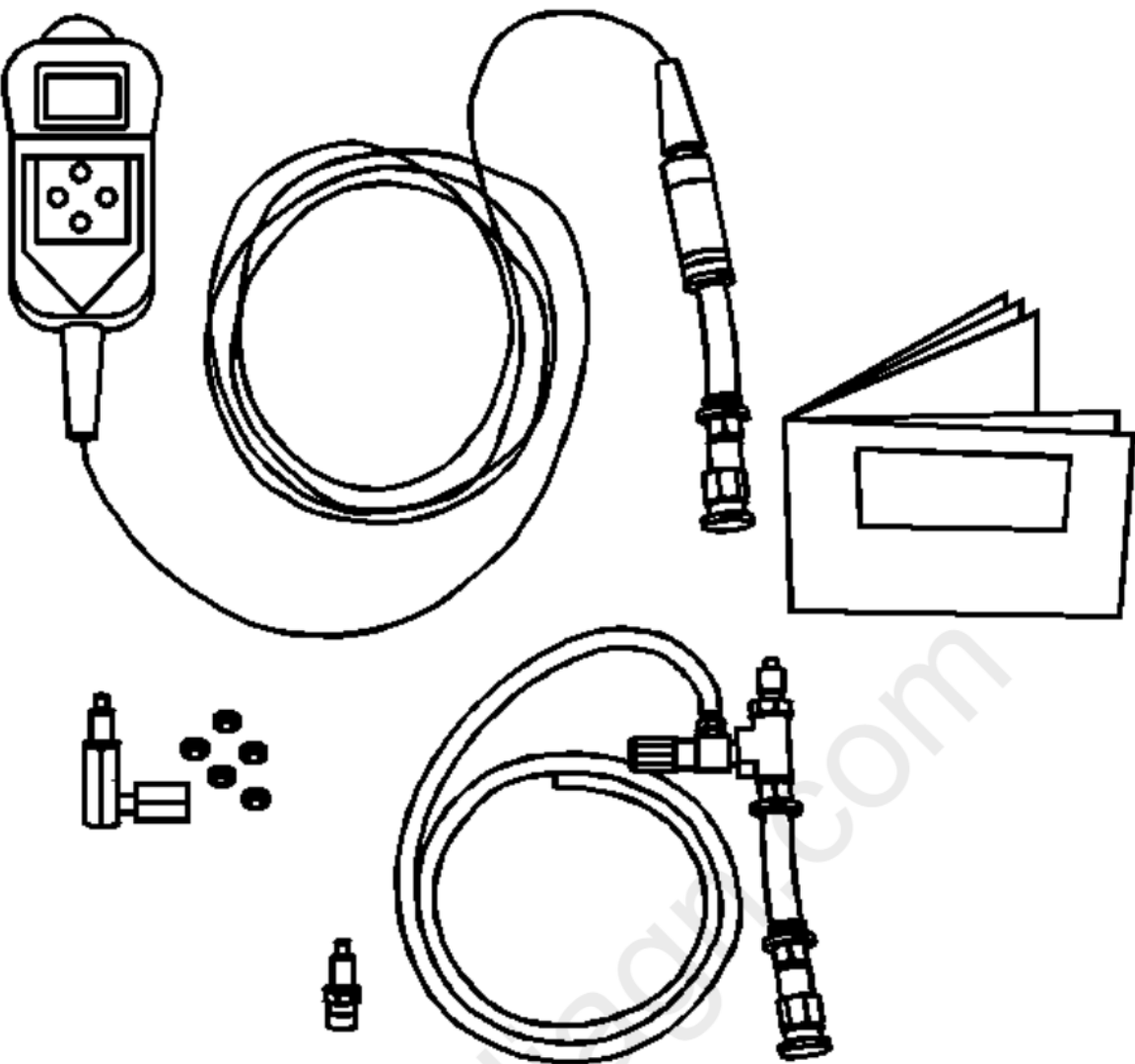
Illustration	Tool Number/Description
 The illustration shows a digital pressure gauge kit. It includes a digital pressure gauge with a small LCD screen and four buttons. A long, coiled hose is connected to the gauge. Another hose with a connector is shown separately. There are also several small connectors and a manual or instruction booklet. A watermark 'cardinal.com' is visible across the bottom half of the illustration.	CH-48027 Digital Pressure gauge South America - Use Local Equivalent

Illustration	Tool Number/Description
 cardiagn.com	CH-51321 Vent Tube and Valve Assembly
	EN-34730-91 Pressure Tester

Illustration

Tool
Number/Description

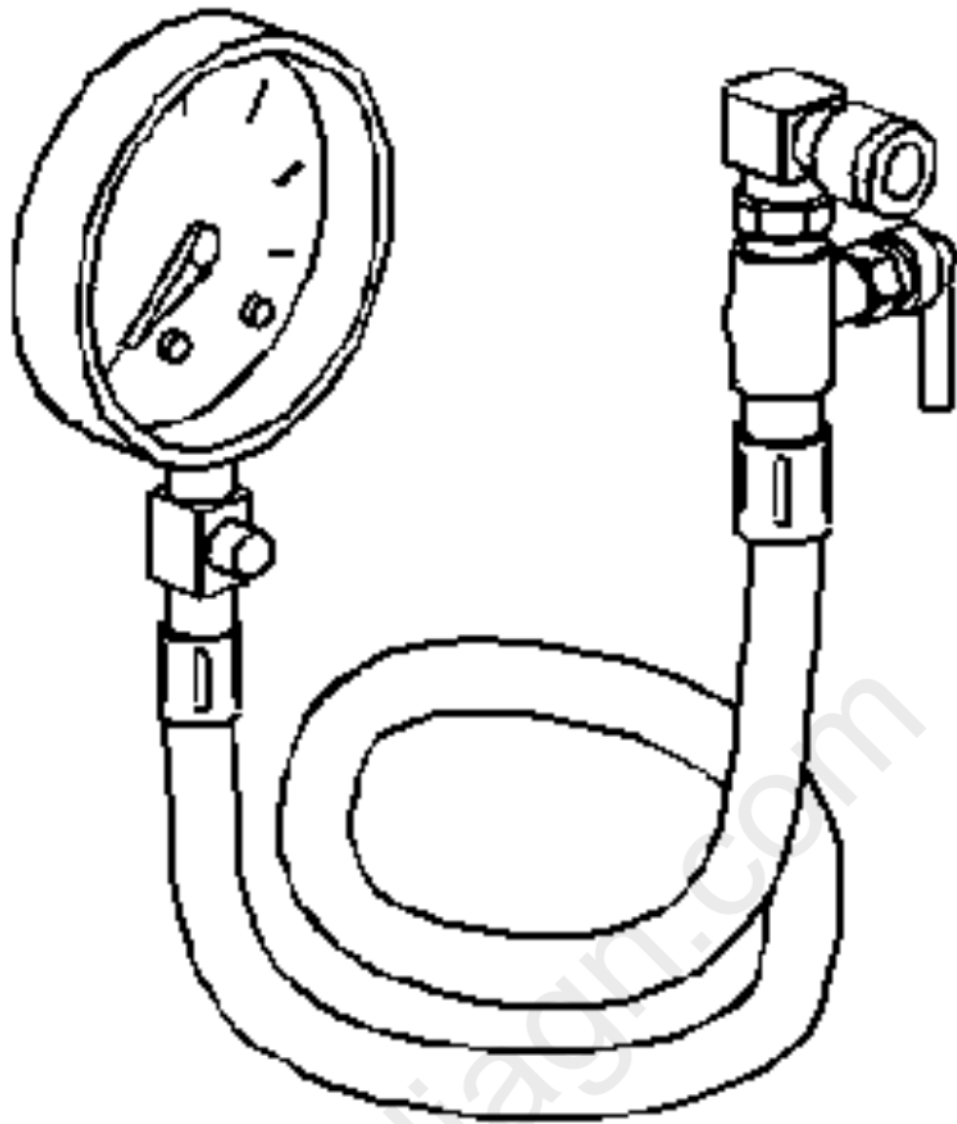
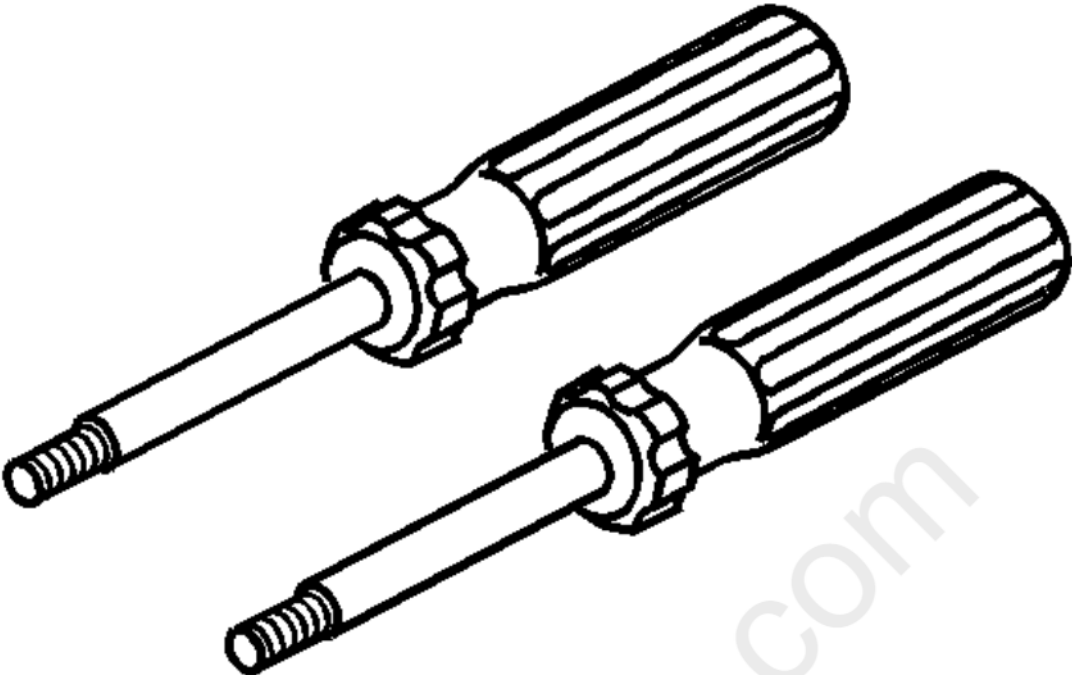
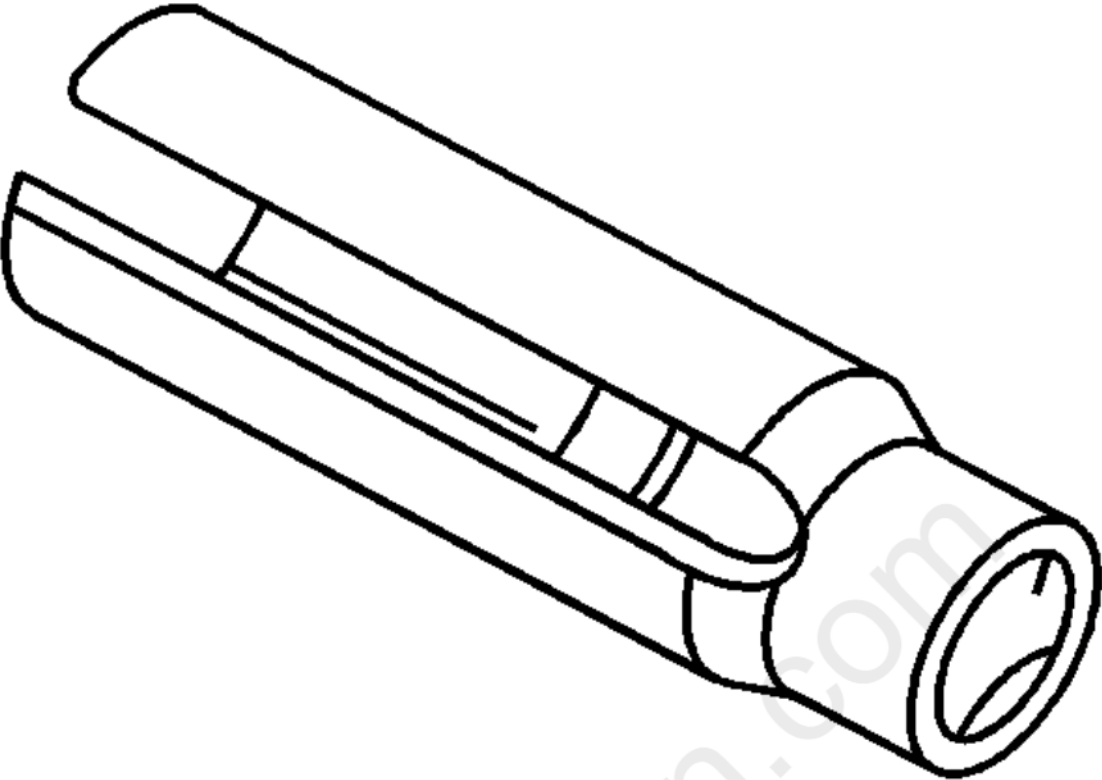


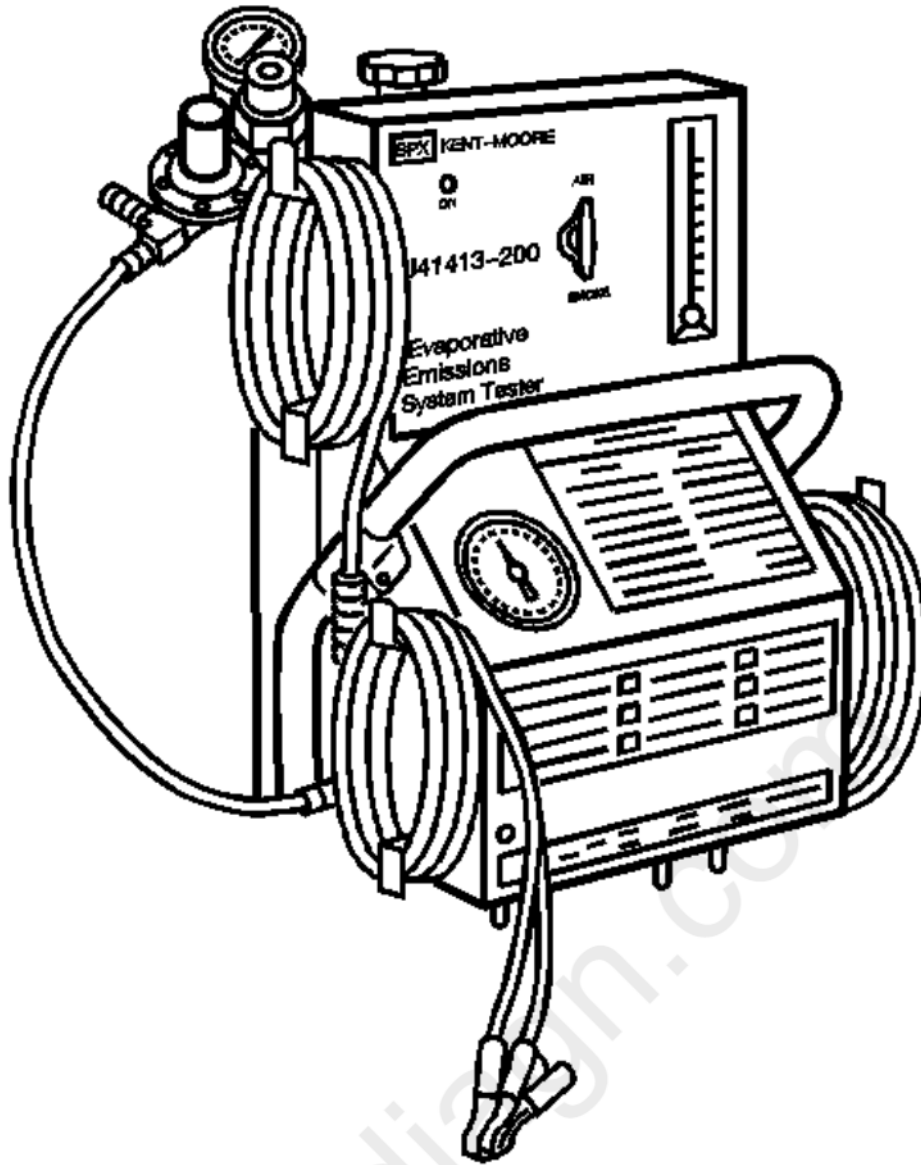
Illustration	Tool Number/Description
 cardiagn.com	EN-6009 Remover and Installer Ignition Module

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Illustration	Tool Number/Description
	EN-6197 EN-46577 KM-6197 CH-39194-C Oxygen Sensor Remover/Installer

Illustration

Tool
Number/Description



GE- 41413-200
Evaporative Pressure
and Pressure Purge
Station

J-45529
Tank Removal Tool

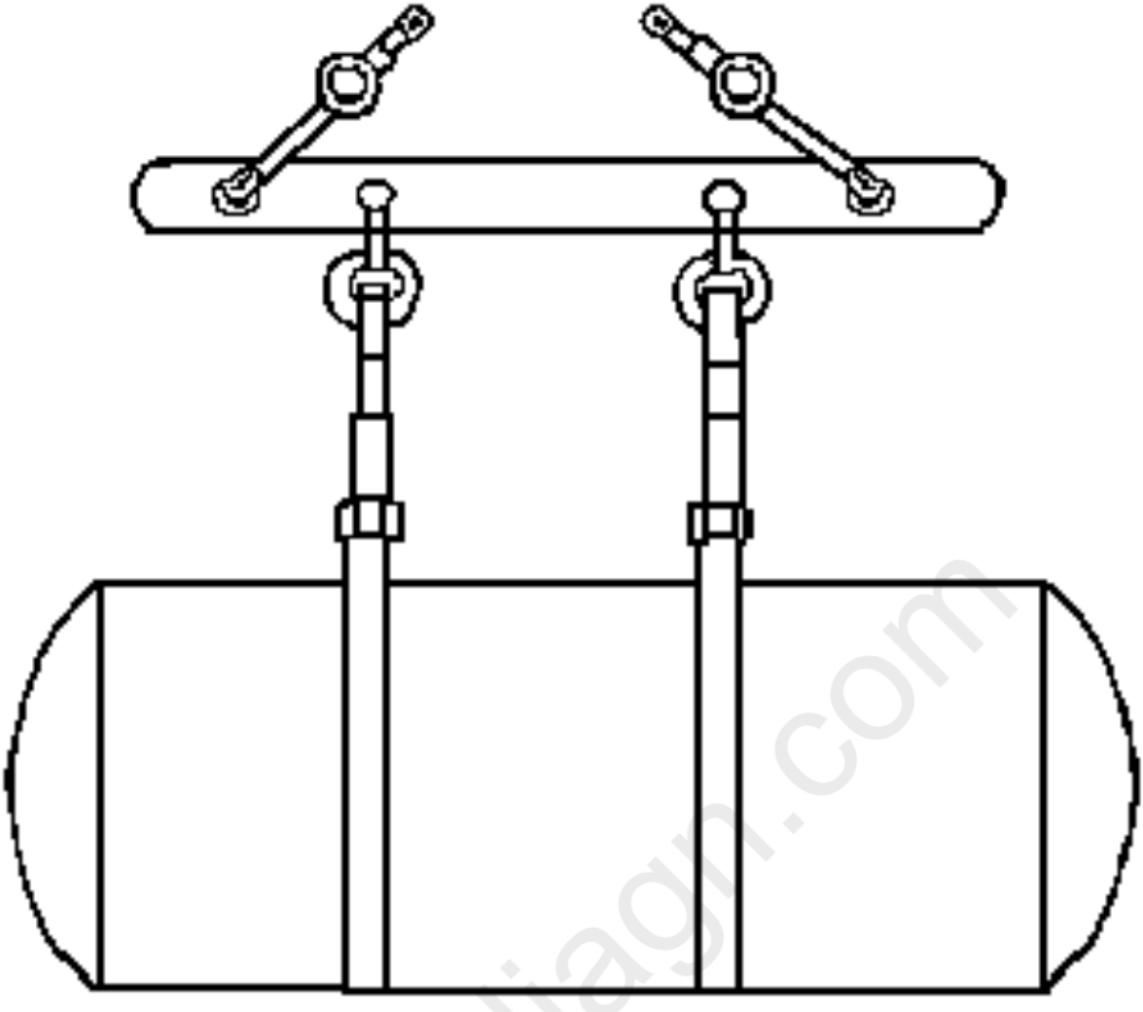
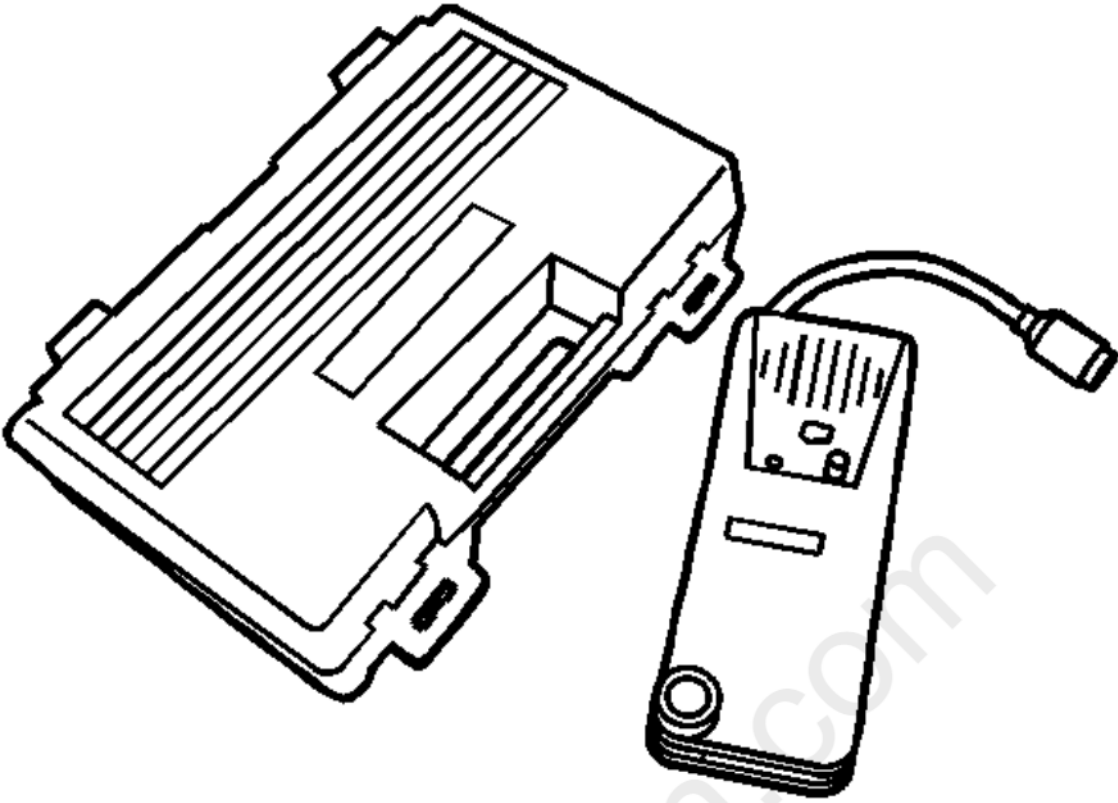
Illustration	Tool Number/Description
	

Illustration	Tool Number/Description
	J-45878 Combustible Gas Detector

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 3.6L (LFX) - Specifications - Impala

SPECIFICATIONS

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 1002 ohms
45Â°C (113Â°F)	1167 to 1223 ohms
40Â°C (104Â°F)	1430 to 1500 ohms
35Â°C (95Â°F)	1763 to 1849 ohms
30Â°C (86Â°F)	2185 to 2295 ohms
25Â°C (77Â°F)	2725 to 2865 ohms
20Â°C (68Â°F)	3418 to 3604 ohms
15Â°C (59Â°F)	4318 to 4564 ohms
10Â°C (50Â°F)	5493 to 5823 ohms
5Â°C (41Â°F)	7041 to 7485 ohms
0Â°C (32Â°F)	9097 to 9701 ohms
-5Â°C (23Â°F)	11844 to 12678 ohms
-10Â°C (14Â°F)	15540 to 16700 ohms
-15Â°C (5Â°F)	20559 to 22183 ohms
-20Â°C (-4Â°F)	27439 to 29725 ohms
-30Â°C (-22Â°F)	50264 to 54924 ohms
-40Â°C (-40Â°F)	95953 to 105777 ohms

TEMPERATURE VERSUS RESISTANCE - INTAKE AIR TEMPERATURE SENSOR (HITACHI SENSOR)

Temperature CÂ°/FÂ°	Resistance Minimum Ohms	Resistance Maximum Ohms
Hitachi Intake Air Temperature (IAT) Sensor		
-40/-40	37, 527	49, 882
-20/-4	13, 110	16, 329
-10/14	8, 145	9, 851
0/32	5, 205	6, 122
20/68	2, 298	2, 570
25/77	1, 900	2, 100
40/104	1, 073	1, 226
60/140	537	639
80/176	289	356

Temperature CÂ°/FÂ°	Resistance Minimum Ohms	Resistance Maximum Ohms
Hitachi Intake Air Temperature (IAT) Sensor		
100/212	165	210
120/248	99	129
140/284	62	83
150/302	49	67

ALTITUDE VERSUS BAROMETRIC PRESSURE (WITH LFX)

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
Firing Order	1 - 2 - 3 - 4 - 5 - 6
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
Evaporative Emission Canister Purge Solenoid Valve O-ring
Fuel Pressure Sensor O-ring
Fuel Tank Module O-ring
High Pressure Fuel Pump Gasket
High Pressure Fuel Pump O-ring
Throttle Body Seal

NOTE:

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application
Upper Intake Manifold Gasket

Single Use Threaded Fastener/Component Tightening Specifications**NOTE:**

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application	Specification
	Metric (English)
Fuel Feed Intermediate Pipe Fitting	28 N.m (21 lb ft)
Fuel Feed Pipe Fitting	28 N.m (21 lb ft)
Fuel Injection Fuel Rail Fuel Pressure Sensor	33 N.m (11 lb ft)
High Pressure Fuel Pump Bolt	
• First Pass:	15 N.m (11 lb ft)
• Final Pass:	60 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)
Camshaft Position Actuator Solenoid Valve Fastener	10 N.m (89 lb in)
Camshaft Position Sensor Fastener	10 N.m (89 lb in)
Chassis Control Module Fastener	9 N.m (80 lb in)
Crankshaft Position Sensor Bolt	10 N.m (89 lb in)
Engine Coolant Temperature Sensor	20 N.m (15 lb ft)
Evaporative Emission Canister Purge Solenoid Valve Bolt	10 N.m (89 lb in)
Fuel Feed Front Hose @ Fuel Filter Housing	
• First Pass:	3 N.m (27 lb in)
• Final Pass:	90 degrees
Fuel Feed Pipe Bolt	50 N.m (37 lb ft)
Fuel Pipe Shield Bolt	10 N.m (89 lb in)
Fuel Pressure Sensor @ Fuel Feed Pipe	15 N.m (11 lb ft)
Fuel Rail Bolt (LFX)	
• First Pass:	12 N.m (106 lb in)
• Final Pass:	23 N.m (17 lb ft)

NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Fuel Tank Filler Pipe Bolt	9 N.m (80 lb in)
Fuel Tank Filler Pipe Hose Clamp	4 N.m (35 lb in)
Fuel Tank Filler Tube Hose Clamp	4 N.m (35 lb in)
Fuel Tank Shield Bolt (CNG)	10 N.m (89 lb in)
Fuel Tank Strap Bolt	27 N.m (20 lb ft)
Heated Oxygen Sensor	42 N.m (31 lb ft)
Ignition Coil Bolt	10 N.m (89 lb in)
Knock Sensor Bolt	25 N.m (18 lb ft)
Knock Sensor Heat Shield Bolt - Lower	58 N.m (43 lb ft)
Knock Sensor Heat Shield Bolt - Upper	9 N.m (80 lb in)
Lower Intake Manifold Assembly Fastener	7 N.m (62 lb in)
Manifold Absolute Pressure Sensor Fastener	4 N.m (35 lb in)
Secondary Air Injection Bypass Valve Fastener	22 N.m (16 lb ft)
Secondary Air Injection Check Valve Fastener	22 N.m (16 lb ft)
Secondary Air Injection Pump Fastener	10 N.m (89 lb in)
Spark Plug	18 N.m (13 lb ft)
Throttle Body Fastener	10 N.m (89 lb in)

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number
Anti-Seize Compound	Lubricant	GM P/N 88862477 (Canadian P/N 88862478)
Camshaft Gear Access Hole Plug	Sealant	GM P/N 12346004 (Canadian P/N 10953480)
Coolant Temperature Sensor Threads	Sealant	GM P/N 12346004 (Canadian P/N 10953480)
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)

Application	Type of Material	GM Part Number
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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