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Engine Controls And Fuel - 1.6L (LH7) Diesel - Description And Operation - Equinox & Terrain

DESCRIPTION AND OPERATION

ACCELERATOR PEDAL POSITION SYSTEM DESCRIPTION

The accelerator pedal position (APP) system along with the engine control module (ECM) and other components is used to calculate and control the amount of acceleration and deceleration by controlling the amount of fuel delivery.

The APP system includes the following components:

- The APP sensor assembly.
- The engine control module (ECM).

Accelerator Pedal Position (APP) Sensor

The APP sensor is mounted on the accelerator pedal control assembly. The sensor is made up of 2 individual sensors within one housing. Two separate signals, low reference, and 5 V reference circuits are used in order to interface the accelerator pedal sensor assembly with the engine control module (ECM). Each sensor has a unique functionality to determine pedal position. The ECM uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle. The APP sensor 1 voltage should increase as the accelerator pedal is depressed, from below 0.7 V at 0% pedal travel to 4.5 V at 100% pedal travel. APP sensor 2 voltage should increase from above 0.3 V at 0% pedal travel to 2.2 V at 100% pedal travel.

ENGINE CONTROL MODULE DESCRIPTION

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

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

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

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

The ECM constantly monitors the information from various sensors and other inputs, and controls the systems that affect the vehicle performance and emissions. The ECM also performs diagnostic tests on various parts of the system. The ECM can recognize operational problems and alert the driver via the

MIL. When the ECM detects a malfunction, the ECM stores a DTC. The condition area is identified by the particular DTC that is set. This aids the technician in making repairs.

ECM Function

The engine control module (ECM) can supply 5 V, 12 V, or ground to various sensors or switches. Voltage is supplied through pull-up resistors to the regulated power supplies within the ECM. In some cases an ordinary shop voltmeter will not give an accurate reading due to low input resistance. A DMM with at least 10 MΩ input impedance is required in order to ensure accurate voltage readings.

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

EEPROM

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

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

ECM Default Actions

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

ECM Output Controls

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

Data Link Connector (DLC)

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

Malfunction Indicator Lamp (MIL)

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

ECM Service Precautions

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

Powertrain Expansion Bus

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

FUEL SYSTEM DESCRIPTION

LFS Fuel System Diagram with Fuel Pump Driver Control Module

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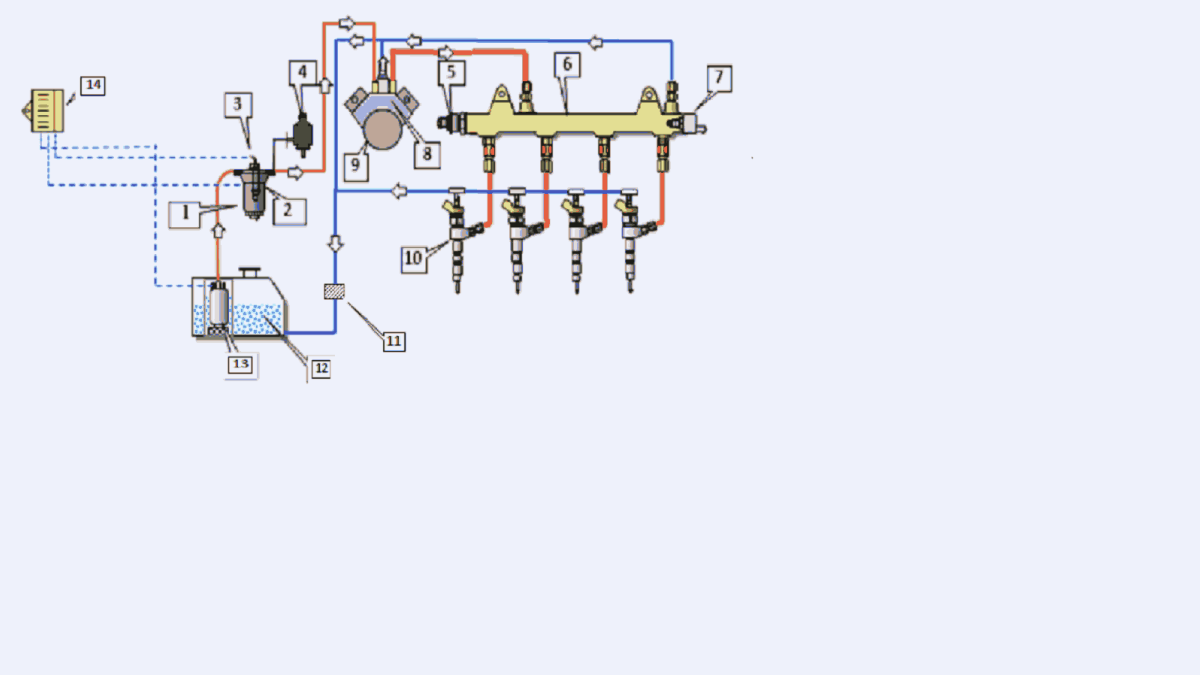

Fig. 1: LFS Fuel System Diagram With Fuel Pump Driver Control Module Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Filter with Water in Fuel Sensor
2	Fuel Heater
3	Fuel Temperature Sensor
4	Fuel Pressure Sensor
5	Dual Fuel Rail Pressure Sensor (Contains Fuel Rail Pressure Sensor 1 and Fuel Rail Pressure Sensor 2)
6	Fuel Rail Assembly
7	Fuel Rail Pressure Regulator 2
8	Fuel Pressure Regulator 1 (Located in Fuel Injection Pump)
9	Fuel Injection Pump
10	Fuel Injectors
11	Fuel Tank
12	Electric 3 - Phase Fuel Pump
13	Fuel Pump Driver Control Module

The fuel tank stores the fuel supply and contains a 3 - phase electric fuel pump that is controlled by the fuel pump driver control module and engine control module. Fuel is pumped from the fuel tank through the fuel feed line to the fuel filter assembly. The fuel filter assembly consists of a fuel filter/water separator, fuel heater, fuel temperature sensor, and a water in fuel sensor. Fuel flows out of the fuel filter assembly through the rear fuel feed pipe to the fuel pressure sensor and fuel injection pump. The belt driven fuel injection pump is mounted on the upper right corner of the engine block. High pressure fuel is supplied through the high pressure fuel line to the fuel rail and then through the fuel injector lines to the fuel injectors. High pressure fuel is controlled by the ECM, fuel pressure regulator 1 and fuel pressure regulator 2. Excess fuel returns to the fuel tank through the fuel return pipes.

Fuel Tank

The fuel tank (1) stores the fuel supply. The fuel tank is held in place by 2 metal straps. The fuel tank is molded from high density polyethylene.

Fuel Filler Cap

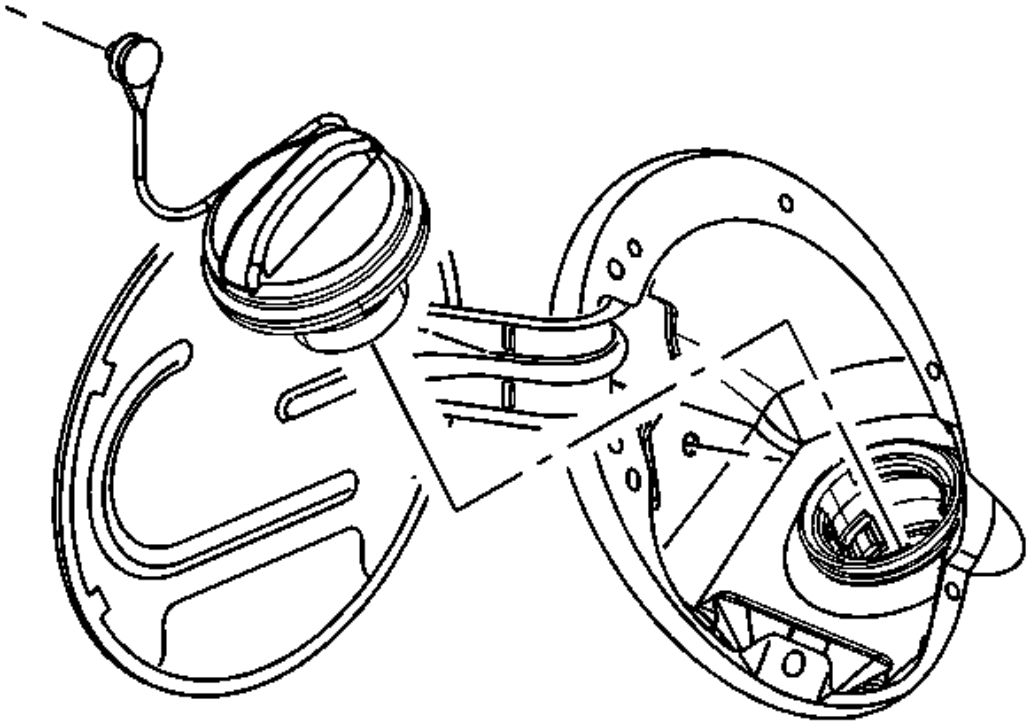

Fig. 2: Filler Door And Tethered Fuel Filler Cap
Courtesy of GENERAL MOTORS COMPANY

The fuel filler cap has a torque-limiting device that prevents the cap from being over tightened. To install, turn the cap clockwise until you hear audible clicks. This indicates that the cap is fully seated.

Fuel Tank Fuel Pump Module

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

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

Fuel Level Sensor

The fuel level sensor consists of a float, a wire float arm, and a ceramic resistor card. The position of the float arm indicates the fuel level. The fuel level sensor contains a variable resistor which changes resistance in correspondence with the amount of fuel in the fuel tank. The fuel pump driver control module sends the fuel level information via the engine control module (ECM) to the instrument panel cluster (IPC). This information is used for the instrument panel (I/P) fuel gauge and the low fuel warning indicator. The fuel pump driver control module also monitors the fuel level input for various diagnostics.

Fuel Pump

The fuel pump is mounted in the primary fuel tank module reservoir. The engine control module (ECM) supplies voltage to the fuel pump driver control module for 30 s when the ignition is turned on and continuously when the engine is running. While this voltage is being received, the ECM sends a serial data signal to the fuel pump driver control module containing the desired fuel pump speed. The fuel

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pump driver control module actuates the brushless fuel pump by means of a three phase signal and controls the fuel pump speed according to serial data signals received from the ECM containing the desired fuel pump speed.

Fuel Strainer

The fuel strainer attaches to the lower end of the fuel sender. The fuel strainer is made of woven plastic. The functions of the fuel strainer are to filter contaminants and to wick fuel. The fuel strainer is self-cleaning and normally requires no maintenance. Fuel stoppage at this point indicates that the fuel tank contains an abnormal amount of sediment.

Fuel Filter Assembly

The fuel filter assembly (3) is mounted to the right side of the fuel tank. The paper filter element traps particles in the fuel that may damage the fuel injection system. The fuel filter assembly consists of the following major components:

- Fuel Filter/Water Separator
- Fuel Heater
- Fuel Temperature Sensor
- Water in Fuel Sensor

Fuel Filter/Water Separator

The paper filter element traps particles in the fuel that may damage the fuel injection system and is designed to allow trapped water particles to settle to the bottom of the filter assembly.

Fuel Heater

The fuel heater located in the fuel conditioning module is controlled by the engine control module (ECM). When the temperature of the fuel is below the calibrated level the ECM will command the fuel heater relay ON. With the relay ON battery voltage is supplied to the fuel heater to assist in cold weather operation.

Fuel Temperature Sensor

The fuel temperature sensor is a thermistor that is located in the fuel filter assembly. The ECM monitors the fuel temperature sensor through the fuel pump driver control module in order to calculate the temperature of the fuel entering the fuel injection pump.

Water in Fuel Sensor

The water in fuel sensor is a sensor that monitors for the presence of diesel fuel and water. When water is present the fuel pump driver control module detects low voltage on the signal circuit and sends a message to the ECM. The ECM sends a serial data message to the instrument panel cluster to display the WATER IN FUEL SERVICE REQUIRED message.

Fuel Feed and Return Pipes

The fuel feed pipe carries fuel from the fuel tank to the fuel filter/heater element housing. The fuel return pipe carries fuel from the fuel rail assemblies back to the fuel tank. The fuel pipes consist of 2 sections:

- The rear fuel pipe assemblies are located from the top of the fuel tank to the chassis fuel pipes. The rear fuel pipes are constructed of nylon.
- The chassis fuel pipes are located under the vehicle and connect the rear fuel pipes to the fuel rail pipes.
- Nylon fuel pipes are somewhat flexible and can be shaped around gradual turns under the vehicle. However, if nylon fuel pipes are forced into sharp bends, the pipes may kink and restrict the flow of fuel. Also, once exposed to fuel, nylon pipes may become stiffer and are more likely to kink if bent too far. Exercise special care when working on a vehicle with nylon fuel pipes.

Quick-Connect Fittings

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

Fuel Pipe O-Rings

O-rings seal the connections in the fuel system. Fuel system O-ring seals are made of special material. Service the O-ring seals with the correct service part.

Fuel Injection Pump

The fuel injection pump (5) is a mechanical high pressure pump. The fuel injection pump is located on the upper right side of the engine. Fuel is pumped to the fuel rail (8) at a specified pressure. Fuel pressure is regulated by two fuel pressure regulators located in the fuel injection pump and the end of the fuel rail, both are controlled by the engine control module (ECM). Excess fuel from the fuel injection pump returns to the fuel tank through the fuel return pipe.

Fuel Pressure Regulator

The engine control module (ECM) controls the fuel rail pressure using a pulse width modulated fuel rail pressure regulator. The fuel pressure regulator is located in the fuel injection pump and meters the amount of fuel that enters the high pressure side of the pump. From the high pressure pump, the fuel moves to the fuel rail through a high pressure steel line. The fuel rail distributes high pressure fuel to all 4 fuel injectors.

Fuel Pressure Regulator 2 (if equipped)

Fuel Pressure Regulator 2 Filter Screen

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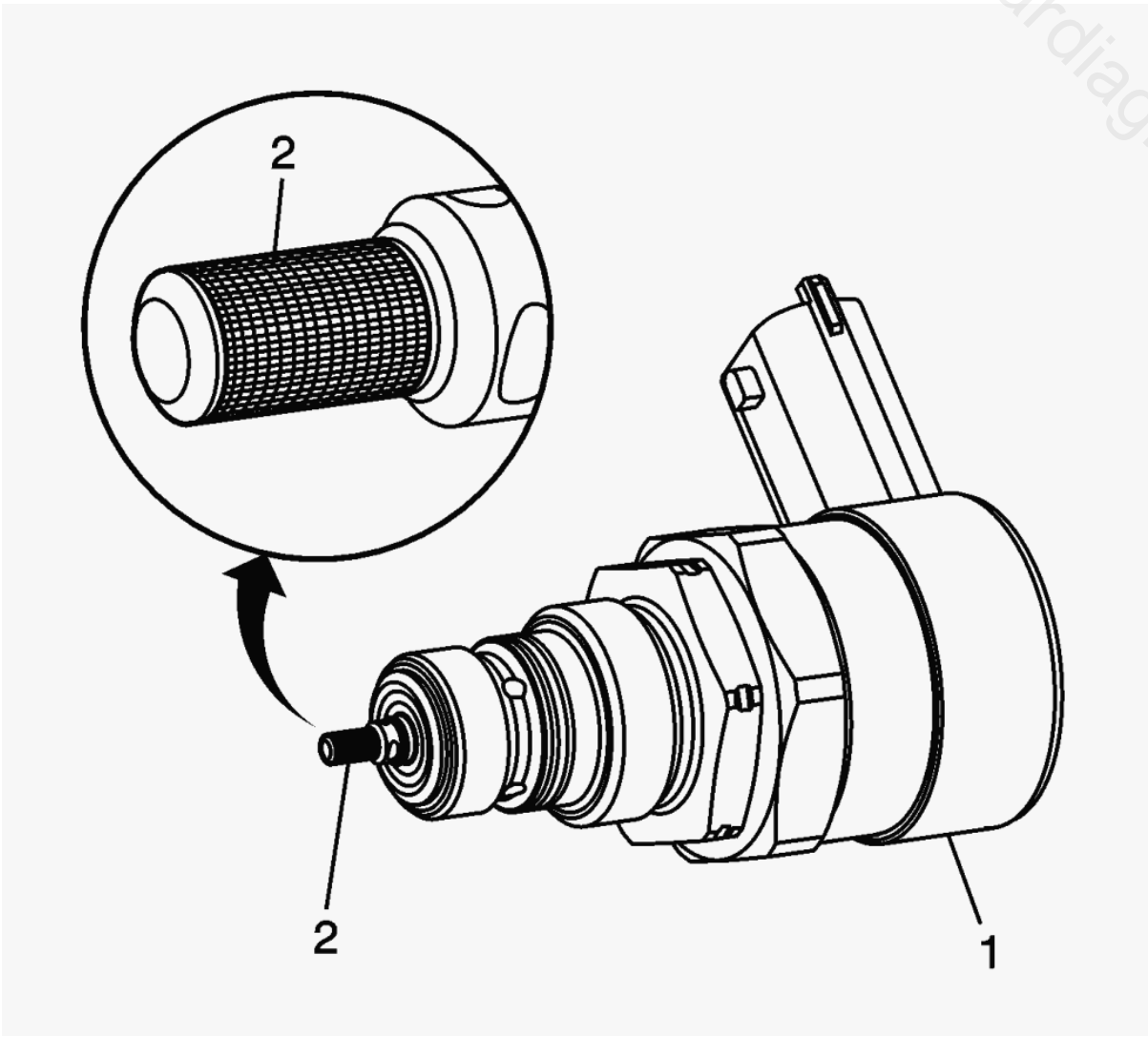

Fig. 3: Fuel Pressure Regulator 2 Filter And Screen
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Pressure Regulator 2
2	Filter Screen

At engine start, the engine control module (ECM) commands the fuel pressure regulator 2 to control fuel pressure at idle. The engine will remain in this mode if the fuel temperature is below 15Â°C (59Â°F), or until the fuel pressure regulator 2 adapts (which occurs at higher engine loads), or until fuel temperature reaches 60Â°C (140Â°F). The adaptation is a learned factor that adjusts the fuel pressure regulator 2 current to compensate for manufacturing tolerances and component aging. Once the adaptation is complete, the vehicle will use fuel pressure regulator 1 for rail pressure control at idle. The fuel pressure regulator 2 adaptation will attempt to run again at the next drive cycle.

Fuel Rail Pressure Sensor

The fuel rail pressure sensor is located in the rear of the fuel rail assembly. The fuel rail pressure sensor provides the engine control module (ECM) an indication of the actual fuel rail pressure. The ECM uses this information to regulate the fuel pressure, by commanding the fuel pressure regulator to obtain the desired fuel pressure

Fuel Rail Pressure Sensor - Dual (if equipped)

The dual fuel rail pressure sensor contains fuel pressure regulator 1 and fuel pressure regulator 2 and is located in the rear of the fuel rail assembly. The dual fuel rail pressure sensor provides the ECM an indication of the actual fuel rail pressure. The ECM uses this information to regulate the fuel pressure, by commanding the fuel pressure regulator to obtain the desired fuel pressure.

Fuel Injection Fuel Rail Assembly

The fuel rail assembly attaches to the cylinder head. The fuel rail assembly distributes pressurized fuel to the fuel injectors through the fuel lines.

Fuel Pressure Sensor (if equipped)

The fuel pressure sensor is located in the fuel feed pipe. The engine control module (ECM) monitors the fuel pressure sensor by serial data received from the fuel pump driver control module. The ECM monitors the voltage of the fuel pressure sensor in order to provide fuel pressure control.

Fuel Injectors and Return Lines

The fuel injectors are located above each cylinder and deliver fuel directly into the cylinder. Each injector has a high pressure fuel pipe from the fuel rail and a return line.

A fuel injector is a solenoid device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder. Fuel pressure is released from above the fuel injector pintle, and is returned to the fuel tank through the fuel return lines. The difference in fuel pressure above and below the pintle causes the pintle to open. Fuel from the fuel injector tip is sprayed directly into the combustion chamber on the compression stroke of the engine.

EXHAUST AFTERTREATMENT SYSTEM DESCRIPTION

System Overview

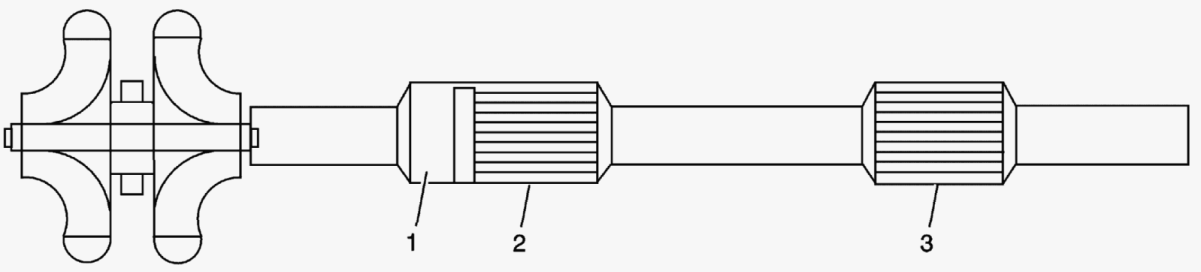

Fig. 4: Exhaust After Treatment System 3 Stage Description
Courtesy of GENERAL MOTORS COMPANY

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The diesel exhaust aftertreatment system is designed to reduce the levels of hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOx), and particulate matter remaining in the vehicle's exhaust gases. Reducing these pollutants to acceptable levels is achieved through a 3 stage process:

1. A diesel oxidation catalyst (DOC) stage
2. A diesel particulate filter (DPF) stage
3. A selective catalyst reduction (SCR) stage

In stage 1, the DOC removes exhaust HC and CO through an oxidation process. After stage 1, particulate matter consisting of extremely small particles of carbon remaining after combustion are removed from the exhaust gas by the large surface area of the DPF. In the final or stage 3 process, reductant, also known as diesel exhaust fluid (DEF) or urea, is injected into the exhaust gases prior to entering the SCR stage. Within the SCR, NOx is converted to nitrogen (N2), carbon dioxide (CO2), and water vapor (H20) through a catalytic reduction fueled by the injected reductant.

Exhaust Aftertreatment System

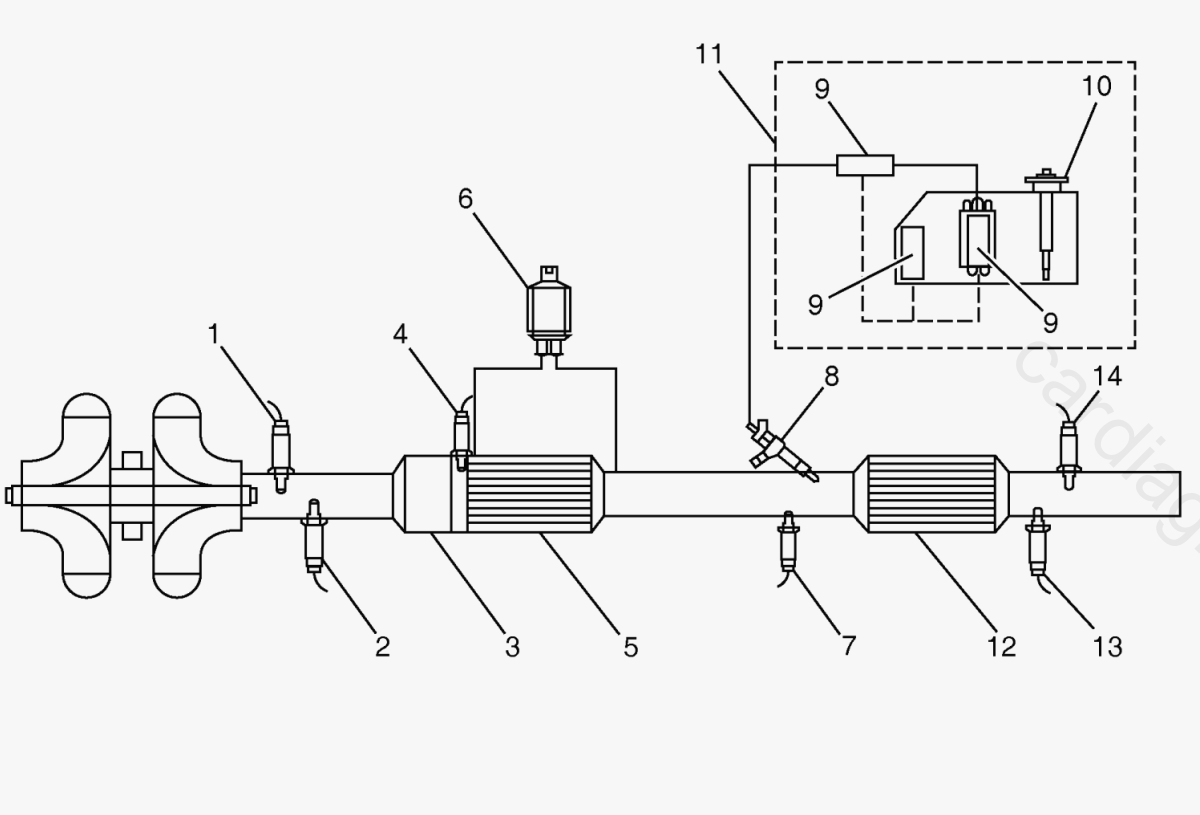

Fig. 5: Exhaust Aftertreatment System Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	NOx Sensor 1 (Upstream)
2	Exhaust Gas Temperature (EGT) 1
3	Diesel Oxidation Catalyst (DOC)
4	Exhaust Gas Temperature (EGT) 2
5	Diesel Particulate Filter (DPF)
6	DPF Pressure Sensor (DPS)
7	Exhaust Gas Temperature (EGT) 3
8	Reductant Injector and Dosing Module
9	SCR Pump, Tank and Line Heaters
10	Reductant Level and Temperature Sensors
11	Reductant Tank and Supply Module
12	Selective Catalyst Reduction (SCR)
13	NOx Sensor 2 (Downstream)
14	Particulate Matter Sensor (PMS)

Diesel Oxidation Catalyst (DOC) Operation

The DOC functions much like the catalytic converter used with gasoline fueled engines. As with all catalytic converters, the DOC must be hot in order to effectively convert the exhaust HC and CO into CO2 and H20. On cold starts, the exhaust gases are not hot enough to create temperatures within the DOC high enough to support full HC and CO conversion. The temperature at which full conversion occurs is known as light-off.

In addition to reducing emissions, the DOC also generates the exhaust heat needed by the SCR stage. Exhaust gas temperature (EGT) sensors are located upstream (EGT 1) and downstream (EGT 2) of the DOC. By monitoring the temperature differential between these two sensors, the ECM is able to confirm DOC light-off. Light-off is confirmed by a DOC output temperature that is greater than its input temperature.

In order to generate the high exhaust temperatures needed for regeneration, the aftertreatment system increases exhaust temperatures by injecting diesel fuel into the exhaust gases entering the DOC. This is accomplished by means post-injection using the engines fuel injectors.

Proper DOC function requires the use of ultra-low sulfur diesel (ULSD) fuel containing less than 15 parts-per-million (ppm) sulfur. Levels above 15 ppm will reduce catalyst efficiency and eventually result in poor driveability and one or more DTCs being set.

Diesel Particulate Filter (DPF)

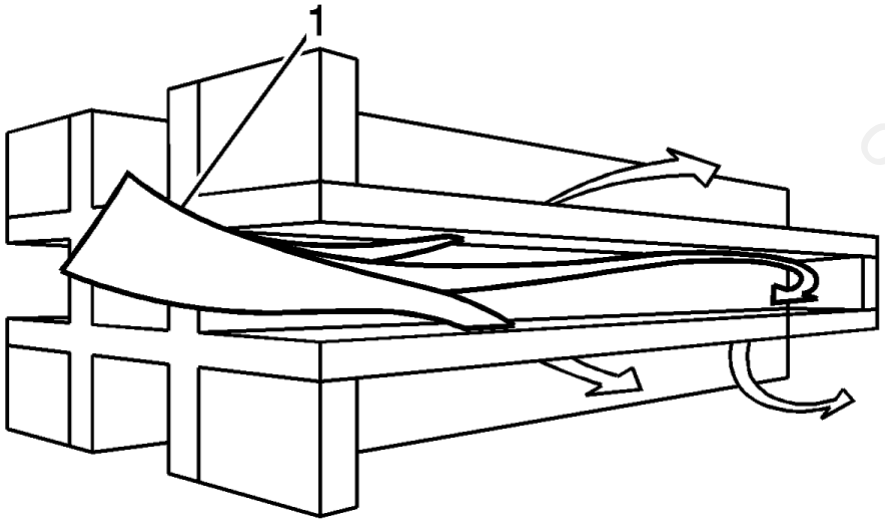

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Fig. 6: Identifying Diesel Particulate Filter (DPF)
Courtesy of GENERAL MOTORS COMPANY

The DPF captures diesel exhaust gas particulates, also known as soot, preventing their release into the atmosphere. This is accomplished by forcing particulate-laden exhaust through a filter substrate consisting of thousands of porous cells. Half of the cells are open at the filter inlet but are capped at the filter outlet. The other half of the cells are capped at the filter inlet and open at the filter outlet. This forces the particulate-laden exhaust gases (1) through the porous walls of the inlet cells into the adjacent outlet cells trapping the particulate matter. The DPF is capable of removing more than 90% of particulate matter, or soot carried in the exhaust gases.

Particulate Matter Sensor (PMS)

The PM sensor determines the amount of the particulates (soot) in the diesel exhaust gas exiting the tailpipe by monitoring the collection efficiency of the DPF and to aid in OBD-II emission diagnostics.

The PM sensor is similar to the heated oxygen sensor with a ceramic element but also includes an individually calibrated control unit. The PM sensor sensing element includes two comb-shaped inter-digital electrodes, a heater and a positive temperature coefficient (PTC) resistor for temperature measurement.

The operation of the PM sensor is based on the electrical conductivity characteristic of the soot. As the exhaust gas flows over the sensing element, soot is absorbed in the combs between the electrodes, eventually creating a conductive path. When the path is formed, it generates a current based on the

voltage being applied to the element. The measurement process continues until a preset current value is reached. To avoid misleading readings, the sensor operates on a "regenerative" principle, where the soot is cleaned off by heating up the element to burn off the carbon, before the measurement phase begins. The amount of regenerations is based on vehicle strategy; when the amount of regeneration is reached, the cumulative current readings are used to determine the amount of soot concentration in the exhaust gas, and thus the collection efficiency of the DPF.

The PM sensor is operated in 3 successive modes:

1. Standby mode after power-up to ensure protective heating. On power-up, the control unit starts the heating process to avoid condensation of liquids on the sensing element. Presence of liquid can cause thermal shock during the heating process, resulting in damage to the ceramic element. Regeneration is not initiated until the dew point temperature has been exceeded.
2. Regeneration mode is conducted before each measurement to ensure a soot free sensing element. Before starting measurements, absorbed soot is burned off the sensing element by heating it up; this ensures each measurement start off at the same condition. Regeneration is conducted for a pre-determined period of time based on soot level.
3. Measurement mode is when soot is actively collected on the sensing element. The sensor heater is deactivated during measurement, so the temperature on the element is equivalent to that of the exhaust gas. Voltage is applied until a preset 12 micro-amp current threshold is achieved due to increasing current as the soot builds up on the element. The time from the end of the regeneration to reach the threshold is used to calculate the concentration of soot in the exhaust gas.

Differential Pressure Sensor (DPS)

Pressure connections at the DPF inlet and outlet allow the DPS to measure the pressure drop across the diesel particulate filter. This pressure drop increases as trapped soot collects in the cells of the DPF during vehicle operation. The rate at which soot collects varies with the power demands placed on the engine. If left unchecked, the increasing backpressure will eventually result in a driveability problem. There are two sensing elements in the DPS; one for the upstream side of the DPF, and the other for the downstream side. Pressure from each side of the DPF is applied to the bottom side of a silicon diaphragm in each sensing element; atmospheric pressure is applied to the top side of each diaphragm. Relative pressure differences in each sensing element is converted to a voltage (V1 & V2). The difference in these voltages is sent to the ECM. As the DPF becomes clogged, the pressure on the upstream side increases because of back pressure due to the restriction of the exhaust gas flow through the DPF.

Normal DPF Regeneration

Over time, the soot trapped on the cell walls acts to restrict exhaust flow through the DPF reducing its effectiveness as well as reducing engine efficiency. This restriction in exhaust flow produces a pressure drop across the DPF that increases as the once porous cell walls become saturated with trapped soot. A DPS monitors the pressure drop across the DPF and provides the ECM with a voltage signal proportional to soot buildup. Once soot buildup reaches a specified limit, (usually around 22 - 25 grams) as signaled by the increased pressure drop across the DPF, the ECM commands a regeneration event to burn-off the collected soot during normal vehicle operation. Regeneration events occurring during vehicle operation are known as normal regenerations as they occur automatically and without driver knowledge. In general, the vehicle will need to be operating continuously at speeds above 48 km/h (30 mph) for approximately 20 - 30 minutes for a full and effective regeneration to complete.

The frequency of normal DPF regeneration is a function of the engine run time, miles driven, and fuel consumed since the last regeneration event. Under normal operating conditions, the normal DPF regeneration is initiated after approximately 85 gallons of fuel used or a maximum distance traveled of 2009 km (1250 miles.) To initiate a normal DPF regeneration event, the ECM commands additional fuel via post-injection in order to create the additional exhaust heat in the DOC necessary to promote regeneration and burn-off the collected soot.

During regeneration exhaust temperatures may exceed 550Â°C (1, 022Â°F) due to the rapid catalytic combustion of soot within the DPF. Conversely, under low engine speed or light loads, exhaust temperatures may be too low to promote proper regeneration. To protect the DPF catalyst from thermal damage due to excessive soot combustion or from sulfate poisoning at low temperatures, the ECM monitors EGT sensors upstream and downstream of the DPF during regeneration. If the vehicle is

slowed to idle speed during a normal DPF regeneration, the engine may maintain an elevated idle of 800 RPM until the DPF is cooled to a calibrated temperature.

Should the EGT sensors indicate that regeneration temperatures have exceeded a calibrated threshold, regeneration will be temporally suspended until the sensors return to a normal temperature. If regeneration temperatures fall below a calibrated threshold, regeneration is terminated and a corresponding DTC is set in the ECM.

Under most conditions, the soot collected within the DPF burns off during normal regeneration cycles. Periodic regeneration prevents the buildup of soot from reaching a level where its burn-off could produce damaging high temperatures within the DPF. Vehicles operated at prolonged low speed or low loads where normal regeneration does not occur will eventually reach a high soot load condition. When the increased pressure drop across the DPF is detected by the DPS, the ECM illuminates the DPF lamp in the instrument cluster and sends a Clean Exhaust Filter message to the driver information center (DIC). The owner's manual diesel supplement describes how the vehicle should be driven in order to enable normal regeneration.

Service Regeneration

WARNING: **Tailpipe outlet exhaust temperature will be greater than 300Â°C (572Â°F) during this procedure. To help prevent personal injury or property damage from fire or burns, perform the following:**

1. **Do not connect any shop exhaust removal hoses to the vehicle tailpipe.**
2. **Park the vehicle outdoors and keep people, other vehicles, and combustible material away during this procedure.**
3. **Do not leave the vehicle unattended.**

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Should the vehicle operator fail to drive the vehicle within the conditions necessary to initiate a normal regeneration cycle, the ECM illuminates the Service Engine Soon lamp and displays a REDUCED ENGINE POWER message on the DIC once the soot buildup exceeds a calibrated value. The vehicle will remain in the reduced power model until service regeneration is performed.

Service regeneration is required because the amount of soot collected in the DPF, known as soot load, is too high to be burned off without possible thermal damage to the DPF's ceramic substrate.

Service regeneration is one of several output control functions available on the scan tool. When service regeneration is commanded, the ECM takes control of engine operation until the service regeneration is completed in about 35 minutes or until the service regeneration is either cancelled by the technician or is aborted by the ECM when it detects unexpected conditions. The ECM commands additional fuel via post-injection in order to create the additional exhaust heat in the DOC necessary to promote regeneration and burn-off the collected soot.

The service regeneration can be terminated by applying the brake pedal, commanding service regeneration Off using the scan tool, or disconnecting the scan tool from the vehicle.

Service Regeneration Precautions

Exhaust temperatures at the tailpipe may exceed 300Â°C (572Â°F) during service regeneration. Observe the following precautions:

- Service regeneration must be performed outdoors. Most exhaust removal hoses cannot withstand the high exhaust temperatures generated during regeneration.
- Park the vehicle outdoors and keep people, other vehicles, and combustible material away during service regeneration.
- Park the vehicle in an area that provides a clearance area of at least 10 feet on all sides of the vehicle and open the hood.
- Ensure the tailpipe is not obstructed by mud or debris.
- Do not leave the vehicle unattended during service regeneration.

The ECM uses two EGT sensors to measure the temperature of the exhaust gases at the inlet (EGT 2) and outlet (EGT 3) of the particulate filter. Optimum particulate filter temperature is crucial for emission reduction and for ensuring complete regeneration. Excessive particulate filter temperatures could damage the ceramic substrate. The ECM monitors the inlet and outlet exhaust gas temperature sensors in order to maintain the particulate filter at its optimum temperature.

Ash Loading

Ash is a non-combustible by-product from normal oil consumption. Low Ash content engine oil (CJ-4 API) is required for vehicles with the DPF system. Ash accumulation will eventually cause a restriction in the DPF. Being non-combustible, ash is not burned off during regeneration. An ash loaded DPF will need to be removed from the vehicle and replaced.

Selective Catalyst Reduction (SCR) Operation

While diesel engines are more fuel efficient and produce less HC and CO than gasoline engines, as a rule they generate much higher levels of NOx. In order to meet today's tighter NOx limits, an SCR catalyst, along with reductant, is used to convert NOx into N2, CO2, and H2O.

NOx Sensor

The ECM uses two smart NOx sensors to control exhaust NOx levels. The first NOx sensor is located at the turbocharger outlet and monitors the engine out NOx. The second NOx sensor is located in the exhaust pipe downstream of the SCR and monitors NOx levels exiting the aftertreatment system. The smart NOx sensors communicate with the ECM over the serial data line.

The NOx sensors incorporate an electric heater to quickly bring the sensors to operating temperature. As moisture remaining in the exhaust pipe could interfere with sensor operation, the ECM delays turning on the heaters until the exhaust temperature exceeds a calibrated value. This allows any moisture remaining in the exhaust pipe to boil off before it can effect NOx sensor operation. Depending on engine temperature at start up, the delay can be less than a minute or as long as two minutes. Typically, NOx sensor 1 will reach operating temperature faster than NOx sensor 2 as it's closer to the engine's hot exhaust. At idle or low engine speeds, NOx sensor 2 may require up to 5 minutes to reach operating temperature. The sensors must be hot before accurate exhaust NOx readings are available to the ECM.

Reductant (Diesel Exhaust Fluid or DEF)

Reductant is a mixture of deionized water and urea. Within the SCR, exhaust heat converts the urea into ammonia (NH3) that reacts with NOx to form nitrogen, CO2, and water vapor. Optimum NOx reduction occurs at SCR temperatures above 250Â°C (480Â°F). At temperatures below 250Â°C, the incomplete conversion of urea forms sulfates that can poison the catalyst. To prevent this poisoning, the ECM suspends reductant injection when exhaust temperature falls below a calibrated limit.

Exhaust Gas Temperature (EGT) sensor

The 1.6L (LH7) engine uses exhaust gas temperature management to maintain the SCR catalyst within the optimum NOx conversion temperature range of 200 - 400Â°C (390 - 750Â°F). The ECM monitors EGT sensors located upstream (EGT 2) and downstream (EGT 3) of the SCR in order to determine if the SCR catalyst is within the temperature range where maximum NOx conversion occurs.

Diesel Exhaust Fluid (DEF) System

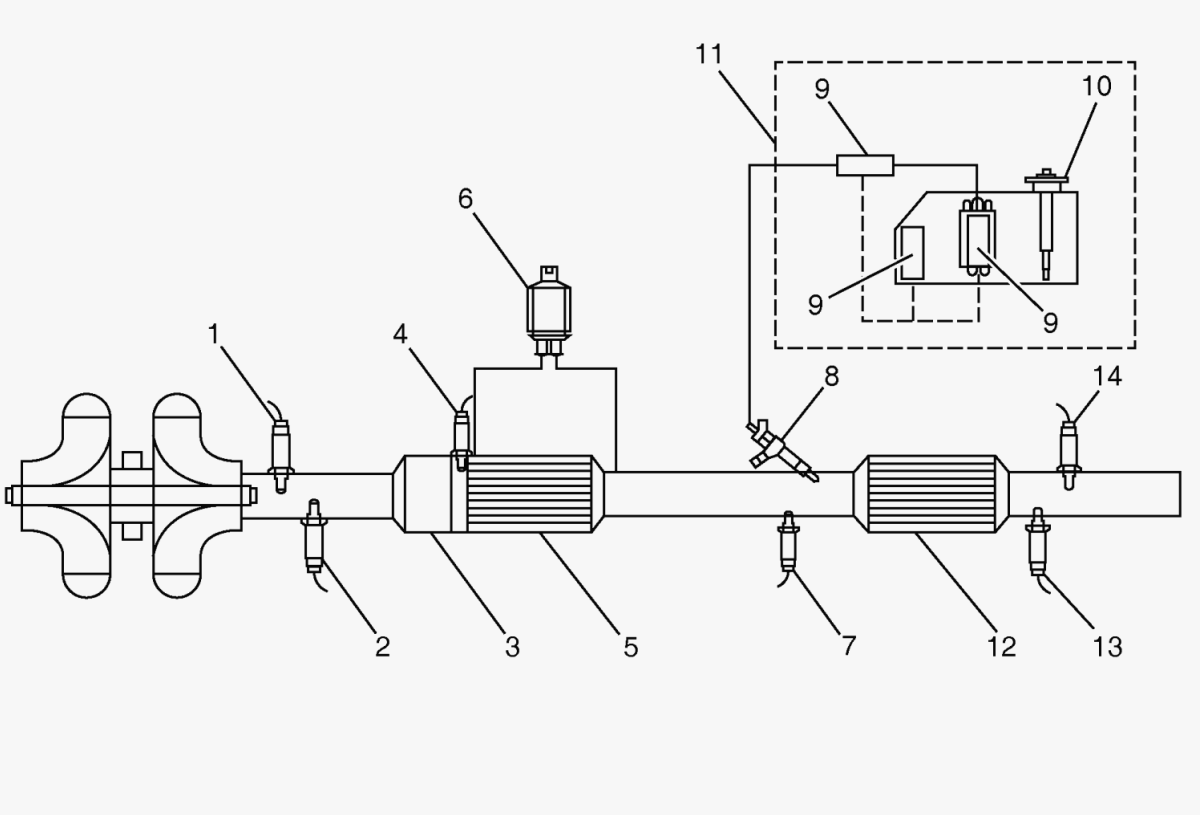

Fig. 7: Exhaust Aftertreatment System Components
Courtesy of GENERAL MOTORS COMPANY

The DEF system consists of the following components located at the reductant reservoir:

- An electrically-operated reductant pump (11)
- A integrated reductant level sensor and reductant temperature sensor (10)
- SCR Pump, Tank and Line Heaters (9)

The remaining reductant system component, an electrically-controlled reductant injector, is external to the reservoir.

An ECM controlled pump within the reservoir supplies pressurized reductant to the reductant injector located upstream of the SCR. A smart reductant level sensor within the reductant reservoir sends the ECM a serial data message indicating reductant level. The reductant pressure sensor provides the ECM with a voltage signal proportional to the reductant pressure generated by the reductant pump. The ECM varies the duty-cycle of the pump voltage to maintain reductant pressure within a calibrated range.

The state of the reductant purge valve determines whether reductant from the reductant pump is directed to the reductant injector or returned to the reservoir. In the normally de-energized state, the reductant purge valve directs reductant from the pump to the reductant injector. When the ignition is turned Off, the ECM energizes both the reductant purge valve and reductant pump for about 30 to 45 seconds in order to purge the supply line of reductant. The ECM also commands the reductant injector to 100% to prevent vacuum from forming during the purge process. Purging prevents the reductant from freezing in the pump or supply line to the reductant injector.

The ECM energizes the reductant injector to dispense a precise amount of reductant upstream of the SCR in response to changes in exhaust NOx levels. Feedback from NOx sensors 1 and 2 allow the ECM to accurately control the amount of reductant supplied to the SCR. If more reductant is supplied to the SCR than is needed for a given NOx level, the excess reductant results in what is called ammonia slip where significant levels of ammonia exit the SCR. Since the NOx sensors are unable to differentiate between NOx and ammonia, ammonia slip will cause NOx sensor 2 to detect higher NOx levels than actually exist.

Cold Weather Operation

As reductant will freeze at temperatures below 0Â°C (32Â°F), there are 2 reductant heaters. Reductant heater 1 is in the reductant reservoir and reductant heater 2 is in the supply line to the reductant injector. The reductant control module monitors the reductant temperature sensor located within the reservoir in

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order to determine if reductant temperature is below its freeze point. If the module determines that the reductant may be frozen, it energizes the reductant heaters.

Reductant pump operation is disabled for a calibrated amount of time to allow the heaters time to thaw the frozen reductant. Once the thaw period expires, the module energizes the reductant pump to circulate warm reductant back to the reservoir to speed thawing. The ECM looks for an increase in the reductant temperature to verify that the reductant reservoir heater is working.

EXHAUST GAS RECIRCULATION (EGR) SYSTEM DESCRIPTION

The exhaust gas recirculation (EGR) system is used to reduce the amount of nitrogen oxide (NOx) emission levels caused by high combustion temperatures. At temperatures above 1 371Â°C (2, 500Â°F), oxygen and nitrogen combine to form oxides of nitrogen (NOX). Introducing small amounts of exhaust gas back into the combustion chamber displaces the amount of oxygen entering the engine. With less oxygen in the air/fuel mixture, the combustion pressures are reduced, and as a result, combustion temperatures are decreased, restricting the formation of NOX.

Exhaust Gas Recirculation (EGR) System Operation

The exhaust gas recirculation (EGR) cooler bypass solenoid valve is controlled by the Engine Control Module (ECM). At engine cold start, the EGR cooler bypass allows hot exhaust gas to heat the intake air in the manifold. Once the engine operating temperature is reached, the ECM will close the EGR cooler bypass

The mass air flow (MAF) sensor signal is used by the engine control module (ECM) to detect the proper amount of EGR flow. The ECM will close the EGR valve, then open the EGR valve to 100%. The ECM will then calculate the MAF difference and determine if the proper EGR flow has been detected.

GLOW PLUG SYSTEM DESCRIPTION

In the diesel engine, air alone is compressed in the cylinder. Then, after the air has been compressed, a charge of fuel is sprayed into the cylinder and ignition occurs, due to the heat of compression. Glow plugs are used as an aid to starting.

The glow plug control module is integrated in the engine control module (ECM) and is a solid state device which operates the glow plugs. The temperature and the power consumption is controlled within a wide range to suit the engine pre-heating requirements. The glow plug initial ON time will vary based on the system voltage and temperature. Lower temperatures cause longer ON times.

A normal functioning system operates as follows:

- Turn the ignition ON with the engine OFF, and at room temperature.
- The glow plugs turn ON and heat up in 2 seconds and then are pulse-width modulated (PWM) for another 2 seconds.
- The glow plug wait lamp is ON for 1 second during cold start.
- The glow plug wait lamp may not illuminate during a warm engine start.
- If the engine is cranked during or after the above sequence, the glow plugs may cycle ON and OFF after the ignition switch is returned from the start position, whether the engine starts or not. The engine does not have to be running to terminate the glow plug cycling.

The glow plug initial ON time will vary based on the system voltage and temperature. Lower temperatures cause longer ON times.

The ECM provides glow plug operation after starting a cold engine. This post-start operation is initiated when the ignition switch is returned to Run, from the Start position. This function helps clean up excessive white smoke and/or poor idle quality after starting.

Glow Plugs

The glow plugs are heaters in each of the cylinders that turn ON, they are pulse-width modulated when the ignition switch is turned to the RUN position prior to starting the engine. The ECM remains pulsing the glow plugs a short time after starting, then are turned OFF.

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A Wait to Start lamp on the instrument panel provides information on engine starting conditions. The Wait to Start lamp will not illuminate during post-start glow plug operation.

TURBOCHARGER SYSTEM DESCRIPTION

The variable vane position turbocharger is used to increase the power output of the engine by increasing the mass of the oxygen and therefore the fuel entering the engine. The turbocharger is mounted to the exhaust manifold and is driven by the energy generated by the flow of exhaust gas through the turbine, which is connected by a shaft to the compressor mounted in the induction system. The turbocharger utilizes a vane control actuator to vary the vane angle to manage the boost pressure as necessary.

Turbocharger Pressure Sensor

The manifold absolute pressure (MAP) sensor is mounted on the intake manifold and is used to measure boost pressure.

Turbocharger Vane Control Actuator

The turbocharger uses a vacuum operated vane position actuator with an integral vane position sensor, to control the turbocharger vane angle. The actuator utilizes a remotely mounted solenoid valve to regulate the vacuum. The solenoid is controlled by the engine control module (ECM), which provides ignition voltage and a pulse width modulation (PWM) low side drive control circuit. The turbocharger vane angles are varied to control the amount of boost pressure, dependent upon the load requirements of the engine. The turbocharger vanes are mounted to a drive ring that can be rotated by the actuator to change the vane angle. The ECM uses the turbocharger vane position sensor to monitor the turbocharger vane angle.

The Engine Control Module (ECM) performs the turbocharger learn procedure automatically when the enabling criteria have been met. After each ignition cycle, and before the enable criteria have been met, the ECM will use the previously learned value. If the ECM does not have a previously learned value, it will default to a stored calibrated value.

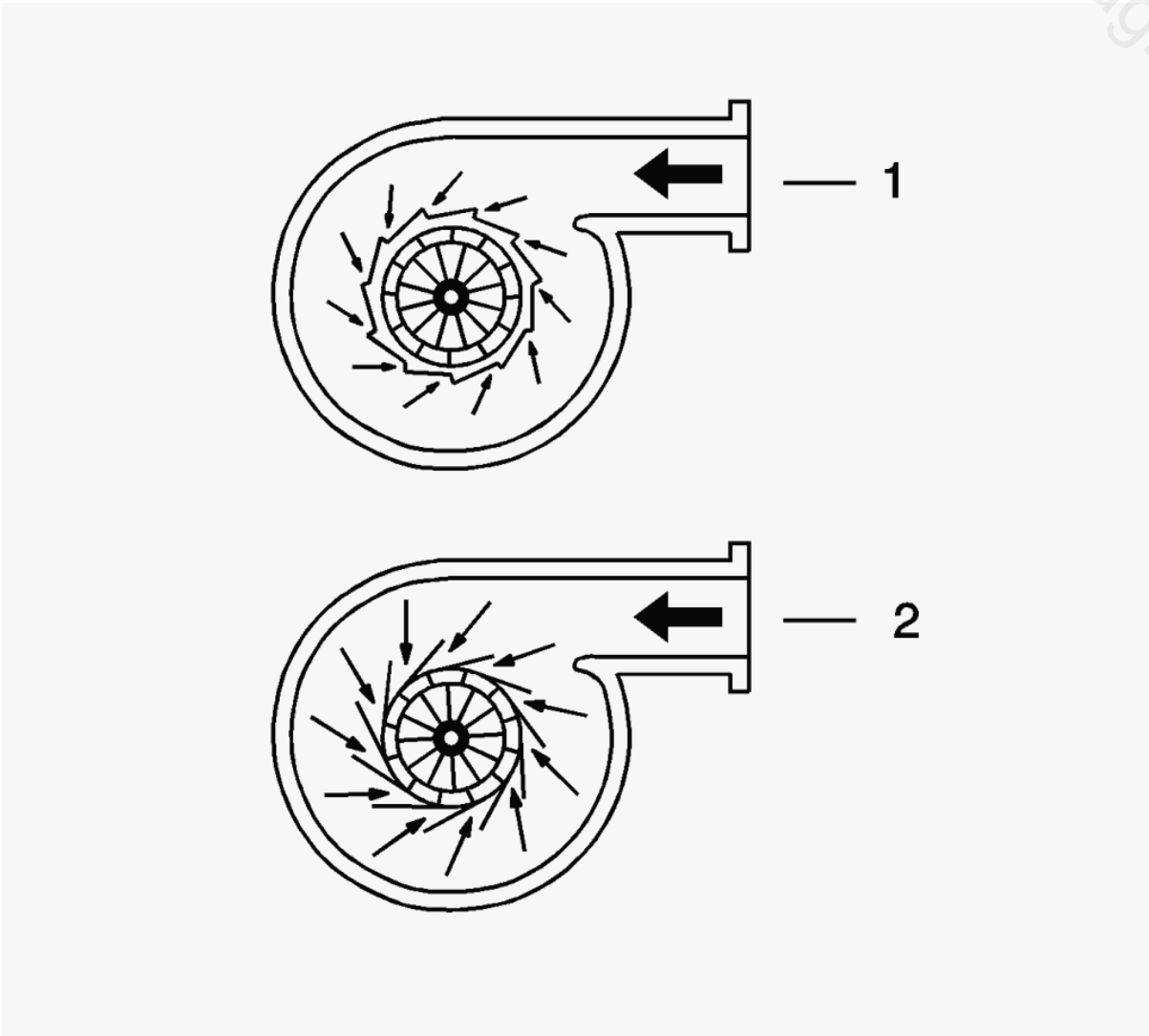

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Fig. 8: Turbocharger Vanes
Courtesy of GENERAL MOTORS COMPANY

The turbocharger vanes (2) are normally open when the engine is not under a load. The ECM commands the boost pressure actuator to close the turbocharger vanes (1) to increase engine power by increasing boost pressure.

The ECM may close the vanes (1) to create back pressure to drive exhaust gas through the exhaust gas recirculation (EGR) valve as required. At extreme cold temperatures, the ECM may close the vanes (1) at low load conditions in order to accelerate engine coolant heating. The ECM may also close the vanes (1) under exhaust braking conditions.

The Charged Air Cooler (Turbocharger Intercooler)

The charged air cooler is located in front of the radiator. The turbocharger supplies hot compressed air from the turbine to the engine to increase power. The airflow through the radiator cools the hot compressed air from the turbocharger.

Engine Control Module (ECM)

The ECM controls all turbocharger control functions. The ECM monitors information from various sensor inputs that include the following:

- Accelerator pedal position sensor.
- Engine coolant temperature (ECT) sensor.
- Mass air flow (MAF) sensor.
- Manifold absolute pressure (MAP) sensor.
- Vehicle speed sensor (VSS).
- Transmission gear position or range information sensors.

INTAKE AIRFLOW VALVE SYSTEM DESCRIPTION

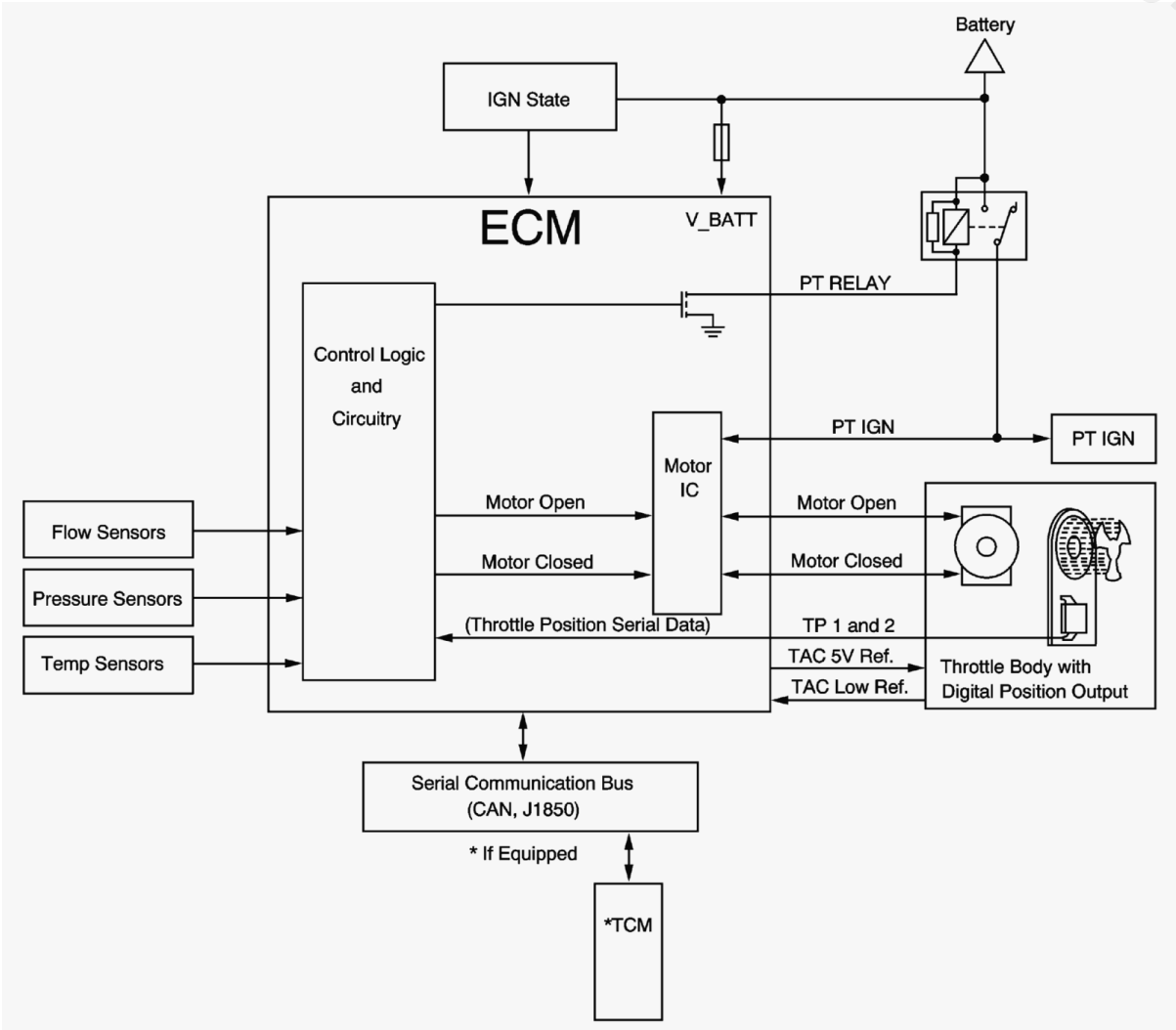

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Fig. 9: Intake Airflow Valve System
Courtesy of GENERAL MOTORS COMPANY

The intake airflow valve is a throttle plate actuator and is used to achieve high exhaust gas recirculation rates. It increases the pressure difference between exhaust and intake so that the appropriate exhaust quantity can be mixed with the intake air. The intake airflow valve 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 valve assembly and is not serviceable. The engine control module (ECM) supplies the valve assembly 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 valve assembly to the ECM. The valve assembly cannot receive data from the ECM over the signal/serial data circuit. The throttle position sensor provides a signal that changes relative to throttle blade angle. The customized integrated circuit translates the signal 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 valve assembly 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.

SPEED LIMITING DESCRIPTION

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

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

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Functions that will limit the vehicle speed

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

System Components

Engine Control Module (ECM)

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

Body Control Module (BCM)

The body control module monitors the top speed limiting requests from serial data communication modules (listed below) along with internally set values (tire, propshaft, valet, and teen limits) to determine the lowest top speed limit and transmits the value to engine control module for final top speed limit determination.

Electronic Brake Control Module (EBCM)

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

Suspension and Damping System

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

OnStar Enhanced Services

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

Automatic Leveling Control

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

Integrated Chassis Control Module

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

Rear Driveline Control Module/Transfer Case Control Module

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

Hybrid Module

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

Transmission Control Module

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

Driver Information Center

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

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Back To Article

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0016: CRANKSHAFT POSITION - CAMSHAFT POSITION NOT PLAUSIBLE

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 P0016

Crankshaft Position - Camshaft Position Not Plausible

Circuit/System Description

The ECM compares the signals of the crankshaft position sensor and the camshaft position sensor to detect if the signals are out of sync.

Conditions for Running the DTC

- DTC P0335, P0336, P0340, P0341 = Not set
- Engine = Cranking or Running
- Crankshaft Position Sensor & Camshaft Position Sensor = Synchronized
- Camshaft Position Actuator Solenoid Valve = Park position
- Time since diagnostic ran last = For less than 1 s

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

Conditions for Setting the DTC

The deviation of the relative camshaft position is greater than -10Â° in one direction or greater than 10Â° in the other direction (measured in degrees of the crankshaft).

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

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Circuit/System Verification

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

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

    - **Go to next step: If none of the DTCs are set**
3. Engine - Idling - At normal operating temperature
4. Verify DTC P0016 is not set.
    - **If the DTC is set**
    1. Ignition/Vehicle - Off
    2. Verify the following conditions do not exist:
        - B23 Camshaft Position Sensor - Incorrect installation
        - B26 Crankshaft Position Sensor - Incorrect installation
        - Reluctor Ring - Misaligned @ Crankshaft
        - Timing Chain - Excessive play
        - Timing Chain Tensioner - Incorrect installation
        - If a condition exists - Repair or replace as necessary
        - If none of the conditions exists - Refer to step 2.
    - **Go to next step: If the DTC is not set**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

    - **If the DTC sets**

      One of the above conditions still exist.

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

Repair Instructions

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

- Refer to **Camshaft Position Sensor Replacement**
- Refer to **Crankshaft Position Sensor Replacement**
- Refer to **Timing Chain Tensioner Replacement**

DTC P003A: TURBOCHARGER BOOST CONTROL POSITION NOT LEARNED

Diagnostic Instructions

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

DTC Descriptor

DTC P003A

Turbocharger Boost Control Position Not Learned

Circuit/System Description

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The Engine Control Module (ECM) performs the turbocharger learn procedure automatically when the enabling criteria have been met. After each ignition cycle, and before the enable criteria have been met, the ECM will use the previously learned value. If the ECM does not have a previously learned value, it will default to a stored calibrated value.

The ECM commands the turbocharger vane control solenoid to position the turbocharger vanes, and a turbocharger vane position sensor monitors the actual position of the vanes. The ECM varies the boost dependant upon the load requirements of the engine.

Conditions for Running the DTC

- DTCs P0116, P0117, P0118, P0119, P0128, or P111E is not set.
- The engine speed is 700 to 900 RPM.
- The battery voltage is between 9 - 30 V.
- The ambient temperature is greater than 60Â°C (140Â°F).
- The engine coolant temperature (ECT) is 10 to 105Â°C (158 to 221Â°F).
- The ECM controls the turbocharger vanes open or closed automatically once per key cycle during a position learn process.
- DTC P003A runs once per key cycle when the above conditions are met.

Conditions for Setting the DTC

The engine control module (ECM) determines that the difference between the turbocharger desired vane position sensor and the actual turbocharger vane position exceed a calibrated threshold during a valid learn event.

Action Taken When the DTC Sets

DTC P003A is a Type A DTC.

Conditions for Clearing the DTC

DTC P003A is a Type A DTC.

Diagnostic Aids

If any service has been performed on the turbocharger or on the turbocharger components, a turbocharger relearn must be performed. Failure to perform the turbocharger learn procedure may cause other DTCs to set.

The turbocharger learn procedure is required when the following service procedures have been performed:

- Turbocharger vane position control solenoid valve replacement
- Turbocharger vane position sensor replacement
- ECM replacement
- Turbocharger replacement
- Any service that disturbs the turbocharger components

Description and Operation

Turbocharger System Description

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Once the enable conditions have been met the throttle must remain at idle. Do not change the accelerator pedal during this procedure.**

1. Verify that DTC P0045, P0047, P0048, P0234, P226B, P2564, P2565, P2598 or P2599 is not set.
   - **If other DTCs are set**

     Refer to Diagnostic Trouble Code (DTC) List - Vehicle

   - **Go to next step: If no other DTCs are set**
2. Inspect the vacuum system for an inoperative vacuum pump, leaks or loose hoses.
   - **If a condition is found**

     Repair as necessary.

   - **Go to next step: If a condition is not found**
3. Inspect the turbocharger for a mechanical condition.
   - **If a condition is found**

     Refer to Turbocharger Replacement

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

   Verify that DTC P003A does not set.

   - **If DTC P003A sets**

     Replace the K20 Engine Control Module.

   - **Go to next step: If DTC P003A does not set**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

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

DTC P0045, P0047, OR P0048: TURBOCHARGER BOOST CONTROL CIRCUIT

Diagnostic Instructions

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

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- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**
- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

DTC Descriptor

DTC P0045

Turbocharger Boost Control Circuit

DTC P0047

Turbocharger Boost Control Circuit Low Voltage

DTC P0048

Turbocharger Boost Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P0047, P2670	P0045	P2671	-
Control	P0047	P0045	P0048	-

Circuit/System Description

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

Circuit	Description
Ignition	Regulated voltage supplied by the control module.
Control	The output circuit is switched to ground to activate the component.

Component	Description
Q41 Turbocharger Vane Position Control Solenoid Valve	In the unpowered state, the output port of the valve is connected to the ventilation port (atmospheric pressure). The more voltage applied, the more the valve shifts over from the ventilation port to the vacuum port so that the vacuum at the output port becomes stronger.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

- Ignition/Vehicle - On or the engine is running
- System Voltage = Greater than 11 V
- Boost Pressure Solenoid Control = On and Off at least once during the ignition cycle.

DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The commanded state of the driver and the actual state of the control circuit do not match for greater than 10 s.

Actions Taken When the DTC Sets

- DTCs listed in the DTC Descriptor Category = Type A DTC
- A message and/or warning indicator may be displayed to the driver.

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Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

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Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Perform the scan tool control function: Turbocharger Vane Position Actuator - 0 to 80%

   Verify the scan tool parameter:

   - Turbocharger Vane Position Solenoid Valve Circuit Low Voltage Test Status = OK
   - Turbocharger Vane Position Solenoid Valve Circuit Open Test Status = OK
   - Turbocharger Vane Position Solenoid Valve Circuit High Voltage Test Status = OK
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify DTC P0045, P0047, P0048 is not set.
   - **If the DTC sets**

     Refer to: Circuit/System Testing

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

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off

2. Disconnect the electrical connector: Q41 Turbocharger Vane Position Control Solenoid Valve
3. Ignition - On/Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points: Ignition circuit terminal 2 & Ground
    - **If the test lamp does not turn On**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Test for infinite resistance between the test points: Ignition circuit terminal 2 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance
    4. Test for less than 2 ohms between the test points: Ignition circuit terminal 2 @ Component harness & Terminal 36 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K20 Engine Control Module
    - **Go to next step: If the test lamp turns On**
5. Connect a test lamp between the test points: Control circuit terminal 1 & Ignition circuit terminal 2
6. Perform the scan tool control function: Turbocharger Vane Position Actuator - 0 to 80%

    Verify the test lamp turns On and changes intensity.

    - **If the test lamp is always Off**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Ignition - On/Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: Control circuit terminal 1 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for less than 2 ohms between the test points: Control circuit terminal 1 @ Component harness & Terminal 35 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K20 Engine Control Module
    - **If the test lamp turns On but does not change intensity**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Test for infinite resistance between the test points: Control circuit terminal 1 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component: K20 Engine Control Module
    - **Go to next step: If the test lamp turns On and changes intensity**
7. Replace the component: Q41 Turbocharger Vane Position Control Solenoid Valve

Repair Instructions

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

- Refer to **Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve Replacement** - Q41 Turbocharger Vane Position Control Solenoid Valve
- For control module replacement, programming, and setup refer to: **Control Module References**

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DTC P0046, P2598, OR P2599: TURBOCHARGER BOOST CONTROL POSITION PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0046

Turbocharger Boost Control Position Performance

DTC P2598

Turbocharger Vane Position Performance - Low Position

DTC P2599

Turbocharger Vane Position Performance - High Position

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference	P0651, P2564*	P2564	P0651*	-
Signal	P2564	P2565	P2565	P0046, P2598, P2599
Low Reference	-	P2565	-	-
* Additional DTCs may set.				

Typical Scan Tool Data

Turbocharger Vane Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: • Ignition - On/Vehicle - In Service Mode **Parameter Normal Range:** • 0.26 to 4.75 V			
5V Reference	0 V	0 V	5 V
Signal	0 V	0 V	5 V
Low Reference	-	5 V	-

Circuit/System Description

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

Circuit	Description
5V Reference	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to 5 V.
Ground	Grounded through the control module.

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Component	Description
B112 Turbocharger Vane Position Sensor	The sensor is an analog potentiometer that varies its resistance proportionally with the position of the control rod.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

P0046, P2599

- DTC P003A, P0071-P0074, P0117-P0119 = Not set
- Ignition Voltage = Greater than 11 V
- Turbocharger Vane Position Command = Steady State

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 1 s

P2598

- DTC P003A, P00EA, P00EB, P00EC, P0117-P0119 = Not set
- Ignition Voltage = Greater than 11 V
- Engine Coolant Temperature = Greater than -7Â°C (19Â°F)
- IAT Sensor 3 = Greater than -7Â°C (19Â°F)
- Engine Speed = Greater than 1, 500 RPM
- Turbocharger Vane Position Command = Steady State

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 1 s

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Conditions for Setting the DTC

DTC P0046

Actual & Desired Turbocharger Vane Position = Not within 16% of each other - For greater than 8 s

DTC P2598

Actual & Desired Turbocharger Vane Position = Not within 25% of each other - More open than desired - For greater than 4 s

DTC P2599

Actual & Desired Turbocharger Vane Position = Not within 25% of each other - More closed than desired & DTC P0046 is set.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC - Additional actions taken:

Warning Message = Reduced Engine Power

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

Special Tools

EN-23738-A Vacuum Pump

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

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P0045, P0047, P0048, P2564, P2565 is not set.
   - **If the DTC is set**

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

   - **Go to next step: If the DTC is not set**
3. Verify the scan tool parameter: Turbocharger Vane Position Sensor = 0-5%
   - **If not in the specified range**

     Refer to: Circuit/System Testing

   - **Go to next step: If in the specified range**
4. Clear the DTCs.
5. Engine - Idling
6. Verify the scan tool parameter: Turbocharger Vane Position Sensor = 90-100%
   - **If not in the specified range**

     Refer to: Circuit/System Testing

   - **Go to next step: If in the specified range**
7. Perform the scan tool control function: Turbocharger Vane Position - From 20 to 80% and back to 20%.

   Verify the difference between the following parameters is less than 3%:

   - Desired Turbocharger Vane Position
   - Turbocharger Vane Position Sensor
   - **If the difference is greater than 3%**

     Refer to: Circuit/System Testing

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- **Go to next step: If the difference is less than 3%**

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

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

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

9. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the component: Vacuum Hose @ Turbocharger Wastegate Actuator Vacuum Source Tube - Hose/line going to the component: Turbocharger Wastegate Actuator - Above: Q14 Exhaust Gas Recirculation Valve
3. Install the special tool: EN-23738-A Vacuum Pump - Turbocharger Wastegate Actuator Vacuum Source Tube - Hose/line going to the component: Q41 Turbocharger Vane Position Control Solenoid Valve
4. Engine - Idling
5. Perform the scan tool control function: Turbocharger Vane Position Actuator - 80%
6. Verify the special tool reading: Greater than -60 kPa (-8.7 PSI)
   - **If -60 kPa (-8.7 PSI) or less**

     Test or replace the component: Q41 Turbocharger Vane Position Control Solenoid Valve

   - **Go to next step: If greater than -60 kPa (-8.7 PSI)**
7. Perform the scan tool control function: Turbocharger Vane Position Actuator - 20%
8. Verify the special tool reading: Less than -10 kPa (-1.5 PSI)
   - **If -10 kPa (-1.5 PSI) or greater**

     Test or replace the component: Q41 Turbocharger Vane Position Control Solenoid Valve

   - **Go to next step: If less than -10 kPa (-1.5 PSI)**
9. Ignition/Vehicle - Off
10. Install the special tool: EN-23738-A Vacuum Pump - Turbocharger Wastegate Actuator Vacuum Source Tube - Hose/line going to the component: Turbocharger Vane Position Actuator - B112 Turbocharger Vane Position Sensor
11. Ignition - On/Vehicle - In Service Mode
12. Use the special tool: EN-23738-A Vacuum Pump -58 kPa (-0.5 bar, -8.4 PSI) can be achieved and holds steady for 2 min.

    Perform the following action:

    - Verify the control rod of the vacuum actuator moves smoothly over the full range.
    - Verify the scan tool parameter: Turbocharger Vane Position Sensor = 100%
    - **If not the specified values**

    1. Ignition/Vehicle - Off
    2. Test or inspect for the following: Turbocharger Wastegate Actuator Vacuum Source Tube - Vacuum hoses with kinks, leaks, or improper connections.
       - If a condition exists - Repair or replace as necessary
       - If no condition exists - Test or replace the component: Turbocharger Vane Position Actuator

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

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13. Test or replace the component: Q41 Turbocharger Vane Position Control Solenoid Valve

Repair Instructions

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

- Refer to **Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve Replacement** - Q41 Turbocharger Vane Position Control Solenoid Valve
- Refer to **Turbocharger Replacement** - Turbocharger Vane Position Actuator
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P007B: CHARGE AIR COOLER TEMPERATURE SENSOR 1 PERFORMANCE

Diagnostic Instructions

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

DTC Descriptors

DTC P007B

Charge Air Cooler Temperature Sensor 1 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P007C	P007D	P007D*	P007B, P026A
Low Reference	-	P007D	P007D*	P007B, P026A
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Charge Air Cooler Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON or Engine Running **Parameter Normal Range:** -39 to +198Â°C (-38 to +388Â°F)			
Signal	215Â°C (419Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The charge air cooler (CAC) temperature sensor is a variable resistor. The sensor is located in the CAC inlet duct before CAC assembly. Its signal is used by the ECM to measure the temperature of the intake air entering the CAC. The engine control module (ECM) supplies 5 V to the signal circuit and a ground for the low reference circuit. The ECM continuously monitors the sensor signal for an excessively high or low voltage, or for a start-up signal that is not in correlation with the intake air temperature (IAT) sensor 3 start-up signal.

Conditions for Running the DTC

- DTC P00E9, P00EA, P00EB, P00EC, P007C, P007D, P007E, P0181, P0182, P0183, or P2610 is not set.
- Ignition OFF for 8 hours or greater.
- The ignition is On or the engine is operating for less than 10 s
- The ignition voltage is greater than 11 V.
- The difference between the IAT 3 and the fuel temperature is less than 45Â°C (81Â°F).

- The DTC runs continuously when the enabling condition is met.

Conditions for Setting the DTC

NOTE: **The scan tool display range is between -40 and +215Â°C (-40 and +419Â°F).**

- The ECM detects a difference of greater than 20Â°C (68Â°F) between CAC inlet temperature sensor signal and the combined average temperature of IAT 3 and the fuel temperature sensors.
- The condition exists for greater than 100 ms.

Action Taken When the DTC Sets

- DTC P007B is Type B DTC.
- The ECM commands reduced engine power.
- The driver information center (DIC) or indicator may display reduced engine power.
- Service Emission System message is displayed on the driver information center (DIC).
- Diesel particulate filter (DPF) regeneration is inhibited.

Conditions for Clearing the DTC

DTC P007B is Type B DTC.

Diagnostic Aids

An inaccurate CAC temperature sensor may cause DTC P0101 to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

NOTE:

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

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- **The vehicle sitting in direct sun light or having the block heater ON will skew the results.**

1. Ignition On.
2. Verify that DTCs P00E9, P00EA, P00EB, P00EC, P007C, P007D, P007E, P0181, or P2610 are not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
   - **Go to next step: If none of the DTCs are set**
3. Verify the following scan tool parameters are within 15Â°C (27Â°F) of each other.
   - Fuel Temperature Sensor
   - IAT Sensor 3
   - Charge Air Cooler Temperature
   - **If not within 15Â°C (27Â°F)**

     Refer to Circuit System Testing.
   - **Go to next step: If within 15Â°C (27Â°F)**
4. Engine idling.
5. Verify the scan tool Charge Air Cooler Temperature parameter is between -39 to +215Â°C (-38 to +419Â°F).
   - **If not within the specified range**

     Refer to Circuit System Testing.
   - **Go to next step: If within the specified range**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

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

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

Circuit/System Testing

NOTE:

- **You must perform the Circuit/System Verification before proceeding with the Circuit/System Testing.**
- **You must perform the Diagnostic Repair Verification after completing the Circuit/System Testing.**

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 connector at the B193A Charge Air Cooler Inlet Temperature Sensor.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.

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- If less than 2 Ω replace the K20 Engine Control Module.
- **Go to next step: If less than 5 Ω**

3. Test for 4.8 - 5.2 V between the signal circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**

     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 X2 harness connector at the K20 Engine Control Module.
   2. Ignition ON, test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If between 4.8 - 5.2 V**
4. Test or replace the B193A Charge Air Cooler Inlet Temperature Sensor.

Component Testing

- Ignition Off.
- Test the B193A Charge Air Cooler Inlet Temperature Sensor by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool Charge Air Cooler Temperature parameter. The values should be within 5%.
  - **If not within the specified range**

    Replace the B193A Charge Air Cooler Inlet Temperature Sensor.

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

Repair Instructions

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

- Perform the **Diesel Particulate Filter (DPF) Service Regeneration** after completing the repair.
- Refer to **Charge Air Temperature Sensor Replacement (Inlet)** **Charge Air Temperature Sensor Replacement (Outlet)** for B193A Charge Air Cooler Inlet Temperature Sensor replacement
- Refer to **Control Module References** for engine control module replacement, programming, and setup

DTC P007C, P007D OR P007E: CHARGE AIR COOLER TEMPERATURE SENSOR 1 CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

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DTC P007C

Charge Air Cooler Temperature Sensor 1 Circuit Low Voltage

DTC P007D

Charge Air Cooler Temperature Sensor 1 Circuit High Voltage

DTC P007E

Charge Air Cooler Temperature Sensor 1 Circuit Erratic

Diagnostic Fault Information

Charge Air Cooler Inlet Temperature Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P007C	P007D	P007D*	P007B, P026A
Low Reference	-	P007D	P007D*	P007B, P026A
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Charge Air Cooler Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON or Engine Running **Parameter Normal Range:** -39 to +198Â°C (-38 to +388Â°F)			
Signal	215Â°C (419Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The charge air cooler (CAC) temperature sensor is a variable resistor. The sensor is located in the CAC inlet duct before CAC assembly. Its signal is used by the ECM to measure the temperature of the intake air entering the CAC. The engine control module (ECM) supplies 5 V to the signal circuit and a ground for the low reference circuit. The ECM continuously monitors the sensor signal for an excessively high or low voltage, or for a start-up signal that is not in correlation with the ambient air temperature signal.

Conditions for Running the DTC

P007C or P007D

- The ignition is ON or the engine is operating.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously when the enabling condition is met.

P007E

- DTC P007C or P007D is not set.
- The ignition is ON or the engine is operating.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously when the enabling condition is met.

Conditions for Setting the DTC

NOTE: **The scan tool display range is between -40 and +215Â°C (-40 and +419Â°F).**

P007C

The CAC temperature sensor 1 signal is warmer than 300Â°C (572Â°F) for greater than 5 s.

P007D

The CAC temperature sensor 1 signal is colder than -40Â°C (-40Â°F) for greater than 5 s.

P007E

The CAC temperature sensor 1 signal is noisy or changes abruptly for greater than 5 s.

Action Taken When the DTC Sets

- DTCs P007C, P007D, and P007E are Type B DTCs.
- The ECM commands reduced engine power.
- The driver information center (DIC) or indicator may display reduced engine power.
- Service Emission System message is displayed on the driver information center (DIC).
- Diesel particulate filter (DPF) regeneration is inhibited.

Conditions for Clearing the DTC

DTCs P007C, P007D, and P007E are Type B DTCs.

Diagnostic Aids

An inaccurate CAC temperature sensor may cause DTC P0101 to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

> **NOTE:** **If you were sent here from DTC P026A, refer to Circuit System Testing.**

1. Engine idling.
2. Verify the scan tool Charge Air Cooler Temperature parameter is between -39 to +215Â°C (-38 to +419Â°F).

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- **If not within the specified range**

  Refer to Circuit System Testing.

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

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

     Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE: **You must perform the Diagnostic Repair Verification after completing the Circuit/System Testing.**

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 connector at the B193A Charge Air Cooler Inlet Temperature sensor.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Test for 4.8 - 5.2 V between the signal circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 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 X2 harness connector at the K20 Engine Control Module.
   2. Ignition ON, test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If between 4.8 - 5.2 V**
4. Test or replace the B193A Charge Air Cooler Inlet Temperature sensor.

Component Testing

- Test the B193A Charge Air Cooler Inlet Temperature sensor by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool

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Charge Air Cooler Outlet Temperature Sensor parameter. The values should be within 5%.

- If not within the specified range, replace the B193A Charge Air Cooler Inlet Temperature sensor.

Repair Instructions

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

- Perform the **Diesel Particulate Filter (DPF) Service Regeneration** after completing the repair.
- Refer to **Charge Air Temperature Sensor Replacement (Inlet)** for B193A Charge Air Cooler Inlet Temperature sensor replacement
- Refer to **Control Module References** for engine control module replacement, programming, and setup

DTC P0087, P0089, P228C, P228D, OR P2293: FUEL RAIL LOW PRESSURE/FUEL PRESSURE REGULATORS

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 P0087

Fuel Rail Low Pressure

DTC P0089

Fuel Pressure Regulator 1 Performance

DTC P228C

Fuel Pressure Regulator 1 Control Performance - Low Pressure

DTC P228D

Fuel Pressure Regulator 1 Control Performance - High Pressure

DTC P2293

Fuel Pressure Regulator 2 Performance

Circuit/System Description

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

Component	Description
Q18A Fuel Pressure Regulator 1	The fuel pressure regulator is a solenoid valve that restricts the flow of fuel to the high pressure fuel pump and thereby controls the pressure the pump can produce.
Q18B Fuel Pressure Regulator 2	The fuel pressure regulator is the solenoid valve that controls the pressure in the fuel rail.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

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Conditions for Running the DTC

P0087

- Engine = Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously

P0089

- Engine = Running
- Ignition Voltage = Greater than 11 V
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 1.

Frequency the DTC runs = Continuously

P228C, P228D

- Ambient Air Temperature = Warmer than -7Â°C (19Â°F)
- BARO Sensor 2 = Greater than 60 kPa (8.7 PSI)
- Engine = Running
- Ignition Voltage = Greater than 11 V
- Fuel level = Greater than 10%
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 1.

P2293

- Engine = Running
- Ignition Voltage = Greater than 11 V
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 2.

Frequency the DTC runs = Continuously

Conditions for Setting the DTC

P0087, P0089, P2293

Fuel Rail Pressure = Not within a calibrated range - For greater than 1 s

P228C, P228D

Fuel Rail Pressure = Not within a calibrated range - For greater than 6 s

Actions Taken When the DTC Sets

DTC P0087, P0089, P2293 = Type A DTC

DTC P228C, P228D = Type B DTC

Conditions for Clearing the DTC

DTC P0087, P0089, P2293 = Type A DTC

DTC P228C, P228D = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P0090, P0091, P0092, P0191, P0192, P0193, P0627, P0628, P1255, P2293, P2294, P2295, P2296, P2635 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Engine Cranking or Running
4. Verify the scan tool parameter: Fuel Pressure Sensor = 370 to 450 kPa (54 to 65 PSI)
   - **If less than 370 kPa (54 PSI)**

     Refer to: **Fuel System Diagnosis**

   - **If greater than 450 kPa (65 PSI)**

     Refer to: **Fuel Return System Diagnosis**

   - **Go to next step: If between 370 and 450 kPa (54 and 65 PSI)**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

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

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Verify the following conditions do not exist:
   - Q17 Fuel Injector - Leaking/Restricted

     Refer to: **Fuel Injector Balance Test with Scan Tool**

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- Direct Fuel Injection Fuel Rail - Leaking/Restricted

  Refer to: **Fuel Leak Diagnosis**

- Fuel - Contaminated/Poor Quality

  Refer to: **Contaminants-in-Fuel Diagnosis**

- Fuel Feed Pipe - Leaking/Restricted

  Refer to: **Fuel Leak Diagnosis**

- **If a condition exists**

  Repair or replace as necessary.

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

3. Perform the scan tool control function: Fuel Pressure Control - Regulator 1 - Increase & Decrease

   Verify the scan tool parameter: Fuel Rail Pressure Sensor 1 = The value should change with each command.

   - **If the value does not change**

     Replace the component: Q18A Fuel Pressure Regulator 1

   - **Go to next step: If the value changes**

4. Perform the scan tool control function: Fuel Pressure Control - Regulator 2 - Increase & Decrease

   Verify the scan tool parameter: Fuel Rail Pressure Sensor 1 = The value should change with each command.

   - **If the value does not change**

     Replace the component: Q18B Fuel Pressure Regulator 2

   - **Go to next step: If the value changes**

5. All OK.

Repair Instructions

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

- Refer to **Fuel Injection Fuel Rail Assembly Replacement** - Q18B Fuel Pressure Regulator 2
- Refer to **Fuel Injection Pump Metering Valve Replacement** - Q18A Fuel Pressure Regulator 1
- Refer to **Fuel Injector Replacement**

DTC P0090, P0091, OR P0092: FUEL PRESSURE REGULATOR 1 CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P0090

Fuel Pressure Regulator 1 Control Circuit

DTC P0091

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Fuel Pressure Regulator 1 Control Circuit Low Voltage

DTC P0092

Fuel Pressure Regulator 1 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - High	P0091	P0090	P0690, P16B3	-
Control - Low	P0091	P0090	P0092, P0690, P16B3	-

Circuit/System Description

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

Circuit	Description
Control - High	The output circuit is switched to 12 V to activate the component. The output is PWM controlled.
Control - Low	The output circuit is switched to ground to activate the component. The output is PWM controlled.

Component	Description
G18 High Pressure Fuel Pump	The fuel pressure regulator is a solenoid valve that restricts the flow of fuel to the high pressure fuel pump and thereby controls the pressure the pump can produce.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

- DTC Present = No
- Battery Voltage = Greater than 11 V
- Engine Speed = Greater than 50 RPM
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 1.
- Ignition On - Engine Running

DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0090

Low Control = Open - Greater than 0.275 s

P0091

Low Control = Short to Ground - Greater than 0.275 s

P0092

Low Control = Short to Voltage - Greater than 0.275 s

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Actions Taken When the DTC Sets

DTC P0090, P0091, P0092 = Type A DTC

Conditions for Clearing the DTC

DTC P0090, P0091, P0092 = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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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

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P0689, P0690, P1682 is not set.
   - If any of the DTCs are set

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

   - If none of the DTCs are set
3. Perform the scan tool control function: Fuel Pressure Regulator 1 - On and Off

   Verify the scan tool parameter:

   - Fuel Pressure Regulator 1 Control Circuit High Voltage Test Status = OK or Not Run
   - Fuel Pressure Regulator 1 Control Circuit Open Test Status = OK or Not Run
   - Fuel Pressure Regulator 1 Control Circuit Low Voltage Test Status = OK or Not Run
   - **If not the specified state**

     Refer to: Circuit/System Testing

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

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Refer to: Circuit/System Testing

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

6. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q18A Fuel Pressure Regulator 1
3. Connect a test lamp between the test points: Control circuit terminal 1 & Control circuit terminal 2
4. Ignition - On/Vehicle - In Service Mode
5. Perform the scan tool control function: Fuel Pressure Regulator 1 - On and Off

   Verify the test lamp turns On and Off.

   - **If the test lamp does not turn On and Off**

   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Disconnect the electrical connector: X1 @ K20 Engine Control Module
   3. Ignition - On/Vehicle - In Service Mode
   4. Test for less than 1 V between the test points:
      - Control circuit terminal 1 @ Component harness & Ground
      - Control circuit terminal 2 @ Component harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - If less than 1 V
   5. Test for less than 2 ohms between the test points:
      - Control circuit terminal 1 @ Component harness & Terminal 21 @ Control module harness
      - Control circuit terminal 2 @ Component harness & Terminal 36 @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K20 Engine Control Module

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

6. Replace the component: Q18A Fuel Pressure Regulator 1

Repair Instructions

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

- Refer to **Fuel Injection Pump Metering Valve Replacement** - Q18A Fuel Pressure Regulator 1
- For control module replacement, programming, and setup refer to: **Control Module References**

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

Diagnostic Instructions

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

DTC Descriptor

DTC P0096

Intake Air Temperature (IAT) Sensor 2 Performance

DTC P0111

Intake Air Temperature (IAT) Sensor 1 Performance

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Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P2199	P0113, P2199	P0111*, P0113*, P0114, P2199	P0111*, P2199
Low Reference	-	P0097, P00F4, P0113, P227D	P0113*, P0114	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

IAT Sensor 2 and Intake Air Humidity

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

Typical Scan Tool Data

IAT Sensor 1

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

IAT Sensor 2 and Intake Air Humidity Sensor

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient humidity, temperature, and engine bay conditions			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz 0%	-40Â°C (-40Â°F) 10 Hz 0%	-
Signal	-40Â°C (-40Â°F) 10 Hz 100%	-40Â°C (-40Â°F) 10 Hz 0%	-40Â°C (-40Â°F) 10 Hz* 0%
Ground	-	-40Â°C (-40Â°F) 10 Hz 0%	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

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

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

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

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

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

IAT Sensor 2 - Temperature, Frequency Table

IAT Sensor 2	IAT Sensor 2 Frequency	IAT Sensor 2 Temperature
Cold	10 Hz	-40Â°C (-40Â°F)
Warm	302 Hz	104Â°C (219Â°F)

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Conditions for Running the DTCs

P0096 and P0111

- DTCs P0097, P0098, P0099, P00E9, P00EA, P00EB, P00EC, P0112, P0113, P0117, P0118, P16A7, P16BC, or P1682 are not set.
- The vehicle has been OFF at least 8 hours.
- Ignition voltage is at least 11 V for greater than 1 s.
- The DTCs run once per ignition cycle when the conditions above are met.

Conditions for Setting the DTCs

P0096

- The ECM determines the absolute difference between the IAT sensor 2 start-up temperature and the IAT sensor 1 and 3 start-up temperatures is greater than 25Â°C (45Â°F).
- The DTCs run once per ignition cycle when the conditions above are met.

P0111

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 and 3 start-up temperatures is greater than 25Â°C (45Â°F).
- The DTCs run once per ignition cycle when the conditions above are met.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTCs

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

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View 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. Ignition On.
2. Verify that DTC P00EA, P00EB, P00EC, P0097, P0098, P0099, P00F4, P00F5, P00F6, P0102, P0103, P0112, P0113, P0114, P0641, P0651, P0697, or P06A3 is not set.
   - **If any of the DTCs are set**

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

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

NOTE: **To minimize the effects of residual engine heat and sensor internal**

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heating elements, perform Steps 3 and 4 of this verification procedure only if the ignition has been OFF for 8 hours or more.

3. Ignition On.
4. Verify the following scan tool parameters are within 25Â°C (45Â°F) of each other.
    - Start-Up IAT Sensor 1
    - Start-Up IAT Sensor 2
    - Start-Up IAT Sensor 3
    - **If not within 25Â°C (45Â°F)**

      Refer to Circuit/System Testing.

    - **Go to next step: If within 25Â°C (45Â°F)**
5. Engine running.
6. Verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
    - IAT Sensor 1
    - IAT Sensor 2
    - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

      Refer to Circuit/System Testing.

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

      Refer to Circuit/System Testing.

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

Circuit/System Testing

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

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

      Repair or replace component as necessary.

    - **Go to next step: If no condition exists**
2. Ignition Off, and all vehicle systems Off, it may take up to 2 min. for all vehicle systems to power down.
3. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
4. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
    - **If 5 Ω or greater**
    1. Disconnect the harness connector X1 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.

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- If less than 2 Ω replace the K20 Engine Control Module.
- **Go to next step: If less than 5 Ω**

5. Test for less than 5 Ω between the ground circuit terminal 7, and ground.
   - **If 5 Ω or greater**
   1. Ignition Off.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **Go to next step: If less than 5 Ω**
6. Ignition On.
7. Verify the scan tool Intake Air Temperature Sensor 1 parameter is colder than -39Â°C (-38Â°F).
   - **If warmer than -39Â°C (-38Â°F).**
   1. Ignition Off, disconnect the harness connector X1 at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 1 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **Go to next step: If colder than -39Â°C (-38Â°F).**
8. Ignition Off, connect a 3 A fused jumper wire between the IAT 1 signal circuit terminal 1 and the low reference circuit terminal 3.
9. Ignition On.
10. Verify the scan tool Intake Air Temperature Sensor 1 parameter is warmer than 148Â°C (298Â°F).
    - **If 148Â°C (298Â°F) or colder**
    1. Ignition Off, remove the jumper wire, disconnect the harness connector X1 at the K20 Engine Control Module.
    2. Ignition On.
    3. Test for less than 1 V between the signal circuit and ground.
       - If 1 V or greater, repair the short to voltage on the circuit.
       - If less than 1 V.
    4. Ignition Off.
    5. Test for less than 2 Ω in the signal circuit end to end.
       - If 2 Ω or greater, repair the open/high resistance in the circuit.
       - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If warmer than 148Â°C (298Â°F).**

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

11. Verify the scan tool Intake Air Humidity Sensor parameter is less than 1%.
    - **If 1% or greater**
    1. Ignition Off, disconnect the harness connector X1 at the K20 Engine Control Module.
    2. Test for infinite resistance between the IAT 2 signal circuit terminal 8 and ground.
       - If less than infinite resistance, repair the short to ground on the circuit.
       - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If less than 1%**
12. Ignition Off, connect a 3 A fused jumper wire between the IAT 2 signal circuit terminal 8 and the low reference circuit terminal 3.
13. Ignition On.
14. Verify the scan tool Intake Air Humidity Sensor parameter is greater than 99%.
    - **If 99% or less**

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

1. Ignition Off, remove the jumper wire and disconnect the harness connector X1 at the K20 Engine Control Module.
2. Ignition On.
3. Test for less than 1 V between the IAT 2 signal circuit terminal 8 and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V.
4. Ignition Off.
5. Test for less than 2 Ω in the signal circuit end to end.
   - If 2 Ω or greater, repair the open/high resistance in the circuit.
   - If less than 2 Ω, replace the K20 Engine Control Module.

- **Go to next step: If greater than 99%**

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

Component Testing

Multifunction Intake Air Sensor

1. Vehicle OFF, disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
2. Connect a DMM between the IAT sensor 1 signal terminal 1 and the low reference terminal 3.

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

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

     Replace the B75C Multifunction Intake Air Sensor.

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

Multifunction Intake Air Sensor

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

     Replace the B75C Multifunction Intake Air Sensor.

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

IAT 2 Circuit Testing with EL-38522-A

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

1. Perform the following test using a **EL-38522-A** Variable Signal Generator or equivalent, if available.
2. Ignition Off, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
   1. Red lead to the signal circuit terminal 8 at the harness connector
   2. Black leads to ground

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3. Battery voltage supply lead to B+

3. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
   - Signal switch to 5 V
   - Duty Cycle switch to 50% (Normal)
   - Frequency switch to 250 Hz
4. Ignition On.
5. Verify the scan tool IAT Sensor 2 parameters listed below are within the ranges listed below:
   - IAT Sensor 2 is between 248 - 252 Hz

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

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

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

   - Intake Air Humidity Sensor is between 48 - 52%
   - **If a parameter is not within the specified range**
   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, replace the K20 Engine Control Module.
   - **Go to next step: If all the parameters are within the specified range**
6. All OK.

Repair Instructions

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

- Refer to **Mass Airflow Sensor Replacement** for B75C Multifunction Intake Air Sensor replacement
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

DTC P00C7: INTAKE AIR PRESSURE MEASUREMENT SYSTEM

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 P00C7

Intake Air Pressure Measurement System - Multiple Sensors Not Plausible

Circuit/System Description

This system consists of the following components:

- B65 Intake Manifold Pressure and Air Temperature Sensor
- B75C Multifunction Intake Air Sensor - BARO Sensor 2
- K20 Engine Control Module - BARO Sensor 1

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This DTC sets when the control module detects an inconsistency between the pressure sensors and cannot identify which sensor failed.

Conditions for Running the DTC

Condition 1

- DTC P0107, P0108, P2228, P2229, P227C, P227D = Not pending
- DTC P0106, P0107, P0108, P2227, P2228, P2229, P2230, P227B, P227C, P227D, P227E = Not set
- Engine = Not Running
- Time between current ignition cycle and the last time the engine was running = Greater than 5 s
- Manifold Absolute Pressure = 50 to 115 kPa (7.3 to 16.7 PSI)
- Barometric Pressure - BARO Sensor 1 = 50 to 115 kPa (7.3 to 16.7 PSI)
- Barometric Pressure - BARO Sensor 2 = 50 to 115 kPa (7.3 to 16.7 PSI)

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

Condition 2

- DTC P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8, P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0335, P0336, P062B, P062D, P111E, P122D, P1248, P1249, P124A, P124B, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P2227, P2228, P2229, P2230, P227B, P227C, P227D, P227E = Not set
- Ignition Voltage = Greater than 11 V
- Engine = Running
- Engine Speed = Less than 950 RPM
- Intake Air Flow Valve Position = Greater than 90%
- Calculated Fuel Flow = Less than a predefined threshold
- Engine Coolant Temperature = Warmer than 70Â°C (158Â°F)

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

Conditions for Setting the DTC

Manifold Absolute Pressure & Barometric Pressure = Not within 10 kPa (1.5 PSI) of each other.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P0106, P0107, P0108, P2227, P2228, P2229, P2230, P227B, P227C, P227D, P227E is not set.
    - **If any of the DTCs are set**

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

    - **Go to next step: If none of the DTCs are set**
3. Verify the following conditions do not exist:
    - Q38 Throttle Body - Loose Clamps/Visible Damage
    - Air Cleaner Element - Dirty/Restricted
    - Intake Air Duct & Intake Manifold - Cracked/Loose Clamps/Visible Damage
    - B75C Multifunction Intake Air Sensor - Cracked/Loose Clamps/Visible Damage
    - Air Inlet Valve - BARO Sensor 1 @ K20 Engine Control Module/Leaking/Missing/Clogged/Visible Damage
    - O-Ring @ B65 Intake Manifold Pressure and Air Temperature Sensor/Leaking/Missing/Visible Damage
    - Positive Crankcase Ventilation System - Leaking/Incorrect connection/Restricted
    - Vacuum Hoses - Kinked/Leaking/Incorrect connection/Restricted
    - Vacuum leak @ Engine/Intake Manifold/Q38 Throttle Body
    - **If a condition exists**

      Repair or replace as necessary.

    - **Go to next step: If no condition exists**
4. Verify the scan tool parameter:
    - BARO Sensor 1 = **Altitude Versus Barometric Pressure** - The value should be within the range listed in the table.
    - BARO Sensor 2 = **Altitude Versus Barometric Pressure** - The value should be within the range listed in the table.
    - MAP Sensor = **Altitude Versus Barometric Pressure** - The value should be within the range listed in the table.
    - **If not in the specified range**
    - {BARO Sensor 1} Refer to: **DTC P2227-P2230**
    - {BARO Sensor 2} Refer to: **DTC P227B**
    - {MAP Sensor} Refer to: **DTC P0106**
    - **Go to next step: If in the specified range**
5. All OK.

Repair Instructions

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

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

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Diagnostic Instructions

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

DTC Descriptor

DTC P00E9

Intake Air Temperature (IAT) Sensor 3 Circuit Performance

Typical Scan Tool Data

IAT Sensor 3

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

Circuit/System Description

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

IAT Sensor 3 - Temperature, Resistance, Voltage Table

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

Condition 1

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

AND

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

AND

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

Condition 2

- The ECM determines the Start-Up IAT Sensor 1 temperature is between the Start-Up IAT Sensor 3 temperature and the Start-Up IAT Sensor 2 temperature.

  AND

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

  AND

- The absolute difference between Start-Up IAT Sensor 3 temperature and the Start-Up IAT Sensor 1 temperature is greater than the absolute difference between the Start-Up IAT Sensor 2 temperature and the Start-Up IAT Sensor 1 temperature.

Condition 3

- The ECM determines the Start-Up IAT Sensor 2 temperature is between the Start-Up IAT Sensor 3 temperature and the Start-Up IAT Sensor 1 temperature.

  AND

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

  AND

- The absolute difference between Start-Up IAT Sensor 3 temperature and the Start-Up IAT Sensor 2 temperature is greater than the absolute difference between Start-Up IAT Sensor 2 temperature and the Start-Up IAT Sensor 1 temperature.

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Action Taken When the DTC Sets

DTC P00E9 is a Type B DTC.

Conditions for Clearing the DTCs

DTC P00E9 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify that DTC P00EA, P00EB, P00EC, P0097, P0098, P0099, P0112, P0113, P0114, P0641, P0651, P0697, or P06A3 is not set.
   - **If any of the DTCs are set**

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

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

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

3. Ignition On.
4. Verify the scan tool parameters listed below are within 25Â°C (45Â°F).
   - Start-Up IAT Sensor 1
   - Start-Up IAT Sensor 2
   - Start-Up IAT Sensor 3
   - **If not within the specified range**

     Refer to Circuit/System Testing.

   - **Go to next step: 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.

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

Circuit/System Testing

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

1. Verify the conditions listed below do not exist with the air induction system:
   - A loose or disconnected charge air cooler hose or pipe; where equipped
   - A blocked or obstructed charge air cooler, including: after-market grill covers; where equipped
   - Any snow or ice build-up at the charge air cooler in cold climates; where equipped
   - Any mud or dirt build-up at the charge air cooler; where equipped
   - A restricted or collapsed air intake duct
   - An intake manifold leak
   - A MAP sensor seal that is leaking, missing, or damaged
   - A misaligned or damaged air intake duct
   - Any water intrusion in the induction system
   - An intake manifold resonator with a leaking seal, or a cracked or broken housing
   - **If a condition exists**

     Repair or replace the component as necessary.

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

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

Component Testing

Intake Manifold Pressure and Air Temperature Sensor

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

     Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

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

Repair Instructions

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

- Refer to **Intake Air Pressure and Temperature Sensor Replacement** for B65 Intake Manifold Pressure and Air Temperature Sensor replacement.
- Refer to **Control Module References** for engine control module replacement, programming, and setup

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

Diagnostic Instructions

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

DTC Descriptor

DTC P00EA

Intake Air Temperature (IAT) Sensor 3 Circuit Low Voltage

DTC P00EB

Intake Air Temperature (IAT) Sensor 3 Circuit High Voltage

DTC P00EC

Intake Air Temperature (IAT) Sensor 3 Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P00EA	P00EB	P00EB*	P00E9
Low Reference	-	P00EB**	P00EA, P00EC*	-
* Internal control module or component damage may occur if the circuit shorts to B+. ** Additional DTCs may set.				

Typical Scan Tool Data

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IAT Sensor 3

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** -39 to +129Â°C (-38 to +264Â°F)			
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

Circuit	Description
Signal	The control module input circuit has an internal resistance connected to 5 V.
Low Reference	Grounded through the control module.

Component	Description
B65 Intake Manifold Pressure and Air Temperature Sensor	The intake air temperature sensor 3 and the intake manifold pressure sensor are integrated in the same housing, which is located behind the throttle body.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

- Engine = Running
- Battery Voltage = Greater than 11 V

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

Conditions for Setting the DTC

P00EA

IAT Sensor 3 = Warmer than 149Â°C (300Â°F) - For greater than 5 s

P00EB

IAT Sensor 3 = Colder than -39Â°C (-38Â°F) - For greater than 5 s

P00EC

IAT Sensor 3 = Signal noisy or erratic - For greater than 5 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

NOTE: **If you were sent here from DTC P0096, P00E9, P0101, P0111 - Refer to: Circuit/System Testing.**

1. Ignition - On/Vehicle - In Service Mode
2. Verify the scan tool parameter: IAT Sensor 3 = -39 to 149Â°C (-38 to 300Â°F)
   - **If not between -39 and 149Â°C (-38 and 300Â°F)**

     Refer to: Circuit/System Testing

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

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: B65 Intake Manifold Pressure and Air Temperature Sensor
   - Wiggle the harness and connector: X2 @ K20 Engine Control Module
   - **If the value spikes or drops out**

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

   - **Go to next step: If the value does not spike or drop out**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

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

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B65 Intake Manifold Pressure and Air Temperature Sensor
3. Test for less than 5 ohms between the test points: Low Reference circuit terminal 3 & Ground

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- **If 5 ohms or greater**

1. Disconnect the electrical connector: X2 @ K20 Engine Control Module
2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 3 @ Component harness & Terminal 80 @ Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component: K20 Engine Control Module

- **Go to next step: If less than 5 ohms**

4. Ignition - On/Vehicle - In Service Mode
5. Verify the scan tool parameter: IAT Sensor 3 = Colder than -39Â°C (-38Â°F)
    - **If 39Â°C (38Â°F) or warmer**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Test for infinite resistance between the test points: Signal circuit terminal 1 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component: K20 Engine Control Module

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

6. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 1 & Low Reference circuit terminal 3
7. Verify the scan tool parameter: IAT Sensor 3 = Warmer than 149Â°C (300Â°F)
    - **If 149Â°C (300Â°F) or colder**

    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Ignition - On/Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: Signal circuit terminal 1 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for less than 2 ohms between the test points: Signal circuit terminal 1 @ Component harness & Terminal 26 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K20 Engine Control Module

    - **Go to next step: If warmer than 149Â°C (300Â°F)**

8. Test or replace the component: B65 Intake Manifold Pressure and Air Temperature Sensor

Repair Instructions

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

- Refer to **Intake Air Pressure and Temperature Sensor Replacement**
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P0097, P0098, P0099, P00F4, P00F5, OR P00F6: INTAKE AIR TEMPERATURE (IAT) SENSOR 2 CIRCUIT/INTAKE AIR HUMIDITY SENSOR CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

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DTC P0097

Intake Air Temperature (IAT) Sensor 2 Circuit Low Voltage

DTC P0098

Intake Air Temperature (IAT) Sensor 2 Circuit High Voltage

DTC P0099

Intake Air Temperature (IAT) Sensor 2 Circuit Intermittent

DTC P00F4

Intake Air Humidity Sensor Circuit Low Voltage

DTC P00F5

Intake Air Humidity Sensor Circuit High Voltage

DTC P00F6

Intake Air Humidity Sensor Circuit Erratic

Diagnostic Fault Information

IAT 2 and Intake Air Humidity

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

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Typical Scan Tool Data

Intake Air Humidity Sensor

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient humidity, 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+			

IAT 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Ignition	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-

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

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

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

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Conditions for Running the DTCs

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

Conditions for Setting the DTCs

P0097

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

The ECM detects that the IAT sensor 2 signal is less than 13 Hz, colder than -60Â°C (-76Â°F), for greater than 4 s.

P0098

The ECM detects that the IAT sensor 2 signal is greater than 390 Hz, warmer than 150Â°C (302Â°F), for greater than 4 s.

P0099

The ECM detects that the absolute difference in 10 consecutive 100 ms samples of IAT sensor 2 signal is greater than 100Â°C (180Â°F), for greater than 4 s.

P00F4

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

P00F5

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

P00F6

The ECM monitors the humidity sensor signal every 0.1 s, to determine if the signal has changed more than 80%. The DTC fails when the condition exists for greater than 4 s.

Action Taken When the DTC Sets

- DTC P0097, P0098, P0099, P00F4, P00F5, and P00F6 are Type B DTCs.
- The ECM commands the cooling fans ON.

Conditions for Clearing the MIL/DTC

DTC P0097, P0098, P0099, P00F4, P00F5, and P00F6 are Type B DTCs.

Diagnostic Aids

- The Intake Air Humidity Signal parameter displays the measured humidity within the air intake system and may differ from atmospheric humidity measured outside the air intake system.
- With the ignition ON, the engine OFF, if the engine is cold, a properly functioning humidity sensor will gradually increase the scan tool Intake Air Humidity Signal parameter. This is due to the heat that is generated by the multifunction intake air sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the Intake Air Humidity parameter displays the value: 0% or 100%, and there are also IAT Sensor 2 DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Powertrain Component Views

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

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

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

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

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

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.

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

     Refer to Circuit/System Testing.

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

Circuit/System Testing

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

1. Ignition Off, disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 5 Ω between the ground circuit terminal 7 and ground.
   - **If 5 Ω or greater**
   1. Disconnect the sensor chassis ground.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the chassis ground connection.
   - **Go to next step: If less than 5 Ω**

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

3. Verify the scan tool Intake Air Humidity Sensor parameter is less than 1%.
   - **If 1% or greater**
   1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the IAT 2 signal circuit terminal 8 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.

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- **Go to next step: If less than 1%**

4. Ignition Off, connect a 3 A fused jumper wire between the IAT 2 signal circuit terminal 8 and the ground circuit terminal 7.
5. Ignition On.
6. Verify the scan tool Intake Air Humidity Sensor parameter is greater than 99%.
    - **If 99% or less**

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

        1. Ignition Off, remove the jumper wire and disconnect the harness connector X1 at the K20 Engine Control Module.
        2. Ignition On.
        3. Test for less than 1 V between the IAT 2 signal circuit terminal 8 and ground.
            - If 1 V or greater, repair the short to voltage on the circuit.
            - If less than 1 V.
        4. Ignition Off.
        5. Test for less than 2 Ω in the signal circuit end to end.
            - If 2 Ω or greater, repair the open/high resistance in the circuit.
            - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If greater than 99%**
7. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

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

      Replace the B75C Multifunction Intake Air Sensor.

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

IAT 2 Circuit Testing with EL-38522-A

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

1. Perform the following test using a **EL-38522-A** Variable Signal Generator or equivalent, if available.
2. Ignition Off, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
    1. Red lead to the signal circuit terminal 8 at the harness connector
    2. Black leads to ground
    3. Battery voltage supply lead to B+
3. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
    - Signal switch to 5 V
    - Duty Cycle switch to 50% (Normal)
    - Frequency switch to 250 Hz
4. Ignition On.
5. Verify the scan tool IAT Sensor 2 parameters listed below are within the ranges listed below:
    - IAT Sensor 2 is between 248 - 252 Hz

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

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

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

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

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

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

6. All OK.

Repair Instructions

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

- Refer to **Mass Airflow Sensor Replacement** for B75C Multifunction Intake Air Sensor replacement
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

DTC P00FF, P069E, P06EC, P0700, P0800, P0AC4, P1700, P1E00, P2561, P25A2, P25AF, P25C9, P26C8, OR P26C9: 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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each of the diagnostic category.

DTC Descriptor

DTC P00FF

Body Control Module Requested MIL Illumination

DTC P069E

Fuel Pump Control Module Requested MIL Illumination

DTC P06EC

Fuel Injector Control Module Requested MIL Illumination

DTC P0700

Transmission Control Module Requested MIL Illumination

DTC P0800

Active Transfer Case Control Module Requested MIL Illumination

DTC P0AC4

Hybrid/EV Powertrain Control Module Requested MIL Illumination

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DTC P1E00

Hybrid/EV Powertrain Control Module 2 Requested MIL Illumination

DTC P2561

Air Conditioning (A/C) Control Module Requested MIL Illumination

DTC P25A2

Brake System Control Module Requested MIL Illumination

DTC P25AF

Coolant Temperature Control Module Requested MIL Illumination

DTC P25C9

Brake System Control Module 2 Requested MIL Illumination

DTC P26C8

Chassis Control Module Requested MIL Illumination

DTC P26C9

Auxiliary Chassis Control Module Requested MIL Illumination

Circuit/System Description

Control modules constantly monitor the vehicle for any condition which may adversely affect vehicle performance. If a condition is detected, the module sets a DTC and sends a serial data message to the engine control module (ECM). The ECM sets a DTC to inform the technician that the module has set a DTC. The serial data message sent by the 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 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 DTC set.

Conditions for Running the DTC

- The ignition is ON or the engine is running.
- These DTCs run continuously.

Conditions for Setting the DTC

The ECM receives a serial data message from a specific module indicating that DTC has set in the module.

Action Taken When the DTC Sets

DTCs P00FF, P069E, P06EC, P0700, P0800, P0AC4, P1E00, P2561, P25A2, P25AF, P25C9, P26C8, and P26C9 are Type A DTCs.

Conditions for Clearing the MIL/DTC

DTCs P00FF, P069E, P06EC, P0700, P0800, P0AC4, P1E00, P2561, P25A2, P25AF, P25C9, P26C8, and P26C9 are Type A DTCs.

Diagnostic Aids

Communication codes, U-codes, and P-codes that set in a module can request a DTC 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 these informational DTCs.**
- **Correct any engine control and communication DTCs before diagnosing these DTCs.**

1. Vehicle in Service Mode.
2. Verify there are no engine control or communication DTCs set.
   - **If a DTC is set**

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

   - **Go to next step: If a DTC is not set**
3. Verify there are no DTCs set in any other control module.
   - **If a DTC is set**

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

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

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

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

Repair Instructions

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

DTC P0101: MASS AIR FLOW (MAF) SENSOR PERFORMANCE

Diagnostic Instructions

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

DTC Descriptors

DTC P0101

Mass Air Flow (MAF) Sensor Performance

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0103	P0102	P0103	P0101
Signal	P0102	P0102	P0103	P0101
Ground	-	P0102	-	-

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at idle, engine coolant temperature (ECT) sensor warmer than 60Â°C (140Â°F) **Parameter Normal Range:** 10 - 40 g/s **Operating Conditions:** Engine running at idle, ECT sensor colder than 60Â°C (140Â°F) **Parameter Normal Range:** 30 - 40 g/s			
Ignition Voltage	0.0 g/s	0.0 g/s	-
Signal	0.0 g/s	0.0 g/s	0.0 g/s
Ground	-	0.0 g/s	-

Circuit 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 scan tool Induction System Leak Indication parameter is calculated by dividing the mass air flow sensor signal reading, by the estimated air flow.

The estimated air flow is based on the following signal readings:

- Engine speed
- Manifold absolute pressure (MAP)
- Intake manifold temperature (IAT 3) sensor

When the EGR valve is closed, the ideal Induction System Leak Indication parameter is 1.0:1; the normal range is between 0.75:1 and 1.25:1.

A scan tool Induction System Leak Indication parameter greater than 1.25:1, when the EGR valve is commanded closed, may indicate:

- A leak after the turbocharger
- An inaccurate boost pressure sensor
- An inaccurate IAT sensor 3
- A skewed MAF sensor

A scan tool Induction System Leak Indication parameter less than 0.80:1, when the EGR valve is commanded closed, may indicate:

- A leak before the turbocharger
- An inaccurate boost pressure sensor
- An inaccurate IAT sensor 3
- A skewed MAF sensor
- A leaking EGR valve, when it is commanded closed
- A leaking positive crankcase valve (PCV) system

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

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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 the sensors listed below.

The multifunction intake air sensor houses the following:

- Intake Air Temperature (IAT) sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- Turbocharger inlet air pressure (TCIAP) sensor - BARO 2

Conditions for Running the DTC

- DTCs P00C7, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8, P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0405, P0406, P049D, P0502, P0503, P062B, P062D, P0722, P0723, P111E, P122D, P124A, P124B, P1248, P1249, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P2227, P2228, P2229, or P2230 is not set.
- The engine speed is between 700 and 1, 200 RPM.
- The ignition voltage is greater than 11 V.
- The barometric pressure (BARO) is greater than 69.5 kPa (10.09 PSI).
- The ambient air temperature is warmer than -7Â°C (19Â°F).
- The IAT 1 is warmer than -7Â°C (19Â°F).
- The engine coolant temperature (ECT) is 40 to 130Â°C (104 to 266Â°F).
- The intake airflow valve position is greater than 85%.
- The EGR position is less than 1%.
- The vehicle speed is less than 3 kph (2 mph).
- The DTCs run continuously when the enabling conditions are met for greater than 1 s.

Conditions for Setting the DTC

- The ECM determines that the actual airflow is not within a predetermined range when the EGR valve is commanded closed.
- The condition exists for greater than 8 s

Action Taken When the DTC Sets

DTC P0101 is Type B DTC.

Conditions for Clearing the DTC

DTC P0101 is Type B DTC.

Diagnostic Aids

- Certain aftermarket air filters may cause this DTC to set.
- Certain aftermarket air induction systems may cause this DTC to set.
- An inaccurate MAF sensor, an intake air flow restriction, any unmetered air that enters the engine downstream of the MAF sensor, or an air induction leak may cause this DTC to set.
- An aftermarket exhaust system may reduce engine back-pressure excessively and cause this DTC to set.
- A faulty EGR valve that does not close fully, may set this DTC.
- An inaccurate CAC temperature sensor may cause this DTC to set.
- Use a smoke generating device or a solution of dish soap and water in a spray bottle to pinpoint any suspected air leaks in the induction system and in the charge air cooler assembly.

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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-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 DTCs P00C7, P00EA, P00EB, P00EC, P0097, P0098, P0099, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8, P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0405, P0406, P049D, P0502, P0503, P062B, P062D, P0722, P0723, P111E, P122D, P124A, P124B, P1248, P1249, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P2227, P2228, P2229, and P2230 are not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
   - **Go to next step: If none of the DTCs are set**

NOTE:

- **To minimize the effects of residual engine heat, perform Step 3 of this verification procedure only if the ignition has been OFF for 8 hours or more.**
- **The vehicle sitting in direct sun light or having the block heater ON will skew the results.**

3. Verify the following scan tool parameters are within 25Â°C (45Â°F) of each other.
   - Start-Up IAT Sensor 1
   - Start-Up IAT Sensor 2
   - Start-Up IAT Sensor 3
   - **If a parameter is not within 25Â°C (45Â°F) of the others**

     Refer to the appropriate procedure listed below for further diagnosis.

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- Refer to **DTC P0096 or P0111** for IAT 1 or IAT 2.
- Refer to **DTC P00E9** for IAT 3.
- **Go to next step: If all are within 25Â°C (45Â°F)**

4. Engine running at a warm stabilized idle, perform the following:
   1. Command the EGR Valve to 0% with a scan tool.
   2. Verify the Induction System Leak Indication parameter is between 0.75:1 and 1.25:1 for at least 10 s.
   - **If not stable or between 0.75:1 and 1.25:1 after 10 s**

     Refer to Circuit/System Testing.

   - **Go to next step: If stable and between 0.75:1 and 1.25:1 after 10 s**
5. Ignition On, engine Off, verify the scan tool MAP Sensor and BARO Sensor 2 parameters are within 4 kPa (0.58 PSI) of each other.
   - **If not within 4 kPa (0.58 PSI).**

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

   - **Go to next step: If within 4 kPa (0.58 PSI).**
6. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
   1. Engine idling
   2. Increase the engine speed slowly to 3, 000 RPM and then back to idle.
   3. Exit from the scan tool data list and review the stored data within the Stored Data function of the scan tool.
   4. Observe the MAF Sensor parameter frame by frame.
   - **If the MAF Sensor parameter does not change smoothly and or gradually**

     Refer to Circuit/System Testing.

   - **Go to next step: If the MAF Sensor parameter changes smoothly and gradually**
7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE:

- **You must perform the Circuit/System Verification before proceeding with the Circuit/System Testing.**
- **You must perform the Diagnostic Repair Verification after completing the Circuit/System Testing.**

1. Verify none of the following conditions exist:
   - A dirty or deteriorating air filter element
   - A leaking, loose, disconnected, or cracked positive crankcase ventilation (PCV) valve, pipe, or seal
   - A loose or disconnected charge air cooler hose or pipe

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- A restricted or collapsed air intake duct
- A misaligned or damaged air intake duct
- Any objects blocking the air inlet probe of the Mass Air Flow/Intake Air Temperature sensor
- Any contamination or debris on the sensing elements in the probe of the Mass Air Flow/Intake Air Temperature sensor
- A cracked or damaged mass air flow sensor housing
- Any water intrusion in the induction system
- Any snow or ice build-up at the air cleaner, mass air flow sensor, charge air cooler, or manifold absolute pressure sensor, in cold climates
- An intake manifold leak
- A manifold absolute pressure sensor seal that is leaking, missing, or damaged
- An Intake Manifold Resonator with a leaking seal, or a cracked or broken housing
- A restriction in the exhaust system. Refer to **Restricted Exhaust** .
- A leak in the exhaust system. Refer to **Exhaust Leakage** .
- **If a condition exists**

  Repair as necessary.

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

2. Engine idling at operating temperature, command the EGR Valve to 0% with a scan tool.
3. Verify the Induction System Leak Indication parameter is between 0.75:1 and 1.25:1 for at least 10 s.
   - **If not stable or between 0.75:1 and 1.25:1 after 10 s**
   1. Verify the Q14 Exhaust Gas Recirculation Valve is in the closed position, by visual inspection. Refer to **Exhaust Gas Recirculation Valve Replacement** .
      - If the Q14 Exhaust Gas Recirculation Valve is not closed.

        Replace the Q14 Exhaust Gas Recirculation Valve and gaskets.

      - If the Q14 Exhaust Gas Recirculation Valve is closed.
   2. Test the charge air cooler system and air inlet system for leaks. Perform the **Charge Air Cooler Diagnosis (Leak Test)** **Charge Air Cooler Diagnosis (Smoke Test)** .
      - If a condition exists.

        Repair or replace the component as necessary.

   - **Go to next step: If stable and between 0.75:1 and 1.25:1 after 10 s**
4. Ignition Off and all systems Off. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
5. Test for less than 5 Ω between the ground circuit terminal 7 and ground.
   - **If 5 Ω or greater**
   1. Disconnect the sensor chassis ground.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the chassis ground connection.
   - **Go to next step: If less than 5 Ω**
6. Ignition On, verify a test lamp illuminates between the voltage supply circuit terminal 5 and ground.
   - **If the test lamp does not illuminate**
   1. Ignition Off, remove the test lamp, and disconnect harness connector X2 at the K20 Engine Control Module.
   2. Test for infinite resistance between the voltage supply circuit, and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.

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- If infinite resistance.

3. Test for less than 2 Ω in the voltage supply circuit, end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.
- **Go to next step: If the test lamp illuminates**

7. 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 X1 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 harness connector X1 at the K20 Engine Control Module.
    2. Ignition On.
    3. Test for less than 1 V between the signal circuit terminal 6 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If between 4.8 - 5.2 V**
8. 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+
9. 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 5 KHz
10. Engine idling.
11. Verify the scan tool MAF Sensor parameter is between 4, 950 - 5, 050 Hz.
    - **If not between 4, 950 - 5, 050 Hz.**

      Replace the K20 Engine Control Module.

    - **Go to next step: If between 4, 950 - 5, 050 Hz.**
12. Replace the B75C Multifunction Intake Air sensor.

Repair Instructions

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

- Perform the **Diesel Particulate Filter (DPF) Service Regeneration** after completing the repair.
- Refer to **Mass Airflow Sensor Replacement** for B75C Multifunction Intake Air sensor replacement.
- Refer to **Control Module References** for ECM replacement, programming, and setup

DTC P0102 OR P0103: MASS AIR FLOW (MAF) SENSOR CIRCUIT LOW/HIGH FREQUENCY

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Diagnostic Instructions

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

DTC Descriptors

DTC 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	P0103	P0102	P0103	P0101
Signal	P0102	P0102	P0103	P0101
Ground	-	P0102	-	-

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at idle, engine coolant temperature (ECT) sensor warmer than 60Â°C (140Â°F) **Parameter Normal Range:** 10 - 40 g/s **Operating Conditions:** Engine running at idle, ECT sensor colder than 60Â°C (140Â°F) **Parameter Normal Range:** 30 - 40 g/s			
Ignition Voltage	0.0 g/s	0.0 g/s	-
Signal	0.0 g/s	0.0 g/s	0.0 g/s
Ground	-	0.0 g/s	-

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Circuit 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:

The multifunction intake air sensor houses the following:

- Intake Air Temperature (IAT) sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- Turbocharger inlet air pressure (TCIAP) sensor - BARO 2

Conditions for Running the DTC

- The engine speed is greater than 49 RPM.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously when the enabling conditions are met for greater than 1 s.

Conditions for Setting the DTC

P0102

The ECM detects that the MAF sensor signal is less than 276 Hz.

P0103

The ECM detects that the MAF sensor signal is greater than 14, 400 Hz.

Action Taken When the DTC Sets

DTCs P0102 and P0103 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0102 and P0103 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

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 at normal operating temperature.
2. Verify the scan tool MAF Sensor parameter is between 5 - 40 g/s.
    - **If not between 5 - 40 g/s**

      Refer to Circuit/System Testing.

    - **Go to next step: If between 5 - 40 g/s**

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

      Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF and all systems OFF. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
2. Test for less than 5 Ω between the ground circuit terminal 7 and ground.
    - **If 5 Ω or greater**
    1. Disconnect the sensor chassis ground.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the chassis ground connection.
    - **Go to next step: If less than 5 Ω**
3. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal 5 and ground.
    - **If the test lamp does not illuminate**
    1. Ignition OFF, remove the test lamp and disconnect harness connector X2 at the K20 Engine Control Module.
    2. Test for infinite resistance between the voltage supply 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 voltage supply circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp illuminates**
4. Ignition ON, test for 4.8 - 5.2 V between the MAF signal circuit terminal 6 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect harness connector X1 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 X1 at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the signal circuit terminal 6 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If between 4.8 - 5.2 V**
5. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:

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- Red lead to the signal circuit terminal 6 at the harness connector
- Black leads to ground
- Battery voltage supply lead to B+

6. 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 5 KHz
7. Engine idling.
8. Verify the scan tool MAF Sensor parameter is between 4, 950 - 5, 050 Hz.
   - **If not between 4, 950 - 5, 050 Hz.**

     Replace the K20 Engine Control Module.

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

Repair Instructions

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

- Perform the **Diesel Particulate Filter (DPF) Service Regeneration** after completing the repair.
- Refer to **Mass Airflow Sensor Replacement** for B75C Multifunction Intake Air sensor replacement
- Refer to **Control Module References** for ECM replacement, programming, and setup

DTC P0106: MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0106

Manifold Absolute Pressure (MAP) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open	Short to Voltage	Signal Performance
5 V Reference	P0651**	P0107	P0651**	-
Signal	P0107	P0108	P0108	-
Low Reference	P0108	P00EB, P0108	*	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+. ** Additional DTCs may set.				

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition On at sea level **Parameter Normal Range:** 96 - 104 kPa (13.9 - 15.1 PSI)			
5 V Reference	0 kPa (0 PSI) 0.0 V	0 kPa (0 PSI) 0.0 V	98 kPa (14.2 PSI) 1.25 V

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Circuit	Short to Ground	Open	Short to Voltage
Signal	0 kPa (0 PSI) 0.0 V	435 kPa (63 PSI) 4.98 V	435 kPa (63 PSI) 4.98 V
Low Reference	-	435 kPa (63 PSI) 4.98 V	*
* 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. Integrated within this sensor is also the intake air temperature sensor (IAT).

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

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

Under normal operation the greatest pressure that can exist in the intake manifold is at ignition ON, engine OFF, which is equal to the 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

Condition 1

- Before the ECM can report that DTC P0106 failed, DTCs P0107, P0108, P2228, P2229, P227C, or P227D must run and pass.
- DTC P0106, P0107, P0108, P2227, P2228, P2229, P2230, or P2610 is not set.
- The ignition is On, engine Off.
- The time between the current ignition cycle and the previous drive cycle is greater than 5 s.
- DTC P0106 runs continuously when the conditions above exist.

Condition 2

- DTC P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8, P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0335, P0336, P062B, P062D, P111E, P122D, P1248, P1249, P124A, P124B, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P2227, P2228, P2229, P2230, P227C, or P227D is not set.
- The engine is operating.
- The ignition voltage is greater than 11 V.
- The engine speed is less than 1, 100 RPM.
- The intake airflow valve position is greater than 90%.
- The engine coolant temperature (ECT) is warmer than 70Â°C (158Â°F)
- DTC P0106 runs continuously when the conditions above exist.

Conditions for Setting the DTC

- The ECM detects that the MAP Sensor pressure is greater or less than a threshold as compared to the pressure inputs from the BARO and TCIAP (BARO 2) sensors.

- The condition exists for greater than 5 s.

Action Taken When the DTC Sets

DTC P0106 is a Type A DTC.

Conditions for Clearing the DTC

DTC P0106 is a Type A DTC.

Diagnostic Aids

- A skewed or stuck engine coolant temperature (ECT) or intake air temperature (IAT) will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to **Temperature Versus Resistance - Intake Air Temperature Sensor** .
- A skewed MAP sensor may cause the first and second intake manifold models to disagree with the actual MAP sensor measurements. Use the scan tool and compare the MAP Sensor parameter to a known good vehicle, under various operating conditions.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Powertrain Component Views

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Turbocharger System Description

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

GE-23738-A Vacuum Pump

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

Circuit/System Verification

1. Ignition On.
2. Verify that DTCs P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8,

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P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0335, P0336, P062B, P062D, P0641, P0651, P0697, P06A3, P111E, P122D, P1248, P1249, P124A, P124B, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P2227, P2228, P2229, P2230, P227C, P227D, or P227E are not set.

- **If any of DTCs are set**

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

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

3. Verify the scan tool MAP Sensor parameter is within the range listed in the following table: **Altitude Versus Barometric Pressure** .
   - **If not in the specified range**

     Refer to Circuit/System Testing.

   - **Go to next step: If in the specified range**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTCs are not set.

   - **If the DTCs sets**

     Refer to Circuit/System Testing

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

Circuit/System Testing

1. Check the integrity of the entire air induction system and verify that none of the following conditions exist:
   - Any damaged components
   - Improper operation of turbocharger vane position actuator
   - Loose or improper installation of the turbocharger and the charge air cooler, including the inlet and outlet ducts
   - 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
   - A restriction in the MAP Sensor port
   - Proper operation of the positive crankcase ventilation system
   - Missing, restricted or leaking exhaust components. Refer to **Symptoms - Engine Exhaust** .
   - Engine mechanical condition; for example: low compression or incorrect timing chain installation. Refer to **Symptoms - Engine Mechanical** .
   - **If a condition is found**

     Repair or replace the component as necessary.

   - **Go to next step: If no condition is found**
2. Ignition Off, and all vehicle systems OFF, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B65 Intake Manifold Pressure and Air Temperature Sensor.
3. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
   - **If 5 Ω or greater**
     1. Disconnect the harness connector X2 at the K20 Engine Control Module.
     2. Test for less than 2 Ω in the low reference circuit end to end.

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

- **Go to next step: If less than 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 harness connector X2 at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition Off, disconnect harness connector X2 at the K20 Engine Control Module.
   2. Ignition On, test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If between 4.8 - 5.2 V**
6. Verify the scan tool MAP Sensor voltage parameter is greater than 4.7 V.
   - **If 4.7 V or less**
   1. Ignition Off, disconnect the harness connector X2 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, replace the K20 Engine Control Module.
   - **Go to next step: If greater than 4.7 V**

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

7. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
8. Verify the scan tool MAP Sensor voltage parameter is less than 0.2 V.
   - **If 0.2 V or greater**
   1. Ignition Off, remove the jumper wire, disconnect the harness connector X2 at the K20 Engine Control Module.
   2. Ignition On.
   3. 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
   4. Ignition Off.
   5. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 0.2 V**
9. Test or replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

Component Testing

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

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Component Testing.

Skewed Sensor Test

1. Ignition Off, remove the B65 Intake Manifold Pressure and Air Temperature Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition On, apply 17 kPa (5.0 in Hg) of vacuum to the B65 Intake Manifold Pressure and Air Temperature Sensor, with the **GE-23738-A** . Verify the scan tool MAP Sensor pressure parameter decreases between 13 - 21 kPa (1.8 - 3.0 PSI).
   - **If the parameter does not decrease between 13 - 21 kPa (1.8 - 3.0 PSI).**

     Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

   - **Go to next step: If the parameter does decrease between 13 - 21 kPa (1.8 - 3.0 PSI).**
3. Apply 34 kPa (10.0 in Hg) of vacuum to the B65 Intake Manifold Pressure and Air Temperature Sensor, with the **GE-23738-A** . Verify the scan tool MAP Sensor pressure parameter decreases between 30 - 38 kPa (4.4 - 5.5 PSI).
   - **If the parameter does not decrease between 30 - 38 kPa (4.4 - 5.5 PSI).**

     Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

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

Erratic Signal Test

1. Ignition Off, disconnect the harness connector and remove the B65 Intake Manifold Pressure and Air Temperature Sensor.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 2 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 3 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 4 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 B65 Intake Manifold Pressure and Air Temperature Sensor.

   - **Go to next step: If between 0.2 - 4.9 V and there are no spikes or dropouts**
8. All OK.

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Repair Instructions

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

- Refer to **Intake Air Pressure and Temperature Sensor Replacement** for B65 Intake Manifold Pressure and Air Temperature Sensor replacement.
- Refer to **Control Module References** for ECM replacement, programming and setup

DTC P0107 OR P0108: MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT LOW/HIGH VOLTAGE

Diagnostic Instructions

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

DTC Descriptors

DTC P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open	Short to Voltage	Signal Performance
5 V Reference	P0651**	P0107	P0651**	-
Signal	P0107	P0108	P0108	-
Low Reference	P0108	P0108**	*	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+. ** Additional DTCs may set.				

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition On at sea level **Parameter Normal Range:** 96 - 104 kPa (13.9 - 15.1 PSI)			
5 V Reference	0 kPa (0 PSI) 0.0 V	0 kPa (0 PSI) 0.0 V	98 kPa (14.2 PSI) 1.25 V
Signal	0 kPa (0 PSI) 0.0 V	435 kPa (63 PSI) 4.98 V	435 kPa (63 PSI) 4.98 V
Low Reference	-	435 kPa (63 PSI) 4.98 V	*
* 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. Integrated within this sensor is also the intake air temperature sensor (IAT).

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

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

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

Conditions for Running the DTC

- The ignition is ON, or the engine is operating.
- The DTCs run continuously when the conditions above exist.

Conditions for Setting the DTC

P0107

The ECM detects that the MAP sensor pressure is less than 7.5 kPa (1.08 PSI), for greater than 4 s.

P0108

The ECM detects that the MAP sensor pressure is greater than 421.5 kPa (61.1 PSI), for greater than 4 s.

Action Taken When the DTC Sets

DTC P0107 and P0108 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0107 and P0108 are Type B DTCs.

Diagnostic Aids

- A skewed or stuck engine coolant temperature (ECT) or intake air temperature (IAT) will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to **Temperature Versus Resistance - Intake Air Temperature Sensor** .
- A skewed MAP sensor may cause the first and second intake manifold models to disagree with the actual MAP sensor measurements. Use the scan tool and compare the MAP Sensor parameter to a known good vehicle, under various operating conditions.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component Views

Powertrain Component Views

Description and Operation

Turbocharger System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

GE-23738-A Vacuum Pump

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

Circuit/System Verification

NOTE: **If you were sent here from P0106 proceed to step 2 of Circuit/System Testing.**

1. Ignition On.
2. Verify that DTCs P0641, P0651, P0697 or P06A3 is not set.
   - **If a DTC is set**

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

   - **Go to next step: If a DTC is not set**
3. Engine running, verify the scan tool MAP sensor parameter is between 20 - 300 kPa (2.9 - 43.5 PSI) and changes with accelerator input.
   - **If not within range or does not change**

     Refer to Circuit/System Testing.

   - **Go to next step: If within range and changes**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC is not set.

   - **If the DTCs sets**

     Refer to Circuit/System Testing

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

Circuit/System Testing

1. Check the integrity of the entire air induction system and verify that none of the following conditions exist:
   - Any damaged components
   - Improper operation of turbocharger actuators or solenoid valves
   - Loose or improper installation of the turbocharger and the charge air cooler, including the flexible ductwork
   - An air flow restriction
   - Any vacuum leak
   - Improperly routed vacuum hoses
   - In cold climates, inspect for any snow or ice buildup at the BARO port on the ECM
   - A restriction in the MAP Sensor port
   - Proper operation of the positive crankcase ventilation system
   - **If a condition is found**

     Repair or replace the component as appropriate.

   - **Go to next step: If no condition is found**
2. Ignition Off, and all vehicle systems OFF, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B65 Intake Manifold Pressure and Air Temperature Sensor.
3. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
   - **If 5 Ω or greater**

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1. Disconnect the harness connector X2 at the K20 Engine Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **Go to next step: 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 harness connector X2 at the K20 Engine Control Module.
2. Test for infinite resistance between the 5 V reference circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the 5 V reference circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition Off, disconnect harness connector X2 at the K20 Engine Control Module.
2. Ignition On, test for less than 1 V between the 5 V reference circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

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

6. Verify the scan tool MAP Sensor voltage parameter is greater than 4.7 V.

- **If 4.7 V or less**

1. Ignition Off, disconnect the harness connector X2 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, replace the K20 Engine Control Module.

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

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

7. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
8. Verify the scan tool MAP Sensor voltage parameter is less than 0.2 V.

- **If 0.2 V or greater**

1. Ignition Off, remove the jumper wire, disconnect the harness connector X2 at the K20 Engine Control Module.
2. Ignition On.
3. 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
4. Ignition Off.
5. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

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

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

Component Testing

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

Skewed Sensor Test

1. Ignition OFF, remove the B65 Intake Manifold Pressure and Air Temperature Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply 17 kPa (5.0 in Hg) of vacuum to the B65 Intake Manifold Pressure and Air Temperature Sensor, with the **GE-23738-A** . Verify the scan tool MAP Sensor pressure parameter decreases between 13 - 21 kPa (1.8 - 3.0 PSI).
   - **If the parameter does not decrease between 13 - 21 kPa (1.8 - 3.0 PSI).**

     Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

   - **Go to next step: If the parameter does decrease between 13 - 21 kPa (1.8 - 3.0 PSI).**
3. Apply 34 kPa (10.0 in Hg) of vacuum to the B65 Intake Manifold Pressure and Air Temperature Sensor, with the **GE-23738-A** . Verify the scan tool MAP Sensor pressure parameter decreases between 30 - 38 kPa (4.4 - 5.5 PSI).
   - **If the parameter does not decrease between 30 - 38 kPa (4.4 - 5.5 PSI).**

     Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

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

Erratic Signal Test

1. Ignition OFF, disconnect the harness connector and remove the B65 Intake Manifold Pressure and Air Temperature Sensor.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 2 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 3 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 4 of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply between 0 - 15 kPa (0 - 4.4 in Hg) of vacuum to the sensor with the **GE-23738-A** . Verify the voltage changes, without any spikes or dropouts, between 0.2 - 4.9 V.
   - **If not between 0.2 - 4.9 V or has spikes or dropouts**

     Replace the B65 Intake Manifold Pressure and Air Temperature Sensor.

   - **Go to next step: If between 0.2 - 4.9 V and there are no spikes or dropouts**
7. All OK.

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Repair Instructions

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

- Refer to **Intake Air Pressure and Temperature Sensor Replacement** for B65 Intake Manifold Pressure and Air Temperature Sensor replacement.
- Refer to **Control Module References** for ECM replacement, programming and setup

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

Diagnostic Instructions

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

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, P2199	P0113, P2199	P0111*, P0113*, P0114, P2199	P0111*, P2199
Low Reference	-	P0097, P00F4, P0113, P227D	P0113*, P0114	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT Sensor 1

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

Circuit/System Description

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

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Mass Air Flow (MAF) sensor
- Turbocharger inlet air pressure (TCIAP) sensor - BARO 2

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 0 s.

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- 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 149Â°C (300Â°F) for greater than 4 s.

P0113

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

The ECM detects that the IAT sensor 1 signal is colder than -60Â°C (-76Â°F) for greater than 4 s.

P0114

- The ECM detects that the IAT sensor 1 signal has changed greater than 80Â°C (128Â°F) within 1 s.
- The condition exists for a cumulative of 4 s or greater.

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

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

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

     Refer to Circuit/System Testing.
   - **Go to next step: If between -38 to +149Â°C (-36 to +300Â°F)**
3. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

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

     Refer to Circuit/System Testing.
   - **Go to next step: If the DTC does not set.**
4. All OK

Circuit/System Testing

1. 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 5 Ω between the low reference circuit terminal 3 and ground.
   - **If 5 Ω or greater**
   1. Disconnect the harness connector X1 at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Ignition On.
4. Verify the scan tool IAT Sensor 1 parameter is colder than -39Â°C (-38Â°F).
   - **If warmer than -39Â°C (-38Â°F)**
   1. Ignition Off, disconnect the harness connector X1 at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 1 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If colder than -39Â°C (-38Â°F).**
5. Ignition Off, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3, ignition On.
6. Verify the scan tool IAT Sensor 1 parameter is warmer than 149Â°C (300Â°F).
   - **If colder than 149Â°C (300Â°F).**
   1. Ignition Off, remove the jumper wire, disconnect the harness connector X1 at the K20 Engine Control Module.
   2. Ignition On.
   3. Test for less than 1 V between the signal circuit and ground.

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

4. Ignition Off.
5. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.
- **Go to next step: If warmer than 149Â°C (300Â°F).**

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

Component Testing

Multifunction Intake Air Sensor

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

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

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

      Replace the B75C Multifunction Intake Air sensor.

    - **Go to next step: If within the table values.**
3. All OK

Repair Instructions

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

- Refer to **Mass Airflow Sensor Replacement** for B75C Multifunction Intake Air Sensor replacement.
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0117

Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

DTC P0119

Engine Coolant Temperature (ECT) Sensor Circuit Intermittent

Diagnostic Fault Information

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

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** -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. 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 when the above conditions are met.

P0118

- The ignition is ON.

  OR

- The engine is running for greater than 15 s.

  OR

- The engine run time is less than 15 s when the IAT is warmer than -7Â°C (19Â°F).
- This DTC runs continuously when the above conditions are met.

P0119

- DTCs P0117, or P0118 are not set.
- The ignition is ON.
- This DTC runs continuously when the above conditions are met.

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.

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P0119

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

Action Taken When the DTC Sets

- DTC P0117, P0118 or P0119 are a Type B DTC.
- The cooling fans will be commanded ON.
- The AC compressor will be commanded OFF.

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

     Refer to Circuit/System Testing.

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

     Refer to Circuit/System Testing.

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

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

Component Testing

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

     Replace the B34 Engine Coolant Temperature Sensor.

   - **Go to next step: If within the specified range**
3. Test for infinite resistance between each terminal and the sensor housing.
   - **If less than infinite resistance**

     Replace the B34 Engine Coolant Temperature Sensor.

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

4. All OK.

Repair Instructions

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

- Refer to **Engine Coolant Temperature Sensor Replacement (FWD)** **Engine Coolant Temperature Sensor Replacement (AWD)**
- Refer to **Control Module References** for ECM replacement, setup, and programming

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

Diagnostic Instructions

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

DTC Descriptor

DTC P0128

Engine Coolant Temperature (ECT) Below Thermostat Temperature

Diagnostic Fault Information

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

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: -39 to 139Â°C (-38 to 282Â°F)			
ECT Sensor 1 Signal	140Â°C (284Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-

Circuit/System Description

The engine control module (ECM) uses this diagnostic to determine if the engine coolant temperature (ECT) has reached the minimum calibrated thermostat regulating temperature. The ECM supplies 5 volts to the ECT signal circuit, and a ground for the ECT low reference circuit. The ECM monitors the temperature of the coolant by using the input received from the ECT sensor. The ECM uses a modeled profile of the engine heat up cycle by monitoring the fuel injection quantity, the start-up ECT and the ambient temperature and then uses this profile to determine if the vehicle has been driven within the conditions that would allow the engine coolant to heat up normally to the thermostat regulating temperature. If the coolant temperature does not increase normally, or does not reach the regulating temperature of the thermostat, the engine is considered not warm enough for stable, low emission operation.

Conditions for Running the DTC

- DTC P0102, P0112, P0113, P0117, P0118, P2122, P2123, P2127, P2128, P2138, or P2199 is not set.
- The engine is running.
- The engine run time is less than 24 m.
- The start-up ECT is between -40Â°C and 58Â°C (-40Â°F and 136Â°F).

- The ambient temperature is between -7Â°C and 60Â°C (19Â°F and 140Â°F)
- The vehicle spends at least 50 percent of the time off idle (Throttle Position is greater than 10%, Vehicle Speed is greater than 16 km/ph (10 mph), and Engine Speed is greater than 1, 000 RPM).
- DTC runs once per ignition cycle when above conditions are met.

Conditions for Setting the DTC

The ECM determines that the modeled ECT has met the calibrated target of 88Â°C (190Â°F) and the measured ECT is less than 77Â°C (171Â°F) for greater than 1 s.

Action Taken When the DTC Sets

DTC P0128 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0128 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling System Description and Operation

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, verify that DTC P0101, P0102, P0103, P0112, P0113, P0117, P0118, P2122, P2123, P2127, P2128, P2138, or P2199 is not set.

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- **If DTC P0101, P0102, P0103, P0112, P0113, P0117, P0118, P2122, P2123, P2127, P2128, P2138, or P2199 is set**

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

- **Go to next step: If DTC P0101, P0102, P0103, P0112, P0113, P0117, P0118, P2122, P2123, P2127, P2128, P2138, or P2199 is not set**

2. Verify the cooling system is filled to the correct coolant level. Refer to **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)** , and **Loss of Coolant** .
   - **If the coolant level is not correct**

     Repair as necessary

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

     Replace the Engine Coolant Thermostat.

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

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the B34 Engine Coolant Temperature sensor harness connector at the sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -38Â°C (-36Â°F).
   - **If warmer than -38Â°C (-36Â°F)**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 1 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **Go to next step: If colder than -38Â°C (-36Â°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2.
6. Verify the scan tool ECT sensor parameter is warmer than 138Â°C (280Â°F).
   - **If 138Â°C (280Â°F) or colder**

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

- **Go to next step: If warmer than 138Â°C (280Â°F)**

7. Test the B34 Engine Coolant Temperature Sensor.

    Refer to Component Testing.

Component Testing

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

      Replace the B34 Engine Coolant Temperature Sensor.

    - **Go to next step: If infinite resistance**
4. Refer to **Thermostat Diagnosis** .

Repair Instructions

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

- Refer to **Engine Coolant Temperature Sensor Replacement (FWD)** **Engine Coolant Temperature Sensor Replacement (AWD)** .
- Refer to **Engine Coolant Thermostat Replacement (LH7)** .
- Refer to **Control Module References** for ECM replacement, setup, and programming.

DTC P0171 OR P0172: FUEL SYSTEM LEAN/RICH

Diagnostic Instructions

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

DTC Descriptors

DTC P0171

Fuel System Lean

DTC P0172

Fuel System Rich

Circuit/System Description

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In order to compensate for variations in the fuel system, the fuel mass observer function adapts a correction quantity using the difference between the measured and modeled oxygen content of the exhaust gas coming from NOx Sensor 1. A DTC will set when the correction quantity reaches the maximum control limit. If the correction quantity is below the calibrated feedback limit for a specified time, the corresponding "Fuel System Lean" fault will be set. If the correction quantity is above the calibrated feedback limit for a specified time, the corresponding "Fuel System Rich" fault will be set.

Conditions for Running the DTC

- DTC P0071-P0074, P0101-P0103, P10B-P10D, P0111-P0114, P0116-P0119, P0128, P0181-P0183, P0201-P0204, P020A-P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0335, P0336, P0502, P0503, P062B, P062D, P0722, P0723, P111E, P2147, P2148, P1249, P124A-P124C, P2150-P2154, P2156, P2157 P2227-P2230 or P262B is not set.
- Ignition voltage is greater than 11 V.
- Ambient air temperature is warmer than -7Â°C (19Â°F).
- Engine coolant temperature is warmer than 65Â°C (149Â°F).
- NOx sensor must be active.
- Engine running.
- BARO is above 75 kPa.
- Diesel Particulate Filter (DPF) regeneration is not active.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM has determined that the Fuel Mass Observer emission correction quantity has exceeded the calibrated limit for greater than 12 s.

Action Taken When the DTC Sets

DTCs P0171 and P0172 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0171 and P0172 are Type B DTCs.

Diagnostic Aids

- This Diagnostic parameter is stored in the ECM over a period of time. Time to set this DTC may take several drive cycles.
- Contaminated or improper fuel quality may cause this DTC to set.
- Worn base engine components or differences in cylinder compression may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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. Verify DTC P0101, P0102, P0103, P014C, P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set** .
2. Verify the scan tool MAF Sensor parameter is between 5 and 40 g/s.
   - **If less than 5 g/s**

     Check for intake system leaks. Refer to Charge Air Cooler Diagnosis (Leak Test) Charge Air Cooler Diagnosis (Smoke Test) .

     If no intake system leaks are found, perform a Diesel Particulate Filter (DPF) Service Regeneration .

   - **If greater than 40 g/s**

     Check for intake system leaks. Refer to Charge Air Cooler Diagnosis (Leak Test) Charge Air Cooler Diagnosis (Smoke Test) .

   - **Go to next step: If between 5 and 40 g/s**
3. Verify there are no exhaust system leaks. Refer to Exhaust Leakage .
   - **If exhaust system leaks were found**

     Repair as necessary.

   - **Go to next step: If no exhaust system leaks were found**
4. Replace the B195A Nitrogen Oxides Sensor 1.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic repair.

- Refer to Nitrogen Oxides Sensor Replacement - Position 1
- Perform the scan tool NOx Sensor 1 Reset procedure after replacing NOx sensor 1.
- Refer to Fuel Injector Replacement
- Perform the Fuel Injector Flow Rate Programming procedure after replacement of a fuel injector.

DTC P0181, P0182, P0183, OR P0184: FUEL TEMPERATURE SENSOR PERFORMANCE/FUEL TEMPERATURE SENSOR CIRCUIT

Diagnostic Instructions

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

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- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0181

Fuel Temperature Sensor Performance

DTC P0182

Fuel Temperature Sensor Circuit Low Voltage

DTC P0183

Fuel Temperature Sensor Circuit High Voltage

DTC P0184

Fuel Temperature Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0182	P0183, P0184	P0183, P0184	P0181
Low Reference	-	P0183, P0184	P0184	P0181

Circuit/System Description

The fuel temperature sensor is integrated within the fuel filter assembly. The fuel temperature sensor is a variable resistor that measures the temperature of the fuel. The engine control module (ECM) supplies 5 V to the signal circuit and supplies a ground to the low reference circuit. The following table illustrates the difference between temperature, resistance, and voltage:

Fuel Temperature Sensor	Resistance	Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTC

P0181

- DTC P0116, P0117, P0118, P0182, P0183, P1103, P111E, P16D7-P16D9, or P262B is not set.
- Engine is running.
- Engine Off time is greater than 8 h.
- Engine run time is between 8 and 9 s.
- Fuel Temperature Sensor is within 23Â°C (41Â°F) of the ECT Sensor
- Ignition voltage is greater than 11 V.
- Start-up ECT is greater than -40Â°C (-40Â°F).
- This DTC runs once per ignition cycle when the above conditions are met.

P0182 or P0183

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

P0184

- DTC P0182 or P0183 is not set.

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- Ignition voltage is greater than 11 V.
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0181

The ECM recognizes the malfunction of the circuit via an internal evaluation logic.

P0182

The ECM detects the fuel temperature sensor is shorted to ground for more than 2 s.

P0183

The ECM detects the fuel temperature sensor is shorted to voltage for more than 2 s.

P0184

The ECM detects that the fuel temperature sensor signal is intermittent or has abruptly changed for at least 1.5 s.

Action Taken When the DTC Sets

DTCs P0181, P0182, P0183 and P0184 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0181, P0182, P0183 and P0184 are Type B DTCs.

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that the scan tool Fuel Temperature Sensor parameter is within the operating range of -39 to 149Â°C (-38 to 300Â°F), depending on current ambient temperature and the vehicle operating conditions.
    - **If not within the specified range**

      Refer to Circuit/System Testing

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

      Refer to Circuit/System Testing

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

Circuit/System Testing

1. Ignition Off and all vehicle systems Off.
2. It may take up to 2 min for all vehicle systems to power down before an accurate ground or low reference circuit continuity test can be performed.
3. Disconnect harness connector at the E11A Fuel Heater/Water in Fuel Sensor.
4. Test for less than 10 Ω between the low reference circuit terminal 1 and ground.
    - **If 10 Ω or greater**
    1. Ignition Off.
    2. Disconnect harness connector X2 at the K20 Engine Control Module.
    3. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 10 Ω**
5. Ignition On.
6. Verify the scan tool Fuel Temperature Sensor parameter is colder than -39Â°C (-38Â°F).
    - **If warmer than -39Â°C (-38Â°F)**
    1. Ignition Off.
    2. Disconnect harness connector X2 at the K20 Engine Control Module.
    3. Test for infinite resistance between the signal circuit terminal 2 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If colder than -39Â°C (-38Â°F)**
7. Install a 3 A fused jumper wire between the signal circuit terminal 2 and ground.
8. Verify that the scan tool Fuel Temperature Sensor parameter is warmer than 149Â°C (300Â°F).
    - **If colder than 149Â°C (300Â°F)**
    1. Ignition Off.
    2. Disconnect harness connector X2 at the K20 Engine Control Module.
    3. Ignition On.
    4. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    5. Ignition Off.
    6. Test for less than 2 Ω in the circuit end to end.

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

- **Go to next step: If warmer than 149Â°C (300Â°F)**

9. Replace the E11A Fuel Heater/Water in Fuel Sensor.

Repair Instructions

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

- For E11A Fuel Heater/Water in Fuel Sensor replacement refer to: **Fuel Filter Assembly Replacement (AWD)** **Fuel Filter Assembly Replacement (FWD)**
- For Control Module replacement, programming and setup refer to: **Control Module References**

DTC P018B, P018C, OR P018D: FUEL PRESSURE SENSOR PERFORMANCE/FUEL PRESSURE SENSOR CIRCUIT VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

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	P0097, P00F4, P018C, P0641, P0340, P0405, P0522, P0532, P2199, P227C, P2454	P018C	P018D, P0641, P0523, P0533, P227D, P2455	P018B
Signal	P018C	P018C, P2635	P018D*	P018B
Low Reference	-	P018B	*	P018B
* Internal control module or component damage may occur if the circuit shorts to B+.				

Typical Scan Tool Data

Fuel Pressure Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Running **Parameter Normal Range:** 0.2 to 4.8 V			
5 V Reference	0 V	0 V	5 V
Signal	0 V	0 V	5 V
Low Reference	-	5 V	-

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Circuit/System Description

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

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to ground.
Low Reference	Grounded through the control module.

Component	Description
B47 Fuel Pressure Sensor	The sensor measures the pressure in the component: Fuel Line The signal voltage increases when the pressure increases.
K111 Fuel Pump Driver Control Module	The control module K111 supplies the fuel pump with a 3-phase voltage in order to achieve the desired pump speed required for building fuel line pressure.

The control module uses the fuel pressure sensor to constantly adjust the fuel pump's feed rate so that the ideal pressure is permanently maintained in the low pressure section (between the fuel pump and the high pressure fuel pump) by means of a closed loop control.

Conditions for Running the DTC

P018B

- DTC P018C, P018D, P0641, P1029, P102A, P102B, P102C, P1255, P129F, P12A6, P165C = Not set
- Engine = Running - For greater than 5 s
- Fuel Pump Enable = On
- Fuel level = Greater than 10%

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

P018C, P018D

Engine = Running

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

Conditions for Setting the DTC

P018B

Fuel Pressure Sensor = Change is less than 30 kPa (4.4 PSI) - For greater than 5 s

P018C

Fuel Pressure Sensor = Less than 0.2 V - For greater than 5 s

P018D

Fuel Pressure Sensor = Greater than 4.8 V - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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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

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Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P0641, P165C is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Verify there are no DTCs set related to the following system/component:
   - K111 Fuel Pump Driver Control Module
   - 5V Reference
   - **If a related DTC is set**

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

   - **Go to next step: If a related DTC is not set**
4. Engine - Running
5. Verify the scan tool parameter: Fuel Pressure Sensor = 0.2 to 4.8 V
   - **If not between 0.2 and 4.8 V**

     Refer to: Circuit/System Testing

   - **Go to next step: If between 0.2 and 4.8 V**
6. Verify the scan tool parameter: Fuel Pressure Sensor = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: B47 Fuel Pressure Sensor
   - Wiggle the harness and connector: K111 Fuel Pump Driver Control Module
   - **If the value spikes or drops out**

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

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

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

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

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

8. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B47 Fuel Pressure Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 2 & Ground
   - **If 10 ohms or greater**
   1. Disconnect the electrical connector: K111 Fuel Pump Driver Control Module
   2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 2 @ Component harness & Terminal 27 @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K111 Fuel Pump Driver Control Module
   - **Go to next step: If less than 10 ohms**
4. Ignition - On/Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 1 & Low Reference circuit terminal 2
   - **If less than 4.8 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K111 Fuel Pump Driver Control Module
   3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 1 @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 ohms between the test points: 5 V Reference circuit terminal 1 @ Component harness & Terminal 12 @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K111 Fuel Pump Driver Control Module
   - **If greater than 5.2 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K111 Fuel Pump Driver Control Module
   3. Ignition - On/Vehicle - In Service Mode

      NOTE: **Internal control module or component damage may occur if the circuit shorts to B+.**

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4. Test for less than 1 V between the test points: 5 V Reference circuit terminal 1 @ Component harness & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - If less than 1 V - Replace the component: K111 Fuel Pump Driver Control Module
- **Go to next step: If between 4.8 and 5.2 V**

6. Verify the scan tool parameter: Fuel Pressure Sensor = Less than 0.2 V
    - **If 0.2 V or greater**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K111 Fuel Pump Driver Control Module
    3. Ignition - On/Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: Signal circuit terminal 3 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component: K111 Fuel Pump Driver Control Module
    - **Go to next step: If less than 0.2 V**
7. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 3 & 5 V Reference circuit terminal 1
8. Verify the scan tool parameter: Fuel Pressure Sensor = Greater than 4.8 V
    - **If 4.8 V or less**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the electrical connector: K111 Fuel Pump Driver Control Module
    3. Test for infinite resistance between the test points: Signal circuit terminal 3 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance
    4. Test for less than 2 ohms between the test points: Signal circuit terminal 3 @ Component harness & Terminal 26 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K111 Fuel Pump Driver Control Module
    - **Go to next step: If greater than 4.8 V**
9. Test or replace the component: B47 Fuel Pressure Sensor

Repair Instructions

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

- Refer to **Fuel Pressure Sensor Replacement - Fuel Feed Pipe (AWD)** **Fuel Pressure Sensor Replacement - Fuel Feed Pipe (FWD)** - B47 Fuel Pressure Sensor
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P0191, P0192, OR P0193: FUEL RAIL PRESSURE SENSOR PERFORMANCE/FUEL RAIL PRESSURE SENSOR CIRCUIT VOLTAGE

Diagnostic Instructions

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

DTC Descriptors

DTC P0191

Fuel Rail Pressure Sensor Performance

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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	P0193, P06A3, P127D	P0193, P127D	P0193, P06A3, P127D	-
Fuel Rail Pressure Sensor Signal 1	P0192	P0193	P0193	P0191
Fuel Rail Pressure Sensor Signal 2	P127C	P127D	P127D	P0191
Low Reference	-	P0193, P127D	P0193, P127D	P0191

Circuit/System Description

The fuel rail pressure sensor measures the fuel pressure within the fuel rail. The engine control module (ECM) monitors the voltage on the fuel rail pressure sensor circuits. The ECM supplies 5 V to the 5 V reference circuit and a ground to the low reference circuit. The fuel rail pressure sensor provides a signal voltage to the ECM, relative to the pressure changes within the fuel rail, on the fuel rail pressure sensor signal circuit.

Conditions for Running the DTC

P0191

- DTC P0116, P0117, P0118, P0119, P0128, P0192, P0193 or P111E is not set.
- Engine Coolant Temperature is warmer than -40Â°C (-40Â°F)
- Ignition voltage is greater than 6.0 V.
- The DTC runs continuously when the above conditions are met.

P0192 or P0193

- Ignition On or engine running.
- Ignition voltage is greater than 8.6 V
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0191

The fuel rail pressure sensor voltage is less than 0.3 V or greater than 0.7 V for 1 s, with the ignition On.

OR

The difference between fuel rail pressure sensor 1 and fuel rail pressure sensor 2 is greater than 21 MPa (3046 PSI) for more than 1 s.

P0192

The ECM detects that the fuel pressure sensor voltage is less than 0.2 V for 1 s.

P0193

The ECM detects that the fuel pressure sensor voltage is greater than 4.8 V for 1 s.

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Action Taken When the DTC Sets

DTCs P0191, P0192, and P0193 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0191, P0192, and P0193 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. With engine running, verify the scan tool Fuel Rail Pressure Sensor is between 0.4 - 4.5 V and changes with engine load conditions.
   - **If not between 0.4 - 4.5 V or does not change**

     Refer to Circuit/System Testing.

   - **Go to next step: If between 0.4 - 4.5 V and changes**
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 P0191, P0192, or P0193 is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If DTC P0191, P0192, or P0193 is not set**
4. All OK.

Circuit/System Testing

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1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B47B Fuel Rail Pressure Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 3 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 10 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module control module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If between 4.8 - 5.2 V**
5. Verify the scan tool Fuel Rail Pressure Sensor parameter is greater than 4.8 V.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 4 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If 5 V**
6. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and ground.
7. Verify the scan tool Fuel Rail Pressure Sensor parameter is less than 0.4 V.
    - **If parameter is greater than 0.4 V**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If the parameter is less than 0.4 V**
8. Replace the B47B Fuel Rail Pressure Sensor.

Repair Instructions

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

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

DTC P01CB, P01CC, P01CD, P01CE, P01CF, P01D0, P01D1, OR P01D2: CYLINDER 1-4 INJECTION TIMING RETARDED/ADVANCED

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 P01CB

Cylinder 1 Injection Timing Retarded

DTC P01CC

Cylinder 1 Injection Timing Advanced

DTC P01CD

Cylinder 2 Injection Timing Retarded

DTC P01CE

Cylinder 2 Injection Timing Advanced

DTC P01CF

Cylinder 3 Injection Timing Retarded

DTC P01D0

Cylinder 3 Injection Timing Advanced

DTC P01D1

Cylinder 4 Injection Timing Retarded

DTC P01D2

Cylinder 4 Injection Timing Advanced

Circuit/System Description

To minimize engine vibrations at idle the engine control module can detect even small variations in engine speed and compensates these variations by adjusting the amount of injected fuel for each cylinder individually. This smooth-running control works only inside calibrated limits. The engine control module calculates the injected fuel quantity in two different ways:

- Fuel quantity based on the time the injector was turned on.
- Fuel quantity based on the increase in crankshaft speed when a specific cylinder fires.

Values that differ too much indicate that the injector is not working properly or that something is mechanically wrong with the cylinder.

Conditions for Running the DTC

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- DTC Present = No
- Battery Voltage = Greater than 11 V
- Ambient Air Temperature = Warmer than -7Â°C (19Â°F)
- Fuel level = Greater than 10%
- BARO Sensor 2 = Greater than 72 kPa (10 PSI)
- Fuel Temperature = 0 to 70Â°C (32 to 158Â°F)
- Engine Coolant Temperature = 68 to 126Â°C (154 to 259Â°F)
- Transmission Gear = Gear 3, 4, 5, 6
- Diesel Particulate Filter Regeneration Active = No
- Deceleration Fuel Cut-Off = Active - Greater than 20 s
- Engine Speed = 1200 to 2100 RPM
- Accelerator Pedal Position = Less than 0.05%
- Vehicle Speed = Greater than 0 km/h (0 MPH)

DTC runs once per trip when the above conditions are met for greater than 1 s.

Conditions for Setting the DTC

DTC P01CB, P01CC

- Fuel Injection Quantity = Out Of Range - Cylinder 1
- Fuel Injection Timing = Out Of Range - Cylinder 1

DTC P01CD, P01CE

- Fuel Injection Quantity = Out Of Range - Cylinder 2
- Fuel Injection Timing = Out Of Range - Cylinder 2

DTC P01CF, P01D0

- Fuel Injection Quantity = Out Of Range - Cylinder 3
- Fuel Injection Timing = Out Of Range - Cylinder 3

DTC P01D1, P01D2

- Fuel Injection Quantity = Out Of Range - Cylinder 4
- Fuel Injection Timing = Out Of Range - Cylinder 4

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Verify DTC P0087, P00C7, P00E9, P00EA, P00EB, P00EC, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0181, P0182, P0183, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02E4, P02E5, P02EE, P02EF, P02F0, P02F1, P0335, P0336, P0403, P0405, P0406, P042E, P042F, P049D, P062B, P062D, P0806, P0807, P0808, P080A, P1089, P111E, P1248, P1249, P124A, P124B, P1402, P1407, P140F, P1424, P163A, P16F3, P2006, P2008, P2009, P200A, P2010, P2015, P2016, P2017, P20F8, P2147, P2148, P2150, P2151, P2227, P2228, P2229, P2230, P228A, P228B, P228C is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
2. Verify the condition does not exist:
   - Fuel Type Incorrect
   - Fuel Contaminated/Poor Quality
   - **If a condition exists**

     Refer to: **Fuel System Specifications** , **Contaminants-in-Fuel Diagnosis**

   - If no condition exists
3. Inspect for aftermarket devices which may affect the operation of the system.
   - If a condition exists - Repair or replace as necessary
   - If no condition exists
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to: Circuit/System Testing

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

Circuit/System Testing

1. Perform a conventional engine compression test. Refer to: **Engine Compression Test**
   - ***If one or more cylinders indicate low compression***

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Repair as necessary

- ***Go to next step: If all cylinders indicate normal compression***

2. Replace the component: Q17 Fuel Injector

Repair Instructions

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

- Refer to **Fuel Injector Replacement**
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P01F0: COOLANT TEMPERATURE DROPPED BELOW DIAGNOSTIC MONITORING TEMPERATURE

Diagnostic Instructions

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

DTC Descriptor

DTC P01F0

Coolant Temperature Dropped Below Diagnostic Monitoring Temperature

Diagnostic Fault Information

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

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** -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 thermostat diagnosis is responsible to detect a delay in warming up of the engine coolant temperature. A stuck open thermostat is detected by monitoring the coolant temperature for a decrease below the diagnostic monitoring threshold during driving after the temperature once increases above the same threshold.

The purpose of this rationality diagnostics is to use the ECT sensor to determine if the engine coolant will heat up at the correct rate, and also meet the calibrated target temperatures under various operating conditions.

Conditions for Running the DTC

- No active DTCs set.
- The Engine Speed is less than 5000 RPM.
- The Engine run time is greater than 30 s.

- The Ambient Air Temperature is greater than -7Â°C (19Â°F)
- The Engine Coolant Temperature is less than 70Â°C (158Â°F) during the current ignition cycle.
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM determines that the engine coolant temperature is less than 70Â°C (158Â°F) for more than 80 s.

Action Taken When the DTC Sets

DTC P01F0 is a Type B DTC.

Conditions for Clearing the DTC

DTC P01F0 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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, verify that DTC P0117, P0118, P0119, or P0128 is not set.
   - **If DTC P0117, P0118, P0119, or P0128 is set**

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

   - **Go to next step: If DTC P0117, P0118, P0119, or P0128 is not set**

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2. Verify the cooling system is filled to the correct coolant level. Refer to **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)** , and **Loss of Coolant** .
    - **If the coolant level is not correct**

      Repair as necessary

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

      Replace the Engine Coolant Thermostat.

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

      Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the 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 X2 at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 5 Ω**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -39Â°C (-38Â°F).
    - **If warmer than -39Â°C (-38Â°F)**
    1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If colder than -39Â°C (-38Â°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 150Â°C (302Â°F).
    - **If 150Â°C (302Â°F) or colder**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector X2 at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.

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4. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.
- **Go to next step: If warmer than 150Â°C (302Â°F)**

7. Test the B34 Engine Coolant Temperature Sensor.

   Refer to Component Testing.

Component Testing

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

      Replace the B34 Engine Coolant Temperature Sensor.

    - **Go to next step: If within the specified range**
3. Test for infinite resistance between each terminal and the sensor housing.
    - **If less than infinite resistance**

      Replace the B34 Engine Coolant Temperature Sensor.

    - **Go to next step: If infinite resistance**
4. Refer to **Thermostat Diagnosis** .

Repair Instructions

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

- Refer to **Engine Coolant Temperature Sensor Replacement (FWD)** **Engine Coolant Temperature Sensor Replacement (AWD)** .
- Refer to **Engine Coolant Thermostat Replacement (LH7)** Engine Coolant Thermostat Replacement.
- Refer to **Control Module References** for ECM replacement, setup, and programming.

DTC P0201, P0202, P0203, OR P0204: CYLINDER 1-4 INJECTOR CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P0201

Cylinder 1 Injector Control Circuit

DTC P0202

Cylinder 2 Injector Control Circuit

DTC P0203

Cylinder 3 Injector Control Circuit

DTC P0204

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Cylinder 4 Injector Control Circuit

Diagnostic Fault Information

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

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the injector positive voltage control circuits. The ECM energizes each fuel injector by grounding the control circuit of that fuel injector. The ECM monitors the status of the injector positive voltage control circuits and the fuel injector control circuits. The injectors are separated into the following two groups:

- Group 1 - Injectors 1 and 4
- Group 2 - Injectors 2 and 3

When a fuel injector circuit condition is detected by the ECM, the affected fuel injector will be disabled and may disable the affected group of fuel injectors.

Conditions for Running the DTC

- The engine is running.
- The ECM monitors for a condition once per camshaft revolution.

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 500 ms.

Action Taken When the DTC Sets

DTCs P0201, P0202, P0203 and P0204 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0201, P0202, P0203 and P0204 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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. Engine running.
2. Verify that DTCs P062D, P2147, P2148, P2150 or P2151 is not set.
   - **If DTCs P062D, P2147, P2148, P2150 or P2151 is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
   - **Go to next step: If DTCs P062D, P2147, P2148, P2150 or P2151 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 that DTCs P0201, P0202, P0203 and P0204 does not set.
   - **If DTC P0201, P0202, P0203, or P0204 is set**

     Refer to Circuit/System Testing
   - **Go to next step: If DTC P0201, P0202, P0203, or P0204 is not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems off.
2. It may take up to 2 min for all vehicle systems to power down.
3. Disconnect the harness connector at the appropriate Q17 Fuel Injector.
4. Ignition ON.
5. Test for 4.5 - 6.5 V between the high voltage supply circuit terminal 1 and ground.
   - **If less than 4.5 V**

   1. Ignition OFF.
   2. Disconnect the X2 harness connector at the K20 Engine Control Module.
   3. Test for infinite resistance between the supply circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 Ω in the supply circuit end to end.

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

- **If greater 6.5 V**

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

- **Go to next step: If between 4.5 - 6.5 V**

6. Test for 0.60 - 0.80 V between the high voltage control circuit terminal 2 and ground.
    - **If less than 0.60 V**

    1. Ignition OFF.
    2. Disconnect the harness connector X2 at the K20 Engine Control Module.
    3. 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
    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 greater than 0.80 V**

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

    - **Go to next step: If between 0.60 - 0.80 V**

7. Test or replace the appropriate Q17 Fuel Injector.

Component Testing

Static Test

1. Ignition OFF.
2. Disconnect the harness connector at the appropriate Q17 Fuel Injector.

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

3. Test for 0.2 - 1.5 Ω between the supply terminal 1 and the control terminal 2.
    - **If not between 0.2 - 1.5 Ω**

      Replace the appropriate Q17 Fuel Injector.

    - **Go to next step: If between 0.2 - 1.5 Ω**

4. Test for infinite resistance between each terminal and the injector housing/case.
    - **If less than infinite resistance**

      Replace the appropriate Q17 Fuel Injector.

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

5. All OK

Repair Instructions

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

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

DTC P020A, P020B, P020C, OR P020D: CYLINDER 1-4 INJECTION TIMING

Diagnostic Instructions

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

DTC Descriptors

DTC P020A

Cylinder 1 Injection Timing

DTC P020B

Cylinder 2 Injection Timing

DTC P020C

Cylinder 3 Injection Timing

DTC P020D

Cylinder 4 Injection Timing

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Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the injector positive voltage control circuits. The ECM energizes each fuel injector by grounding the control circuit of that fuel injector. The ECM monitors the status of the injector positive voltage control circuits and the fuel injector control circuits. The injectors are separated into the following two groups:

- Group 1 - Injectors 1 and 4
- Group 2 - Injectors 2 and 3

When a fuel injector circuit condition is detected by the ECM, the affected fuel injector will be disabled and may disable the affected group of fuel injectors.

Conditions for Running the DTC

- The engine is running.
- No other injector faults a present
- The ECM monitors for a condition once per camshaft revolution.

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 P020A, P020B, P020C and P020D are Type C DTCs.

Conditions for Clearing the DTC

DTCs P020A, P020B, P020C and P020D are Type C DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify that DTCs P062D, P2147, P2148, P2150 or P2151 is not set.
   - **If DTCs P062D, P2147, P2148, P2150 or P2151 is set**

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

   - **Go to next step: If DTCs P062D, P2147, P2148, P2150 or P2151 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 that DTCs P020A-P020D do not set.
   - **If DTC P020A-P020D is set**

     Refer to Circuit/System Testing

   - **Go to next step: If DTC P020A-P020D is not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems off.
2. It may take up to 2 min for all vehicle systems to power down.
3. Disconnect the harness connector at the appropriate Q17 Fuel Injector.
4. Ignition ON.
5. Test for 4.5 - 6.5 V between the high voltage supply circuit terminal 1 and ground.
   - **If less than 4.5 V**

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1. Ignition OFF.
2. Disconnect the X2 harness connector at the K20 Engine Control Module.
3. Test for infinite resistance between the supply circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
4. Test for less than 2 Ω in the supply circuit end to end.
    - 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 6.5 V**

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

- **Go to next step: If between 4.5 - 6.5 V**

6. Test for 0.60 - 0.80 V between the high voltage control circuit terminal 2 and ground.
    - **If less than 0.60 V**

    1. Ignition OFF.
    2. Disconnect the harness connector X2 at the K20 Engine Control Module.
    3. 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
    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 greater than 0.80 V**

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

    - **Go to next step: If between 0.60 - 0.80 V**

7. Test or replace the appropriate Q17 Fuel Injector.

Component Testing

Static Test

1. Ignition OFF.
2. Disconnect the harness connector at the appropriate Q17 Fuel Injector.

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

3. Test for 0.2 - 1.5 Ω between the supply terminal 1 and the control terminal 2.
    - **If not between 0.2 - 1.5 Ω**

      Replace the appropriate Q17 Fuel Injector.

    - **Go to next step: If between 0.2 - 1.5 Ω**

4. Test for infinite resistance between each terminal and the injector housing/case.
    - **If less than infinite resistance**

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Replace the appropriate Q17 Fuel Injector.

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

5. All OK

Repair Instructions

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

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

DTC P0216: INJECTOR TIMING CONTROL CIRCUITRY

Diagnostic Instructions

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

DTC Descriptors

DTC P0216

Injector Timing Control Circuitry

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the injector positive voltage control circuits. The ECM energizes each fuel injector by grounding the control circuit of that fuel injector. The ECM monitors the status of the injector positive voltage control circuits and the fuel injector control circuits.

Conditions for Running the DTC

- The engine is running.
- The ECM monitors for a Energizing time - Signal plausibility failure.

Conditions for Setting the DTC

The ECM detects that the energizing time exceeds limit of overrun monitoring for more than 140 events every 20 ms.

Action Taken When the DTC Sets

DTC P0216 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0216 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Fuel System Description

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify with scan tool that no other DTCs are set.
    - **If DTCs are set**

      Refer to Diagnostic Trouble Code (DTC) List - Vehicle

    - **Go to next step: If DTCs are not set**
3. Operate the vehicle within the Conditions for Running the DTC.
4. Verify that DTC P0216 does not set.
    - **If DTC P0216 is set**

      Replace the K20 Engine Control Module.

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

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Refer to Control Module References for ECM replacement, programming and setup.

DTC P0234, P0299, OR P2263: ENGINE OVERBOOST/ENGINE UNDERBOOST/TURBOCHARGER BOOST SYSTEM PERFORMANCE

Diagnostic Instructions

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

DTC Descriptors

DTC P0234

Engine Overboost

DTC P0299

Engine Underboost

DTC P2263

Turbocharger Boost System Performance

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Circuit/System Description

The Manifold Absolute Pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by turbocharger output, engine speed, accelerator pedal input, ambient air temperature, and Barometric Pressure (BARO). A diaphragm within the MAP pressure sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates these changes into electrical resistance. The Engine Control Module (ECM) supplies a regulated 5 volts on the 5 volt reference circuit and a ground on a low reference circuit. The MAP sensor provides a signal voltage to the ECM, relative to intake manifold pressures, on the MAP sensor signal circuit. The ECM converts the signal voltage input to a pressure value. Under normal operation, the lowest pressure that can exist in the intake manifold is equal to the BARO. This occurs when the throttle is not being used, and while the vehicle is operated at idle or when the ignition is On, and the engine is Off. The highest manifold pressures occur when the turbocharger output is high. Manifold pressure can range from 58 kPa (8 psi) when pressures are low to greater than 276 kPa (40 psi) when pressures are high, depending on the BARO. The MAP pressure sensor has a range of 0 - 365 kPa (0 - 46.8 psi). The ECM monitors boost deviation by comparing a calculated value at a predetermined engine load and speed, to the actual sensor input.

Conditions for Running the DTC

P0234

- The ignition voltage is greater than 11 V.
- The engine is operating in Closed Loop.
- The engine speed is between 1, 600 and 1, 700 RPM
- The barometric pressure is between 70 and 110 kPa (10 and 16 PSI)
- The ambient air temperature is between -7 and 55Â°C (19 and 131Â°F).
- The engine coolant temperature is between 70 and 130Â°C (158 and 266Â°F).
- Air flow/throttle valve position is at least 85% when active or at least 75% if not active.
- The ECM is commanding a steady desired boost pressure.
- The DTCs run continuously when the above conditions are met for at least 1 s.

P0299

- The ignition voltage is greater than 11 V.
- The engine is operating in Closed Loop.
- The engine speed is between 900 and 1, 600 RPM
- The barometric pressure is between 70 and 110 kPa (10 and 16 PSI)
- The ambient air temperature is between -7 and 55Â°C (19 and 131Â°F).
- The engine coolant temperature is between 70 and 130Â°C (158 and 266Â°F).
- Air flow/throttle valve position is at least 85% when active or at least 75% if not active.
- The ECM is commanding a steady desired boost pressure.
- The DTCs run continuously when the above conditions are met for at least 1 s.

P2263

- The ignition voltage is greater than 11 V.
- The engine is operating in Closed Loop.
- The engine speed is between 560 and 3, 100 RPM
- The barometric pressure is between 70 and 110 kPa (10 and 16 PSI)
- The ambient air temperature is between -7 and 55Â°C (19 and 131Â°F).
- The engine coolant temperature is between 70 and 130Â°C (158 and 266Â°F).
- Air flow/throttle valve position is at least 85% when active or at least 75% if not active.
- The desired boost pressure is between 70 and 320 kPa (10 and 46 PSI).
- The ECM is commanding a steady desired boost pressure.
- The DTCs run continuously when the above conditions are met for at least 1 s.

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Conditions for Setting the DTC

P0234

The actual turbocharger boost pressure is greater than the desired range for greater than 10 s.

P0299

The actual turbocharger boost pressure is less than the desired range for greater than 10 s.

P2263

The actual boost pressure is greater or less than expected, during steady state boost control, for a cumulative time of greater than 10 s.

Action Taken When the DTC Sets

- DTCs P0234 and P0299 are Type B DTCs.
- DTC P2263 is Type A DTC
- Engine power is reduced

Conditions for Clearing the DTC

- DTCs P0234 and P0299 are Type B DTCs.
- DTC P2263 is Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

EN-23738-A Mityvac

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

Circuit/System Verification

1. Ignition ON
2. Verify that DTC P003A, P0045, P0047, P0048, P00C7, P007B, P007C, P007D, P007E, P0106, P0107, P0108, P02E0, P02E2, P02E3, P02E4, P02E5, P026A, P0502, P0503, P0722, P0723,

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P0111, P0112, P0113, P0114, P0101, P0102, P0103, P010B, P010C, P010D, P0116, P0117, P0118, P0119, P0128, P111E, P02E8, P02E9, P122D, P16A0, P16A1, P16A2, P2227, P2228, P2229, or P2230 is not set.

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

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

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

3. Verify the scan tool MAP Sensor parameter is within the range listed in the following table: **Altitude Versus Barometric Pressure**
   - **If not within the specified range**

     Refer to **DTC P0107 or P0108** Circuit/System Testing.

   - **Go to next step: If within the specified range**
4. Engine running, increase the engine speed to 2, 000 RPM.
5. Verify the scan tool MAP Sensor pressure parameter increases and decreases with the engine speed.
   - **If the MAP Sensor parameter does not increase and decrease**

     Refer to Circuit/System Testing.

   - **Go to next step: If the MAP Sensor parameter does increase and decrease**
6. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

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Circuit/System Testing

1. Verify the conditions listed below do not exist:
   - Loose clamps, cracks or other damage in the air intake system.
   - Collapsed or restricted intake duct system.
   - Air flow restrictions, including the air filter.
   - Air leaks between the turbocharger and the intake air flow valve, including the charge air cooler assembly, refer to **Charge Air Cooler Diagnosis (Leak Test)** **Charge Air Cooler Diagnosis (Smoke Test)**
   - Leaks at the positive crankcase ventilation (PCV) heater to air cleaner outlet duct interface.
   - Missing, restricted or leaking exhaust components including the EGR valve, refer to **Symptoms - Engine Exhaust** .
   - Loose or incorrect installation of any components.
   - Aftermarket components.
   - Incorrect fuel content or contamination, refer to **Contaminants-in-Fuel Diagnosis** .
   - **If any condition is found**

     Repair the condition or replace the component as necessary.

   - **Go to next step: If no condition is found**
2. Verify the conditions listed below do not exist:
   - Damaged turbocharger.
   - Debris in the turbocharger.

- Sticking or obstructed turbocharger vanes.
- Damaged or restricted turbocharger vane control actuator.
- **If any condition is found**

  Repair the condition or replace the component as necessary.

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

3. Disconnect the vacuum source from the Q41 Turbocharger Vane Position Control Solenoid Valve.
4. Connect the **EN-23738-A** Mityvac to the Q41 Turbocharger Vane Position Control Solenoid Valve vacuum supply hose. Engine running, verify the vacuum is greater than -50 kPa (-7.25 PSI).
   - **If -50 kPa (-7.25 PSI) or less**

     Inspect the vacuum supply hose and filter for a leak or restriction. If the supply hose is normal, replace the vacuum pump.

   - **Go to next step: If greater than -50 kPa (-7.25 PSI)**
5. Connect the vacuum source to the Q41 Turbocharger Vane Position Control Solenoid Valve. Connect the **EN-23738-A** Mityvac to the Q41 Turbocharger Vane Position Control Solenoid Valve vacuum port on the Q41 Turbocharger Vane Position Control Solenoid Valve.
6. Engine running, command the Turbocharger Vane Position to 5% with a scan tool. Verify the vacuum is between 0 to -40 kPa (0 to - 5.8 PSI).
   - **If greater than -40 kPa (-5.8 PSI)**

     Replace the Q41 Turbocharger Vane Position Control Solenoid Valve.

   - **Go to next step: If between 0 to -40 kPa (-5.8 PSI)**
7. Command the Turbocharger Vane Position ON with a scan tool. Verify the vacuum is greater than -50 kPa (-7.25 PSI).
   - **If -50 kPa (-7.25 PSI) or less**

     Replace the Q41 Turbocharger Vane Position Control Solenoid Valve.

   - **Go to next step: If greater than -50 kPa (-7.25 PSI)**
8. Inspect the turbocharger oil supply lines for a restriction.
   - **If any restrictions are present**

     Repair or replace as necessary.

   - **Go to next step: If no restrictions are present**
9. Replace the turbocharger.

Repair Instructions

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

- Refer to **Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve Replacement** - Q41 Turbocharger Vane Position Control Solenoid Valve
- Refer to **Turbocharger Replacement**
- Refer to **Control Module References** for Engine Control Module replacement, programming and setup.

DTC P0261, P0262, P0264, P0265, P0267, P0268, P0270, OR P0271: CYLINDER 1-4 INJECTOR CONTROL CIRCUIT LOW/HIGH VOLTAGE

Diagnostic Instructions

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

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DTC Descriptors

DTC P0261

Cylinder 1 Injector Control Circuit Low Voltage

DTC P0262

Cylinder 1 Injector Control Circuit High Voltage

DTC P0264

Cylinder 2 Injector Control Circuit Low Voltage

DTC P0265

Cylinder 2 Injector Control Circuit High Voltage

DTC P0267

Cylinder 3 Injector Control Circuit Low Voltage

DTC P0268

Cylinder 3 Injector Control Circuit High Voltage

DTC P0270

Cylinder 4 Injector Control Circuit Low Voltage

DTC P0271

Cylinder 4 Injector Control Circuit High Voltage

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Diagnostic Fault Information

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

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the injector positive voltage control circuits. The ECM energizes each fuel injector by grounding the control circuit of that fuel injector. The ECM monitors the status of the injector positive voltage control circuits and the fuel injector control circuits. The injectors are separated into the following two groups:

- Group 1 - Injectors 1 and 4
- Group 2 - Injectors 2 and 3

When a fuel injector circuit condition is detected by the ECM, the affected fuel injectors will be disabled and may disable the affected group of fuel injectors.

Conditions for Running the DTC

- The engine is running.
- The ECM monitors for a condition once per camshaft revolution.

Conditions for Setting the DTC

DTC P0261

The ECM detects that the Injector 1 low control circuit has a short to ground for greater than 500 ms

DTC P0262

The ECM detects that the Injector 1 low control circuit has a short to voltage for greater than 500 ms

DTC P0264

The ECM detects that the Injector 2 low control circuit has a short to ground for greater than 500 ms

DTC P0265

The ECM detects that the Injector 2 low control circuit has a short to voltage for greater than 500 ms

DTC P0267

The ECM detects that the Injector 3 low control circuit has a short to ground for greater than 500 ms

DTC P0268

The ECM detects that the Injector 3 low control circuit has a short to voltage for greater than 500 ms

DTC P0270

The ECM detects that the Injector 4 low control circuit has a short to ground for greater than 500 ms

DTC P0271

The ECM detects that the Injector 4 low control circuit has a short to voltage for greater than 500 ms

Action Taken When the DTC Sets

DTCs P0261, P0262, P0264, P0265, P0267, P0268, P0270 and P0271 are Type C DTCs.

Conditions for Clearing the DTC

DTCs P0261, P0262, P0264, P0265, P0267, P0268, P0270 and P0271 are Type C DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Powertrain Component Views

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P2147, P2148, P2150, or P2151 is not set.
   - **If DTC P2147, P2148, P2150, or P2151 is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
   - **Go to next step: If DTC P2147, P2148, P2150, or P2151 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 P0261, P0262, P0264, P0265, P0267, P0268, P0270 or P0271 does not set.
   - **If DTC P0261, P0262, P0264, P0265, P0267, P0268, P0270 or P0271 is set**

     Refer to Circuit/System Testing
   - **Go to next step: If DTC P0261, P0262, P0264, P0265, P0267, P0268, P0270 or P0271 is not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems off.
2. It may take up to 2 min for all vehicle systems to power down.
3. Disconnect the harness connector at the appropriate Q17 Fuel Injector.
4. Ignition ON.
5. Test for 4.5 - 6.5 V between the high voltage supply circuit terminal 1 and ground.
   - **Go to next step: If less than 4.5 V**

   1. Ignition OFF.
   2. Disconnect the X2 harness connector at the K20 Engine Control Module.
   3. Test for infinite resistance between the supply circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 Ω in the supply circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.

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- **If greater 6.5 V**

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

- **Go to next step: If between 4.5 - 6.5 V**

6. Test for 0.60 - 0.80 V between the high voltage control circuit terminal 2 and ground.
    - **If less than 0.60 V**

    1. Ignition OFF.
    2. Disconnect the harness connector X2 at the K20 Engine Control Module.
    3. 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
    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 greater than 0.80 V**

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

    - **Go to next step: If between 0.60 - 0.80 V**

7. Test or replace the appropriate Q17 Fuel Injector.

Component Testing

Static Test

1. Ignition OFF.
2. Disconnect the harness connector at the appropriate Q17 Fuel Injector.

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

3. Test for 0.2 - 1.5 Ω between the supply terminal 1 and the control terminal 2.
    - **If not between 0.2 - 1.5 Ω**

      Replace the appropriate Q17 Fuel Injector.

    - **Go to next step: If between 0.2 - 1.5 Ω**

4. Test for infinite resistance between each terminal and the injector housing/case.
    - **If less than infinite resistance**

      Replace the appropriate Q17 Fuel Injector.

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

5. All OK

Repair Instructions

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

- Refer to **Fuel Injector Replacement**

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

DTC P0263, P0266, P0269, OR P0272: CYLINDER 1-4 BALANCE SYSTEM

Diagnostic Instructions

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

DTC Descriptors

DTC P0263

Cylinder 1 Balance System

DTC P0266

Cylinder 2 Balance System

DTC P0269

Cylinder 3 Balance System

DTC P0272

Cylinder 4 Balance System

Circuit/System Description

The control functions for the fuel injection system are integrated in the Engine Control Module (ECM). The ECM monitors changes in crankshaft speed using input from the crankshaft position sensor. The ECM adjusts the fuel delivery to each fuel injector in order to maintain correct fuel balance and minimize crankshaft speed changes.

Conditions for Running the DTC

- Engine running
- The ECM monitors for a condition once per camshaft revolution.

Conditions for Setting the DTC

DTC P0263

The ECM detects unstable crankshaft acceleration for cylinder 1.

DTC P0266

The ECM detects unstable crankshaft acceleration for cylinder 2.

DTC P0269

The ECM detects unstable crankshaft acceleration for cylinder 3.

DTC P0272

The ECM detects unstable crankshaft acceleration for cylinder 4.

Action Taken When the DTC Sets

DTCs P0263, P0266, P0269 and P0272 are Type B DTCs.

Conditions for Clearing the DTC

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DTCs P0263, P0266, P0269 and P0272 are Type B DTCs.

Diagnostic Aids

During cold ambient temperatures, condensation can occur causing water/ice to collect inside the charge air cooler tube resulting in poor combustion and possible engine stall. As a result of poor combustion, this DTC may set. Check CAC inlet tubes for water/ice blockage.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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. Verify that DTC P0263, P0266, P0269 or P0272 is not set.
   - **If DTC P0263, P0266, P0269, or P0272 is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If DTC P0263, P0266, P0269, or P0272 is not 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 DTC P0263, P0266, P0269, or P0272 is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If DTC P0263, P0266, P0269, or P0272 is not set**
3. All OK.

Circuit/System Testing

1. Perform a scan tool Compression Test. Refer to **Fuel Injector Balance Test with Scan Tool** .
   - **If cylinder compression is not within specification**

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Refer to the appropriate engine mechanical repair.

- **Go to next step: If cylinder compression is within specification**

2. Replace the appropriate Q17 Fuel Injector.

Repair Instructions

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

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

DTC P026A: CHARGE AIR COOLER (CAC) LOW EFFICIENCY

Diagnostic Instructions

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

DTC Descriptor

DTC P026A

Charge Air Cooler (CAC) Low Efficiency

Diagnostic Fault Information

CAC Inlet Temperature Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P007C	P007D	P007D*	P007B, P026A
Low Reference	-	P007D	P007D*	P007B, P026A
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

CAC Outlet Temperature Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P10D6	P10D7	P10D7*	P026A, P10D5
Low Reference	-	P10D7	P10D7*	P026A, P10D5
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Charge Air Cooler Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON or Engine Running **Parameter Normal Range:** -39 to +1988Â°C (-38 to +388Â°F)			
Signal	215Â°C (419Â°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+.			

Charge Air Cooler Outlet Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON or Engine Running **Parameter Normal Range:** -39 to +1988Â°C (-38 to +388Â°F)			
Signal	215Â°C (419Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

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Circuit/System Description

The engine control module (ECM) monitors the ambient air temperature, and the charge air temperature before and after the charge air cooler to calculate the efficiency of the charge air cooler (CAC). The charge air cooler systems' function is to reduce the temperature of the induction air charge that is heated by the turbocharger to improve the efficiency and performance of the engine.

The charge air cooler inlet temperature sensor, located at the outlet of the turbocharger, the charge air cooler outlet temperature sensor, located near the intake air flow valve are variable resistors. The ECM supplies 5 V to the signal circuit, and a ground for the sensors' low reference circuits.

Conditions for Running the DTC

- DTC P00C7, P0071, P0072, P0073, P0074, P007B, P007C, P007D, P007E, P0101, P0102, P0103, P00E9, P00EA, P00EB, P00EC, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P02E8, P02E9, P0502, P0503, P0722, P0723, P10D5, P10D6, P10D7, P10D8, P111E, P122D, P16A0, P16A1, P16A2, P2227, P2228, P2229, or P2230 is not set.
- Vehicle speed is greater than 64 kph (39 MPH).
- The intake airflow valve position is greater than 85%.
- The engine coolant temperature (ECT) is warmer than 70Â°C (+158Â°F).
- The mass air flow is between 20 and 50 gm/s.
- The absolute difference between the CAC inlet air temperature and the ambient air temperature is greater than 36Â°C (65Â°F).
- Ambient temperature is greater than -7Â°C (19Â°F).
- The barometric pressure is greater than 69.6 kPa (10.09 PSI).
- This DTC runs continuously when the above conditions exist for greater than 9 s.

Conditions for Setting the DTC

The CAC efficiency is computed as a ratio between CAC inlet temperature - CAC outlet temperature and CAC inlet temperature - ambient air temperature.

The ECM detects that the average temperature reduction ratio of the CAC is less than 25% for greater than 20 s.

Action Taken When the DTC Sets

DTC P026A is a Type B DTC.

Conditions for Clearing the DTC

DTC P026A is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

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 P00C7, P0071, P0072, P0073, P0074, P007B, P007C, P007D, P007E, P0101, P0102, P0103, P0106, P0107, P0108, P0119, P02E8, P02E9, P0502, P0503, P0722, P0723, P105D, P10D6, P10D7, P10D8, P122D, P16A0, P16A1, P16A2, P2227, P2228, P2229, or P2230 is not set.
   - **If any of the DTCs are set**

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

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

   NOTE:
   - **To minimize the effects of residual engine heat and sensor internal heating elements, perform Step 3 of this verification procedure only if the ignition has been OFF for 8 hours or more.**
   - **The vehicle sitting in direct sun light or having the block heater ON will skew the results.**

3. Verify the following scan tool parameters are within 10Â°C (18Â°F) of each other.
   - Charge Air Cooler Temperature
   - Charge Air Cooler Outlet Temperature
   - Ambient Air Temperature
   - **If not within 10Â°C (18Â°F)**

     Refer to DTC P007C-P007E; for further diagnosis of the Charge Air Cooler Inlet Temperature Sensor.

     Refer to DTC P10D6-P10D8 ; for further diagnosis of the Charge Air Cooler Outlet Temperature Sensor.

     Refer to DTC P0071-P0074 ; for further diagnosis of the Ambient Air Temperature Sensor.

   - **Go to next step: If within 10Â°C (18Â°F)**

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

4. Road test the vehicle under various operating conditions.
5. Verify the following scan tool parameters change temperature.
   - Charge Air Cooler Temperature
   - Charge Air Cooler Outlet Temperature
   - **If the temperature does not change**

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Refer to **DTC P007C-P007E**; for further diagnosis of the Charge Air Cooler Inlet Temperature Sensor.

Refer to **DTC P10D6-P10D8** ; for further diagnosis of the Charge Air Cooler Outlet Temperature Sensor.

- **Go to next step: If the temperature changes**

6. Operate the vehicle within the Conditions for Running the DTC.
7. Verify the scan tool parameter Charge Air Cooler Outlet Temperature is cooler than the scan tool parameter Charge Air Cooler Temperature.
   - **If not cooler**

     Refer to Circuit/System Testing.

   - **Go to next step: If cooler**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

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

1. Check the engine cooling system and front of the vehicle to verify that none of the conditions listed below exist:
   - Obstruction of the grille
   - Debris in the radiator, condenser, or CAC fins

     Refer to **Radiator Cleaning** .

   - Bent radiator, condenser, or CAC fins
   - Engine overheating

     Refer to **Engine Overheating** .

   - **If a condition exists**

     Repair or replace as appropriate.

   - **Go to next step: If no condition exists**
2. Replace the Charge Air Cooler.

Repair Instructions

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

- Refer to **Charge Air Cooler Replacement**
- Refer to **Control Module References** for engine control module replacement, programming, and setup

DTC P02CC, P02CD, P02CE, P02CF, P02D0, P02D1, P02D2, OR P02D3: CYLINDER 1-4 INJECTOR EXCEEDED MINIMUM/MAXIMUM LEARNING LIMIT

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Diagnostic Instructions

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

DTC Descriptors

DTC P02CC

Cylinder 1 Injector Exceeded Minimum Learning Limit

DTC P02CD

Cylinder 1 Injector Exceeded Maximum Learning Limit

DTC P02CE

Cylinder 2 Injector Exceeded Minimum Learning Limit

DTC P02CF

Cylinder 2 Injector Exceeded Maximum Learning Limit

DTC P02D0

Cylinder 3 Injector Exceeded Minimum Learning Limit

DTC P02D1

Cylinder 3 Injector Exceeded Maximum Learning Limit

DTC P02D2

Cylinder 4 Injector Exceeded Minimum Learning Limit

DTC P02D3

Cylinder 4 Injector Exceeded Maximum Learning Limit

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Circuit/System Description

The control functions for the fuel injection system are integrated in the ECM. The ECM during normal running conditions performs a check on the difference between injected quantities and expected quantities. This check is done on each injector. If the difference is too big a DTC set indicating the injector to be investigated.

Conditions for Running the DTC

- The engine is running.
- The ECM monitors for a condition once per camshaft revolution.

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

DTC P02CC, P02CD, P02CE, P02CF, P02D0, P02D1, P02D2 and P02D3 are Type B DTCs.

Conditions for Clearing the DTC

DTC P02CC, P02CD, P02CE, P02CF, P02D0, P02D1, P02D2 and P02D3 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

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Circuit/System Verification

1. Engine running, verify that DTC P2147, P2148, P2150, or P2151 is not set.
   - **If DTC P2147, P2148, P2150, or P2151 is set**

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

   - **Go to next step: If DTC P2147, P2148, P2150, or P2151 is 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 DTC P02CC, P02CD, P02CE, P02CF, P02D0, P02D1, P02D2, or P02D3 is set**

     Replace the appropriate Q17 Fuel Injector.

   - **Go to next step: If DTC P02CC, P02CD, P02CE, P02CF, P02D0, P02D1, P02D2, or P02D3 is not set**
3. All OK.

Repair Instructions

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

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

DTC P02E0, P02E2, P02E3, P02EB, P122B, P122C, OR P1425: INTAKE AIR FLOW VALVE CONTROL CIRCUIT/INTAKE AIR FLOW VALVE CONTROL MOTOR

Diagnostic Instructions

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

DTC Descriptor

DTC P02E0

Intake Air Flow Valve Control Circuit

DTC P02E2

Intake Air Flow Valve Control Circuit Low Voltage

DTC P02E3

Intake Air Flow Valve Control Circuit High Voltage

DTC P02EB

Intake Air Flow Valve Control Motor Current Performance

DTC P122B

Intake Air Flow Valve Control Supply Voltage Circuit

DTC P122C

Intake Air Flow Valve Control Circuit Shorted

DTC P1425

Intake Air Flow Valve Control Motor High Temperature

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Circuit/System Description

An intake airflow valve actuator is used to achieve high exhaust gas recirculation rates. It increases the pressure difference between exhaust and intake so that the appropriate exhaust quantity can be mixed with the intake air. The ECM transmits the desired angle as a PWM signal to the airflow valve actuator. The airflow valve actuator operates a DC motor to control the valve based on the PWM signal from the ECM. The airflow valve position is monitored by an internal position sensor.

In the event that the engine control module (ECM) detects the engine speed increases beyond desired control limits. Upon detection, the engine will be shutdown by closing the intake air flow valve and disabling the fuel injectors.

Conditions for Running the DTC

- Battery voltage is greater than 11 V.
- Engine is running.
- Intake air flow valve motor control circuit is active.
- The DTCs run continuously whenever the above conditions are met.

Conditions for Setting the DTC

P02E0

The ECM detects an open circuit condition of the intake air flow valve control circuit.

P02E2

The ECM detects that the intake air flow valve control circuit voltage is less than a calibrated threshold.

P02E3

The ECM detects that the intake air flow valve control circuit voltage is greater than a calibrated threshold.

P02EB

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match.

P122B

The ECM detects an open circuit on the intake air flow valve control circuit.

P122C

The ECM detects a short circuit on the intake air flow valve control circuit voltage for greater than 0.5 s.

P1425

The ECM detects that the intake air flow valve control circuit internal temperature is greater than a calibrated threshold.

Action Taken When the DTC Sets

- DTC P02E0, P02E2, P02E3, P02EB, P122B, P122C, and P1425 are Type A DTCs, with LH7
- DTC P02E0, P02E2, P02E3, P02EB, P122B, P122C, and P1425 are Type B DTCs, with NE4, NCP, or NCV

Conditions for Clearing the DTC

- DTC P02E0, P02E2, P02E3, P02EB, P122B, P122C, and P1425 are Type A DTCs, with LH7
- DTC P02E0, P02E2, P02E3, P02EB, P122B, P122C, and P1425 are Type B DTCs, with NE4, NCP, or NCV

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, verify the scan tool parameters listed below display OK or Not Run.
   - Intake Air Flow Valve Control Circuit Open Test Status
   - Intake Air Flow Valve Control Circuit Low Voltage Test Status

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- Intake Air Flow Valve Control Circuit High Voltage Test Status
- Intake Air Flow Valve Control Circuit Shorted Test Status
- **If Malfunction**

  Refer to Circuit/System Testing.

- **Go to next step: If OK or Not Run**

2. Clear the DTCs with a scan tool, ignition Off for 1 min.
3. Ignition On, verify DTC P02E0, P02E2, P02E3, P02EB, P122B, P122C, or P1425 is not set.
   - **If the DTC is set**

     Refer to Circuit/System Testing.

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

     Refer to Circuit/System Testing

   - **Go to next step: If none of the DTCs set**
6. 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.
2. Verify the conditions listed below do not exist:
   - Intake air flow valve blade that is not in the rest position.
   - Intake air flow valve blade that is binding open or closed.
   - Intake air flow valve blade that opens or closes without spring pressure.
   - Dirt, debris or coking in the intake air flow valve.
   - Damaged intake air flow valve blade or shaft.
   - **If a condition exists**

     Repair or replace the component as necessary.

   - **Go to next step: If none of the conditions exist**
3. Disconnect the harness connector at the Q20 Intake Air Flow Valve.
4. Ignition On, test for 1.5 - 2.5 V between the throttle control open circuit terminal 1 and ground.
   - **If less than 1.5 V**
   1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between control circuit terminal 1 and ground.
      - If less than infinite resistance, repair the short to ground in the circuit.
      - If infinite resistance.
   3. Test for infinite resistance between the motor control circuit terminals 1 and 2.
      - If less than infinite resistance, repair the short between the control circuits.
      - If infinite resistance.
   4. Test for less than 2 Ω in the control circuit terminal 1, end to end.
      - If 2 Ω or greater, repair open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 2.5 V**
   1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.

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2. Ignition On.
3. Test for less than 1 V between the control circuit terminal 1 and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
- **Go to next step: If 1.5 - 2.5 V**

5. Connect a test lamp between the control circuit terminal 2 and B+.
6. Ignition On, verify the test lamp does not illuminate.
    - **If the test lamp illuminates**
    1. Ignition Off, remove the test lamp.
    2. Disconnect the X2 harness connector at the K20 Engine Control Module.
    3. Test for infinite resistance between control circuit terminal 2 and ground.
        - If less than infinite resistance, repair the short to ground in the control circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp does not illuminate**
7. Connect a test lamp between the control circuit terminal 2 and ground.
8. Ignition On, verify the test lamp does not illuminate.
    - **If the test lamp illuminates**
    1. Ignition Off, remove the test lamp.
    2. Disconnect the X2 harness connector at the K20 Engine Control Module, ignition On.
    3. Test for less than 1 V between the control circuit terminal and ground.
        - If 1 V or greater, repair the short to voltage in the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp does not illuminate**
9. Remove the test lamp.
10. Test for 1.5 - 2.5 V between the control circuit terminal 1 and the control circuit terminal 2.
    - **If not within the specified range**
    1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the control circuit terminal 2, end to end.
        - If 2 Ω or greater, repair open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If within the specified range**
11. Test or replace the component: Q20 Intake Air Flow Valve

Repair Instructions

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

- Refer to **Throttle Body Assembly Replacement** - Q20 Intake Air Flow Valve
- Refer to **Control Module References** for ECM replacement, programming and setup.

DTC P02E1, P02E4, OR P02E5: INTAKE AIR FLOW VALVE CONTROL PERFORMANCE/INTAKE AIR FLOW VALVE STUCK

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 P02E1

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Intake Air Flow Valve Control Performance

DTC P02E4

Intake Air Flow Valve Stuck Open

DTC P02E5

Intake Air Flow Valve Stuck Closed

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - Terminal 1	P122C	P02E0	P122C, P122D	P1425
Control - Terminal 2	P122C	P02E0	P122C, P122D	P1425

Circuit/System Description

For an overview of the component/system, refer to: **Intake Airflow Valve System Description**

Circuit	Description
Control - Terminal 1	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.
Control - Terminal 2	The output circuit is switched from ground to 12 V to activate the component. The output is PWM controlled.

Component	Description
K20 Engine Control Module	The control module contains a microprocessor used to process input data to control outputs. The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
Q20 Intake Air Flow Valve	The intake air flow valve of diesel engines reduces the intake air flow rate in part load operation so that a higher exhaust gas recirculation rate can be achieved.

Conditions for Running the DTC

- DTC P02E8, P02E9, P0651, P16A0-P16A2 = Not set
- Ignition = On or Engine = Running
- Ignition Voltage = Greater than 5 V

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 2 s

Conditions for Setting the DTC

P02E1

Control Circuit = Commanded state does not match the actual state - For greater than 1 s

P02E4

Actual & Desired Intake Air Flow Valve Position Not within 16% of each other - Commanded duty cycle = Less than 34%

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P02E5

Actual & Desired Intake Air Flow Valve Position Not within 16% of each other - Commanded duty cycle = Greater than 34%

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- Reduced Engine Power = Active
- P16 Instrument Cluster = Reduced Engine Power
- Under certain conditions, the control module commands the engine Off.

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

- A high resistance condition on the component circuits may cause a DTC to set.
- A weak battery may cause this DTC to set.
- If the throttle blade becomes stuck, a DTC will set. Depending on the position of the throttle blade, the ECM may enter Engine Shutdown Mode. The ECM will disable fuel and de-energize the throttle actuator. If the condition remains present during the next ignition cycle, the ECM may disable engine cranking. Inspect the throttle body assembly for a stuck throttle blade if a throttle actuator DTC is current and the engine won't crank.
- Inspect for a condition in which the throttle blade may have been held open. For example, ice may have formed in the throttle bore causing the throttle blade not to close.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component Views

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P02E8, P02E9, P16A0-P16A2 is not set.

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

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

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

3. Engine at Idle Verify the scan tool parameter:
   - Intake Air Flow Valve Control Circuit Open Test Status = OK or Not Run
   - Intake Air Flow Valve Control Circuit Low Voltage Test Status = OK or Not Run
   - Intake Air Flow Valve Control Circuit High Voltage Test Status = OK or Not Run
   - Intake Air Flow Valve Control Circuit Shorted Test Status = OK or Not Run
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
4. Clear the DTCs.
5. Ignition Off - For greater than 1 min
6. Ignition - On/Vehicle - In Service Mode
7. Verify DTC P02E1, P02E4, P02E5 is not set.
   - **If the DTC sets**

     Refer to: Circuit/System Testing

   - **Go to next step: If the DTC does not 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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

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

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Verify the following conditions do not exist:

   WARNING: **Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.**

   - Intake air flow valve blade that opens or closes without spring pressure.
   - Intake air flow valve blade that is binding open or closed.
   - Dirt, debris, or coking in the intake air flow valve.
   - Damaged intake air flow valve blade or shaft.
   - **If a condition exists**

     Replace the component: Q20 Intake Air Flow Valve

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

NOTE: **Disconnecting the component electrical connector causes additional DTCs to set.**

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3. Disconnect the electrical connector: Q20 Intake Air Flow Valve
4. Ignition - On/Vehicle - In Service Mode
5. Test for 1.5 to 2.5 V between the test points: Control circuit terminal 1 & Ground
    - **If less than 1.5 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Test for infinite resistance between the test points: Control circuit terminal 1 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance
    4. Test for infinite resistance between the test points: Control circuit terminal 1 & Control circuit terminal 2
        - If less than infinite resistance - Repair the short between the circuits.
        - If infinite resistance
    5. Test for less than 2 ohms between the test points: Control circuit terminal 1 @ Component harness & The other end of the circuit @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K20 Engine Control Module
    - **If greater than 2.5 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Ignition - On/Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: Control circuit terminal 1 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component: K20 Engine Control Module
    - **Go to next step: If between 1.5 and 2.5 V**
6. Verify a test lamp does not turn On between the test points: Control circuit terminal 2 & B+
    - **If the test lamp turns On**
    1. Ignition/Vehicle - Off Remove - Test Lamp
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Test for infinite resistance between the test points: Control circuit terminal 2 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component: K20 Engine Control Module
    - **Go to next step: If the test lamp does not turn On**
7. Verify a test lamp does not turn On between the test points: Control circuit terminal 1 & Ground
    - **If the test lamp turns On**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Ignition - On/Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: Control circuit terminal 2 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component: K20 Engine Control Module
    - **Go to next step: If the test lamp does not turn On**
8. Test for 1.5 to 2.5 V between the test points: Control circuit terminal 1 & Control circuit terminal 2
    - **If not between 1.5 and 2.5 V**
    1. Ignition/Vehicle - Off

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2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
3. Test for less than 2 ohms between the test points: Control circuit terminal 2 @ Component harness & The other end of the circuit @ Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component: K20 Engine Control Module
- **Go to next step: If between 1.5 and 2.5 V**

9. Test or replace the component: Q20 Intake Air Flow Valve

Repair Instructions

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

- Refer to **Throttle Body Assembly Replacement** - Q20 Intake Air Flow Valve
- For the system learn/reset procedure refer to: **Control Module References**
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P0300: ENGINE MISFIRE DETECTED

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 P0300

Engine Misfire Detected

Circuit/System Description

For an overview of the component/system, refer to: **Fuel 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

- DTC P0016, P00C7, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0191, P0192, P0193, P0335, P0336, P0340, P0341, P0601, P0604, P0606, P0641, P0651, P0697, P06A3, P122B, P122C, P122D, P16A0, P16A1, P16A2, P16F3, P2122, P2123, P2127, P2128, P2138, P2227, P2228, P2229, P2230, P227B, P227C, P227D, P227E = Not set
- Crankshaft Position Sensor & Camshaft Position Sensor = Synchronized
- Engine Coolant Temperature = -7 to 125Â°C (19.4 to 257Â°F)
- Engine Speed = 1, 000 to 3, 200 RPM
- Rough Road Signal = Not Detected
- System Voltage = 9 to 32 V

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

Conditions for Setting the DTC

The control module K20 detects a crankshaft rotation speed variation indicating a single cylinder misfire rate sufficient to cause emissions levels to exceed mandated standards.

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Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Engine - Idling
2. Verify there is no abnormal noise from the component: Engine
    - **If an abnormal noise is present**

      Refer to: **Symptoms - Engine Mechanical**

    - **Go to next step: If no abnormal noise is present**
3. Perform the scan tool learn/reset function: **Crankshaft Position Variation Learn**
4. Verify there are no DTCs set related to the following system/component:
    - B23 Camshaft Position Sensor
    - B26 Crankshaft Position Sensor
    - Q17 Fuel Injector
    - Fuel System
    - Mechanical Condition
    - **If a related DTC is set**

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

    - **Go to next step: If a related DTC is not set**
5. Perform the scan tool control function: Cylinder Power Balance - Enable

   Verify the sound of the engine changes the same way when turning off each individual injector.

    - **If the engine sound does not change the same way for one or more cylinders**

      Refer to: Circuit/System Testing

    - **Go to next step: If the engine sound changes the same way for all cylinders**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

    - **If the DTC sets**

      Refer to: Circuit/System Testing

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

Circuit/System Testing

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1. Verify the following conditions do not exist:
    - Accessory drive bracket - Defective/Loose/Visible Damage
    - Belt Driven Device - Defective/Loose/Visible Damage
    - Brake Rotor - Excessive runout
    - Component Malfunction - Transmission
    - Drive Belt - Defective/Loose/Visible Damage
    - Drive Shaft - Excessive runout
    - During certain road conditions: Rough
    - Fuel - Contaminated/Dirty/Fill Level = Low - Refer to: **Contaminants-in-Fuel Diagnosis**
    - Fuel Pressure - Low - Refer to: **Fuel System Diagnosis**
    - High resistance in the circuits of the component may set DTC P0300 without setting the DTC for the component: Q17 Fuel Injector
    - If the condition is intermittent, wiggle the related wiring harnesses and connectors, with the ignition/vehicle on or engine running, while monitoring the scan tool circuit status parameters for the component. The parameters will display if there is a condition with the circuit or a connection.
    - Tire and wheel assemblies which exhibit excessive runout can produce vibrations even if the assemblies are balanced.
    - **If a condition exists**

      Repair or replace as necessary.

    - **Go to next step: If no conditions exist**
2. Perform the following procedure/test: Fuel Injector Balance - Refer to: **Fuel Injector Balance Test with Scan Tool**

   Verify the procedure/test passes.

    - **If the procedure/test does not pass**

      Replace the component that failed the test: Q17 Fuel Injector

    - **Go to next step: If the procedure/test passes**
3. Verify the condition does not exist: An engine mechanical condition. - Refer to: **Symptoms - Engine Mechanical**
    - **If a condition exists**

      Repair or replace as necessary.

    - **Go to next step: If no condition exists**
4. All OK.

Repair Instructions

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

Perform **Crankshaft Position Variation Learn**

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

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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 Reluctor Ring 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

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

Repair Instructions

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

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For control module replacement, programming, and setup refer to: **Control Module References**

DTC P0335 OR P0336: CRANKSHAFT POSITION SENSOR CIRCUIT/PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0335

Crankshaft Position Sensor Circuit

DTC P0336

Crankshaft Position Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0335, P0651	P0335	P0651	P0336
Signal	P0335, P0506	P0335	P0335	P0336
Low Reference	-	P0335	-	P0336

Circuit/System Description

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to 5 V.
Low Reference	Grounded through the control module.

Component	Description
B26 Crankshaft Position Sensor	The sensor contains a hall-effect sensor and additional electronics that processes the signal. It detects the change of strength of the magnetic field caused by the reluctor ring. When the strength changes, the sensor changes the amount of current it consumes. This results in a square wave signal of the current, while the voltage stays constant. The control module detects the frequency in which the current changes, which is proportional to the rotational speed.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
Reluctor Ring	There are 58 teeth or invisible magnetic segments on the edge of the crankshaft position reluctor ring mounted on the crankshaft. Each tooth or magnetic segment on the ring is spaced at a 60 segment spacing with 2 missing segments for a reference gap.

Conditions for Running the DTC

P0335 Condition 1

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- DTC P0016, P0102, P01CB, P01CC, P01CD, P01CE, P01CF, P01D0, P01D1, P01D2, P0315, P0506, P0507 = Not set
- Camshaft Position Sensor = Signal received
- MAF Sensor = Greater than 2 g/s
- Starter = Active

Condition 2

- Crankshaft and camshaft position sensors have been learned.
- Engine Speed = Greater than 550 RPM
- Starter = Inactive

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

P0336 Condition 1

- DTC P0016, P0102, P01CB, P01CC, P01CD, P01CE, P01CF, P01D0, P01D1, P01D2, P0315, P0506, P0507 = Not set
- Engine Speed = Greater than 450 RPM
- Crankshaft Position Sensor = Not Detected

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

Conditions for Setting the DTC

P0335

Crankshaft Position Sensor = No Signal - During 6 engine revolutions.

P0336

Crankshaft Position Sensor = Sync gap not detected. - Greater than 3 pulses

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- Camshaft Position Sensor = Used for engine position

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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**

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P0641, P0651 is not set.
   - **If the DTC is set**

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

   - **Go to next step: If the DTC is not set**
3. Engine - Running
4. Verify DTC P0336 is not set.
   - **If the DTC is set**

     Refer to: Circuit/System Testing

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

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

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

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B26 Crankshaft Position Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 2/B & Ground
   - **If 10 ohms or greater**
   1. Disconnect the electrical connector: K20 Engine Control Module
   2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 2/B @ Component harness & The other end of the circuit @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K20 Engine Control Module
   - **Go to next step: If less than 10 ohms**
4. Ignition - On/Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 1/A & Ground
   - **If less than 4.8 V**
   1. Ignition/Vehicle - Off

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2. Disconnect the electrical connector: K20 Engine Control Module
3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 1/A @ Component harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - If infinite resistance
4. Test for less than 2 ohms between the test points: 5 V Reference circuit terminal 1/A @ Component harness & The other end of the circuit @ Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component: K20 Engine Control Module

- **If greater than 5.2 V**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: K20 Engine Control Module
3. Ignition - On/Vehicle - In Service Mode
4. Test for less than 1 V between the test points: 5 V Reference circuit terminal 1/A @ Component harness & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - If less than 1 V - Replace the component: K20 Engine Control Module

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

6. Rapidly tap a 3 A fused jumper wire between the test points: Signal circuit terminal 3/C & Ground

    Verify the scan tool parameter: Crankshaft Position Active Counter = Increments

- **If the parameter value does not increment**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: K20 Engine Control Module
3. Ignition - On/Vehicle - In Service Mode
4. Test for less than 1 V between the test points: Signal circuit terminal 3/C @ Component harness & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - If less than 1 V

1. Ignition/Vehicle - Off
2. Test for infinite resistance between the test points: Signal circuit terminal 3/C @ Component harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 ohms between the test points: Signal circuit terminal 3/C @ Component harness & The other end of the circuit @ Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component: K20 Engine Control Module

- **Go to next step: If the parameter value increments**

7. Verify DTC P0336 is not set.
    - **If the DTC is set**

      Verify the following conditions do not exist:

    - B26 Crankshaft Position Sensor & Reluctor Ring - Excessive play/Foreign material passing between the components/Incorrect air gap/Incorrect installation/Loose/Visible Damage
    - Camshaft Sprocket - Visible Damage/Worn
    - Crankshaft Sprocket - Visible Damage/Worn
    - Engine Oil - Contaminated/Dirty
    - Timing Chain or Timing Belt - Visible Damage/Worn
    - Timing Chain Tensioner or Timing Belt Tensioner - Visible Damage/Worn

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- If a condition exists - Repair or replace as necessary
- If no condition exists - Test or replace the component: B26 Crankshaft Position Sensor

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

8. Test or replace the component: B26 Crankshaft Position Sensor

Repair Instructions

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

- Refer to **Crankshaft Position Sensor Replacement**
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P0340 OR P0341: CAMSHAFT POSITION SENSOR CIRCUIT/PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P0340

Camshaft Position Sensor Circuit

DTC P0341

Camshaft Position Sensor Performance

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0651*	P0340	P0651*	-
Signal	P0340	P0340	P0340	P0341
Low Reference	-	P0340	P0340	-
* Additional DTCs may set.				

Circuit/System Description

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to 5 V.
Low Reference	Grounded through the control module.

Component	Description
B23 Camshaft Position Sensor	The sensor contains a hall-effect sensor and additional electronics that processes the signal. It detects the change of strength of the magnetic field caused by the reluctor ring. When the strength changes, the sensor changes the amount of current it consumes. This results in a square wave signal of the current, while the voltage stays constant. The control module detects the frequency in which the current changes, which is proportional to the rotational speed.

Component	Description
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
Reluctor Ring	There are 4 equally spaced teeth on the edge of the camshaft position reluctor ring mounted on the camshaft.

Conditions for Running the DTC

- DTC P0016, P0315 = Not set
- Camshaft Position Sensor = Signal received
- Crankshaft and camshaft position sensors have been learned.
- Crankshaft Position Sensor = Signal received
- Engine Speed = Greater than 600 RPM

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

Conditions for Setting the DTC

P0340

Camshaft Position Sensor = No Signal - During 3 engine revolutions.

P0341

Camshaft Position Sensor = Sync gap not detected. - Greater than 6 pulses

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Control module command = Reduced Engine Power

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

The cranking period may take longer.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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**

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P0641, P0651 is not set.
   - **If the DTC is set**

     Refer to: **DTC P0641, P0651, P0697, or P06A3**

   - **Go to next step: If the DTC is not set**
3. Engine - Running
4. Verify DTC P0341 is not set.
   - **If the DTC is set**

     Refer to: Circuit/System Testing

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

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

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

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B23 Camshaft Position Sensor
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 2/B & Ground
   - **If 10 ohms or greater**
   1. Disconnect the electrical connector: K20 Engine Control Module
   2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 2/B @ Component harness & The other end of the circuit @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K20 Engine Control Module
   - **Go to next step: If less than 10 ohms**
4. Ignition - On/Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 1/A & Ground
   - **If less than 4.8 V**
   1. Ignition/Vehicle - Off

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2. Disconnect the electrical connector: K20 Engine Control Module
3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 1/A @ Component harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - If infinite resistance
4. Test for less than 2 ohms between the test points: 5 V Reference circuit terminal 1/A @ Component harness & The other end of the circuit @ Control module harness
    - If 2 ohms or greater - Repair the open/high resistance in the circuit.
    - If less than 2 ohms - Replace the component: K20 Engine Control Module

- **If greater than 5.2 V**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: K20 Engine Control Module
3. Ignition - On/Vehicle - In Service Mode
4. Test for less than 1 V between the test points: 5 V Reference circuit terminal 1/A @ Component harness & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - If less than 1 V - Replace the component: K20 Engine Control Module

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

6. Test for 4.8 and 5.2 V between the test points: Signal circuit terminal 3/C & Ground
    - **If less than 4.8 V**

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

    - **If greater than 5.2 V**

    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Ignition - On/Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: Signal circuit terminal 3/C @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component: K20 Engine Control Module

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

7. Verify DTC P0341 is not set.
    - **If the DTC is set**

      Verify the following conditions do not exist:

      - B23 Camshaft Position Sensor & Reluctor Ring - Excessive play/Foreign material passing between the components/Incorrect air gap/Incorrect installation/Loose/Visible Damage
      - Engine Oil - Contaminated/Dirty
      - Timing Chain or Timing Belt - Visible Damage/Worn
      - Timing Chain Tensioner or Timing Belt Tensioner - Visible Damage/Worn
          - If a condition exists - Repair or replace as necessary
          - If no condition exists - Test or replace the component: B23 Camshaft Position Sensor

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

8. Test or replace the component: B23 Camshaft Position Sensor

Repair Instructions

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

- Refer to **Camshaft Position Sensor Replacement**
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P034A OR P034B: CRANKSHAFT POSITION SENSOR - ENGINE START POSITION INCORRECT/CRANKSHAFT DIRECTION INCORRECT

Diagnostic Instructions

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

DTC Descriptor

DTC P034A

Crankshaft Position Sensor - Engine Start Position Incorrect

DTC P034B

Crankshaft Position Sensor - Crankshaft Direction Incorrect

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Circuit/System Description

The engine control module monitors the speed and the direction of rotation of the crankshaft during an autostop event and memorizes the crankshaft angle at which the engine stopped to be able to start the engine quicker.

Conditions for Running the DTC

P034A

- DTC P0335, P0336, P0651 = Not set
- Engine = Running - After an autostop event.
- Crankshaft position is being verified.

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

P034B

- DTC P0335, P0336, P0651 = Not set
- Engine Speed = 400 to 2, 000 RPM
- MAF Sensor = Greater than 2 g/s
- Crankshaft Position Sensor = Signal received

Frequency the DTC runs = Continuously - After the running conditions are met - For greater than 4 s

Conditions for Setting the DTC

P034A Condition 1

The difference between the memorized and actual crankshaft position was greater than 1 reluctor ring teeth during 3 autostart events in one ignition cycle.

Condition 2

The difference between the memorized and actual crankshaft position was greater than 1 reluctor ring teeth during 5 autostart events in one ignition cycle.

P034B

The direction of rotation of the crankshaft has changed more than 3 times within 10 s.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

A DTC may set depending on certain driving conditions and would not require a component replacement. The Circuit/System Verification must be performed.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P0335, P0336, P0651 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Test or replace the component: B26 Crankshaft Position Sensor

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

Repair Instructions

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

Refer to **Crankshaft Position Sensor Replacement**

DTC P037A, P037B, OR P0381: WAIT TO START INDICATOR CONTROL CIRCUIT

Diagnostic Instructions

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

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DTC Descriptor

DTC P037A

Wait to Start Indicator Control Circuit Low Voltage

DTC P037B

Wait to Start Indicator Control Circuit High Voltage

DTC P0381

Wait to Start Indicator Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Wait To Start Indicator Control	P037A	P0381	P037B	-

Typical Scan Tool Data

Wait To Start Indicator Control Circuit Low Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON **Parameter Normal Range:** OK/Not Run			
Wait To Start Indicator Control	Malfunction	OK/Not Run	OK/Not Run

Wait To Start Indicator Control Circuit Open Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON **Parameter Normal Range:** OK/Not Run			
Wait To Start Indicator Control	OK/Not Run	Malfunction	OK/Not Run

Wait To Start Indicator Control Circuit High Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON **Parameter Normal Range:** OK/Not Run			
Wait To Start Indicator Control	OK/Not Run	OK/Not Run	Malfunction

Circuit/System Description

The engine control module (ECM) provides a ground to the Wait To Start Indicator Control circuit when conditions require the Wait To Start Indicator to be turned on. The ECM monitors the Wait To Start Indicator Control circuit for proper operation.

Conditions for Running the DTC

P037A

- Wait to Start Indicator is illuminated.
- Battery voltage is greater than 11 V.
- Engine Speed is greater than 650 RPM.
- DTC P037A runs continuously when the above conditions are met.

P037B

- Wait to Start Indicator is not illuminated
- Battery voltage is greater than 11 V.
- Engine Speed is greater than 650 RPM.

- DTC P037B runs continuously when the above conditions are met.

P0381

- Battery voltage is greater than 11 V.
- Engine Speed is greater than 650 RPM.
- DTC P0381 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P037A

- The ECM detects a short to ground on the Wait To Start Indicator Control circuit for greater than 3 s.

P037B

- The ECM detects a short to voltage on the Wait To Start Indicator Control circuit for greater than 1 s.

P0381

- The ECM detects an open circuit on the Wait To Start Indicator Control circuit for greater than 0.2 s.

Action Taken When the DTC Sets

DTCs P037A, P037B and P0381 are Type B DTC.

Conditions for Clearing the DTC

DTCs P037A, P037B and P0381 are Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

- **Glow Plug System Description**
- **Fuel System Description**

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Command the Wait to Start Indicator ON and OFF with a scan tool. Verify that the Wait to Start Indicator turns ON and OFF with each command.
   - **If Wait to Start Indicator does not turn on and off**

     Refer to Circuit/System Testing.

   - **Go to next step: If Wait to Start Indicator turns on and off**
3. Command the Wait to Start Indicator ON and OFF with a scan tool while observing the following control circuit status parameters:
   - Wait To Start Indicator Control Circuit Low Voltage Test Status
   - Wait To Start Indicator Control Circuit Open Test Status
   - Wait To Start Indicator Control Circuit High Voltage Test Status

     Each parameter should display OK or Not Run.

   - **If parameter displays Malfunction**

     Refer to Circuit/System Testing.

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

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition ON.
2. Verify that the (IPC) Instrument Panel Cluster warning indicators are illuminated.
   - **If IPC warning indicators do not illuminate**
   1. Test the IPC Cluster fuse for an open.
      - If the fuse is open, repair the short to ground or high resistance in the circuit.
      - If the fuse is not open
   2. Test for battery voltage between the IPC Cluster fuse and ground.
      - If battery voltage is not present, repair the open in the circuit.
      - If battery voltage is present, replace the P16 Instrument Cluster.
   - **Go to next step: If IPC warning indicators illuminate**
3. Ignition OFF.
4. Disconnect the harness connector X1 at the K20 Engine Control Module
5. Ignition ON.
6. Verify that the Wait to Start indicator does not illuminate.
   - **If Wait to Start indicator illuminates**
   1. Test for infinite resistance between the wait to start indicator lamp control circuit ECM connector X1 terminal 19 and ground.
      - If less than infinite resistance, repair the short to ground in the circuit.
      - If infinite resistance, replace the P16 Instrument Cluster.

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- **Go to next step: If Wait to Start indicator does not illuminate**

7. Test for less than 1 V between the wait to start indicator lamp control circuit ECM connector X1 terminal 19 and ground.
   - **If greater than 1 V**

     Repair the short to voltage in the circuit.

   - **If less than 1 V**
8. Connect a 3A fused jumper wire between the Wait To Start Indicator Control circuit ECM connector X1 terminal 19 and ground. The Wait to Start indicator should illuminate.
   - **If Wait to Start indicator does not illuminate**
   1. Test for an open or high resistance in the wait to start indicator lamp control circuit.
      - If an open or high resistance is found, repair the open or high resistance in the circuit.
      - If an open or high resistance is not found, replace the P16 Instrument Cluster.
   - **Go to next step: If Wait to Start indicator illuminates**
9. Replace the K20 Engine Control Module.

Repair Instructions

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

- Refer to **Instrument Cluster Replacement (Equinox)** **Instrument Cluster Replacement (Terrain)**
- Refer to **Control Module References** for ECM replacement, setup, and programming

DTC P037E OR P037F: GLOW PLUG FEEDBACK CIRCUIT LOW/HIGH VOLTAGE

Diagnostic Instructions

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

DTC Descriptors

DTC P037E

Glow Plug Feedback Circuit Low Voltage

DTC P037F

Glow Plug Feedback Circuit High Voltage

Circuit/System Description

The glow plug control module is integrated in the engine control module (ECM) and is a solid state device which operates the glow plugs. The temperature and the power consumption is controlled within a wide range to suit the engine pre-heating requirements. The glow plug initial ON time will vary based on the system voltage and temperature. Lower temperatures cause longer ON times.

Conditions for Running the DTC

- The ignition is ON.
- The ignition voltage is between 9 - 16 V.
- Engine running (cranking excluded).
- No fault on supply system.
- Glow plug system ON.
- No electrical fault on glow plugs.

Conditions for Setting the DTC

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The ECM detects an internal fault in the integrated glow plug module.

Action Taken When the DTC Sets

DTC P037E and P037F are Type C DTCs.

Conditions for Clearing the DTC

DTC P037E and P037F are Type C DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 with a scan tool that no other DTCs are set.
   - **If DTCs are set**

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

   - **Go to next step: If DTCs are not set**
3. Clear all DTCs with a scan tool
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**

     Replace the K20 Engine Control Module

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

Repair Instructions

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

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

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DTC P0401 OR P0402: EXHAUST GAS RECIRCULATION (EGR) FLOW INSUFFICIENT/EXCESSIVE

Diagnostic Instructions

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

DTC Descriptors

DTC P0401

Exhaust Gas Recirculation (EGR) Flow Insufficient

DTC P0402

Exhaust Gas Recirculation (EGR) Flow Excessive

Circuit/System Description

The Exhaust Gas Recirculation (EGR) valve is controlled by the Engine Control Module (ECM). The ECM controls the EGR valve by supplying a 12-volt pulse width modulated signal to the EGR Valve low control circuit and 12 volts to the high control circuit. The ECM monitors the EGR flow performance when the EGR is active by comparing the desired Mass Air Flow (MAF) to the actual MAF. If the actual MAF is less than or greater than a calibrated threshold level the amount of detected EGR flow is out of range.

Conditions for Running the DTC

P0401

- DTC P0071, P0072, P0073, P0074, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0502, P0503, P0722, P0723, P111E, or P262B is not active.
- Engine speed is between 750-2, 000 RPM.
- Calculated fuel rate is between 5-60 mm^3
- Ambient air temperature is warmer than -7Â°C (19.4Â°F).
- Engine coolant temperature is warmer than 70Â°C (158Â°F).
- Barometric Pressure is greater than 69.6 kPa (10.9 psi).
- Ignition voltage is greater than 11 V.
- EGR valve position is greater than 0%.

The DTC runs continuously when the above conditions are met for greater than 1 s.

P0402

- DTC P0071, P0072, P0073, P0074, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0502, P0503, P0722, P0723, P111E, or P262B is not active.
- Engine speed is between 1, 250-1, 900 RPM.
- Calculated fuel rate is between 21-36 mm^3
- Ambient air temperature is warmer than -7Â°C (19.4Â°F).
- Engine coolant temperature is warmer than 70Â°C (158Â°F).
- Barometric Pressure is greater than 69.6 kPa (10.9 psi).
- Ignition voltage is greater than 11 V.
- EGR valve position is greater than 0%.

The DTC runs continuously when the above conditions are met for greater than 1 s.

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Conditions for Setting the DTC

P0401

The ECM detects that the difference between the actual mass air flow and the desired mass air flow is less than a calibrated value for greater than 10 s.

P0402

The ECM detects that the difference between the actual mass air flow and the desired mass air flow is greater than a calibrated value for greater than 10 s.

Action Taken When the DTC Sets

DTC P0401 and P0402 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0401 and P0402 are Type B DTCs.

Diagnostic Aids

Inspect for the following conditions that may cause this DTC to set:

- Contamination on the MAF sensor element
- Restriction before or after the MAF sensor
- Skewed MAF sensor
- Aftermarket air filter

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 P0403, P0405, P0406, P0489, P0490, P1407, P140D, P140E, or P140F is not set.
   - **If any of the DTCs are set**

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

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

NOTE: **When using scan tool functions, Engine Reduced Power and Clean Exhaust Filter messages may occur after a short delay when commanding large EGR positions. The messages are a result of ECM protecting hardware during device control mode. No DTCs will be stored and the Diesel Particulate Filter does not need to be service cleaned. Exiting device control will restore normal function.**

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3. Verify the scan tool Desired EGR Position and the EGR Position Sensor parameters remain within 3% when commanding the EGR Valve between 0 - 60% with a scan tool.
    - **If not within 3%**

      Refer to Circuit/System Testing.

    - **Go to next step: If within 3%**
4. Engine running.

NOTE: **The MAF parameter is not valid if the Reduced Engine Power message is active.**

5. Command the EGR Valve to 0% with a scan tool and record the MAF Sensor g/s parameter.
6. Command the EGR Valve to 60% with a scan tool and record the MAF Sensor g/s parameter.
7. Verify the MAF Sensor parameter is between 2 - 12 g/s and changes when the commanding the EGR Valve 60% with the scan tool.
    - **If not between 2 - 12 g/s or does not change**

      Refer to Circuit/System Testing.

    - **Go to next step: If between 2 - 12 g/s and changes**
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 a DTC sets**

      Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE: **Perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Verify the conditions listed below do not exist:
    - Restrictions in the EGR cooler, EGR cooler bypass valve and passages.
    - Wet or restricted air filter.
    - Loose or improperly connected hoses.
    - Damaged or missing components.
    - Induction/charge air cooler system restrictions.
    - Exhaust system restrictions.
    - Binding, damaged or restricted intake air flow valve.
    - Binding, damaged or restricted EGR valve.
    - Induction/charge air cooler system leaks. Refer to **Charge Air Cooler Diagnosis (Leak Test)** **Charge Air Cooler Diagnosis (Smoke Test)** - Induction System Smoke Test and Full System Air Leak Test.
    - Exhaust system/turbo charger leaks.
    - Restrictions or damage to the turbocharger.
    - **If a condition exists**

      Repair or replace the component as necessary.

    - **Go to next step: If none of the conditions exist**
2. Test or replace the Q14 Exhaust Gas Recirculation Valve.

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Component Testing

NOTE: **Perform the Circuit/System Testing before proceeding with the Component Testing.**

1. Ignition Off.
2. Remove the Q14 Exhaust Gas Recirculation Valve. Refer to **Exhaust Gas Recirculation Valve Replacement** .
3. Verify the conditions listed below do not exist:
   - Sticking, binding, or frozen EGR valve
   - Leaks or restrictions in the EGR valve body and EGR ports and passages
   - Coking, soot build up, debris or damage that can cause the EGR valve to stick partially open or closed
   - **If a condition is found**

     Repair or replace the component as necessary.

   - **Go to next step: If none of the conditions exist**
4. All OK.

Repair Instructions

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

Refer to **Exhaust Gas Recirculation Valve Replacement**

DTC P0403, P0490, P1402, P1407, OR P140F: EXHAUST GAS RECIRCULATION (EGR) CIRCUITS/EXHAUST GAS RECIRCULATION (EGR) CURRENT PERFORMANCE

Diagnostic Instructions

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

DTC Descriptors

DTC P0403

Exhaust Gas Recirculation (EGR) Control Circuit

DTC P0490

Exhaust Gas Recirculation (EGR) Motor Control Circuit - High Voltage

DTC P1402

Exhaust Gas Recirculation (EGR) Supply Circuit

DTC P1407

Exhaust Gas Recirculation (EGR) Control Circuit Shorted

DTC P140F

Exhaust Gas Recirculation (EGR) Current Performance

Circuit/System Description

The engine control module (ECM) supplies the Exhaust Gas Recirculation (EGR) valve with a 5 V reference circuit, a low reference circuit, an H-bridge motor directional control circuit, and a signal circuit. The EGR position sensor provides a signal voltage that changes relative to EGR position. The

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EGR position sensor information is transmitted between the EGR valve and the ECM on the signal circuit. The Mass Air Flow (MAF) sensor signal is used by the ECM to detect the proper amount of EGR flow. The ECM will close the EGR valve, then open the EGR valve to 100%. The ECM will then calculate the MAF difference and determine if the proper EGR flow has been detected.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is greater than 11 V.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0403

The ECM detects an open on the control circuit for greater than 2.5 s.

P0490

The ECM detects a short to voltage on the control circuit for greater than 2.5 s.

P1402

The ECM detects a low voltage on the EGR motor supply for greater than 2.5 s.

P1407

The ECM detects a short circuit between the open and close terminals of the EGR motor for greater than 2.5 s.

P140F

The ECM detects excessive current flow to the EGR motor for greater than 2.5 s.

Action Taken When the DTC Sets

DTCs P0403, P0490, P1402, P1407 and P140F are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0403, P0490, P1402, P1407 and P140F are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON

NOTE: **When using an Scan tool Control Functions, Engine Reduced Power and Clean Exhaust Filter messages may occur after a short delay when commanding large EGR positions. The messages are a result of ECM protecting hardware during device control mode. No DTCs will be stored and the Diesel Particulate Filter does not need to be service cleaned. Exiting device control will restore normal function.**

2. Verify the EGR Position Sensor percentage parameter remains within 5% of the EGR Valve Commanded State when commanding the EGR valve between 0 - 100% with a scan tool.
   - **If not within 5%**

     Refer to Circuit/System Testing.

   - **Go to next step: If within 5%**
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 a DTC does not set.
   - **If a DTC sets**

     Refer to Circuit/System Testing

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

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the Q14 Exhaust Gas Recirculation Valve, ignition On.
2. Test for 0.1 - 0.5 V between the EGR motor control circuit terminal 2 and ground.
   - **If greater than 0.5 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 control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If less than 0.1 V**
   1. Ignition Off, disconnect the X2 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
   3. 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 between 0.1 - 0.5 V**
3. Test for 1 - 3 V between the EGR motor control circuit terminal 6 and ground.
   - **If greater than 3 V**
   1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module, ignition On.

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

1. Ignition Off, disconnect the X2 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
3. 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 between 1 - 3 V**

4. Replace the Q14 Exhaust Gas Recirculation Valve.

Repair Instructions

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

- Refer to **Exhaust Gas Recirculation Valve Replacement**
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P0404, P0405, OR P0406: EXHAUST GAS RECIRCULATION (EGR) OPEN POSITION PERFORMANCE/EXHAUST GAS RECIRCULATION (EGR) POSITION SENSOR CIRCUIT VOLTAGE

Diagnostic Instructions

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

DTC Descriptors

DTC P0404

Exhaust Gas Recirculation (EGR) Open Position Performance

DTC P0405

Exhaust Gas Recirculation (EGR) Position Sensor Circuit Low Voltage

DTC P0406

Exhaust Gas Recirculation (EGR) Position Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
5 V Reference	P0097, P00F4, P018C, P0340, P0405, P0522, P0532, P0641, P2199, P227C, P2454, P2495	P0405	P018D, P0406, P0523, P0533, P0641, P227D, P2455, P2495

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
EGR Valve Position Sensor Signal	P0405	P018D, P0406, P0523, P0533, P0641, P227D, P2455	P0406
Low Reference	-	P0406	-

Typical Scan Tool Data

EGR Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** 0.25 - 4.8 V			
5 V Reference Voltage	0 V	0 V	5.0 V
EGR Sensor Signal	0 V	5.0 V	5.0 V
Low Reference	-	5.0 V	-

Circuit/System Description

The Engine Control Module (ECM) uses the Exhaust Gas Recirculation (EGR) position sensor to determine the position of the EGR valve. The ECM sends a reference voltage through the 5 V reference circuit to the EGR position sensor. The ECM provides a voltage return path for the sensor through the low reference circuit. A variable voltage signal, based on the EGR valve position, is sent from the sensor to the ECM through the EGR position sensor signal circuit.

Conditions for Running the DTC

The DTCs run continuously when the ignition voltage is greater than 11 V.

Conditions for Setting the DTC

P0404

The ECM detects a stuck valve.

P0405

The ECM detects that the EGR position sensor voltage is less than 0.25 V for greater than 5 s.

P0406

The ECM detects that the EGR position sensor voltage is greater than 4.8 V for greater than 5 s.

Action Taken When the DTC Sets

- DTCs P0404, P0405 and P0406 are Type B DTCs.
- The driver information center may display Service Emissions System message.

Conditions for Clearing the DTC

DTCs P0404, P0405 and P0406 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

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

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

NOTE: **When using an EGR device control, Engine Reduced Power and Clean Exhaust Filter messages may occur after a short delay when commanding large EGR positions. The messages are a result of ECM protecting hardware during device control mode. No DTCs will be stored and the Diesel Particulate Filter does not need to be service cleaned. Exiting device control will restore normal function.**

3. Verify the scan tool Desired EGR Position and the EGR Position Sensor parameters are within 5% when commanding EGR between 0-100% with a scan tool.
   - **If not within 5%**

     Refer to Circuit/System Testing.

   - **Go to next step: If within 5%**
4. 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.
5. Verify a DTC does not set.
   - **If a DTC sets**

     Refer to Circuit/System Testing

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

Circuit/System Testing

1. Ignition Off and all vehicle systems Off, disconnect the harness connector at the Q14 Exhaust Gas Recirculation Valve. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 3 and ground.
   - **If 10 Ω or greater**
   1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.

- **Go to next step: If less than 10 Ω**

3. Ignition On.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.
    - **If less than 4.8 V**
    1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module, ignition On.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If between 4.8 - 5.2 V**
5. Verify the scan tool EGR Position Sensor parameter is between 4.8-5.2 V.
    - **If less than 4.8 V**
    1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 5 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If greater than 5.2 V**
    1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for less than 1 V between the signal circuit terminal 5 and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If between 4.8-5.2 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 5 and the low reference circuit terminal 3.
7. Verify the scan tool EGR Position Sensor parameter is less than 0.2 V.
    - **If 0.2 V or greater**
    1. Ignition Off, remove the jumper wire, disconnect the X2 harness connector at the K20 Engine Control Module, ignition On.
    2. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 0.2 V**
8. Test or replace the Q14 Exhaust Gas Recirculation Valve.

Repair Instructions

- Refer to **Exhaust Gas Recirculation Valve Replacement**
- Refer to **Control Module References** for ECM replacement, setup and programming.

Repair Verification

1. Perform the **Diagnostic Repair Verification** after completing the repair.
2. Perform the **Reductant System Tamper Service Bay Test** with a scan tool to clear the Service Emission System message, if illuminated.

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- **If the Service Emission System message does not turn Off**

  A condition with the system still exists.

- **Go to next step: If the Service Emission System message turns Off**

3. All OK.

DTC P0407, P0408, P046E, OR P046F: EXHAUST GAS RECIRCULATION COOLER COOLANT INLET TEMPERATURE SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P0407

Exhaust Gas Recirculation Cooler Coolant Inlet Temperature Sensor Circuit Low Voltage

DTC P0408

Exhaust Gas Recirculation Cooler Coolant Inlet Temperature Sensor Circuit High Voltage

DTC P046E

Exhaust Gas Recirculation Cooler Coolant Inlet Temperature Sensor Performance

DTC P046F

Exhaust Gas Recirculation Cooler Coolant Inlet Temperature Sensor Circuit Erratic

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0407	P0408	P0408*	P046E, P046F
Low Reference	-	P0408	-	P046E, P046F
* ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

EGR Cooler Coolant Inlet Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** -39 to 149Â°C (-38 to 300Â°F)			
EGR Cooler Coolant Inlet Temperature Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-

Circuit/System Description

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

Conditions for Running the DTC

P0407 and P0408

- Ignition On

- Ignition voltage greater than 11 V
- Engine not cranking

This DTC runs continuously when the above conditions are met.

P046E

- DTCs P007B-P007E, P0407, P0408, P046F, P10D5-P10D8 or P2610 are not set.
- Ignition voltage is greater than 11 V
- The vehicle has been off for at least 8 hours
- The engine is running for greater than 5 s.
- The absolute value of the difference between the Charge Air Cooler upstream air temperature and Charge Air Cooler downstream air temperature is less than or equal to 10Â°C
- This DTC runs continuously when the above conditions are met.

P046F

- DTCs P0407 or P0408 are not set.
- Ignition is on and engine is not cranking
- Ignition voltage is greater than 11 V
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0407

The ECM detects that the EGR cooler inlet coolant temperature resistance value is less than 55 Ω for greater than 2.4 s.

P0408

The ECM detects that the EGR cooler inlet coolant temperature resistance value is greater than 134 kΩ for greater than 2.4 s.

P046E

There is greater than 10Â°C (50Â°F) difference between the EGR cooler inlet coolant temperature and the average value between the Charge Air Cooler Inlet Temperature Sensor and Charge Air Cooler Outlet Temperature Sensor.

P046F

The ECM detects that the EGR cooler inlet coolant temperature is colder than -39Â°C (-38Â°F) or warmer than 149Â°C (300Â°F) for greater than 5 s.

Action Taken When the DTC Sets

DTC P0407, P0408, P046E, or P046F are Type B DTCs.

Conditions for Clearing the DTC

DTC P0407, P0408, P046E, or P046F are a Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Description and Operation

Exhaust Aftertreatment 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 scan tool EGR Cooler Coolant Inlet Temperature parameter is warmer than -40Â°C (-40Â°F) and colder than 150Â°C (302Â°F) and changes with engine run time.
   - **If colder than -39Â°C (-38Â°F) or warmer than 149Â°C (300Â°F) or does not change**

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

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the B318A Exhaust Gas Recirculation 1 Cooler Temperature Sensor-Coolant Inlet 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 X2 connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Ignition ON.
4. Verify the scan tool EGR Cooler Coolant Inlet Temperature parameter is colder than -39Â°C (-38Â°F).
   - **If warmer than -39Â°C (-38Â°F)**
   1. Ignition OFF, disconnect X2 connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.

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

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

5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool EGR Cooler Coolant Inlet Temperature Sensor parameter is warmer than 149Â°C (300Â°F).
   - **If 149Â°C (300Â°F) or colder**
   1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V
   3. Ignition OFF.
   4. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If warmer than 149Â°C (300Â°F)**
7. Test or replace the B318A Exhaust Gas Recirculation 1 Cooler Temperature Sensor - Coolant.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B318A Exhaust Gas Recirculation 1 Cooler Temperature Sensor - Coolant.
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 B318A Exhaust Gas Recirculation 1 Cooler Temperature Sensor - Coolant.

   - **Go to next step: If within the specified range**
3. Test for infinite resistance between each terminal and the sensor housing.
   - **If less than infinite resistance**

     Replace the B318A Exhaust Gas Recirculation 1 Cooler Temperature Sensor - Coolant.

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

Repair Instructions

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

- Refer to **Engine Coolant Temperature Sensor Replacement (FWD)** **Engine Coolant Temperature Sensor Replacement (AWD)**
- Refer to **Control Module References** for ECM replacement, setup, and programming

DTC P0421: CATALYST 1 LOW EFFICIENCY

Diagnostic Instructions

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

DTC Descriptors

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DTC P0421

Catalyst 1 Low Efficiency

Circuit Description

The main function of the close coupled diesel oxidation catalyst (CCDOC) is to control emissions of non methane hydrocarbons and carbon monoxide (CO). Its secondary function is to assist with the diesel particulate filter (DPF) regeneration, by obtaining and sustaining the temperature necessary for regeneration. In order to generate the high exhaust temperatures needed for regeneration, the aftertreatment system increases exhaust temperatures by injecting diesel fuel into the exhaust system via post-injection. The injected fuel is converted into heat by the DOC to incinerate soot accumulated in the DPF. The engine control module (ECM) monitors the exhaust gas temperature sensor 1 and 2 to determine if catalyst downstream temperatures are achieved during a DPF regeneration.

Conditions for Running the DTC

- Ambient Air Temperature = -7 to 42Â°C (19 to 108Â°F)
- BARO Sensor = Greater than 70 kPa (10.2 PSI)
- Calculated Catalyst Temperature = Colder than 55Â°C (131Â°F)
- Coolant Temperature = Colder than 55Â°C (131Â°F)
- Engine - Running

DTC P0421 runs when the above conditions are met for greater than 150 s

Conditions for Setting the DTC

The ECM determines that the efficiency of the diesel oxidation catalyst has degraded below a calibrated threshold.

Action Taken When the DTC Sets

DTCs P0421 is a Type B DTC.

Conditions for Clearing the DTC

DTCs P0421 is a Type B DTC.

Diagnostic Aids

The continuing use of non ultra low sulfur fuel may be a contributor to diesel oxidation catalyst failure.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Verify that DTCs P0100, P010B, P010C, P010D, P014C, P014D, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P020A, P020B, P020C, P020D, P020E, P020F, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0, P02F1, P02F2, P02F3, P02F4, P02F5, P113D, P113F, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192, P1193, P1194, P1196, P1198, P119A, P119B, P119C, P11C5, P11C6, P11DB, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P12AF, P12B0, P12B1, P12B2, P2004, P2205, P2006, P2008, P2009, P200A, P2010, P2015, P2016, P2017, P201B, P201D, P20F8, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2205, P2206, P2207, P2208, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P2297, P242B, P242C, P242D, P242E, P2452, P2453, P2454, P2455, P2456, P2481, P2482, P2483, P2484, P2627, P2628, P2A00, U029D are not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
3. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If no DTCs set**
4. All OK.

Circuit/System Testing

1. Verify the following conditions do not exist with the air induction system and exhaust system:
   - Induction system leaks.
   - Exhaust leaks before or after the diesel oxidation catalyst. Refer to **Exhaust Leakage** for further diagnosis.
   - Physical damage.
   - Loose or missing hardware.
   - **If a condition is found**

     Repair or replace the affected exhaust system components as necessary.

   - **Go to next step: If no condition is found**
2. Verify the following conditions do not exist with the diesel oxidation catalyst:
   - Physical damage or alterations.
   - Internal rattles caused by a damaged catalyst substrate.
   - Restrictions.
   - **If a condition is found**

     Replace the diesel oxidation catalyst.

   - **Go to next step: If no condition is found**
3. Verify the following conditions do not exist:
   - Off road fuel or red dye fuel.
   - Low quality B20 fuel.

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- Fuel containing high sulfur content.
- Engine oil or coolant consumption.
- **If a condition is found**

  Repair as necessary.

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

4. Replace the component: B131B Exhaust Temperature Sensor 2 & diesel oxidation catalyst

Repair Instructions

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

- Refer to **Oxidation Catalytic Converter Replacement (LH7)**
- Refer to **Exhaust Temperature Sensor Replacement - Position 2**
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P042E OR P042F: EXHAUST GAS RECIRCULATION (EGR) OPEN/CLOSED 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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P042E

Exhaust Gas Recirculation (EGR) Open Position Performance

DTC P042F

Exhaust Gas Recirculation (EGR) Closed Position Performance

Circuit/System Description

The engine control module (ECM) uses the exhaust gas recirculation (EGR) position sensor to determine the position of the EGR valve. The ECM sends a reference voltage through the 5 V reference circuit to the EGR position sensor. The ECM provides a voltage return path for the sensor through the low reference circuit. A signal based on the EGR valve position, is sent from the EGR sensor to the ECM.

Conditions for Running the DTC

- DTCs P0403, P0405, P0406, P0489, P0490, P049D, P1402, P1407, P140F, or P1424 are not set
- The engine is running

These DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P042E

The ECM detects the position of the EGR valve more open than desired for greater than 10 s.

P042F

The ECM detects the position of the EGR valve more closed than desired for greater than 10 s.

Action Taken When the DTC Sets

DTCs P042E and P042F are Type A DTCs.

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Conditions for Clearing the DTC

DTCs P042E and P042F are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exhaust Gas Recirculation (EGR) 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, verify that the EGR Position Sensor parameter reading is between 0.25 - 4.75 V.
    - **If not within the specified range**

      Refer to **DTC P0404-P0406**.

    - **Go to next step: If within the specified range**
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 that DTC P042E or P042F does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Verify that the conditions listed below are not present at the Q14 Exhaust Gas Recirculation Valve:
    - Stuck Q14 Exhaust Gas Recirculation Valve
    - Any coking, soot build up, debris or damage that can cause the EGR valve to stick partially open or closed
    - **If a condition is present**

      Repair as necessary

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

2. Ignition Off, disconnect the harness connector at the Q14 Exhaust Gas Recirculation Valve, ignition On.
3. Verify a test lamp does illuminate between the EGR motor control circuit terminal 6 and ground.
    - **If the test lamp does not illuminate**
    1. Ignition Off, remove the test lamp and disconnect the X2 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
    3. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module
    - **Go to next step: If the test lamp illuminates**
4. Ignition ON, verify a test lamp does not illuminate between the EGR motor control circuit terminal 5 and B+.
    - **If the test lamp illuminates**
    1. Ignition Off, remove the test lamp and disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module
    - **Go to next step: If the test lamp does not illuminate**
5. Ignition On, verify a test lamp illuminates between the EGR motor control circuit terminal 2 and B+ when commanding the EGR Motor to 10% with a scan tool.
    - **If the test lamp does not illuminate**
    1. Ignition Off, remove the test lamp and disconnect the X2 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
    3. Ignition ON, test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp illuminates**
6. Replace the Q14 Exhaust Gas Recirculation Valve.

Repair Instructions

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

- Refer to **Exhaust Gas Recirculation Valve Replacement**
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

DTC P049D: EXHAUST GAS RECIRCULATION (EGR) POSITION NOT LEARNED

Diagnostic Instructions

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

DTC Descriptors

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DTC P049D

Exhaust Gas Recirculation (EGR) Position Not Learned

Circuit/System Description

The offset of the EGR valve is checked after the offset learning has been completed in after-run/post drive. The difference between the maximum and minimum EGR valve offset values is calculated by the engine control module (ECM). If the difference is above a calibrated threshold or the offset learned value is not within a calibrated range, a fault is recognized. While the offset learning is active, the EGR valve is checked for a stuck valve. If the valve is stuck during opening or closing for a calibrated time, a fault is reported. If either of these conditions occur, the DTC will be set.

Conditions for Running the DTC

- DTC P0117, P0118, P0403, P0405, P0406, P042E, P042F, P0490, P1402, P1407, P140F or P1424 is not set.
- Ignition is OFF and the engine is in after-run/post drive.
- Battery voltage is greater than 5 V.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the offset learned value for the EGR valve is not within a calibrated range.

Action Taken When the DTC Sets

DTC P049D is a Type B DTC.

Conditions for Clearing the DTC

DTC P049D is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition On.
2. Verify P0403, P0490, P1407, or P140F is not set.

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

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

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

NOTE: **When using scan tool functions, Engine Reduced Power and Clean Exhaust Filter messages may occur after a short delay when commanding large EGR positions. The messages are a result of ECM protecting hardware during scan tool functions. No DTCs will be stored and the Diesel Particulate Filter does not need to be service cleaned. Exiting device control will restore normal function.**

3. Verify the scan tool Desired EGR Position and the EGR Position Sensor parameters remain within 3% when commanding the EGR Valve between 0 - 40% with a scan tool.
   - **If not within 3%**

     Refer to Circuit/System Testing.

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

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition Off, remove the Q14 EGR valve. Refer to **Exhaust Gas Recirculation Valve Replacement** .
2. Verify the conditions listed below do not exist:

- Sticking, binding or frozen EGR valve.
- Coking, soot build up, debris or damage that can cause the EGR valve to stick partially open or closed.
  - **If a condition exists**

    Repair or replace the component as necessary.

  - **Go to next step: If none of the conditions exist**
- Test or replace the Q14 Exhaust Gas Recirculation Valve.

Repair Instructions

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

- Refer to **Exhaust Gas Recirculation Valve Replacement**
- Refer to **Control Module References** for ECM replacement, programming and setup

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Back To Article

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P040B, P040C, P040D, P040E, P041B, P041C, P041D, OR P041E: EXHAUST GAS RECIRCULATION (EGR) TEMPERATURE SENSOR 1-2

Diagnostic Instructions

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

DTC Descriptors

DTC P040B

Exhaust Gas Recirculation (EGR) Temperature Sensor 2 Performance

DTC P040C

Exhaust Gas Recirculation (EGR) Temperature Sensor 2 Circuit Low Voltage

DTC P040D

Exhaust Gas Recirculation (EGR) Temperature Sensor 2 Circuit High Voltage

DTC P040E

Exhaust Gas Recirculation (EGR) Temperature Sensor 2 Circuit Erratic

DTC P041B

Exhaust Gas Recirculation (EGR) Temperature Sensor 1 Performance

DTC P041C

Exhaust Gas Recirculation (EGR) Temperature Sensor 1 Circuit Low Voltage

DTC P041D

Exhaust Gas Recirculation (EGR) Temperature Sensor 1 Circuit High Voltage

DTC P041E

Exhaust Gas Recirculation (EGR) Temperature Sensor 1 Circuit Erratic

Circuit/System Description

The exhaust gas recirculation (EGR) temperature sensors are variable resistors that measure the temperature of the exhaust gas at the inlet and outlet of the EGR cooler. The engine control module (ECM) supplies 5 volts to the EGR temperature sensor signal circuit and a ground for the low reference circuit. When the EGR temperature sensor is cold, the sensor resistance is high. When the EGR temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a higher voltage on the EGR temperature signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the EGR temperature signal circuit.

Conditions for Running the DTC

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P040B, P041B

- The engine is running.
- The ignition voltage is greater than 11 V.
- The engine has been OFF for greater than 8 hours.
- DTC P262B is not set.

The DTCs run continuously when the above conditions are met.

P040C, P040D, P040E, P041C, P041D, P041E

- The ignition is ON.
- The ignition voltage is greater than 11 V.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P040B, P041B

The ECM detects that the EGR temperature sensor has not changed greater than a calibrated amount for greater than a calibrated amount of time following a cold start.

P040C, P041C

The ECM detects that the EGR temperature sensor resistance is less than 147 Ω for greater than 5 s.

P040D, P041D

The ECM detects that the EGR temperature sensor resistance is greater than 885 Ω for greater than 5 s.

P040E, P041E

The ECM detects that the EGR temperature sensor resistance has changed greater than 25 Ω in 0.1 s.

Action Taken When the DTC Sets

DTCs P040B, P040C, P040D, P040E, P041B, P041C, P041D and P041E are Type B DTCs.

Conditions for Clearing the DTC

DTCs P040B, P040C, P040D, P040E, P041B, P041C, P041D and P041E are Type B DTCs.

Diagnostic Aids

- Inspect the EGR cooler temperature sensor terminals for corrosion.
- If the EGR cooler temperature sensor signal circuit is shorted to a separate 5-volt source, the DTC will set.
- If the engine has cooled for at least 8 hrs, the scan tool EGR Temperature Sensor 1, EGR Temperature Sensor 2 and the ECT Sensor values should display within 3Â°C (5Â°F).
- EGR cooler temperature sensors may fail while operating under extreme temperatures. Review the Freeze Frame/Failure Records to verify the failure criteria.
- With a fault present, the sensor reads a software defaulted value of 200Â°C (392Â°F) and does not change with a temperature increase or decrease.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 25070 Heat Gun 500 - 750Â°F

Circuit/System Verification

1. Engine running.
2. Verify the scan tool the appropriate EGR Temperature Sensor parameter is between -39Â° to +999Â°C (-38Â° to +1, 830Â°F) and changes with engine run time.
   - **If not between -39Â° to +999Â°C (-38Â° to +1, 830Â°F) or does not change**

     Refer to Circuit/System Testing.

   - **Go to next step: If between -39Â° to +999Â°C (-38Â° to +1, 830Â°F) and changes**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify that DTC does not set.
   - **If DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If 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 B130 Exhaust Gas Recirculation Temperature Sensor. It may take up to 2 min 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 X3 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 10 Ω**
3. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
4. 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.

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

5. Test for less than 2 Ω in the signal circuit end to end.
    - **If 2 Ω or greater**

      Repair the open/high resistance in the circuit.

    - **Go to next step: If less than 2 Ω**
6. Ignition ON.
7. 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.

    - **Go to next step: If less than 1 V**
8. Test or replace the appropriate B130 Exhaust Gas Recirculation Temperature Sensor.
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 that DTC does not set.
    - **If DTC sets**

      Replace the K20 Engine Control Module

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

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B130 Exhaust Gas Recirculation Temperature Sensor.

   NOTE: **The J 25070 may be used to evaluate the sensor under high temperature conditions.**

2. Verify the resistance between the signal circuit terminal 1 and the low reference circuit terminal 2 is within the range specified in the **Temperature Versus Resistance (B13 Transmission Fluid Temperature Sensor)** Table.
    - **If not within the range specified**

      Replace the appropriate B130 Exhaust Gas Recirculation Temperature Sensor.

    - **Go to next step: If within the range specified**
3. Test for infinite resistance between each terminal and the sensor housing/case.
    - **If less than infinite resistance**

      Replace the appropriate B130 Exhaust Gas Recirculation Temperature Sensor.

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

Repair Instructions

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

- Refer to **Exhaust Gas Recirculation Cooler Temperature Sensor Replacement - Position 1**
- Refer to **Exhaust Gas Recirculation Cooler Temperature Sensor Replacement - Position 2**
- Refer to **Exhaust Gas Recirculation Valve Replacement**
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

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DTC P0506 OR P0507: IDLE SPEED LOW/HIGH

Diagnostic Instructions

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

DTC Descriptors

DTC P0506

Idle Speed Low

DTC P0507

Idle Speed High

Circuit/System Description

The engine control module (ECM) adjusts the fuel delivery in order to control crankshaft speed at idle. The ECM monitors the engine speed and will detect an out of range idle speed for the amount of fuel that is delivered.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0171, P0172, P0300, P0301, P0302, P0303, P0304, P0400, P0401, P0402, P0403, P0405, P0406, P042E, P042F, P0462, P0463, P0489, P0490, P049D, P062D, P0502, P0503, P0722, P0723, P0806, P0807, P0808, P140B, P140C, P2227, P2228, P2229, P2230 or P2271 is not set.
- Engine is operating for at least 60 s.
- Time since gear change is at least 3 s.
- Time since torque converter clutch state change greater than 3 s.
- Engine idling for greater than 5 s.
- Ignition voltage is 11 - 32 V.
- Barometric pressure is greater than 70 kPa (10.1 psi).
- Engine coolant temperature (ECT) is between 60 to 120Â°C (140 - 248Â°F).
- Intake air temperature (IAT) is greater than -20Â°C (-4Â°F).
- Clutch pedal position is less than 12% or greater than 75%, if equipped.
- Scan tool service bay control not active.
- DTC P0506 and P0507 run continuously when the above conditions are met.

Conditions for Setting the DTC

P0506

The ECM detects the actual idle speed is below a predetermined speed for greater than 10 s.

P0507

The ECM detects the actual idle speed is above a predetermined speed for greater than 10 s.

Action Taken When the DTC Sets

DTCs P0506 and P0507 are type B DTCs.

Conditions for Clearing the DTC

DTCs P0506 and P0507 are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End Views

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. Observe the DTC information with a scan tool. Verify there are no other DTCs set.
   - **If a DTC is set**

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

   - **Go to next step: If a DTC is not set**
3. Engine idling at the normal operating temperature.
4. Compare the scan tool Desired Idle Speed parameter to the Engine Speed parameter. Both parameters should be within 200 RPM.
   - **If parameters are not within 200 RPM**

     Refer to Circuit/System Testing.

   - **Go to next step: If parameters are within 200 RPM**
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 a DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

P0506

1. Verify none of the following conditions exist.
   - A crankcase overfill can cause oil to be forced through the positive crankcase ventilation (PCV) system.
   - Restricted exhaust
   - Mechanical conditions that limits engine speed.
   - Parasitic load on the engine - For example, a transmission condition, a belt driven accessory condition.

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- **If a condition is found**

  Repair as necessary.

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

2. All OK.

P0507

1. Verify none of the following conditions exist.
   - An outside source that has allowed oil or fuel to enter the air induction system.
   - Fuel in engine oil being drawn into the engine.
   - An aftermarket performance kit using an external fuel source.
   - **If a condition is found**

     Repair as necessary.

   - **Go to next step: If a condition is not found**
2. All OK.

Repair Instructions

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

DTC P053A, P053B, OR P053C: POSITIVE CRANKCASE VENTILATION HEATER CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P053A

Positive Crankcase Ventilation Heater Control Circuit

DTC P053B

Positive Crankcase Ventilation Heater Control Circuit Low Voltage

DTC P053C

Positive Crankcase Ventilation Heater Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Positive Crankcase Ventilation Heater Control Circuit	P053B	P053A	P053C	-
Ignition Circuit	P053A*	P053A	-	-
* Opens circuit fuse or opens circuit.				

Typical Scan Tool Data

Positive Crankcase Ventilation Heater Control Circuit Open Test Status

Circuit	Short to Ground	Open	Short to Voltage

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Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, component commanded Off. **Parameter Normal Range:** OK/Not Run			
Positive Crankcase Ventilation Heater Control	OK/Not Run	Malfunction	OK/Not Run

Positive Crankcase Ventilation Heater Control Circuit Low Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, component commanded Off. **Parameter Normal Range:** OK/Not Run			
Positive Crankcase Ventilation Heater Control	Malfunction	OK/Not Run	OK/Not Run

Positive Crankcase Ventilation Heater Control Circuit High Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, component commanded On. **Parameter Normal Range:** OK/Not Run			
Positive Crankcase Ventilation Heater Control	OK/Not Run	OK/Not Run	Malfunction

Circuit/System Description

The positive crankcase ventilation heater is controlled by the ECM. Ignition voltage is directly supplied to the positive crankcase ventilation heater and the ECM provides a controlled ground circuit.

Conditions for Running the DTC

- Ignition ON or engine operating.
- Battery voltage is greater than 11 V.
- Engine temperature is less than 90Â°C (194Â°F).
- The DTCs run continuously when the above conditions are met.

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Conditions for Setting the DTC

P053A

The ECM detects an open circuit on the positive crankcase ventilation heater control circuit for greater than 5 s.

P053B

The ECM detects a short to ground on the positive crankcase ventilation heater control circuit for greater than 5 s.

P053C

The ECM detects a short to voltage on the positive crankcase ventilation heater control circuit for greater than 5 s.

Action Taken When the DTC Sets

DTCs P053A, P053B and P053C are Type C DTCs.

Conditions for Clearing the DTC

DTCs P053A, P053B and P053C are Type C DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Command the Positive Crankcase Ventilation Heater ON and OFF with a scan tool while observing the following control circuit status parameters:
   - Positive Crankcase Ventilation Heater Control Circuit Open Test Status
   - Positive Crankcase Ventilation Heater Control Circuit Low Voltage Test Status
   - Positive Crankcase Ventilation Heater Control Circuit High Voltage Test Status

     Each parameter should not display Malfunction.

   - **If Malfunction**

     Refer to Circuit/System Testing.

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

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF.
2. Disconnect the harness connector at the E45 Positive Crankcase Ventilation Heater.
3. Ignition ON.
4. Connect a test lamp between the Ignition Circuit terminal 2 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ignition circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.

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- If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

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

1. Ignition OFF.
2. Test for infinite resistance, between the ignition circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the E45 Positive Crankcase Ventilation Heater.

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

5. Connect a test lamp between the control circuit terminal 1 and the ignition circuit terminal 2.
6. Verify the test lamp turns ON and OFF when commanding the Positive Crankcase Ventilation Heater from OFF to ON and back to OFF with a scan tool.

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

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.
3. Ignition OFF.
4. Test for less than 2 Ω in the control 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 the test lamp is always ON**

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

- **Go to next step: If the test lamp turns ON and OFF**

7. Replace the E45 Positive Crankcase Ventilation Heater.

Repair Instructions

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

- Refer to **Camshaft Housing Replacement** for E45 Positive Crankcase Ventilation Heater replacement.
- Refer to **Control Module References** for ECM replacement, setup, and programming

DTC P0545, P0546, P2032, P2033, P242C OR P242D: EXHAUST GAS TEMPERATURE SENSOR CIRCUIT VOLTAGES

Diagnostic Instructions

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

DTC Descriptors

DTC P0545

Exhaust Gas Temperature Sensor 1 Circuit Low Voltage

DTC P0546

Exhaust Gas Temperature Sensor 1 Circuit High Voltage

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DTC P2032

Exhaust Gas Temperature Sensor 2 Circuit Low Voltage

DTC P2033

Exhaust Gas Temperature Sensor 2 Circuit High Voltage

DTC P242C

Exhaust Gas Temperature Sensor 3 Circuit Low Voltage

DTC P242D

Exhaust Gas Temperature Sensor 3 Circuit High Voltage

Circuit/System Description

The exhaust gas temperature sensors are variable resistors that measures the temperature of the exhaust gas. The exhaust temperature sensor 1 is the first exhaust temperature sensor on the exhaust system, the following exhaust temperature sensors are counted upward from the engine outlet to the exhaust system end. The engine control module (ECM) supplies 5 V to the exhaust gas temperature signal circuit and supplies a ground to the low reference circuit. The exhaust gas temperature sensor temperature information is used by the ECM during the exhaust gas particulate filter cleaning process.

Conditions for Running the DTC

- The ignition is ON.
- The ignition voltage is greater than 11 V.

These DTCs run continuously when the above conditions are met.

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Conditions for Setting the DTC

DTC P0545, P2032, P242C

The ECM detects that the exhaust gas temperature sensor is less than 158 Ω for greater than 2 s.

DTC P0546, P2033, P242D

The ECM detects that the exhaust gas temperature sensor is greater than 900 Ω for greater than 2 s.

Action Taken When the DTC Sets

DTCs P0545, P0546, P2032, P2033, P242C and P242D are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0545, P0546, P2032, P2033, P242C and P242D are Type B DTCs.

Diagnostic Aids

- After starting the engine, the exhaust gas temperature sensor temperature should rise steadily, then stabilize after the engine reaches operating temperature.
- Exhaust gas temperature sensors may fail intermittently while operating under extreme temperatures. Review the Freeze Frame/Failure Records to verify the failure criteria.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that no other DTCs are set.
   - **If any other DTCs are set**

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

   - **Go to next step: If no other DTC 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.
3. Verify DTC P0545, P0546, P2032, P2033, P242C and P242D does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B131 Exhaust Temperature Sensor. It may take up to 2 min 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 X3 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 10 Ω**
3. Ignition ON, test for 4.8 - 5.2 V between the signal circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF.
   2. Disconnect the X3 harness connector at the K20 Engine Control Module.
   3. Test for infinite resistance between signal circuit and ground
      - If less than infinite resistance, repair the short to ground in the circuit.
      - If infinite resistance
   4. Test for less than 2 Ω in the signal circuit end to end.
   - If 2 Ω or greater, repair the open/high resistance in the circuit.
   - If less than 2 Ω

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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.
2. Test for less than 1 V between the signal circuit and ground
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V

      Replace the K20 Engine Control Module.

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

4. Replace the appropriate B131 Exhaust Temperature Sensor.

Repair Instructions

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

- Refer to **Exhaust Temperature Sensor Replacement - Position 1**
- Refer to **Exhaust Temperature Sensor Replacement - Position 2**
- Refer to **Exhaust Temperature Sensor Replacement - Position 3**
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

DTC P054E OR P054F: IDLE CONTROL - FUEL QUANTITY

Diagnostic Instructions

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

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DTC Descriptors

DTC P054E

Idle Control - Fuel Quantity Lower Than Expected

DTC P054F

Idle Control - Fuel Quantity Higher Than Expected

Circuit/System Description

The idle speed directly depends on the injection quantity. The monitor compares the commanded injection quantity with calculated thresholds. The commanded idle fuel needs to be between 50 percent of max and min expected fuel. The expected fuel is dependent on accessory loads, ambient temperature, BARO, engine coolant temperature and engine speed.

Conditions for Running the DTC

- Accelerator Pedal Position is less than 0.05%.
- Ambient air temperature is greater than -20Â°C (-4Â°F).
- Engine is running.
- Engine Coolant Temperature is greater than -20Â°C (-4Â°F).
- Engine speed is 546 - 1560 RPM.
- Ignition voltage is greater than 11 V.
- No gear change has occurred.
- Transmission shall be in neutral/park or in gear.
- Vehicle speed is less than 3 kph (1.86 mph).

The DTC runs continuously when the above conditions are met for 5 s.

Conditions for Setting the DTC

P054E

A fault is detected when the current fuel injection quantity is lower than the allowed limit for greater than 24 s.

P054F

A fault is detected when the current fuel injection quantity is higher than the allowed limit for greater than 24 s.

Action Taken When the DTC Sets

DTCs P054E and P054F are Type B DTCs.

Conditions for Clearing the DTC

DTCs P054E and P054F are Type B DTCs.

Diagnostic Aids

- Contaminated or improper fuel quality may cause this DTC to set.
- Clutch slippage may cause this DTC to set, if equipped.
- Excessive loads on the accessory drive or transmission due to damage may cause this DTC to set.
- When operating the vehicle within the Conditions for Running DTC P054E, turn Off all electrical loads. (HVAC fan, air conditioning, lights, seat heaters, defroster, etc.)
- When operating the vehicle within the Conditions for Running DTC P054F, turn On all electrical loads. (HVAC fan, air conditioning, lights, seat heaters, defroster, etc.)

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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Control Module References for scan tool information.

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0071, P0072, P0073, P0074, P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0171, P0172, P01CB, P01CC, P01CD, P01CE, P01CF, P01D0, P01D1, P01D2, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0261, P0262, P0263, P0264, P0265, P0266, P0267, P0268, P0269, P0270, P0271, P0272, P02CC, P02CD, P02CE, P02CF, P02D0, P02D1, P02D2, P02D3, P02EE, P02EF, P02F0, P02F1, P0335, P0336, P0502, P0503, P0697, P06A3, P111E, P1248, P1249, P124A, P124B, P2122, P2123, P2127, P2128, P2138, P2147, P2148, P2150, P2151, P268C, P268D, P268E, P268F is not set.
   - **If any of the DTCs are set**

     Refer to Diagnostic Trouble Code (DTC) List - Vehicle .
   - **Go to next step: If none of the DTCs are set**
3. Verify there are no aftermarket performance enhancing devices installed on the vehicle.
4. Worn or failed accessory drive components may cause this DTC to set.
5. Verify the proper fuel is used. Refer to Fuel System Specifications , and Contaminants-in-Fuel Diagnosis .
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
7. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.
   - **Go to next step: If the DTC does not set**
8. All OK.

Circuit/System Testing

NOTE: **Only perform the Circuit/System Testing portion of the Fuel Injector Balance Test.**

1. Verify that no cylinders have low compression and no fuel injector nozzles are clogged, stuck open, or stuck closed. Perform the Circuit/System Testing of the Fuel Injector Balance Test.

   Refer to Fuel Injector Balance Test with Scan Tool .
   - **If a fuel injector nozzle is clogged, stuck open, or stuck closed**

     Replace the appropriate Q17 Fuel Injector.
   - **If one or more of the cylinders indicate low compression**

     Repair as necessary.
   - **Go to next step: If all cylinders indicate normal compression and no fuel injector nozzles are clogged, stuck open, or stuck closed**
2. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Refer to Fuel Injector Replacement

DTC P057B, P057C, P057D, OR P057E: BRAKE PEDAL POSITION SENSOR

Diagnostic Instructions

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

DTC 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

DTC P057E

Brake Pedal Position Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P057C	P057C	P057D	P057B, P057E
5 V Reference	P057C P0651	P057C	P0651	-
Low Reference	-	P057D	P057D	-

Typical Scan Tool Data

Brake Pedal Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. **Normal Range:** 0.25 - 4.75 V			
5 V Reference	0 V	0 V	-
Signal	0 V	0 V	5 V
Low Reference	-	5 V	-

Circuit/System Description

The brake pedal position (BPP) sensor is part of the engine brake pedal override feature. The engine control module (ECM) continuously monitors the vehicle speed and the position of the brake pedal. These two main inputs, along with other ECM inputs are used to determine if the vehicle is decelerating at the proper speed and rate with the brake pedal applied. When the engine brake pedal override system is active, the ECM reduces engine torque to assist in reducing vehicle speed.

The BPP sensor is a six wire sensor, and is part of a dual brake position sensor. One BPP Sensor is used for the stop lamps and the other BPP Sensor is used for the engine brake pedal override feature. The BPP Sensor for engine brake pedal override communicates with the ECM. The ECM supplies a 5 V reference circuit, low reference circuit, and signal circuit to the BPP sensor. The BPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage greater than 0.25 V when the brake pedal is released to a voltage less than 4.75 V when the brake pedal is fully applied.

For information on the Stop Lamps side of the BPP Sensor, refer to **Exterior Lighting Systems Description and Operation** .

Conditions for Running the DTC

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P057B

- DTCs P057C, or P057D are not set.
- Ignition voltage is greater than 10 V.
- Shift lever has been in Park at least once during key ON.
- Shift lever is not in Park.
- Vehicle speed is greater than 8 Km/h (5 mph).
- Accelerator Pedal Position is less than 5%.
- DTC runs once per key cycle when above conditions are met.

P057C, P057D, or P057E

- Ignition voltage is greater than 10 V.
- DTC runs continuously when above condition is met.

Conditions for Setting the DTC

P057B

ECM detects the BPP sensor signal is stuck in a range for greater than 1 s.

P057C

ECM detects the BPP sensor voltage is less than 0.25 V greater than 1 s.

P057D

ECM detects the BPP sensor voltage is greater than 4.75 V greater than 1 s.

P057E

ECM detects the BPP sensor value varies greater than a calibrated value.

Action Taken When the DTC Sets

- P057B, P057C, P057D and P057E are Type A DTCs.
- Brake Pedal Position Sensor parameter defaults to 0%.

Conditions for Clearing the DTC

P057B, P057C, P057D and P057E are Type A DTCs

Reference Information

Schematic Reference

- **Engine Controls Wiring Schematics 1.6L (LH7)**
- **Exterior Lights Wiring Schematics**

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Electrical Information Reference

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

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **The 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** .

   - **Go to next step: If none of the DTCs are set**
3. Transmission in Park, and service brake pedal released.
4. Verify the scan tool Brake Pedal Position Sensor parameter in the ECM displays greater than 0.25 V.
   - **If 0.25 V or less**

     Refer to Circuit/System Testing.

   - **Go to next step: If greater than 0.25 V**
5. Verify the scan tool Brake Pedal Position Sensor parameter voltage changes as the brake pedal is applied and displays less than 4.75 V when the brake pedal is fully applied.
   - **If the voltage does not change, or is greater than 4.74 V**

     Refer to Circuit/System Testing.

   - **Go to next step: If the voltage changes and less than 4.75 V**
6. Verify the scan tool Brake Pedal Position Sensor Learned Release Position parameter is within 0.1 V of the Brake Pedal Position Sensor parameter when the brake pedal is fully released.
   - **If difference is greater than 0.1 V**

     Perform the **Brake Pedal Position Sensor Calibration** .

   - **Go to next step: If difference is 0.1 V or less**
7. Verify the Brake Pedal Position Sensor parameter transitions smoothly without any spikes or dropouts when slowly applying and releasing the brake pedal.
   - **If parameter does not transition smoothly or has spikes or dropouts**

     Refer to Circuit/System Testing.

   - **Go to next step: If parameter transitions smoothly and there are no spikes or dropouts**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

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NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B22 Brake Pedal Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

NOTE: **All terminal references are for the vehicle harness brake pedal position sensor connector.**

2. Test for less than 10 Ω between the low reference circuit terminal 6 and ground.
   - **If 10 Ω or greater**
   1. Disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 10 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 5 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance.
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If between 4.8 - 5.2 V**
5. Verify the scan tool Brake Pedal Position Sensor parameter is less than 0.25 V.
   - **If 0.25 V or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 0.25 V between the signal circuit terminal 4 and ground.
      - If 0.25 V or greater, repair the short to voltage on the circuit.
      - If less than 0.25 V, replace the K20 Engine Control Module.
   - **Go to next step: If less than 0.25 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 5.
7. Verify the scan tool Brake Pedal Position Sensor parameter is greater than 4.8 V.
   - **If 4.8 V or less**
   1. Ignition OFF, remove the jumper wire, and disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 4 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance.
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.

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- If less than 2 Ω, replace the K20 Engine Control Module.
- **Go to next step: If greater than 4.8 V**

8. Replace the B22 Brake Pedal Position Sensor.

Repair Instructions

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

- Refer to **Brake Pedal Position Sensor Replacement**
- Perform the **Brake Pedal Position Sensor Calibration** following the replacement of the ECM or BPP sensor, or any repair that effects the BPP sensor alignment.
- Refer to **Control Module References** for Engine Control Module replacement, programming and setup.

DTC P0601, P0602, P0603, P0604, P0606, P062B, P062F, P0630, P16F3 OR P262B: CONTROL MODULE/VIN NOT PROGRAMMED OR MISMATCHED - ENGINE 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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each of the diagnostic category.

DTC Descriptors

DTC P0601

Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P0606

Control Module Processor Performance

DTC P062B

Control Module Fuel Injector Control Performance

DTC P062F

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

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Control Module Power Off Timer Performance

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the ECM. This diagnostic also addresses if the ECM is not programmed.

Conditions for Running the DTCs

P0601, P0602, P0630

These DTCs run continuously when the ignition is in ON.

P0603, P062F

These DTCs run once per ignition cycle.

P0604

DTC P0604 runs continuously when the ignition is ON for greater than 30 s.

P0606, P062B

These DTCs run continuously when Ignition 1 Signal voltage is greater than 11 V.

P16F3

- The engine speed is greater than 680 RPM.
- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P2227, P2228, P2229 or P2230 are not set.
- DTC P16F3 runs continuously when the above conditions are met.

P262B

DTC P262B runs during ECM power down.

Conditions for Setting the DTCs

The ECM detects an internal failure or incomplete programming for more than 10 s.

Actions Taken When the DTC Sets

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P0630 and P16F3 are Type A DTCs.
- DTC P262B is a Type B DTC.
- DTC P062F is a Type C DTC.

Conditions for Clearing the MIL/DTC

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P0630 and P16F3 are Type A DTCs.
- DTC P262B is a Type B DTC.
- DTC P062F is a Type C DTC.

Diagnostic Aids

- A disconnected Camshaft Position Sensor could set DTC P0606 and may cause a no crank condition.
- Low voltage or a momentary loss of power or ground to the ECM may cause a DTC to set. Verify the following:
  - The battery cables are clean and tight, and the battery is fully charged. Refer to **Battery Inspection/Test** .
  - The ECM ground circuits do not have an open or high resistance.
  - The ECM power circuits do not have an open, short to ground or high resistance.

Reference Information

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Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 DTC P0602 or P0630 is not set.
   - **If any of the DTCs are set**
   1. Program the K20 Engine Control Module. Refer to **Control Module References** .
   2. Verify DTC P0602 or P0630 is not set.
      - If any of the DTCs are set, replace the K20 Engine Control Module.
      - If none of the DTCs are set
   3. All OK.
   - **Go to next step: If none of the DTCs are set**
3. Verify DTC P0601, P0603, P0604, P0606, P062B, P062F, P16F3 or P262B is not set.
   - **If any of the DTCs are set**

     Replace the K20 Engine Control Module.

   - **Go to next step: If none of the DTCs are set**
4. All OK.

Repair Instructions

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

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

DTC P0627, P0628, OR P0629: FUEL PUMP ENABLE CIRCUIT

Diagnostic Instructions

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

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DTC Descriptor

DTC P0627

Fuel Pump Enable Circuit

DTC P0628

Fuel Pump Enable Circuit Low Voltage

DTC P0629

Fuel Pump Enable Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0171, P0506, P0628, P12A6	P0171, P0506, P0627, P12A6	P0629	P12A6

Circuit/System Description

The engine control module (ECM) supplies voltage to the fuel pump driver control module for 30 s when the ignition is on and continuously when the engine is running. While this voltage is being received, a serial data signal containing the desired fuel pump speed is also received from the ECM. After the voltage and data have been received the fuel pump driver control module actuates the brushless fuel pump by means of a high power three phase signal.

Conditions for Running the DTC

- The engine speed is greater than 0 RPM.
- The ignition voltage is greater than 11 V.
- The fuel pump enable circuit is commanded On.

The DTC runs continuously when the conditions above are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 s.

Action Taken When the DTC Sets

DTCs P0627, P0628 and P0629 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0627, P0628 and P0629 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

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Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the Fuel Pump Enable On and Off with a scan tool.
   - Fuel Pump Enable Circuit Low Voltage Test Status
   - Fuel Pump Enable Circuit Open Test Status
   - Fuel Pump Enable Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

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

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition Off, disconnect the K111 Fuel Pump Driver Control Module harness connector.
2. Ignition On for 10 s.
3. Verify that a test lamp does not illuminate between the control circuit terminal 18 and ground.
   - **If the test lamp illuminates**
   1. Ignition Off, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module, ignition On.
   2. Test for less than 1 V between the control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool Fuel Pump Enable Circuit Low Voltage Test Status parameter is OK when commanding the Fuel Pump Enable On with a scan tool.
   - **If OK is not displayed**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

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2. Test for infinite resistance between the control circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K20 Engine Control Module.
- **Go to next step: If OK is displayed**

6. Install a 3 A fused jumper wire between the control circuit terminal 18 and ground.
7. Verify the scan tool Fuel Pump Enable Circuit Low Voltage Test Status parameter is Malfunction when commanding the Fuel Pump Enable On with a scan tool.
    - **If Malfunction is not displayed**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If Malfunction is displayed**
8. Replace the K111 Fuel Pump Driver Control Module.

Repair Instructions

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

For control module replacement, setup and programming, refer to **Control Module References**

DTC P062D OR P062E: CONTROL MODULE FUEL INJECTOR

Diagnostic Instructions

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

DTC Descriptors

DTC P062B

Control Module Fuel Injector Control Performance

DTC P062D

Control Module Fuel Injector Driver Performance

DTC P062F

Control Module Long Term Memory Performance

Circuit/System Description

These DTCs apply 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 DTC

P062B, P062D and P062F

- The engine is running.
- The DTC runs continuously once the above condition is met.

Conditions for Setting the DTC

P062B

The ECM detects an internal fuel injector condition once per camshaft revolution.

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P062D

The ECM detects an internal EEPROM failure.

P062F

The ECM detects an internal EEPROM failure.

Action Taken When the DTC Sets

- DTC P062B is a Type C DTC.
- DTCs P062D and P062F are Type A DTCs.

Conditions for Clearing the DTC

- DTC P062B is a Type C DTC.
- DTCs P062D and P062F are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

Diagnostic Trouble Code (DTC) List - Vehicle

Scan Tool Reference

K20 Engine Control Module: Scan Tool Information for scan tool information

Circuit/System Testing

1. Ignition ON,
2. Verify with a scan tool that no other DTC is set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Verify with a scan tool that DTC P062B is not set.
   - **If DTC P062B is set**

     Refer to **DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3 or P262B** for further diagnosis

NOTE:	**Before proceeding ECM replacement it is necessary to perform the Ignition Relay Diagnosis to verify the ECM voltage supply circuit is not open or shorted.**

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- **Go to next step: If DTC P062B is not set**

4. Program the ECM with a scan tool, and verify that DTCs does not reset
    - **If DTCs reset**

      Replace the K20 Engine Control Module

    - **Go to next step: If DTCs does not reset**
5. All OK.

Repair Instructions

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

Refer to **K20 Engine Control Module: Programming and Setup** for Engine Control Module replacement, programming and setup.

DTC P0641, P0651, P0697 OR P06A3: 5V REFERENCE 1-4 CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC 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 5 internal 5V reference circuits. Each internal reference circuit provides external 5V reference circuits for more than one sensor. A short to ground or short to voltage on one external 5V reference circuit can affect all the components connected to the same internal 5V reference circuit.

Conditions for Running the DTC

These DTCs run continuously when the ignition voltage is greater than 6.4 V.

Conditions for Setting the DTC

The ECM detects a short to ground or voltage on any of the 5V reference circuits for greater than 0.5 s.

Action Taken When the DTC Sets

DTCs P0641, P0651, P0697 and P06A3 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0641, P0651, P0697 and P06A3 are Type A DTCs.

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Diagnostic Aids

The 5V reference 1 circuit provides 5 V to the sensors listed below:

- Air conditioning (A/C) refrigerant pressure sensor
- Multifunction intake air sensor
- Exhaust gas recirculation valve
- Camshaft position sensor
- Engine oil pressure sensor
- Diesel particulate filter exhaust differential pressure sensor
- Multifunction switch - center console

The 5V reference 2 circuit provides 5 V to the sensors listed below:

- Manifold absolute pressure/air temperature sensor
- Crankshaft position sensor
- Throttle position sensor
- Brake pedal position sensor
- Brake booster vacuum sensor
- Turbocharger vane position sensor

The 5V reference 3 circuit provides 5 V to the accelerator pedal position sensor 2.

The 5V reference 4 circuit provides 5 V to the sensors listed below:

- Accelerator pedal position sensor 1
- Fuel rail pressure sensor

Disconnecting one component at a time from the affected 5V reference circuit while observing the scan tool 5V Reference Circuit Status parameter may help locate the fault. The scan tool parameter will change from Malfunction to OK when the source of the fault is disconnected. If all 5V reference components have been disconnected and a fault is still indicated, the fault may exist in the wiring harness.

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify scan tool 5V Reference 1-5 Circuit Status parameters do not display Malfunction.
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

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

     Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE: Additional DTCs will set when disconnecting the components.

1. Ignition OFF, disconnect the harness connector at all appropriate sensors for the applicable DTC. Refer to Diagnostic Aids.
2. Ignition ON.
3. Test for 4.8 - 5.2 V between one of the 5V reference circuits and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5V reference circuit for each applicable component and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
   2. Test for less than 1 V between the 5V reference circuit for each applicable component and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If between 4.8 - 5.2 V**

   NOTE: A short to voltage or ground on the signal circuit of certain components may cause this DTC to set.

4. Verify the appropriate scan tool 5V Reference 1, 2, 3, 4 or 5 Circuit Status parameter displays OK while connecting each component associated with the 5V reference circuit one at a time.
   - **If OK is not displayed when a component is connected**

     Test the signal circuit of the component for a short to ground or voltage. If the circuit tests normal, replace the component.

   - **Go to next step: If OK is displayed after all components have been connected**
5. All OK.

Repair Instructions

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

- Refer to **Air Conditioning Cycling and Fan Control Refrigerant Pressure Sensor Replacement**
- Refer to **Camshaft Position Sensor Replacement - Exhaust**
- Refer to **Camshaft Position Sensor Replacement - Intake**
- Refer to **Exhaust Gas Recirculation Valve Replacement**
- Refer to **Intake Air Pressure and Temperature Sensor Replacement**
- Refer to **Engine Oil Pressure Sensor Replacement**
- Refer to **Crankshaft Position Sensor Replacement (FWD)** **Crankshaft Position Sensor Replacement (AWD)**
- Refer to **Brake Pedal Position Sensor Replacement**
- Refer to **Power Brake Booster Vacuum Pipe Replacement (LH7)**
- Refer to **Accelerator Pedal Assembly Replacement**
- Refer to **Throttle Body Assembly Replacement**
- Refer to **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**
- Refer to **Intake Air Pressure and Temperature Sensor Replacement** for turbocharger boost/intake air temperature sensor replacement.
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

DTC P0650, P263A OR P263B: MALFUNCTION INDICATOR LAMP (MIL) CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P0650

Malfunction Indicator Lamp (MIL) Control Circuit

DTC P263A

Malfunction Indicator Lamp (MIL) Control Circuit Low Voltage

DTC P263B

Malfunction Indicator Lamp (MIL) Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0650	P0650	-	-
Control	P0650, P263A*	P0650, P263A	P263B	-
* The MIL remains ON				

Circuit/System Description

The malfunction indicator lamp (MIL) illuminates to inform the driver that an emission system fault has occurred and the powertrain control system requires service. Ignition voltage is supplied directly to the MIL. The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit when the emission system fault occurs. Under normal operating conditions, the MIL should be ON only when the ignition is ON and the engine is OFF.

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Conditions for Running the DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 11 - 32 V.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P0650 or DTC P263A

The ECM detects low voltage during the MIL control circuit driver OFF state. This indicates either a shorted to ground or an open MIL control circuit.

DTC P263B

The ECM detects high voltage on the MIL control circuit during the driver ON state. This indicates a shorted to voltage MIL control circuit.

Action Taken When the DTC Sets

DTC P0650, P263A and P263B are Type B DTCs.

Conditions for Clearing the DTC

DTC P0650, P263A and P263B are Type B DTCs.

Diagnostic Aids

- If the condition is intermittent, move the related harnesses and connectors while monitoring the scan tool MIL control circuit status parameters. Perform this test with the ignition ON and the engine OFF, and with the engine running. The MIL control circuit status parameters change from OK or Not Run to Malfunction if there is a condition with a circuit or a connection.
- If the ECM detects low voltage on the MIL control circuit during the control circuit driver OFF state, DTCs P0650 and DTC P263A may set simultaneously.

Reference Information

Schematic Reference

- **Engine Controls Wiring Schematics 1.6L (LH7)**
- **Instrument Cluster Wiring Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - The MIL Control Circuit Low Voltage Test Status
    - The MIL Control Circuit Open Test Status
    - The MIL Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing.

    - **Go to next step: If Malfunction is not displayed**
3. Engine running.
4. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - The MIL Control Circuit Low Voltage Test Status
    - The MIL Control Circuit Open Test Status
    - The MIL Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing.

    - **Go to next step: If Malfunction is not displayed**
5. Verify the malfunction indicator lamp turns ON and OFF when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - **If the malfunction indicator lamp does not turn ON and OFF**

      Refer to Circuit/System Testing.

    - **Go to next step: If the malfunction indicator lamp turns ON and OFF**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
    - **If the DTC sets**

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

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

Circuit/System Testing

1. Ignition OFF.
2. Disconnect the X1 harness connector at the K20 Engine Control Module.
3. Ignition ON, verify the malfunction indicator lamp does not illuminate.
    - **If the malfunction indicator lamp illuminates**
    1. Test for infinite resistance between the control circuit terminal X1 18 and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance, replace the P16 Instrument Cluster.
    - **Go to next step: If the malfunction indicator lamp does not illuminate**
4. Connect a 3 A fused jumper wire between the control circuit terminal X1 18 and ground.
5. Verify the malfunction indicator lamp illuminates.
    - **If the malfunction indicator lamp illuminates**

      Replace the K20 Engine Control Module.

    - **If the malfunction indicator lamp does not illuminate**
    1. Test for less than 1 V between the control circuit terminal X1 18 and ground.

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

2. Ignition OFF.
3. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω.

6. Ignition OFF, disconnect the harness connector at the instrument cluster.
7. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal 16 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the ignition voltage circuit and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ignition voltage circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - **Go to next step: If the test lamp illuminates**
8. Replace the P16 Instrument Cluster.

Repair Instructions

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

- Refer to **Instrument Cluster Replacement (Equinox)** **Instrument Cluster Replacement (Terrain)**
- Refer to **Control Module References** for control module replacement, programming and setup.

DTC P0658 OR P0659: ACTUATOR HIGH CONTROL CIRCUIT GROUP 1 LOW/HIGH VOLTAGE

Diagnostic Instructions

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

DTC Descriptors

DTC P0658 00

Actuator High Control Circuit Group 1 Low Voltage

DTC P0659 00

Actuator High Control Circuit Group 1 High Voltage

Circuit/System Description

These DTC apply to internal 5 V reference voltage supply within the ECM.

Conditions for Running the DTC

- The ignition is ON.
- The DTCs run continuously once the above condition is met.

Conditions for Setting the DTC

P0658

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The internal 5 V reference voltage is to low.

P0659

The internal 5 V reference voltage is to high.

Action Taken When the DTC Sets

DTC P0658 and P0659 are Type C DTCs.

Conditions for Clearing the DTC

DTC P0658 and P0659 are Type C DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

1. Observe the Freeze Frame/Failure Records with a scan tool.
2. Clear the DTCs with a scan tool.
3. Ignition OFF for 30 s.
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.
5. Verify the DTCs P0658 or P0659 are not set.
   - **If the DTCs P0658 or P0659 are set**

     Replace the K20 Engine Control Module

   - **Go to next step: If the DTCs P0658 or P0659 are not set**
6. All OK.

Repair Instructions

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

Refer to **Control Module References** for ECM replacement programming and setup.

DTC P066A, P066B, P066C, P066D, P066E, P066F, P0671, P0672, P0673, P0674, P067A OR P067B: CYLINDER 1-4 GLOW PLUG CONTROL CIRCUIT

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Diagnostic Instructions

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

DTC Descriptor

DTC P066A

Cylinder 1 Glow Plug Control Circuit Low Voltage

DTC P066B

Cylinder 1 Glow Plug Control Circuit High Voltage

DTC P066C

Cylinder 2 Glow Plug Control Circuit Low Voltage

DTC P066D

Cylinder 2 Glow Plug Control Circuit High Voltage

DTC P066E

Cylinder 3 Glow Plug Control Circuit Low Voltage

DTC P066F

Cylinder 3 Glow Plug Control Circuit High Voltage

DTC P0671

Cylinder 1 Glow Plug Control Circuit

DTC P0672

Cylinder 2 Glow Plug Control Circuit

DTC P0673

Cylinder 3 Glow Plug Control Circuit

DTC P0674

Cylinder 4 Glow Plug Control Circuit

DTC P067A

Cylinder 4 Glow Plug Control Circuit Low Voltage

DTC P067B

Cylinder 4 Glow Plug Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Glow Plug Supply Voltage	P161E	P161E	-
Cylinder 1 Glow Plug Control	P1307, P066A	P1307, P0671	P1307, P066B

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Cylinder 2 Glow Plug Control	P1308, P066C	P1308, P0672	P1308, P066D
Cylinder 3 Glow Plug Control	P1309, P066E	P1309, P0673	P1309, P066F
Cylinder 4 Glow Plug Control	P130A, P067A	P130A, P0674	P130A, P067B

Circuit/System Description

The glow plug control module is integrated in the engine control module (ECM) and is a solid state device which operates the glow plugs. The temperature and the power consumption is controlled within a wide range to suit the engine pre-heating requirements. The glow plug initial ON time will vary based on the system voltage and temperature. Lower temperatures cause longer ON times.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The ignition is ON.
- Engine is running.

Conditions for Setting the DTC

DTC P066A, P066C, P066E and P067A

The engine control module detects a short to ground at the Control Circuit for greater than 1 s.

DTC P066B, P066D, P066F and P067B

The engine control module detects a short to voltage at the control circuit for greater than 1 s.

DTC P0671, P0672, P0673 and P0674

The engine control module detects an open/high circuit at the control circuit for greater than 1 s.

Action Taken When the DTC Sets

DTCs P066A, P066B, P066C, P066D, P066E, P066F, P0671, P0672, P0673, P0674, P067A and P067B are Type C DTCs.

Conditions for Clearing the DTC

DTCs P066A, P066B, P066C, P066D, P066E, P066F, P0671, P0672, P0673, P0674, P067A and P067B are Type C DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Glow Plug System Description

Electrical Information Reference

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

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- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Using a scan tool perform the Glow Plug Self-Test while observing the following parameters.

   Verify that all parameters display OK or Not Run.

   - Cylinder 1, 2, 3 or 4 Glow Plug Control Circuit Open Test Status
   - Cylinder 1, 2, 3 or 4 Glow Plug Control Circuit High Voltage Test Status
   - Cylinder 1, 2, 3 or 4 Glow Plug Control Circuit Low Voltage Test Status
   - **If specified state is not displayed**

     Refer to Circuit/System Testing.

   - **Go to next step: If specified state is displayed**
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not set. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - **If a DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE: **If a glow plug is replaced and the tip is missing or burned off, the cylinder head must be removed and all debris be cleaned out of the cylinder.**

1. Ignition Off, disconnect the harness connector at the appropriate E12 Glow Plug.
2. Ignition On.
3. Verify the glow plug is command Off with a scan tool.
4. Test for less than 0.2 V between the glow plug supply voltage circuit terminal 1 and ground.
   - **If greater than 0.2 V**
   1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Ignition On.
   3. Test for less than 0.2 V between the glow plug supply voltage circuit and ground.
      - If 0.2 V or greater, repair the short to voltage in the circuit.
      - If less than 0.2 V replace the K20 Engine Control Module.
   - **Go to next step: If less than 0.2 V**

   NOTE: **The glow plug supply voltage circuit will only stay On for 3 s when commanding the glow plugs On with the scan tool.**

5. Test for greater than 0.2 V while commanding the appropriate glow plug On with a scan tool.
   - **If less than 0.2 V**

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1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the appropriate glow plug supply voltage circuit and ground.
    - If less than infinite resistance, repair the short to ground in the circuit.
    - If infinite resistance.
3. Test for less than 2Ω in the glow plug supply voltage circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

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

6. Test or replace the appropriate E12 Glow Plug.

Component Testing

1. Ignition Off.
2. Disconnect the harness connector of the appropriate glow plug.
3. Test for less than 2 Ω between glow plug terminal and the component's housing.
    - **If the resistance is more than 2 Ω**

      Replace the affected glow plug.

    - **Go to next step: If the resistance is less than 2 Ω**
4. All OK.

Repair Instructions

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

- Refer to **Glow Plug Replacement**
- Refer to **Control Module References** for Control Module replacement, programming and setup.

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DTC P0685, P0686, P0687, P0689, P0690 OR P1682: ENGINE CONTROLS IGNITION RELAY/IGNITION 1 SWITCH CIRCUIT 2

Diagnostic Instructions

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

DTC Descriptors

DTC P0685

Engine Controls Ignition Relay Control Circuit

DTC P0686

Engine Controls Ignition Relay Control Circuit Low Voltage

DTC P0687

Engine Controls Ignition Relay Control Circuit High Voltage

DTC P0689

Engine Controls Ignition Relay Feedback Circuit Low Voltage

DTC P0690

Engine Controls Ignition Relay Feedback Circuit High Voltage

DTC P1682

Ignition 1 Switch Circuit 2

Diagnostic Fault Information

Engine Controls Ignition Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Relay Coil Supply Voltage	P0689, P1682, P16A7, P16AF	P0685, P0689, P1682, P16A7, P16AF	-
Relay Control Circuit	P0686, P0690, P16B3	P0685, P0689, P1682, P16A7, P16AF	P0685, P0687, P0689, P1682, P16A7, P16AF
Relay Feedback Circuit	P0689, P1682, P16A7, P16AF	P0689, P1682, P16A7, P16AF	P0690, P16B3

Typical Scan Tool Data

Engine Controls Ignition Relay Control Circuit Low Voltage, Open and High Voltage Test Status - Component Commanded OFF

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded OFF **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage Test Status and Not Run for High Voltage Test Status • Component ON - Not Run for Open/Low Voltage Test Status and OK for High Voltage Test Status			
B+	Malfunction	Malfunction	-
Control	Malfunction	Malfunction	Not Run

Engine Controls Ignition Relay Control Circuit Low Voltage, Open and High Voltage Test Status - Component Commanded ON

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded ON **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage Test Status and Not Run for High Voltage Test Status • Component ON - Not Run for Open/Low Voltage Test Status and OK for High Voltage Test Status			
B+	Not Run	Not Run	-
Control	Not Run	Not Run	Malfunction

Circuit/System Description

There are 3 ignition voltage circuits supplied to the engine control module (ECM). Two are supplied by the engine controls ignition relay, and the other is supplied by the ignition main relay. The ECM monitors and compares the ignition voltage supplied by the 2 relays.

Conditions for Running the DTC

P0685, P0686, P0687

The DTC runs when Ignition 1 signal voltage is greater than 11 V.

P0689

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- DTC P0685 is not set.
- The engine controls ignition relay is commanded ON.
- Ignition 1 signal voltage is greater than 11 V.
- The DTC runs continuously when the above conditions are met.

P0690

- DTC P0685 is not set.
- The engine controls ignition relay is commanded OFF.
- The DTC runs continuously when the above conditions are met.

P1682

- The engine controls ignition relay is commanded ON.
- Ignition voltage is greater than 5.5 V.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0685

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 s.

P0686

The ECM detects a short to ground on the control circuit for greater than 2 s.

P0687

The ECM detects a short to voltage on the control circuit for greater than 2 s.

P0689

The ECM detects the engine controls ignition relay feedback circuit is less than 5 V.

P0690

The ECM detects the engine controls ignition relay feedback circuit is greater than 4 V for greater than 5 s.

P1682

The ECM detects that the voltage level difference is greater than 3 V between the 2 ignition voltage circuits for greater than 1 s.

Action Taken When the DTC Sets

- DTCs P0685, P0686, P0687, P0689 and P0690 are Type C DTCs.
- DTC P1682 is a Type A DTC.

Conditions for Clearing the DTC

- DTCs P0685, P0686, P0687, P0689 and P0690 are Type C DTCs.
- DTC P1682 is a Type A DTC.

Diagnostic Aids

The engine controls ignition relay may also be labeled the powertrain relay, the engine control module relay, or the main relay. The ignition main relay may also be labeled the run/crank relay, the ignition run relay, the ignition 1 relay or the ignition relay.

Reference Information

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Schematic Reference

- **Engine Controls Wiring Schematics 1.6L (LH7)**
- Power Distribution Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Electrical Center Identification Views**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **A short to voltage on other components may cause DTC P0690 to set. If any other DTC is set, diagnose that DTC first.**
- **If you were sent here from Engine Cranks But Does Not Run, proceed to Circuit/System Testing.**

1. Ignition ON, observe the scan tool DTC information. Verify DTC P0685, P0686, P0687, P0689, P0690 or P1682 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing.

   - **Go to next step: If none of the DTCs are set**
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing unless sent here from Engine Cranks But Does Not Run.**

1. Ignition OFF, disconnect the KR75 Engine Controls Ignition Relay.
2. Verify a test lamp illuminates between ground and the B+ terminals listed below:

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- Terminal 1
- Terminal 3
- **If the test lamp does not illuminate**

  Replace the front compartment fuse block.

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

NOTE:

- **High resistance in the circuit/underhood fuse block for either the KR75 Engine Controls Ignition Relay or the KR73 Ignition Main Relay can cause DTC P1682 to set.**
- **A short to voltage on any of the circuits supplied by the engine controls ignition relay can cause DTC P0690 to set.**

3. Ignition ON.
4. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal 5 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 1.
      - If 1 V or greater, repair the short to voltage in the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If the test lamp does not illuminate**
5. Ignition OFF, connect a 20 A fused jumper wire between the B+ circuit terminal 3 and the ignition voltage circuit terminal 5.
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 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 ignition voltage circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **Go to next step: If B+ is displayed**
8. Ignition OFF, connect a DMM, set to the diode setting, between control circuit terminal 2 and ground.
9. Verify the DMM displays OL.
   - **If OL is not displayed**
   1. Disconnect the X1 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between ground and the relay control circuit.
      - If less than infinite resistance, repair the short to ground in the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **Go to next step: If OL is displayed**
10. Ignition ON.
11. Verify the DMM displays less than 1 V.
    - **If 1 V or greater**
    1. Ignition OFF, disconnect the X1 connector at the K20 Engine Control Module.

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2. Ignition ON.
3. Test for less than 1 V on the relay control circuit.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V
4. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - if less than 2 Ω, replace the K20 Engine Control Module.

- **Go to next step: If less than 1 V**

12. Test or replace the KR75 Engine Controls Ignition Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR75 Engine Controls Ignition Relay.
2. Test for 70 - 110 Ω between terminals 1 and 2:
    - **If less than 70 Ω or greater than 110 Ω**

      Replace the KR75 Engine Controls Ignition Relay.

    - **Go to next step: If between 70 - 110 Ω**
3. Test for infinite resistance between the terminals listed below:
    - 3 and 2
    - 3 and 5
    - 3 and 1
    - 1 and 5
    - **If less than infinite resistance**

      Replace the KR75 Engine Controls Ignition Relay.

    - **Go to next step: If infinite resistance**
4. Install a 20 A fused jumper wire between relay terminal 1 and 12 V. Install a jumper wire between relay terminal 2 and ground.
5. Test for less than 2 Ω between terminals 3 and 5.
    - **If 2 Ω or greater**

      Replace the KR75 Engine Controls Ignition Relay.

    - **Go to next step: If less than 2 Ω**
6. All OK.

Repair Instructions

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

- Refer to **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC C1201, P1000, P1001, P1003, P1008, P1009, P100A, P100E, P103D, P103E, P10B6-P10B9, P10BF, P10C6, P10C7, P10C8, P10F5, P1100, P1103, P117A, P11FF, P1200, P128C, P128D, P128E, P128F, P129E, P12A8, P130F, P135C, P135D, P135E, P135F, P1436, P143A, P143B, P1472, P14A0, P14B6, P14BD, P14CD, P14CE, P14D4, P14D5, P14D6, P150C, P151A, P151D, P153C, P153D, P155D, P1591, P15E2, P15F2, P15F9, P15FA, P15FB, P165C, P167F, P16E8, P16FF, P175F, P1761, P1762, P1775, P179B, P189C, P2544, P308D, P30B4, P30B5, P30BC, P30BD, P30D5, P30DE, P3168, P3169 OR P316B: MESSAGE COUNTER INCORRECT

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Diagnostic Instructions

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

DTC Descriptor

DTC C1201

Transmission Range Redundant Command Message Counter Incorrect

DTC P1000

Fuel Pump Driver Control Module Reset Count Message Counter Incorrect

DTC P1001

Evaporative Emission (EVAP) System Signals Message Counter Incorrect

DTC P1003

Fuel Composition Signals Message Counter Incorrect

DTC P1008

Engine Coolant Bypass Valve Command Signal Message Counter Incorrect

DTC P1009

Fuel Pump Driver Control Module Temperature High Signal Message Counter Incorrect

DTC P100A

Turbocharger Boost Control Signal Message Counter Incorrect

DTC P100E

Accelerator Pedal Position Signal Message Counter Incorrect

DTC P103D

Engine Coolant Pump Control Signal Message Counter Incorrect

DTC P103E

Auxiliary Coolant Pump Control Signal Message Counter Incorrect

DTC P10B6

Mass Air Flow Sensor Intake Air Signals Message Counter Incorrect Bank 1

DTC P10B7

Mass Air Flow Sensor Intake Air Signals Message Counter Incorrect Bank 2

DTC P10B8

Mass Air Flow Sensor Barometric Pressure Sensor Signal Message Counter Incorrect Bank 2

DTC P10B9

Mass Air Flow Sensor Barometric Pressure Sensor Signal Message Counter Incorrect Bank 1

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DTC P10BF

Engine Coolant Bypass Valve Secondary Command Signal Message Counter Incorrect

DTC P10C6

Engine Diagnostic Status Signal Message Counter Incorrect

DTC P10C7

Reductant Control System Signal Message Counter Incorrect

DTC P10C8

Reductant Temperature Signal Message Counter Incorrect

DTC P10F5

EVAP Purge Pump Status Message Counter Incorrect

DTC P1100

Fuel Level Sensor 2 Signal Message Counter Incorrect

DTC P1103

Water in Fuel Signal Message Counter Incorrect

DTC P117A

Engine Block Coolant Valve Signal Message Counter Incorrect

DTC P11FF

Fuel Pump Command Signal Message Counter Incorrect

DTC P1200

Fuel Level Sensor 1 Signal Message Counter Incorrect

DTC P128C

Fuel Rail Temperature Sensor 1 Signal Message Counter Incorrect

DTC P128D

Fuel Rail Temperature Sensor 2 Signal Message Counter Incorrect

DTC P128F

Fuel Rail Pressure Sensors 1 and 2 Signals Message Counter Incorrect

DTC P129E

Fuel Pump Driver Control Module Signal Message Counter Incorrect

DTC P12A8

Fuel Pump Control Status Signal Message Counter Incorrect

DTC P130F

Ignition On/Start Voltage Signal Message Counter Incorrect

DTC P135C

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Cooling Fan 1 Status Signals Message Counter Incorrect

DTC P135D

Cooling Fan 2 Status Signals Message Counter Incorrect

DTC P135E

Cooling Fan 3 Status Signals Message Counter Incorrect

DTC P135F

Cooling Fan 4 Status Signals Message Counter Incorrect

DTC P1436

Particulate Matter Sensor Control Module Temperature Signal Message Counter Incorrect

DTC P143A

Reductant Control System Diagnostic Signal Message Counter Incorrect

DTC P143B

Reductant Control System Information Signal Message Counter Incorrect

DTC P1472

Particulate Matter Sensor Signal Message Counter Incorrect

DTC P14A0

Charge Air Cooler Coolant Pump Status Signal Message Counter Incorrect

DTC P14B6

Mass Air Flow Sensor Signal Message Counter Incorrect

DTC P14BD

Mass Air Flow Sensor Signal Message Counter Incorrect Bank 2

DTC P14CD

Fuel Pump Driver Control Module Configuration Command Signal 1 Message Counter Incorrect

DTC P14CE

Fuel Pump Driver Control Module Configuration Status Signal Message Counter Incorrect

DTC P14D4

Fuel Pump Driver Control Module Configuration Command Signal 2 Message Counter Incorrect

DTC P14D5

Fuel Pump Driver Control Module Configuration Command Signal 3 Message Counter Incorrect

DTC P14D6

Fuel Pump Driver Control Module Configuration Command Signal 5 Message Counter Incorrect

DTC P150C

Transmission Control Module Engine Speed Request Signal Message Counter Incorrect

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DTC P151A

Throttle Actuator Control (TAC) Signal Message Counter Incorrect

DTC P151D

Transmission Control Module Engine Shutdown Request Signal Message Counter Incorrect

DTC P153C

Engine Speed Signal Message Counter Incorrect

DTC P153D

Driver Torque Request Signal Message Counter Incorrect

DTC P155D

Hill Descent Control Message Counter Incorrect

DTC P1591

Body Control Module Engine Speed Request Signal Message Counter Incorrect

DTC P15E2

Alternative Fuel System Request Signal Message Counter Incorrect

DTC P15F2

Engine Torque Command Signal Message Counter Incorrect

DTC P15F9

Hybrid/EV System Engine Speed Control Intervention Request Type Signal Message Counter Incorrect

DTC P15FA

Wheel Slip Status Signal Message Counter Incorrect

DTC P15FB

Brake Pedal Position Sensor Signal Message Counter Incorrect

DTC P165C

Sensor Reference Voltage Status Message Counter Incorrect

DTC P167F

Battery Voltage Signal Message Counter Incorrect

DTC P16E8

Engine Controls Ignition Relay Signal Message Counter Incorrect

DTC P16FF

Engine Controls Ignition Relay Request Signal Message Counter Incorrect

DTC P175F

Acceleration Sensor Signal Message Counter Incorrect

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DTC P1761

Up and Down Shift Switch Signal Message Counter Incorrect

DTC P1762

Transmission Mode Switch Signal Message Counter Incorrect

DTC P1775

Transmission Range Request Signal Message Counter Incorrect

DTC P179B

Transmission Range State Command Signal Message Counter Incorrect

DTC P189C

Transmission Range Command Message Performance

DTC P2544

Transmission Torque Request Signal Message Counter Incorrect

DTC P30B4

NOx Sensor 1 Signal Message Counter Incorrect

DTC P30B5

NOx Sensor 2 Signal Message Counter Incorrect

DTC P30BC

Particulate Matter Sensor Control Module Status Signal Message Counter Incorrect

DTC P30BD

Engine Stall Prevention Active Signal Message Counter Incorrect

DTC P30D5

NOx Sensor 3 Signal Message Counter Incorrect

DTC P30DE

Fuel Rail Pressure Sensor 2 Signal Message Counter Incorrect

DTC P3168

Fuel Injector Set 2 Commands Signal Message Counter Incorrect

DTC P3169

Fuel Injector Control Module Commands Signal Message Counter Incorrect

DTC P316B

Secondary Fuel System Requests Signal Message Counter Incorrect

Circuit/System Description

Control modules connected to the serial data circuits monitor the communication during normal vehicle operation. Operating information and commands are exchanged among the control modules. Each

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module on the serial data circuit maintains a transmit error counter and a receive error counter. The counter values increase with detected errors and decrease with error-free messages.

Conditions for Running the DTC

- Ignition = On - For greater than 3 s
- Serial Data = Enabled

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

Conditions for Setting the DTC

Serial Data = Message Counter Incorrect - Control module that has set the DTC

The above condition(s) must occur 5 times.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type C DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type C DTC

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following system/component: Serial Data
   - **If a related DTC is set**

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

   - **Go to next step: If a related DTC is not set**
3. Clear the DTCs.
4. Operate the vehicle within the Conditions for Running the DTC.

   Verify the DTC does not set.

   - **If the DTC sets**

   1. Ignition/Vehicle - Off
   2. Replace the component: The control module that is sending the error message.
   3. Operate the vehicle within the Conditions for Running the DTC.

      Verify the DTC does not set.

      - If the DTC sets

        Replace the component: Control module that has set the DTC

      - If the DTC does not set
   4. All OK.

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

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5. All OK.

Repair Instructions

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

For control module replacement, programming and setup, refer to **Control Module References**

DTC P1004, P119D, P119E, P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0, P11D1, P11D2, P11D5, P11D8, P11D9, P11DA, P11DC, P11FC, P11FD, P11FE, P22A0, P22A1, P22A3, P22A4, P22A5, P22A6, P22A7, P22A8, P22A9 OR P22FE: NOX SENSOR 2

Diagnostic Instructions

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

DTC Descriptors

DTC P119D

NOx Sensor 2 Signal Circuit

DTC P119E

NOx Sensor 2 Signal Circuit Low Voltage

DTC P119F

NOx Sensor 2 Signal Circuit High Voltage

DTC P11BE

O2 Reference Voltage Circuit (NOx Sensor 2)

DTC P11BF

O2 Reference Voltage Circuit Low Voltage (NOx Sensor 2)

DTC P11C0

O2 Reference Voltage Circuit High Voltage (NOx Sensor 2)

DTC P11C7

NOx Sensor 2 Heater Ground Circuit

DTC P11C8

NOx Sensor 2 Heater Ground Circuit High

DTC P11D0

O2 Signal Circuit (NOx Sensor 2)

DTC P11D1

O2 Signal Circuit Low Voltage (NOx Sensor 2)

DTC P11D2

O2 Signal Circuit High Voltage (NOx Sensor 2)

DTC P11D5

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NOx Sensor 2 Exceeded Minimum Learning Limit

DTC P11D8

O2 Pump Current Control Circuit (NOx Sensor 2)

DTC P11D9

O2 Pump Current Control Circuit Low Voltage (NOx Sensor 2)

DTC P11DA

O2 Pump Current Control Circuit High Voltage (NOx Sensor 2)

DTC P11DC

NOx Sensor 2 Current Performance

DTC P11FC

O2 Low Reference Circuit (NOx Sensor 2)

DTC P11FD

O2 Low Reference Circuit Low Voltage (NOx Sensor 2)

DTC P11FE

O2 Low Reference Circuit High Voltage (NOx Sensor 2)

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DTC P22A0

NOx Sensor 2 Circuit Low Voltage

DTC P22A1

NOx Sensor 2 Circuit High Voltage

DTC P22A3

NOx Sensor 2 Heater Control Circuit

DTC P22A4

NOx Sensor 2 Heater Control Circuit Low Voltage

DTC P22A5

NOx Sensor 2 Heater Control Circuit High Voltage

DTC P22A6

NOx Sensor 2 Heater Feedback Circuit

DTC P22A7

NOx Sensor 2 Heater Feedback Performance

DTC P22A8

NOx Sensor 2 Heater Feedback Circuit Low Voltage

DTC P22A9

NOx Sensor 2 Heater Feedback Circuit Low Voltage

DTC P22FE

NOx Sensor 2 Performance - Sensing Element

Circuit/System Description

The nitrogen oxides (NOx) sensors are part of the selective catalytic reduction system, a device used to reduce Nox emission on diesel engines. There are two NOx sensors, one placed upstream of selective catalytic reduction, to measure inlet NOx concentration, and one placed downstream. They are connected with the control module via CAN and all the information is exchanged through it. Since it is a smart sensor, all the electrical monitoring is performed inside the sensor and only the results are sent to the ECM. Each NOx sensor contains a sensing cell, a pumping cell, and a heater. A sample of exhaust gas passes through a diffusion gap between the sensing cell and the pumping cell. The NOx sensor maintains a constant reference voltage across the sensing cell. An electronic circuit within the sensor controls the pump current through the pumping cell in order to maintain a constant voltage in the sensing cell. The amount of current required to maintain the reference voltage in the sensing cell is proportional to the concentration of NOx in the exhaust. The ECM varies the amount of diesel exhaust fluid (reductant) added by varying the reductant injector duty cycle in response to changes in engine exhaust NOx levels. The smart NOx sensors consist of two components, the NOx module and the NOx sensor element that are serviced as a unit. A circuit or performance condition with a NOx sensor is detected by the NOx sensor module. The smart NOx sensor module communicates the condition to the ECM over the serial data line. The ECM sets a DTC when a serial data message is received from the NOx sensor module.

Conditions for Running the DTCs

P119D, P119E, P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0, P11D1, P11D2, P11D8, P11D9, P11DA, P11FC, P11FD, P11FE, P22A3, P22A4, P22A5, P22A6, P22A8, P22A9

- DTC U029E is not set
- The Engine Controls Ignition Relay Feedback Signal voltage is greater than 11 V
- The NOx Sensor 2 Heater Operation parameter displays Allowed
- The NOx sensor supply voltage is greater than 10.8 V.

These DTCs run continuously when the above conditions are met

P11D5

- DTC P003A, P0046, P0087, P00AF, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P122B-P122D, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02E0, P02E3-P02E5, P02E8, P02E9, P02EB, P02EE, P02EF, P02F0-P02F5, P0335, P0336, P0403, P0405, P0406, P042E, P042F, P049D, P0489, P0490, P062B, P062D, P111E, P119D-P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0-P11D2, P11D8, P11D9, P11DA, P11DC, P11DE, P11FC-P11FE, P1248, P1249, P124A-P124F, P126A, P1402, P1407, P140F, P1424, P1425, P16D7-P16D9, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227-P2230, P228A, P220B, P228B, P229E, P229F, P22A0, P22A1, P22A3-P22A9, P22FE, U029E is not set
- The Engine Controls Ignition Relay Feedback Signal voltage is greater than 11 V
- The NOx Sensor 2 Heater Operation parameter displays Allowed
- The NOx sensor supply voltage is greater than 10.8 V.
- The engine speed is between 550 - 3, 500 RPM.
- The intake manifold pressure lower than 300 kPa (43.5 psi).
- Time elapsed since diesel particulate filter regeneration is greater than 300 s.

These DTCs run continuously when the above conditions are met

P11DC

- DTC P119D-P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0-P11D2, P11D8, P11D9, P11DA, P11FC-P11FE, P220B, P229E, P22A3-P22A9, or U029E is not set.

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- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx Sensor 2 Heater Operation parameter displays Allowed.
- The NOx sensor supply voltage is greater than 10.8 V.

The DTC runs continuously when the above conditions are met.

P22A0, P22A1

- DTC P11BE, P11BF, P11C0, P11C7, P11C8, P11D0, P11D1, P11D2, P11D8, P11D9, P11DA, P11DC, P11DE, P11FC, P11FD, P11FE, P119D, P119E, P119F, P220B, P229E, P22A3, P22A4, P22A5,

  P22A6, P22A7, P22A8, P22A9, U029D is not set

- The engine is running.
- The Engine Controls Ignition Relay Feedback Signal voltage is greater than 11 V
- The NOx Sensor 2 Heater Operation parameter displays Allowed
- The NOx sensor supply voltage is greater than 10.8 V.

These DTCs run continuously when the above conditions are met.

P22A7

- DTC U029D is not set
- The Engine Controls Ignition Relay Feedback Signal voltage is greater than 11 V
- The NOx Sensor 2 Heater Operation parameter displays Allowed
- The NOx sensor supply voltage is greater than 10.8 V.

The DTC runs continuously when the above conditions are met for greater than 180 s.

P22FE

- DTC P0070, P0071, P0E9, P0EA-P0EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P021A, P021B, P0234, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0299, P02EE, P02EF, P02F0-P02F5, P0335, P0336, P0405, P0406, P049D, P0502, P0503, P0545, P0546, P062B, P062D, P0772, P0773, P111E, P113B, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P1192-P1194, P119A-P119F, P11BE, P11BF, P11C0, P11C5-P11C8, P11CC, P11D0-P11D2, P11D8, P11D9, P11DA-P11DE, P11FC-P11FE, P1248, P1249, P124A-P124F, P2081, P2082, P20CB, P20CD, P20CE, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2205-P2211, P220A, P220B, P2227, P2228, P2229, P2230, P2263, P229E, P229F, P22A0, P22A1, P22A3-P22A9, P22F9, P22FA, P2670, U029D or U029E is not set
- The Engine Controls Ignition Relay Feedback Signal voltage is greater than 11 V
- The NOx Sensor 1 and 2 Heater Operation parameters display Allowed
- The NOx sensor supply voltage is greater than 10.8 V.
- The engine speed is between 0 - 1, 000 RPM.

The DTC runs up to 10 times per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The NOx sensor module detects a fault in the NOx sensor circuitry or a performance fault in the NOx sensor for greater than 2 s.

Action Taken When the DTC Sets

DTCs P119E, P119F, P11BF, P11C0, P11C8, P11D1, P11D2, P11D5, P11D9, P11DA, P11DC, P11FD, P11FE, P22A0, P22A1, P22A4, P22A5, P22A7, P22A8, P22A9 and P22FE are Type B DTCs.

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DTCs P119D, P11BE, P11C7, P11D0, P11D8, P11FC, P22A3 and P22A6, are Type A DTCs.

Conditions for Clearing the DTC

DTCs P119E, P119F, P11BF, P11C0, P11C8, P11D1, P11D2, P11D5, P11D9, P11DA, P11DC, P11FD, P11FE, P22A0, P22A1, P22A4, P22A5, P22A7, P22A8, P22A9 and P22FE are Type B DTCs.

DTCs P119D, P11BE, P11C7, P11D0, P11D8, P11FC, P22A3 and P22A6, are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTCs P119D, P119E, P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0, P11D1, P11D2, P11D5, P11D8, P11D9, P11DA, P11DC, P11FC, P11FD, P11FE, P22A0, P22A1, P22A3, P22A4, P22A5, P22A6, P22A7, P22A8, P22A9 or P22FE are not set
   - **If any of the DTCs are set**

     Replace the B195B Nitrogen Oxides Sensor 2

   - **Go to next step: If none of the DTCs are set**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set
   - **If the DTC sets**

     Replace the B195B Nitrogen Oxides Sensor 2

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

Repair Instructions

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

Refer to **Nitrogen Oxides Sensor Replacement - Position 2**

DTC P1005: FUEL PUMP DRIVER CONTROL MODULE ENABLE TOO MANY RESETS

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Diagnostic Instructions

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

DTC Descriptor

DTC P1005

Fuel Pump Driver Control Module Enable Too Many Resets

Circuit/System Description

The fuel pump driver control module sends a message every 100 ms to the engine control module (ECM) that indicates the amount of time elapsed since the last controller reset (power up or running reset). This message is used to detect if the fuel pump driver control module has unexpectedly reset and will eventually set a DTC if the resets continue.

Conditions for Running the DTC

- DTC U18A2 is not set.
- Ignition voltage is greater than 11 V.
- KR73 Ignition Main Relay is commanded On.

The DTC runs continuously when the conditions above are met.

Conditions for Setting the DTC

The fuel pump driver control module has exceeded 320 resets in less than 200 s

Action Taken When the DTC Sets

DTC P1005 is a Type B DTC.

Conditions for Clearing the DTC

DTC P1005 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify DTC U18A2 is not set.
   - **If DTC U18A2 is set**

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

   - **Go to next step: If DTC U18A2 is not 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.
3. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition Off and all vehicle systems Off.
2. It may take up to 2 min for all vehicle systems to power down before an accurate ground or low reference circuit continuity test can be performed.
3. Disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
4. Test for less than 10 Ω between the ground circuit terminal 22 and ground.
   - ***If 10 Ω or greater***
   1. Test for less than 2 Ω between the ground circuit terminal 22 and Terminal G402.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - ***Go to next step: If less than 10 Ω***
5. Verify that a test lamp illuminates between the B+ circuit terminal 7 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Remove B+ fuse.
   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 B+ 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. Remove B+ fuse.
   2. Test for infinite resistance between the B+ circuit terminal 7 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit
      - If infinite resistance, replace the K111 Fuel Pump Driver Control Module
   - **Go to next step: If the test lamp illuminates**
6. Ignition On.
7. Verify a test lamp illuminates between the ignition circuit terminal 17 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Remove ignition fuse.
   2. Test for less than 2 Ω in the ignition circuit end to end.

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- If 2 Ω or greater, repair the open/high resistance in the ignition 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. Remove ignition fuse.
2. Test for infinite resistance between the ignition circuit terminal 17 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit
    - If infinite resistance, replace the K111 Fuel Pump Driver Control Module

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

8. Verify a test lamp illuminates between the voltage supply circuit terminal 16 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Remove voltage supply circuit fuse.
    2. Test for less than 2 Ω in the voltage supply circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the ignition 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. Remove voltage supply circuit fuse and all components on the same circuit.
    2. Test for infinite resistance between the voltage supply circuit terminal 16 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit
        - If infinite resistance, replace the K111 Fuel Pump Driver Control Module
    - **Go to next step: If the test lamp illuminates**
9. Replace the K111 Fuel Pump Driver Control Module.

Repair Instructions

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

For Control Module replacement, programming and setup, refer to **Control Module References**

DTC P1007 OR P129D: FUEL PUMP DRIVER CONTROL MODULE IGNITION ON/START SWITCH CIRCUIT VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P1007

Fuel Pump Driver Control Module Ignition On/Start Switch Circuit High Voltage

DTC P129D

Fuel Pump Driver Control Module Ignition On/Start Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P129D	P129D	P1007	-

Circuit/System Description

The fuel pump driver control module monitors the ignition voltage circuit in order to determine if the voltage is within the normal operating range.

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Conditions for Running the DTC

- Engine is cranking or running
- The powertrain sensor relay is commanded ON

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P1007

The fuel pump driver control module ignition switch circuit voltage is greater than a calibrated value for 1 s.

P129D

The fuel pump driver control module ignition switch circuit voltage is less than a calibrated value for 1 s.

Action Taken When the DTC Sets

DTC P1007 and P129D are Type B DTCs.

Conditions for Clearing the DTC

DTC P1007 and P129D are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the engine cranks.
    - **If the engine does not crank**

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Refer to **Starter Solenoid Does Not Click (Without KL9)** **Starter Solenoid Does Not Click (KL9)** .

- **Go to next step: If the engine cranks**

2. Ignition ON.
3. Verify DTC P0562 or P0563 is not set.
   - **If DTC P0562 or P0563 is set**

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

   - **Go to next step: DTC P0562 or P0563 is not set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

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

1. Ignition OFF, all vehicle systems OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Ignition ON.
3. Verify a test lamp illuminates between the ignition circuit terminal 17 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp.
   2. Test for less than 2 Ω in the ignition circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp.
   2. Test for infinite resistance between the ignition circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K111 Fuel Pump Driver Control Module.
   - **Go to next step: If the test lamp illuminates**
4. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
5. Verify a test lamp does not illuminate between the ignition circuit terminal 17 and ground.
   - **If the test lamp illuminates**

     Repair the short to voltage on the circuit.

   - **Go to next step: If the test lamp does not illuminate**
6. Replace the K111 Fuel Pump Driver Control Module.

Repair Instructions

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

For control module replacement, programming, and setup refer to **Control Module References**

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DTC P1015, P1016, P1017, P1018, P1019 OR P101A: REDUCTANT CONTROL MODULE SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P1015

Reductant Control Module Sensor Serial Communication Circuit Low Voltage

DTC P1016

Reductant Control Module Sensor Serial Communication Circuit High Voltage

DTC P1017

Reductant Control Module Sensor Serial Communication Circuit Performance

DTC P1018

Reductant Control Module Sensor Communication Voltage Supply Circuit Low Voltage

DTC P1019

Reductant Control Module Sensor Communication Voltage Supply Circuit High Voltage

DTC P101A

Reductant Control Module Sensor Communication Ground Circuit High Voltage

Circuit/System Description

The reductant quality sensor is located in the reductant tank and uses an ultrasonic signal to measure reductant fluid quality. The reductant quality sensor includes an integrated temperature sensor to measure reductant fluid temperature. The reductant quality sensor communicates with the reductant control module using serial data.

Conditions for Running the DTC

P1015, P1016

- DTC U010E is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The reductant control module is not initializing.

The DTCs run continuously when the above conditions are met.

P1017

- DTC P1015, P1016 or U010E is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The reductant control module is not initializing.

The DTCs run continuously when the above conditions are met.

P1018, P1019, P101A

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- DTC P1015, P1016, P1017 or U010E is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The reductant control module is not initializing.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P1015

The reductant control module detects a low circuit fault on the signal circuit for greater than 1 s.

P1016

The reductant control module detects a high circuit fault on the signal circuit for greater than 1 s.

P1017

The reductant control module detects a performance fault on the signal circuit for greater than 1 s.

P1018

The reductant control module detects a short to ground on the 5 V reference circuit for greater than 1 s.

P1019

The reductant control module detects a short to voltage on the 5 V reference circuit for greater than 1 s.

P101A

The reductant control module detects a short to voltage on the low reference circuit for greater than 1 s.

Action Taken When the DTC Sets

DTCs P1015, P1016, P1017, P1018, P1019 and P101A are Type A DTCs.

- The reductant quality value is replaced with the last measured value.
- The reductant quality sensor temperature value is replaced with a default value
- The Warning/Inducement strategy is activated.

Conditions for Clearing the DTC

DTCs P1015, P1016, P1017, P1018, P1019 and P101A are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTCs P1015, P1016, P1017, P1018, P1019 or P101A are not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing

   - **Go to next step: If none of the DTC 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.
3. Verify that DTCs P1015, P1016, P1017, P1018, P1019 or P101A are not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing

   - **Go to next step: If no DTC Is set**
4. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the B295 Reductant Quality Sensor.
2. Ignition On.
3. Test for less than 20 Ω between low reference terminal 3 and ground.
   - **If greater than 20 Ω**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant 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 K115 Reductant Control Module.
   - **Go to next step: If less than 20 Ω**
4. Test for 4.8-5.2 V between 5 V reference circuit terminal 1 and ground
   - **If less than 4.8 V**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. 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
   3. 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, replace the K115 Reductant Control Module
   - **If greater than 5.2 V**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. Test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage in the circuit.
      - If less than 1 V, replace the K115 Reductant Control Module
   - **Go to next step: If between 4.8-5.2 V**
5. Ignition ON, test for 4.2-4.8 V between signal circuit terminal 2 and ground.
   - **If less than 4.2 V**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. Test for less than 2 Ω in the signal circuit end to end.

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

3. Test for infinite resistance between the signal circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K115 Reductant Control Module

- **If greater than 4.8 V**

1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant 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 in the circuit.
    - If less than 1 V, replace the K115 Reductant Control Module

- **Go to next step: If between 4.2-4.8 V**

6. Replace the B295 Reductant Quality Sensor.

Repair Instructions

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

- Refer to **Emission Reduction Fluid Controller Replacement**
- Refer to **Emission Reduction Fluid Tank Replacement** - B295 Reductant Quality Sensor

DTC P1029, P102A, OR P102B: FUEL PUMP PHASE U-V-W CIRCUITS

Diagnostic Instructions

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

DTC Descriptor

DTC P1029

Fuel Pump Phase U-V-W Circuits Open

DTC P102A

Fuel Pump Phase U-V-W Circuits Low Voltage

DTC P102B

Fuel Pump Phase U-V-W Circuits High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Control Circuit Shorted to Control Circuit
Control - Terminal 1 @ A7 Fuel Pump and Level Sensor Assembly	P102A	P1029	P102B	-
Control - Terminal 2 @ A7 Fuel Pump and Level Sensor Assembly	P102A	P1029	P102B	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Control Circuit Shorted to Control Circuit
Control - Terminal 3 @ A7 Fuel Pump and Level Sensor Assembly	P102A	P1029	P102B	-

Typical Scan Tool Data

Fuel Pump Phase U-V-W Circuits High Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage	Control Circuit Shorted to Control Circuit
Operating Conditions: Ignition = On **Parameter Normal Range:** OK or Not Run				
Control - Terminal 1 @ A7 Fuel Pump and Level Sensor Assembly	-	-	Malfunction	-
Control - Terminal 2 @ A7 Fuel Pump and Level Sensor Assembly	-	-	Malfunction	-
Control - Terminal 3 @ A7 Fuel Pump and Level Sensor Assembly	-	-	Malfunction	-

Fuel Pump Phase U-V-W Circuits Low Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage	Control Circuit Shorted to Control Circuit
Operating Conditions: Ignition = On **Parameter Normal Range:** OK or Not Run				
Control - Terminal 1 @ A7 Fuel Pump and Level Sensor Assembly	Malfunction	-	-	-
Control - Terminal 2 @ A7 Fuel Pump and Level Sensor Assembly	Malfunction	-	-	-
Control - Terminal 3 @ A7 Fuel Pump and Level Sensor Assembly	Malfunction	-	-	-

Fuel Pump Phase U-V-W Circuits Open Test Status

Circuit	Short to Ground	Open	Short to Voltage	Control Circuit Shorted to Control Circuit
Operating Conditions: Ignition = On **Parameter Normal Range:** OK or Not Run				
Control - Terminal 1 @ A7 Fuel Pump and Level Sensor Assembly	-	Malfunction	-	-
Control - Terminal 2 @ A7 Fuel Pump and Level Sensor Assembly	-	Malfunction	-	-
Control - Terminal 3 @ A7 Fuel Pump and Level Sensor Assembly	-	Malfunction	-	-

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Circuit/System Description

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

Circuit	Description
Control	The output circuit varies between ground and 12 V.

Component	Description
G12A Fuel Pump - Primary	The component has a 3-phase motor. The control module converts the DC voltage from the battery to 3-phase AC to power the motor.
K111 Fuel Pump Driver Control Module	The control module K111 supplies the fuel pump with a 3-phase voltage in order to achieve the desired pump speed required for building fuel line pressure.

Conditions for Running the DTC

P1029

- KR73 Ignition Main Relay = On
- Fuel Pump Speed = 0 RPM

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

P102A, P102B

KR73 Ignition Main Relay = On

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

Conditions for Setting the DTC

P1029

Fuel Pump Phase U-V-W Circuits = Open - For greater than 1 s

P102A

Fuel Pump Phase U-V-W Circuits = Short to Ground - For greater than 1 s

P102B

Fuel Pump Phase U-V-W Circuits = Short to Voltage - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Component View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC U18A2 is not set.
   - **If the DTC is set**

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

   - **Go to next step: If the DTC is not set**
3. Verify the scan tool parameter:
   - Fuel Pump Phase U-V-W Circuits High Voltage Test Status = OK or Not Run
   - Fuel Pump Phase U-V-W Circuits Low Voltage Test Status = OK or Not Run
   - Fuel Pump Phase U-V-W Circuits Open Test Status = OK or Not Run
   - **If not the specified state**

     Refer to Circuit/System Testing

   - **Go to next step: If the specified state**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing

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

Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: K111 Fuel Pump Driver Control Module
3. Ignition - On/Vehicle - In Service Mode
4. Test for less than 1 V between the test points:
   - Control circuit terminal 8 & Ground
   - Control circuit terminal 9 & Ground
   - Control circuit terminal 24 & Ground
   - **If 1 V or greater**

     Repair the short to voltage on the circuit.

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- **Go to next step: If less than 1 V**

5. Ignition/Vehicle & All vehicle systems - Off
6. Test for infinite resistance between the test points:
    - Control circuit terminal 8 & Ground
    - Control circuit terminal 9 & Ground
    - Control circuit terminal 24 & Ground
    - **If less than infinite resistance**

      Repair the short to ground on the circuit.

    - **Go to next step: If infinite resistance**
7. Disconnect the electrical connector: A7 Fuel Pump and Level Sensor Assembly
8. Test for less than 2 Ω between the test points:
    - Control circuit terminal 8 @ Control module harness & Terminal 1 @ Component harness
    - Control circuit terminal 9 @ Control module harness & Terminal 2 @ Component harness
    - Control circuit terminal 24 @ Control module harness & Terminal 3 @ Component harness
    - **If 2 Ω or greater**

      Repair the open/high resistance in the circuit:

    - **Go to next step: If less than 2 Ω**
9. Replace the component: A7 Fuel Pump Driver Control Module
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.

    Verify the DTC does not set.

    - **If the DTC sets**

      Replace the component: K111 Fuel Pump and Level Sensor Assembly

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

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Repair Instructions

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

- Refer to **Fuel Tank Fuel Pump Module Replacement (FWD)** **Fuel Tank Fuel Pump Module Replacement (AWD)** - A7 Fuel Pump and Level Sensor Assembly
- For control module replacement, programming and setup, refer to **Control Module References**

DTC P103F OR P1040: REDUCTANT PUMP DRIVER HIGH TEMPERATURE/REDUCTANT PUMP CONTROL CIRCUIT SHORTED

Diagnostic Instructions

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

DTC Descriptors

DTC P103F

Reductant Pump Driver High Temperature

DTC P1040

Reductant Pump Control Circuit Shorted

Circuit/System Description

The selective catalytic reduction system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of reductant into the exhaust gas stream entering the selective catalytic reduction catalyst. Within the selective catalytic reduction catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provides the engine control module and the reductant control module via serial data. The engine control module (ECM) controls the reductant injector duty cycle in response to changes in engine-out NOx levels. The reductant control module supplies system voltage to the reductant pump motor. The reductant control module controls the solenoid by grounding the control circuit. The reductant control module can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

- DTC U010E is not set.
- The battery voltage is greater than 11 V.
- Ignition On or engine running.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P103F

The reductant control module detects a motor pump driver high temperature

P1040

The reductant control module detects a motor pump phases shorted error

Action Taken When the DTC Sets

- DTCs P103F and P1040 are Type A DTCs.

Conditions for Clearing the DTC

- DTCs P103F and P1040 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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Circuit/System Verification

1. Ignition On
2. Verify that no other reductant system DTCs are set.
   - **If any other DTCs are set**

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

   - **Go to next step: If no other DTCs are set**
3. Verify that DTC P103F or P1040 is not set.
   - **If a DTC Is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If no DTC is set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify that DTC P103F or P1040 is not set.
   - **If a DTC sets**

     Refer to Circuit/System Testing

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

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 15 and ground.
   - **If 10 Ω or greater**
     1. Ignition Off.
     2. Test for less than 2 Ω at the circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K115 Reductant Control Module.
   - **Go to next step: If less than 10 Ω**
3. Disconnect the X2 harness connector at the K115 Reductant Control Module.
4. Test for less than 2 Ω between the terminals listed below:
   - A38 Reductant Pump and Sensor Assembly harness connector terminal 16 and K115 Reductant Control Module harness connector terminal 1
   - A38 Reductant Pump and Sensor Assembly harness connector terminal 8 and K115 Reductant Control Module harness connector terminal 2
   - A38 Reductant Pump and Sensor Assembly harness connector terminal 7 and K115 Reductant Control Module harness connector terminal 3
   - **If greater than 2 Ω**

     Repair the open/high resistance in the appropriate circuit.

   - **Go to next step: If less than 2 Ω**
5. Ignition Off, test for infinite resistance between each control circuit and ground.
   - **If less than infinite resistance**

     Repair the short to ground at the appropriate circuit.

   - **Go to next step: If infinite resistance**
6. Ignition On, test for less than 1 V between each control circuit and ground.
   - **If 1 V or greater**

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Repair the short to voltage on the appropriate circuit.

- **Go to next step: If less than 1 V**

7. Replace the A38 Reductant Pump and Sensor Assembly.
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**

      Replace the K115 Reductant Control Module

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

Repair Instructions

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

Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Tank Replacement** for reductant pump and sensor assembly replacement.
- Refer to **Emission Reduction Fluid Controller Replacement**

DTC P1048, P1049, P2047, P2048, OR P2049: REDUCTANT INJECTOR CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P1048

Reductant Injector High Control Circuit Low Voltage

DTC P1049

Reductant Injector High Control Circuit High Voltage

DTC P2047

Reductant Injector Control Circuit

DTC P2048

Reductant Injector Control Circuit Low Voltage

DTC P2049

Reductant Injector Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Reductant Injector High Control	P1048	P2047	P1049
Reductant Injector Low Control	P2048	P2047	P2049

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Circuit/System Description

The reductant injector is a component of the selective catalytic reduction system used to dose the reductant fluid to the exhaust gas and participate in the reduction reactions. The Engine Control Module (ECM) calculates the injection time of the reductant injector based on the measurement of the NOx sensors. To activate the injector the ECM supplies a Pulse Width Modulated signal to the high control circuit and the low control circuit is always commanded ON.

Conditions for Running the DTCs

- The engine is running.
- The battery voltage is greater than 11 V.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

DTC P1048

The Reductant Control Module detects a short to ground in the high control circuit

DTC P1049

The Reductant Control Module detects a short to voltage in the high control circuit

DTC P2047

The Reductant Control Module detects an open in the control circuit

DTC P2048

The Reductant Control Module detects a short to ground in the low control circuit

DTC P2049

The Reductant Control Module detects a short to voltage in the low control circuit

Action Taken When the DTC Sets

DTCs P1048, P1049, P2047, P2048 and P2049 are Type A DTCs.

- The reductant injector is shut off.
- The reductant tank and line heaters are shut off.
- The selective catalytic reduction system is in stand-by mode.

Conditions for Clearing the DTC

DTCs P1048, P1049, P2047, P2048 and P2049 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the scan tool Reductant Injector Control Circuit Status parameters listed below display OK or Not Run.
   - Reductant Injector Control Circuit Open Status
   - Reductant Injector Control Circuit Low Voltage Test Status
   - **If OK or Not Run is not displayed**

     Refer to Circuit/System Testing.

   - **Go to next step: If OK or Not Run is displayed**
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 DTC P1048, P1049, P2047, P2048 or P2049 does not set.
   - **If any of the DTCs sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q61 Reductant Injector.
2. Ignition ON, test for 2 - 3 V between the reductant injector low control circuit terminal 2 and ground.
   - **If less than 2 V**
   1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω between the test points: Terminal 1 @ Q61 Reductant injector Component harness & Terminal 1 X3 @ Control module harness
      - 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 Q61 Reductant Injector harness terminal 1 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 greater than 3 V**
   1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, Ignition ON.
   2. Test for less than 1.0 V between Q61 Reductant Injector harness low control circuit terminal 1 and ground.
      - If greater than 1.0 V, repair the short to voltage at the circuit.
      - If less than 1.0 V, replace the K20 Engine Control Module.
   - **Go to next step: If between 2 - 3 V**
3. Connect a test lamp between the Q61 Reductant Injector low control circuit harness terminal 1 and the Q61 Reductant Injector high control circuit harness terminal 2

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4. Ignition ON, verify a test lamp flashes several times while commanding the Reductant Injector on with a scan tool.
    - **If the test lamp is always off**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω between Q61 Reductant Injector harness high control circuit terminal 2 to K20 Engine Control Module X3 harness connector terminal 1.
        - 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 Q61 Reductant Injector harness reductant injector high control circuit terminal 2 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 ON**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1.0 V between the Q61 Reductant Injector harness high control circuit terminal 2 and ground.
        - If greater than 1.0 V, repair the short to voltage at the circuit.
        - If less than 1.0 V, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp flashes**
5. Refer to **Component Testing**

Component Testing

1. Ignition OFF, disconnect the harness connector at the Q61 Reductant Injector.
2. Test for 10 - 14 Ω between the high control circuit terminal 2 and low control circuit terminal 1.
    - **If not within 10 - 14 Ω**

      Replace the Q61 Reductant Injector

    - **Go to next step: If within 10 - 14 Ω**
3. Test for infinite resistance between each terminal and the sensor housing/case.
    - **If less than infinite resistance**

      Replace the Q61 Reductant Injector.

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

Repair Instructions

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

Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

Refer to **Emission Reduction Fluid Injector Replacement (AWD)** **Emission Reduction Fluid Injector Replacement (FWD)**

- Refer to **Reductant System Tamper Service Bay Test**
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P1050: REDUCTANT LEVEL SENSOR INVALID RANGE

Diagnostic Instructions

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

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- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P1050

Reductant Level Sensor Invalid Range

Circuit/System Description

The reductant level sensor provides discrete information about the diesel exhaust fluid quantity present in the reductant tank. The sensor signal provides information to the reductant control module to determine 4 different states: FULL, OK, WARNING1 and WARNING2. The reductant control module diagnoses the sensor for open circuit, short to ground and short to voltage electrical faults. The sensor is also checked for invalid range output by determining if the float is mechanically stuck in a plausible position.

Conditions for Running the DTC

- DTC P203C, P203D or U010E is not set.
- The battery voltage is greater than 11 V.
- The ignition is On or the engine is running.

DTC P1050 runs when the above conditions have been met.

Conditions for Setting the DTC

The reductant level sensor value is outside a calibrated range.

Action Taken When the DTC Sets

DTC P1050 is a Type B DTC.

Conditions for Clearing the DTC

DTC P1050 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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1. Ignition On.
2. Verify that DTC P203C or P203D is not set.
    - **If a DTC Is set**

      Refer to **DTC P203C or P203D**.

    - **Go to next step: If no 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 from the Freeze Frame/Failure Records data.
4. Verify DTC P1050 does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing

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

Circuit/System Testing

1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module

   NOTE: **The reductant tank level must be full to ensure accurate resistance readings.**

2. Verify the resistance is within the specified range between the harness connector terminals listed below:
    - Terminal 15 - 16 (3.37 - 3.43 kΩ)
    - Terminal 16 - 17 (7.2 - 7.34 kΩ)
    - **If not within the specified range**

      Replace the A38 Reductant Pump and Sensor Assembly.

    - **Go to next step: If within the specified range**
3. Replace the K115 Reductant Control Module.

Repair Instructions

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

Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Controller Replacement**
- Refer to **Emission Reduction Fluid Supply Pump Module Replacement** for reductant pump and sensor assembly replacement.

DTC P1051 OR P1052: REDUCTANT HEATER 1-2 DRIVER HIGH TEMPERATURE

Diagnostic Instructions

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

DTC Descriptors

DTC P1051

Reductant Heater 1 Driver High Temperature

DTC P1052

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Reductant Heater 2 Driver High Temperature

Circuit/System Description

As reductant will freeze at temperatures below -11Â°C (12Â°F), there are 2 reductant heaters. Reductant heater 1 is integral to the Emission Reduction Fluid Supply Pump Module, located in the reductant tank. Reductant heater 2 is located in the supply line to the reductant injector. The ECM monitors the reductant temperature in the tank in order to determine if the fluid is below its freeze point. If the ECM determines that the reductant may be frozen, it activates a "defrost strategy", by energizing the reductant heaters. The heaters are deactivated when the fluid temperature exceeds a calibrated value.

Conditions for Running the DTCs

- DTC P205B, P205C, P205D or U010E is not set.
- The ignition is On or the engine is running.
- The battery voltage is greater than 11 V.

Conditions for Setting the DTC

P1051

The ECM indicates the reductant tank heater temperature is over the calibrated threshold for greater than 5 s.

P1052

The ECM indicates the reductant line heater temperature is over the calibrated threshold for greater than 5 s.

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Action Taken When the DTC Sets

DTCs P1051 and P1052 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P1051 and P1052 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify that no other reductant heater DTCs are set.
    - **If any other DTCs are set**

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

    - **Go to next step: If no other DTCs are set**
3. Command the Reductant heater 1 and 2 On and Off with a scan tool.
4. Verify that the appropriate reductant heater parameter is between 0 - 25.5 A.
    - **If not within the specified range**

      Refer to Circuit/System Testing.

    - **Go to next step: 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 DTC P1051 or P1052 does not set.
    - **If a DTC sets**

      Refer to Circuit/System Testing.

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

Circuit/System Testing

DTC P1051

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 A38 Reductant Pump and Sensor Assembly.
2. Test for less than 10 Ω between the low reference circuit terminal 11 and ground.
    - **If 10 Ω or greater**
    1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
    2. Test for less than 2 Ω in the circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K115 Reductant Control Module.
    - **Go to next step: If less than 10 Ω**
3. Connect a test lamp between the heater control circuit terminal 9 and ground.
4. Ignition On, verify the test lamp turns On and Off while commanding the Reductant Heater 1 On and Off with a scan tool.
    - **If the test lamp is always Off**
    1. Ignition Off, remove the test lamp and disconnect the X2 harness connector at the K115 Reductant Control Module.
    2. Test for infinite resistance between control 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 circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K115 Reductant Control Module.
    - **If the Test lamp is always On**
    1. Ignition On, test for less than 1.0 V between the control circuit and ground.
        - If 1.0 V or greater, repair the short to voltage in the circuit.
        - If less than 1.0 V, replace the K115 Reductant Control Module.
    - **Go to next step: If the Test lamp turns On and Off**

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5. Test or replace the E53 Reductant Tank Heater

DTC P1052

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 connector at the E52 Reductant Line Heater.
2. Test for less than 10 Ω between the low reference circuit terminal 1 and ground.
   - **If 10 Ω or greater**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. Test for less than 2 Ω in the circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K115 Reductant Control Module.
   - **Go to next step: If less than 10 Ω**
3. Connect a test lamp between the heater control circuit terminal 2 and ground.
4. Ignition On, Verify the test lamp turns On and Off while commanding the Reductant Heater 2 On and Off with a scan tool.
   - **If the test lamp is always Off**
   1. Ignition Off, remove the test lamp and disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. Test for infinite resistance between control circuit and ground.
      - If less than infinite resistance, repair the short to ground in the circuit.
      - If infinite resistance
   3. Ignition Off.
   4. Test for less than 2 Ω in the circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K115 Reductant Control Module.
   - **If the Test lamp is always On**
   1. Ignition On, test for less than 1.0 V between the control circuit and ground.
      - If 1.0 V or greater, repair the short to voltage in the circuit.
      - If less than 1.0 V, replace the K115 Reductant Control Module.
   - **Go to next step: If the Test lamp turns On and Off**
5. Test or replace the E52 Reductant Line Heater

Component Testing

Reductant Tank Heater

1. Ignition Off, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly.

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

2. Test for 1 - 2 Ω between terminals 9 - 11 at the A38 Reductant Pump and Sensor Assembly.
   - **If less than 1 Ω or greater than 2 Ω**

     Replace the A38 Reductant Pump and Sensor Assembly.

   - **Go to next step: If between 1 - 2 Ω**
3. Test for infinite resistance between each terminal and the A38 Reductant Pump and Sensor Assembly housing/case.
   - **If less than infinite resistance**

     Replace the A38 Reductant Pump and Sensor Assembly.

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

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4. All OK.

Reductant Line Heater

1. Ignition Off, disconnect the harness connector at the E52 Reductant Line Heater.

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

2. Test for 1 - 2 Ω between terminals 1 - 2 at the E52 Reductant Line Heater.
   - **If less than 1 Ω or greater than 2 Ω**

     Replace the E52 Reductant Line Heater.

   - **Go to next step: If between 1 - 2 Ω**
3. Test for infinite resistance between each terminal and the E52 Reductant Line Heater housing/case.
   - **If less than infinite resistance**

     Replace the E52 Reductant Line Heater.

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

Repair Instructions

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

Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Supply Pump Module Replacement** for reductant tank heater replacement.

  Refer to **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (FWD)** **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Front AWD)** **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Rear AWD)** for reductant line heater replacement.

- Refer to **Emission Reduction Fluid Controller Replacement**

DTC P105A: REDUCTANT PUMP LOW SPEED

Diagnostic Instructions

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

DTC Descriptors

DTC P105A

Reductant Pump Low Speed

Circuit/System Description

The reductant pump motor is controlled by the reductant control module. The engine control module (ECM) sends a command to the reductant control module via direct wire connection. This command is converted by the reductant control module into a desired pump speed The ECM checks the state of the wire to the reductant control module for circuit continuity. The signal sent by the ECM to the reductant control module is diagnosed for open circuit, short circuit to ground, and short circuit to voltage.

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Conditions for Running the DTCs

- DTC P103F, P1040, P208A, P208C, P208D, P214E or U010E is not set.
- The ignition is On or the engine is running.
- The battery voltage is greater than 11 V.
- The reductant system is not in frozen tank status.
- The Diesel Exhaust Fluid pump is being commanded to move forward or reverse.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The reductant control module detects that the reductant pump motor is stalled for greater than 5 s.

Action Taken When the DTC Sets

DTC P105A is a Type A DTC.

- The reductant injector is disabled.
- The reductant tank and line heaters are disabled.
- The reductant pump is disabled.

Conditions for Clearing the DTC

DTC P105A is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On, verify that no other reductant pump DTCs are set.
   - **If any other DTCs are set**

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

   - **Go to next step: If no other DTCs are set**
2. Verify that the status parameters listed below do not display Malfunction while commanding the Reductant Pump to 50% with a scan tool:
   - Reductant Pump Control Circuit High Voltage Test Status

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- Reductant Pump Control Circuit Open Test Status
- Reductant Pump Control Circuit Low Voltage Test Status
- **If Malfunction is displayed**

  Refer to Circuit/System Testing

- **Go to next step: If Malfunction is not displayed**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify DTC P105A does not set.
   - **If a DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If no DTC sets**
5. 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.
2. Disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly.
3. Test for less than 10 Ω between the low reference circuit terminal 15 and ground.
   - **If 10 Ω or greater**
   1. Ignition Off.
   2. Disconnect the X2 harness connector at the K115 Reductant Control Module.
   3. Test for less than 2 Ω between A38 Reductant Pump and Sensor Assembly harness connector terminal 15 and K115 Reductant Control Module harness connector terminal 5.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K115 Reductant Control Module.
   - **Go to next step: If less than 10 Ω**
4. Disconnect the X2 harness connector at the K115 Reductant Control Module.
5. Test for less than 2 Ω between the control terminals listed below
   - A38 Reductant Pump and Sensor Assembly harness connector terminal 16 and K115 Reductant Control Module harness connector terminal 1
   - A38 Reductant Pump and Sensor Assembly harness connector terminal 8 and K115 Reductant Control Module harness connector terminal 2
   - A38 Reductant Pump and Sensor Assembly harness connector terminal 7 and K115 Reductant Control Module harness connector terminal 3
   - **If greater than 2 Ω**

     Repair the open/high resistance in the circuit.

   - **Go to next step: If less than 2 Ω**
6. Test for infinite resistance between each control circuits listed above and ground.
   - **If less than infinite resistance**

     Repair the short to ground in the circuit.

   - **Go to next step: If infinite resistance**
7. Ignition On, test for less than 1 V between each control circuits listed above and ground.
   - **If 1 V or greater**

     Repair the short to voltage on the circuit.

   - **Go to next step: If less than 1 V**

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8. Replace the A38 Reductant Pump and Sensor Assembly.

Repair Instructions

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

Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Controller Replacement**
- Refer to **Emission Reduction Fluid Supply Pump Module Replacement** for A38 Reductant Pump and Sensor Assembly replacement.

DTC P1089: FUEL RAIL PRESSURE PERFORMANCE DURING DECELERATION FUEL CUT-OFF

Diagnostic Instructions

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

DTC Descriptors

DTC P1089

Fuel Rail Pressure Performance During Deceleration Fuel Cut-Off

Circuit/System Description

The Engine Control Module (ECM) monitors for changes in fuel rail pressure when the vehicle is in a deceleration condition and the fuel injected quantity is at zero. When scan tool parameter Deceleration Fuel Cut-Off is active, the fuel rail pressure should not deviate more than 2 MPa (290 PSI) from a calculated setpoint. If the fuel rail pressure deviates more than 2. MPa (290 PSI) from the calculated setpoint for approximately 10 seconds of cumulative deceleration (this may take multiple drive cycles), the DTC will set.

Conditions for Running the DTC

- Ignition voltage is greater than 11 V.
- Engine coolant temperature is between 68 - 117Â°C (154 - 243Â°F).
- Fuel temperature is between 0 - 70Â°C (32 - 158Â°F).
- Transmission is in 4th, 5th or 6th gear.
- Deceleration Fuel Cut-Off is active for greater than 13 s.
- Engine speed is greater than 1500 RPM.
- The DTC runs continuous when the above conditions exist.

Conditions for Setting the DTC

Rail pressure deviates more than 2 MPa (290 PSI) from a calculated setpoint while in Fuel Cut-Off for greater than 10 s of cumulative deceleration.

Action Taken When the DTC Sets

DTC P1089 is a Type B DTC.

Conditions for Clearing the DTC

DTC P1089 is a Type B DTC.

Diagnostic Aids

- Aftermarket components to improve performance may cause a DTC to set.

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- This Diagnostic parameter is stored in the ECM over a period of time. Time to set this DTC may take several drive cycles.
- A restricted, kinked, or damaged fuel supply line including restricted fuel filter may cause this DTC to set.
- Water or contaminated fuel may cause this DTC to intermittently set. Refer to **Contaminants-in-Fuel Diagnosis** .

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Ignition On, observe the DTC information with a scan tool. Verify there are no other DTCs set.
   - **If a DTC is set**

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

   - **Go to next step: If a DTC is not set**
2. Verify the proper fuel is used. Refer to **Fastener Specifications** and **Contaminants-in-Fuel Diagnosis** .
3. Verify there are no aftermarket performance enhancing devices installed on the vehicle.
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 DTC P1089 does not set.
   - **If DTC P1089 is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If DTC P1089 is not set**
6. All OK.

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Circuit/System Testing

NOTE:

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

1. Verify there are no fuel system leaks. Refer to **Fuel Leak Diagnosis** .
   - **If a fuel leak is found**

     Repair as necessary.

   - **Go to next step: If a fuel leak is not found**
2. Engine cranking or running, verify scan tool parameter Fuel Pressure Sensor is between 370-450 kPa (54-65 PSI).
   - ***If not within 370-450 kPa (54-65 PSI)***

     Refer to **Fuel System Diagnosis** for further diagnosis.

   - ***Go to next step: If within 370-450 kPa (54-65 PSI)***
3. Verify that no fuel injector nozzles are stuck in the open position. Refer to **Fuel Injector Balance Test with Scan Tool** and perform the procedure under Circuit/System Testing.
   - **If a fuel injector nozzle is stuck open**

     Replace the appropriate Q17 Fuel Injector.

   - **Go to next step: If a fuel injector nozzle is not stuck open**
4. Perform the scan tool control function: Fuel Pressure Control - Regulator 1 - Increase & Decrease

   Verify the scan tool parameter: Fuel Rail Pressure Sensor 1 = The value should change with each command.

   - If the value does not change

     Replace the component: Q18A Fuel Pressure Regulator 1

   - If the value changes
5. Perform the scan tool control function: Fuel Pressure Control - Regulator 2 - Increase & Decrease

   Verify the scan tool parameter: Fuel Rail Pressure Sensor 1 = The value should change with each command.

   - If the value does not change

     Replace the component: Q18B Fuel Pressure Regulator 2

   - If the value changes
6. All OK.

Repair Instructions

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

- For Q18A Fuel Pressure Regulator 1 replacement, refer to **Fuel Injection Pump Metering Valve Replacement**
- For Q18B Fuel Pressure Regulator 2 replacement refer to **Fuel Injection Fuel Rail Assembly Replacement**
- Refer to **Fuel Injector Replacement**
- For engine control module replacement, programming and setup, refer to **Control Module References**

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DTC P10D1: REDUCTANT INJECTOR TEMPERATURE - EXHAUST GAS TEMPERATURE NOT PLAUSIBLE

Diagnostic Instructions

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

DTC Descriptors

DTC P10D1

Reductant Injector Temperature - Exhaust Gas Temperature Not Plausible

Circuit/System Description

The reductant injector is a component of the selective catalytic reduction system used to dose the reductant fluid to the exhaust gas and participate in the reduction reactions. The Engine Control Module (ECM) calculates the injection time of the reductant injector based on the measurement of the NOx sensors. To activate the injector the ECM supplies a Pulse Width Modulated signal to the high control circuit and the low control circuit is always commanded ON. The reductant injector temperature is modeled based on internal injector resistance of the injector coil and is used to monitor the temperature of the injector to prevent damage.

Conditions for Running the DTCs

- The ignition has been OFF for 8 h or greater.
- The ignition is ON or the engine is running.
- The engine is not cranking.
- The battery voltage is greater than 11 V.

The DTC runs when the above conditions are met.

Conditions for Setting the DTC

The engine control module detects that the temperature difference between the reductant injector and the exhaust is greater than a calibrated value.

Action Taken When the DTC Sets

DTC P10D1 is a Type B DTC.

Conditions for Clearing the DTC

DTC P10D1 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Electrical Information Reference

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

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, verify that no other DTCs are set.
   - **If any other DTCs are set**

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

   - **Go to next step: If no other DTCs are set**
2. Verify the scan tool Reductant Injector Control Circuit Status parameters listed below display OK or Not Run.
   - Reductant Injector Control Circuit Open Status
   - Reductant Injector Control Circuit Low Voltage Test Status
   - **If OK or Not Run is not displayed**

     Refer to Circuit/System Testing.

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

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q61 Reductant Injector.
2. Ignition ON, test for 2 - 3 V between the reductant injector low control circuit terminal 1 and ground.
   - **If less than 2 V**
   1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.

      Test for less than 2 Ω between Q61 Reductant Injector harness high control circuit terminal 1 to K20 Engine Control Module X3 harness connector terminal 1.

      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω
   2. Test for infinite resistance between the reductant injector low control circuit terminal 2 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 greater than 3 V**
   1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, Ignition ON.
   2. Test for less than 1.0 V between the low control circuit terminal 1 and ground.
      - If greater than 1.0 V, repair the short to voltage in the circuit.
      - If less than 1.0 V, replace the K20 Engine Control Module.

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- **Go to next step: If between 2 - 3 V**

3. Connect a test lamp between the reductant injector low control circuit terminal 1 and the reductant injector high control circuit terminal 2
4. Ignition ON, verify a test lamp flashes several times while commanding the Reductant Injector on with a scan tool.
    - **If the test lamp is always off**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω between Q61 Reductant Injector harness high control circuit terminal 2 to K20 Engine Control Module X3 harness connector terminal 15.
        - 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 reductant injector high control circuit terminal 2 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 ON**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, Ignition ON.
    2. Test for less than 1.0 V between the high control circuit terminal 15 and ground.
        - If greater than 1.0 V, repair the short to voltage at the circuit.
        - If less than 1.0 V, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp flashes**
5. Refer to **Component Testing**

Component Testing

1. Ignition OFF, disconnect the harness connector at the Q61 Reductant Injector.
2. Test for 10 - 14 Ω between the reductant injector high control circuit terminal 1 and the reductant dosing valve low control circuit terminal 2.
    - **If not within 10 - 14 Ω**

      Replace the Q61 Reductant Injector

    - **Go to next step: If within 10 - 14 Ω**
3. Test for infinite resistance between each terminal and the sensor housing/case.
    - **If less than infinite resistance**

      Replace the Q61 Reductant Injector.

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

Repair Instructions

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

- Refer to **Emission Reduction Fluid Injector Replacement (AWD)** **Emission Reduction Fluid Injector Replacement (FWD)**
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P10D5: CHARGE AIR COOLER TEMPERATURE SENSOR 2 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.

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- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P10D5

Charge Air Cooler Temperature Sensor 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P10D6	P10D7	P10D7*	P10D5, P026A
Low Reference	-	P10D7	10D7*	P10D5, P026A
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Charge Air Cooler Outlet Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON or Engine Running **Parameter Normal Range:** -39 to +198Â°C (-38 to +388Â°F)			
Signal	215Â°C (419Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The charge air cooler (CAC) temperature sensor 2 is a variable resistor. The sensor is located in the CAC outlet duct after the CAC assembly. Its signal is used by the ECM to measure the temperature of the intake air exiting the CAC. The engine control module (ECM) supplies 5 V to the signal circuit and a ground for the low reference circuit. The ECM monitors the sensor signal for a start-up signal that is not in correlation with the intake air temperature (IAT) sensor 3 start-up signal and fuel temperature sensor signal.

Conditions for Running the DTC

- DTC P00E9, P00EA, P00EB, P00EC, P0181, P10D6, P10D7, P10D8 or P2610 is not set.
- Ignition Off for 8 hours or greater.
- Ignition is On or the engine is operating for less than 10 s.
- Ignition voltage is greater than 11 V.
- The difference between the IAT Sensor 3 and the fuel temperature is less than 45Â°C (81Â°F).
- DTC runs when the enabling conditions are met.

Conditions for Setting the DTC

NOTE: **The scan tool display range is between -40 and +215Â°C (-40 and +419Â°F).**

- The ECM detects a difference of greater than 20Â°C (68Â°F) between CAC outlet temperature sensor signal and the combined average temperature of IAT 3 and the fuel temperature sensors.
- The condition exists for greater than 1 s.

Action Taken When the DTC Sets

P10D5 is a Type B DTC.

Conditions for Clearing the DTC

P10D5 is a Type B DTC.

Diagnostic Aids

An inaccurate CAC temperature sensor may cause DTC P0101 to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

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.**
- **The vehicle sitting in direct sun light or having the block heater ON will skew the results.**

1. Ignition On.
2. Verify DTC P00E9, P00EA, P00EB, P00EC, P0181, P10D6, P10D7, P10D8 or P2610 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Verify the following scan tool parameters are within 15Â°C (27Â°F) of each other.
   - Fuel Temperature Sensor
   - IAT Sensor 3
   - Charge Air Cooler Outlet Temperature
   - **If not within 15Â°C (27Â°F)**

     Refer to Circuit System Testing.

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- **Go to next step: If within 15Â°C (27Â°F)**

4. Engine idling.
5. Verify the scan tool Charge Air Cooler Outlet Temperature parameter is -39 to +198Â°C (-38 to +388Â°F).
   - **If not between -39 to +198Â°C (-38 to +388Â°F)**

     Refer to Circuit System Testing.

   - **Go to next step: If between -39 to +198Â°C (-38 to +388Â°F)**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE:

- **You must perform the Circuit/System Verification before proceeding with the Circuit/System Testing.**
- **You must perform the Diagnostic Repair Verification after completing the Circuit/System Testing.**

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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 connector at the B193B Charge Air Cooler Outlet Temperature Sensor.
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 X2 at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Test for 4.8 - 5.2 V between the signal circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**

     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 X2 at the K20 Engine Control Module.
   2. Ignition ON, test for less than 1 V between the signal circuit and ground.

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

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

4. Test or replace the B193B Charge Air Cooler Outlet Temperature Sensor.

Component Testing

- Ignition Off.
- Test the B193B Charge Air Cooler Outlet Temperature sensor by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool Charge Air Cooler Outlet Temperature parameter. The values should be within 5%.
  - **If not within the specified range**

    Replace the B193B Charge Air Cooler Outlet Temperature Sensor.

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

Repair Instructions

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

- Perform the **Diesel Particulate Filter (DPF) Service Regeneration** after completing the repair.
- Refer to **Charge Air Temperature Sensor Replacement (Outlet)** for B193A Charge Air Cooler Outlet Temperature Sensor replacement
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P10D6, P10D7, P10D8: CHARGE AIR COOLER TEMPERATURE SENSOR 2 CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P10D6

Charge Air Cooler Temperature Sensor 2 Circuit Low Voltage

DTC P10D7

Charge Air Cooler Temperature Sensor 2 Circuit High Voltage

DTC P10D8

Charge Air Cooler Temperature Sensor 2 Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P10D6	P10D7	P10D7	P026A, P10D5
Low Reference	-	P10D7	P10D7	P026A, P10D5
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Charge Air Cooler (CAC) Temperature Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON or Engine Running **Parameter Normal Range:** -39 to +198Â°C (-38 to +388Â°F)			
Signal	215Â°C (419Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The charge air cooler (CAC) temperature sensor 2 is a variable resistor. The sensor is located in the CAC outlet duct after CAC assembly. Its signal is used by the ECM to measure the temperature of the intake air leaving the CAC. The engine control module (ECM) supplies 5 V to the signal circuit and a ground for the low reference circuit. The ECM continuously monitors the sensor signal for an excessively high or low voltage, or for a start-up signal that is not in correlation with the ambient air temperature signal.

Conditions for Running the DTC

P10D6 or P10D7

- The ignition is ON or the engine is running.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously when the enabling condition is met.

P10D8

- DTC P10D6 or P10D7 is not set.
- The ignition is ON or the engine is running.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously when the enabling condition is met.

Conditions for Setting the DTC

NOTE: **The scan tool display range is between -40 and +215Â°C (-40 and +419Â°F).**

P10D6

Charge Air Cooler Outlet Temperature = Warmer than 300Â°C (572Â°F) For greater than 5 s

P10D7

Charge Air Cooler Outlet Temperature = Colder than -40Â°C (-40Â°F) For greater than 5 s

P10D8

Charge Air Cooler Outlet Temperature Signal noisy or erratic. For greater than 5 s

Action Taken When the DTC Sets

- DTCs P10D6, P10D7 and P10D8 are Type B DTCs.
- The ECM commands reduced engine power.
- The driver information center (DIC) or indicator may display reduced engine power.
- Service Emission System message is displayed on the driver information center (DIC).

Conditions for Clearing the DTC

DTCs P10D6, P10D7 and P10D8 are Type B DTCs.

Diagnostic Aids

An inaccurate CAC temperature sensor may cause DTC P0101 to set.

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

NOTE: **If you were sent here from DTC P026A, refer to Circuit System Testing.**

1. Engine idling.
2. Verify the scan tool Charge Air Cooler Outlet Temperature parameter is between -39 to +198Â°C (-38 to +388Â°F).
   - **If not between -39 to +198Â°C (-38 to +388Â°F)**

     Refer to Circuit System Testing.

   - **Go to next step: If between -39 to +198Â°C (-38 to +388Â°F)**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE: **You must perform the Diagnostic Repair Verification after completing the Circuit/System Testing.**

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 connector at the B193B Charge Air Cooler Outlet Temperature sensor.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.

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- **If 5 Ω or greater**

1. Ignition OFF, disconnect the 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 or high resistance in the circuit.
    - If less than 2 Ω replace the K20 Engine Control Module.

- **Go to next step: If less than 5 Ω**

3. Test for 4.8 - 5.2 V between the signal circuit terminal 1 and ground.
    - **If less than 4.8 V**

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

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

4. Test or replace the B193B Charge Air Cooler Outlet Temperature sensor.

Component Testing

- Test the B193B Charge Air Cooler Temperature sensor by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool CAC Temperature Sensor parameter. The values should be within 5%.
    - If not within the specified range, replace the B193B Charge Air Cooler Outlet Temperature sensor.

Repair Instructions

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

- Perform the **Diesel Particulate Filter (DPF) Service Regeneration** after completing the repair.
- Refer to **Charge Air Temperature Sensor Replacement (Inlet)** for B193A Charge Air Cooler Inlet Temperature sensor replacement
- Refer to **Control Module References** for engine control module replacement, programming and setup

DTC P111E: ENGINE COOLANT TEMPERATURE SENSOR NOT PLAUSIBLE

Diagnostic Instructions

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

DTC Descriptor

DTC P111E

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Engine Coolant Temperature Sensor Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Signal	P0117	P0118	P0118	P0118	P0128, P111E
Low Reference	-	P0118	P0118	-	P0128

Typical Scan Tool Data

ECT Sensor Temperature

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** -39 to +120Â°C (-38 to +248Â°F)			
ECT Sensor	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)

Circuit/System Description

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

The purpose of this diagnostic is to determine if the input from the ECT sensor is skewed warmer than normal. The internal clock of the ECM will record the amount of time the engine is OFF. If the required engine OFF time is met at start-up, the ECM will compare the temperature difference between the actual measured ECT and a calibrated ECT model. The information for this model is derived from the previous drive cycle and includes the accumulated mass air flow (MAF), the engine run time, the ambient air temperature and the ECT at the end of the drive cycle.

If the ECM detects that the temperature difference between the measured and modeled ECT is not within an acceptable operating range of each other, then the ECM will continue to run this diagnostic to determine if a block heater was active during the engine OFF time.

Conditions for Running the DTC

- DTCs P0111, P0112, P0113, P0114, P0117, P0118, P0128, P0502, P0503, P0601, P1621 or P2610 are not set.
- The vehicle has had a minimum ignition OFF time of 8 hours.
- The engine is running.
- The start-up modeled ECT is colder than 50Â°C (+122Â°F).
- The previous accumulated MAF is greater than 6, 000 grams.
- The previous engine run time is greater than 600 seconds.

OR

- The vehicle has had a minimum ignition OFF time of 8 hours.
- The engine is running.
- The previous ECT at engine shutdown is warmer than 75Â°C (+167Â°F).
- The previous accumulated MAF is greater than 6, 000 grams.
- The previous engine run time is greater than 600 seconds.
- This DTC runs once per ignition cycle within the enabling conditions.

Conditions for Setting the DTC

P111E

The ECM detects a temperature difference at initial power-up that indicates that the actual measured ECT is 10Â°C (18Â°F) greater than the modeled ECT, and an active block heater has not been detected.

Action Taken When the DTC Sets

DTC P111E is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P111E is a Type B DTC.

Diagnostic Aids

- Engine coolant that is leaking through the sensor will create a high resistance short to ground. This condition results in less voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a warmer ECT.
- The ECM memory which includes the ignition OFF timer is maintained by battery power. If the ECM or the battery are disconnected for less than 15 seconds the proper operation of the ECM memory and the timer can be disrupted. Always disconnect these components for greater than 30 seconds.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Turn OFF the ignition.
2. Inspect the cooling system surge tank for the proper engine coolant level. Refer to **Cooling System Leak Testing** and **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)** .
3. If the ignition has been OFF for 8 hours or greater, the intake air temperature (IAT) sensor, the IAT sensor 2, and the ECT sensor should be within 9Â°C (16Â°F) of each other and also the ambient temperature. Ignition ON, observe the scan tool IAT Sensor, IAT Sensor 2 and the ECT Sensor parameters. Compare those sensor parameters to each other and also to the ambient temperature to determine if the ECT sensor is skewed warmer.
4. Engine running, observe the ECT Sensor parameter. The reading should be between -39 to +120Â°C (-38 to +248Â°F) depending on the current ambient temperature and the vehicle operating conditions.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

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

Component Testing

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

      Replace the B34 Engine Coolant Temperature Sensor.

    - **Go to next step: If within the specified range**
3. Test for infinite resistance between each terminal and the sensor housing.
    - **If less than infinite resistance**

      Replace the B34 Engine Coolant Temperature Sensor.

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

Repair Instructions

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

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- Refer to **Engine Coolant Temperature Sensor Replacement (FWD)** **Engine Coolant Temperature Sensor Replacement (AWD)**
- Refer to **Control Module References** for ECM replacement, programming and setup.

DTC P113B, P113C, OR P113D: EXHAUST GAS TEMPERATURE SENSOR 1, 2, 3

Diagnostic Instructions

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

DTC Descriptors

DTC P113B

Exhaust Gas Temperature Sensor 1 Not Plausible

DTC P113C

Exhaust Gas Temperature Sensor 2 Not Plausible

DTC P113D

Exhaust Gas Temperature Sensor 3 Not Plausible

Typical Scan Tool Data

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** -39 - 999Â°C (-38 - 1, 830Â°F)			
Exhaust Gas Temperature Sensor Signal	-40Â°C (-40Â°F)	1, 000Â°C (1, 832Â°F)	1, 000Â°C (1, 832Â°F)
Exhaust Gas Temperature Sensor Low Reference	-	1, 000Â°C (1, 832Â°F)	1, 000Â°C (1, 832Â°F)

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Circuit/System Description

The exhaust gas temperature sensors are variable resistors that measure the temperature of the exhaust gas at the inlet and outlet of the diesel oxidation catalyst as well as the inlet and outlet of the Diesel Particulate Filter (DPF). The Engine Control Module (ECM) supplies a bias 5-volt signal to the exhaust gas temperature sensor signal circuit, and supplies a ground to the low reference circuit. The exhaust gas temperature information is used by the ECM during the particulate filter cleaning process.

The following table illustrates the relationship between the temperature of the exhaust gas, and the resistance and voltage of the exhaust gas temperature sensor.

Temperature	Resistance	Voltage
Low	Low	Low
High	High	High

Conditions for Running the DTC

P113B, P113C, P113DF

- DTC P0545, P0546, P2032, P2033, P242C, P242D, P2470, P2471, P2481 or P2482 is not set.
- Engine is running.
- Ignition voltage is greater than 11 V.
- The vehicle has had a minimum OFF time of 8 h.

Conditions for Setting the DTC

P113B, P113C, P113DF

The ECM detects a exhaust gas temperature value that is not plausible when ignition is switched on.

Action Taken When the DTC Sets

DTCs P113B, P113C and P113D are Type B DTCs.

Conditions for Clearing the DTC

DTCs P113B, P113C and P113D are Type B DTCs.

Diagnostic Aids

After starting the engine, the exhaust gas temperature sensor temperatures should rise steadily, then stabilize after the engine reaches operating temperature.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Exhaust Aftertreatment System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information.

Special Tools

J 25070 Heat Gun 500 - 750Â°F

Circuit/System Verification

1. Ignition ON
2. Verify DTCs P0545, P0546, P2032, P2033, P242C, P242D, P2470, P2471, P2481 or P2482 are not set.
    - **If any of the DTCs are set**

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

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

NOTE: **Determine the ambient temperature by using an accurate thermometer.**

3. Ignition OFF for greater than 8 hours.
4. Observe the scan tool Exhaust Gas Temperature Sensor 1, 2 and 3 parameters and compare them to the ambient temperature. The reading for EGT 1, 2 and 3 should be within 30Â°C (54Â°F) of the ambient temperature.
   - **If not within the specified range**

     Refer to Circuit/System Testing.

   - **Go to next step: If within the specified range**
5. Ignition ON
6. Observe the scan tool Exhaust Gas Temperature Sensor 1, 2, and 3 parameters. The reading should be between -40 - 999Â°C (-40 - 1, 830Â°F) depending on the current ambient temperature and the vehicle operating conditions.
   - **If not within the specified range**

     Refer to Circuit/System Testing.

   - **Go to next step: 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.
8. Verify DTC P113B, P113C, P113D, P113E or P113F does not set
   - **If a DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B131 Exhaust Temperature Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 10 Ω**
3. Ignition ON.
4. Verify the appropriate scan tool Exhaust Gas Temperature Sensor parameter is warmer than 998Â°C (1828Â°F).
   - **If 998Â°C (1828Â°F) or less**
   1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 1 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **Go to next step: If greater than 998Â°C (1828Â°F)**

CAUTION: **If the fuse in the jumper wire opens, the signal circuit may have a**

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short to a voltage or a short to ground and the sensor might be damaged.

5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2.
6. Verify the scan tool Exhaust Gas Temperature parameter is colder than -35Â°C (-31Â°F).
    - **If -35Â°C (-31Â°F) or greater**
    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.
    - **Go to next step: If less than -35Â°C (-31Â°F)**
7. Test or replace the appropriate B131 Exhaust Gas Temperature sensor.

Component Testing

NOTE: **The *J 25070* Heat Gun 500 - 750Â°F may be used to evaluate the sensor under high temperature conditions.**

1. Ignition OFF, remove appropriate B131 Exhaust Gas Temperature sensor while leaving the harness connector connected.
2. Measure and record the resistance of the B131 Exhaust Gas Temperature sensor and compare the measurements to the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** chart.
    - **If not within the specified range**

      Replace the B131 Exhaust Gas Temperature sensor.

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

Repair Instructions

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

- Refer to **Exhaust Temperature Sensor Replacement - Position 1**
- Refer to **Exhaust Temperature Sensor Replacement - Position 2**
- Refer to **Exhaust Temperature Sensor Replacement - Position 3**
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11CC, P11D3, P11DB, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P2210, OR P2211: NOX SENSOR 1

Diagnostic Instructions

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

DTC Descriptor

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DTC P115E

O2 Reference Voltage Circuit (NOx Sensor 1)

DTC P115F

O2 Reference Voltage Circuit Low Voltage (NOx Sensor 1)

DTC P1160

O2 Reference Voltage Circuit High Voltage (NOx Sensor 1)

DTC P116A

O2 Signal Circuit (NOx Sensor 1)

DTC P116B

O2 Signal Circuit Low Voltage (NOx Sensor 1)

DTC P116C

O2 Signal Circuit High Voltage (NOx Sensor 1)

DTC P116D

O2 Pump Current Control Circuit (NOx Sensor 1)

DTC P116E

O2 Pump Current Control Circuit Low Voltage (NOx Sensor 1)

DTC P116F

O2 Pump Current Control Circuit High Voltage (NOx Sensor 1)

DTC P1192

O2 Low Reference Circuit (NOx Sensor 1)

DTC P1193

O2 Low Reference Circuit Low Voltage (NOx Sensor 1)

DTC P1194

O2 Low Reference Circuit High Voltage (NOx Sensor 1)

DTC P119A

NOx Sensor 1 Signal Circuit

DTC P119B

NOx Sensor 1 Signal Circuit Low Voltage

DTC P119C

NOx Sensor 1 Signal Circuit High Voltage

DTC P11C5

NOx Sensor 1 Heater Ground Circuit

DTC P11C6

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NOx Sensor 1 Heater Ground Circuit High

DTC P11CC

NOx Sensor 1 Performance - Signal Low

DTC P11D3

NOx Sensor 1 Exceeded Minimum Learning Limit

DTC P11DB

NOx Sensor 1 Current Performance

DTC P2202

NOx Sensor 1 Circuit Low Voltage

DTC P2203

NOx Sensor 1 Circuit High Voltage

DTC P2205

NOx Sensor 1 Heater Control Circuit

DTC P2206

NOx Sensor 1 Heater Control Circuit Low Voltage

DTC P2207

NOx Sensor 1 Heater Control Circuit High Voltage

DTC P2208

NOx Sensor 1 Heater Feedback Circuit

DTC P2209

NOx Sensor 1 Heater Control Circuit

DTC P2210

NOx Sensor 1 Heater Feedback Circuit Low Voltage

DTC P2211

NOx Sensor 1 Heater Feedback Circuit High Voltage

Circuit/System Description

The nitrogen oxides (NOx) sensors are part of the selective catalytic reduction system, a device used to reduce NOx emission on diesel engines. There are two NOx sensors, one placed upstream of selective catalytic reduction, to measure inlet NOx concentration, and one placed downstream. They are connected with the control module via CAN and all the information is exchanged through it. Since it is a smart sensor, all the electrical monitoring is performed inside the sensor and only the results are sent to the ECM. Each NOx sensor contains a sensing cell, a pumping cell, and a heater. A sample of exhaust gas passes through a diffusion gap between the sensing cell and the pumping cell. The NOx sensor maintains a constant reference voltage across the sensing cell. An electronic circuit within sensor controls the pump current through the pumping cell in order to maintain a constant voltage in the sensing cell. The amount of current required to maintain the reference voltage in the sensing cell is proportional to the concentration of NOx in the exhaust. The ECM varies the amount of diesel exhaust fluid (reductant) added by varying the reductant injector duty cycle in response to changes in engine exhaust NOx levels. The smart NOx sensors consist of two components, the NOx module and the NOx

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sensor element that are serviced as a unit. A circuit or performance condition with a NOx sensor is detected by the NOx sensor module. The smart NOx sensor module communicates the condition to the ECM over the serial data line. The ECM sets a DTC when a serial data message is received from the NOx sensor module.

Conditions for Running the DTC

P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P2205, P2206, P2207, P2208, P2210 or P2211

- DTC U029D is not set
- The Engine Controls Ignition Relay Feedback Signal voltage is greater than 11 V
- The NOx Sensor 1 Heater Operation parameter displays Allowed
- The NOx sensor supply voltage is greater than 10.8 V.

These DTCs run continuously when the above conditions are met

P11CC

- DTC P0071, P0072, P0073, P0074, P0087, P0089, P0101-P0103, P0106, P0107, P0108, P010B-P010D, P0111-P0114, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0502, P0503, P0545, P0546, P062B, P062D, P0722, P0723, P111E, P113B, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P1248, P1249, P124A-P124F, P126A, P2080, P2081, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P228A, P228B, P262B or U029D is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The barometric pressure is between 75 - 200 kPa (10.8 - 29 psi).
- The coolant temperature is between 70 - 128Â°C (158 - 262Â°F).
- The ambient temperature is warmer than -7Â°C (19.4Â°F).
- The manifold absolute pressure is less than 300 kPa (43.5 psi).
- The engine speed is between 800 - 2, 300 RPM.

The DTC runs continuously when the above conditions are met.

P11D3

- DTC P003A, P0046, P0070, P0071, P0072, P0073, P0074, P0087, P00AF, P00C7, P00EA, P00EB, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P122B-P122D, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02E0, P02E3-P02E5, P02E8, P02E9, P02EB, P02EE, P02EF, P02F0-P02F5, P0335, P0336, P0403, P0405, P0406, P042E, P042F, P0489, P049D, P0490, P0545, P0546, P062B, P062D, P0772, P0773, P111E, P113B, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11CC, P11DB, P11DD, P122B-P122D, P1248, P1249, P124A-P124F, P126A, P1402, P1407, P140F, P1424, P1425, P16A0-P16A2, P16D7-P16D9, P2081, P2082, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P228A, P228B, P22F9, P22FA, P2459, P245C, P262B or U029D is not set.
- The engine is running.
- The engine not in cranking phase
- The ignition voltage is greater than 11 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.

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- The NOx sensor supply voltage is greater than 10.8 V
- The engine speed is between 1, 100 - 3, 500 RPM.
- The manifold absolute pressure is less than 300 kPa (43.5 psi).

The DTC runs continuously when the above conditions are met.

P11DB

- DTC P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11DD, P2200, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, or U029D is not set.
- The engine is running.
- The engine not in cranking phase
- The ignition voltage is greater than 11 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The NOx sensor supply voltage is greater than 10.8 V.

The DTC runs continuously when the above conditions are met.

P2202, P2203

- DTC P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P2200, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211 or U029D is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The NOx sensor supply voltage is greater than 10.8 V.

The DTC runs continuously when the above conditions are met.

P2209

- DTC U029D is not set
- The Engine Controls Ignition Relay Feedback Signal voltage is greater than 11 V
- The NOx Sensor 1 Heater Operation parameter displays Allowed
- The NOx sensor supply voltage is greater than 10.8 V.

These DTCs run continuously when the above conditions are met for greater than 180 s.

P22F9

- DTC P003A, P0046, P0070-P0074, P0087, P0096-P0099, P00AF, P00C7, P00E9, P00EA-P00EC, P00F4, P00F5, P0101-P0103, P0106-P0108, P0111-P0114, P0116-P0119, P0128, P0191-P0193, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02E0, P02E3-P02E5, P02E8, P02E9, P02EB, P02EE, P02EF, P02F0-P02F5, P0335, P0336, P0403, P0405, P0406, P042E, P042F, P0489, P049D, P0490, P0545, P0546, P062B, P062D, P0772, P0773, P111E, P113B, P115E, P115F, P1160, P116A-P116F, P118E, P1192 - P1194, P119A-P119C, P11C5, P11C6, P11CC, P11DB, P11DD, P122B-P122D, P1248, P1249, P124A-P124F, P126A, P1402, P1407, P140F, P1424, P1425, P16A0-P16A2, P2081, P2082, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205 - P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P228A, P228B, P22FA, P2459, P245C, P262B or U029D is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The engine speed is between 600 - 3, 500 RPM.

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The DTC runs continuously when the above conditions are met.

P22FA

- DTC P0087, P0096-P0099, P00C7, P00E9, P00EA-P00EC, P00F4, P00F5, P0101-P0103, P0106-P0108, P0191-P0193, P0201-P0208, P020A-P020F, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0403, P0405, P0406, P042E, P042F, P049D, P0490, P062B, P062D, P11CC, P11DB, P1248, P1249, P124A-P124F, P1402, P1407, P140F, P1424, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2202, P2203, P2227, P2228, P2229, P2230, P228A, P228B, or U029D is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The engine speed is between 1, 500 - 3, 000 RPM.
- The manifold absolute pressure is less than 300 kPA (43.5 psi).

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The NOx sensor module detects a fault in the NOx sensor circuitry or a performance fault in the NOx sensor for greater than 2 s.

Action Taken When the DTC Sets

- DTCs P115E, P116A, P116D, P1192, P119A, P11C5, P2205, and P2208 are Type A DTCs.
- DTCs P115F, P1160, P116B, P116C, P116E, P116F, P1193, P1194, P119B, P119C, P11C6, P11CC, P11D3, P11DB, P2202, P2203, P2206, P2207, P2209, P2210 and P2211 are Type B DTCs.

Conditions for Clearing the DTC

- DTCs P115E, P116A, P116D, P1192, P119A, P11C5, P2205, and P2208 are Type A DTCs.
- DTCs P115F, P1160, P116B, P116C, P116E, P116F, P1193, P1194, P119B, P119C, P11C6, P11CC, P11D3, P11DB, P2202, P2203, P2206, P2207, P2209, P2210 and P2211 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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. Verify that no other DTCs are set.
    - **If any of the DTCs are set**

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

    - **Go to next step: If none of the DTCs are set**
2. Verify none of the conditions listed below exist:
    - Intake system leaks
    - Exhaust system leaks
    - A loose or disconnected charge air cooler hose or pipe
    - Physical damage
    - Soot plugged B195A Nitrogen Oxides Sensor 1
    - Loose B195A Nitrogen Oxides Sensor 1 or B131 Exhaust Temperature Sensors
    - Loose or missing hardware
    - **If any condition is found**

      Repair as necessary

    - **Go to next step: If no conditions exist**
3. Verify that DTC P11CC is not set
    - **If the DTC is set**

      Replace the B195A Nitrogen Oxides Sensor 1.

    - **Go to next step: If the DTC is not set**
4. Operate the vehicle with the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze/Failure Records data.
5. Verify that DTC P11CC is not set
    - **If the DTC is set**

      Replace the B195A Nitrogen Oxides Sensor 1.

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

      All OK.

Repair Instructions

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

Refer to **Nitrogen Oxides Sensor Replacement - Position 1** - B195A Nitrogen Oxides Sensor 1

DTC P1176 OR P1177: FUEL PUMP DRIVER CONTROL MODULE 5V REFERENCE 1-2 CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P1176

Fuel Pump Driver Control Module 5V Reference 1 Circuit

DTC P1177

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Fuel Pump Driver Control Module 5V Reference 2 Circuit

Circuit/System Description

The Fuel Pump Driver Control Module has 2 internal 5V reference circuits. Each internal reference circuit provides external 5V reference circuits to one sensor. A short to ground or short to voltage on one external 5V reference circuit can affect the component connected to the same internal 5V reference circuit.

Conditions for Running the DTC

These DTCs run continuously when the ignition voltage is greater than 6.4 V.

Conditions for Setting the DTC

The Fuel Pump Driver Control Module 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 P1176, P1177 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P1176, P1177 are Type A DTCs.

Diagnostic Aids

P1176

The 5V reference 1 circuit provides 5 V circuits to the sensors listed below:

P1177

The 5V reference 2 circuit provides 5 V circuits to the sensors listed below:

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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Circuit/System Verification

1. Ignition ON.
2. Verify scan tool 5V Reference 1-2 Circuit Status parameters do not display Malfunction.
   - **If any of the parameters display Malfunction**

     Refer to Circuit/System Testing.

   - **Go to next step: If none of the parameters display Malfunction**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE: **Additional DTCs will set when disconnecting the components.**

1. Ignition OFF, disconnect the harness connector at all appropriate sensors for the applicable DTC. Refer to **Diagnostic Aids**.
2. Ignition ON.
3. Test for 4.8 - 5.2 V between one of the 5V reference circuits and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connectors at the K111 Fuel Pump Driver 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 K111 Fuel Pump Driver Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the harness connectors at the K111 Fuel Pump Driver 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 K111 Fuel Pump Driver Control Module.
   - **Go to next step: If between 4.8 - 5.2 V**

   NOTE: **A short to voltage or ground on the signal circuit of certain components may cause this DTC to set.**

4. Verify the appropriate scan tool 5V Reference 1, 2 Circuit Status parameter displays OK while connecting each component associated with the 5V reference circuit one at a time.
   - **If the parameter does not display OK 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.

   - **Go to next step: If the parameter displays OK when all components are connected**
5. All OK.

Repair Instructions

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

- Refer to **Fuel Pump Power Control Module Replacement (AWD)** **Fuel Pump Power Control Module Replacement (FWD)**
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P1178 OR P1179: FUEL PUMP DRIVER CONTROL MODULE SENSOR 1-2 INTERNAL SUPPLY CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P1178

Fuel Pump Driver Control Module Sensor 1 Internal Supply Circuit

DTC P1179

Fuel Pump Driver Control Module Sensor 2 Internal Supply Circuit

Circuit/System Description

The fuel pump power control module is in constant communication with the engine control module (ECM) regarding the operating state of the fuel pump power control system. Serial data messages are sent in a continuously repeating series of rolling counts with associated password protect samples. Each count/sample is assigned a value. When the ECM determines there is an error in the fuel pump control module fuel level sensor internal supply circuit, the ECM sets DTC P1178 or P1179.

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 ECM detects an error value for over 1 s.

Action Taken When the DTC Sets

DTC P1178 and P1179 are Type A DTCs.

Conditions for Clearing the DTC

DTC P1178 and P1179 are Type A DTCs.

Diagnostic Aids

An intermittent fault in the CAN circuits will cause the ECM to set DTC P1178 or P1179.

Reference Information

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **DTC P1178 and P1179 are informational DTCs.**
- **Diagnose all other engine control module DTCs prior to DTC P1178 or P1179.**

1. Verify that no other DTCs are set except for DTC P1178 or P1179.
   - **If any other DTCs are set**

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

   - **Go to next step: If only DTC P1178 or P1179 is set**
2. Replace the K111 Fuel Pump Power Control Module.
3. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
   - **If DTC sets**

     Replace the K20 Engine Control Module.

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

Repair Instructions

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

- Refer to **Fuel Pump Power Control Module Replacement (AWD)** **Fuel Pump Power Control Module Replacement (FWD)** for K111 Fuel Pump Power Control Module Replacement
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P118B: PARTICULATE MATTER SENSOR TEMPERATURE NOT PLAUSIBLE

Diagnostic Instructions

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

DTC Descriptors

DTC P118B

Particulate Matter Sensor Temperature Not Plausible

Circuit/System Description

The particulate matter (PM) sensor monitors the amount of the particulates (soot) in the diesel exhaust gas exiting the tailpipe. The PM sensor is similar to the heated oxygen sensor with a ceramic element, but also includes an individually calibrated sensor control unit (SCU). The sensing element includes comb-shaped interdigital electrodes (IDE), a heater and a positive temperature coefficient resistor for temperature measurement.

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The operation of the PM Sensor is based on the electrical conductivity characteristic of the diesel particulate. As the exhaust gas flows over the sensing element, soot is absorbed in the combs between the electrodes, eventually creating a conductive path. When the path is formed, it generates a current based on the voltage being applied to the element. The measurement process continues until a preset current value is reached. To avoid misleading readings, the sensor performs a regeneration where the soot is cleaned off by heating up the element, before the measurement phase begins. The amount of regenerations is based on vehicle strategy; when the calibrated number of regenerations is reached, the cumulative current readings are used to determine the amount of soot concentration in the exhaust gas which in turn determines the collection efficiency of the diesel particulate filter (DPF).

Conditions for Running the DTCs

- DTC P00C7, P142C, P142D, P142E, P142F, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P24B0, P24B1, P24B3, P24B5, P24B6, P262B or U02A3 is not set.
- The ignition is ON.
- The ignition voltage is greater than 11 V.
- The reductant control module relay 2 is commanded ON.
- The barometric pressure is greater than 75 kPa (10.9 psi).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The particular matter sensor control unit detects an internal fault of the sensor.

Action Taken When the DTC Sets

DTC P118B is a Type B DTC.

Conditions for Clearing the DTC

DTC P118B is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Exhaust Aftertreatment System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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Control Module References for scan tool information.

Circuit/System Verification

1. Ignition On.

   Verify no other DTCs are set

   - **If any other DTCs are set**

     Refer to Diagnostic Trouble Code (DTC) List - Vehicle

   - **Go to next step: If no other DTCs are set**
2. Verify DTC P118B is not set.
   - **If the DTC sets**

     Replace the B136 Exhaust Particulate Matter Sensor.

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

Repair Instructions

Refer to Exhaust Particulate Sensor Replacement

DTC P118E, P118F OR P1196: EXHAUST GAS TEMPERATURE SENSOR 1, 2, 3 PERFORMANCE - ENGINE RUNNING

Diagnostic Instructions

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

DTC Descriptors

DTC P118E

Exhaust Gas Temperature Sensor 1 Performance - Engine Running

DTC P118F

Exhaust Gas Temperature Sensor 2 Performance - Engine Running

DTC P1196

Exhaust Gas Temperature Sensor 3 Performance - Engine Running

Circuit/System Description

The exhaust gas temperature sensors are variable resistors that measures the temperature of the exhaust gas. The exhaust temperature sensor 1 is the first exhaust temperature sensor on the exhaust system, the following exhaust temperature sensors are counted upward from the engine outlet to the exhaust system end. The engine control module (ECM) supplies 5 V to the exhaust gas temperature signal circuit and supplies a ground to the low reference circuit. The exhaust gas temperature sensor temperature information is used by the ECM during the exhaust gas particulate filter cleaning process.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is greater than 11 V.
- 120 s or greater has elapsed since the last diesel particulate filter (DPF) regeneration.
- The estimated exhaust gas temperature is within a calibrated value.

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These DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the difference between measured exhaust gas temperature and the estimated exhaust gas temperature is greater than a calibrated amount for greater than 1 s.

Action Taken When the DTC Sets

DTCs P118E, P118F and P1196 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P118E, P118F and P1196 are Type B DTCs.

Diagnostic Aids

- After starting the engine, the exhaust gas temperature sensor temperatures should rise steadily, then stabilize after the engine reaches operating temperature.
- Inspect the exhaust gas temperature sensor terminals for corrosion.
- Inspect the exhaust gas temperature sensor wiring for pinches, cuts, and damaged insulation.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC P003A, P0070, P0071, P0072, P0073, P0074, P00C7, P00E9, P00EA, P00EB, P00EC, P0100, P0101, P0102, P0103, P010B, P010C, P010D, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P014D, P014C, P0191, P0192, P0193, P0194, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P020A, P020B, P020C, P020D, P020E, P020F, P0216, P021A, P021B, P0234, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0299, P02EE, P02EF, P02F0, P02F1, P02F2, P02F3, P02F4, P02F5, P0405, P0406, P041B, P041C, P041D, P041E, P044C, P044D, P049D, P049E, P0502, P0503, P0545, P0546, P062B, P062D, P0722, P0723, P111E, P113B, P113C, P113D, P113E, P113F, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192, P1193, P1194, P1197, P1198, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P126A, P12AF, P12B0, P12B1, P12B2, P1427, P1428, P16B0, P16B1, P16B2, P2004, P2006, P2008, P2009, P200A, P2010, P2015, P2016, P2017, P201B, P201D, P2032, P2033, P2081, P2080, P2084, P2085, P20F8, P2147, P2148, P2150, P2151, P2153,

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P2154, P2156, P2157, P2200, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P2263, P226B, P2297, P242B, P242C, P242D, P242E, P2452, P2453, P2454, P2455, P2456, P246F, P2470, P2471, P2472, P2481, P2482, P2483, P2484, P2564, P2565, P2627, P2628, P2A00 or U029D, is not set.

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

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

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

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 that DTC P118E, P118F or P1196 does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B131 Exhaust Temperature Sensor. It may take up to 2 min 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 X3 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω

        Replace the K20 Engine Control Module.

   - **Go to next step: If less than 10 Ω**
3. Ignition ON, test for 4.8 - 5.2 V between the signal circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF.
   2. Disconnect the X3 harness connector at the K20 Engine Control Module.
   3. Test for infinite resistance between signal circuit and ground
      - If less than infinite resistance, repair the short to ground in the circuit.
      - If infinite resistance
   4. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω

        Replace the K20 Engine Control Module.

   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
   2. Test for less than 1 V between the signal circuit and ground
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 2 Ω

        Replace the K20 Engine Control Module.

   - **Go to next step: If between 4.8 - 5.2 V**
4. Replace the appropriate B131 Exhaust Temperature Sensor.

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Repair Instructions

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

- Refer to **Exhaust Temperature Sensor Replacement - Position 1**
- Refer to **Exhaust Temperature Sensor Replacement - Position 2**
- Refer to **Exhaust Temperature Sensor Replacement - Position 3**
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P122D: INTAKE AIR FLOW VALVE POSITION SENSOR EXCEEDED LEARNING LIMIT

Diagnostic Instructions

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

DTC Descriptor

DTC P122D

Intake Air Flow Valve Position Sensor Exceeded Learning Limit

Circuit/System Description

A throttle plate actuator is used to achieve high exhaust gas recirculation rates. It increases the pressure difference between exhaust and intake so that the appropriate exhaust quantity can be mixed with the intake air. The ECM transmits the desired angle as a PWM signal to the throttle plate actuator. The throttle plate actuator operates the DC motor to control the throttle plate based on the PWM signal from the ECM.

The throttle body assembly contains a contactless 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 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.

In the event that the engine control module (ECM) detects the engine speed increases beyond desired control limits. Upon detection, the engine will be shutdown by closing the intake air flow valve and disabling the fuel injectors.

Conditions for Running the DTC

- Ignition ON, engine running or engine power down
- This DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The ECM detects an incorrect throttle valve position.

Action Taken When the DTC Sets

- DTC P122D is a Type A DTC, with LH7.
- DTC P122D is a Type B DTC, with NE4, NCP or NCV.
- DTC P122D is a Type C DTC, all others.

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Conditions for Clearing the DTC

- DTC P122D is a Type A DTC, with LH7.
- DTC P122D is a Type B DTC, with NE4, NCP, or NCV.
- DTC P122D is a Type C DTC, all others.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information 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 DTC P02E0, P02E2, P02E3, P02E4, P02E5, P02EB, P0697, P122B, P122C, P1425 is not set.
    - **If any of the DTCs are set**

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

    - **Go to next step: If none of the DTCs are set**
3. Clear the DTCs with a scan tool, ignition Off for 1 min.
4. Ignition On, verify DTC P122D is not set.
    - **If the DTC is set**
    1. Ignition Off.
    2. Verify the conditions listed below do not exist:
        - Intake air flow valve blade that is not in the rest position.
        - Intake air flow valve blade that is binding open or closed.
        - Intake air flow valve blade that opens or closes without spring pressure.
        - Dirt, debris or coking in the intake air flow valve.
        - Damaged intake air flow valve blade or shaft.
        - If a condition exists.

          Repair or replace the component as necessary.

    - **Go to next step: If the DTC is not set**
5. 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.
6. Verify a DTC does not set.

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- **If any DTC sets**

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

- **Go to next step: If no DTC sets**

7. All OK.

Repair Instructions

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

- Refer to **Throttle Body Assembly Replacement**
- Refer to **Control Module References** for Engine Control Module replacement, programming and setup.

DTC P1248, P1249, P124A, OR P124B: CYLINDER 1-4 INJECTOR HIGH CONTROL CIRCUIT SHORTED TO CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P1248

Cylinder 1 Injector High Control Circuit Shorted to Control Circuit

DTC P1249

Cylinder 2 Injector High Control Circuit Shorted to Control Circuit

DTC P124A

Cylinder 3 Injector High Control Circuit Shorted to Control Circuit

DTC P124B

Cylinder 4 Injector High Control Circuit Shorted to Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Cylinder 1 Fuel Injector High Voltage Supply	P2147	P0201	P2148	P1248*
Cylinder 2 Fuel Injector High Voltage Supply	P2150	P0202	P2151	P1249*
Cylinder 3 Fuel Injector High Voltage Supply	P2150	P0203	P2151	P124A*
Cylinder 4 Fuel Injector High Voltage Supply	P2147	P0204	P2148	P124B*
Cylinder 1 Fuel Injector High Voltage Control	P0261	P0201	P0262, P2148	P1248*

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Cylinder 2 Fuel Injector High Voltage Control	P0264	P0202	P0265, P2151	P1249*
Cylinder 3 Fuel Injector High Voltage Control	P0267	P0203	P0268, P2151	P124A*
Cylinder 4 Fuel Injector High Voltage Control	P0270	P0204	P0271, P2148	P124B*
* Short from Supply Circuit to Control Circuit				

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 greater than 11 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P1248

The ECM detects the injector 1 high voltage supply circuit is shorted to the injector 1 high voltage control circuit for greater than 500 ms.

DTC P1249

The ECM detects the injector 2 high voltage supply circuit is shorted to the injector 2 high voltage control circuit for greater than 500 ms.

DTC P124A

The ECM detects the injector 3 high voltage supply circuit is shorted to the injector 3 high voltage control circuit for greater than 500 ms.

DTC P124B

The ECM detects the injector 4 high voltage supply circuit is shorted to the injector 4 high voltage control circuit for greater than 500 ms.

Action Taken When the DTC Sets

DTC P1248, P1249, P124A and P124B are Type A DTCs.

Conditions for Clearing the DTC

DTC P1248, P1249, P124A and P124B are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify that DTC P0685 or P1682 is not set.
   - **If DTC P0685 or P1682 is set**

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

   - **Go to next step: If DTC P0685 or P1682 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.
   - **If DTC P1248, P1249, P124A or P124B sets**

     Refer to Circuit/System Testing

   - **Go to next step: If DTC P1248, P1249, P124A or P124B does not set**
4. 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.
2. Disconnect the harness connector at the appropriate Q17 Fuel Injector.
3. Ignition On.
4. Test for 4.5 - 6.5 V between the high voltage supply circuit terminal 1 and ground.
   - **If less than 4.5 V**

   1. Ignition Off.
   2. Disconnect the X2 harness connector at the K20 Engine Control Module.
   3. Test for infinite resistance between the supply circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 Ω in the supply circuit end to end.

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

- **If greater 6.5 V**

1. Ignition Off.
2. Disconnect the harness connector X2 at the K20 Engine Control Module, Ignition On.
3. Test for less than 1 V between the high voltage supply circuit terminal 1 and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **Go to next step: If between 4.5 - 6.5 V**

5. Test for 0.60 - 0.80 V between the high voltage control circuit terminal 2 and ground.

- **If less than 0.60 V**

1. Ignition Off.
2. Disconnect the harness connector X2 at the K20 Engine Control Module.
3. 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
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 greater than 0.80 V**

1. Ignition Off.
2. Disconnect the harness connector X2 at the K20 Engine Control Module, Ignition On.
3. Test for less than 1 V between the control circuit terminal 2 and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **Go to next step: If between 0.60 - 0.80 V**

6. Test or replace the appropriate Q17 Fuel Injector.

Component Testing

Static Test

1. Ignition Off
2. Disconnect the harness connector at the appropriate Q17 Fuel Injector.

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

3. Test for 0.2 - 1.5 Ω between the supply terminal 1 and the control terminal 2.

- **If not between 0.2 - 1.5 Ω**

  Replace the appropriate Q17 Fuel Injector.

- **Go to next step: If between 0.2 - 1.5 Ω**

4. Test for infinite resistance between each terminal and the injector housing/case.

- **If less than infinite resistance**

  Replace the appropriate Q17 Fuel Injector.

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

5. All OK

Repair Instructions

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

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- Refer to **Fuel Injector Replacement**
- For Engine Control Module replacement, programming and setup refer to: **Control Module References**

DTC P1255: FUEL PUMP CONTROL MODULE DRIVER HIGH TEMPERATURE

Diagnostic Instructions

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

DTC Descriptors

DTC P1255

Fuel Pump Control Module Driver High Temperature

Circuit/System Description

The engine control module (ECM) supplies voltage to the fuel pump driver control module for 30 s when the ignition is on and continuously when the engine is running. While this voltage is being received, a serial data signal containing the desired fuel pump speed is also received from the ECM. After the voltage and data have been received the fuel pump driver control module actuates the brushless fuel pump by means of a high power three phase signal.

Conditions for Running the DTC

- DTC U18A2 is not set.
- KR73 Ignition Main Relay is commanded On.

The DTC runs continuously when the conditions above are met.

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Conditions for Setting the DTC

The fuel pump driver control module detects a driver temperature greater than 160Â°C (320Â°F) for less than 0.5 s.

Action Taken When the DTC Sets

DTC P1255 is a Type B DTC.

Conditions for Clearing the DTC

DTC P1255 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 DTC U18A2 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Verify that the area where the K111 Fuel Pump Driver Control Module is located is free of debris, clutter or any insulating material that would cause the fuel pump driver control module to overheat.
   - **If any debris, clutter or other material is found**
   1. Clear the area where the K111 Fuel Pump Driver Control Module is located.
   2. Clear the DTC and test drive the vehicle.
   3. Verify the DTC does not set.
      - If the DTC sets, replace the K111 Fuel Pump Driver Control Module.
      - If the DTC does not set
   4. All OK.
   - **Go to next step: If no debris, clutter or other material is found**
4. Clear the DTC and test drive the vehicle.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Replace the K111 Fuel Pump Driver Control Module.

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

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Refer to Control Module References for Control Module replacement, programming and setup

DTC P127C OR P127D: FUEL RAIL PRESSURE SENSOR 2 CIRCUIT LOW/HIGH VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

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DTC P127C

Fuel Rail Pressure Sensor 2 Circuit Low Voltage

DTC P127D

Fuel Rail Pressure Sensor 2 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0193, P06A3, P127D	P0193, P127D	P0193, P06A3, P127D	-
Fuel Rail Pressure Sensor 1 - Signal	P0192	P0193	P0193	P0191
Fuel Rail Pressure Sensor 2 - Signal	P127C	P127D	P127D	P0191
Low Reference	-	P0193, P127D	P0193, P127D	P0191

Typical Scan Tool Data

Fuel Rail Pressure Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Running **Parameter Normal Range:** 0.4 to 4.5 V			
5 V Reference	5 V	5 V	5 V
Signal	0 V	5 V	5 V
Low Reference	-	5 V	-

Circuit/System Description

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

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to 5 V.
Low Reference	Grounded through the control module.

Component	Description
B47B Fuel Rail Pressure Sensor	The sensor measures the pressure in the component: Fuel Rail - The signal voltage decreases when the pressure increases.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

- Engine = Running
- Ignition Voltage = Greater than 8 V

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

Conditions for Setting the DTC

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P127C

Fuel Rail Pressure Sensor 2 = Less than 0.25 V - For greater than 1 s

P127D

Fuel Rail Pressure Sensor 2 = Greater than 4.75 V - For greater than 1 s

Actions Taken When the DTC Sets

DTC P127C, P127D = Type A DTC

Engine = Reduced Engine Power

Conditions for Clearing the DTC

DTC P127C, P127D = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify the scan tool parameter: Fuel Rail Pressure Sensor 2 = 0.4 to 4.5 V and changes
   - **If not between 0.4 and 4.5 V or does not change**

     Refer to Circuit/System Testing

   - **Go to next step: If between 0.4 and 4.5 V and changes**
3. Perform the scan tool control function: Fuel Rail Pressure - Increase & Decrease

   Verify the scan tool parameter: Fuel Rail Pressure Sensor 2 = The value should change with each command.

   - **If the value does not change**

     Refer to Circuit/System Testing

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- **Go to next step: If the value changes**

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

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing

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

5. All OK.

Circuit/System Testing

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

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B47B Fuel Rail Pressure Sensor
3. Test for less than 10 Ω between the test points: Low Reference circuit terminal 3 & Ground
   - **If 10 Ω or greater**
   1. Disconnect the electrical connector: K20 Engine Control Module
   2. Test for less than 2 Ω between the test points: Low Reference circuit terminal 3 @ Component harness & Terminal 69 @ Control module harness
      - If 2 Ω or greater - Repair the open/high resistance in the circuit.
      - If less than 2 Ω - Replace the component: K20 Engine Control Module
   - **Go to next step: If less than 10 Ω**
4. Ignition - On/Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 1 & Low Reference circuit terminal 3
   - **If less than 4.8 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 1 @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 Ω between the test points: 5 V Reference circuit terminal 1 @ Component harness & Terminal 89 @ Control module harness
      - If 2 Ω or greater - Repair the open/high resistance in the circuit.
      - If less than 2 Ω - Replace the component: K20 Engine Control Module
   - **If greater than 5.2 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K20 Engine Control Module
   3. Ignition - On/Vehicle - In Service Mode
   4. Test for less than 1 V between the test points: 5 V Reference circuit terminal 1 @ Component harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - If less than 1 V - Replace the component: K20 Engine Control Module
   - **Go to next step: If between 4.8 and 5.2 V**
6. Verify the scan tool parameter: Fuel Rail Pressure Sensor 2 = Greater than 4.8 V
   - **If 4.8 V or less**

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1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: K20 Engine Control Module
3. Test for infinite resistance between the test points: Signal circuit terminal 2 @ Component harness & Ground
    - If less than infinite resistance - Repair the short to ground on the circuit.
    - If infinite resistance - Replace the component: K20 Engine Control Module
- **Go to next step: If greater than 4.8 V**

7. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 2 & Low Reference circuit terminal 3
8. Verify the scan tool parameter: Fuel Rail Pressure Sensor 2 = Less than 0.3 V
    - **If 0.3 V or greater**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Ignition - On/Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: Signal circuit terminal 2 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for less than 2 Ω between the test points: Signal circuit terminal 2 @ Component harness & Terminal 38 @ Control module harness
        - If 2 Ω or greater - Repair the open/high resistance in the circuit.
        - If less than 2 Ω - Replace the component: K20 Engine Control Module
    - **Go to next step: If less than 0.3 V**
9. Test or replace the component: B47B Fuel Rail Pressure Sensor

Repair Instructions

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

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

DTC P129F: FUEL PUMP DRIVER CONTROL MODULE FUEL PUMP SPEED SIGNAL INCORRECT

Diagnostic Instructions

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

DTC Descriptor

DTC P129F

Fuel Pump Driver Control Module Fuel Pump Speed Signal Incorrect

Circuit/System Description

The fuel pump driver control module sends reports of the actual fuel pump speed to the engine control module (ECM) as serial data every 10 ms. The ECM calculates the error between the commanded fuel pump speed and the fuel pump speed that was reported from the fuel pump driver control module. A DTC will be set If the fuel pump speed is outside a calibrated threshold.

Conditions for Running the DTC

- DTC P1029, P102A, P102B, P102C, P1255, P12A6 or U18A2 is not set.

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- Ignition voltage is greater than 11 V.
- KR73 Ignition Main Relay is commanded On.

Conditions for Setting the DTC

The difference between the commanded fuel pump speed and actual fuel pump speed is outside a calibrated range for greater than 7 s.

Action Taken When the DTC Sets

DTC P129F is a Type B DTC.

Conditions for Clearing the DTC

DTC P129F is a Type B DTC.

Diagnostic Aids

Any failure that exists on the fuel pump output circuit (3 phases) will be manifested in a Fuel Pump Speed and may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 DTC P1029, P102A, P102B, P102C, P1255, P12A6 or U18A2 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Verify the scan tool parameter:

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- Fuel Pump Phase U-V-W Circuits Shorted Test Status = OK/Not Run
- **If not the specified state**

  Refer to Circuit/System Testing

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

4. Engine running.
5. Verify scan tool parameters Fuel Pump Speed Command and Fuel Pump Speed are within 250 RPM of each other while operating the vehicle through varying loads.
   - **If not within 250 RPM**

     Refer to Circuit/System Testing

   - **Go to next step: If within 250 RPM**
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 DTC P129F did not set.
   - **If the DTC is set**

     Refer to Circuit/System Testing

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

Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: K111 Fuel Pump Driver Control Module
3. Test for less than 2 Ω between the test points:
   - Control circuit terminal 8 @ Control module harness & Terminal 1 @ Component harness
   - Control circuit terminal 9 @ Control module harness & Terminal 2 @ Component harness
   - Control circuit terminal 24 @ Control module harness & Terminal 3 @ Component harness
   - **If 2 Ω or greater**

     Repair the open/high resistance in the circuit.

   - **Go to next step: If less than 2 Ω**
4. Test for infinite resistance between the test points:
   - Control circuit terminal 8 @ Control module harness & Control circuit terminal 9 @ Control module harness
   - Control circuit terminal 8 @ Control module harness & Control circuit terminal 24 @ Control module harness
   - Control circuit terminal 9 @ Control module harness & Control circuit terminal 24 @ Control module harness
   - **If less than infinite resistance**

     Repair the short between the circuits.

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

NOTE: **It may be necessary to remove engine components for the visual inspections.**

5. Verify that no fuel waxing, icing, or debris is obstructing operation of the A7 Fuel Pump and Level Sensor Assembly.
   - ***If any obstruction is found***

     Repair or replace as necessary.

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

6. Replace the component: A7 Fuel Pump and Level Sensor Assembly
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**

      Replace the component: K111 Fuel Pump Driver Control Module

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

Repair Instructions

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

- Refer to **Fuel Tank Fuel Pump Module Replacement (FWD)** **Fuel Tank Fuel Pump Module Replacement (AWD)**
- For control module replacement, programming and setup refer to **Control Module References**

DTC P12A6: FUEL PUMP DRIVER CONTROL MODULE ENABLE CIRCUIT PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P12A6

Fuel Pump Driver Control Module Enable Circuit Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P12A6	P12A6	-	P12A6

Circuit/System Description

After the vehicle has been powered Off for at least 2 min and the ignition is turned On, the engine control module (ECM) sends a signal via the fuel pump primary relay circuit to the fuel pump driver control module. The fuel pump driver control module enables the fuel pump for 30 s or continuously when the engine is running. The fuel pump driver control module actuates the brushless fuel pump by means of a high power three phase signal and controls the fuel pump speed according to serial data signals received from the ECM containing the desired fuel pump speed.

Conditions for Running the DTC

- DTC U18A2 is not set.
- KR73 Ignition Main Relay is commanded On.

The DTC runs continuously when the condition above is met.

Conditions for Setting the DTC

The engine control module state of the Fuel Pump Relay control circuit does not match the state of the Fuel Pump Relay control circuit sensed by the fuel pump driver control module for greater than 0.5 s.

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Action Taken When the DTC Sets

DTC P12A6 is a Type A DTC.

Conditions for Clearing the DTC

DTC P12A6 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 scan tool parameter Fuel Pump Speed is greater than 0 RPM within 30 s of turning On ignition.
   - **If Fuel Pump Speed is 0 RPM**

     Refer to Circuit/System Testing.

   - **Go to next step: If Fuel Pump Speed is greater than 0 RPM**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

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1. Ignition Off, disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
2. Ignition On.
3. Verify that a test lamp illuminates between the control circuit terminal 18 and ground.
    - **If the test lamp does not illuminate**
    1. Ignition Off, disconnect the harness connector X1 at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit
        - If infinite resistance
    3. Test for less than 2 Ω between the control circuit end to end.
        - If greater than 2 Ω, repair the open/high resistance in the circuit
        - If less than 2 Ω, replace the K20 Engine Control Module
    - **Go to next step: If the test lamp illuminates**
4. Ignition On for greater than 30 s.
5. Verify that a test lamp does not illuminate between the control circuit terminal 18 and ground.
    - **If the test lamp illuminates**
    1. Ignition Off, remove the test lamp, disconnect the harness connector X1 at the K20 Engine Control Module.
    2. Ignition On.
    3. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp does not illuminate**
6. Replace the K111 Fuel Pump Driver Control Module.

Repair Instructions

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

For Control Module replacement, programming and setup, refer to **Control Module References**

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DTC P1307-P130A: CYLINDER 1-4 GLOW PLUG RESISTANCE

Diagnostic Instructions

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

DTC Descriptors

DTC P1307

Cylinder 1 Glow Plug Resistance

DTC P1308

Cylinder 2 Glow Plug Resistance

DTC P1309

Cylinder 3 Glow Plug Resistance

DTC P130A

Cylinder 4 Glow Plug Resistance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Glow Plug Supply Voltage	P161E	P161E	-
Cylinder 1 Glow Plug Control	P1307, P066A	P1307, P0671	P1307, P066B
Cylinder 2 Glow Plug Control	P1308, P066C	P1308, P0672	P1308, P066D
Cylinder 3 Glow Plug Control	P1309, P066E	P1309, P0673	P1309, P066F
Cylinder 4 Glow Plug Control	P130A, P067A	P130A, P0674	P130A, P067B

Circuit/System Description

The glow plug control module is integrated in the engine control module (ECM) and is a solid state device which operates the glow plugs. The temperature and the power consumption is controlled within a wide range to suit the engine pre-heating requirements. The glow plug initial ON time will vary based on the system voltage and temperature. Lower temperatures cause longer ON times.

Conditions for Running the DTC

- The engine is running.
- Ignition voltage is greater than 11 V.
- The glow plugs are commanded On.
- The DTC runs continuously when conditions above are met.

Conditions for Setting the DTC

The ECM detects the glow plug electrical resistance is outside a calibratable range for greater than 2 s.

Action Taken When the DTC Sets

DTCs P1307, P1308, P1309 and P130A are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1307, P1308, P1309 and P130A are Type B DTCs.

Diagnostic Aids

If the battery is connected with the ignition On, the glow plugs could be damaged without finding any circuit fault.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Glow Plug System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify DTC P037E, P037F, P066A-P066F, P0671-P0674, P067A or P067B is not set.
   - **If DTC P037E, P037F, P066A-P066F, P0671-P0674, P067A or P067B is set**

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

   - **Go to next step: If a DTC P037E, P037F, P066A-P066F, P0671-P0674, P067A or P067B is not set**
3. Ignition On.
4. Using a scan tool perform the Glow Plug Self-Test while observing the following parameters.

   Verify that all parameters display OK or Not Run.

   - Cylinder 1, 2, 3 or 4 Glow Plug Control Circuit Open Test Status
   - Cylinder 1, 2, 3 or 4 Glow Plug Control Circuit High Voltage Test Status
   - Cylinder 1, 2, 3 or 4 Glow Plug Control Circuit Low Voltage Test Status
   - **If specified state is not displayed**

     Refer to Circuit/System Testing.

   - **Go to next step: If specified state is displayed**
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not set. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - **If a DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE: **If a glow plug is replaced and the tip is missing or burned off, the cylinder head must be removed and all debris be cleaned out of the cylinder.**

1. Ignition Off, disconnect the harness connector at the appropriate E12 Glow Plug.
2. Ignition On.
3. Verify the glow plug is command Off with a scan tool.
4. Test for less than 0.2 V between the glow plug supply voltage circuit terminal 1 and ground.
   - **If greater than 0.2 V**
   1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Ignition On.

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3. Test for less than 0.2 V between the glow plug supply voltage circuit and ground.
    - If 0.2 V or greater, repair the short to voltage in the circuit.
    - If less than 0.2 V replace the K20 Engine Control Module.
- **Go to next step: If less than 0.2 V**

NOTE: **The glow plug supply voltage circuit will only stay On for 3 s when commanding the glow plugs On with the scan tool.**

5. Test for greater than 0.2 V while commanding the appropriate glow plug On with a scan tool.
    - **If less than 0.2 V**
    1. Ignition Off, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the appropriate glow plug supply voltage 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 glow plug supply voltage circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If greater than 0.2 V**
6. Test or replace the appropriate E12 Glow Plug.

Component Testing

1. Ignition Off.
2. Disconnect the harness connector of the appropriate glow plug.
3. Test for less than 2 Ω between glow plug terminal and the component's housing.
    - **If the resistance is more than 2 Ω**

      Replace the affected glow plug.

    - **Go to next step: If the resistance is less than 2 Ω**
4. All OK.

Repair Instructions

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

- Refer to **Glow Plug Replacement**
- Refer to **Control Module References** for control module replacement, programming and setup.

DTC P140B OR P140C: EXHAUST GAS RECIRCULATION (EGR) SLOW RESPONSE - INCREASING/DECREASING FLOW

Diagnostic Instructions

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

DTC Descriptors

DTC P140B

Exhaust Gas Recirculation (EGR) Slow Response - Increasing Flow

DTC P140C

Exhaust Gas Recirculation (EGR) Slow Response - Decreasing Flow

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Circuit/System Description

The exhaust gas recirculation (EGR) valve is an electrically controlled valve that is controlled by the engine control module (ECM). The EGR allows a specific amount of exhaust gas into the intake manifold. This exhaust gas mixes with the intake air and cools the combustion process. The recirculated exhaust gas also prevents the formation of nitrogen oxides (NOx).

Conditions for Running the DTC

P140B

- DTC P0033-P0035, P003A, P0046, P0070-P0074, P0087, P00AF, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0243, P0245-P0250, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02E0, P02E2-P02E5, P02E8, P02E9, P02EB, P02EE, P02EF, P02F0-P02F5, P0335, P0336, P0403, P0405, P0406, P041B-P041E, P042E, P042F, P049D, P0490, P0545, P0546, P062B, P062D, P0772, P0773, P111E, P113B, P118E, P122B-P122D, P1248, P1249, P124A-P124F, P1402, P1407, P140F, P1424, P1425, P1428, P16A0-P16A2, P2080, P2081, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2262, P2263, P22CF, P22D0, P22D1, P2459, P245C, or P262B is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The barometric pressure is greater than 69.6 kPa (10.1 psi).
- The outside air temperature is warmer than -7Â°C (19.4Â°F).
- The engine speed is between 750-2, 400 RPM.

The DTC runs continuously when the above conditions are met.

P140C

- DTC P0033-P0035, P003A, P0046, P0070-P0074, P0087, P00AF, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0243, P0245-P0250, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02E0, P02E2-P02E5, P02E8, P02E9, P02EB, P02EE, P02EF, P02F0-P02F5, P0335, P0336, P0403, P0405, P0406, P041B-P041E, P042E, P042F, P049D, P0490, P0545, P0546, P062B, P062D, P0772, P0773, P111E, P113B, P118E, P122B-P122D, P1248, P1249, P124A-P124F, P1402, P1407, P140F, P1424, P1425, P1428, P16A0-P16A2, P2080, P2081, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2262, P2263, P22CF, P22D0, P22D1, P2459, P245C, or P262B is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The barometric pressure is greater than 69.6 kPa (10.1 psi).
- The outside air temperature is warmer than -7Â°C (19.4Â°F).
- The engine speed is between 1, 000-1, 900 RPM.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P140B

The ECM detects that the actual EGR flow is higher than a calibrated value for greater than 5 s.

P140C

The ECM detects that the actual EGR flow is lower than a calibrated value for greater than 5 s.

Action Taken When the DTC Sets

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DTCs P140B and P140C are Type B DTCs.

Conditions for Clearing the DTC

DTCs P140B and P140C are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 P0033-P0035, P003A, P0046, P0070-P0074, P0087, P00AF, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0243, P0245-P0250, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02E0, P02E2-P02E5, P02E8, P02E9, P02EB, P02EE, P02EF, P02F0-P02F5, P0335, P0336, P0403, P0405, P0406, P041B-P041E, P042E, P042F, P049D, P0490, P0545, P0546, P062B, P062D, P0772, P0773, P111E, P113B, P118E, P122B-P122D, P1248, P1249, P124A-P124F, P1402, P1407, P140F, P1424, P1425, P1428, P16A0-P16A2, P2080, P2081, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2262, P2263, P22CF, P22D0, P22D1, P2459, P245C or P262B is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Verify that none of the conditions listed below exist:
   - Binding, damaged or restricted intake air flow valve
   - Leaking or restricted intake system/charge air hoses
   - Leaking or restricted exhaust system/turbo charger
   - Wet or restricted air filter
   - Loose or improperly connected hoses
   - Damaged or missing components
   - **If a condition is found**

     Repair as necessary.

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

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4. Verify that DTC P140B or P140C is not set.
    - **If the DTC is set**
    1. Clear all DTCs with a scan tool
    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 that DTC P140B or P140C is not set.
        - If a DTC is set, replace the Q14 Exhaust Gas Recirculation valve
        - If no DTC is set.
    4. All OK.
    - **Go to next step: If no DTC is set**
5. All OK.

Repair Instructions

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

Refer to **Exhaust Gas Recirculation Valve Replacement**

DTC P1424: EXHAUST GAS RECIRCULATION (EGR) MOTOR OVERTEMPERATURE

Diagnostic Instructions

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

DTC Descriptors

DTC P1424

Exhaust Gas Recirculation (EGR) Motor Overtemperature

Circuit/System Description

An EGR actuator is used to adjust the exhaust gas recirculation inside the intake manifold so that the appropriate exhaust quantity can be mixed with the intake air. The Engine Control Module transmits the desired position of EGR pintle lift as a Pulse Width Modulated signal to the EGR actuator. The EGR position is monitored by an internal position sensor.

Conditions for Running the DTC

- The ignition is ON or engine running.
- The engine is not cranking.
- The ignition voltage is greater than 11 V.

This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects an over temperature condition on the EGR actuator driver for a time greater than 1 s.

Action Taken When the DTC Sets

DTC P1424 is a Type B DTC.

Conditions for Clearing the DTC

DTC P1424 is a Type B DTC.

Reference Information

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Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exhaust Gas Recirculation (EGR) 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 DTCs P0401, P0402, P0403, P0405, P0406, P042E, P042F, P0489, P0490, P049D, P1402, P1407 or P140F are not set
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify DTC P1424 does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the Q14 Exhaust Gas Recirculation Valve, ignition On.
2. Test for 0.1 - 0.5 V between the EGR motor control circuit terminal 2 and ground.
   - **If greater than 0.5 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 control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If less than 0.1 V**

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1. Ignition Off, disconnect the X2 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
3. 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 between 0.1 - 0.5 V**

3. Test for 1 - 3 V between the EGR motor control circuit terminal 6 and ground.
    - **If greater than 3 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 control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.

    - **Go to next step: If less than 1 V**

    1. Ignition Off, disconnect the X2 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
    3. 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 between 1 - 3 V**

4. Replace the Q14 Exhaust Gas Recirculation Valve.

Repair Instructions

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

- Refer to **Exhaust Gas Recirculation Valve Replacement**
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P1428 OR P142A: EGR TEMPERATURE SENSOR 1-2 - INTAKE AIR TEMPERATURE 2 NOT PLAUSIBLE

Diagnostic Instructions

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

DTC Descriptors

DTC P1428

EGR Temperature Sensor 1 - Intake Air Temperature 2 Not Plausible

DTC P142A

EGR Temperature Sensor 2 - Intake Air Temperature 2 Not Plausible

Circuit/System Description

The exhaust gas recirculation (EGR) temperature sensors are variable resistors that measure the temperature of the exhaust gas at the inlet and outlet of the EGR cooler. The engine control module

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(ECM) supplies 5 volts to the EGR temperature sensor signal circuit and a ground for the low reference circuit. When the EGR temperature sensor is cold, the sensor resistance is high. When the EGR temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a higher voltage on the EGR temperature signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the EGR temperature signal circuit.

Conditions for Running the DTC

- DTCs P00E9, P010B, P0111, P0114, P0116, P0117, P0118, P0119, P0128, P017B, P017C, P017D, P111E, P117B, P117C, P117D, P117E, P117F or P262B are not set.
- The ignition has been OFF for 8 h or greater.
- The ignition is in run or crank.

These DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the EGR cooler temperature sensor 1 or 2 is greater than 20Â°C (36Â°F) different from intake air temperature (IAT) sensor 2.

Action Taken When the DTC Sets

DTCs P1428 and P142A are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1428 and P142A are Type B DTCs.

Diagnostic Aids

- Inspect the EGR cooler temperature sensor 1 and 2 terminals for corrosion.
- Inspect the EGR cooler temperature sensor 1 and 2 wiring for pinches, cuts and damaged insulation.
- EGR cooler temperature sensors may fail while operating under extreme temperatures. Review the Freeze Frame/Failure Records to verify the failure criteria.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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J 25070 Heat Gun 500 - 750Â°F

Circuit/System Verification

1. Ignition ON
2. Verify DTCs P0096, P0097, P0098, P0099, P00E9, P010B, P0111, P0114, P0116, P0117, P0118, P0119, P0128, P017B, P017C, P017D, P111E, P117B, P117C, P117D, P117E, P117F or P262B are not set.
   - **If any of the DTCs are set**

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

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

   NOTE: **Determine the ambient temperature by using an accurate thermometer.**

3. Ignition OFF for greater than 8 hours.
4. Observe the scan tool EGR Cooler Temperature Sensor 1 and 2 parameters and compare them to the ambient temperature. The reading for EGR Cooler Temperature Sensor 1 and 2 should be within 30Â°C (54Â°F) of the ambient temperature.
   - **If not within the specified range**

     Refer to Circuit/System Testing.

   - **Go to next step: If within the specified range**
5. Engine running.
6. Verify the scan tool EGR Temperature Sensor 1 and EGR Temperature Sensor 2 parameters are between -39Â° to +999Â°C (-38Â° to +1, 830Â°F) and changes with engine run time.
   - **If not between -39Â° to +999Â°C (-38Â° to +1, 830Â°F) or does not change**

     Refer to Circuit/System Testing.

   - **Go to next step: If between -39Â° to +999Â°C (-38Â° to +1, 830Â°F) and changes**
7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B130 Exhaust Gas Recirculation Temperature Sensor. It may take up to 2 min 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 X3 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 10 Ω**
3. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
4. 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.

   - **Go to next step: If infinite resistance**
5. Test for less than 2 Ω in the signal circuit end to end.
   - **If 2 Ω or greater**

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Repair the open/high resistance in the circuit.

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

6. Ignition ON.
7. 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.

   - **Go to next step: If less than 1 V**
8. Test or replace the appropriate B130 Exhaust Gas Recirculation Temperature Sensor.
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 that DTC does not set.
    - **If DTC sets**

      Replace the K20 Engine Control Module

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

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B130 Exhaust Gas Recirculation Temperature Sensor.

   NOTE: **The J 25070 may be used to evaluate the sensor under high temperature conditions.**

2. Verify the resistance between the signal circuit terminal 1 and the low reference circuit terminal 2 is within the range specified in the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** Table.
   - **If not within the range specified**

     Replace the appropriate B130 Exhaust Gas Recirculation Temperature Sensor.

   - **Go to next step: If within the range specified**
3. Test for infinite resistance between each terminal and the sensor housing/case.
   - **If less than infinite resistance**

     Replace the appropriate B130 Exhaust Gas Recirculation Temperature Sensor.

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

Repair Instructions

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

- Refer to **Exhaust Gas Recirculation Cooler Temperature Sensor Replacement - Position 1**
- Refer to **Exhaust Gas Recirculation Cooler Temperature Sensor Replacement - Position 2**
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

DTC P142B, P142C, P142D, P142E, P142F, OR P1435: PARTICULATE MATTER SENSOR CONTROL MODULE TEMPERATURE

Diagnostic Instructions

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

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- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P142B

Particulate Matter Sensor Control Module High Temperature

DTC P142C

Particulate Matter Sensor Control Module Temperature Sensor 1 Low Voltage

DTC P142D

Particulate Matter Sensor Control Module Temperature Sensor 1 High Voltage

DTC P142E

Particulate Matter Sensor Control Module Temperature Sensor 2 Low Voltage

DTC P142F

Particulate Matter Sensor Control Module Temperature Sensor 2 High Voltage

DTC P1435

Particulate Matter Sensor Control Module Temperature Sensors 1-2 Not Plausible

DTC P1436

Particulate Matter Sensor Control Module Temperature Signal Message Counter Incorrect

Circuit/System Description

The particulate matter (PM) sensor monitors the amount of the particulates (soot) in the diesel exhaust gas exiting the tailpipe. The PM sensor is similar to the heated oxygen sensor with a ceramic element, but also includes an individually calibrated sensor control unit (SCU). The sensing element includes comb-shaped interdigital electrodes (IDE), a heater and a positive temperature coefficient resistor for temperature measurement.

The operation of the PM Sensor is based on the electrical conductivity characteristic of the diesel particulate. As the exhaust gas flows over the sensing element, soot is absorbed in the combs between the electrodes, eventually creating a conductive path. When the path is formed, it generates a current based on the voltage being applied to the element. The measurement process continues until a preset current value is reached. To avoid misleading readings, the sensor performs a regeneration where the soot is cleaned off by heating up the element, before the measurement phase begins. The amount of regenerations is based on vehicle strategy; when the calibrated number of regenerations is reached, the cumulative current readings are used to determine the amount of soot concentration in the exhaust gas which in turn determines the collection efficiency of the diesel particulate filter (DPF).

Conditions for Running the DTCs

P142B, P1435

- DTC P142C, P142D, P142E, P142F, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0 or U02A3 is not set.
- The ignition is ON and the engine is not cranking.
- The ignition voltage is greater than 11 V.
- The reductant control module relay 2 is commanded ON.

The DTCs run continuously when the above conditions are met.

P142C, P142D, P142E, P142F, P1436

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- DTC P16D7, P16D8, P16D9, P24D0 or U02A3 is not set.
- The ignition is ON and the engine is not cranking.
- The ignition voltage is greater than 11 V.
- The reductant control module relay 2 is commanded ON.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The particular matter sensor control unit detects an internal electrical fault or an over temperature condition on one of the internal temperature sensors.

Action Taken When the DTC Sets

DTCs P142B, P142C, P142D, P142E, P142F, P1435 and P1436 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P142B, P142C, P142D, P142E, P142F, P1435 and P1436 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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.

   Verify DTC P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0 or U02A3 is not set

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

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

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

2. Verify DTC P142B, P142C, P142D, P142E, P142F, P1435 or P1436 is not set.
    - **If the DTC sets**

      Replace the B136 Exhaust Particulate Matter Sensor.

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

Repair Instructions

- Refer to **Exhaust Particulate Sensor Replacement**
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P142B, P142C, P142D, P142E, P142F, P1435 OR P1436: PARTICULATE MATTER SENSOR CONTROL MODULE TEMPERATURE

Diagnostic Instructions

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

DTC Descriptors

DTC P142B

Particulate Matter Sensor Control Module High Temperature

DTC P142C

Particulate Matter Sensor Control Module Temperature Sensor 1 Low Voltage

DTC P142D

Particulate Matter Sensor Control Module Temperature Sensor 1 High Voltage

DTC P142E

Particulate Matter Sensor Control Module Temperature Sensor 2 Low Voltage

DTC P142F

Particulate Matter Sensor Control Module Temperature Sensor 2 High Voltage

DTC P1435

Particulate Matter Sensor Control Module Temperature Sensors 1-2 Not Plausible

DTC P1436

Particulate Matter Sensor Control Module Temperature Signal Message Counter Incorrect

Circuit/System Description

The particulate matter (PM) sensor monitors the amount of the particulates (soot) in the diesel exhaust gas exiting the tailpipe. The PM sensor is similar to the heated oxygen sensor with a ceramic element, but also includes an individually calibrated sensor control unit (SCU). The sensing element includes comb-shaped interdigital electrodes (IDE), a heater and a positive temperature coefficient resistor for temperature measurement.

The operation of the PM Sensor is based on the electrical conductivity characteristic of the diesel particulate. As the exhaust gas flows over the sensing element, soot is absorbed in the combs between

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the electrodes, eventually creating a conductive path. When the path is formed, it generates a current based on the voltage being applied to the element. The measurement process continues until a preset current value is reached. To avoid misleading readings, the sensor performs a regeneration where the soot is cleaned off by heating up the element, before the measurement phase begins. The amount of regenerations is based on vehicle strategy; when the calibrated number of regenerations is reached, the cumulative current readings are used to determine the amount of soot concentration in the exhaust gas which in turn determines the collection efficiency of the diesel particulate filter (DPF).

Conditions for Running the DTCs

P142B, P1435

- DTC P142C, P142D, P142E, P142F, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0 or U02A3 is not set.
- The ignition is ON and the engine is not cranking.
- The ignition voltage is greater than 11 V.
- The reductant control module relay 2 is commanded ON.

The DTCs run continuously when the above conditions are met.

P142C, P142D, P142E, P142F, P1436

- DTC P16D7, P16D8, P16D9, P24D0 or U02A3 is not set.
- The ignition is ON and the engine is not cranking.
- The ignition voltage is greater than 11 V.
- The reductant control module relay 2 is commanded ON.

The DTCs run continuously when the above conditions are met.

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Conditions for Setting the DTC

The particular matter sensor control unit detects an internal electrical fault or an over temperature condition on one of the internal temperature sensors.

Action Taken When the DTC Sets

DTCs P142B, P142C, P142D, P142E, P142F, P1435 and P1436 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P142B, P142C, P142D, P142E, P142F, P1435 and P1436 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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.

   Verify DTC P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0 or U02A3 is not set

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

     Refer to Diagnostic Trouble Code (DTC) List - Vehicle

   - **Go to next step: If none of the DTCs are set**
2. Verify DTC P142B, P142C, P142D, P142E, P142F, P1435 or P1436 is not set.
   - **If the DTC sets**

     Replace the B136 Exhaust Particulate Matter Sensor.

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

Repair Instructions

- Refer to Exhaust Particulate Sensor Replacement
- Refer to Control Module References for engine control module replacement, programming and setup.

DTC P1436: PARTICULATE MATTER SENSOR CONTROL MODULE TEMPERATURE SIGNAL MESSAGE COUNTER INCORRECT

Diagnostic Instructions

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

DTC Descriptor

DTC P1436

Particulate Matter Sensor Control Module Temperature Signal Message Counter Incorrect

Circuit/System Description

Control modules connected to the serial data circuits monitor the communication during normal vehicle operation. Operating information and commands are exchanged among the control modules. Each module on the serial data circuit maintains a transmit error counter and a receive error counter. The counter values increase with detected errors and decrease with error-free messages.

Conditions for Running the DTC

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Ignition Voltage = Greater than 11 V

DTC runs continuously when the above condition is met for greater than 3 s.

Conditions for Setting the DTC

Serial Data = Message Counter Incorrect - Between the following control modules:

- K181 Exhaust Particulate Matter Sensor Control Module
- K20 Engine Control Module

Actions Taken When the DTC Sets

DTC P1009 = Type B DTC

Conditions for Clearing the DTC

DTC P1009 = Type B DTC

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following system/component: Serial Data
    - **If other DTCs are set**

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

    - **If no other DTCs are set**

    1. Ignition/Vehicle - Off
    2. Replace the component: K181 Exhaust Particulate Matter Sensor Control Module
    3. Operate the vehicle within the Conditions for Running the DTC.
    4. Verify the DTC does not set.
        - If the DTC sets - Replace the component: K20 Engine Control Module
        - If the DTC is not set
    5. All OK.

    - **Go to next step: If no DTC is set**
3. 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 P144E OR P144F: CLOSED LOOP DIESEL PARTICULATE FILTER (DPF) REGENERATION CONTROL AT LIMIT - STAGE 2 LOW/HIGH TEMPERATURE

Diagnostic Instructions

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

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- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P144E

Closed Loop Diesel Particulate Filter (DPF) Regeneration Control At Limit - Stage 2 Low Temperature

DTC P114F

Closed Loop Diesel Particulate Filter (DPF) Regeneration Control At Limit - Stage 2 High Temperature

Circuit/System Description

The main function of the close coupled diesel oxidation catalyst (CCDOC) is to control emissions of non methane hydrocarbons and carbon monoxide (CO). Its secondary function is to assist with the diesel particulate filter (DPF) regeneration, by obtaining and sustaining the temperature necessary for regeneration. In order to generate the high exhaust temperatures needed for regeneration, the aftertreatment system increases exhaust temperatures by injecting diesel fuel into the exhaust system via post-injection. The injected fuel is converted into heat by the DOC to incinerate soot accumulated in the DPF. The engine control module (ECM) monitors the exhaust gas temperature sensor 1 and 2 to determine if catalyst downstream temperatures are achieved during a DPF regeneration.

Conditions for Running the DTCs

P144E and P144F

- DTC P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0772, P0773, P111E, P113C, P118F, P1248, P1249, P124A-P124F, P126A, P2032, P2033, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156 or P2157 is not set,
- Ignition voltage is greater than 11 V.
- Vehicle speed is greater than 0 km/h (0 mph).
- The ECM is commanding a DPF regeneration.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P144E and P144F

The ECM detects insufficient exhaust temperature downstream of the first diesel oxidation catalyst during a DPF regeneration.

Action Taken When the DTC Sets

DTCs P144E is a Type B DTC.

DTCs P144F is a Type A DTC.

Conditions for Clearing the DTC

DTCs P144E is a Type B DTC.

DTCs P144F is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 DTC P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0772, P0773, P111E, P113C, P118F, P1248, P1249, P124A-P124F, P126A, P2032, P2033, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156 or P2157 is not set,
   - **If a DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
   - **Go to next step: If a DTC is not set**
3. Verify that the resistance of B131 Exhaust Gas Temperature Sensor 1 and 2 is within the value specified in **Temperature Versus Resistance**
   - **If not within the specified range**

     Replace the appropriate B131 Exhaust Gas Temperature Sensor
   - **Go to next step: If within the specified range**
4. Verify the following conditions do not exist:
   - Exhaust system leaks - Refer to **Exhaust Leakage** .
   - A loose or disconnected charge air cooler hose or pipe
   - Loose or missing induction or exhaust system components
   - **If a condition is found**

     Repair as necessary.
   - **Go to next step: If no condition is found**
5. Perform the Diesel Particulate Filter Service Regeneration

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6. Verify that EGT Sensor 2 reads at least 100Â°C (180Â°F) warmer than EGT Sensor 1 during regeneration.
    - **If EGT Sensor 2 is less than 100Â°C (180Â°F) warmer than EGT Sensor 1**

      Replace the diesel oxidation catalyst

    - **Go to next step: If EGT Sensor 2 is at least 100Â°C (180Â°F) warmer than EGT Sensor 1**
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**

      Replace the diesel oxidation catalyst.

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

Repair Instructions

- Refer to **Oxidation Catalytic Converter Replacement (LH7)** Perform the scan tool Catalyst 1 Reset after replacing the oxidation catalytic converter.
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P1474, P1475, P1476, P1477, P1478, P1479, P147B OR P1488: PARTICULATE MATTER SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P1474

Particulate Matter Sensor Electrode Supply Circuit

DTC P1475

Particulate Matter Sensor Electrode Supply Circuit Low Voltage

DTC P1476

Particulate Matter Sensor Electrode Supply Circuit High Voltage

DTC P1477

Particulate Matter Sensor Temperature Circuit Low Voltage

DTC P1478

Particulate Matter Sensor Temperature Circuit High Voltage

DTC P1479

Particulate Matter Sensor Sensitivity Factor Performance

DTC P147B

Particulate Matter Sensor Shunt Circuit High Current

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DTC P1488

Particulate Matter Sensor Protection Tube Performance

Circuit/System Description

The particulate matter (PM) sensor monitors the amount of the particulates (soot) in the diesel exhaust gas exiting the tailpipe. The PM sensor is similar to the heated oxygen sensor with a ceramic element, but also includes an individually calibrated sensor control unit (SCU). The sensing element includes comb-shaped interdigital electrodes (IDE), a heater and a positive temperature coefficient resistor for temperature measurement.

The operation of the PM Sensor is based on the electrical conductivity characteristic of the diesel particulate. As the exhaust gas flows over the sensing element, soot is absorbed in the combs between the electrodes, eventually creating a conductive path. When the path is formed, it generates a current based on the voltage being applied to the element. The measurement process continues until a preset current value is reached. To avoid misleading readings, the sensor performs a regeneration where the soot is cleaned off by heating up the element, before the measurement phase begins. The amount of regenerations is based on vehicle strategy; when the calibrated number of regenerations is reached, the cumulative current readings are used to determine the amount of soot concentration in the exhaust gas which in turn determines the collection efficiency of the diesel particulate filter (DPF).

Conditions for Running the DTCs

P1474, P1475, P1476, P1477, P1478

- DTC P16D7, P16D8, P16D9, P24D0 or U02A3 is not set.
- The ignition is ON and the engine is not cranking.
- The ignition voltage is greater than 11 V.
- The reductant control module relay 2 is commanded ON.

These DTCs run continuously when the above conditions are met.

P1479, P147B

- DTC P142D, P142C, P142F, P142E, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0 or U02A3 is not set.
- The ignition is ON.
- The ignition voltage is greater than 11 V.
- The reductant control module relay 2 is commanded ON.

These DTCs run continuously when the above conditions are met.

P1488

- DTC P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0772, P0773, P111E, P113F, P1198, P1248, P1249, P124A-P124F, P126A, P142D, P142C, P142F, P142E, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P2032, P2033, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2481, P2482, P2483, P2484, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0, P262B or U02A3 is not set.
- The ignition has been Off for greater than 8 h.
- The ignition is ON.
- The ignition voltage is greater than 11 V.
- The particulate matter sensor temperature is between 0-300Â°C (32-572Â°F).
- The reductant control module relay 2 is commanded ON.

The DTC runs continuously when the above conditions are met.

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Conditions for Setting the DTC

The particular matter sensor control unit detects a fault in the particulate matter sensor circuitry.

Action Taken When the DTC Sets

DTCs P1474, P1475 P1476, P1477, P1478, P1479, P147B and P1488 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1474, P1475 P1476, P1477, P1478, P1479, P147B and P1488 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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.

   Verify no other DTCs are set

   - **If any other DTCs are set**

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

   - **Go to next step: If no other DTCs are set**
2. Verify DTC P1474, P1475, P1476, P1477, P1478, P1479, P147B or P1488 is not set.
   - **If the DTC sets**

     Replace the B136 Exhaust Particulate Matter Sensor.

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

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Repair Instructions

- Refer to **Exhaust Particulate Sensor Replacement**
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P157A: SENSOR SUPPLY VOLTAGE RELAY FEEDBACK CIRCUIT HIGH VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P157A

Sensor Supply Voltage Relay Feedback Circuit High Voltage

Circuit/System Description

The reductant control module relay 1 & 2 supply ignition voltage to the Reductant Control Module. The Reductant Control Module Relay 2 also supplies ignition voltage to Nitrogen Oxide Sensor 1 & 2 and the Exhaust Particulate Matter Sensor. Both Reductant Control Module Relay 1 & 2 are controlled by a low side driver in the ECM.

Conditions for Running the DTC

- The DTC runs when Ignition OFF.

Conditions for Setting the DTC

The ECM detects the reductant control module relay 2 feedback circuit is shorted to voltage.

Action Taken when the DTC Sets

DTC P157A is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P157A is a Type B DTC.

Reference Information

Schematic Reference

Power Moding Wiring Schematics

Connector End View Reference

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 43244 Relay Puller Pliers

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

Circuit/System Verification

1. Ignition ON.
2. Verify with a scan tool that no other DTC is set.
   - **If any other DTC is set**

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

   - **Go to next step: If no other DTC is set**
3. Operate the vehicle within the Conditions for Running the DTC. It may be helpful to operate the vehicle within the conditions identified from the Freeze Frame/Failure Records data
4. Verify DTC P157A is not set.
   - **If the DTC P157A is set.**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC P157A is not set.**
5. All OK.

Circuit/System Testing

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

1. Ignition Off and all vehicle systems Off.
2. Disconnect the KR121A Reductant Control Module Relay 1.
3. Test for less than 1 V between the ignition circuit terminal 30 & Ground.

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

   - **If 1 V or greater**
4. Repair the short to voltage in the circuit.
   - **Go to next step: If less than 1 V**
5. Test or replace KR121A Reductant Control Module Relay 1.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR121A Reductant Control Module Relay 1.
2. Test for 70 - 110 Ω between terminals 85 and 86 of the relay.
   - **If not within 70 - 100 Ω**

     Replace the relay.

   - **Go to next step: If within 70 - 100 Ω**

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3. Test for infinite resistance between the following terminals listed below:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
        - **If less than infinite resistance**

          Replace the relay.

        - **Go to next step: If infinite resistance**
4. Install a 20 A fused jumper wire between relay terminal 85 and B+. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 Ω between terminals 30 and 87.
    - **If 2 Ω or greater**

      Replace the relay.

    - **Go to next step: If less than 2 Ω**
6. All OK.

Repair Instructions

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

- Refer to **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- For control module replacement, programming and setup, refer to **Control Module References**

DTC P161E: GLOW PLUG SUPPLY VOLTAGE CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P161E

Glow Plug Supply Voltage Circuit

Circuit/System Description

The glow plug control module is integrated in the engine control module (ECM) and is a solid state device which operates the glow plugs. The temperature and the power consumption is controlled within a wide range to suit the engine pre-heating requirements. The glow plug initial ON time will vary based on the system voltage and temperature. Lower temperatures cause longer ON times.

Conditions for Running the DTC

- Ignition ON, or engine running.
- The ignition voltage is greater than 11 V.
- The DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The ECM detects the internal glow plug module is not powered up for greater than 1 s.

Action Taken When the DTC Sets

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DTC P161E is a Type C DTC.

Conditions for Clearing the DTC

DTC P161E is a Type C DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 with a scan tool that no other DTCs are set.
   - **If any other DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
   - **Go to next step: If no other DTC is set**
3. Verify that DTC P161E is not set.
   - **If the DTC P161E is set**

     Refer to Circuit/System Testing.
   - **Go to next step: If the DTC P161E is not 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 the DTC not reset.
   - **If the DTC P161E resets**

     Refer to Circuit/System Testing
   - **Go to next step: If DTC P161E does not reset**
6. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 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 less than 10 Ω between the low reference circuit terminal 6 and ground.

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- **If 10 Ω or greater**

1. Ignition OFF.
2. Test for less than 2 Ω at the circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, repair the open/high resistance in the ground connection.

- **Go to next step: If less than 10 Ω**

3. Ignition ON, verify a test lamp illuminates between the Voltage circuit terminal 5 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 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 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 voltage circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.

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

4. Ignition OFF, reconnect the harness connector at the K20 Engine Control Module.
5. Verify with a scan tool that the DTC does not reset
    - **If DTC resets**

      Replace the K20 Engine Control Module

    - **Go to next step: If the DTC does not reset**

6. All OK.

Repair Instructions

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

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

DTC P163A: CONTROL MODULE FUEL PRESSURE REGULATOR 1 CONTROL SYSTEM CIRCUITRY PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P163A

Control Module Fuel Pressure Regulator 1 Control System Circuitry Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Control	P0091	P0091	-	-
Low Control	P0091	P0090	P0092	P163A

Circuit/System Description

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The fuel pressure regulator 1 is used to control the fuel pressure at the high pressure pump. The engine control module (ECM) supplies the voltage directly to fuel pressure regulator 1. The ECM controls the solenoid by grounding the control circuit with a solid state device called a driver.

Conditions for Running the DTC

- DTC P0090, P0091 or P0092 is not set.
- The ignition voltage is greater than 11 V.
- The Fuel rail pressure is being controlled by fuel pressure regulator 1.
- The DTC runs continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded current flowing through Fuel Pressure Regulator 1 is out of range for greater than 1 s.

Action Taken When the DTC Sets

DTC P163A is a type B DTC.

Conditions for Clearing the DTC

DTC P163A is a type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 with a scan tool that DTC P0090, P0091, P0092, P0689, P0690 or P1682, is not set.
    - **If DTC P0090, P0091, P0092, P0689, P0690 or P1682 is set**

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

- **Go to next step: If DTC P0090, P0091, P0092, P0689, P0690 or P1682 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 in the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If DTC P163A is set**

     Refer to Circuit/System Testing

   - **Go to next step: If DTC P163A is not set**
5. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the Q18A Fuel Pressure Regulator 1, Ignition On.
2. Verify a test lamp illuminates between the high control circuit terminal 1 and ground.
   - **If the test lamp does not illuminate**
   1. Ignition Off, disconnect the X1 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the high control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the high control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If the test lamp illuminates**
3. Ignition Off.
4. Verify the test lamp is not illuminated
   - **If the test lamp illuminates**
   1. Disconnect the X1 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.
   - **Go to next step: If the test lamp is not illuminated**
5. Connect a test lamp between the low control circuit terminal 2 and the high control circuit terminal 1.
6. Ignition On, verify the test lamp turns On and Off when Commanding Fuel Pressure Regulator 1 On and Off with a scan tool.
   - **If the test lamp is always Off**
   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 low control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V
   3. Ignition Off.
   4. Test for less than 2 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 the test lamp is always On**
   1. Ignition Off, disconnect the X1 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the low control circuit and ground.

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

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

7. Replace the Q18A Fuel Pressure Regulator 1.

Repair Instructions

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

- For Q18A Fuel Pressure Regulator 1 replacement, refer to **Fuel Injection Pump Metering Valve Replacement**
- For control module replacement, programming and setup, refer to **Control Module References**

DTC P163B: CONTROL MODULE FUEL PRESSURE REGULATOR 2 CONTROL SYSTEM CIRCUITRY PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P163B

Control Module Fuel Pressure Regulator 2 Control System Circuitry Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P2295	P2295	P0690, P16B3	-
Low Control	P2295	P2294	P0690, P16B3, P2296	-

Circuit/System Description

Fuel pressure regulator 2 is used to control the fuel pressure at the fuel rail. The engine control module (ECM) supplies the voltage directly to fuel pressure regulator 2. The ECM controls the solenoid by grounding the control circuit with a solid state device called a driver.

Conditions for Running the DTC

- DTC P2294, P2295 or P2296 is not set.
- The ignition voltage is greater than 11 V.
- The Fuel rail pressure is being controlled by fuel pressure regulator 2.
- The DTC runs continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the current flowing through Fuel Pressure Regulator 2 value is out of range for greater than 1 s.

Action Taken When the DTC Sets

DTC P163B is a type B DTC.

Conditions for Clearing the DTC

DTC P163B is a type B DTC.

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Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

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Circuit/System Verification

1. Ignition ON.
2. Verify with a scan tool that DTC P0689, P0690, P1682, P2294, P2295 or P2296 is not set.
   - **If DTC P0689, P0690, P1682, P2294, P2295 or P2296 is set**

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

   - **Go to next step: If DTC P0689, P0690, P1682, P2294, P2295 or P2296 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 in the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If DTC P163B is set**

     Refer to Circuit/System Testing

   - **Go to next step: If DTC P163B is not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q18B Fuel Pressure Regulator 2, Ignition ON.
2. Verify a test lamp illuminates between the high control circuit terminal 1 and ground.
   - **If the test lamp does not illuminate**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the high control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance

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

3. Ignition Off.
4. Verify the test lamp is not illuminated
    - **If the test lamp illuminates**
    1. Disconnect the X2 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.
    - **Go to next step: If the test lamp is not illuminated**
5. Connect a test lamp between the low control circuit terminal 2 and the high control circuit terminal 1.
6. Ignition ON, verify the test lamp turns ON and OFF when Commanding Fuel Pressure Regulator 2 ON and OFF with a scan tool.
    - **If the test lamp is always Off**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    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. Ignition OFF.
    4. 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 the test lamp is always On**
    1. Ignition OFF, disconnect the X2 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.
    - **Go to next step: If the test lamp turns On and Off**
7. Replace the Q18B Fuel Pressure Regulator 2.

Repair Instructions

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

- For Q18B Fuel Pressure Regulator 2 replacement, refer to **Fuel Injection Fuel Rail Assembly Replacement**
- For control module replacement, programming and setup, refer to **Control Module References**

DTC P02E8, P02E9, P16A0, P16A1, OR P16A2: SENSOR COMMUNICATION CIRCUIT 1/INTAKE AIR FLOW VALVE POSITION SENSOR CIRCUIT VOLTAGE

Diagnostic Instructions

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

DTC Descriptors

DTC P16A0

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Sensor Communication Circuit 1 Low Voltage

DTC P16A1

Sensor Communication Circuit 1 High Voltage

DTC P16A2

Sensor Communication Circuit 1 Performance

DTC P02E8

Intake Air Flow Valve Position Sensor Circuit Low Voltage

DTC P02E9

Intake Air Flow Valve Position Sensor Circuit High Voltage

Circuit/System Description

The throttle body assembly contains a contactless 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 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 and is used as voltages for throttle position sensor 1 and 2.

Conditions for Running the DTC

P02E8 and P02E9

- Ignition is On or engine is running.
- DTC P0651 is not set
- The DTCs run continuously when the conditions above are met.

P16A0, P16A1 or P16A2

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

Conditions for Setting the DTC

P16A0

The ECM detects a low voltage circuit condition on the throttle position sensor signal circuit for greater than 0.5 s.

P16A1

The ECM detects a high voltage circuit condition on the throttle position sensor signal circuit for greater than 0.5 s.

P16A2

The ECM detects an incorrect message was received over the throttle position sensor signal circuit for greater than 0.5 s.

P02E8

The ECM detects that the throttle valve position sensor voltage is less than a calibrated threshold for 0.5 s.

P02E9

The ECM detects that the throttle valve position sensor voltage is greater than a calibrated threshold for 0.5 s.

Action Taken When the DTC Sets

- DTCs P16A0, P16A1, P16A2, P02E8 and P02E9 are Type A DTCs, with LH7.
- DTCs P16A0, P16A1, P16A2, P02E8 and P02E9 are Type B DTCs, with NE4, NCP or NCV.
- DTCs P16A0, P16A1, P16A2, P02E8 and P02E9 are Type C DTCs, all others.

Conditions for Clearing the DTC

- DTCs P16A0, P16A1, P16A2, P02E8 and P02E9 are Type A DTCs, with LH7
- DTCs P16A0, P16A1, P16A2, P02E8 and P02E9 are Type B DTCs, with NE4, NCP or NCV
- DTCs P16A0, P16A1, P16A2, P02E8 and P02E9 are Type C DTCs, all others

Diagnostic Aids

- A high resistance condition on the throttle position or throttle actuator control circuits could cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 P02E0, P02E2, P02E3, P02EB, P0651, P122B or P122C is not set.
   - **If a DTC is set.**

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

   - **Go to next step: If none of the DTCs are set**
3. Verify DTC P02E8, P02E9, P16A0, P16A1 or P16A2 is not set.
   - **If P02E8 or P02E9 are the only DTCs set**

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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.

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

4. Ignition On, verify the scan tool Intake Air Flow Valve Position parameter is between 0 - 100% and changes when commanding the Intake Air Flow Valve Position between 0 - 100%.
   - **If not within the specified range or does not change**

     Refer to Circuit/System Testing

   - **Go to next step: If within the specified range and changes**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - **If a DTC sets**

     Refer to Circuit/System Testing

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

Circuit/System Testing

NOTE: **Disconnecting the throttle body harness connector may cause additional DTCs to set.**

1. Ignition Off, and all vehicle systems Off, disconnect the harness connector at Q38 Throttle Body Assembly. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 4 and ground.
   - **If 10 Ω or greater**
   1. Ignition Off, disconnect the harness connector X2 at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 10 Ω**
3. Ignition On.
4. Test for greater than 4.8 V between the 5 V reference circuit terminal 5 and ground.
   - **If less than 4.8 V**
   1. 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.
   - **Go to next step: If greater than 4.8 V**
5. Ignition On.
6. Test for 4.6 - 5.2 V between the signal circuit terminal 3 and ground.
   - **If less than 4.8 V**
   1. Ignition Off, disconnect the harness connector X2 at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.

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- **If greater than 5.2 V**

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

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

7. Replace the Q38 Throttle Body Assembly.

Repair Instructions

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

- Refer to **Throttle Body Assembly Replacement**
- Refer to **Control Module References** for Engine Control Module replacement, programming and setup.

DTC P16A7, P16AF OR P16B3: ENGINE CONTROLS IGNITION RELAY FEEDBACK CIRCUIT 2

Diagnostic Instructions

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

DTC Descriptors

DTC P16A7

Engine Controls Ignition Relay Feedback Circuit 2

DTC P16AF

Engine Controls Ignition Relay Feedback Circuit 2 Low Voltage

DTC P16B3

Engine Controls Ignition Relay Feedback Circuit 2 High Voltage

Diagnostic Fault Information

Engine Controls Ignition Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Relay Coil Supply Voltage	P0689, P1682, P16A7, P16AF	P0685, P0689, P1682, P16A7, P16AF	-
Relay Control Circuit	P0686, P0690, P16B3	P0685, P0689, P1682, P16A7, P16AF	P0685, P0687, P0689, P1682, P16A7, P16AF
Relay Feedback Circuit	P0689, P1682, P16A7, P16AF	P0689, P1682, P16A7, P16AF	P0690, P16B3

Typical Scan Tool Data

Engine Controls Ignition Relay Control Circuit Low Voltage, Open and High Voltage Test Status - Component Commanded OFF

Circuit	Short to Ground	Open	Short to Voltage

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Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded OFF **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage Test Status and Not Run for High Voltage Test Status • Component ON - Not Run for Open/Low Voltage Test Status and OK for High Voltage Test Status			
B+	Malfunction	Malfunction	-
Control	Malfunction	Malfunction	Not Run

Engine Controls Ignition Relay Control Circuit Low Voltage, Open and High Voltage Test Status - Component Commanded ON

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded ON **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage Test Status and Not Run for High Voltage Test Status • Component ON - Not Run for Open/Low Voltage Test Status and OK for High Voltage Test Status			
B+	Not Run	Not Run	-
Control	Not Run	Not Run	Malfunction

Circuit/System Description

There are 3 ignition voltage circuits supplied to the engine control module (ECM). Two are supplied by the engine controls ignition relay, and the other is supplied by the ignition main relay. The ECM monitors and compares the ignition voltage supplied by the 2 relays.

Conditions for Running the DTC

P16A7

- The engine controls ignition relay is commanded ON.
- Ignition voltage is greater than 5.5 V.
- The DTC runs continuously when the above conditions are met.

P16AF

- The engine controls ignition relay is commanded ON.
- Ignition 1 signal voltage is greater than 11 V.
- The DTC runs continuously when the above conditions are met.

P16B3

The DTC runs when the engine controls ignition relay is commanded OFF.

Conditions for Setting the DTC

P16A7

The ECM detects that the voltage level difference is greater than 3 V between the 2 ignition voltage circuits for greater than 1 s.

P16AF

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The ECM detects the engine controls ignition relay feedback circuit 2 is less than 5 V.

P16B3

The ECM detects the engine controls ignition relay feedback circuit 2 is greater than 4 V for greater than 5 s.

Action Taken When the DTC Sets

- DTC P16A7 is a Type A DTC.
- DTCs P16AF and P16B3 are Type C DTCs.

Conditions for Clearing the DTC

- DTC P16A7 is a Type A DTC.
- DTCs P16AF and P16B3 are Type C DTCs.

Diagnostic Aids

The engine controls ignition relay may also be labeled the powertrain relay, the engine control module relay, or the main relay. The ignition main relay may also be labeled the run/crank relay, the ignition run relay, the ignition 1 relay, or the ignition relay.

Reference Information

Schematic Reference

- **Engine Controls Wiring Schematics 1.6L (LH7)**
- Power Distribution Wiring Schematics

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- **Connector Repairs**
- **Electrical Center Identification Views**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **A short to voltage on other components may cause DTC P16B3 to set. If any other DTC is set, diagnose that DTC first.**
- **If you were sent here from Engine Cranks But Does Not Run, proceed to Circuit/System Testing.**

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1. Ignition ON, observe the scan tool DTC information. Verify DTC P16A7, P16AF or P16B3 is not set.
    - **If any of the DTCs are set**

      Refer to Circuit/System Testing.

    - **Go to next step: If none of the DTCs are set**
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing unless sent here from Engine Cranks But Does Not Run.**

1. Ignition OFF, disconnect the KR75 Engine Controls Ignition Relay.
2. Verify a test lamp illuminates between ground and the B+ terminals listed below:
    - Terminal 85
    - Terminal 30
    - **If the test lamp does not illuminate**

      Replace the front compartment fuse block.

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

      NOTE:
      - **High resistance in the circuit/underhood fuse block for either the KR75 Engine Controls Ignition Relay or the KR73 Ignition Main Relay can cause DTC P16A7 to set.**
      - **A short to voltage on any of the circuits supplied by the engine controls ignition relay can cause DTC P16B3 to set.**
3. Ignition ON.
4. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal 87 and ground.
    - **If the test lamp illuminates**
    1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
    2. Ignition ON.
    3. Test for less than 1 V between ground and connector terminal 73.
        - If 1 V or greater, repair the short to voltage in the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp does not illuminate**
5. Ignition OFF, connect a 20 A fused jumper wire between the B+ circuit terminal 30 and the ignition voltage circuit terminal 87.
6. Ignition ON.
7. Verify the scan tool Engine Controls Ignition Relay Feedback Signal parameter displays B+.
    - **If B+ is not displayed**
    1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module
    2. Test for less than 2 Ω in the relay switch ignition voltage circuit end to end.

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

3. Test for infinite resistance between the relay switch ignition voltage circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K20 Engine Control Module.
- **Go to next step: If B+ is displayed**

8. Ignition OFF, connect a DMM, set to the diode setting, between control circuit terminal 86 and ground.
9. Verify the DMM displays OL.
    - **If OL is not displayed**
    1. Disconnect the X1 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between ground and the relay control circuit.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If OL is displayed**
10. Ignition ON.
11. Verify the DMM displays less than 1 V.
    - **If 1 V or greater**
    1. Ignition OFF, disconnect the X1 connector at the K20 Engine Control Module.
    2. Ignition ON.
    3. Test for less than 1 V on the relay control circuit.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    4. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - if less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 1 V**
12. Test or replace the KR75 Engine Controls Ignition Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR75 Engine Controls Ignition Relay.
2. Test for 70 - 110 Ω between terminals 85 and 86:
    - **If less than 70 Ω or greater than 110 Ω**

      Replace the KR75 Engine Controls Ignition Relay.

    - **Go to next step: If between 70 - 110 Ω**
3. Test for infinite resistance between the terminals listed below:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - **If less than infinite resistance**

      Replace the KR75 Engine Controls Ignition Relay.

    - **Go to next step: If infinite resistance**
4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 Ω between terminals 30 and 87.

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- **If 2 Ω or greater**

  Replace the KR75 Engine Controls Ignition Relay.

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

6. All OK.

Repair Instructions

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

- Refer to **Battery Distribution Engine Compartment Fuse Block Replacement** .
- Refer to **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P16D7, P16D8, OR P16D9: SENSOR SUPPLY VOLTAGE RELAY CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P16D7

Sensor Supply Voltage Relay Control Circuit

DTC P16D8

Sensor Supply Voltage Relay Control Circuit Low Voltage

DTC P16D9

Sensor Supply Voltage Relay Control Circuit High Voltage

Circuit/System Description

The reductant control module relay 1 & 2 supply ignition voltage to the Reductant Control Module. The Reductant Control Module Relay 2 also supplies ignition voltage to Nitrogen Oxide Sensor 1 & 2 and the Exhaust Particulate Matter Sensor. Both Reductant Control Module Relay 1 & 2 are controlled by a low side driver in the ECM.

Conditions for Running the DTC

P16D7, P16D8

- The DTC runs when Ignition OFF.

P16D9

- The DTC runs when Ignition ON.

Conditions for Setting the DTC

The ECM detects an open circuit, short to voltage or short to ground on the reductant control module relay control circuit.

Action Taken When the DTC Sets

DTC P16D7, P16D8 are Type A DTCs.

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DTC P16D9 is Type B DTC.

Conditions for Clearing the DTC

DTC P16D7, P16D8 are Type A DTCs.

DTC P16D9 is Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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, observe the scan tool DTC information. Verify DTC P16D7, P16D8, P16D9 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing.

   - **Go to next step: If none of the DTCs are set**
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF, disconnect the K115 Reductant Control Module Relay 1 & K115 Reductant Control Module Relay 2.
2. connect a DMM, set to the diode setting, between control circuit terminal 86 of K115 Reductant Control Module Relay 2 and ground.
3. Verify the DMM displays OL.
   - **If OL is not displayed**
   1. Disconnect the X3 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between ground and the relay control circuit.

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

- **Go to next step: If OL is displayed**

4. Ignition ON.
5. Verify the DMM displays less than 1 V.
   - **If 1 V or greater**
   1. Ignition OFF, disconnect the X3 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 2 Ω
   5. Disconnect the DMM from terminal 86 of K115 Reductant Control Module Relay 2.
   6. Connect the DMM to control circuit terminal 85 of K115 Reductant Control Module Relay 1 and ground.
   7. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - if less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 1 V**
6. All OK.

Repair Instructions

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

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

DTC P2002: DIESEL PARTICULATE FILTER (DPF) LOW EFFICIENCY

Diagnostic Instructions

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

DTC Descriptor

DTC P2002

Diesel Particulate Filter (DPF) Low Efficiency

Circuit/System Description

The diesel exhaust aftertreatment system consists of an under hood pre-catalyst and an underbody catalyst. The underbody catalyst also consists of the main diesel oxidation catalyst and the coated Diesel Particulate Filter (DPF). One of the main purposes of the DPF is to collect particulates from the engine exhaust in order to minimize discharge of soot to the atmosphere. The soot particles accumulate in the channels of the DPF and are burned off at regular intervals through a process called regeneration. This prevents the DPF from clogging. The ECM commands the DPF regeneration after calculating various vehicle conditions such as DPF pressure difference, exhaust gas temperature, engine oil quality, engine speed, etc. Excessive accumulation of the soot in the DPF can cause a drop in the engine performance. During regeneration, additional fuel is injected via multiple post injections in order to increase the

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exhaust gas temperature. During this period, the DPF temperature is raised to approximately 600Â°C (1, 112Â°F) and the accumulated soot is oxidized or burned off into carbon dioxide (CO2).

Conditions for Running the DTC

- DTC P0071, P0072, P0073, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P140C, P140D, P0191, P0192, P0193, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P0545, P0546, P062B, P062D, P0722, P0723, P111E, P113B, P115E, P115F, P1160, P116A-P116F, P118E, P1192-P1194, P119A-P119C, P11C5, P11C6, P1248, P1249, P124A-P124F, P126A, P142C, P142D, P142E, P142F, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P2032, P2033, P2080, P2081, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2205-P2211, P2227, P2228, P2229, P2230, P2297, P2452-P2456, P2481, P2482, P2483, P2484, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0, P24D1, P2627, P2628, P262B, P2A00 or U029D is not set.
- The engine is cranking or running.
- The ignition voltage is greater than 11 V.
- The ambient temperature is warmer than -7Â°C (19.4Â°F).
- The particulate matter sensor is operating.
- The NOx Sensor 1 Heater Operation parameter displays Allowed
- The NOx sensor supply voltage is greater than 10.8 V.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the particulate filter has degraded beyond a calibrated threshold.

Action Taken When the DTC Sets

DTC P2002 is a type B DTC.

Conditions for Clearing the DTC

DTC P2002 is a type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

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Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0071, P0072, P0073, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P140C, P140D, P0191, P0192, P0193, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P0545, P0546, P062B, P062D, P0722, P0723, P111E, P113B, P115E, P115F, P1160, P116A-P116F, P118E, P1192-P1194, P119A-P119C, P11C5, P11C6, P1248, P1249, P124A-P124F, P126A, P142C, P142D, P142E, P142F, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P2032, P2033, P2080, P2081, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2205-P2211, P2227, P2228, P2229, P2230, P2297, P2452-P2456, P2481, P2482, P2483, P2484, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0, P24D1, P2627, P2628, P262B, P2A00 or U029D is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Verify DTC P2002 is not set.
   - **If the DTC is set**

     Replace the diesel particulate filter.

   - **Go to next step: If no DTC is set**
4. All OK.

Repair Instructions

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

Refer to **Oxidation Catalytic Converter Replacement (LH7)** Perform the scan tool DPF/Catalyst 2 Reset after replacing the exhaust particulate filter.

DTC P2006 OR P200A: INTAKE MANIFOLD RUNNER CONTROL VALVE

Diagnostic Instructions

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

DTC Descriptor

DTC P2006

Intake Manifold Runner Control Valve Stuck Closed

DTC P200A

Intake Manifold Runner Control Valve Performance

Circuit/System Description

The position of the intake manifold swirl flaps is controlled by the engine control module (ECM). The ECM controls the intake manifold runner control valve actuator to create a swirl in the combustion chamber to get a homogeneous diesel air mixture.

Ignition voltage is supplied directly to the intake manifold tuning valve actuator. The engine control module (ECM) controls the valve actuator motor by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage signal.

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The runner control valve actuator contains a position sensor, which outputs a pulse width modulated (PWM) signal, to detect the actual position of the actuator in relation to its commanded position. Variations in the duty cycle of the PWM signal enables the ECM to detect a physically broken, restricted or stuck actuator.

Conditions for Running the DTC

P2006

- DTC P0071, P0072, P0073, P0074, P0117, P0118, P0119, P200A, P2008, P2009, P2010, P2015, P2016, P2017 or P20F8 is not set.
- The engine is running.
- The battery voltage is greater than 11 V.
- The ambient air temperature is warmer than -7Â°C (19Â°F).
- The engine coolant temperature (ECT) is warmer than 60Â°C (140Â°F).
- The actuator is commanded On for greater than 30 s.
- The actuator command is steady at less than 50% for greater than 50 s.
- The DTC runs continuously when the above conditions are met.

P200A

- DTC P0117, P0118, P0119, P2008, P2009, P2010, P2015, P2016 or P2017 is not set.
- The battery voltage is greater than 11 V.
- The engine coolant temperature (ECT) is warmer than 60Â°C (140Â°F).
- The actuator is commanded On for greater than 30 s.
- The DTC runs once per trip when the ignition is switched Off.

Conditions for Setting the DTC

P2006

The ECM detects that the intake manifold runner control valve is stuck closed for greater than 25 ms

P200A Condition 1

The ECM detects that the runner control valve position is not within 80 - 93% when commanded closed, or the time to achieve the desired position is greater than 5 s.

Condition 2

The ECM detects that the runner control valve position is not within 25 - 40% when commanded open, or the time to achieve the desired position is greater than 5 s.

Condition 3

The ECM detects that the total time for the intake manifold runner control valve to open and close is greater than 10 s.

Action Taken When the DTC Sets

- DTC P2006 is a Type A DTC.
- DTC P200A is a Type B DTC.

Conditions for Clearing the DTC

- DTC P2006 is a Type A DTC.
- DTC P200A is a Type B DTC.

Reference Information

Schematic Reference

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Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON
2. Verify that DTC P2008, P2009, P2010, P2015, P2016 or P2017 is not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
3. Command the Intake Manifold Runner Control Valve between 30 and 80%.
4. Verify the scan tool the Intake Manifold Runner Control Valve Feedback Signal parameter increases and decreases as commanded.
   - **If the Intake Manifold Runner Control Valve Feedback Signal does not increase and decrease**
   1. Ignition Off.
   2. Verify that the Intake Manifold Runner Valve is not stuck - refer to **Intake Manifold Cleaning and Inspection**
      - If a condition exists, repair or replace as necessary.
   - **Go to next step: If the Intake Manifold Runner Control Valve Feedback Signal does increase and decrease**
5. 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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to **Intake Manifold Cleaning and Inspection** .

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

Repair Instructions

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

- Refer to **Intake Manifold Replacement** - M98 Intake Manifold Runner Valve Actuator replacement.

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

DTC P2008, P2009, OR P2010: INTAKE MANIFOLD RUNNER CONTROL VALVE CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P2008

Intake Manifold Runner Control Valve Control Circuit

DTC P2009

Intake Manifold Runner Control Valve Control Circuit Low Voltage

DTC P2010

Intake Manifold Runner Control Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P2009, P201B	P2009, P2017	-	P201D, P20F8
Control	P2009	P2008	P2010	P201D, P20F8

Typical Scan Tool Data

Intake Manifold Runner Control Valve Feedback Signal

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine - Idling - At normal operating temperature **Parameter Normal Range:** 32%			
Ignition	0%	100%	100%
Control	0%	29%	29%

Circuit/System Description

Circuit	Description
Ignition	Supplied from a fuse.
Control	The output is PWM controlled.

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

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Component	Description
M98 Intake Manifold Runner Valve Actuator	The intake manifold runner control solenoid valve is actuated by a DC motor. The control valve is spring loaded to the closed position. The motor overcomes the spring pressure to open the control valve. An increase in current flow through the motor increases the opening of the control valve.

Conditions for Running the DTC

- Ignition = On or Engine = Running
- Ignition Voltage = Greater than 11 V
- Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Control Circuit = Commanded state does not match the actual state - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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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 control function: Intake Manifold Runner Control Valve - Increase & Decrease

   Verify the scan tool parameter:

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- Intake Manifold Runner Control Valve Control Circuit High Voltage Test Status = OK or Not Run
- Intake Manifold Runner Control Valve Control Circuit Open Test Status = OK or Not Run
- Intake Manifold Runner Control Valve Control Circuit Low Voltage Test Status = OK or Not Run
- **If not the specified state**

  Refer to Circuit/System Testing

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

3. Perform the scan tool control function: Intake Manifold Runner Control Valve - Increase

   Verify the scan tool parameter: Intake Manifold Runner Control Valve Feedback Signal = The value should not spike or drop out.

   - Perform the action while monitoring the parameter:
     - Wiggle the harness and connector: K20 Engine Control Module
     - Wiggle the harness and connector: M98 Intake Manifold Runner Valve Actuator
   - **If the value spikes or drops out**

     Refer to: Circuit/System Testing

   - **Go to next step: If the value does not spike or drop out**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing

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

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Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: M98 Intake Manifold Runner Valve Actuator
3. Ignition - On/Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points: Ignition circuit terminal 6 & Ground
   - **If the test lamp does not turn On and the circuit fuse is OK**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Test for less than 2 Ω between the test points: Ignition circuit terminal 6 & Output terminal @ F3UA Fuse
      - If 2 Ω or greater - Repair the open/high resistance in the circuit.
      - If less than 2 Ω - Verify the fuse is OK and there is voltage at the fuse.
   - **If the test lamp does not turn On and the circuit fuse is open**
   1. Connect the electrical connector: M98 Intake Manifold Runner Valve Actuator
   2. Replace the component: F3UA Fuse
   3. Verify the fuse does not open.
      - If the fuse opens and there are components connected to the circuit - Disconnect a component listed below and repeat step 4.2
      - E45 Positive Crankcase Ventilation Heater
      - M98 Intake Manifold Runner Valve Actuator

- If the fuse opens with all components disconnected from the circuit - Repair the short to ground on the circuit.
- If the fuse does not open after disconnecting a component from the circuit - Replace the component disconnected last.
- If the fuse does not open with all components connected.

4. Ignition - On/Vehicle - In Service Mode

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

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

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

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

6. All OK.

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

5. Verify a test lamp does not turn On between the test points: Control circuit terminal 1 & B+
   - **If the test lamp turns On**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
   3. Test for infinite resistance between the test points: Control circuit terminal 1 @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance - Replace the component: K20 Engine Control Module
   - **Go to next step: If the test lamp does not turn On**
6. Remove - Test Lamp
7. Verify the scan tool parameter: Intake Manifold Runner Control Valve Control Circuit High Voltage Test Status = OK
   - **If not the specified state**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
   3. Ignition - On/Vehicle - In Service Mode
   4. Test for less than 1 V between the test points: Control circuit terminal 1 @ Component harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - If less than 1 V - Replace the component: K20 Engine Control Module
   - **Go to next step: If the specified state**
8. Connect a 3 A fused jumper wire between the test points: Control circuit terminal 1 & Ignition circuit terminal 6
9. Perform the scan tool control function: Intake Manifold Runner Control Valve - Increase

   Verify the scan tool parameter: Intake Manifold Runner Control Valve Control Circuit High Voltage Test Status = Malfunction

   - **If not the specified state**
   1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
   2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
   3. Test for less than 2 Ω between the test points: Control circuit terminal 1 @ Component harness & Terminal 54 @ Control module harness
      - If 2 Ω or greater - Repair the open/high resistance in the circuit.
      - If less than 2 Ω - Replace the component: K20 Engine Control Module

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

10. Test or replace the component: M98 Intake Manifold Runner Valve Actuator

Repair Instructions

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

- Refer to **Intake Manifold Replacement** - M98 Intake Manifold Runner Valve Actuator
- For control module replacement, programming and setup, refer to **Control Module References**

DTC P200C: DIESEL PARTICULATE FILTER (DPF) HIGH TEMPERATURE

Diagnostic Instructions

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

DTC Descriptor

DTC P200C

Diesel Particulate Filter (DPF) High Temperature

Circuit/System Description

The diesel exhaust aftertreatment system consists of a diesel oxidation catalyst and a Diesel Particulate Filter (DPF). One of the main purposes of the DPF is to collect particulates from the engine exhaust in order to minimize discharge of soot to the atmosphere. The soot particles accumulate in the channels of the DPF and are burned off at regular intervals through a process called regeneration. This prevents the DPF from clogging. The ECM commands the DPF regeneration after calculating various vehicle conditions such as DPF pressure difference, exhaust gas temperature, engine oil quality, engine speed, etc. Excessive accumulation of the soot in the DPF can cause a drop in the engine performance. During regeneration, additional fuel is injected in order to increase the exhaust gas temperature. During this period, the DPF temperature is raised to approximately 600Â°C (1, 112Â°F) and the accumulated soot is oxidized or burned off into carbon dioxide (CO2).

The following table illustrates the difference between temperature, resistance, and voltage:

Exhaust Gas Temperature	Exhaust Gas Temperature Resistance	Exhaust Gas Temperature Signal Voltage
Cold	Low	Low
Warm	High	High

Conditions for Running the DTC

- DTC P113C, P113D, P118F, P1196, P2032, P2033, P2084, P2085, P242B, P242C, P242D or P242E is not set.
- The engine is running.
- The battery voltage is greater than 11 V.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the exhaust gas temperature at exhaust gas temperature sensor 2 is greater than 800Â°C (1, 472Â°F) or greater than 850Â°C (1, 562Â°F) during regeneration for greater than 20 s.

Action Taken When the DTC Sets

- DTC P200C is a Type A DTC.
- DPF regeneration is inhibited

- The cooling fans are activated
- Engine power is reduced
- The engine is shut down when exhaust gas temperature is above a calibrated threshold and the vehicle is stationary

Conditions for Clearing the DTC

DTC P200C is a Type A DTC.

Diagnostic Aids

- After starting the engine, the exhaust gas temperature sensor temperature should rise steadily, then stabilize after the engine reaches operating temperature.
- If the vehicle has set overnight, the exhaust gas temperature sensor and the intake air temperature (IAT) sensor values should display within 3Â°C (5Â°F).

The following conditions can also cause the DTC to set:

- Faulty or plugged exhaust system, such as plugged diesel particulate filter
- Damaged turbocharger
- Inefficient diesel oxidation catalyst
- Engine misfire with excessive oil consumption
- Leaking fuel injectors
- Incorrect fuel rail pressure
- Leaks in the intake system and charge air system

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify that DTCs P0071, P0072, P0073, P0074, P00C7, P00E9, P00EA, P00EB, P00EC, P0100, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P014C, P014D, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P02EE, P02EF, P02F0, P02F1, P0405, P0406, P049D, P0502, P0503, P062B, P062D, P0722, P0723, P111E, P113C, P113D, P118B, P118F, P1196, P1248, P1249, P124A, P124B, P126A, P142B, P142C, P142D, P142E, P142F, P1435, P1436, P1474, P1475, P1476, P1477, P1478, P1479, P147B, P1488,

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P2147, P2148, P2002, P2032, P2033, P2084, P2085, P2150, P2151, P2227, P2228, P2229, P2230, P2297, P242B, P242C, P242D, P242E, P2452, P2453, P2454, P2455, P2456, P2463, P24A4, P24B0, P24B1, P24B3, P24B4, P24B5, P24B6, P24C7, P24D0, P24D1 P2627, P2628, P2A00 or U029D are not set.

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

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

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

3. Verify none of the conditions listed below exist:
   - Leaking fuel injectors. Refer to **Fuel Injector Balance Test with Scan Tool** .
   - Engine oil consumption. Refer to **Oil Consumption Diagnosis** .
   - Incorrect fuel rail pressure. Refer to **Fuel System Diagnosis - High Pressure Side**
   - Damaged, missing, or improperly installed exhaust system components.
   - Restrictions in the exhaust pressure differential sensor ports
   - Damaged, bent, restricted, or kinked exhaust pressure differential sensor lines
   - Leaks in the Induction system or charge air system
   - Missing or disconnected charge air system components
   - Presence of additional washers under fuel injectors
   - Turbocharger underboost
   - **If any condition is found**

     Repair as necessary

   - **Go to next step: If no condition is found**
4. Perform the Diesel Particulate Filter Service Regeneration.
5. Verify the regeneration completed.
   - **If the regeneration did not complete**

     Replace the diesel particulate filter.

   - **Go to next step: If the regeneration completed**
6. All OK.

Repair Instructions

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

- Refer to **Exhaust Muffler Replacement (LH7)** for diesel particulate filter replacement.
- Refer to **Control Module References** for ECM replacement, programming and setup.

DTC P2015, P2016, OR P2017: INTAKE MANIFOLD RUNNER CONTROL VALVE POSITION SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC P2015

Intake Manifold Runner Control Valve Position Sensor Performance

DTC P2016

Intake Manifold Runner Control Valve Position Sensor Circuit Low Voltage

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DTC P2017

Intake Manifold Runner Control Valve Position Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P2009, P2017	P2009, P2017	-	P201D, P2015, P20F8
Signal	P2016	P2017	P2017	P201D, P2015, P20F8
Ground	-	P2017	-	P201D, P2015, P20F8

Circuit/System Description

The position of the swirl flaps is controlled by the engine control module (ECM). The ECM controls the intake manifold runner control solenoid valve to create a swirl in the combustion chamber to get a homogeneous diesel air mixture. The ECM will vary the intake manifold runner control solenoid valve referring to inputs such as manifold absolute pressure and mass air flow. The ECM uses a pulse width modulation on the control circuit to control the intake manifold runner valve actuator.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The starter motor is not engaged.
- The intake runner control valve is being commanded to greater than 0 and less than 100% for greater than 30 s.
- The DTC runs continuously when the condition above are met.

Conditions for Setting the DTC

The ECM detects that the commanded and actual runner control valve positions do not match for greater than 1 s.

Action Taken When the DTC Sets

DTC P2015, P2016 and P2017 are Type B DTCs.

Conditions for Clearing the DTC

DTC P2015, P2016 and P2017 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On/Vehicle in Service Mode.
2. Verify DTC P2009 is not set.
   - **If the DTC is set**

     Refer to **DTC P2008-P2010**.

   - **Go to next step: If the DTC is not set**
3. Verify the Intake Manifold Runner Control Valve Feedback Signal parameter changes when commanding the Intake Manifold Runner Control Valve between 30 - 80% with a scan tool.
   - **If the parameter does not change**

     Refer to Circuit/System Testing

   - **Go to next step: If the parameter changes**
4. 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.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If none of the DTCs set**
5. All OK.

Circuit/System Testing

1. Ignition Off and all vehicle systems Off, disconnect the harness connector at the M98 Intake Manifold Runner Valve Actuator. 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 2 and ground.
   - **If 5 Ω or greater**
   1. Ignition Off.
   2. Test for less than 2 Ω in the circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the high resistance in the ground connection.
   - **Go to next step: If less than 5 Ω**
3. Ignition On.
4. Verify there is between 9 - 11 V between the signal circuit terminal 5 and ground.
   - **If 9 V or less**
   1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance.
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If 11 V or greater**

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1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
- **Go to next step: If between 9 - 11 V**

5. Replace the M98 Intake Manifold Runner Valve Actuator.

Repair Instructions

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

- Refer to **Intake Manifold Replacement** for M98 Intake Manifold Runner Valve Actuator replacement.
- Refer to **Control Module References** for Engine Control Module replacement, programming and setup.

DTC P203C OR P203D: REDUCTANT LEVEL SENSOR CIRCUIT LOW/HIGH VOLTAGE

Diagnostic Instructions

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

DTC Descriptors

DTC P203C

Reductant Level Sensor Circuit Low Voltage

DTC P203D

Reductant Level Sensor Circuit High Voltage

Circuit/System Description

The reductant level sensor provides discrete information about the diesel exhaust fluid quantity present in the Reductant tank. The sensor signal provides information to the reductant control module to determine 4 different states: FULL, OK, WARNING1, and WARNING2. The reductant control module diagnoses the sensor for open circuit, short to ground and short to voltage electrical faults. The sensor is also checked for invalid range output by determining if the float is mechanically stuck in a plausible position.

Conditions for Running the DTC

- DTC U010E is not set.
- The ignition is On or the engine is running.
- The battery voltage is greater than 11 V.

DTC P203C and P203D run when the above conditions have been met.

Conditions for Setting the DTC

P203D

The reductant level sensor signal is less than a calibrated threshold for greater than 5 s.

P203C

The reductant level sensor signal is greater than a calibrated threshold for greater than 5 s.

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Action Taken When the DTC Sets

DTC P203C s a Type A DTC.

DTC P203D is a Type B DTC.

Conditions for Clearing the DTC

DTC P203C s a Type A DTC.

DTC P203D is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify that DTC P203C or P203D is not set.
   - **If a DTC Is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If no 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 from the Freeze Frame/Failure Records data.
4. Verify DTC P203C or P203D does not set.
   - **If a DTC sets**

     Refer to Circuit/System Testing

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

Circuit/System Testing

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 connector at the A38 Reductant Pump and Sensor Assembly.
2. Test for less than 5 Ω between the low reference circuit terminal 6 and ground.
   - **If 5 Ω or greater**

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1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end.
    - If greater than 2 Ω, repair the open or high resistance in the circuit.
    - If 2 Ω or less replace the K115 Reductant Control Module.
- **Go to next step: If less than 5 Ω**

3. Ignition On.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 13 and ground.
    - **If less than 4.8 V**

    1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant 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 K115 Reductant Control Module.
    - **If greater than 5.2 V**

    1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant 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 K115 Reductant Control Module.
    - **Go to next step: If between 4.8 - 5.2 V**

5. Test for 4.4 - 4.8 V between the signal circuit terminal 14 and ground.
    - **If less than 4.4 V**

    1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant 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 K115 Reductant Control Module.
    - **Go to next step: If greater than 4.8 V**

    1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant 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 K115 Reductant Control Module.
    - **Go to next step: If between 4.4 - 4.8 V**

6. Replace the A38 Reductant Pump and Sensor Assembly.
7. Verify that DTC P203C or P203D is not set.
    - **If a DTC sets**

      Replace the K115 Reductant Control Module.

    - **Go to next step: If no DTC sets**

8. All OK.

Repair Instructions

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

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Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Controller Replacement**
- Refer to **Emission Reduction Fluid Tank Replacement** for reductant pump and sensor assembly replacement,

DTC P204B: REDUCTANT PRESSURE SENSOR PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC P204B

Reductant Pressure Sensor Performance

Circuit/System Description

The reductant pressure sensor, located in the Reductant Pump and Sensor Assembly, responds to pressure changes in the reductant system. The Reductant Control Module supplies 5 V to the reductant pressure sensor on the 5 V reference circuit and provides a ground on the low reference circuit. The reductant pressure sensor provides a signal to the Reductant Control Module on the sensor signal circuit relative to the pressure changes in the reductant system. The engine control module (ECM) is connected to the Reductant Control Module via the controller area network (CAN) bus.

Conditions for Running the DTC

- DTCs related to the following system/component = Not Set
  - B214 Reductant Temperature Sensor
  - G33 Reductant Pump
  - Q61 Reductant Injector
- The ignition is Off and the ECM is powering down.
- The reductant temperature is warmer than -7Â°C (19Â°F).

The DTCs runs when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the DEF pressure sensor signal is outside a calibrated threshold.

Action Taken When the DTC Sets

- DTC P204B is Type A DTC.
- The reductant injector is disabled.
- The reductant tank and line heaters are disabled.
- The reductant pump is disabled.

Conditions for Clearing the DTC

DTCs P204B, P204C and P204D are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following system/component:
   - B214 Reductant Temperature Sensor
   - G33 Reductant Pump
   - Q61 Reductant Injector
   - **If a related DTC is set**

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

   - **Go to next step: If a related DTC is not set**
3. Verify DTC P204B is not set.
   - **If DTC P204B is set**
   1. Perform the scan tool control function: Reductant Pump - ON - For 20 s
   2. Wait for greater than 10 s. - After the pump was turned off.
   3. Verify the scan tool parameter: Reductant Pressure = -7 to 7 kPa (-1 to 1 PSI)
      - If not in the specified range

        Refer to Circuit/System Testing.

      - If in the specified range
   - **Go to next step: If DTC P204B is not set**
4. 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.
5. Verify that no DTC listed in the DTC Descriptor Category is set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing.

   - **Go to next step: If none of the DTCs are set**
6. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly.
2. Ignition On.
3. Test for less than 10 Ω between the low reference circuit terminal 3 and ground.
   - **If 10 Ω or greater**

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1. Ignition Off.
2. Disconnect the harness connector at the K115 Reductant Control Module.
3. Test for less than 2 Ω between A38 Reductant Pump and Sensor Assembly harness connector terminal 14 and K115 Reductant Control Module X2 harness connector terminal 3.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K115 Reductant Control Module.

- **Go to next step: If less than 10 Ω**

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 X2 harness connector at the K115 Reductant Control Module.
2. Test for less than 2 Ω between A38 Reductant Pump and Sensor Assembly harness connector terminal 5 and K115 Reductant Control Module X2 harness connector terminal 12.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K115 Reductant Control Module.

- **If greater than 5.2 V**

1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module, ignition On.
2. Test for less than 1 V between the A38 Reductant Pump and Sensor Assembly harness connector terminal 5 and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K115 Reductant Control Module.

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

5. Verify with a scan tool that the Pressure Sensor voltage parameter is 0 V.

- **If greater than 0 V**

1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
2. Test for less than 1 V between the A38 Reductant Pump and Sensor Assembly harness connector terminal 4 and ground.
    - If 1 V or greater, repair the short to voltage in the circuit.
    - If less than 1 V, replace the K115 Reductant Control Module.

- **Go to next step: If 0 V**

6. Install a 3 A fused jumper wire between the between the A38 Reductant Pump and Sensor Assembly harness connector signal circuit terminal 4 and 5 V reference circuit terminal 5. Verify with a scan tool that the Pressure Sensor voltage parameter is greater than 4.5 V

- **If 4.5 V or less**

1. Ignition Off, remove the jumper wire, disconnect the X2 harness connector at the K115 Reductant Control Module.
2. Test for infinite resistance between the A38 Reductant Pump and Sensor Assembly signal circuit harness connector terminal 4 and ground.
    - If less than infinite resistance, repair the short to ground at the circuit.
    - If infinite resistance
3. Test for less than 2 Ω between A38 Reductant Pump and Sensor Assembly harness connector terminal 4 and K115 Reductant Control Module X2 harness connector terminal 13.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K115 Reductant Control Module.

- **If greater than 4.5 V**

7. Replace the A38 Reductant Pump and Sensor Assembly

Repair Instructions

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

Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Controller Replacement**
- Refer to **Emission Reduction Fluid Tank Replacement** for Reductant Pump and Sensor Assembly replacement.

DTC P204C OR P204D: REDUCTANT PRESSURE SENSOR CIRCUIT LOW/HIGH VOLTAGE

Diagnostic Instructions

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

DTC Descriptor

DTC P204C

Reductant Pressure Sensor Circuit Low Voltage

DTC P204D

Reductant Pressure Sensor Circuit High Voltage

Circuit/System Description

The reductant pressure sensor, located in the Reductant Pump and Sensor Assembly, responds to pressure changes in the reductant system. The Reductant Control Module supplies 5 V to the reductant pressure sensor on the 5 V reference circuit and provides a ground on the low reference circuit. The reductant pressure sensor provides a signal to the Reductant Control Module on the sensor signal circuit relative to the pressure changes in the reductant system. The engine control module (ECM) is connected to the Reductant Control Module via the controller area network (CAN) bus.

Conditions for Running the DTC

- The ignition is On.
- The battery voltage is greater than 11 V.
- The engine is not cranking.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P204C

The ECM detects that the reductant pressure sensor signal is open or shorted to ground.

DTC P204D

The ECM detects that the reductant pressure sensor signal is shorted to voltage.

Action Taken When the DTC Sets

- DTCs P204C, and P204D are Type A DTCs.
- The reductant injector is disabled.
- The reductant tank and line heaters are disabled.
- The reductant pump is disabled.

Conditions for Clearing the DTC

DTCs P204C and P204D are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Electrical Information Reference

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

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 P205B, P205C or P205D is not set.
   - **If any of the DTCs are set**

     Refer to **DTC P205B-P205D**

   - **Go to next step: If none of the DTCs are set**
2. Verify that DTC P204C or P204D is not set
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing.

   - **Go to next step: If none of the DTCs are set**
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 that DTC P204C or P204D does not set.
   - **If a DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If no DTCs set**
5. All OK.

Circuit/System Testing

1. Ignition Off, and all vehicle systems Off, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 3 and ground.
   - **If 10 Ω or greater**
     1. Disconnect the harness connector at the K115 Reductant Control Module.
     2. Test for less than 2 Ω between A38 Reductant Pump and Sensor Assembly harness connector terminal 14 and K115 Reductant Control Module X2 harness connector terminal 3.

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- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the K115 Reductant Control Module.

- **Go to next step: If less than 10 Ω**

3. Ignition On, 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 X2 harness connector at the K115 Reductant Control Module.
   2. Test for less than 2 Ω between A38 Reductant Pump and Sensor Assembly harness connector terminal 5 and K115 Reductant Control Module X2 harness connector terminal 12.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K115 Reductant Control Module.

   - **If greater than 5.2 V**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module, ignition On.
   2. Test for less than 1 V between the A38 Reductant Pump and Sensor Assembly harness connector terminal 5 and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K115 Reductant Control Module.

   - **Go to next step: If between 4.8 - 5.2 V**
4. Verify with a scan tool that the Pressure Sensor voltage parameter is 0 V.
   - **If greater than 0 V**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. Test for less than 1 V between the A38 Reductant Pump and Sensor Assembly harness connector terminal 4 and ground.
      - If 1 V or greater, repair the short to voltage in the circuit.
      - If less than 1 V, replace the K115 Reductant Control Module.

   - **Go to next step: If 0 V**
5. Install a 3 A fused jumper wire between the between the A38 Reductant Pump and Sensor Assembly harness connector signal circuit terminal 4 and 5 V reference circuit terminal 5. Verify with a scan tool that the Pressure Sensor voltage parameter is greater than 4.5 V
   - **If 4.5 V or less**
   1. Ignition Off, remove the jumper wire, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. Test for infinite resistance between the A38 Reductant Pump and Sensor Assembly signal circuit harness connector terminal 4 and ground.
      - If less than infinite resistance, repair the short to ground at the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω between A38 Reductant Pump and Sensor Assembly harness connector terminal 4 and K115 Reductant Control Module X2 harness connector terminal 13.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K115 Reductant Control Module.

   - **If greater than 4.5 V**
6. Replace the A38 Reductant Pump and Sensor Assembly

Repair Instructions

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

Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Controller Replacement**

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- Refer to **Emission Reduction Fluid Tank Replacement** for Reductant Pump and Sensor Assembly replacement.

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Back To Article

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P205B-P205D: REDUCTANT TANK TEMPERATURE SENSOR

Diagnostic Instructions

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

DTC Descriptor

DTC P205B

Reductant Tank Temperature Sensor Performance

DTC P205C

Reductant Tank Temperature Sensor Circuit Low Voltage

DTC P205D

Reductant Tank Temperature Sensor Circuit High Voltage

Circuit/System Description

The reductant temperature sensor is a variable resistor used to measure the temperature inside the reductant tank. The sensor is wired to the reductant control module, which acquires the sensor signal and sends it to the engine control module via serial data. The reductant control module supplies 5 V to the reductant temperature sensor signal circuit and a ground for the low reference circuit.

Conditions for Running the DTC

P205B

- DTC P205C, P205D, or U010E is not set
- The ignition is ON and the engine is not running.
- The battery voltage is greater than 11 V.
- The ignition has been OFF for greater than 8 h
- This DTC runs continuously when the above conditions are met.

The DTC runs continuously when the above conditions are met.

P205C or P205D

- DTC P1051, P20B9, P20BB, P20BC or U010E is not set.
- The ignition is ON or the engine is running.
- The engine is not cranking.
- The battery voltage is greater than 11 V.

These DTCs runs continuously when the above conditions are met.

Conditions for Setting the DTC

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DTC P205B

The difference between reductant temperature sensor signal and exhaust gas temperature sensor signals is outside a calibrated range.

DTC P205C

The ECM detects that then reductant temperature sensor signal is open or shorted to ground.

DTC P205D

The ECM detects that the temperature sensor signal is shorted to voltage.

Action Taken When the DTC Sets

- DTC P205B, P205C or P205D are Type A DTC.
- The reductant injector is shut off.
- The reductant tank and line heaters are shut off.
- The reductant pump is shut off.

Conditions for Clearing the DTC

DTC P205B, P205C or P205D are Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 OFF for least 8 h. Ignition ON, compare with a scan tool the IAT 2 parameter, the ambient air temperature parameter, and the Reductant Tank Temperature parameter the reading should be within 9Â°C (16Â°F) of each other
   - **If not within 9Â°C (16Â°F)**

     Refer to Circuit/System testing

   - **Go to next step: If within 9Â°C (16Â°F)**
2. Engine running, verify that the Reductant Tank Temperature parameter is between -40 to +80Â°C (-40Â°F - 176Â°F) depending on the current Ambient Air Temperature, the engine run time, and the vehicle operating conditions.

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- **If not between -40 to +80Â°C (-40Â°F - 176Â°F)**

  Refer to Circuit/System Testing

- **Go to next step: If between -40 to +80Â°C (-40Â°F - 176Â°F)**

3. Verify with a scan tool that no other DTCs are set.
   - **If any other DTCs are set**

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

   - **Go to next step: If no other DTCs are set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly. It may take up to 2 min 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 X2 harness connector at the K115 Reductant 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 K115 Reductant Control Module.
      - **Go to next step: If less than 10 Ω**
3. Ignition ON, verify that the Reductant Tank Temperature is less than -35Â°C (-31Â°F).
   - **If greater than -35Â°C (-31Â°F)**
   1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. Test for infinite resistance between the signal circuit terminal 9 and ground.
   - If less than infinite resistance, repair the short to ground in the circuit.
   - If infinite resistance, replace the K115 Reductant Control Module.
   - **Go to next step: If -35Â°C (-31Â°F) or less.**
4. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2.
5. Verify that the Reductant Tank Temperature sensor parameter is greater than 75Â°C (164Â°F).
   - **If less than 75Â°C (164Â°F)**
   1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K115 Reductant Control Module.
   - **Go to next step: If 75Â°C (164Â°F) or greater**
6. Replace the A38 Reductant Pump and Sensor Assembly.

Repair Instructions

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

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Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Controller Replacement**
- Refer to **Emission Reduction Fluid Tank Replacement** for Reductant Pump and Sensor Assembly replacement.

DTC P205E: REDUCTANT TANK TEMPERATURE SENSOR CIRCUIT ERRATIC

Diagnostic Instructions

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

DTC Descriptor

DTC P205E

Reductant Tank Temperature Sensor Circuit Erratic

Circuit/System Description

The reductant temperature sensor is a variable resistor used to measure the temperature inside the reductant tank. The sensor is wired to the reductant control module, which acquires the sensor signal and sends it to the engine control module via serial data. The reductant control module supplies 5 V to the reductant temperature sensor signal circuit and a ground for the low reference circuit.

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Conditions for Running the DTC

- DTC P205C, P205D, or U010E is not set.
- The ignition is ON or the engine is running.
- The battery voltage is greater than 11 V.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the reductant temperature sensor signal variation is greater than a calibrated value.

Action Taken When the DTC Sets

- DTC P205E is a Type A DTC.
- The reductant injector is shut off.
- The reductant tank and line heaters are shut off.
- The selective catalyst reduction system is put in standby mode.
- The Diesel Exhaust Fluid (DEF) Warning Strategy (Anti-Tampering) is activated.

Conditions for Clearing the DTC

DTC P205E is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTCs P205C, P205D, or U10E are not set.
   - **If any of the DTCs are set**

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

   - **Go to next step: If none of the DTCs are set**
2. Engine running, verify that the Reductant Tank Temperature parameter reading is between -40 to +80Â°C (-40Â°F - 176Â°F).
   - **If not between -40 and +80Â°C (-40Â°F - 176Â°F)**

     Refer to Circuit/System Testing

   - **Go to next step: If between -40 and +80Â°C (-40Â°F - 176Â°F)**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly. It may take up to 2 min for all vehicle systems to power down.
2. Ignition On. Test for less than 25 Ω between the low reference circuit terminal 2 and ground.
   - **If 25 Ω or greater**
   1. Ignition OFF, disconnect the X2 connector at the K115 Reductant 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 K115 Reductant Control Module.
      - **Go to next step: If less than 25 Ω**
3. Ignition ON, verify that the Reductant Tank Temperature is colder than -35Â°C (-31Â°F).
   - **If warmer than -35Â°C (-31Â°F)**
   1. Ignition OFF, disconnect the X2 connector at the K115 Reductant Control Module.
   2. Test for infinite resistance between the signal circuit terminal 9 and ground.
   - If less than infinite resistance, repair the short to ground in the circuit.
   - If infinite resistance, replace the K115 Reductant Control Module.
   - **Go to next step: If -35Â°C (-31Â°F) or colder.**

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4. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2.
5. Verify that the Reductant Tank Temperature sensor parameter is warmer than 75Â°C (164Â°F).
    - **If less than 75Â°C (164Â°F)**
    1. Ignition OFF, disconnect the X2 connector at the K115 Reductant Control Module.
    2. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K115 Reductant Control Module.
    - **Go to next step: If 75Â°C (164Â°F) or greater**
6. Replace the A38 Reductant Pump and Sensor Assembly.

Repair Instructions

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

Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Controller Replacement** - K115 Reductant Control Module
- Refer to **Emission Reduction Fluid Tank Replacement** - A38 Reductant Pump and Sensor Assembly

DTC P206B-P206D: REDUCTANT QUALITY SENSOR CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P206B

Reductant Quality Sensor Circuit Performance

DTC P206C

Reductant Quality Sensor Circuit Low Voltage

DTC P206D

Reductant Quality Sensor Circuit High Voltage

Circuit/System Description

The reductant quality sensor is located in the reductant tank and uses an ultrasonic signal to measure reductant fluid quality. The reductant quality sensor includes an integrated temperature sensor to measure reductant fluid temperature. The reductant quality sensor communicates with the reductant control module using serial data.

Conditions for Running the DTC

P206B

- DTC P1015, P1016, P1017, P1018, P1019, P101A, P206C, P206D, P2ADA, P2ADB, P2ADC, P2ADD, or U010E is not set.
- The ignition is on or the engine is running.
- The ignition voltage is greater than 11 V.
- The reductant tank temperature sensor 2 is greater than 5Â°C (41Â°F).

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- The reductant level is greater than 5 L (1 gal).

The DTCs run continuously when the above conditions are met.

P206C, P206D

- DTC U010E is not set.
- The ignition is on or the engine is running.
- The ignition voltage is greater than 11 V.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P206B

The reductant control module detects a performance fault on the reductant quality sensor for greater than 5 min.

P206C

The reductant control module detects that the reductant quality sensor signal is out of range low for greater than 5 s.

P206D

The reductant control module detects that the reductant quality sensor signal is out of range high for greater than 5 s.

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Action Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

- The reductant quality value is replaced with the last measured value.
- The reductant quality sensor temperature value is replaced with a default value
- The Warning/Inducement strategy is activated.

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

Some reductant fluid (DEF) fill equipment may aerate the fluid which can temporarily affect the operation of the reductant quality sensor. A DTC may set and the Service Emission System message may display in the driver information center. The fluid aeration will quickly dissipate on its own and operation of the reductant quality sensor will return to normal. Filling the reductant fluid tank with the key off will help prevent the reductant quality sensor from being affected by this condition.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify the scan tool parameter: Reductant Concentration = The value should not spike or drop out.

   Perform the action while monitoring the parameter:

   - Wiggle the harness and connector: A39 Reductant Tank
   - Wiggle the harness and connector: K115 Reductant Control Module
   - **If the value spikes or drops out**

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

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

     Refer to: Circuit/System Testing

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

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Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the B295 Reductant Quality Sensor.
2. Ignition On.
3. Test for less than 20 Ω between low reference terminal 3 and ground.
   - **If greater than 20 Ω**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant 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 K115 Reductant Control Module.
   - **Go to next step: If less than 20 Ω**
4. Test for 4.8-5.2 V between 5 V reference circuit terminal 1 and ground
   - **If less than 4.8 V**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. 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
   3. 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, replace the K115 Reductant Control Module
   - **If greater than 5.2 V**

1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
2. Test for less than 1 V between the 5 V reference circuit and ground.
    - If 1 V or greater, repair the short to voltage in the circuit.
    - If less than 1 V, replace the K115 Reductant Control Module
- **Go to next step: If between 4.8-5.2 V**

5. Ignition ON, test for 4.4-4.8 V between signal circuit terminal 2 and ground.
    - **If less than 4.4 V**
    1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant 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
    3. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K115 Reductant Control Module
    - **If greater than 4.8 V**
    1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant 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 in the circuit.
        - If less than 1 V, replace the K115 Reductant Control Module
    - **Go to next step: If between 4.4-4.8 V**
6. Replace the B295 Reductant Quality Sensor.

Repair Instructions

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

- Refer to **Emission Reduction Fluid Tank Replacement** for reductant quality sensor replacement.
- Refer to **Emission Reduction Fluid Controller Replacement**

DTC P2081, P2085, P242E, P2472, OR P2484: EXHAUST GAS TEMPERATURE SENSOR 1, 2, 3 CIRCUIT INTERMITTENT

Diagnostic Instructions

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

DTC Descriptors

DTC P2081

Exhaust Gas Temperature Sensor 1 Circuit Intermittent

DTC P2085

Exhaust Gas Temperature Sensor 2 Circuit Intermittent

DTC P242E

Exhaust Gas Temperature Sensor 3 Circuit Intermittent

Circuit/System Description

The exhaust gas temperature sensors are variable resistors that measures the temperature of the exhaust gas. The exhaust temperature sensor 1 is the first exhaust temperature sensor on the exhaust system, the following exhaust temperature sensors are counted upward from the engine outlet to the exhaust system end. The engine control module (ECM) supplies 5 V to the exhaust gas temperature signal circuit and

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supplies a ground to the low reference circuit. The exhaust gas temperature sensor temperature information is used by the ECM during the exhaust gas particulate filter cleaning process.

Conditions for Running the DTC

- DTC P0545, P0546, P113B-P113F, P118E, P118F, P1196-P1198, P2032, P2033, P242C, P242D, P2470, P2471, P2481, or P2482 is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.

These DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the exhaust gas temperature sensor resistance has changed greater than a calibrated amount in less than 1 s.

Action Taken When the DTC Sets

DTCs P2081, P2085, P242E, P2472, and P2484 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P2081, P2085, P242E, P2472, and P2484 are Type B DTCs.

Diagnostic Aids

- After starting the engine, the exhaust gas temperature sensor temperature should rise steadily, then stabilize after the engine reaches operating temperature.
- Inspect the exhaust gas temperature sensor terminals for corrosion.
- Inspect the exhaust gas temperature sensor wiring for pinches, cuts, and damaged insulation.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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. Verify that no other DTCs are set.
   - **If any other DTCs are set**

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

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- **Go to next step: If no other DTC 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.
3. Verify DTC P2081, P2085, P242E, P2472, or P2484 does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B131 Exhaust Temperature Sensor. It may take up to 2 min 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 X3 harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω

          Replace the K20 Engine Control Module.

    - **Go to next step: If less than 10 Ω**
3. Ignition ON, test for 4.8 - 5.2 V between the signal circuit terminal 1 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF.
    2. Disconnect the X3 harness connector at the K20 Engine Control Module.
    3. Test for infinite resistance between signal circuit and ground
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω

          Replace the K20 Engine Control Module.

    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for less than 1 V between the signal circuit and ground
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 2 Ω

          Replace the K20 Engine Control Module.

    - **Go to next step: If between 4.8 - 5.2 V**
4. Replace the appropriate B131 Exhaust Temperature Sensor.

Repair Instructions

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

- Refer to **Exhaust Temperature Sensor Replacement - Position 1**
- Refer to **Exhaust Temperature Sensor Replacement - Position 2**
- Refer to **Exhaust Temperature Sensor Replacement - Position 3**

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

DTC P208A, P208C, OR P208D: REDUCTANT PUMP CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P208A

Reductant Pump Control Circuit

DTC P208C

Reductant Pump Control Circuit Low Voltage

DTC P208D

Reductant Pump Control Circuit High Voltage

Circuit/System Description

The selective catalytic reduction system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of reductant into the exhaust gas stream entering the selective catalytic reduction catalyst. Within the selective catalytic reduction catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors communicate with the engine control module and the reductant control module via serial data. The reductant control module varies the amount of reductant added by varying the reductant injector duty cycle in response to changes in engine-out NOx levels. The reductant control module supplies system voltage to the reductant pump motor. The reductant control module controls the solenoid by grounding the control circuit. The reductant control module can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

- DTC U010E is not set.
- Ignition ON or engine running.
- The engine is not cranking.
- The battery voltage is greater than 11 V.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P208A

The reductant control module detects an open circuit in the control circuit.

P208C

The reductant control module detects a short to ground in the control circuit.

P208D

The reductant control module detects a short to voltage in the control circuit.

Action Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

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Circuit/System Verification

1. Ignition On
2. Verify that no DTC listed in the DTC Descriptor Category is set.
   - **If a DTC Is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If no 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 from the Freeze Frame/Failure Records data.
4. Verify that no DTC listed in the DTC Descriptor Category is set.
   - **If a DTC sets**

     Refer to Circuit/System Testing

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

Circuit/System Testing

1. Ignition Off, and all vehicle systems Off, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 15 and ground.
   - **If 10 Ω or greater**
   1. Ignition Off.
   2. Test for less than 2 Ω between A38 Reductant Pump and Sensor Assembly harness connector terminal 15 and K115 Reductant Control Module X2 harness connector terminal 5.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K115 Reductant Control Module.

- **Go to next step: If less than 10 Ω**

3. Disconnect the X2 harness connector at the K115 Reductant Control Module.
4. Test for less than 2 Ω between the control circuit terminals listed below:
   - A38 Reductant Pump and Sensor Assembly harness connector terminal 16 and K115 Reductant Control Module X2 harness connector terminal 1
   - A38 Reductant Pump and Sensor Assembly harness connector terminal 8 and K115 Reductant Control Module X2 harness connector terminal 2
   - A38 Reductant Pump and Sensor Assembly harness connector terminal 7 and K115 Reductant Control Module X2 harness connector terminal 3
   - **If greater than 2 Ω**

     Repair the open/high resistance in the appropriate circuit.

   - **Go to next step: If less than 2 Ω**
5. Ignition Off, test for infinite resistance between each control circuits listed above and ground.
   - **If less than infinite resistance**

     Repair the short to ground at the appropriate circuit.

   - **Go to next step: If infinite resistance**
6. Ignition ON, test for less than 1 V between each control circuits listed above and ground.
   - **If 1 V or greater**

     Repair the short to voltage on the appropriate circuit.

   - **Go to next step: If less than 1 V**
7. Replace the A38 Reductant Pump and Sensor Assembly.
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**

     Replace the K115 Reductant Control Module

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

Repair Instructions

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

Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Controller Replacement** - K115 Reductant Control Module
- Refer to **Emission Reduction Fluid Supply Pump Module Replacement** - A38 Reductant Pump and Sensor Assembly

DTC P20B9-P20BF OR P20C0-P20C5: REDUCTANT HEATER 1-2

Diagnostic Instructions

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

DTC Descriptors

DTC P20B9

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Reductant Heater 1 Control Circuit

DTC P20BA

Reductant Heater 1 Performance

DTC P20BB

Reductant Heater 1 Control Circuit Low Voltage

DTC P20BC

Reductant Heater 1 Control Circuit High Voltage

DTC P20BD

Reductant Heater 2 Control Circuit

DTC P20BE

Reductant Heater 2 Performance

DTC P20BF

Reductant Heater 2 Control Circuit Low Voltage

DTC P20C0

Reductant Heater 2 Control Circuit High Voltage

Circuit/System Description

As reductant will freeze at temperatures below -11Â°C (12Â°F), there are 2 reductant heaters located in the reductant tank. One heats the reductant in the tank and one heats the reductant supplied to the reductant injector supply pipe. The ECM monitors the reductant temperature in the tank in order to determine if reductant temperature is below it's freeze point. If the ECM determines that the reductant may be frozen, it activates a "defrost strategy" energizing the reductant heater. This energizing action terminates when the temperature sensor measures a threshold value over which the heater must be deactivated.

Conditions for Running the DTCs

P20B9, P20BB, P20BC

- DTC P205B, P205C, P205D, or U010E is not set.
- The engine is running.
- The battery voltage is greater than 11 V.
- The reductant temperature is colder than 60Â°C (140Â°F).

The DTCs run continuously when the above conditions are met.

P20BA

- DTC P20B9, P20BB, P20BC, P248A, or U010E is not set.
- The engine is running.
- The battery voltage is greater than 11 V.
- The reductant tank heater is turned on.

The DTC runs continuously when the above conditions are met.

P20BD, P20BF, P20C0

- DTC U010E is not set.

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- The engine is running.
- The battery voltage is greater than 11 V.
- The reductant temperature is colder than 60Â°C (140Â°F).

The DTCs run continuously when the above conditions are met.

P20BE

- DTC P20BD, P20BF, P20C0, P248C, or U010E is not set.
- The engine is running.
- The battery voltage is greater than 11 V.
- The reductant line heater is turned on.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P20B9

The ECM indicates the reductant tank heater control circuit is open for greater than 5 s.

P20BA

The ECM indicates the reductant tank heater resistance is greater or less than a calibrated value for greater than 6 s.

P20BB

The ECM indicates the reductant tank heater control circuit is shorted to ground or overloaded for greater than 5 s.

P20BC

The ECM indicates the reductant tank heater control circuit is shorted to a voltage for greater than 5 s.

P20BD

The ECM indicates the reductant line heater control circuit is open for greater than 5 s.

P20BE

The ECM indicates the reductant line heater resistance is greater or less than a calibrated value for greater than 6 s.

P20BF

The ECM indicates the reductant line heater control circuit is shorted to ground or overloaded for greater than 5 s.

P20C0

The ECM indicates the reductant line heater control circuit is shorted to a voltage for greater than 5 s.

Action Taken When the DTC Sets

DTCs P20B9, P20BA, P20BB, P20BC, P20BD, P20BE, P20BF and P20C0 are Type A DTCs.

- The reductant injector is disabled.
- The reductant heaters are disabled.
- The selective catalyst reduction system is put in standby mode.
- The Diesel Exhaust Fluid (DEF) Warning Strategy (Anti-Tampering) is activated.

Conditions for Clearing the DTC

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DTCs P20B9, P20BA, P20BB, P20BC, P20BD, P20BE, P20BF and P20C0 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTCs P16D7, P16D8, P16D9, P248A, P248C, or U010E are not set.
   - **If any of the DTCs are set**
   - Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
   - **Go to next step: If none of the DTCs are set**
3. Command the Reductant heater 1 and 2 ON and OFF with a scan tool and verify that Reductant Heater 1 and 2 Current parameters are between 0 - 25.5 A.
   - **If not between 0 - 25.5 A.**

     Refer to Circuit/System Testing.

   - **Go to next step: If between 0 - 25.5 A**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K115 Reductant Control Module.
2. Connect a test lamp between ignition voltage terminal 8 and ground.
3. Ignition ON, verify the test lamp illuminates.
   - **If the test lamp does not illuminate and fuse F45UA is good**
   1. Ignition OFF, remove KR121A Reductant Control Module Relay 1.
   2. Test for less than 2 Ω between ignition voltage terminal 8 and relay terminal 30.

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- If 2 Ω or greater, repair the open/high resistance in the circuit
- If less than 2 Ω, replace the relay
- **If the test lamp does not illuminate and fuse F45UA is open**

1. Ignition OFF, test for infinite resistance between ignition voltage terminal 8 and ground.

- if less than infinite resistance, repair the short to ground in the circuit
- **Go to next step: If the test lamp illuminates**

DTCs P20B9, P20BA, P20BB or P20BC

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 connector at the A38 Reductant Pump and Sensor Assembly.
2. Ignition On, test for 5 - 7.5 V between terminal 9 and Ground
   - **If less than 5 V**
   1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. Test for infinite resistance between A38 Reductant Pump and Sensor Assembly harness connector terminal 9 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 between A38 Reductant Pump and Sensor Assembly harness connector terminal 9 and K115 Reductant Control Module X2 harness connector terminal 11.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K115 Reductant Control Module.
   - **If greater than 7.5 V**
   1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. Ignition On, test for greater than 1 V between A38 Reductant Pump and Sensor Assembly harness connector terminal 9 and ground
      - If greater than 1 V repair the short to voltage in the circuit
      - If less than 1 V replace the K115 Reductant Control Module
   - **Go to next step: If between 5 and 7.5 V**
3. Connect a test lamp between heater control circuit terminal 9 and low reference circuit terminal 11.
4. Ignition ON, verify the test lamp turns ON for several seconds while commanding Reductant Heater 1 ON with a scan tool.
   - **If the test lamp is always OFF**
   1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. Test for infinite resistance between the A38 Reductant Pump and Sensor Assembly harness connector terminal 11 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 between A38 Reductant Pump and Sensor Assembly harness connector terminal 11 and K115 Reductant Control Module X2 harness connector terminal 4.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω
   4. Test for less than 1.0 V between the A38 Reductant Pump and Sensor Assembly harness connector terminal 11 and ground.
      - If 1.0 V or greater, repair the short to voltage in the circuit.
      - If less than 1.0 V, replace the K115 Reductant Control Module.
   - **Go to next step: If the Test lamp turns ON and OFF**
5. Test or replace the A38 Reductant Pump and Sensor Assembly.

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DTCs P20BD, P20BE, P20BF, P20C0

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 connector at the E52 Reductant Line Heater.
2. Ignition On, test for 5 - 7.5 V between terminal 2 and ground
    - **If less than 5 V**
    1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
    2. Test for infinite resistance between E52 Reductant Line Heater harness connector terminal 2 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω between E52 Reductant Line Heater harness connector terminal 2 and K115 Reductant Control Module X2 harness connector terminal 7.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K115 Reductant Control Module.
    - **If greater than 7.5 V**
    1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
    2. Ignition On, test for greater than 1 V between E52 Reductant Line Heater harness connector terminal 2 and ground
        - If greater than 1 V repair the short to voltage in the circuit
        - If less than 1 V replace the K115 Reductant Control Module
    - **Go to next step: If between 5 and 7.5 V**
3. Connect a test lamp between heater control circuit terminal 2 and low reference circuit terminal 1.
4. Ignition ON, verify the test lamp turns ON for several seconds while commanding Reductant Heater 2 ON with a scan tool.
    - **If the test lamp is always OFF**
    1. Ignition OFF, disconnect the X2 harness connector at the K115 Reductant Control Module.
    2. Test for infinite resistance between the E52 Reductant Line Heater harness connector 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 between E52 Reductant Line Heater harness connector terminal 1 and K115 Reductant Control Module X2 harness connector terminal 20.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω
    4. Test for less than 1.0 V between the E52 Reductant Line Heater harness connector terminal 1 and ground.
        - If 1.0 V or greater, repair the short to voltage in the circuit.
        - If less than 1.0 V, replace the K115 Reductant Control Module.
    - **Go to next step: If the Test lamp turns ON and OFF**
5. Test or replace the E52 Reductant Line Heater.

Component Testing

Reductant Tank Heater

1. Ignition OFF, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly.
2. Test for 1 - 3 Ω between terminals 9 and 11 of the A38 Reductant Pump and Sensor Assembly.
    - **If not within 1 - 3 Ω**

      Replace the A38 Reductant Pump and Sensor Assembly.

    - **Go to next step: If within 1 - 3 Ω**

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3. Test for infinite resistance between each terminal and the A38 Reductant Pump and Sensor Assembly housing/case.
    - terminal 9
    - terminal 11
    - **If less than infinite resistance**

      Replace the A38 Reductant Pump and Sensor Assembly.

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

Reductant Line Heater

1. Ignition OFF, disconnect the harness connector at the E52 Reductant Line Heater.
2. Test for 1 - 4 Ω between terminals 1 and 2 of the Reductant Line Heater.
    - **If not within 1 - 4 Ω**

      Replace the E52 Reductant Line Heater.

    - **Go to next step: If within 1 - 4 Ω**
3. Test for infinite resistance between each terminal and the E52 Reductant Line Heater housing/case.
    - terminal 1
    - terminal 2
    - **If less than infinite resistance**

      Replace the E52 Reductant Line Heater.

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

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Repair Instructions

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

Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Supply Pump Module Replacement** for reductant pump and sensor assembly replacement.
- Refer to **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (FWD)** **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Front AWD)** **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Rear AWD)** for reductant line heater replacement.
- Refer to **Emission Reduction Fluid Controller Replacement**

DTC P20E8 OR P20E9: REDUCTANT LOW/HIGH PRESSURE

Diagnostic Instructions

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

DTC Descriptors

DTC P20E8

Reductant Low Pressure

DTC P20E9

Reductant High Pressure

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
DEF Pump Supply Voltage	P208A, P20E8	P204F, P20E8	P20E9	P204F, P208B, P20E8, P20E9
DEF Pump Control	P208A, P20E8	P204F, P208A, P20E8	P208D, P20E9	P204F, P208B, P20E8, P20E9
DEF Pump Low Reference	P20E8	P204F, P208A, P20E8	P20E9	P204F, P208B, P20E8, P20E9

Typical Scan Tool Data

Reductant Pressure

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Reductant pump On **Parameter Normal Range (Pump On):** 425 - 575 kPa (62 - 83 psi) **Parameter Normal Range (Pump Off):** 0 - 50 kPa (0 - 7 psi)			
5 V Reference	0 kPa	0 kPa	0 kPa
DEF Pressure Sensor Signal	0 kPa	0 kPa	750 - 850 kPa
Low Reference	-	0 kPa	5 - 20 kPa

Circuit/System Description

The selective catalytic reduction (SCR) system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of diesel exhaust fluid (DEF) or reductant into the exhaust gas stream entering the SCR catalyst. Within the SCR catalyst, the DEF reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provide the engine control module (ECM) with engine-out and tailpipe-out NOx levels. The ECM varies the amount of reductant added by varying the reductant injector duty cycle in response to changes in engine-out NOx levels.

The ECM supplies system voltage to the reductant pump motor. The ECM controls the solenoid by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. The ECM supplies a ground to the low reference circuit. As the duty-cycle increases, the output of the reductant pump increases.

Conditions for Running the DTCs

P20E8

- DTCs P204B, P204C, P204D, P208B, P208D, P20A0, P20A2, P20A3 is not set.
- Engine speed is greater than 600 RPM for at least 10 s.
- Battery voltage is greater than 11 V for at least 3 s.
- Reductant pressure is less than 420 kPa (61 psi) for more than 60 s.
- Ambient air temperature is greater than -30Â°C (-22Â°F).
- Reductant Level must not be in restriction or empty level state.
- Reductant must not be frozen or one heating cycle must complete (up to one hour at -20Â°C (-4Â°F)).
- The DTC runs continuously when the above conditions are met.

P20E9

- Engine speed is greater than 600 RPM for at least 10 s.
- Battery voltage is greater than 11 V for at least 3 s.

- The reductant pressure is greater than 650 kPa (94 psi) for more than 10 s or greater than 795 kPa (115 psi) for more than 1 s.
- Ambient air temperature is greater than -30Â°C (-22Â°F).
- Reductant Level must not be in restriction or empty level state.
- Reductant must not be frozen or one heating cycle must complete (up to one hour at -20Â°C (-4Â°F)).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P20E8

- The ECM detects the reductant pressure is less than a calibrated threshold.

P20E9

- The ECM detects the reductant pressure is greater than a calibrated threshold.

Action Taken When the DTC Sets

- DTCs P20E8 and P20E9 are Type A DTCs.
- The ECM inhibits the reductant system for P204F and P20E9.
- The ECM commands the engine to operate in Reduced Engine Power mode.
- The driver information center may display the Engine Power Is Reduced message.

Conditions for Clearing the DTC

- DTCs P20E8 and P20E9 are Type A DTCs.
- The DTCs must run and pass in order to clear the DIC message for P204F.

Diagnostic Aids

- A leak in the reductant system can be determined by inspecting for a build-up of crystallized reductant.
- Water content in the reductant will affect the freezing point.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

- **Diesel Exhaust Fluid (DEF) Warning Strategy (DEF Level)Diesel Exhaust Fluid (DEF) Warning Strategy (DEF Quality)Diesel Exhaust Fluid (DEF) Warning Strategy (Anti-tampering)Diesel Exhaust Fluid (DEF) Warning Strategy (Emission Control)**
- **Exhaust Aftertreatment System Description**

Electrical Information Reference

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

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- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify there are no related DTCs set in the following system:Reductant System
   - **If any other DTCs are set**

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

   - **Go to next step: If no other DTCs are set**
3. Verify that the scan tool Reductant Level is displaying at least 33%.
   - **If less than 33%**

     Add reductant

   - **Go to next step: If 33% or greater**

   NOTE: The reductant must be thawed before continuing.

4. Command the Reductant System Leak Test On with a scan tool. Allow the pressure to build for at least 2 minutes. The first 60 s, the system performs a system purge. Observe the scan tool Reductant Pressure sensor parameter. The reading should be between 400-650 kPa (58-94 psi).
   - **If not between the specified values**

     Refer to Circuit/System Testing

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

     Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE: The reductant temperature must be greater than -7Â°C (+19Â°F) before proceeding.

1. Test the reductant for contamination. Refer to Contaminants-in-Fuel Diagnosis.
   - **If contaminated**

     Repair as necessary

   - **Go to next step: If not contaminated**
2. Ignition - On/Vehicle - In Service Mode

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3. Command the Reductant System Leak Test On with a scan tool. Allow the pressure to build for 2 minutes. Observe the scan tool Reductant Pressure sensor parameter.
4. Verify the scan tool parameter: Reductant Pressure Sensor = 400 to 650 kPa (58 to 94 PSI)
    - **If greater than 650 kPa (94 PSI)**

      Replace the component: A38 Reductant Pump and Sensor Assembly

    - **If less than 400 kPa (58 PSI)**

    1. Verify there are no leaks in the reductant lines.
        - If a leak is found

          Repair as necessary

        - If no leak is found
    2. Remove the Q61 Emission Reduction Fluid Injector from the exhaust pipe leaving the reductant line and electrical connector connected. Place the injector into a suitable container.
    3. Command the Reductant System Leak Test On with a scan tool. Allow the pressure to build.
    4. Verify the injector does not leak.
        - If a leak is found

          Replace the Q61 Emission Reduction Fluid Injector

        - If no leak is found
    5. Replace the component: A38 Reductant Pump and Sensor Assembly
    - **Go to next step: If between 400 and 650 kPa (58 and 94 PSI)**
5. All OK.

Repair Instructions

- Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**
- Perform the scan tool function: **Reductant System Tamper Service Bay Test** - after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.
- Refer to **Emission Reduction Fluid Tank Replacement**
- Refer to **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (FWD)** **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Front AWD)** **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Rear AWD)**
- Refer to **Emission Reduction Fluid Tank Replacement** for G33 Reductant Pump
- Refer to **Emission Reduction Fluid Tank Draining**

DTC P20EE, P249D, OR P249E: NOX CATALYST EFFICIENCY BELOW THRESHOLD/CLOSED LOOP REDUCTANT INJECTION CONTROL AT LIMIT - FLOW TOO LOW/HIGH

Diagnostic Instructions

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

DTC Descriptor

DTC P20EE

NOx Catalyst Efficiency Below Threshold

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DTC P249D

Closed Loop Reductant Injection Control At Limit - Flow Too Low

DTC P249E

Closed Loop Reductant Injection Control At Limit - Flow Too High

Circuit/System Description

The selective catalytic reduction (SCR) system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of diesel exhaust fluid or reductant into the exhaust gas stream entering the SCR. Within the selective catalytic reduction catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provide the engine control module (ECM) with engine-out and tailpipe-out NOx levels. The ECM uses two (NOx) sensors to control exhaust NOx levels. The first NOx sensor is located upstream of the reductant fluid injector and monitors the engine out NOx. The second NOx sensor is located at the outlet of the SCR and monitors NOx levels exiting the SCR. The engine control module (ECM) varies the amount of diesel exhaust fluid (Reductant) or reductant added in response to changes in engine exhaust out NOx levels.

Conditions for Running the DTC

DTC P20EE

- DTC P0071, P0072, P0073, P0074, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0722, P0723, P111E, P113F, P115E, P115F, P1160, P116A-P116F, P1192-P1194, P1198, P119A-P119F, P11BE, P11BF, P11C0, P11C5-P11C8, P11CC, P11D0-P11D3, P11D5, P11D8, P11D9, P11DA-P11DE, P11FC-P11FE, P1248, P1249, P124A-P124F, P202E, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205-P2211, P220A, P220B, P2227, P2228, P2229, P2230, P228A, P228B, P229E, P229F, P22A0, P22A1, P22A3-P22A9, P22FE, P2452-P2456, P2481, P2482, P2483, P2484, P2BAA, U029D or U029E is not set.
- The engine is running.
- The barometric pressure is greater than 70 kPa (10.2 psi).
- The ambient air temperature is warmer than -7Â°C (19.4Â°F).
- The reductant tank is not frozen.
- Vehicle is not in a DPF regeneration.

The DTC runs when the above conditions are met.

DTC P249D, P249E

The DTCs run when the engine is running.

Conditions for Setting the DTC

The selective catalytic reduction measured NOx conversion efficiency is lower than expected.

Action Taken When the DTC Sets

- DTC P20EE is a Type A DTC.
- DTCs P249D and P249E are Type B DTCs.

Conditions for Clearing the DTC

- DTC P20EE is a Type A DTC.
- DTCs P249D and P249E are Type B DTCs.

Diagnostic Aids

- A leak in the reductant system can be located by inspecting for a build-up of crystallized diesel exhaust fluid (Reductant).
- Water in the Reductant tank will cause DTCs to set.
- Using the Reductant Injector Device Control, a ticking sound should be heard at the reductant injector.
- Using fuel other than ultra low sulfur content fuel will cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC P0071, P0072, P0073, P0074, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0722, P0723, P111E, P113F, P115E, P115F, P1160, P116A-P116F, P1192-P1194, P1198, P119A-P119F, P11BE, P11BF, P11C0, P11C5-P11C8, P11CC, P11D0-P11D3, P11D5, P11D8, P11D9, P11DA-P11DE, P11FC-P11FE, P1248, P1249, P124A-P124F, P202E, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205-P2211, P220A, P220B, P2227, P2228, P2229, P2230, P228A, P228B, P229E, P229F, P22A0, P22A1, P22A3-P22A9, P22FE, P2452-P2456, P2481, P2482, P2483, P2484, P2BAA, U029D or U029E is not set.
    - **If any of the DTCs are set**
    1. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
    2. Perform the scan tool control function: **Reductant System Malfunction Service Bay Test** after diagnosing other DTCs
        - If the test does not pass

          Refer to Circuit/System Testing.

        - If the test passes

          All OK.

    - **Go to next step: If no other DTCs are set**
2. Verify that DTC P20EE, P249D, or P249E is not set
    - **If a DTC is set**

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Refer to Circuit/System Testing

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

3. All OK.

Circuit/System Testing

1. Ignition Off
2. Test the reductant system for contamination. Refer to **Contaminants-in-Diesel Exhaust Fluid Diagnosis**.
   - **If any conditions are found**

     Repair as necessary.

   - **Go to next step: If no conditions are found**
3. Ignition - On/Vehicle - In Service Mode
4. Perform the scan tool control function: Reductant System Leak Test - ON
5. Verify that the system is able to build up and reach the reductant pressure sensor parameter greater than 450 kPa.
   - **If less than the specified range**
   1. Command the Reductant Pump to 50% with a scan tool.
   2. Verify the scan tool parameter: Desired Reductant Pump Speed = Reductant Pump Speed
      - If not equal

        Refer to **DTC P105A**

      - If equal
   - **Go to next step: If within the specified range**
6. Verify there are no leaks, kinks or restrictions in the reductant lines
   - **If any condition is found**

     Repair as necessary.

   - **Go to next step: If no conditions are found**
7. Verify the **Reductant Injection Quantity Test** passes.
   - **If the test does not pass**

     Repair as necessary.

   - **Go to next step: If the test passes**
8. Disconnect the Q61 Reductant Injector electrical connector.
9. Engine running and NOx sensors at operating temperature, verify NOx sensor 2 NOx Concentration is less than 50 ppm greater than NOx sensor 1 NOx Concentration.
   - **If NOx sensor 2 NOx Concentration is 50 ppm or greater than NOx sensor 1 NOx Concentration**

     Replace the B195B Nitrogen Oxides Sensor 2

   - **Go to next step: If NOx sensor 2 NOx Concentration is less than 50 ppm greater than NOx sensor 1 NOx Concentration**
10. Idle engine at 1, 500 RPM for 10 min while monitoring Exhaust Gas Temperature Sensor 2.
11. Verify Exhaust Gas Temperature Sensor 2 is colder than 150Â°C (302Â°F)
    - **If 150Â°C (302Â°F) or warmer**
    1. Verify Exhaust Gas Temperature Sensor 2 is warmer than 150Â°C (302Â°F) For greater than 30 min, then continue to the next step.
    - **If colder than 150Â°C (302Â°F)**

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12. Verify NOx sensor 1 NOx Concentration and NOx sensor 2 NOx Concentration are within 50 ppm of each other.
    - **If not within 50 ppm**

      Replace the B195A Nitrogen Oxides Sensor 1

    - **Go to next step: If within 50 ppm**
13. Connect the Q61 Reductant Injector electrical connector.
14. Verify none of the conditions listed below exist:
    - Leaking fuel injectors. Refer to **Fuel Injector Balance Test with Scan Tool**.
    - Engine oil consumption. Refer to **Oil Consumption Diagnosis** .
    - Engine coolant consumption. Refer to **Coolant in Combustion Chamber** .
    - An engine mechanical condition. Refer to **Symptoms - Engine Mechanical** .
    - **If any condition is found**

      Repair as necessary

    - **Go to next step: If no condition is found**
15. Replace SCR Catalyst.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Nitrogen Oxides Sensor Replacement - Position 1**
- Refer to **Nitrogen Oxides Sensor Replacement - Position 2**
- Refer to **Emission Reduction Fluid Supply Pump Module Replacement**
- Refer to **Emission Reduction Fluid Injector Replacement (AWD)** **Emission Reduction Fluid Injector Replacement (FWD)**
- Refer to **Exhaust Muffler Replacement (LH7)** - For SCR Replacement
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

Repair Verification

NOTE: **Before returning the vehicle to the customer, perform the scan tool Reductant System Malfunction Warning Service Bay Test to verify proper reductant system operation.**

1. Perform the scan tool control function: **Reductant System Malfunction Service Bay Test**
    - **If the test does not pass**

      Refer to Circuit/System Testing.

    - **Go to next step: If the test passes**
2. All OK.

DTC P20F8: INTAKE MANIFOLD RUNNER CONTROL VALVE CONTROL CIRCUIT PERFORMANCE

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**
- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

DTC Descriptor

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DTC P20F8

Intake Manifold Runner Control Valve Control Circuit Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P2009, P201B	P2009, P2017	-	P2006, P200A, P20F8
Control	P2009	P2008	P2010	P2006, P200A, P20F8

Typical Scan Tool Data

Intake Manifold Runner Control Valve Feedback Signal

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine - Idling - At normal operating temperature **Parameter Normal Range:** 32%			
Ignition	0%	100%	100%
Control	0%	29%	29%

Circuit/System Description

Circuit	Description
Ignition	Supplied from a fuse.
Control	The output is PWM controlled.

Component	Description
K20 Engine Control Module	The control module contains a microprocessor used to process input data to control outputs. The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
M98 Intake Manifold Runner Valve Actuator	The intake manifold runner control solenoid valve is actuated by a DC motor. The control valve is spring loaded to the closed position. The motor overcomes the spring pressure to open the control valve. An increase in current flow through the motor increases the opening of the control valve.

Conditions for Running the DTC

- DTC P0071-P0074, P0116-P0119, P0128, P111E, P2008-P2010, P2015-P2017 = Not set
- Engine = Running
- Ignition Voltage = Greater than 11 V
- Engine Coolant Temperature = Greater than 59Â°C (138Â°F)
- Outside Ambient Air Temperature Sensor Signal = Greater than -7Â°C (19Â°F)
- Intake Manifold Runner Control Valve Command = ON For greater than 30 s
- Intake Manifold Runner Control Valve Command = Steady State For greater than 1 s
- Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Control Circuit = Commanded state does not match the actual state - For greater than 1 s

Actions Taken When the DTC Sets

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DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component Views

Powertrain Component Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P2008, P2009, P2010, P2015, P2016, P2017 is not set.
3. Perform the scan tool control function: Intake Manifold Runner Control Valve - Increase

   Verify the scan tool parameter:

   - Intake Manifold Runner Control Valve Control Circuit High Voltage Test Status = OK or Not Run
   - Intake Manifold Runner Control Valve Control Circuit Open Test Status = OK or Not Run
   - Intake Manifold Runner Control Valve Control Circuit Low Voltage Test Status = OK or Not Run
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
4. Perform the scan tool control function: Intake Manifold Runner Control Valve - Increase & Decrease - 30 to 80%

   Verify the scan tool parameter: Intake Manifold Runner Control Valve Feedback Signal = Intake Manifold Runner Control Valve Command

   - **If not the specified state**

     Refer to: Circuit/System Testing

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- **Go to next step: If the specified state**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

   - **Go to next step: If the DTC is not set**

6. All OK.

Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: M98 Intake Manifold Runner Valve Actuator
3. Ignition - On/Vehicle - In Service Mode
4. Verify a test lamp does not turn On between the test points: Control circuit terminal 1 & B+
   - **If the test lamp turns On**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
   3. Test for infinite resistance between the test points: Control circuit terminal 1 @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance - Replace the component: K20 Engine Control Module
   - **Go to next step: If the test lamp does not turn On**
5. Remove - Test Lamp
6. Verify the scan tool parameter: Intake Manifold Runner Control Valve Control Circuit High Voltage Test Status = OK
   - **If not the specified state**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
   3. Ignition - On/Vehicle - In Service Mode
   4. Test for less than 1 V between the test points: Control circuit terminal 1 @ Component harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - If less than 1 V - Replace the component: K20 Engine Control Module
   - **Go to next step: If the specified state**
7. Connect a 3 A fused jumper wire between the test points: Control circuit terminal 1 & Ignition circuit terminal 6
8. Perform the scan tool control function: Intake Manifold Runner Control Valve - Increase

   Verify the scan tool parameter: Intake Manifold Runner Control Valve Control Circuit High Voltage Test Status = Malfunction

   - **If not the specified state**
   1. Ignition/Vehicle - Off & Remove - Jumper wire (s)
   2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
   3. Test for less than 2 between the test points: Control circuit terminal 1 @ Component harness & Terminal 54 @ Control module harness
      - If 2 or greater - Repair the open/high resistance in the circuit.
      - If less than 2 - Replace the component: K20 Engine Control Module
   - **Go to next step: If the specified state**

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9. Test or replace the component: M98 Intake Manifold Runner Valve Actuator

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- Refer to **Intake Manifold Cleaning and Inspection** - M98 Intake Manifold Runner Valve Actuator
- Refer to **Intake Manifold Replacement** - M98 Intake Manifold Runner Valve Actuator
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P2122, P2123, P2127, P2128, OR P2138: ACCELERATOR PEDAL POSITION (APP) SENSORS 1-2

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**
- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

DTC Descriptor

DTC P2122

Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

DTC P2123

Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage

DTC P2127

Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage

DTC P2128

Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

DTC P2138

Accelerator Pedal Position (APP) Sensors 1-2 Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference - APP Sensor 1	P0193, P06A3, P127D	P2122, P2138	P0193, P06A3, P127D	P2138
Signal - APP Sensor 1	P2138	P2122, P2138	P2123	P2138
Low Reference - APP Sensor 1	-	P2138	-	P2138
5V Reference - APP Sensor 2	P0697	P2127, P2138	P0697	P2138
Signal - APP Sensor 2	P2127	P2127, P2138	P2128	P2138
Low Reference - APP Sensor 2	-	P2128, P2138	-	P2138

Typical Scan Tool Data

APP Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** 0.8 to 1.1 V			

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Circuit	Short to Ground	Open	Short to Voltage
5 V Reference	0 V	0 V	2 to 3 V
Signal	0 V	0 V	4 to 5 V
Low Reference	-	4 to 5 V	-

APP Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine = Idling **Parameter Normal Range:** 0.4 to 0.6 V			
5 V Reference	0 V	0 V	1 to 3 V
Signal	0 V	0 V	2 to 5 V
Low Reference	-	4 to 5 V	-

Circuit/System Description

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to ground.
Low Reference	Grounded through the control module.

Component	Description
B107 Accelerator Pedal Position Sensor	The pedal assembly contains 2 potentiometer-type accelerator pedal position sensors, which are not serviceable. When the accelerator pedal is pressed, the voltage of one sensor goes up and the voltage of the other sensor goes down. This redundant design enables the control module to detect if the 2 signals indicate the same accelerator pedal position.
K20 Engine Control Module	The control module contains a microprocessor used to process input data to control outputs. The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

DTC P2122, P2123, P2127, P2128

- DTC P0697, P06A3 = Not set
- Ignition = On or Engine Running
- Ignition Voltage = Greater than 6.4 V
- Frequency the DTC runs = Continuously - After the running conditions are met

P2138

- DTC P0697, P06A3, P2122, P2123, P2127, P2128 = Not set
- Ignition Voltage = Greater than 6.4 V
- Reduced Engine Power = Inactive
- Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P2122

APP Sensor 1 = Less than 0.46 V - For greater than 175 ms

P2123

APP Sensor 1 = Greater than 4.75 V - For greater than 175 ms

P2127

APP Sensor 2 = Less than 0.33 V - For greater than 175 ms

P2128

APP Sensor 2 = Greater than 2.6 V - For greater than 175 ms

P2138

- APP Sensor 1 and 2 Disagree = Greater than 5-10% Between Ranges - For greater than 188 ms

  or

- APP Sensor 1, 2 Learned Released Position Disagree = Greater than 0.3 V - For greater than 188 ms

Action Taken When the DTC Sets

- DTCs listed in the DTC Descriptor Category = Type A DTC
- ECM commands the throttle actuator control (TAC) system to operate in a Reduced Engine Power mode.
- A message and/or warning indicator may be displayed to the driver.
- Under certain conditions, the control module commands the engine Off.

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Diagnostic Aids

- A high resistance condition on the component circuits may cause a DTC to set.
- Ensure that the inline harness connector seals are installed correctly. Incorrect installation could result in water intrusion into the connector and may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

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1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P0697, P06A3 is not set.
    - **If any of the DTCs are set**

      Refer to: **DTC P0641, P0651, P0697, or P06A3**

    - **Go to next step: If none of the DTCs are set**
3. Verify the scan tool parameter:
    - APP Sensor 1 = 0.8 to 4.5 V - The value should not spike or drop out while moving the sensor through the entire range.
    - APP Sensor 2 = 0.4 to 2.5 V - The value should not spike or drop out while moving the sensor through the entire range.
    - **If not in the specified range or does not change**

      Refer to: Circuit/System Testing

    - **Go to next step: If in the specified range and changes**
4. Verify the scan tool parameter:
    - APP Sensor 1 = The value should not spike or drop out.
    - APP Sensor 2 = The value should not spike or drop out.
    - Perform the action while monitoring the parameter:
    - Wiggle the harness and connector: B107 Accelerator Pedal Position Sensor
    - Wiggle the harness and connector: K20 Engine Control Module
    - **If the value spikes or drops out**

      Repair as necessary - Wiring/Terminal (s)/Electrical Connector (s)

    - **Go to next step: If the value does not spike or drop out**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

    - **If the DTC sets**

      Refer to: Circuit/System Testing

    - **Go to next step: If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: **It may take up to 2 min for all vehicle systems to power down before an accurate ground or low reference circuit continuity test can be performed.**

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B107 Accelerator Pedal Position Sensor
3. Test for less than 5 ohms between the test points:
    - {APP Sensor 1} Low Reference circuit terminal 4 & Ground
    - {APP Sensor 2} Low Reference circuit terminal 5 & Ground
    - **If 5 ohms or greater**
    1. Disconnect the electrical connector: K20 Engine Control Module
    2. Test for less than 2 ohms between the test points:
        - {APP Sensor 1} Low Reference circuit terminal 4 @ Component harness & The other end of the circuit @ Control module harness

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- {APP Sensor 2} Low Reference circuit terminal 5 @ Component harness & The other end of the circuit @ Control module harness
- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms - Replace the component: K20 Engine Control Module

- **Go to next step: If less than 5 ohms**

4. Ignition - On/Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points:
   - {APP Sensor 1} 5 V Reference circuit terminal 2 & Low Reference circuit terminal 4
   - {APP Sensor 2} 5 V Reference circuit terminal 1 & Low Reference circuit terminal 5
   - **If less than 4.8 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points:
      - 5 V Reference circuit terminal 2 @ Component harness & Ground
      - 5 V Reference circuit terminal 1 @ Component harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 ohms between the test points:
      - 5 V Reference circuit terminal 2 @ Component harness & The other end of the circuit @ Control module harness
      - 5 V Reference circuit terminal 1 @ Component harness & The other end of the circuit @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K20 Engine Control Module
   - **If greater than 5.2 V**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K20 Engine Control Module
   3. Ignition - On/Vehicle - In Service Mode
   4. Test for less than 1 V between the test points:
      - 5 V Reference circuit terminal 2 @ Component harness & Ground
      - 5 V Reference circuit terminal 1 @ Component harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - If less than 1 V - Replace the component: K20 Engine Control Module
   - **Go to next step: If between 4.8 and 5.2 V**
6. Verify the scan tool parameter:
   - APP Sensor 1 = Less than 0.2 V
   - APP Sensor 2 = Less than 0.2 V
   - **If 0.2 V or greater**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K20 Engine Control Module
   3. Ignition - On/Vehicle - In Service Mode
   4. Test for less than 1 V between the test points:
      - {APP Sensor 1} Signal circuit terminal 3 @ Component harness & Ground
      - {APP Sensor 2} Signal circuit terminal 6 @ Component harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - If less than 1 V - Replace the component: K20 Engine Control Module
   - **Go to next step: If less than 0.2 V**
7. Connect a 3 A fused jumper wire between the test points:
   - {APP Sensor 1} Signal circuit terminal 3 & 5 V Reference circuit terminal 2

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- {APP Sensor 2} Signal circuit terminal 6 & 5 V Reference circuit terminal 1

8. Verify the scan tool parameter: = Greater than 4.7 V
    - **If 4.7 V or less**
    1. Ignition/Vehicle - Off & Remove - Jumper wire (s)
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points:
        - {APP Sensor 1} Signal circuit terminal 3 @ Component harness & Ground
        - {APP Sensor 2} Signal circuit terminal 6 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance
    4. Test for less than 2 ohms between the test points:
        - {APP Sensor 1} Signal circuit terminal 3 @ Component harness & The other end of the circuit @ Control module harness
        - {APP Sensor 2} Signal circuit terminal 6 @ Component harness & The other end of the circuit @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K20 Engine Control Module
    - **Go to next step: If greater than 4.8 V**
9. Test or replace the component: B107 Accelerator Pedal Position Sensor

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- Refer to **Accelerator Pedal Position Sensor Replacement** - B107 Accelerator Pedal Position Sensor
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P2147, P2148, P2150, OR P2151: INJECTOR HIGH CONTROL CIRCUIT GROUP 1-2 LOW/HIGH VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2147

Injector High Control Circuit Group 1 Low Voltage

DTC P2148

Injector High Control Circuit Group 1 High Voltage

DTC P2150

Injector High Control Circuit Group 2 Low Voltage

DTC P2151

Injector High Control Circuit Group 2 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Cylinder 1 Fuel Injector High Voltage Supply	P2147	P0201	P2148	P1248*
Cylinder 2 Fuel Injector High Voltage Supply	P2150	P0202	P2151	P1249*
Cylinder 3 Fuel Injector High Voltage Supply	P2150	P0203	P2151	P124A*
Cylinder 4 Fuel Injector High Voltage Supply	P2147	P0204	P2148	P124B*
Cylinder 1 Fuel Injector High Voltage Control	P0261	P0201	P0262, P2148	P1248*
Cylinder 2 Fuel Injector High Voltage Control	P0264	P0202	P0265, P2151	P1249*
Cylinder 3 Fuel Injector High Voltage Control	P0267	P0203	P0268, P2151	P124A*
Cylinder 4 Fuel Injector High Voltage Control	P0270	P0204	P0271, P2148	P124B*
* Short from Supply Circuit to Control Circuit				

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the injector positive voltage control circuits. The ECM energizes each fuel injector by grounding the control circuit of that fuel injector. The ECM monitors the status of the injector positive voltage control circuits and the fuel injector control circuits. The injectors are separated into the following two groups:

- Group 1 - Injectors 1 and 4
- Group 2 - Injectors 2 and 3

When a fuel injector circuit condition is detected by the ECM, the affected fuel injector will be disabled and may disable the affected group of fuel injectors.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 0.5 s.

Action Taken When the DTC Sets

DTC P2147, P2148, P2150 and P2151 are Type A DTCs.

Conditions for Clearing the DTC

DTC P2147, P2148, P2150 and P2151 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **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, verify with a scan tool that DTCs P0201, P0202, P0203 or P0204 are not set.
    - **If DTCs P0201, P0202, P0203 or P0204 are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **Go to next step: If DTCs P0201, P0202, P0203 or P0204 are not 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 DTC P2147, P2148, P2150, or P2151 is set**

      Refer to Circuit/System Testing

    - **Go to next step: If DTC P2147, P2148, P2150, or P2151 is not set**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems off.
2. It may take up to 2 min for all vehicle systems to power down.
3. Disconnect the harness connector at the appropriate Q17 Fuel Injector.
4. Ignition ON.
5. Test for 4.5 - 6.5 V between the high voltage supply circuit terminal 1 and ground.
    - **If less than 4.5 V**
    1. Ignition OFF.
    2. Disconnect the X2 harness connector at the K20 Engine Control Module.
    3. Test for infinite resistance between the supply circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    4. Test for less than 2 Ω in the supply circuit end to end.
        - 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 6.5 V**
    1. Ignition OFF.

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2. Disconnect the harness connector X2 at the K20 Engine Control Module, Ignition ON.
3. Test for less than 1 V between the high voltage supply circuit terminal 1 and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **Go to next step: If between 4.5 - 6.5 V**

6. Test for 0.60 - 0.80 V between the high voltage control circuit terminal 2 and ground.
    - **If less than 0.60 V**

    1. Ignition OFF.
    2. Disconnect the harness connector X2 at the K20 Engine Control Module.
    3. 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
    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 greater than 0.80 V**

    1. Ignition OFF.
    2. Disconnect the harness connector X2 at the K20 Engine Control Module, Ignition ON.
    3. Test for less than 1 V between the control circuit terminal 2 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.

    - **Go to next step: If between 0.60 - 0.80 V**

7. Test or replace the appropriate Q17 Fuel Injector.

Component Testing

Static Test

1. Ignition OFF.
2. Disconnect the harness connector at the appropriate Q17 Fuel Injector.

> **NOTE:** **The DMM and test leads must be calibrated to 0 Ω in order to prevent misdiagnosis.**

3. Test for 0.2 - 1.5 Ω between the supply terminal 1 and the control terminal 2.
    - **If not between 0.2 - 1.5 Ω**

      Replace the appropriate Q17 Fuel Injector.

    - **Go to next step: If between 0.2 - 1.5 Ω**

4. Test for infinite resistance between each terminal and the injector housing/case.
    - **If less than infinite resistance**

      Replace the appropriate Q17 Fuel Injector.

    - **Go to next step: If infinite resistance**

5. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Fuel Injector Replacement**
- Refer to **Control Module References** for Engine Control Module replacement, programming and setup.

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DTC P214E: REDUCTANT PUMP HIGH CURRENT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P214E

Reductant Pump High Current

Circuit/System Description

The selective catalytic reduction system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of reductant into the exhaust gas stream entering the selective catalytic reduction catalyst. Within the selective catalytic reduction catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provides the engine control module and the reductant control module via serial data. The reductant control module varies the amount of reductant added by varying the reductant injector duty cycle in response to changes in engine-out NOx levels. The reductant control module supplies system voltage to the reductant pump motor. The reductant control module controls the solenoid by grounding the control circuit. The reductant control module can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

- DTC U010E is not set.
- Ignition On or engine running.
- The battery voltage is greater than 11 V.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The reductant control module detects that the reductant pump motor current is too high.

Action Taken When the DTC Sets

DTC P214E is a Type A DTC.

Conditions for Clearing the DTC

DTC P214E is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
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- **Wiring Repairs**

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition On
2. Verify that DTC P214E is not set.
   - **If the DTC Is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If the 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 that the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing

   - **Go to next step: If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the X1 harness connector at the A38 Reductant Pump and Sensor Assembly. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 15 and ground.
   - **If 10 Ω or greater**
   1. Ignition Off.
   2. Test for less than 2 Ω at the circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K115 Reductant Control Module.
   - **Go to next step: If less than 10 Ω**
3. Disconnect the X2 harness connector at the K115 Reductant Control Module.
4. Test for less than 2 Ω between the terminals listed below:
   - A38 Reductant Pump and Sensor Assembly harness connector terminal 16 and K115 Reductant Control Module harness connector terminal 1
   - A38 Reductant Pump and Sensor Assembly harness connector terminal 8 and K115 Reductant Control Module harness connector terminal 2
   - A38 Reductant Pump and Sensor Assembly harness connector terminal 7 and K115 Reductant Control Module harness connector terminal 3
   - **If greater than 2 Ω**

     Repair the open/high resistance in the appropriate circuit.

   - **Go to next step: If less than 2 Ω**
5. Ignition Off, test for infinite resistance between each control circuit and ground.
   - **If less than infinite resistance**

     Repair the short to ground at the appropriate circuit.

   - **Go to next step: If infinite resistance**
6. Ignition On, test for less than 1 V between each control circuit and ground.

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- **If 1 V or greater**

  Repair the short to voltage on the appropriate circuit.

- **Go to next step: If less than 1 V**

7. Replace the A38 Reductant Pump and Sensor Assembly.
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**

     Replace the K115 Reductant Control Module

   - **Go to next step: If the DTC does not set**
10. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Perform the **Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Supply Pump Module Replacement**
- Refer to **Emission Reduction Fluid Tank Replacement** for reductant pump and sensor assembly replacement.

DTC P2199: INTAKE AIR TEMPERATURE (IAT) SENSOR 1-2 NOT PLAUSIBLE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2199

Intake Air Temperature (IAT) Sensor 1-2 Not Plausible

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P2199	P0113, P2199	P0111*, P0113*, P0114, P2199	P0111*, P2199
Low Reference	-	P0097, P00F4, P0113, P227D	P0113*, P0114	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

IAT Sensor 2 and Intake Air Humidity

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P2199	P0096, P0097, P00F4, P0102, P2199	-	P0096
Signal	P0097, P00F5, P2199	P0097, P00F4, P2199	P0097*, P00F4*, P2199*	P0096
Ground	-	P0102	-	P0096
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+			

IAT Sensor 2 and Intake Air Humidity

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient humidity, temperature, and engine bay conditions			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz 0%	-40Â°C (-40Â°F) 10 Hz 0%	-
Signal	-40Â°C (-40Â°F) 10 Hz 100%	-40Â°C (-40Â°F) 10 Hz 0%	-40Â°C (-40Â°F) 10 Hz* 0%
Ground	-	-40Â°C (-40Â°F) 10 Hz 0%	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

The intake air temperature (IAT) sensor 1 is a variable resistor that measures the temperature of the air in the sensor bore. The engine control module (ECM) supplies 5 V to the IAT sensor 1 signal circuit and a ground for the IAT sensor 1 low reference circuit. The signal varies with inlet air temperature and is displayed by the scan tool as Â°C (Â°F).

The IAT sensor 2 produces a frequency signal, based on the inlet air temperature, which is equal to the humidity present within the sensor bore. The signal varies with inlet air temperature and is displayed by the scan tool as Â°C (Â°F) and Hertz (Hz) and the relative humidity is displayed in percent (%). The ECM supplies a regulated voltage to the signal circuit. The signal circuit is shared by the IAT sensor 2 and the humidity sensor. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for these sensors:

- IAT sensor 2

- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- Turbocharger inlet air pressure (TCIAP) sensor (BARO 2)

IAT Sensor 1 - Temperature, Resistance, Voltage Table

IAT Sensor 1	IAT Sensor 1 Resistance	IAT Sensor 1 Signal Voltage
Cold	High	High
Warm	Low	Low

IAT Sensor 2 - Temperature, Frequency Table

IAT Sensor 2	IAT Sensor 2 Frequency	IAT Sensor 2 Temperature
Cold	45 Hz	-40Â°C (-40Â°F)
Warm	302 Hz	104Â°C (219Â°F)

Conditions for Running the DTC

- The ignition is ON.
- Ignition 1 voltage is at least 11 V.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

The ECM detects that the absolute difference between the IAT sensor 1 and the IAT sensor 2 temperatures is greater than 55Â°C (99Â°F) for longer than 5 s.

Action Taken When the DTC Sets

DTC P2199 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2199 is a Type B DTC.

Diagnostic Aids

- With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor 2 will gradually increase the scan tool IAT Sensor 2 parameter. This is due to the heat that is generated by the multifunction intake air sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values: 10 Hz; -40Â°C (-40Â°F), and there are Humidity Sensor DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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- **Wiring Repairs**

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)** .

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Circuit/System Verification

1. Ignition On.
2. Verify that DTC P0097, P0098, P0099, P00F4, P00F5, P00F6, P0102, P0103, P0112, P0113, P0114, P0641, P0651, P0697, or P06A3 is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

   - **Go to next step: If none of the DTCs are set**

   NOTE: **To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 3 and 4 of this verification procedure only if the ignition has been OFF for 8 hours or more.**

3. Ignition ON.
4. Verify the following scan tool parameters are within 55Â°C (99Â°F) of each other.
   - Start-Up IAT Sensor 1
   - Start-Up IAT Sensor 2
   - Start-Up IAT Sensor 3
   - **If not within 55Â°C (99Â°F)**

     Refer to Circuit/System Testing.

   - **Go to next step: If within 55Â°C (99Â°F)**
5. Engine running, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
   - IAT Sensor 1
   - IAT Sensor 2
   - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

     Refer to Circuit/System Testing.

- **Go to next step: If between: -38 and +149Â°C (-36 and +300Â°F)**

6. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
7. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
8. All OK

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Check the integrity of the entire air induction system and verify that none of the following conditions exist:
   - A restricted or collapsed air intake duct
   - An intake manifold leak
   - A misaligned or damaged air intake duct
   - Any water intrusion in the induction system
   - **If a condition exists**

     Repair or replace component as appropriate.

   - **Go to next step: If no condition exists**
2. Ignition Off, and all vehicle systems Off, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
3. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
   - **If 5 Ω or greater**
   1. Disconnect the harness connector X1 at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
4. Test for less than 5 Ω between the ground circuit terminal 7 and ground.
   - **If 5 Ω or greater**
   1. Ignition Off.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **Go to next step: If less than 5 Ω**
5. Ignition On.
6. Verify the scan tool IAT Sensor 1 parameter is colder than -39Â°C (-38Â°F).
   - **If warmer than -39Â°C (-38Â°F).**
   1. Ignition Off, disconnect the harness connector X1 at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 1 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **Go to next step: If colder than -39Â°C (-38Â°F).**
7. Ignition Off, install a 3 A fused jumper wire between the IAT 1 signal circuit terminal 1 and the low reference circuit terminal 3.

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8. Ignition On.
9. Verify the scan tool IAT Sensor 1 parameter is warmer than 148Â°C (298Â°F).
    - **If colder than 148Â°C (298Â°F).**
    1. Ignition Off, remove the jumper wire, disconnect the harness connector X1 at the K20 Engine Control Module.
    2. Ignition On.
    3. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    4. Ignition Off.
    5. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If warmer than 148Â°C (298Â°F).**

NOTE: **The intake air temperature sensor 2 signal circuit is pulled up with low current voltage within the controller. Normally, a voltage can be measured on the circuit with a DMM, but the current will not be high enough to illuminate a test lamp.**

10. Verify the scan tool Intake Air Humidity Sensor parameter is less than 1%.
    - **If 1% or greater**
    1. Ignition Off, disconnect the harness connector X3 at the K20 Engine Control Module.
    2. Test for infinite resistance between the IAT 2 signal circuit terminal 8 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If less than 1%**
11. Ignition Off, install a 3 A fused jumper wire between the IAT 2 signal circuit terminal 8 and the low reference circuit terminal 3.
12. Ignition On.
13. Verify the scan tool Intake Air Humidity Sensor parameter is greater than 99%.
    - **If 99% or less**

NOTE: **If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.**

    1. Ignition Off, remove the jumper wire and disconnect the harness connector X3 at the K20 Engine Control Module.
    2. Ignition On.
    3. Test for less than 1 V between the IAT 2 signal circuit terminal 8 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V.
    4. Ignition Off.
    5. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If greater than 99%**
14. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

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1. Ignition Off, disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
2. Connect a DMM between the IAT sensor 1 signal terminal 1 and the low reference terminal 3.

NOTE: **A thermometer can be used to test the sensor off the vehicle.**

3. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor** table. The resistance values should be in range of the table values.
   - **If not within the specified range**

     Replace the B75C Multifunction Intake Air Sensor.

   - **Go to next step: If within the specified range**
4. All OK.

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.
   - **If not within the specified range**

     Replace the B75C Multifunction Intake Air Sensor.

   - **Go to next step: If within the specified range**
2. All OK.

Circuit Testing with EL-38522-A

NOTE: **In-correct diagnosis will result if Circuit/System Testing is not completed before performing the following test.**

1. Perform the following test using a **EL-38522-A** Variable Signal Generator or equivalent, if available.
2. Ignition Off, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
   1. Red lead to the IAT 2 signal circuit terminal 8 at the harness connector
   2. Black leads to ground
   3. Battery voltage supply lead to B+
3. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
   - Signal switch to 5 V
   - Duty Cycle switch to 50% (Normal)
   - Frequency switch to 250 Hz
4. Ignition On.
5. Verify the scan tool IAT Sensor 2 parameters listed below are within the ranges listed below:
   - IAT Sensor 2 is between 248 - 252 Hz

     NOTE: **Changing the frequency should cause a warmer or colder IAT 2 temperature.**

   - IAT Sensor 2 is between 70 - 76Â°C (160 - 166Â°F)

     NOTE: **Increasing or decreasing the duty cycle should have an inverse affect on humidity.**

   - Intake Air Humidity Sensor is between 48 - 52%
   - **If a parameter is not within the specified range**
   1. Ignition Off, disconnect the harness connector X3 at the K20 Engine Control Module.

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2. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.
- **Go to next step: If all the parameters are within the specified range**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Mass Airflow Sensor Replacement** for multifunction intake air sensor replacement
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

DTC P21CB: REDUCTANT CONTROL MODULE SUPPLY VOLTAGE LOW VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P21CB

Reductant Control Module Supply Voltage Low Voltage

Circuit/System Description

The selective catalytic reduction system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of reductant into the exhaust gas stream entering the selective catalytic reduction catalyst. Within the selective catalytic reduction catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provides the engine control module and the reductant control module via serial data. The engine control module (ECM) controls the reductant injector duty cycle in response to changes in engine-out NOx levels. The reductant control module supplies system voltage to the reductant pump motor. The reductant control module controls the solenoid by grounding the control circuit. The reductant control module can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

- DTC U010E is not set.
- The ignition voltage is greater than 11 V.
- The ignition ON.
- The engine is not cranking.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The reductant control module supply voltage is less than a calibrated value for greater than 5 s.

Action Taken When the DTC Sets

- DTC P21CB is a Type B DTC.

Conditions for Clearing the DTC

- DTC P21CB is a Type B DTC.

Reference Information

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Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On
2. Verify that no module communication DTCs are set.
   - **If any other DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **Go to next step: If no other DTCs are set**
3. Verify that DTC P21CB is not set.
   - **If a DTC Is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If no DTC is set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify that DTC P21CB is not set.
   - **If a DTC sets**

     Refer to Circuit/System Testing

   - **Go to next step: If a DTC does not set**
6. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the X1 harness connector at the K115 Reductant Control Module. Ignition ON.
2. Verify that a test lamp illuminates between the module ignition voltage circuit terminal 5 and ground.
   - **If the test lamp does not illuminate**
   1. Ignition Off, remove the test lamp and remove fuse F18 from the X50A Underhood Fuse Block.
   2. Test for less than 2Ω in the module ignition voltage circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.

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- If less than 2 Ω

3. Test for infinite resistance between the module ignition voltage circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
- **Go to next step: If the test lamp illuminates**

3. Ignition ON, verify that a test lamp illuminates between the module ignition voltage circuit terminal 8 and ground.
    - **If the test lamp does not illuminate**
    1. Ignition Off, remove the test lamp and remove the KR121A Reductant Control Module Relay 1 from the X50A Underhood Fuse Block.
    2. Test for less than 2Ω in the module 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 module ignition voltage circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    - **Go to next step: If the test lamp illuminates**
4. Replace the K115 Reductant Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Emission Reduction Fluid Controller Replacement**

DTC P220A OR P220B: NOX SENSOR 1-2 SUPPLY VOLTAGE CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P220A

NOx Sensor 1 Supply Voltage Circuit

DTC P220B

NOx Sensor 2 Supply Voltage Circuit

Circuit/System Description

The NOx sensors are part of the selective catalytic reduction system, a device used to reduce NOx emission on diesel engines. There are two NOx sensors, one placed upstream of selective catalytic reduction, to measure inlet NOx concentration, and one placed downstream. They are connected with the control module via CAN and all the information is exchanged through it. Since it is a smart sensor, all the electrical monitoring is performed inside the sensor and only the results are sent to the ECM. Each NOx sensor contains a sensing cell, a pumping cell, and a heater. A sample of exhaust gas passes through a diffusion gap between the sensing cell and the pumping cell. The NOx sensor maintains a constant reference voltage across the sensing cell. An electronic circuit within sensor controls the pump current through the pumping cell in order to maintain a constant voltage in the sensing cell. The amount of current required to maintain the reference voltage in the sensing cell is proportional to the concentration of NOx in the exhaust. The ECM varies the amount of diesel exhaust fluid (reductant) added by varying the reductant injector duty cycle in response to changes in engine exhaust NOx levels. The smart NOx sensors consist of two components, the NOx module and the NOx sensor element that are serviced as a unit. A circuit or performance condition with a NOx sensor is detected by the NOx

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sensor module. The smart NOx sensor module communicates the condition to the ECM over the serial data line. The ECM sets a DTC when a serial data message is received from the NOx sensor module.

Conditions for Running the DTC

- DTC U029D or U029E is not set
- The reductant control module relay 2 is ON for greater than 1 s.
- The ignition voltage is greater than 11 V
- The NOx Sensor 1 or 2 Heater Operation parameter displays Allowed

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The sensor supply voltage is less than 10.8 V.

Action Taken When the DTC Sets

DTCs P220A and P220B are Type B DTCs.

Conditions for Clearing the DTC

DTCs P220A and P220B are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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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, verify that no other DTCs are set.
    - **If any other DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If no other DTCs are set**
2. Verify that DTC P220A or P220B is not set
    - **If the DTC is set**

      Refer to Circuit/System Testing

    - **Go to next step: If the DTC is not set**

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3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing

    - **Go to next step: If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at appropriate the B195 Nitrogen Oxides Sensor.
2. Ignition ON, verify that a test lamp illuminates between the voltage circuit terminal 1 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the voltage circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the voltage circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the appropriate B195 Nitrogen Oxides Sensor.
    - **Go to next step: If the test lamp illuminates**
3. Replace the appropriate B195 Nitrogen Oxides Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Nitrogen Oxides Sensor Replacement - Position 1**

Refer to **Nitrogen Oxides Sensor Replacement - Position 2**

DTC P2227-P2230: BAROMETRIC PRESSURE (BARO) SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC 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

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Barometric Pressure (BARO) Sensor Circuit Erratic

Circuit/System Description

The barometric pressure (BARO) sensor is integrated within the engine control module (ECM). The BARO sensor responds to changes in altitude and atmospheric conditions. The BARO sensor provides the ECM an indication of barometric pressure. 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 Condition 1

- Before the ECM can report that DTC P2227 failed, DTCs P0107, P0108, P2228, P2229, P227C, and P227D must run and pass.
- DTC P0106, P0107, P0108, P2228, P2229, P2230, P227C, P227D or P2610 is not set.
- The ignition is ON, engine OFF.
- The time between the current ignition cycle and the previous drive cycle is greater than 5 s.
- DTC P2227 runs continuously when the conditions above exist.

P2227 Condition 2

- DTC P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8, P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0335, P0336, P062B, P062D, P111E, P122D, P1248, P1249, P124A, P124B, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P2228, P2229, P2230, P227C, P227D, or P227E is not set.
- The engine is operating.
- The ignition voltage is greater than 11 V.
- The engine speed is less than 1, 100 RPM.
- The intake airflow valve position is greater than 90%.
- The engine coolant temperature (ECT) is warmer than 70Â°C (158Â°F)
- DTC P2227 runs continuously when the conditions above exist.

P2228, P2229, or P2230

- The ignition is ON or the engine is operating.
- The DTCs run continuously when the conditions above exist.

Conditions for Setting the DTC

P2227 Condition 1

The ECM detects that the BARO sensor pressure is less than 50 kPa (7.3 PSI) or greater than 115 kPa (16.7 PSI), for greater than 62.5 ms.

P2227 Condition 2

The ECM detects that the BARO sensor pressure is not within range of the calculated pressure that is derived from a system of models for greater than 5 s.

DTC P2228

The ECM detects that the BARO sensor pressure is less than 50 kPa (7.3 PSI) for greater than 5 s.

DTC P2229

The ECM detects that the BARO sensor pressure is greater than 115 kPa (16.7 PSI) for greater than 5 s.

DTC P2230

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The ECM detects that the BARO sensor pressure signal had an accumulated variation, over a 13 m sample period, of greater than 100 kPa (14.5 PSI) for greater than 50 s.

Action Taken When the DTC Sets

DTC P2227, P2228, P2229, and P2230 are Type B DTCs.

Conditions for Clearing the DTC

DTC P2227, P2228, P2229, and P2230 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 that DTCs P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8, P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0335, P0336, P062B, P062D, P111E, P122D, P1248, P1249, P124A, P124B, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P227C, P227D, or P227E are not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

   - **Go to next step: If none of the DTCs are set**
3. Ignition Off.
4. Inspect the atmospheric vent on the K20 Engine Control Module case for the conditions listed below:
   1. Moisture in the vent inlet
   2. Debris in the vent inlet
   - **If a condition exists**

     Attempt to clean or dry the atmospheric inlet.

   - **Go to next step: If a condition does not 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.

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6. Verify that the DTC does not set.
    - **If the DTC sets**

      Replace the K20 Engine Control Module

    - **Go to next step: If DTCs does not set**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Control Module References** for Engine Control Module replacement, programming and setup.

DTC P2264: WATER IN FUEL SENSOR CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2264

Water in Fuel Sensor Circuit

Circuit/System Description

The water in fuel sensor is located in the fuel filter housing. The water in fuel sensor has a signal circuit, and a low reference circuit. The engine control module (ECM) monitors the signal circuit for a predetermined voltage through serial data from the fuel pump driver control module.

Conditions for Running the DTC

- DTC P1103, P16D7, P16D8, P16D9, or P262B is not set.
- The engine is running.
- Ignition voltage is greater than 11 V.
- KR73 Ignition Main Relay is commanded On.
- Engine run time is greater than 6 m.
- Fuel pump driver control module supply voltage is greater than 11 V.
- The DTC runs continuously once above condition is met.

Conditions for Setting the DTC

The water in fuel sensor signal circuit voltage is outside the expected range for more than 1 s.

Action Taken When the DTC Sets

DTC P2264 is a Type C DTC.

Conditions for Clearing the DTC

DTC P2264 is a Type C DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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COMPONENT CONNECTOR END VIEWS - INDEX

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Powertrain Component Views

Description and Operation

Fuel System Description

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify DTC P1103, P16D7, P16D8, P16D9 or P262B is not set.
   - **If DTC P1103, P16D7, P16D8, P16D9 or P262B is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
   - **Go to next step: If DTC P1103, P16D7, P16D8, P16D9 or P262B 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 in the Freeze Frame/Failure Records data.
4. Verify that DTC P2264 is not set.
   - **If DTC P2264 is set**

     Refer to Circuit/System Testing
   - **Go to next step: If DTC P2264 is not set**
5. All OK

Circuit/System Testing

1. Ignition Off, and all vehicle systems Off, disconnect the harness connector at the B116 Water in Fuel Sensor. 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 2 and ground.
   - **If 5 Ω or greater**

     Repair the open or high resistance in the ground circuit.
   - **Go to next step: If less than 5 Ω**
3. Ignition On.
4. Test for 4.8 - 5.2 V between the 5V reference circuit terminal 1 and ground.
   - ***Go to next step: If less than 4.8 V***
   1. Ignition Off.
   2. Disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
   3. Test for infinite resistance between the 5V reference circuit and ground.

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- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

4. Test for less than 2 Ω in the 5V 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 K111 Fuel Pump Driver Control Module.

- ***Go to next step: If greater than 5.2 V***

1. Ignition Off.
2. Disconnect the harness connector at the K111 Fuel Pump Driver Control Module, Ignition On.
3. Test for less than 1 V between the 5V reference and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K111 Fuel Pump Driver Control Module.

- ***Go to next step: If between 4.8 - 5.2 V***

5. Verify the scan tool parameter Water in Fuel displays No.
    - ***Go to next step: If parameter does not display No***

    1. Ignition Off.
    2. Disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
    3. Test for infinite resistance between the signal circuit terminal 3 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K111 Fuel Pump Driver Control Module.

    - ***Go to next step: If parameter displays No***

6. Install a 3 A fused jumper wire between the signal circuit terminal 3 and low reference circuit terminal 2.
7. Verify the scan tool parameter Water in Fuel displays Yes.
    - **If the parameter does not display Yes**

    1. Ignition Off, remove jumper wire.
    2. Disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
    3. Ignition On.
    4. 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
    5. Ignition Off.
    6. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K111 Fuel Pump Driver Control Module.

    - **Go to next step: If the parameter displays Yes**

8. Replace the B116 Water in Fuel Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- For B116 Water in Fuel Sensor replacement refer to: **Fuel Filter Assembly Replacement (AWD)** **Fuel Filter Assembly Replacement (FWD)**
- Refer to **Control Module References** for Control Module replacement, programming, and setup

DTC P227B: BAROMETRIC PRESSURE (BARO) SENSOR 2 PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

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DTC Descriptor

DTC P227B

Barometric Pressure (BARO) Sensor 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference	P0097, P00F4, P0641, P2199, P227C*	P0097, P00F4, P2199, P227C	P0641, P227D*	P00C7, P227B, P227E
Signal	P227C	P227B, P227D	P227D	P00C7, P227B, P227E
Low Reference	-	P0097, P00F4, P0113, P227D	-	P00C7, P2199, P227B, P227E
* Additional DTCs may set.				

Typical Scan Tool Data

BARO Sensor 2

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			
5V Reference	0 kPa (0.0 PSI)	0 kPa	127 kPa (18.4 PSI)
Signal	0 kPa (0.0 PSI)	127 kPa (18.4 PSI)	127 kPa (18.4 PSI)
Low Reference	-	127 kPa (18.4 PSI)	-

Circuit/System Description

The barometric pressure (BARO) Sensor 2, also referred to as the turbocharger inlet air pressure (TIAP) sensor, is integral to the multifunction intake air sensor and is used for humidity sensor signal correction. The sensor responds to changes in altitude and atmospheric conditions and gives the engine control module (ECM) an indication of intake air pressure relative to humidity. The ECM provides a 5 V reference and signal circuits to the TIAP which shares a low reference circuit with IAT 1 and 2. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor internal circuits for these sensors:

- Intake air temperature (IAT) sensor 1
- IAT sensor 2
- Humidity sensor
- Mass air flow (MAF) sensor
- Turbocharger inlet air pressure (TIAP) sensor (BARO 2)

Conditions for Running the DTC

Condition 1

- Before the ECM can report that DTC P227B failed, DTCs P0107, P0108, P2228, P2229, P227C, and P227D must run and pass.
- DTC P0106, P0107, P0108, P2228, P2229, P2230, P227C, P227D, P227E or P2610 is not set.
- The ignition is ON, engine OFF.
- The time between the current ignition cycle and the previous drive cycle is greater than 5 s.

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- DTC P227B runs continuously when the conditions above exist.

Condition 2

- DTC P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8, P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0335, P0336, P062B, P062D, P111E, P122D, P1248, P1249, P124A, P124B, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P2228, P2229, P2230, P227C, P227D, or P227E is not set.
- The engine is operating.
- The ignition voltage is greater than 11 V.
- The engine speed is less than 1, 100 RPM.
- The intake airflow valve position is greater than 90%.
- The engine coolant temperature (ECT) is warmer than 70Â°C (158Â°F)
- DTC P227B runs continuously when the conditions above exist.

Conditions for Setting the DTC

Condition 1

The ECM detects that the BARO sensor 2 pressure is less than 50 kPa (7.3 PSI) or greater than 115 kPa (16.7 PSI), for greater than 62.5 ms.

Condition 2

The ECM detects that the BARO sensor 2 pressure is not within range of the calculated pressure that is derived from a system of models for greater than 5 s.

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Action Taken When the DTC Sets

DTC P227B is Type B DTC.

Conditions for Clearing the DTC

DTC P227B is Type B DTC.

Diagnostic Aids

- This diagnostic is used to identify pressure sensor internal faults (measurements with an offset or a drift). The plausibility monitor compares the BARO, MAP and TIAP pressures when the Throttle valve is open, the engine is at idle, and the engine coolant temperature is warmer than a threshold. In that condition, the three sensors are expected to measure the same pressure. If a specific pressure sensor signal drifts from the other two signals, a sensor specific performance DTC sets.
- A skewed or stuck engine coolant temperature (ECT) or intake air temperature (IAT) may cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** , and **Temperature Versus Resistance - Intake Air Temperature Sensor** table.
- A skewed pressure sensor may cause the intake manifold models to disagree with the actual pressure sensor measurements. Use the scan tool and compare all the Pressure Sensor parameters to the **Altitude Versus Barometric Pressure** table, and to a known good vehicle, under various operating and extended soak conditions.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 that DTC P0101, P0102, P0103, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201, P0202, P0203, P0204, P020A, P020B, P020C, P020D, P0216, P02EE, P02EF, P02E8, P02E9, P02F0, P02F1, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0335, P0336, P062B, P062D, P111E, P122D, P1248, P1249, P124A, P124B, P126A, P16A0, P16A1, P16A2, P2147, P2148, P2150, P2151, P2228, P2229, P2230, P227C, P227D, or P227E is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

   - **Go to next step: If none of the DTCs are set**
3. Verify the scan tool BARO Sensor 2 parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.
   - **If the parameter is not within the specified range**

     Refer to Circuit/System Testing.

   - **Go to next step: If the parameter is within the specified range**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
6. All OK.

Circuit/System Testing

1. 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.

   - **Go to next step: If none of the conditions exist**

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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 X1 at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 5 Ω**
4. Ignition ON.
5. 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 X3 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 X3 at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If between 4.8 - 5.2 V**
6. Verify the scan tool BARO Sensor 2 parameter is greater than 4.7 V.
    - **If 4.7 V or less**
    1. Ignition OFF, disconnect the harness connector X3 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, replace the K20 Engine Control Module.
    - **Go to next step: If greater than 4.7 V**

    NOTE: **If the signal circuit is shorted to a voltage the ECM or the sensor may be damaged.**

7. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
8. Verify the scan tool BARO Sensor 2 parameter is less than 0.2 V.
    - **If 0.2 V or greater**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector X3 at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit terminal 4 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition Off
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open or high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

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- **Go to next step: If less than 0.2 V**

9. Test or replace the B75C Multifunction Intake Air Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Mass Airflow Sensor Replacement** for B75C Multifunction Intake Air Sensor replacement.
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P227C-P227E: BAROMETRIC PRESSURE (BARO) SENSOR 2 CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P227C

Barometric Pressure (BARO) Sensor 2 Circuit Low Voltage

DTC P227D

Barometric Pressure (BARO) Sensor 2 Circuit High Voltage

DTC P227E

Barometric Pressure (BARO) Sensor 2 Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference	P0097, P00F4, P0641, P2199, P227C*	P0097, P00F4, P2199, P227C	P0641, P227D*	P00C7, P227B, P227E
Signal	P227C	P227B, P227D	P227D	P00C7, P227B, P227E
Low Reference	-	P0097, P00F4, P0113, P227D	-	P00C7, P2199, P227B, P227E
* Additional DTCs may set.				

Typical Scan Tool Data

BARO Sensor 2

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			
5V Reference	0 kPa (0.0 PSI)	0 kPa	127 kPa (18.4 PSI)
Signal	0 kPa (0.0 PSI)	127 kPa (18.4 PSI)	127 kPa (18.4 PSI)

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Circuit	Short to Ground	Open	Short to Voltage
Low Reference	-	127 kPa (18.4 PSI)	-

Circuit/System Description

The barometric pressure (BARO) Sensor 2, also referred to as the turbocharger inlet air pressure (TIAP) sensor, is integral to the multifunction intake air sensor and is used for humidity sensor signal correction. The sensor responds to changes in altitude and atmospheric conditions and gives the engine control module (ECM) an indication of intake air pressure relative to humidity. The ECM provides a 5 V reference and signal circuits to the TIAP which shares a low reference circuit with IAT 1 and 2. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor internal circuits for these sensors:

- Intake air temperature (IAT) sensor 1
- IAT sensor 2
- Humidity sensor
- Mass air flow (MAF) sensor
- Turbocharger inlet air pressure (TIAP) sensor (BARO 2)

Conditions for Running the DTC

- The ignition is ON or the engine is running
- The DTCs run continuously when the above condition is met.

Conditions for Setting the DTC

DTC P227C

The ECM detects that the BARO sensor 2 is less than 50 kPa (7.3 PSI) for greater than 5 s.

DTC P222D

The ECM detects that the BARO sensor 2 is greater than 115 kPa (16.7 PSI) for greater than 5 s.

DTC P227E

The ECM detects that the BARO sensor 2 signal had an accumulated variation, over a 13 ms sample period, of greater than 200 kPa (29.0 PSI) for greater than 50 s.

Action Taken When the DTC Sets

DTCs P227C, P227D and P227E are Type B DTCs.

Conditions for Clearing the DTC

DTCs P227C, P227D and P227E are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify the scan tool BARO Sensor 2 parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.
   - **If the parameter is not within the specified range**

     Refer to Circuit/System Testing.

   - **Go to next step: If the parameter is within the specified range**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
4. All OK.

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Circuit/System Testing

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 connector at the B75C Multifunction Intake Air Sensor.
2. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 2 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector X3 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 X3 at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the 5 V reference circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **Go to next step: If between 4.8 - 5.2 V**

5. Verify the scan tool BARO Sensor 2 parameter is greater than 4.7 V.
    - **If 4.7 V or less**
    1. Ignition OFF, disconnect the harness connector X3 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, replace the K20 Engine Control Module.
    - **Go to next step: If greater than 4.7 V**

NOTE: **If the signal circuit is shorted to a voltage the ECM or the sensor may be damaged.**

6. Connect a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
7. Verify the scan tool BARO Sensor 2 parameter is less than 0.2 V.
    - **If 0.2 V or greater**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector X3 at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit terminal 4 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition Off
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open or high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 0.2 V**
8. Test or replace the B75C Multifunction Intake Air Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Mass Airflow Sensor Replacement** for B75C Multifunction Intake Air Sensor replacement.
- Refer to **Control Module References** for engine control module replacement, programming and setup

DTC P228A OR P228B: FUEL PRESSURE REGULATOR 1-2 CONTROL - FORCED ENGINE SHUTDOWN

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

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DTC P228A

Fuel Pressure Regulator 1 Control - Forced Engine Shutdown

DTC P228B

Fuel Pressure Regulator 2 Control - Forced Engine Shutdown

Circuit/System Description

The engine control module (ECM) controls the fuel rail pressure by controlling fuel pressure regulator 1 and fuel pressure regulator 2 simultaneously to achieve the desired fuel rail pressure. The ECM compares the desired fuel pressure that is calculated and the actual fuel pressure reading from the fuel pressure sensor and monitors these two values to detect faults in the fuel system.

Conditions for Running the DTC

P228A

- The engine is running.
- Ignition voltage is greater than 11 V.
- The Fuel rail pressure is being controlled by fuel pressure regulator 1 in closed loop.
- The DTCs runs continuously once the above conditions are met.

P228B

- The engine is running.
- Ignition voltage is greater than 11 V.
- The Fuel rail pressure is being controlled by fuel pressure regulator 2 in closed loop.
- The DTCs runs continuously once the above conditions are met.

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Conditions for Setting the DTC

P228A or P228B

The ECM detects that the fuel pressure regulator that is commanding the pressure is lower than the desired value for greater than 10 s.

Action Taken When the DTC Sets

- DTC P228A and P228B are Type A DTCs.

Conditions for Clearing the DTC

- DTC P228A and P228B are Type A DTCs.

Diagnostic Aids

- Water or contaminated fuel may cause this DTC to intermittently set. Refer to **Contaminants-in-Fuel Diagnosis**.
- A restricted fuel supply line, a leakage in the high pressure section, too much or too little fuel in the low pressure line may cause DTCs to set. When ambient temperatures are below 0Â°C (32Â°F), the fuel tank pickup screen may be iced over from water in the fuel tank.
- Electrical faults in either circuit of the Fuel Pressure Regulator will cause a DTC to set.
- There are no driveability concerns associated with the fuel rail pressure regulator unless a DTC is present. One of the causes of these DTCs is a sticking fuel rail pressure regulator.
- If the fuel system pressure is actually too high, a fuel knock and a low pressure condition will exist.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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. Verify DTC P0627, P0628, P0629, P1255, P129B, P129C, P12A6, or P2635 is not set
   - **If any of the DTCs are set**

     Refer to: **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If none of the DTCs are set**
2. Verify the proper fuel is used and there is no contamination. Refer to **Fuel System Specifications** , and **Contaminants-in-Fuel Diagnosis**.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - ***If DTC P228A, or P228B is set***

     Refer to Circuit/System Testing

   - ***Go to next step: If DTC P228A, or P228B is not set***
4. All OK.

Circuit/System Testing

1. Verify there are no fuel system leaks. Refer to **Fuel Leak Diagnosis**.
   - **If a fuel leak is found**

     Repair as necessary.

   - **Go to next step: If a fuel leak is not found**

NOTE: **Fuel temperature must be warmer than 20Â°C (68Â°F) before performing the next step or incorrect diagnosis may occur.**

2. Engine cranking or running, verify scan tool parameter Fuel Pressure Sensor is between 370-450 kPa (54-65 PSI).

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- ***If not within 370-450 kPa (54-65 PSI)***

  Refer to **Fuel System Diagnosis** for further diagnosis.

- ***Go to next step: If within 370-450 kPa (54-65 PSI)***

3. Verify that no fuel injector nozzles are stuck in the open position. Refer to **Fuel Injector Balance Test with Scan Tool** and perform the procedure under Circuit/System Testing.
   - **If a fuel injector nozzle is stuck open**

     Replace the appropriate Q17 Fuel Injector.

   - **Go to next step: If a fuel injector nozzle is not stuck open**
4. Perform the scan tool control function: Fuel Pressure Control - Regulator 1 - Increase & Decrease

   Verify the scan tool parameter: Fuel Rail Pressure Sensor 1 = The value should change with each command.

   - If the value does not change

     Replace the component: Q18A Fuel Pressure Regulator 1

   - If the value changes
5. Perform the scan tool control function: Fuel Pressure Control - Regulator 2 - Increase & Decrease

   Verify the scan tool parameter: Fuel Rail Pressure Sensor 1 = The value should change with each command.

   - If the value does not change

     Replace the component: Q18B Fuel Pressure Regulator 2

   - If the value changes
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Fuel Injector Replacement**
- For Q18A Fuel Pressure Regulator 1 replacement, refer to: **Fuel Injection Pump Metering Valve Replacement**
- For Q18B Fuel Pressure Regulator 2 replacement refer to: **Fuel Injection Fuel Rail Assembly Replacement**
- For control module replacement, programming and setup refer to: **Control Module References**

DTC P2294-P2296: FUEL PRESSURE REGULATOR 2 CONTROL CIRCUIT

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**
- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

DTC Descriptor

DTC P2294

Fuel Pressure Regulator 2 Control Circuit

DTC P2295

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Fuel Pressure Regulator 2 Control Circuit Low Voltage

DTC P2296

Fuel Pressure Regulator 2 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control - High	P2295	P2294	P0690, P16B3	P2293
Control - Low	P2295	P2294	P0690, P16B3, P2296	P2293

Circuit/System Description

Circuit	Description
Control - High	The output circuit is switched to 12 V to activate the component. The output is PWM controlled.
Control - Low	The output circuit is switched to ground to activate the component. The output is PWM controlled.

Component	Description
Q18B Fuel Pressure Regulator 2	The fuel pressure regulator is the solenoid valve that controls the pressure in the fuel rail.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

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For an overview of the component/system, refer to: **Fuel System Description**

Conditions for Running the DTC

- Battery Voltage = Greater than 11 V
- Engine Running
- Fuel Rail Pressure is being controlled by Fuel Pressure Regulator 2.
- Ignition Voltage = Greater than 6 V

DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P2294

Control Circuit = Open - Greater than 0.275 s

P2295

Control Circuit = Short to Ground - Greater than 0.275 s

P2296

Control Circuit = Short to Voltage - Greater than 0.275 s

Actions Taken When the DTC Sets

DTC P2294, P2295, P2296 = Type B DTC

Conditions for Clearing the DTC

DTC P2294, P2295, P2296 = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition - On/Vehicle - In Service Mode
2. Verify DTC P0191, P0192, P0193 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. Perform the scan tool control function: Fuel Pressure Regulator 2 - On and Off

   Verify the scan tool parameter:

    - Fuel Pressure Regulator 2 Control Circuit High Voltage Test Status = OK or Not Run
    - Fuel Pressure Regulator 2 Control Circuit Open Test Status = OK or Not Run
    - Fuel Pressure Regulator 2 Control Circuit Low Voltage Test Status = OK or Not Run
    - **If not the specified state**

      Refer to: Circuit/System Testing

    - **Go to next step: If the specified state**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

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5. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to: Circuit/System Testing

    - **Go to next step: If the DTC does not set**
6. All OK.

Circuit/System Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q18B Fuel Pressure Regulator 2
3. Connect a test lamp between the test points: Control circuit terminal 1 & Control circuit terminal 2
4. Ignition - On/Vehicle - In Service Mode
5. Perform the scan tool control function: Fuel Pressure Regulator 2 - On and Off

   Verify the test lamp turns On and Off.

    - **If the test lamp does not turn On and Off**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Ignition - On/Vehicle - In Service Mode
    4. Test for less than 1 V between the test points:
        - Control circuit terminal 1 @ Component harness & Ground
        - Control circuit terminal 2 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for infinite resistance between the test points:
        - Control circuit terminal 1 @ Component harness & Ground
        - Control circuit terminal 2 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance
    7. Test for less than 2 ohms between the test points:
        - Control circuit terminal 1 @ Component harness & Terminal 96 @ Control module harness
        - Control circuit terminal 2 @ Component harness & Terminal 76 @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K20 Engine Control Module
    - **Go to next step: If the test lamp turns On and Off**
6. Replace the component: Q18B Fuel Pressure Regulator 2

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- Refer to **Fuel Injection Fuel Rail Assembly Replacement** - Q18B Fuel Pressure Regulator 2
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P2297 OR P2A00: HO2S PERFORMANCE SENSOR 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

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- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2297

HO2S Performance During Deceleration Fuel Cut-Off Sensor 1

DTC P2A00

HO2S Performance Sensor 1

Circuit/System Description

The oxygen content of the exhaust is measured via the nitrogen oxide (NOx) sensors. The nitrogen oxides (NOx) sensors are part of the selective catalytic reduction system, a device used to reduce NOx emission on diesel engines. There are two NOx sensors, one placed upstream of selective catalytic reduction, to measure inlet NOx concentration, and one placed downstream. They are connected with the control module via CAN and all the information is exchanged through it. Since it is a smart sensor, all the electrical monitoring is performed inside the sensor and only the results are sent to the ECM. Each NOx sensor contains a sensing cell, a pumping cell, and a heater. A sample of exhaust gas passes through a diffusion gap between the sensing cell and the pumping cell. The NOx sensor maintains a constant reference voltage across the sensing cell. An electronic circuit within sensor controls the pump current through the pumping cell in order to maintain a constant voltage in the sensing cell. The amount of current required to maintain the reference voltage in the sensing cell is proportional to the concentration of NOx in the exhaust. The ECM varies the amount of diesel exhaust fluid (reductant) added by varying the reductant injector duty cycle in response to changes in engine exhaust NOx levels. The smart NOx sensors consist of two components, the NOx module and the NOx sensor element that are serviced as a unit. A circuit or performance condition with a NOx sensor is detected by the NOx sensor module. The smart NOx sensor module communicates the condition to the ECM over the serial data line. The ECM sets a DTC when a serial data message is received from the NOx sensor module.

Conditions for Running the DTC

P2297

- DTC P0087, P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0403, P0405, P0406, P042E, P042F, P0489, P0490, P049D, P062B, P062D, P111E, P113B, P113C, P113D, P113F, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192, P1193, P1194, P1196, P1198, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P1248, P1249, P124A-P124F, P126A, P1402, P1407, P140F, P1424, P2032, P2033, P2080, P2081, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P228A, P228B, P242B-P242E, P2452-P2456, P2481-P2484, P2627, or P2628 is not set.
- The ignition voltage is greater than 11 V.
- The NOx sensor supply voltage is greater than 10.8 V.
- The engine speed is between 800-2, 500 RPM.
- The engine is operating under deceleration fuel cut-off.
- The exhaust gas recirculation (EGR) valve position is less than 10%.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The exhaust brake is not active.

DTC P2297 runs continuously when the above conditions are met.

P2A00

- DTC P0087, P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276,

P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P0489, P049D, P062B, P062D, P111E, P113B, P113C, P113D, P113F, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192, P1193, P1194, P1196, P1198, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P1248, P1249, P124A-P124F, P126A, P2032, P2033, P2080, P2081, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P228A, P228B, P242B-P242E, P2452-P2456, P2481-P2484, P2627, or P2628 is not set.

- The ignition voltage is greater than 11 V.
- The NOx sensor supply voltage is greater than 10.8 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.
- The engine speed is between 600-3, 000 RPM.
- The engine is operating under deceleration fuel cut-off.

DTC P2A00 runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The NOx sensor module detects a fault in the NOx sensor circuitry or a performance fault in the NOx sensor.

Action Taken When the DTC Sets

DTCs P2297 and P2A00 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P2297 and P2A00 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 P0087, P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0403, P0405, P0406, P042E, P042F, P0489, P0490, P049D, P062B, P062D, P111E, P113B, P113C, P113D, P113F,

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P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192, P1193, P1194, P1196, P1198, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P1248, P1249, P124A-P124F, P126A, P1402, P1407, P140F, P1424, P2032, P2033, P2080, P2081, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2200, P2202, P2203, P2205, P2206, P2207, P2208, P2209, P220A, P2210, P2211, P2227, P2228, P2229, P2230, P228A, P228B, P242B-P242E, P2452-P2456, P2481-P2484, P2627, or P2628 is not set.

- **If any of the DTCs are set**

  Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **Go to next step: If none of the DTCs are set**

3. Verify that none of the conditions listed below exist:
   - Leaking or restricted intake system/charge air hoses. Refer to **Charge Air Cooler Diagnosis (Leak Test)Charge Air Cooler Diagnosis (Smoke Test)**
   - Leaking exhaust system/turbocharger. Refer to **Exhaust Leakage**
   - Contaminated fuel. Refer to **Contaminants-in-Fuel Diagnosis**
   - **If a condition is found**

     Repair as necessary.

   - **Go to next step: If no condition is found**
4. Clear all DTCs with a scan tool
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 that DTCs P2297 or P2A00 are not set
   - **If any of the DTCs are set**

     Replace the B195A Nitrogen Oxides Sensor 1

   - **Go to next step: If none of the DTCs are set**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Nitrogen Oxides Sensor Replacement - Position 1**

DTC P244A: DIESEL PARTICULATE FILTER (DPF) LOW DIFFERENTIAL PRESSURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P244A

Diesel Particulate Filter (DPF) Low Differential Pressure

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference	P0641	-	P0641	-
Signal	P2454	P2454	P2455	P2453
Low Reference	-	P2455	P2454	-

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Circuit/System Description

The exhaust differential pressure sensor measures the pressure difference across the inlet and outlet of the diesel particulate filter. The pressure difference across the diesel particulate filter increases as captured particulates in the diesel particulate filter increases. The engine control module supplies a 5 V reference circuit and a ground on the low reference circuit. The exhaust differential pressure sensor provides a signal voltage to the engine control module, relative to the back pressure as a function of exhaust flow, diesel particulate filter temperature, and diesel particulate filter soot loading. The engine control module converts the signal voltage input to a pressure value.

Conditions for Running the DTC

- DTC P00C7, P0101, P0102, P0103, P113E, P1197, P2227, P2228, P2229, P2230, P2453, P2470, P2471, or P2472 is not set.
- Engine speed is greater than 800 RPM
- Engine coolant temperature is warmer than 40Â°C (104Â°F)

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P244A

The ECM detects the diesel particulate filter exhaust differential pressure sensor is lower than the minimum threshold.

Action Taken When the DTC Sets

- DTC P244A is a Type A DTC.

Conditions for Clearing the DTC

- DTC P244A is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exhaust Aftertreatment 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

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EN 23738 - A Mityvac

Circuit/System Verification

1. Ignition ON.
2. Verify that DTCs P00C7, P0101, P0102, P0103, P0641, P113E, P113F, P2228, P2229, P2452, P2453, P2454, P2455, P2456, P2470, P2471, P2472, P2481, P2482, or P2484 are not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

   - **Go to next step: If none of the DTCs are set**
3. Ignition ON, verify that the diesel particulate filter (DPF) Differential Pressure parameter is between 0 to +1 kPa (0 to +0.14 PSI).
   - **If not within the specified range**

     Refer to Circuit/System Testing.

   - **Go to next step: If within the specified range**
4. Engine running, verify that the DPF Differential Pressure parameter is greater than 0 kPa (0 PSI).
   - **If not greater than 0 kPa (0 PSI)**

     Refer to Circuit/System Testing.

   - **Go to next step: If greater than 0 kPa (0 PSI)**
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 is not set.
   - **If the DTC is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If no DTC is set**
7. All OK.

Circuit/System Testing

1. Verify the integrity of the DPF system by visually and physically inspecting any of the following conditions:
   - Any damaged exhaust system components
   - Loose or improperly installed exhaust system components.
   - Restrictions in the exhaust differential pressure sensor ports.
   - Damaged, bent, restricted, or kinked exhaust differential pressure lines.
   - **If a condition is found**

     Repair as necessary.

   - **Go to next step: If no condition is found**
2. Remove and inspect the flexible part of the exhaust differential pressure lines for internal restrictions.
   - **If any restrictions are found**

     Repair as necessary.

   - **Go to next step: If no restrictions are found**
3. Connect the exhaust port of the EN 23738 - A vacuum gauge to port one (engine side) of the B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor.
4. Ignition ON, using the EN 23738 - A vacuum gauge, slowly apply pressure to the sensor while observing the DPF Differential Pressure parameter.

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5. Verify the parameter increases smoothly without spikes or dropouts.
    - **If the parameter does not increase smoothly**

      Replace the B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor.

    - **Go to next step: If the parameter increases smoothly**
6. Replace the Diesel Particulate Filter.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Exhaust Pressure Differential Sensor Replacement**

  Perform the scan tool DPF Pressure Sensor Reset after replacing the exhaust pressure differential sensor.

- Refer to **Oxidation Catalytic Converter Replacement (LH7)**

  Perform the scan tool DPF/Catalyst 2 Reset after replacing the exhaust particulate filter.

DTC P244C: CATALYST LOW TEMPERATURE DURING REGENERATION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P244C

Catalyst Low Temperature During Regeneration

Circuit/System Description

The diesel exhaust aftertreatment system consists of an under hood pre-catalytic converter and an underbody catalyst converter. The underbody catalyst converter also consists of the main Diesel Oxidation Catalyst and the coated Diesel Particulate Filter (DPF). One of the main purposes of the DPF is to collect particulates from the engine exhaust in order to minimize discharge of soot to the atmosphere. The soot particles accumulate in the channels of the DPF and are burned off at regular intervals through a process called regeneration. This prevents the DPF from clogging. The ECM commands the DPF regeneration after calculating various vehicle conditions such as DPF pressure difference, exhaust gas temperature, engine oil quality, engine speed, etc. Excessive accumulation of the soot in the DPF can cause a drop in the engine performance. During regeneration, additional fuel is injected via multiple post injections in order to increase the exhaust gas temperature. During this period, the DPF temperature is raised to approximately 600Â°C (1, 112Â°F) and the accumulated soot is oxidized or burned off into carbon dioxide (CO2).

Conditions for Running the DTC

The DTC runs during the DPF regeneration process.

Conditions for Setting the DTC

The exhaust gas temperature is too low during regeneration.

Action Taken When the DTC Sets

DTC P244C is a Type A DTC.

Conditions for Clearing the DTC

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DTC P244C is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition ON.
2. Verify that DTCs P113E, P2470, P2471, or P2472 are not set.
    - **If any of the DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

    - **Go to next step: If none of the DTCs are set**
3. Verify the integrity of the entire air induction system and exhaust system, including all turbocharger components by inspecting for the conditions listed below:
    - Leaks or restrictions in the hoses and pipes to the B136 Exhaust Differential Pressure Sensor
    - Damage to induction system components, including the turbocharger and charge air cooler
    - Loose or improperly installed components
    - Air flow restrictions
    - Exhaust leaks, including the mating surface between the turbocharger and exhaust manifold
    - **If a condition is found**

      Repair as necessary

    - **Go to next step: If no condition is found**
4. Perform the Diesel Particulate Filter Service Regeneration.
5. Verify the regeneration completed.
    - **If the regeneration did not complete**

      Replace the Diesel Particulate Filter

    - **Go to next step: If the regeneration completed**
6. All OK.

Repair Instructions

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Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Oxidation Catalytic Converter Replacement (LH7)**

Perform the scan tool DPF/Catalyst 2 Reset after replacing the exhaust particulate filter.

DTC P2452 OR P2454-P2456: DIESEL PARTICULATE FILTER (DPF) DIFFERENTIAL PRESSURE SENSOR CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2452

Diesel Particulate Filter (DPF) Differential Pressure Sensor Circuit

DTC P2454

Diesel Particulate Filter (DPF) Differential Pressure Sensor Circuit Low Voltage

DTC P2455

Diesel Particulate Filter (DPF) Differential Pressure Sensor Circuit High Voltage

DTC P2456

Diesel Particulate Filter (DPF) Differential Pressure Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5V Reference	P0097, P00F4, P018C, P0340, P0405, P0522, P0532, P0641, P2199, P227C, P2454	P2454	P018D, P0405, P0523, P0533, P0641, P227D, P2455	-
Signal	P2454	P2455	P2455	P2453
Low Reference	-	P2455	P2454	-

Circuit/System Description

The diesel exhaust aftertreatment system consists of an under hood catalyst and an underbody catalyst. The underbody catalyst also consists of the main Diesel Oxidation Catalyst and the coated Diesel Particulate Filter (DPF). One of the main purposes of the DPF is to collect particulates from the engine exhaust in order to minimize discharge of soot to the atmosphere. The soot particles accumulate in the channels of the DPF and are burned off at regular intervals through a process called regeneration. This prevents the DPF from clogging. The ECM commands the DPF regeneration after calculating various vehicle conditions such as DPF pressure difference, exhaust gas temperature, engine oil quality, engine speed, etc. Excessive accumulation of the soot in the DPF can cause a drop in the engine performance. During regeneration, additional fuel is injected via multiple post injections in order to increase the

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exhaust gas temperature. During this period, the DPF temperature is raised to approximately 600Â°C (1, 112Â°F) and the accumulated soot is oxidized or burned off into carbon dioxide (CO2).

Conditions for Running the DTC

P2452

- DTCs P2453, P2454, P2455, P2456, or P262B are not set.
- The ignition has been OFF for greater than 10 s.
- The engine is not running.
- The ignition is ON.

The DTC runs when the above conditions are met.

P2454, P2455

- The ignition is On or the engine is running.
- The ignition voltage is greater than 11 V.

The DTCs run when the above conditions are met.

P2456

- DTCs P2454 and P2455 are not set.
- The ignition is On or the engine is running.
- The ignition voltage is greater than 11 V.

The DTC runs when the above conditions are met.

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Conditions for Setting the DTC

P2452 and P2456

The ECM detects an implausible DPF differential pressure sensor signal.

P2454

The ECM detects a short to ground in the signal circuit.

P2455

The ECM detects an open circuit or a short to voltage in the signal circuit.

Action Taken When the DTC Sets

DTC P2452, P2454, P2455 and P2456 are Type B DTCs.

Conditions for Clearing the DTC

DTC P2452, P2454, P2455 and P2456 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**

- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the integrity of entire DPF system by inspecting for the following conditions:
    - Damaged components
    - Loose or improper installation
    - Leaks or restrictions in the B154 Exhaust Pressure Differential sensor lines or hoses. The pressure lines should be free from sharp bends, or kinks from the pressure sensor to the exhaust filter assembly.
    - **If a condition is found**

      Repair as necessary

    - **Go to next step: If no condition is found**
2. Ignition On.
3. Observe the scan tool DPF Differential Pressure parameter. The value should be between -1.0 kPa and +0.4 kPa (-0.15 psi and +0.058 psi).
    - **If not between the specified values**

      Refer to Circuit/System Testing

    - **Go to next step: If between the specified values**
4. Engine running at a warm stabilized idle, observe the scan tool DPF Differential Pressure parameter. The value should be between 0 - 3 kPa (-0.15 psi to +0.44 psi).
    - **If not between the specified values**

      Refer to Circuit/System Testing

    - **Go to next step: If between the specified values**
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 reset.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **Go to next step: If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Ignition Off and all vehicle systems Off, disconnect the harness connector at the B154 Exhaust Pressure Differential sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
    - **If 5 Ω or greater**
    1. Ignition Off, disconnect the X3 connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.

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- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the K20 Engine Control Module.

- **Go to next step: If less than 5 Ω**

3. Ignition On.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition Off, disconnect the X3 connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module, ignition On.
   2. Test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If between 4.8 - 5.2 V**
5. Connect the harness connector at the B154 Exhaust Pressure Differential sensor.
6. Verify the scan tool DPF Differential Pressure Sensor parameter is greater than 0.0 V or less than 4.8 V.
   - **If between 4.8 - 5.2 V**
   1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 3 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition Off, disconnect the harness connector at the B154 Exhaust Pressure Differential sensor and the X3 connector at the K20 Engine Control Module.
   2. Ignition On.
   3. Test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage in the circuit.
      - If less than 1 V
   4. Ignition Off.
   5. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If 0.0 V**
   1. Ignition Off, disconnect the X3 connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 3 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **Go to next step: If greater than 0.0 V and less than 4.8 V**
7. Test or replace the B154 Exhaust Pressure Differential sensor.

Repair Instructions

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Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Exhaust Pressure Differential Sensor Replacement**

  Perform the scan tool DPF Pressure Sensor Reset after replacing the exhaust pressure differential sensor.

- Refer to **Control Module References** for engine control module replacement, programming, and setup.

DTC P2453: DIESEL PARTICULATE FILTER (DPF) DIFFERENTIAL PRESSURE SENSOR PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2453

Diesel Particulate Filter (DPF) Differential Pressure Sensor Performance

Circuit/System Description

The exhaust differential pressure sensor measures the pressure of the diesel particulate filter. The engine control module supplies a 5 V reference circuit and a ground on the low reference circuit. The exhaust differential pressure sensor provides a signal voltage to the engine control module, relative to the back pressure as a function of exhaust flow, diesel particulate filter temperature, and diesel particulate filter soot loading. The engine control module converts the signal voltage input to a pressure value.

Conditions for Running the DTC

- DTCs P0101, P0102, P0103, P113E, P1197, P2452, P2454, P2455, P2456, P2470, P2471, or P2472 are not set.
- The ignition is On or the engine is running.
- The battery voltage is greater than 11 V.

The DTC runs continuously when the above conditions are met

Conditions for Setting the DTC

The ECM detects that the differential pressure is greater than or less than the calibrated threshold for greater than 1 s.

Action Taken When the DTC Sets

DTC P2453 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2453 is a Type B DTC.

Diagnostic Aids

- A skewed or stuck exhaust differential pressure sensor will cause this DTC to set.
- The flexible part of the exhaust differential pressure lines are made of a high temperature hose that is protected by a braided covering. If the hoses are twisted or bent, they will not return to their normal size and shape. If the hoses are restricted, it may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information 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 that no other DTCs are set.
   - **If any other DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If no other DTCs are set**
3. Ignition ON, verify that the DPF Differential Pressure parameter is between 0 and +3 kPa (0 and +0.14 PSI).
   - **If not within the specified range**

     Refer to Circuit/System Testing.

   - **Go to next step: If within the specified range**
4. Engine running at a warm stabilized idle, observe the scan tool DPF Differential Pressure parameter. The value should be between 0 - 3 kPa (-0.15 psi and +0.44 psi).
   - **If not within the specified range**

     Refer to Circuit/System Testing.

   - **Go to next step: 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 is not set.
   - **If the DTC is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If no DTC is set**
7. All OK.

Circuit/System Testing

1. Verify the following conditions do not exist with the air induction system:
   - A loose air inlet duct

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- A loose turbocharger air inlet clamp
- A damaged air cleaner housing
- A loose, leaking, or cracked intake manifold air resonator
- A cracked or damaged MAF sensor housing
- A skewed, stuck in range, or slow responding MAF sensor - Inspect the MAF sensor for contamination.
- **If a condition is found**

  Repair as necessary

- **Go to next step: If no condition is found**

2. Verify the following conditions do not exist with the DPF, exhaust, and fuel system:
   - Any damaged exhaust system components
   - Loose or improperly installed exhaust system components.
   - Restrictions in the B154 Exhaust Pressure Differential sensor ports
   - Incorrect differential pressure line routing
   - Damaged, bent, completely restricted, exhaust differential pressure lines
   - Inspect for fuel contaminates. Refer to **Contaminants-in-Fuel Diagnosis**.
   - **If a condition is found**

     Repair as necessary

   - **Go to next step: If no condition is found**
3. Ignition Off and all vehicle systems Off, disconnect the harness connector at the B154 Exhaust Pressure Differential sensor. It may take up to 2 minutes for all vehicle systems to power down.
4. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
   - **If 5 Ω or greater**
   1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If less than 5 Ω**
5. Ignition On.
6. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module, ignition On.
   2. Test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If between 4.8 - 5.2 V**
7. Connect the harness connector at the B154 Exhaust Pressure Differential sensor.
8. Verify the scan tool DPF Differential Pressure Sensor parameter is greater than 0.0 V and less than 4.8 V.

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- **If between 4.8 - 5.2 V**

1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal 3 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition Off, disconnect the harness connector at the B154 Exhaust Pressure Differential sensor and K20 Engine Control Module.
2. Ignition On.
3. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage in the circuit.
    - If less than 1 V
4. Ignition Off.
5. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If 0.0 V**

1. Ignition Off, disconnect the X2 connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal 3 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K20 Engine Control Module.

- **Go to next step: If greater than 0.0 V and less than 4.8 V**

9. Test or replace the B154 Exhaust Pressure Differential sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Exhaust Pressure Differential Sensor Replacement**

  Perform the scan tool DPF Pressure Sensor Reset after replacing the exhaust pressure differential sensor.

- Refer to **Control Module References** for engine control module replacement, programming, and setup.

DTC P2457: EXHAUST GAS RECIRCULATION (EGR) COOLER LOW EFFICIENCY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC 2457

Exhaust Gas Recirculation (EGR) Cooler Low Efficiency

Circuit/System Description

The exhaust gas recirculation (EGR) cooler has internal coolant passages and metal fins between the passages to help carry away excessive exhaust gas heat. Engine coolant flowing through the EGR cooler

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helps cool the exhaust gases flowing to the EGR valve. The EGR cooler must remain within a specific temperature range to efficiently reduce emissions. The engine control module (ECM) determines the efficiency of the EGR cooler by monitoring both EGR temperature sensors while the EGR valve is active.

Conditions for Running the DTC

- DTC P0071, P0072, P0073, P0074, P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0335, P0336, P0405, P0406, P040B, P040C, P040D, P040E, P041B, P041C, P041D, P041E, P049D, P0722, P0723, P111E, P1428, P142A, P2227, P2228, P2229, P2230, P245C, or P262B is not set.
- The ignition is ON and the engine is running.
- The ignition voltage is greater than 11 V.
- The EGR temperature sensor 1 is between 95-850Â°C (203-1, 562Â°F).
- The barometric pressure is greater than 70 kPa (10.2 psi).
- The outside air temperature is warmer than -7Â°C (19.4Â°F).
- The engine coolant temperature is between 70-130Â°C (158 - 266Â°F).
- The engine speed is between 560-3, 100 RPM.

The DTC runs once per ignition cycle.

Conditions for Setting the DTC

The ECM detects that the EGR cooler efficiency is lower than a calibrated value for greater than 100 s.

Action Taken When the DTC Sets

DTC P2457 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2457 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

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2. Verify DTC P0071, P0072, P0073, P0074, P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0335, P0336, P0405, P0406, P040B, P040C, P040D, P040E, P041B, P041C, P041D, P041E, P049D, P0722, P0723, P111E, P1428, P142A, P2227, P2228, P2229, P2230, P245C, or P262B is not set.
    - **If any of the DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **Go to next step: If none of the DTCs are set**
3. Verify that none of the conditions listed below exist:
    - Low engine coolant level
    - Contaminated engine coolant
    - Damaged, leaking, or restricted engine cooling system
    - Damaged, leaking, or restricted EGR cooler and cooler pipes/hoses
    - Disconnected, damaged, or missing EGR cooler bypass valve linkage
    - EGR cooler bypass valve binding or stuck
    - **If a condition is found**

      Repair as necessary.

    - **Go to next step: If no condition is found**
4. Verify that DTC P2457 is not set.
    - **If the DTC is set**
    1. Clear all DTCs with a scan tool
    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 that DTC P2457 is not set.
        - If a DTC is set, clean or replace the EGR cooler
        - If no DTC is set.
    4. All OK.
    - **Go to next step: If no DTC is set**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Exhaust Gas Recirculation Cooler Housing Replacement**

DTC P2459: DIESEL PARTICULATE FILTER (DPF) REGENERATION FREQUENCY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2459

Diesel Particulate Filter (DPF) Regeneration Frequency

Circuit/System Description

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The soot particles accumulate in the channels of the DPF and are burned off at regular intervals, through a process called regeneration or cleaning. The diesel particulate filter (DPF) cleaning process prevents the DPF from clogging. Excess soot in filter can cause a drop in engine performance and crack the filter during regeneration.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is greater than 11 V.

The DTC runs when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the actual soot level is greater than an expected soot level when regeneration is triggered.

Action Taken When the DTC Sets

DTC P2459 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2459 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no other DTCs are set.
   - **If any other DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If no other DTCs are set**
3. Verify the conditions listed below do not exist:
   - Any damaged exhaust system components
   - Loose or improperly installed exhaust system components.

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- Restrictions in the exhaust differential pressure sensor ports.
- Damaged, bent, restricted, or kinked exhaust differential pressure lines.
- Induction system leaks.
- Loose or disconnected charge air cooler system components.
- **If a condition is found**

  Repair as necessary

- **Go to next step: If no condition is found**

4. Ignition ON.
5. Verify DTC P2459 is not set.
   - **If the DTC is set**
   1. Perform the Diesel Particulate Filter Service Regeneration.
   2. Verify the regeneration completed.
      - If the regeneration did not complete, replace the Diesel Particulate Filter.
      - If the regeneration completed

        All OK.

   - **Go to next step: If no DTC is set**
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Oxidation Catalytic Converter Replacement (LH7)**

Perform the scan tool DPF/Catalyst 2 Reset after replacing the exhaust particulate filter.

DTC P245A-P245D: EXHAUST GAS RECIRCULATION (EGR) COOLER BYPASS SOLENOID VALVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P245A

Exhaust Gas Recirculation (EGR) Cooler Bypass Solenoid Valve Control Circuit

DTC P245B

Exhaust Gas Recirculation (EGR) Cooler Bypass Solenoid Valve Performance

DTC P245C

Exhaust Gas Recirculation (EGR) Cooler Bypass Solenoid Valve Control Circuit Low Voltage

DTC P245D

Exhaust Gas Recirculation (EGR) Cooler Bypass Solenoid Valve Control Circuit High Voltage

Circuit/System Description

The exhaust gas recirculation (EGR) cooler bypass solenoid valve is controlled by the Engine Control Module (ECM). At engine cold start, the EGR cooler bypass allows hot exhaust gas to heat the intake air

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in the manifold. Once the engine operating temperature is reached, the ECM will close the EGR cooler bypass.

Conditions for Running the DTC

- The engine is running
- The ignition voltage is greater than 11 V.
- These DTCs run when the above conditions are met.

Conditions for Setting the DTC

P245A

The ECM detects an open circuit in the signal circuit.

P245B

The ECM detects that the intake air temperature is higher than maximum allowed value.

P245C

The ECM detects a short to ground in the control circuit.

P245D

The ECM detects a short to voltage in the control circuit.

Action Taken When the DTC Sets

DTCs P245A, P245B, P245C and P245D are Type B DTCs.

Conditions for Clearing the DTC

DTCs P245A, P245B, P245C and P245D are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Electrical Information Reference

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- **Connector Repairs**
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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-23738-A Vacuum Pump

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For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)** .

Circuit/System Verification

1. Disconnect the vacuum source from the EGR Cooler Bypass valve.
2. Connect the **EN-23738-A** Mityvac to the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve vacuum supply hose.
3. Engine running, verify the vacuum is greater than -50 kPa (-7.25 PSI).
    - **If less than -50 kPa (-7.25 PSI)**
    1. Ignition OFF.
    2. Inspect the vacuum supply hose and filter for a leak or restriction
        - If the vacuum supply hose and filter are damaged, repair as necessary.
        - If the vacuum supply hose and filter are not damaged, replace the vacuum pump.
    - **Go to next step: If greater than -50 kPa (-7.25 PSI)**
4. Connect the vacuum source to the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve. Engine running, command the EGR Cooler Bypass valve OFF with a scan tool.
5. Connect the **EN-23738-A** Mityvac to the EGR Cooler Bypass valve vacuum port on the EGR Cooler Bypass valve.
6. Verify the vacuum is at 0 kPa (0 PSI).
    - **If greater than 0 kPa (0 PSI)**

      Replace the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.

    - **Go to next step: If 0 kPa (0 PSI)**
7. Command the EGR Cooler Bypass valve ON with a scan tool.
8. Verify the vacuum is greater than -50 kPa (-7.25 PSI).
    - **If less than -50 kPa (-7.25 PSI)**

      Refer to Circuit/System Testing.

    - **Go to next step: If greater than -50 kPa (-7.25 PSI)**
9. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve. Ignition ON.
2. Connect a test lamp between the control circuit terminal 2 and B+.
3. Verify the test lamp turns ON and OFF while commanding the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve ON and OFF with a scan tool.
    - **If the test lamp is always ON**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If the test lamp is always OFF**
    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. Test for less than 2 Ω in the circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

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- **Go to next step: If the test lamp turns ON and OFF**

4. Ignition ON, verify a test lamp illuminates between the voltage circuit terminal 1 and ground
    - **If the test lamp does not illuminate**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the ignition 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 ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp illuminates**
5. Test or replace the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.
2. Test for 25 - 35 Ω between the control terminal 1 and the voltage terminal 2 of the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.
    - **If not within 20 - 35 Ω**

      Replace the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.

    - **Go to next step: If within 20 - 35 Ω**
3. Test for infinite resistance between each terminal and the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve housing.
    - **If less than infinite resistance**

      Replace the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.

    - **Go to next step: If infinite resistance**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Control Module References** for Engine Control Module replacement, programming and setup.

Refer to **Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve Replacement**

DTC P2463: DIESEL PARTICULATE FILTER (DPF) SOOT ACCUMULATION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2463

Diesel Particulate Filter (DPF) Soot Accumulation

Circuit/System Description

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The soot particles accumulate in the channels of the diesel particulate filter (DPF) and are burned off at regular intervals, through a process called regeneration or cleaning. The DPF cleaning process prevents the DPF from clogging. Excess soot in filter can cause a drop in engine performance and crack the filter during regeneration.

Conditions for Running the DTC

- DTC P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0722, P0723, P111E, P113E, P1197, P1248, P1249, P124A-P124F, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157 is not set.
- Engine speed is greater than 800 RPM
- Ambient temperature is warmer than -40Â°C (-40Â°F)
- Engine coolant temperature is warmer than -40Â°C (-40Â°F)

The DTC runs continuously when the above conditions are met

Conditions for Setting the DTC

The ECM detects that the diesel particulate filter is clogged and needs service regeneration.

Action Taken When the DTC Sets

DTC P2463 is a Type A DTC.

Conditions for Clearing the DTC

DTC P2463 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Electrical Information Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

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 P0422, P244C, or P24A0 is not set.
   - **If any of the DTCs are set**
3. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

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- **Go to next step: If none of the DTCs are set**

4. Verify no other DTCs are set.
   - **If any other DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If no other DTC is set**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Verify the following conditions do not exist with the exhaust pressure differential system:
   - Modifications.
   - Externally damaged or worn components.
   - Loose or improperly installed components.
   - Improperly routed differential pressure lines - The exhaust differential pressure line should have a continuous downward gradient without any sharp bends or kinks from the sensor to the DPF.
   - Leaks or internal restrictions from the B154 Exhaust Pressure Differential sensor lines.
   - **If a condition is found**

     Repair as necessary

   - **Go to next step: If no condition is found**

   NOTE: **Pinhole size leaks in the induction system or exhaust system may cause this DTC to set. Verifying the integrity of these systems is critical to a proper diagnosis. The Full System Air Leak Test must be performed first, then the Induction System Smoke Test must be performed in order to identify any leaks that may exist.**

2. Verify the following conditions do not exist:
   - Charge air cooler (CAC) and Air induction system leaks. Perform the Full System Air Leak Test and then the Induction System Smoke Test. Refer to **Charge Air Cooler Diagnosis (Leak Test)Charge Air Cooler Diagnosis (Smoke Test)**
   - Exhaust system leaks. An exhaust system leak may cause inaccurate B131 Exhaust Gas Temperature sensor or B154 Exhaust Pressure Differential sensor values causing this DTC to set - Refer to **Exhaust Leakage** .
   - Water in fuel contamination - Refer to **Contaminants-in-Fuel Diagnosis**.
   - A cracked or damaged MAF sensor housing.
   - A skewed, stuck in range, or slow responding MAF sensor. Inspect the MAF sensor for contamination. Refer to **DTC P0101** .
   - A skewed or shifted B154 Exhaust Pressure Differential sensor. A sensor that is skewed will cause inaccuracies in the soot model and may cause this DTC to set.
   - Failed, intermittent, improperly installed or loose B131 Exhaust Gas Temperature sensors will cause inaccuracies in the soot model and cause this DTC to set.
   - Engine mechanical condition, for example low compression. Refer to **Symptoms - Engine Mechanical** .
   - **If a condition is found**

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Repair as necessary

- **Go to next step: If no condition is found**

3. Perform **Diesel Particulate Filter (DPF) Service Regeneration** .
   - **If the DPF service regeneration does not complete**

     Replace the diesel particulate filter.

   - **Go to next step: If the DPF service regeneration completes**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Oxidation Catalytic Converter Replacement (LH7)**

Perform the scan tool DPF/Catalyst 2 Reset after replacing the exhaust particulate filter.

DTC P248A-P248D: REDUCTANT HEATER 1-2 FEEDBACK CIRCUIT LOW/HIGH VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P248A

Reductant Heater 1 Feedback Circuit Low Voltage

DTC P248B

Reductant Heater 1 Feedback Circuit High Voltage

DTC P248C

Reductant Heater 2 Feedback Circuit Low Voltage

DTC P248D

Reductant Heater 2 Feedback Circuit High Voltage

Circuit/System Description

As reductant will freeze at temperatures below -11Â°C (12Â°F), there are 2 reductant heaters located in the reductant tank. One heats the reductant in the tank and one heats the reductant supplied to the reductant injector supply pipe. The ECM monitors the reductant temperature in the tank in order to determine if reductant temperature is below its freeze point. If the ECM determines that the reductant may be frozen, it activates a "defrost strategy" energizing the reductant heater. This energizing action terminates when the temperature sensor measures a threshold value over which the heater must be deactivated.

Conditions for Running the DTCs

- DTC U010E is not set.
- The ignition voltage is greater than 11 V.
- The ignition is on or the engine is running.
- The reductant heaters are on.

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The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P248A

There is greater than 3 V difference between battery voltage and reductant tank heater voltage.

P248C

There is greater than 3 V difference between battery voltage and reductant line heater voltage.

Action Taken When the DTC Sets

DTCs P248A, P248B, P248C and P248D are Type A DTCs.

- The reductant injector is disabled.
- The reductant heaters are disabled.
- The selective catalyst reduction system is put in standby mode.
- The Diesel Exhaust Fluid (DEF) Warning Strategy (Anti-Tampering) is activated.

Conditions for Clearing the DTC

DTCs P248A, P248B, P248C and P248D are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 that DTC U010E is not set.
   - **If the DTC is set**
   - Refer to **DTC U0100-U02FF** for further diagnosis.
   - **Go to next step: If the DTC is not set**
3. Command the Reductant heater 1 and 2 ON and OFF with a scan tool and verify that Reductant Heater 1 and 2 Current parameters are between 0 - 25.5 A.
   - **If not between 0 - 25.5 A.**

     Refer to Circuit/System Testing.

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- **Go to next step: If between 0 - 25.5 A**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If no DTC sets**
6. All OK.

Circuit/System Testing

DTC P248A

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 connector at the A38 Reductant Pump and Sensor Assembly.
2. Test for less than 10 Ω between the low reference circuit terminal 11 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K115 Reductant 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 K115 Reductant Control Module.
   - **Go to next step: If less than 10 Ω**
3. Connect a test lamp between heater control circuit terminal 9 and ground.
4. Ignition ON, verify the test lamp turns ON and OFF while commanding Reductant Heater 1 ON and OFF with a scan tool.
   - **If the test lamp is always OFF**
   1. Ignition OFF, disconnect the harness connector at the K115 Reductant 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 K115 Reductant Control Module.
   - **If the Test lamp is always ON**
   1. Ignition OFF, disconnect the harness connector at the K115 Reductant Control Module, ignition ON
   2. Test for less than 1.0 V between the control circuit and ground
      - If 1.0 V or greater, repair the short to voltage in the circuit.
      - If less than 1.0 V, replace the K115 Reductant Control Module.
   - **Go to next step: If the Test lamp responds appropriately to the commanded states**
5. Test or replace the A38 Reductant Pump and Sensor Assembly.

DTC P248C

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 connector at the E52 Reductant Line Heater.
2. Test for less than 10 Ω between the low reference circuit terminal 1 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K115 Reductant Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.

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- If less than 2 Ω, replace the K115 Reductant Control Module.
- **Go to next step: If less than 10 Ω**

3. Connect a test lamp between heater control circuit terminal 2 and ground.
4. Ignition ON, Verify the test lamp turns ON and OFF while commanding Reductant Heater 2 ON and OFF with a scan tool.
   - **If the test lamp is always OFF**
   1. Ignition OFF, disconnect the harness connector at the K115 Reductant 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 K115 Reductant Control Module.
   - **If the Test lamp is always ON**
   1. Ignition OFF, disconnect the harness connector at the K115 Reductant Control Module, ignition ON
   2. Test for less than 1.0 V between the control circuit and ground
      - If 1.0 V or greater, repair the short to voltage in the circuit.
      - If less than 1.0 V, replace the K115 Reductant Control Module.
   - **Go to next step: If the Test lamp responds appropriately to the commanded states**
5. Test or replace the E52 Reductant Line Heater.

Component Testing

Reductant Tank Heater

1. Ignition OFF, disconnect the harness connector at the A38 Reductant Pump and Sensor Assembly.
2. Test for 1 - 2 Ω between terminals 9 and 11 of the A38 Reductant Pump and Sensor Assembly.
   - **If not within 1 - 2 Ω**

     Replace the A38 Reductant Pump and Sensor Assembly.

   - **Go to next step: If within 1 - 2 Ω**
3. Test for infinite resistance between each terminal and the A38 Reductant Pump and Sensor Assembly housing/case.
   - terminal 9
   - terminal 11
   - **If less than infinite resistance**

     Replace the A38 Reductant Pump and Sensor Assembly.

   - **Go to next step: If infinite resistance**
4. All OK.

Reductant Line Heater

1. Ignition OFF, disconnect the harness connector at the E52 Reductant Line Heater.
2. Test for 1 - 2 Ω between terminals 1 and 2 of the Reductant Line Heater.
   - **If not within 1 - 2 Ω**

     Replace the E52 Reductant Line Heater.

   - **Go to next step: If within 1 - 2 Ω**
3. Test for infinite resistance between each terminal and the E52 Reductant Line Heater housing/case.

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- terminal 1
- terminal 2
- **If less than infinite resistance**

  Replace the E52 Reductant Line Heater.

- **Go to next step: If infinite resistance**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Perform the **Reductant System Tamper Service Bay Test** after completing the repair to clear the Service Emission System or Service Exhaust Fluid System warning message, if displayed.

- Refer to **Emission Reduction Fluid Tank Replacement** for reductant pump and sensor assembly replacement.
- Refer to **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (FWD)** **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Front AWD)** **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Rear AWD)** for reductant line heater replacement.
- Refer to **Emission Reduction Fluid Controller Replacement**

DTC P24A5: EXHAUST GAS RECIRCULATION (EGR) COOLER BYPASS VALVE STUCK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P24A5

Exhaust Gas Recirculation (EGR) Cooler Bypass Valve Stuck

Circuit/System Description

The exhaust gas recirculation (EGR) cooler bypass solenoid valve is controlled by the engine control module (ECM). At engine cold start, the EGR cooler bypass allows hot exhaust gas to heat the intake air in the manifold. Once the engine operating temperature is reached, the ECM will close the EGR cooler bypass.

The EGR cooler bypass valve is intrusively opened under stationary idle engine conditions. The ECM detects the change in temperature downstream of the EGR cooler while the bypass valve is closed and open.

Conditions for Running the DTC

- Engine speed is between 680 - 950 RPM.
- Vehicle speed is less than 2 km/h (1.2 MPH)
- Engine coolant temperature is between 70 - 117Â°C (158 - 243Â°F).
- Ignition voltage is greater than 11 V.
- DTC P24A5 runs when the above conditions are met.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

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The ECM detects that the absolute difference between temperature change after a change in the valve position and temperature change before change in the valve position is less than a calibrated threshold.

Action Taken When the DTC Sets

DTC P24A5 is a Type B DTC.

Conditions for Clearing the DTC

DTC P24A5 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 P0116, P0117, P0118, P0119, P011E, P0128, P040B, P040C, P040D, P040E, P041B, P041C, P041D, P041E, P042E, P042F, P0502, P0503, P0722, P0723, P1427, P1428, P1429, P142A, P245A, P245C, or P245D is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **Go to next step: If none of the DTCs are set**
3. Ignition OFF, verify the conditions listed below do not exist:

   NOTE: **All vacuum lines, including those routed to the EGR cooler bypass valve and brake booster must be carefully inspected.**

   - Leaking, damaged, kinked, restricted or incorrectly routed vacuum lines.
   - Damaged Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.
   - Damaged EGR cooler bypass actuator.
   - Damaged or incorrect installation of power brake booster.
   - **If a condition exists**

     Repair or replace as necessary.

   - **Go to next step: If none of the conditions exist**

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4. Disconnect the vacuum supply hose at the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve and connect the **GE 23738-A** , or a suitable vacuum gauge, to the hose.
5. Engine idling, verify the vacuum is 50 kPa (14.8 in. Hg.) or greater.
    - **If less than 50 kPa (14.8 in. Hg.)**

      Check the vacuum pump for proper operation and the vacuum reservoir for leaks.

    - **Go to next step: If 50 kPa (14.8 in. Hg.) or greater**
6. Ignition Off, reconnect the vacuum supply hose to the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.
7. Disconnect the vacuum outlet hose from the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve and connect the **GE 23738-A** to the outlet port on the valve.
8. Engine idling, verify the vacuum changes from 0 kPa (0 in. Hg.) to 40 kPa (11.8 in. Hg.) or greater while commanding the EGR Cooler Bypass Solenoid Valve On and Off with a scan tool.
    - If less than 40 kPa (11.8 in. Hg.)

      Replace the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve

    - If 40 kPa (11.8 in. Hg.) or greater
9. Reconnect the vacuum hose at the Q47 Exhaust Gas Recirculation Cooler Bypass Solenoid Valve.
10. Verify the EGR cooler bypass actuator linkage extends and retracts while commanding the EGR Cooler Bypass Solenoid Valve On and Off with a scan tool.
    - **If the linkage does not extend or retract**
    1. Disconnect the EGR cooler bypass valve actuator linkage from the EGR manifold.
    2. Verify the linkage extends and retracts while commanding the EGR Cooler Bypass Solenoid Valve On and Off with a scan tool.
        - If the linkage does not extend or retract, replace the EGR cooler bypass valve actuator.
        - If the linkage extends and retracts, repair or replace the EGR manifold as necessary.
    - **Go to next step: If the linkage extends and retracts**
11. Clean or replace the EGR cooler.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Exhaust Gas Recirculation Valve Replacement**
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P24B0-P24B6, P24C7, P24D0, OR P24D1: PARTICULATE MATTER SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P24B0

Particulate Matter Sensor Circuit Low Voltage

DTC P24B1

Particulate Matter Sensor Circuit High Voltage

DTC P24B3

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Particulate Matter Sensor Heater Control Circuit

DTC P24B4

Particulate Matter Sensor Heater Control Circuit Performance

DTC P24B5

Particulate Matter Sensor Heater Control Circuit Low Voltage

DTC P24B6

Particulate Matter Sensor Heater Control Circuit High Voltage

DTC P24C7

Particulate Matter Sensor Temperature Circuit Performance

DTC P24D0

Particulate Matter Sensor Supply Voltage Circuit Low Voltage

DTC P24D1

Particulate Matter Sensor Regeneration Incomplete

Circuit/System Description

The particulate matter (PM) sensor monitors the amount of the particulates (soot) in the diesel exhaust gas exiting the tailpipe. The PM sensor is similar to the heated oxygen sensor with a ceramic element, but also includes an individually calibrated sensor control unit (SCU). The sensing element includes comb-shaped interdigital electrodes (IDE), a heater and a positive temperature coefficient resistor for temperature measurement.

The operation of the PM Sensor is based on the electrical conductivity characteristic of the diesel particulate. As the exhaust gas flows over the sensing element, soot is absorbed in the combs between the electrodes, eventually creating a conductive path. When the path is formed, it generates a current based on the voltage being applied to the element. The measurement process continues until a preset current value is reached. To avoid misleading readings, the sensor performs a regeneration where the soot is cleaned off by heating up the element, before the measurement phase begins. The amount of regenerations is based on vehicle strategy; when the calibrated number of regenerations is reached, the cumulative current readings are used to determine the amount of soot concentration in the exhaust gas which in turn determines the collection efficiency of the diesel particulate filter (DPF).

Conditions for Running the DTCs

P24B0

- DTC P142C, P142D, P142E, P142F, P1474, P1474, P1476, P1477, P1478, P16D7, P16D8, P16D9, P24B1, P24B3, P24B5, P24B6, P24D0, or U02A3 is not set.
- The ignition is ON.
- The ignition voltage is greater than 11 V.
- The particulate matter sensor temperature is between 580 - 800Â°C (1, 076 - 1, 472Â°F).
- The reductant control module relay 2 is commanded ON.

The DTC runs continuously when the above conditions are met.

P24B1, P24B3, P24B5, P24B6, P24D0

- DTC P16D7, P16D8, or P16D9, P24D0, or U02A3 is not set.
- The ignition is ON and the engine is not cranking.
- The ignition voltage is greater than 11 V.

- The reductant control module relay 2 is commanded ON.

The DTCs run continuously when the above conditions are met.

P24C7

- DTC P0071, P0072, P0073, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0772, P0773, P111E, P113F, P1198, P1248, P1249, P124A-P124F, P126A, P142D, P142C, P142F, P142E, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P2032, P2033, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2481, P2482, P2483, P2484, P24B0, P24B1, P24B3, P24B5, P24B6, P24D0, P262B, or U02A3 is not set.
- The ignition is ON and the engine is not cranking.
- The ignition voltage is greater than 11 V.
- The ambient temperature is warmer than -12Â°C (10Â°F).
- The barometric pressure is greater than 75 kPa (10.9 psi).
- The reductant control module relay 2 is commanded ON.
- The Particulate Matter Sensor Operation parameter displays Allowed.
- The time since particulate matter sensor regeneration is greater than 225 s.

The DTC runs continuously when the above conditions are met.

P24B4

- DTC P0071, P0072, P0073, P142C, P142D, P142E, P142F, P1474, P1474, P1476, P1477, P1478, P16D7, P16D8, or P16D9, P24B1, P24B3, P24B5, P24B6, P24D0, or U02A3 is not set.
- The ignition is ON and the engine is not cranking.
- The ignition voltage is greater than 11 V.
- The ambient temperature is warmer than -40Â°C (-40Â°F).
- The reductant control module relay 2 is commanded ON.

The DTC runs continuously when the above conditions are met.

P24D1

- DTC P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0772, P0773, P111E, P113F, P1198, P1248, P1249, P124A-P124F, P126A, P16D7, P16D8, P16D9, P2032, P2033, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2481, P2482, P2483, P2484, P262B, or U02A3 is not set.
- The ignition is ON.
- The ignition voltage is greater than 11 V.
- The reductant control module relay 2 is commanded ON.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The particular matter sensor control unit detects an internal fault of the sensor, fault of the sensor circuitry, or low voltage on the sensor supply circuit.

Action Taken When the DTC Sets

DTCs P24B0, P24B1, P24B3, P24B5, P24B6, P24C7, P24D0, and P24D1 are Type B DTCs.

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DTC P24B4 is a Type C DTC.

Conditions for Clearing the DTC

DTCs P24B0, P24B1, P24B3, P24B5, P24B6, P24C7, P24D0, and P24D1 are Type B DTCs.

DTC P24B4 is a Type C DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Exhaust Aftertreatment 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.

   Verify that DTC P0071, P0072, P0073, P00C7, P00E9, P00EA-P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P062B, P062D, P0772, P0773, P111E, P113F, P1198, P1248, P1249, P124A-P124F, P126A, P142D, P142C, P142F, P142E, P1474, P1475, P1476, P1477, P1478, P16D7, P16D8, P16D9, P2032, P2033, P2084, P2085, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2481, P2482, P2483, P2484, P262B, or U02A3 is not set.

   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If none of the DTCs are set**
2. Verify DTC P24D0 is not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing

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- **Go to next step: If the DTC does not set**

3. Verify DTC P24B0, P24B1, P24B3, P24B4, P24B5, P24B6, P24C7, or P24D1 is not set.
   - **If the DTC sets**

     Replace the B136 Exhaust Particulate Matter Sensor.

   - **Go to next step: If the DTC does not set**
4. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the B136 Exhaust Particulate Matter Sensor, ignition On.
2. Verify that a test lamp illuminates between the sensor ignition voltage circuit terminal 6 and ground.
   - **If the test lamp does not illuminate**
   1. Ignition Off, remove the test lamp and remove fuse F19 from the X50A Underhood Fuse Block.
   2. Test for less than 2Ω in the sensor 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 sensor ignition voltage circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   - **Go to next step: If the test lamp illuminates**
3. Replace the B136 Exhaust Particulate Matter Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Exhaust Particulate Sensor Replacement**

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DTC P2544: TRANSMISSION TORQUE REQUEST CIRCUIT MESSAGE COUNTER INCORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for a overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2544

Transmission Torque Request Circuit Message Counter Incorrect

Circuit/System Description

To improve shift feel, the transmission control module (TCM) is constantly sending the engine control module (ECM) serial data messages with requests to modify engine speed or torque. These serial data messages are sent through two circuits which are part of a communication network called the controller area network (CAN). The ECM sets DTC P2544 when it detects a discrepancy in the structure of the message causing the integrity of the message to be questioned.

Conditions for Running the DTC

- The engine run time is greater than 0.5 s.
- No other CAN errors are present.

Conditions for Setting the DTC

The ECM detects that the engine speed and torque modification messages from the TCM are either corrupted or intermittently missing for greater than 4 s.

Action Taken When the DTC Sets

- DTC P2544 is a Type B DTC.
- The TCM commands maximum line pressure during shifts, which results in harsh shifts.
- The TCM freezes adaptive functions.

Conditions for Clearing the DTC

DTC P2544 is a Type B DTC.

Diagnostic Aids

An intermittent fault in the CAN circuits will cause the ECM to set DTC P2544.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

NOTE:

- **DTC P2544 is an informational DTC.**
- **Diagnose all other engine control module DTCs prior to DTC P2544.**

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1. Verify that no other DTCs are set except for DTC P2544.
   - **If any other DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **Go to next step: If only DTC P2544 is set**
2. Replace the K71 Transmission Control Module.
3. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
4. Verify the DTC does not set.
   - **If DTC sets**

     Replace the K20 Engine Control Module.

   - **Go to next step: If DTC does not set**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Control Module References** for ECM or TCM replacement, programming, and setup

DTC P2564 OR P2565: TURBOCHARGER VANE POSITION SENSOR CIRCUIT LOW/HIGH VOLTAGE

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

DTC Descriptor

DTC P2564

Turbocharger Vane Position Sensor Circuit Low Voltage

DTC P2565

Turbocharger Vane Position Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0107, P0335, P0557, P057C, P0651, P0700, P16A0, P2564, P2803	P2564	P0651*	-
Signal	P2564	P2565	P2565	P0046, P2598, P2599
Low Reference	-	P2565	P2565	P0046, P2599
* Additional DTCs may set.				

Typical Scan Tool Data

Turbocharger Vane Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine - Idling - At normal operating temperature **Parameter Normal Range:** 85 to 95% 3 to 4 V			
5 V Reference	0% 0.0 V	0% 0.1 V	100% 5.0 V
Signal	0% 0.0 V	100% 5.0 V	100% 5.0 V
Low Reference	-	100% 5.0 V	-

Circuit/System Description

For an overview of the component/system, refer to: **Turbocharger System Description**

Circuit	Description
5 V Reference	Regulated voltage supplied by the control module.
Signal	The control module input circuit has an internal resistance connected to 5 V.
Low Reference	Grounded through the control module.

Component	Description
K20 Engine Control Module	The control module contains a microprocessor used to process input data to control outputs. The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

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Component	Description
B112 Turbocharger Vane Position Sensor	The sensor is an analog potentiometer that varies its resistance proportionally with the position of the control rod. The variable geometry turbocharger includes a ring of aerodynamically shaped vanes in the turbine housing at the exhaust inlet. With changing the angle of the vanes it is possible to regulate the boost pressure. The vanes are rotated by a vacuum actuator which is controlled by a solenoid valve.

Conditions for Running the DTC

- Ignition = On or Engine = Running
- Ignition Voltage = Greater than 11 V
- Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Turbocharger Vane Position Sensor = No Signal - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type A DTC

Warning Message = Reduced Engine Power

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type A DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Engine = Running

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2. Verify the scan tool parameter: Turbocharger Vane Position Sensor = 0.5 to 4.5 V
    - **If not between 0.5 and 4.5 V**

      Refer to: Circuit/System Testing

    - **Go to next step: If between 0.5 and 4.5 V**
3. Verify the scan tool parameter: Turbocharger Vane Position Sensor = The value should change with accelerator pedal input.
    - **If the value does not change**

      Refer to: Circuit/System Testing

    - **Go to next step: If the value changes**
4. Perform the scan tool control function: Turbocharger Vane Position - Increase

   Verify the scan tool parameter: Turbocharger Vane Position = The value should not spike or drop out while moving the sensor through the entire range.

    - Perform the action while monitoring the parameter:
        - Wiggle the harness and connector: K20 Engine Control Module

          WARNING: **While engine is operating, the exhaust system will become extremely hot. To prevent burns avoid contacting a hot exhaust system.**

        - Wiggle the harness and connector: B112 Turbocharger Vane Position Sensor
    - **If the value spikes or drops out**

      Repair as necessary - Wiring/Terminal (s)/Electrical Connector (s)

    - **Go to next step: If the value does not spike or drop out**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

    - **If the DTC sets**

      Refer to: Circuit/System Testing

    - **Go to next step: If the DTC is not set**
6. All OK.

Circuit/System Testing

NOTE: **It may take up to 2 min for all vehicle systems to power down before an accurate ground or low reference circuit continuity test can be performed.**

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B112 Turbocharger Vane Position Sensor
3. Test for less than 5 ohms between the test points: Low Reference circuit terminal 2 & Ground
    - **If 5 ohms or greater**
    1. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 2 @ Component harness & The other end of the circuit @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K20 Engine Control Module
    - **Go to next step: If less than 5 ohms**

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4. Ignition - On/Vehicle - In Service Mode
5. Test for 4.8 to 5.2 V between the test points: 5 V Reference circuit terminal 3 & Low Reference circuit terminal 2
    - **If less than 4.8 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Test for infinite resistance between the test points: 5 V Reference circuit terminal 3 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance
    4. Test for less than 2 ohms between the test points: 5 V Reference circuit terminal 3 @ Component harness & The other end of the circuit @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K20 Engine Control Module
    - **If greater than 5.2 V**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Ignition - On/Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: 5 V Reference circuit terminal 3 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V - Replace the component: K20 Engine Control Module
    - **Go to next step: If between 4.8 and 5.2 V**
6. Verify the scan tool parameter: Turbocharger Vane Position = Greater than 4.7 V
    - **If 4.7 V or less**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Test for infinite resistance between the test points: Signal circuit terminal 1 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component: K20 Engine Control Module
    - **Go to next step: If greater than 4.7 V**
7. Connect a 3 A fused jumper wire between the test points: Signal circuit terminal 1 & Low Reference circuit terminal 2
8. Verify the scan tool parameter: Turbocharger Vane Position = Less than 0.3 V
    - **If 0.3 V or greater**
    1. Ignition/Vehicle - Off & Remove - Jumper wire (s)
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Ignition - On/Vehicle - In Service Mode
    4. Test for less than 1 V between the test points: Signal circuit terminal 2 @ Component harness & Ground
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V
    5. Ignition/Vehicle - Off
    6. Test for less than 2 ohms between the test points: Signal circuit terminal 2 @ Component harness & The other end of the circuit @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K20 Engine Control Module
    - **Go to next step: If less than 0.3 V**
9. Test or replace the component: B112 Turbocharger Vane Position Sensor

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Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- Refer to **Turbocharger Replacement** - B112 Turbocharger Vane Position Sensor
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P25BD: UNMETERED FUEL - FORCED ENGINE SHUTDOWN

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P25BD

Unmetered Fuel - Forced Engine Shutdown

Circuit/System Description

Detects engine overspeed in the event that there is an error in the ECM or engine damage has occurred which is resulting in the engine speed increasing beyond desired control limits. Upon failure detection, the engine will be shutdown by closing the diesel intake air valve and disabling the fuel injectors.

Conditions for Running the DTC

- Ignition is ON.
- Engine speed is greater than 1500 RPM.
- DTC runs continuously when the above condition are met.

Conditions for Setting the DTC

The ECM detects that the engine speed is greater than 5200 RPM for greater than 100 s.

Action Taken When the DTC Sets

DTC P25BD is a Type A DTC.

The ECM commands the intake air valve closed.

The ECM disables the fuel injectors.

Conditions for Clearing the DTC

DTC P25BD is a Type A DTC.

Diagnostic Aids

Possible Causes of an Engine Overspeed

- Aftermarket power-up devices.
- Leaking or failed turbocharger oil seals
- Oil evident in the intake runners and compressor side of the turbocharger.
- Starting fluid use or alternative fuel added to the engine such as ether.
- Excessive oil build-up in the charge air cooler.

Reference Information

Schematic Reference

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Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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Circuit/System Verification

1. Verify that no other DTCs are set.
   - **If any other DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **Go to next step: If any other DTCs are not set**
2. Review the Freeze Frame/Failure Records data, the Engine Speed should exceed 5200 RPM.
   - **If greater than 5200 RPM**

     Refer to Circuit/System Testing.

   - **Go to next step: If less than 5200 RPM**
3. Verify there is no engine damage.
   - **If there is engine damage**

     Refer to **Symptoms - Engine Mechanical** .

   - **Go to next step: If there is no engine damage**
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 DTC P25BD is not set.
   - **If DTC P25BD is set**

     Refer to Circuit/System Testing.

   - **Go to next step: If DTC P25BD is not set**
6. All OK.

Circuit/System Testing

1. Review the Freeze Frame/Failure Records data to verify if Engine Speed exceeded 5200 RPM.
    - **If the Engine Speed exceeded 5200 RPM**

      Inspect the engine for the following:

    - Aftermarket power-up devices.
    - Modified fuel system.
    - Contaminated engine oil.
    - Un-metered fuel source.
    - **Go to next step: If the Engine Speed did not exceed 5200 RPM.**
2. Replace the K20 Engine Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Refer to **Control Module References** for ECM replacement, programming, and setup.

DTC P2627 OR P2628: HO2S PUMP CURRENT TRIM CIRCUIT LOW/HIGH VOLTAGE SENSOR 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2627

HO2S Pump Current Trim Circuit Low Voltage Sensor 1

DTC P2628

HO2S Pump Current Trim Circuit High Voltage Sensor 1

Circuit/System Description

The oxygen content of the exhaust is measured via the nitrogen oxide (NOx) sensors. The nitrogen oxides (NOx) sensors are part of the selective catalytic reduction system, a device used to reduce NOx emission on diesel engines. There are two NOx sensors, one placed upstream of selective catalytic reduction, to measure inlet NOx concentration, and one placed downstream. They are connected with the control module via CAN and all the information is exchanged through it. Since it is a smart sensor, all the electrical monitoring is performed inside the sensor and only the results are sent to the ECM. Each NOx sensor contains a sensing cell, a pumping cell, and a heater. A sample of exhaust gas passes through a diffusion gap between the sensing cell and the pumping cell. The NOx sensor maintains a constant reference voltage across the sensing cell. An electronic circuit within sensor controls the pump current through the pumping cell in order to maintain a constant voltage in the sensing cell. The amount of current required to maintain the reference voltage in the sensing cell is proportional to the concentration of NOx in the exhaust. The ECM varies the amount of diesel exhaust fluid (reductant) added by varying the reductant injector duty cycle in response to changes in engine exhaust NOx levels. The smart NOx sensors consist of two components, the NOx module and the NOx sensor element that are serviced as a unit. A circuit or performance condition with a NOx sensor is detected by the NOx sensor module. The smart NOx sensor module communicates the condition to the ECM over the serial data line. The ECM sets a DTC when a serial data message is received from the NOx sensor module.

Conditions for Running the DTC

P2627

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- DTC P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P2200, P2205, P2206, P2207, P2208, P2209, P2210, P220A, or P2211 is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx sensor supply voltage is greater than 10.8 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.

The DTC runs continuously when the above conditions are met.

P2628

- DTC P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P0546, P0545, P111E, P113B, P113C, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P1248, P1249, P124A-P124F, P126A, P2032, P2033, P2081, P2085, P2200, P2205, P2206, P2207, P2208, P2209, P2210, P220A, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2211, P2227, P2228, P2229, or P2230 is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The NOx sensor supply voltage is greater than 10.8 V.
- The NOx Sensor 1 Heater Operation parameter displays Allowed.

The DTC runs continuously when the above conditions are met.

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Conditions for Setting the DTC

The NOx sensor module detects a fault in the NOx sensor circuitry.

Action Taken When the DTC Sets

DTCs P2627 and P2628 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P2627 and P2628 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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 P00C7, P00E9, P00EA, P00EB, P00EC, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0128, P0201-P0208, P020A-P020F, P0216, P021A, P021B, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P02EE, P02EF, P02F0-P02F5, P0405, P0406, P049D, P0546, P0545, P111E, P113B, P113C, P115E, P115F, P1160, P116A, P116B, P116C, P116D, P116E, P116F, P118E, P118F, P1192, P1193, P1194, P119A, P119B, P119C, P11C5, P11C6, P11DB, P11DD, P1248, P1249, P124A-P124F, P126A, P2032, P2033, P2081, P2085, P2200, P2205, P2206, P2207, P2208, P2209, P2210, P220A, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2211, P2227, P2228, P2229, P2230, or U029D is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **Go to next step: If none of the DTCs are set**
3. Verify that DTCs P2627 or P2628 are not set
   - **If any of the DTCs are set**

     Replace the B195A Nitrogen Oxides Sensor 1

   - **Go to next step: If none of the DTCs are set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Replace the B195A Nitrogen Oxides Sensor 1

   - **Go to next step: If no DTC sets**
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Nitrogen Oxides Sensor Replacement - Position 1**

Perform the scan tool NOx Sensor 1 Reset after replacing the Nitrogen Oxides Sensor Position 1 replacement.

DTC P2635: FUEL PUMP FLOW PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2635

Fuel Pump Flow Performance

Circuit/System Description

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After the vehicle has been powered Off for at least 2 min and the ignition is turned On, the engine control module (ECM) sends a signal via the fuel pump primary relay circuit to the fuel pump driver control module. The fuel pump driver control module enables the fuel pump for 30 s or continuously when the engine is running. The fuel pump driver control module actuates the brushless fuel pump by means of a high power three phase signal and controls the fuel pump speed according to serial data signals received from the ECM containing the desired fuel pump speed.

Conditions for Running the DTC

- DTC P018B, P018C, P018D, P0641, P1007, P1029, P102A, P102B, P102C, P1255, P129D, P129F, P12A6, P20CD, P2227, P2228, P2229, P2230, or U18A2 is not set.
- Fuel pump control is enabled.
- Ignition voltage is between 11 - 32 V.
- Engine is running for more than 40 s.
- KR73 Ignition Main Relay is commanded On.
- Low fuel level warning not present.

The DTC runs continuously when the conditions above are met.

Conditions for Setting the DTC

The ECM detects the actual fuel pressure is not within 40 kPa (5.8 PSI) of the commanded fuel pressure for greater than 30 s.

Action Taken When the DTC Sets

DTC P2635 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2635 is a Type B DTC.

Diagnostic Aids

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P018B, P018C, P018D, P0641, P1007, P1029, P102A, P102B, P102C, P1255, P129D, P129F, P12A6, P20CD, P2227, P2228, P2229, P2230, or U18A2 is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **Go to next step: If none of the DTCs are set**
3. Verify scan tool parameters Fuel Pressure Sensor and Desired Fuel Pressure are within 40 kPa (5.8 psi) of each other while operating the vehicle through varying loads.
   - **If greater than 40 kPa (5.8 PSI)**

     Refer to Circuit/System Testing.

   - **Go to next step: If less than 40 kPa (5.8 PSI)**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **Go to next step: If the DTC does not set**
6. All OK.

Circuit/System Testing

1. Verify no condition exist with the fuel system pressure. Refer to **Fuel System Diagnosis**.
   - **If a condition is found with the fuel system pressure**

     Repair the fuel system as necessary.

   - **Go to next step: If a condition is not found with the fuel system pressure**
2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Fuel Tank Fuel Pump Module Replacement (FWD)** **Fuel Tank Fuel Pump Module Replacement (AWD)**

DTC P2670 OR P2671: ACTUATOR HIGH CONTROL CIRCUIT GROUP 2 LOW/HIGH VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

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DTC P2670

Actuator High Control Circuit Group 2 Low Voltage

DTC P2671

Actuator High Control Circuit Group 2 High Voltage

Circuit/System Description

The DTCs apply to internal engine control module (ECM) high side driver voltage supply.

Conditions for Running the DTC

P2670

- The ignition is ON.
- The DTCs run continuously once the above condition is met.

Conditions for Setting the DTC

P2670

The ECM recognizes a short to ground on high side driver voltage supply to the turbocharger wastegate solenoid valve.

P2671

The ECM recognizes a short to voltage on high side driver voltage supply to the turbocharger wastegate solenoid valve.

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Action Taken When the DTC Sets

DTC P2670 and P2671 are Type A DTCs.

Conditions for Clearing the DTC

DTC P2670 and P2671 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

1. Ignition OFF, disconnect the harness connector at the Q41 Turbocharger Vane Position Control Solenoid Valve.
2. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 2 and ground.
    - **If the test lamp does not illuminate**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between ignition 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.
    - **Go to next step: If the test lamp illuminates**
3. Verify that a test lamp illuminates weakly between the ignition circuit terminal 2 and the control circuit terminal 1, while commanding the Turbocharger Vane Position Actuator with a scan tool.
    - **If the test lamp illuminates**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for less than 1.0 V between the control circuit and ground.
        - If greater than 1.0 V, repair the short to voltage in the circuit.
        - If less than 1.0 V, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp illuminates weakly**
4. Replace the Q41 Turbocharger Vane Position Control Solenoid Valve.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair

Refer to **Control Module References** for Engine Control Module replacement, programming and setup.

DTC P2687-P2689: FUEL HEATER RELAY CONTROL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2687

Fuel Heater Relay Control Circuit

DTC P2688

Fuel Heater Relay Control Circuit Low Voltage

DTC P2689

Fuel Heater Relay Control Circuit High Voltage

Circuit/System Description

Ignition voltage is supplied to the coil side of the fuel heater relay whenever the ignition is ON. The engine control module (ECM) provides a ground to control the fuel heater relay. When the ECM is commanding the fuel heater ON, the voltage of the control circuit should be low, near 0 V. When the ECM is commanding the fuel heater OFF, the voltage of the control circuit should be high, near battery voltage.

Conditions for Running the DTC

DTC P2687, P2688, or P2689

- Ignition voltage is greater than 11 V.

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- Ignition On or engine running. (engine not cranking)

Conditions for Setting the DTC

DTC P2687

The ECM detects the fuel heater relay control circuit is open for greater than 1 s.

DTC P2688

The ECM detects the fuel heater relay control circuit is shorted to ground for greater than 1 s.

DTC P2689

The ECM detects the fuel heater relay control circuit is shorted to voltage for greater than 1 s.

Action Taken When the DTC Sets

DTC P2687, P2688, and P2689 are type C DTCs.

Conditions for Clearing the DTC

DTC P2687, P2688, and P2689 are type C DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

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Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Command the Fuel Heater Relay On and Off with a scan tool. Verify that you hear or feel the KR22 Fuel Heater Relay click.
    - **If a click is not heard or felt**

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Refer to Circuit/System Testing.

- **Go to next step: If a click is heard or felt**

3. Verify with a scan tool that the Fuel Temperature Sensor parameter slowly starts to rise when the fuel heater relay is commanded On.
   - **If the fuel temperature does not rise**

     Refer to **Fuel Heater Diagnosis**.

   - **Go to next step: If the fuel temperature rises**
4. All OK

Circuit/System Testing

1. Ignition Off.
2. Remove the KR22 Fuel Heater Relay from X50A Fuse Block-Underhood.
3. Ignition On.
4. Verify that a test lamp illuminates between the ignition voltage circuit terminal 1 and ground.
   - **If the test lamp does not illuminate**

     Refer to **DTC P0685-P0687, P0689, P0690, or P1682**

   - **Go to next step: If the test lamp illuminates**
5. Connect a test lamp between the relay control circuit terminal 2 and a battery voltage.
6. Ignition On.
7. Verify the test lamp turns on and off when commanding the Fuel Heater parameter On and Off with a scan tool.
   - **If the test lamp is always Off**
   1. Ignition Off.
   2. Disconnect the harness connector X3 at the K20 Engine Control Module.
   3. Test for less than 2 Ω in the relay control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω
   4. Ignition On, test for less then 1 V between the relay control circuit and ground.
   5. If 1 V or greater, repair the short to voltage in the circuit.
   6. If less than 1 V, replace the K20 Engine Control Module.
   - **If the test lamp is always On**
   1. Ignition Off.
   2. Disconnect the harness connector X3 at the K20 Engine Control Module.
   3. Test for infinite resistance between relay control circuit terminal 2 and ground.
      - If less than infinite resistance, repair the short to ground in the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **Go to next step: If the test lamp turns On and Off**
8. Test or replace the KR22 Fuel Heater Relay.

Component Testing

1. Ignition Off.
2. Remove the KR22 Fuel Heater Relay from X50A Fuse Block-Underhood.
3. Test for 70 - 110 Ω between terminals 1 and 2.
   - **If not between 70 - 110 Ω**

     Replace the KR22 Fuel Heater Relay.

   - **Go to next step: If between 70 - 110 Ω**

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4. Test for infinite resistance between the following terminals:
    - 3 and 1
    - 3 and 5
    - 3 and 2
    - 2 and 5
    - **If less than infinite resistance**

      Replace the KR22 Fuel Heater Relay.

    - **Go to next step: If infinite resistance**
5. Install a 20 A fused jumper wire between relay terminal 1 and 12 V.
6. Install a jumper wire between relay terminal 2 and ground.
7. Test for less than 2 Ω between terminals 3 and 5.
    - **If 2 Ω or greater**

      Replace the KR22 Fuel Heater Relay.

    - **Go to next step: If 2 Ω or less**
8. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- For control module replacement, programming and setup, refer to: **Control Module References**

DTC P268A: FUEL INJECTION CALIBRATION NOT PROGRAMMED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P268A

Fuel Injection Calibration Not Programmed

Circuit/System Description

The control functions for the fuel injection system are integrated in the ECM.

Conditions for Running the DTC

Ignition = On

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

Control Module = Internal Malfunction or System Programming Malfunctions

Action Taken When the DTC Sets

DTC P268A is a Type A DTC.

Conditions for Clearing the DTC

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DTC P268A is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

Diagnostic Aids

Injector Flow Rate Programming is required after replacing the ECM or a fuel injector.

Perform the Fuel Injection Small Quantity Learn after Injector Flow Rate Programming.

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P268A is not set.
    - **If DTC P268A is set**
    1. Perform the Fuel Injection Small Quantity Learn procedure with a scan tool.
    2. Verify the DTC does not set.
        - If DTC P268A is set, replace the K20 Engine Control Module.
        - If DTC P268A is not set
    3. All Ok.
    - **Go to next step: If DTC P268A is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Control Module References** for Engine Control Module replacement, programming and setup.

DTC P268C-P268F: CYLINDER 1-4 INJECTOR CALIBRATION INCORRECT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

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DTC P268C

Cylinder 1 Injector Calibration Incorrect

DTC P268D

Cylinder 2 Injector Calibration Incorrect

DTC P268E

Cylinder 3 Injector Calibration Incorrect

DTC P268F

Cylinder 4 Injector Calibration Incorrect

Circuit/System Description

The control functions for the fuel injection system are integrated in the ECM. During the manufacturing process, each injector flow rate is measured and recorded as injection quantity adjustment flow rate data. This data, together with the injectors cylinder position, is stored in the ECM. When the ignition is turned ON, the ECM monitors the fuel injection flow rate numbers to ensure they are present.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The fuel injector injection quantity adjustment flow rate data is not programmed.

Action Taken When the DTC Sets

DTC P268C, P268D, P268E and P268F are Type A DTCs.

Conditions for Clearing the DTC

DTC P268C, P268D, P268E and P268F are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

Diagnostic Aids

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Verify that the ECM has the correct part number for the application.

Circuit/System Verification

1. Ignition ON.
2. Verify that DTCs P268C, P268D, P268E, or P268F are not set.
    - **If one of the DTC is Set**
    1. Perform the Injector Flow Rate Programming
    2. Ignition OFF and all vehicle systems OFF, it may take up to 2 min for all vehicle systems to power down.
    3. Verify the DTC does not set.
        - If one of the DTC resets, replace the K20 Engine Control Module.
        - If the DTC does not set
    - **Go to next step: If no DTC is set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Control Module References** for Engine Control Module replacement, programming and setup.

DTC P2ADA-P2ADD: REDUCTANT TANK TEMPERATURE SENSOR 2 CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2ADA

Reductant Tank Temperature Sensor 2 Circuit Performance

DTC P2ADB

Reductant Tank Temperature Sensor 2 Circuit Low Voltage

DTC P2ADC

Reductant Tank Temperature Sensor 2 Circuit High Voltage

DTC P2ADD

Reductant Tank Temperature Sensor 2 Circuit Erratic

Circuit/System Description

The reductant quality sensor is located in the reductant tank and uses an ultrasonic signal to measure reductant fluid quality. The reductant quality sensor includes an integrated temperature sensor to measure reductant fluid temperature. The reductant quality sensor communicates with the reductant control module using serial data.

Conditions for Running the DTC

P2ADA

- DTC P1015, P1016, P1017, P1018, P1019, P101A, P262B, P2ADB, P2ADC, P2ADD, or U010E is not set.
- The ignition is on.

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- The ignition voltage is greater than 11 V.
- The ignition has been off for greater than 8 h.

Frequency the DTC runs = Per ignition cycle - For 8 s - After the running conditions are met

P2ADB, P2ADC

- DTC P1015, P1016, P1017, P1018, P1019, P101A, or U010E is not set.
- The ignition is on.
- The ignition voltage is greater than 11 V.
- The reductant control module is not initializing.

The DTCs run continuously when the above conditions are met.

P2ADD

- DTC P1015, P1016, P1017, P1018, P1019, P101A, P206C, P206D, or U010E is not set.
- The ignition is on.
- The ignition voltage is greater than 11 V.
- The reductant control module is not initializing.

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2ADA, P2ADD

The reductant control module detects a performance fault on the reductant quality sensor temperature signal for greater than 1 s.

P2ADB

The reductant control module detects that the reductant quality sensor temperature signal is out of range low for greater than 1 s.

P2ADC

The reductant control module detects that the reductant quality sensor temperature signal is out of range high for greater than 1 s.

Action Taken When the DTC Sets

DTCs P2ADA, P2ADB, P2ADC, and P2ADD are Type A DTCs.

- The reductant quality value is replaced with the last measured value.
- The reductant quality sensor temperature value is replaced with a default value
- The Warning/Inducement strategy is activated.

Conditions for Clearing the DTC

DTCs P2ADA, P2ADB, P2ADC, and P2ADD are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTCs P2ADA, P2ADB, P2ADC, and P2ADD are not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing

   - **Go to next step: If none of the DTC 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.
3. Verify that DTCs P2ADA, P2ADB, P2ADC, and P2ADD are not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing

   - **Go to next step: If no DTC Is set**
4. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the B295 Reductant Quality Sensor.
2. Ignition On.
3. Test for less than 20 Ω between low reference terminal 3 and ground.
   - **If greater than 20 Ω**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant 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 K115 Reductant Control Module.
   - **Go to next step: If less than 20 Ω**
4. Test for 4.8-5.2 V between 5 V reference circuit terminal 1 and ground
   - **If less than 4.8 V**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. 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
   3. 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, replace the K115 Reductant Control Module
   - **If greater than 5.2 V**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant Control Module.
   2. Test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage in the circuit.

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- If less than 1 V, replace the K115 Reductant Control Module
- **Go to next step: If between 4.8-5.2 V**

5. Ignition ON, test for 4.4-4.8 V between signal circuit terminal 2 and ground.
   - **If less than 4.4 V**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant 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
   3. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K115 Reductant Control Module
   - **If greater than 4.8 V**
   1. Ignition Off, disconnect the X2 harness connector at the K115 Reductant 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 in the circuit.
      - If less than 1 V, replace the K115 Reductant Control Module
   - **Go to next step: If between 4.4-4.8 V**
6. Replace the B295 Reductant Quality Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Emission Reduction Fluid Tank Replacement** for reductant quality sensor replacement.
- Refer to **Emission Reduction Fluid Controller Replacement**

DTC P2BAA: EXHAUST NOX CONCENTRATION HIGH - LOW REDUCTANT CONSUMPTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2BAA

Exhaust NOx Concentration High - Low Reductant Consumption

Circuit/System Description

The selective catalytic reduction (SCR) system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of diesel exhaust fluid or reductant into the exhaust gas stream entering the SCR. Within the selective catalytic reduction catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provide the engine control module (ECM) with engine-out and tailpipe-out NOx levels. The ECM uses two (NOx) sensors to control exhaust NOx levels. The first NOx sensor is located upstream of the reductant fluid injector and monitors the engine out NOx. The second NOx sensor is located at the outlet of the SCR and monitors NOx levels exiting the SCR The engine control module (ECM) varies the amount of diesel exhaust fluid (Reductant) or reductant added in response to changes in engine exhaust out NOx levels.

Conditions for Running the DTC

- DTCs related to the following system/component = Not Set
  - Reductant System
  - B9 Ambient Air Temperature Sensor

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    - B17 Barometric Pressure Sensor
    - B34 Engine Coolant Temperature Sensor
    - B66 Intake Air Temperature Sensor
    - B75C Multifunction Intake Air Sensor
    - B115 Vehicle Speed Sensor
    - B195 Nitrogen Oxides Sensor
    - Q14 Exhaust Gas Recirculation Valve
    - Q17 Fuel Injector
- Ambient Air Temperature = Warmer than -20Â°C (-4Â°F)
- BARO Sensor = Greater than 70 kPa (10.2 PSI)
- ECT Sensor = Greater than 70Â°C (158Â°F)
- Engine = Running
- Fuel Level Sensor = Greater than 10%
- Reductant Level = Greater than 5 L (1.5 US Liquid Gal)
- Reductant Tank Temperature 1 = Greater than 5Â°C (41Â°F)
- Vehicle is not in or near a DPF regeneration.

The DTC runs when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the diesel exhaust fluid (DEF) delivery is lower than a calibrated amount.

Action 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

- Using the Reductant Injector Device Control, a ticking sound should be heard at the reductant injector.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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Circuit/System Verification

1. Verify there are no DTCs set related to the following system/component:
   - Reductant System
   - B9 Ambient Air Temperature Sensor
   - B17 Barometric Pressure Sensor
   - B34 Engine Coolant Temperature Sensor
   - B66 Intake Air Temperature Sensor
   - B75C Multifunction Intake Air Sensor
   - B115 Vehicle Speed Sensor
   - B195 Nitrogen Oxides Sensor
   - Q14 Exhaust Gas Recirculation Valve
   - Q17 Fuel Injector
   - **If a related DTC is set**
   1. Refer to: **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
   2. Clear All Vehicle DTCs
   3. Ignition/Vehicle - Off - For greater than 2 min
   4. Engine - Running
   5. Perform the scan tool control function: **Reductant System Tamper Service Bay Test**
   6. Verify the procedure/test passes.
      - If the procedure/test does not pass

        Refer to Circuit/System Testing.

      - If the procedure/test passes

        All OK.

   - **Go to next step: If a related DTC is not set**
2. Verify that DTC P2BAA is not set
   - **If the DTC is set**

     Refer to Circuit/System Testing

   - **Go to next step: If the DTC is not set**
3. All OK.

Circuit/System Testing

1. Ignition Off
2. Test the reductant system for contamination. Refer to **Contaminants-in-Diesel Exhaust Fluid Diagnosis**.
   - **If any conditions are found**

     Repair as necessary.

   - **Go to next step: If no conditions are found**
3. Ignition - On/Vehicle - In Service Mode
4. Perform the scan tool control function: Reductant System Leak Test - ON
5. Verify that the system is able to build up and reach the reductant pressure sensor parameter greater than 450 kPa.
   - **If less than the specified range**
   1. Command the Reductant Pump to 50% with a scan tool.
   2. Verify the scan tool parameter: Desired Reductant Pump Speed = Reductant Pump Speed
      - If not equal

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Refer to **DTC P105A**

- If equal

  Refer to the next step

- **Go to next step: If greater than 450 kPa (66 PSI)**

6. Verify there are no leaks, kinks or restrictions in the reductant lines
   - **If any condition is found**

     Repair as necessary.

   - **Go to next step: If no conditions are found**
7. Perform the scan tool control function: **Reductant Injection Quantity Test**
8. Verify the procedure/test passes.
   - **If the procedure/test does not pass**

     Repair as necessary.

   - **Go to next step: If the procedure/test passes**
9. Ignition/Vehicle - Off - For greater than 2 min
10. Engine - Running
11. Perform the scan tool control function: **Reductant System Tamper Service Bay Test**
12. Verify the procedure/test passes.
    - **If the test does not pass**

      A condition with the system still exists. - Refer to step 1

    - **Go to next step: If the test passes**
13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Emission Reduction Fluid Supply Pump Module Replacement**
- Refer to **Emission Reduction Fluid Injector Replacement (AWD)** **Emission Reduction Fluid Injector Replacement (FWD)**
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

Repair Verification

NOTE: **Before returning the vehicle to the customer, perform the scan tool Reductant System Malfunction Warning Service Bay Test to verify proper reductant system operation.**

1. Perform the scan tool control function: **Reductant System Tamper Service Bay Test**
2. Verify the procedure/test passes.
   - **If the test does not pass**

     Refer to Circuit/System Testing.

   - **Go to next step: If the test passes**
3. All OK.

SYMPTOMS - ENGINE CONTROLS

Diagnostic Instructions

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- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

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

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.

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 irregularly at idle. If 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.

Fuel Knock/Combustion Noise

A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with the throttle opening.

More than the customer would desire Smoke (Black)

Black smoke under load, idle or start up, hot or cold.

More than the customer would desire Smoke (White)

White smoke under load, idle or start up, hot or cold.

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More than the customer would desire Smoke (Gray or Blue)

Gray or Blue smoke under load, idle or start up, hot or cold.

Reference Information

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 reference

Symptoms Verification

Verify the following conditions are true:

- The engine control module (ECM) and the malfunction indicator lamp (MIL) are operating correctly.
- There are no diagnostic trouble codes (DTCs) stored.
- The scan tool data is within a normal operating range.
- The fuel system is not leaking.
- The air filter element is not restricted.
- The vehicle tires are correctly inflated and meet original equipment specifications.

Symptoms Testing

Cuts Out/Misses, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, Fuel Knock/Combustion Noise, Surges/Chuggles, or more than the customer would desire Smoke - Black, White, Gray, or Blue

1. Test for the following conditions:
    - The sensor systems for the following:
        - Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor Replacement** .
        - Test for an intermittent fuel rail pressure sensor signal by wiggling the harness between the sensor and the ECM with the ignition ON and the engine OFF, while monitoring the parameter with a scan tool.
        - Inspect for an intermittent crankshaft position sensor signal.
        - Inspect the engine coolant temperature (ECT) sensor. Use the scan tool in order to compare the ECT with the intake air temperature (IAT) sensor on a cold engine. The ECT should be within 3Â°C (5Â°F) of the IAT. If not within the specified range, inspect for a high resistance in the coolant sensor circuit or the sensor. Compare sensor resistance to the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** tables.
    - The Fuel System for the following:
        - Inspect for external fuel leaks.
        - Inspect for low fuel pressure. Refer to **Fuel System Diagnosis**.
        - Inspect the fuel system for a plugged fuel filter or air in the fuel system. Refer to **Fuel System Diagnosis**.
        - Inspect the fuel supply to the fuel injection pump. Refer to **Fuel System Diagnosis**.
        - Inspect the fuel tank cap vent for proper operation.
        - Inspect the fuel quality. Refer to **Contaminants-in-Fuel Diagnosis**.

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- Observe the actual desired fuel rail pressure with a scan tool, with the engine idling.
- If the ECM or a fuel injector has recently been replaced, it may be necessary to confirm the fuel injector flow rate values.
- Inspect for restricted or plugged fuel injectors.
- Inspect for a sticking Fuel Pressure Regulator. The symptom for this condition will be an idle surge of at least 100 RPM. This surge will be from 50 RPM above Desired Idle Speed to 50 RPM below Desired Idle Speed.

- Engine mechanical for the following.
  - Improper valve timing
  - Worn rocker arms
  - Low engine compression. Refer to **Engine Compression Test** .
  - Broken or weak valve springs
  - Worn camshaft lobes
  - More than the customer would desire oil in the combustion chamber. Leaking valve seals

2. If the above conditions do not address the symptom, refer to the additional symptoms tests.

Additional Symptoms Tests

Hard Start

- Verify the ECT has not shifted in value. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** .
- Inspect for a slow cranking speed. Refer to **Symptoms - Engine Electrical** .
- Verify the engine electrical system for correct operation. Refer to **Symptoms - Engine Electrical** .
- Verify the driver is using the correct starting procedure as described in the owner's manual.
- Inspect for a restriction in turbocharger inlet duct.
- Inspect for a restriction or a leak in the intake manifold.
- Inspect the exhaust system for a possible restriction. Refer to **Restricted Exhaust** .
- Inspect for more than the customer would desire crankshaft end play that will cause the crankshaft position sensor reluctor wheel to move out of alignment with the crankshaft position sensor.

Hesitation, Sag, Stumble

- Test the generator. Refer to **Symptoms - Engine Electrical** .
- Inspect for more than the customer would desire crankshaft end play that will cause the crankshaft position sensor reluctor wheel to move out of alignment with the crankshaft position sensor.

Poor Fuel Economy

- Heavy loads being carried or towed
- Acceleration rate too much or too often
- Inspect the brake system for brake drag.
- Inspect the tires for the correct air pressure.
- Inspect for incorrect operation of the speedometer.
- Inspect for an air leak in the charge air cooler.
- Inspect the air conditioning system for proper operation.
- Suggest to the owner to fill the fuel tank and inspect the fuel economy.
- Suggest to the driver to read the Important Facts on Fuel Economy in the Owner's Manual.
- Verify the ECT has not shifted in value. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** .

Lack of Power, Hesitation, or Cut Out

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- Inspect the engine electrical system for correct operation. Refer to **Symptoms - Engine Electrical** .
- Compare the vehicle with a similar model. Ensure the vehicle has an actual condition.
- Inspect for a proper transmission operation.
- Inspect the engine oil level and quality.
- Inspect for an air leak in the charge air cooler.
- Inspect for a worn or damaged turbo charger turbine wheel, shaft or compressor wheel.
- Inspect for a restricted or plugged exhaust. Refer to **Restricted Exhaust** .
- Inspect for a restriction in the charge air cooler.
- Inspect for a skewed mass air flow (MAF) sensor.
- Inspect that the exhaust gas recirculation (EGR) valve is fully closing.
- Ensure that the EGR valve does not bind when manually moving the valve.
- Inspect the torque converter clutch (TCC) operation.
- Inspect the air conditioning system for the correct operation.

Rough, Unstable, or Incorrect Idle and Stalling

- Inspect the engine mounts.
- Inspect the intake and exhaust manifolds for casting flash.
- The exhaust system for damaged or collapsed pipes
- The exhaust manifold for a collapsed inner wall
- The mufflers for heat distress or possible internal failure
- Inspect the park neutral position switch circuit.

Surges/Chuggles

- Ensure the driver understands the torque converter clutch (TCC) operation.
- Ensure the driver understands the A/C compressor operation.
- Use the scan tool to ensure the vehicle speed sensor (VSS) reading matches the speedometer.

Fuel Knock/Combustion Noise

- Inspect for obvious overheating problems.
- Inspect for a low engine coolant level.
- Inspect for any restricted air flow through the radiator.
- Inspect for a malfunctioning or incorrect thermostat.
- Inspect for a correct coolant solution. The solution should be a 50/50 mix of anti-freeze and water.
- Perform the Small Quantity Learn.

More than the customer would desire Smoke (Black)

Normal Operation

- During light to moderate acceleration there should be no black smoke.
- During the 2 - 3 hard accelerations after normal light load driving there may be some black smoke momentarily but should not last for greater than 5 s.
- During hard acceleration there may always be a very faint puff of black smoke.

Abnormal Operation

- Black smoke during light to moderate acceleration
- Heavy black smoke during hard acceleration that lasts for greater than 5 s
- Heavy black smoke during every hard acceleration and/or during transmission shift transitions
- Inspect for an air leak in the charge air cooler or the air ducts between the turbocharger and the intake manifold.

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- Inspect for a restriction in the turbocharger charge air cooler.
- Inspect for a restriction in the intake manifold.
- Inspect that the EGR valve is fully closing. Remove the EGR valve and visually inspect that there is no light seen between the valves and the valve seats.
- Ensure that the EGR valve does not bind when manually moving the valve.
- Inspect for more than the customer would desire oil entering the combustion chamber.

More than the customer would desire Smoke (White or Gray)

- Inspect the coolant level in the reservoir. White coolant smoke may be mistaken for blue/gray smoke. If the coolant level is low, refer to **Loss of Coolant**
- If more than the customer would desire smoke is present, inspect for a stuck open fuel injector by performing the following procedure:
    1. Disconnect the electrical connector at the fuel injection pump.
    2. Remove the glow plugs. Refer to **Glow Plug Replacement** .

    NOTE: **Do not stand in front of the glow plug holes while cranking the engine.**

    3. Crank the engine while observing the glow plug holes for fuel spray.
    4. Replace the fuel injectors for the cylinders that spray fuel.
    5. Inspect for contaminated oil or high oil level.
- If the ECM or a fuel injector has recently been replaced, it may be necessary to confirm the fuel injector flow rate values.
- Inspect the fuel injectors.

MALFUNCTION INDICATOR LAMP (MIL) DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Circuit/System Description

Ignition voltage is supplied to the instrument cluster. The ECM turns the MIL ON by grounding the MIL control circuit.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

Diagnostic Trouble Code (DTC) List - Vehicle

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTCs U0073, U0100, or U0155 are not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **Go to next step: If no DTC is set**
2. Ignition ON.
3. Command the MIL with a scan tool ON and OFF.
   - **If the MIL does not turn ON and OFF**

     Refer to Circuit/System Testing.

   - **Go to next step: If the MIL turns ON and OFF**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the appropriate harness connector at the P16 Instrument Cluster. Ignition ON.
2. Verify a test lamp illuminates between the Ignition voltage circuit terminal 1 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ignition voltage circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for infinite resistance between the ignition voltage circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test all components connected to the ignition voltage circuit and replace as necessary.
   - **Go to next step: If the test lamp illuminates**
3. Ignition OFF, disconnect the appropriate harness connector at the P16 Instrument Cluster.
4. Ignition ON, command the malfunction indicator lamp OFF with a scan tool.
5. Verify that a test lamp does not illuminate between the X1 harness connector ignition circuit terminal 1 and the X1 harness connector control circuit terminal 18.
   - **If the test lamp illuminates**
   1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **Go to next step: If the test lamp does not illuminate**
6. Ignition ON, command the malfunction indicator lamp ON with a scan tool.
7. Verify that a test lamp does illuminate between the X1 harness connector ignition circuit terminal 1 and the X1 harness connector control circuit terminal 18.
   - **If the test lamp is always OFF**
   1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module. Ignition ON.

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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. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.
- **Go to next step: If the test lamp is ON**

8. Test or replace the P16 Instrument Cluster.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Instrument Cluster Replacement (Equinox)** **Instrument Cluster Replacement (Terrain)**
- Refer to **Control Module References** for ECM replacement programming and setup.

WATER-IN-FUEL LAMP DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Circuit/System Description

The Water In Fuel Sensor monitors for the presence of water in the fuel. When water is present, the Engine Control Module (ECM) detects low voltage on the signal circuit and sends a request to the instrument panel cluster via the CAN communication circuit to display the WATER IN FUEL message.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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NOTE: **If other contaminants are noticed in the fuel, a fuel system flush may be necessary.**

1. Verify there is NO water in the fuel

   Refer to **Water-in-Fuel Draining**

   - **If there is water in the fuel**

     Drain off the water completely.

   - **Go to next step: If there is No water in the fuel**
2. Ignition ON.
3. Verify the WATER IN FUEL message is not displayed.
   - **If the WATER IN FUEL message is displayed**

     Refer to Circuit/System testing.

   - **Go to next step: If the WATER IN FUEL message is not displayed**
4. All OK

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Ignition OFF, and all vehicle systems OFF. Disconnect the harness connector at the E11A Fuel Heater/Water in Fuel Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the Ground circuit terminal 4 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect Ground G307.

      Refer to **Ground Views** .

   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **Go to next step: If less than 10 Ω**
3. Reconnect the harness connector at the E11A Fuel Heater/Water in Fuel Sensor.
4. Ignition ON.
5. Using the scan tool, observe the Water in Fuel parameter. The parameter should display NO.
   - **If No is not displayed**
   1. Ignition OFF.
   2. Test for infinite resistance between the Signal circuit terminal 3 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **Go to next step: If No is displayed**
6. Install a 3 A fused jumper wire between the Signal circuit terminal 3 and the Ground circuit terminal 4. The Water In Fuel Sensor parameter should display YES.
   - **If the 3 A fuse opens and the Water In Fuel Sensor parameter does not display Yes**

     Test the signal circuit for a short to voltage. If the circuit tests normal replace the K20 Engine Control Module.

   - **If the 3 A fuse does not open and the Water In Fuel Sensor parameter does not display Yes**

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Test the signal circuit for an open. If the circuit tests normal replace the K20 Engine Control Module.

- **Go to next step: If the 3 A fuse does not open and the Water In Fuel Sensor parameter displays Yes**

7. Replace the E11A Fuel Heater/Water in Fuel Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Refer to **Fuel Filter Assembly Replacement (AWD)** **Fuel Filter Assembly Replacement (FWD)** for E11A Fuel Heater/Water in Fuel Sensor.
- Refer to **Control Module References** for ECM replacement, programming, and setup.

ENGINE CRANKS BUT DOES NOT RUN

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Circuit/System Description

The Engine Cranks but Does Not Run diagnostic table is an organized approach to identifying a condition that causes an engine not to start. This diagnostic directs the service technician to the appropriate system diagnosis.

Diagnostic Aids

If the engine cranks but does not run condition occurs only in cold ambient temperatures, fuel contamination, poor fuel quality, or fuel waxing may be the cause. Fuel icing, due to water contamination, and fuel waxing may cause fuel system restrictions significant enough to prevent the engine from starting. A restriction will be indicated by a high vacuum in the fuel supply lines while cranking the engine in a cold state. The engine may start after the vehicle is brought into the service bay and the fuel is sufficiently warmed up. The use of an unapproved fuel, such as fuel containing greater than 20% bio-diesel, may cause severe fuel system restrictions. Unapproved fuel usage can also cause the engine to start and stall, or to start but have no acceleration. Engine block heaters may be used to alleviate some fuel icing and waxing concerns.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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

NOTE: **This diagnostic assumes the following:**

- **The battery is completely charged.**

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- **There is adequate fuel in the fuel tank.**

1. Engine cranking for 15 s, observe the DTC information with a scan tool. Verify that DTC P0090, P0190, P0191, P0335, P0602-P0607, P060A-P060C, P061C, P062B-P062F, P0627, P0630, P064C, P0670, P0671, P0672, P0673, P0674, P161C, P161E, P161F, P2146, P2149, P2510, P2687, or P268A is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If no DTCs are set**
2. Ignition ON
3. Verify the security indicator on the instrument panel cluster illuminates momentarily.
   - **If the indicator stays illuminated or is flashing**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** , and **Immobilizer Description and Operation**

   - **Go to next step: If the indicator does not stay illuminated or is not flashing**
4. Verify the scan tool Engine Speed parameter is greater than 0 RPM while cranking the engine.
   - **If 0 RPM**

     Refer to **DTC P0335 or P0336**

   - **Go to next step: If greater than 0 RPM**
5. Verify the scan tool Engine Speed parameter, while cranking the engine, is greater than 50 RPM on a cold engine and 125 RPM on a hot engine.
   - **If less than 50 RPM on a cold engine or less than 125 RPM on a hot engine**

     Refer to **Engine Cranks Slowly**

   - **Go to next step: If greater than 50 RPM on a cold engine or greater than 125 RPM on a hot engine**
6. Verify there are no fuel system leaks from the fuel tank to the high pressure pump.
   - **If a fuel leak is present**

     Refer to **Fuel Leak Diagnosis**

   - **Go to next step: If a fuel leak is not present**
7. Ignition ON
8. Verify the Fuel Pressure Sensor 1 scan tool parameter displays 54 - 65 PSI 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 **Fuel System Diagnosis**

   - **Go to next step: If the fuel pump turns ON and OFF**
9. Verify the scan tool Fuel Rail Pressure Sensor parameter is greater than 10 MPa (1, 450 psi) while cranking the engine.
   - **If not 10 MPa (1, 450 psi) or greater**

     Refer to **Fuel System Diagnosis - High Pressure Side**

   - **Go to next step: If greater than 10 MPa (1, 450 psi)**
10. Verify the following conditions do not exist:
    - Collapsed or restricted air intake duct to the throttle body
    - Restricted air filter element

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- A skewed engine coolant temperature (ECT) sensor. Refer to **DTC P0117, P0118, or P0119**
- Exhaust system restricted. Refer to **Restricted Exhaust** .
- Fuel contamination. Refer to **Contaminants-in-Fuel Diagnosis**.
- Engine mechanical condition, for example, worn timing chain and gears or low compression. Refer to **Symptoms - Engine Mechanical** , or **Engine Compression Test** .
    - **If a condition is found**

      Repair as necessary.

    - **Go to next step: If a condition is not found**

11. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

FUEL SYSTEM DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Circuit/System Description

Low Pressure System

After the vehicle has been powered Off for at least 2 min and the ignition is turned On, the engine control module (ECM) sends a signal via the fuel pump primary relay circuit to the fuel pump driver control module. The fuel pump driver control module enables the fuel pump for 30 s or continuously when the engine is running. The fuel pump driver control module actuates the brushless fuel pump by means of a high power three phase signal and controls the fuel pump speed according to serial data signals received from the ECM containing the desired fuel pump speed.

The fuel tank stores the fuel supply and the brushless fuel pump, pumps fuel from the fuel tank through the fuel filter/heater element housing, which contains the water separator, water in fuel sensor, fuel heater element, fuel temperature sensor, and fuel filter element. The fuel pressure is sensed by the fuel pressure sensor and then delivered to the high-pressure pump.

The fuel return system uses the unused return fuel to cool and lubricate the fuel injectors and fuel injection pump. If the high side fuel pressure becomes excessive, fuel pressure regulator 2 releases the fuel into the fuel return system. The returned fuel travels through the fuel return lines and fuel cooler to the fuel tank.

During a cold start, in order to warm the fuel the high pressure pump operates at full output and the pressure in the rail is regulated by fuel pressure regulator 2. This mode is also active during fuel injection cut-off. When in this mode, the fuel return line can flow up to 230 l/h (60.8 g/h).

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **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-37287-1A** Fuel Pressure Gauge Adapter
- **CH-48027** Digital Fuel Pressure Gauge

For equivalent regional tools refer to: **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

Circuit/System Verification

1. Verify DTC P018B, P018C, or P018D 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**

     Refer to Circuit/System Testing.

Circuit/System Testing

NOTE: **It may be necessary to remove engine components for the visual inspections.**

1. Verify the following conditions do not exist:
   - Hoses and lines that have kinks that would restrict the flow of fuel
   - Fuel leaks between the fuel tank and the fuel injection pump
   - ***If any conditions exist***

     Repair or replace as necessary.

   - ***Go to next step: If no conditions exist***
2. Verify that adequate fuel is in the fuel tank.

NOTE: **A fuel return line that is leaking, is a good indication there is a restriction in the return system.**

3. Verify there are no leaks in the fuel return lines.
   - **If a leak is found**

     Refer to: **Fuel Return System Diagnosis**

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- **Go to next step: If a leak is not found**

4. Ignition Off and all vehicle systems Off. It may take up to 2 minutes for all vehicle systems to power down.

NOTE: **Fuel temperature must be warmer than 20Â°C (68Â°F) before performing the next step or incorrect diagnosis may occur.**

5. Ignition On, verify scan tool parameter Fuel Pressure Sensor is between 370-450 kPa (54-65 PSI).
   - ***If not within 370-450 kPa (54-65 PSI)***
   1. Ignition Off and all vehicle systems Off. It may take up to 2 minutes for all vehicle systems to power down.
   2. Disconnect the fuel supply inlet line at the fuel filter assembly.
   3. Install the **CH-37287-1A** Fuel Pressure Gauge Adapter and attach the **CH-48027** Digital Fuel Pressure Gauge.
   4. Ignition On, verify the fuel pressure is between 370-450 kPa (54-65 PSI).
      - If not within 370-450 kPa (54-65 PSI), replace the G12A Fuel Pump - Primary.
      - If within 370-450 kPa (54-65 PSI), replace the fuel filter.
   - ***Go to next step: If within 370-450 kPa (54-65 PSI)***
6. Verify engine cranks and runs smoothly.
   - ***If engine cranks but does not run or starts but runs poorly***

     Refer to **Fuel System Diagnosis - High Pressure Side**.

   - ***Go to next step: If engine cranks and runs smoothly***
7. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- Refer to **Fuel Filter Replacement (AWD)** **Fuel Filter Replacement (FWD)**
- Refer to **Fuel Tank Fuel Pump Module Replacement (FWD)** **Fuel Tank Fuel Pump Module Replacement (AWD)**

FUEL SYSTEM DIAGNOSIS - HIGH PRESSURE SIDE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Circuit/System Description

High Pressure System

The fuel tank stores the fuel supply and contains an electric fuel pump that is controlled by the fuel pump driver control module and engine control module. Fuel is pumped from the fuel tank through the fuel feed line to the fuel filter assembly. The fuel filter assembly consists of a fuel filter/water separator, fuel heater, fuel temperature sensor, and a water in fuel sensor. Fuel flows out of the fuel filter assembly through the rear fuel feed pipe to the fuel pressure sensor and then to the high pressure fuel pump. High pressure fuel is supplied through the high pressure fuel line to the fuel rails and then through the fuel injector lines to the fuel injectors. High pressure fuel is controlled by the ECM, fuel pressure regulator 1 and fuel pressure regulator 2. Excess fuel returns to the fuel tank through the fuel return pipes.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

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Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **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.
2. Verify there are no external leaks or damage to the fuel return and supply lines.
   - **If external leaks or damage is found**

     Refer to **Fuel Leak Diagnosis**.

   - **Go to next step: If no external leaks or damage is found**
3. Verify that adequate fuel is in the fuel tank before proceeding.
4. Engine cranking or running, verify scan tool parameter Fuel Pressure Sensor is between 370-450 kPa (54-65 PSI).
   - **If not within 370-450 kPa (54-65 PSI)**

     Refer to: **Fuel System Diagnosis**

   - **Go to next step: If within 370-450 kPa (54-65 PSI)**
5. Ignition Off, disconnect all the glow plug harness connector nuts and remove the glow plugs.
6. Using a scan tool, enable the control function Compression Test.
7. Hold a clean rag over the glow plug holes.
8. Crank the engine for 6 compression strokes. No fuel vapor should be emitted onto the rag.
   - **If fuel vapor is emitted**

     Replace the appropriate Q17 Fuel Injector.

   - **Go to next step: If fuel vapor is not emitted**
9. Disconnect the Q18B Fuel Pressure Regulator 2 return hose and plug the hose to prevent fuel leakage.
10. Install a section of rubber fuel hose on the fuel pressure regulator 2 outlet and place the loose end of hose into a clean fuel container.
11. Perform the applicable test listed below:

    ENGINE NO START:

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1. Engine cranking for 15 seconds.
2. Observe the volume of fuel from fuel pressure regulator 2. The volume of fuel should be less than 10 ml (0.4 oz).
    - If greater than 10 ml (0.4 oz), replace Q18B Fuel Pressure Regulator 2.
    - If less than 10 ml (0.4 oz)

NOTE:

- **Perform the following two Sub-Steps for each injector.**
- **Complete the following two Sub-Steps on all of the fuel injectors before performing any repairs.**

3. Disconnect the electrical connector and the fuel return line from one of the fuel injectors.
4. Engine Cranking for 15 seconds, verify no fuel leaks from the fuel injector.
    - If fuel leaks from the fuel injector, replace the appropriate Q17 Fuel Injector.
    - If no fuel leaks from the fuel injector, replace the G18 High Pressure Fuel Pump.

ENGINE STARTS:

1. Disconnect the Q18B Fuel Pressure Regulator 2 return hose and plug the hose to prevent fuel leakage.
2. Install a section of rubber fuel hose on the fuel pressure regulator 2 outlet and place the loose end of hose into a clean fuel container.
3. Engine at idle.
4. Fuel temperature must be greater than -25Â°C (-13Â°F)
5. Engine at a stable idle.
6. Engine at normal operating temperature.

NOTE: **Engine speed greater than 1800 RPM will cause incorrect test results.**

7. Slowly increase engine speed to 1700 RPM and then back to idle within 15 s.
8. Observe the volume of fuel from fuel pressure regulator 2. The volume of fuel should be less than 10 ml (0.4 oz).
    - If greater than 10 ml (0.4 oz), replace Q18B Fuel Pressure Regulator 2.
    - If less than 10 ml (0.4 oz)
9. Reconnect the Q18B Fuel Pressure Regulator 2 return line.
10. Engine Idling.

NOTE: **When commanding fuel rail pressure at idle the maximum achievable pressure will be approximately 120 MPa (17405 psi).**

11. Command the fuel pressure incrementally through the entire fuel pressure range with a scan tool.
12. Verify the scan tool Fuel Rail Pressure Sensor 1 and the Desired Fuel Rail Pressure are within 2000 kPa (290 psi) for the entire fuel pressure range and note results.
    - **If the fuel pressure parameters are not within 2000 kPa (290 psi)**

      Replace the Q18A Fuel Pressure Regulator 1.

    - **Go to next step: If the fuel pressure parameters are within 2000 kPa (290 psi)**
13. Replace the G18 High Pressure Fuel Pump.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

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- For Q18A Fuel Pressure Regulator 1 replacement refer to: **Fuel Injection Pump Metering Valve Replacement**
- For Q18B Fuel Pressure Regulator 2 replacement refer to: **Fuel Injection Fuel Rail Assembly Replacement**
- Refer to **Fuel Injection Pump Replacement**
- Refer to **Fuel Injector Replacement**

FUEL RETURN SYSTEM DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Circuit/System Description

The fuel return system is designed to cool and lubricate the fuel injectors and the fuel injection pump. If the high side fuel pressure becomes excessive, the fuel pressure regulators release the excess fuel into the fuel return side where it returns to the fuel tank.

Diagnostic Aids

Bent or pinched fuel return lines may cause engine performance concerns.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

Circuit/System Verification

1. Verify the following condition not exist:

   NOTE: **It may be necessary to remove engine components for visual inspections.**

   - Fuel return hoses and lines that are bent or kinked

     NOTE: **A fuel return line that is leaking, is a good indication a restriction exists in the fuel return system.**

   - Fuel return hoses and lines externally leaking in engine compartment
   - Fuel return hoses and lines externally leaking between engine compartment and fuel tank
   - **If any condition exist**

     Repair or replace as necessary.

   - **Go to next step: If no condition exist**

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Refer to Circuit/System Testing.

Circuit/System Testing

NOTE: **DO NOT apply more than the specified air pressure to the return line.**

1. Disconnect the fuel return line at the engine. Refer to.
2. Remove the fuel filler cap.
3. Apply 6.9 kPa (1 psi) of air pressure into the fuel return line at the engine.
4. Verify air flow can be detected exiting the fuel filler tube.
    - **If air flow was not detected**
    1. Disconnect the fuel return line at the fuel sender.
    2. Apply 6.9 kPa (1 psi) of air pressure into the fuel return line at the engine.
    3. Verify air flow can be detected exiting the fuel return line.
        - If air flow was present, replace the fuel sender assembly.
        - If no air flow was present, inspect for a restricted and replace the affected fuel return line.
    - **Go to next step: If air flow was detected**
5. All OK.

Repair Instructions

NOTE: **If a restriction was present it may be necessary to clean fuel system. Refer to Fuel System Cleaning .**

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Fuel Tank Fuel Pump Module Replacement (FWD)** **Fuel Tank Fuel Pump Module Replacement (AWD)**

FUEL LEAK DIAGNOSIS

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**
- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

Diagnostic Aids

Fluorescent dye assists in locating leaks in the system. A high-intensity black light will make the dye glow. - Green or Yellow

Illuminate the area (s) of concern. For example:

- G18 High Pressure Fuel Pump
- Q17 Fuel Injector
- Fuel Line
- Fuel Rail
- {If equipped} Fuel Return Pipe

Reference Information

Special Tools

- **J-28428-E** High-Intensity Black Light Kit
- **J-42220** Universal 12 V Leak Detection Lamp

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Circuit/System Verification

1. Perform the following action: Clean all of the components in the suspected area using a cleaning solution and allow the components to dry: Fuel System
2. Perform the following action: Add 237 mL (8 US fl oz) of GM Approved Oil Dye to the component: Fuel Tank - Primary
3. Engine - Idling - For 3 to 5 min
4. Perform the scan tool control function: Fuel Pressure Control - Regulator 1 - Increase - Maximum Pressure - If applicable

CAUTION: **When performing a Fuel Leak Diagnosis, it is VERY IMPORTANT to use only GM approved Oil Dye, Part Number 88861206. If any other oil dye is used, it will cause damage to the fuel injection system components, as well as the emission control components. This will result in necessary replacement of the damaged components.**

5. Use the special tool: **J-28428-E** High-Intensity Black Light Kit or J-42220 Universal 12 V Leak Detection Lamp - Illuminate the area (s) of concern.

   Verify there are no leaks in the component/system: High Pressure Side of the Fuel System or Return Side of the Fuel System

   - **{High Pressure Side of the Fuel System} If a leak is present**

     Repair or replace as necessary.

   - **{Return Side of the Fuel System} If a leak is present**

     Refer to: Diagnostic Procedure Instructions

   - **Go to next step: If no leak is present**

6. All OK.

FUEL SPECIFIC GRAVITY TESTING

The fuel quality hydrometer provides a general indication of fuel quality and should not be considered scientifically accurate.

Fuel Oil Specific Gravity Requirements

Specification	Number 2-Diesel	Number 1-Diesel	Tool
API Gravity	30 - 39	39 - 44	J 38641 B

1. Drain the fuel filter housing by following the steps below:
   1. Stop the engine.
   2. Place a container under the water drain valve on the bottom of the fuel filter.
   3. Open the drain valve.
   4. Fill a 1 l (0.95 quart) container with a sample of fuel.
   5. Close the drain valve.
2. Obtain a **J 38641-B** Diesel Fuel Quality Tester.
3. Fill the hydrometer with the fuel sample by doing the following:
   1. Squeeze the hydrometer bulb.
   2. Submerse the hydrometer tip into the sample.
   3. Release the bulb, allowing fuel to enter the glass tube until the fuel completely floats the glass bulb inside the tube.
   4. Gently spin the hydrometer to relieve the surface tension of the fuel sample. Read the scale on the glass bulb at the point where the top of the fuel sample contacts the scale. By reading this value, the value will give an approximate fuel oil specific gravity. Refer to tool instructions on how to determine API Gravity.

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4. Refer to the Fuel Oil Specific Gravity Requirements table. If the correct fuel is being used in the conditions listed in Fuel Quality, and meets number 1-Diesel or number 2-Diesel fuel oil specific gravity requirements, fuel is OK. If not, the fuel should be replaced.

CHARGE AIR COOLER DIAGNOSIS (LEAK 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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Reference Information

Special Tools

- **EN-47603** Compression Gauge Adapter
- **EN-46091** Charge Air Cooler Tester
- **EN-46091-10A** Diesel Engine Pressure Test Adapter

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)** .

EN 46091-1 Pressure Regulator Adjustment

NOTE: **Some EN-46091-1 regulators may have the adjusting knob riveted in place. The rivet head must be drilled out with a 5/16 inch drill bit before adjustment. Do not drill more than 1/8 inch in depth, or just enough to remove the rivet head. The rivet shaft does not have to be removed from the regulator.**

1. Connect the **EN-47603** to the **EN-46091-1** gauge set outlet and connect shop air to the **EN-47603** .
2. Open the shutoff valve, then slowly adjust the regulator on the **EN-46091-1** until the gauge reads 55 kPa (8 psi).
3. Close the air supply valve and remove the **EN-47603** from the gauge assembly.
4. The gauge set is now calibrated to perform the test.

Induction System Inlet Connection

1. Loosen the rear air cleaner outlet duct clamp at the turbocharger compressor inlet.
2. Disconnect the rear air cleaner outlet duct from the air cleaner upper housing.
3. Use the existing clamp to attach the **EN-46091-10A** to the air cleaner outlet duct and tighten the clamp securely.
4. Tighten the rear air cleaner outlet duct clamp at the turbocharger compressor inlet.
5. Attach the safety cable on the **EN-46091-10A** to a suitable location.

Air Pressure Application

1. Attach the **EN-46091-1** outlet hose to the quick disconnect fitting on **EN-46091-10A** .
2. Connect the air supply to the air valve on the gauge/regulator assembly.
3. Open the air supply valve slowly, increasing the air pressure to a maximum of 55 kPa (8 psi).

Leak Test

1. Verify air leaks do not exist by listening for excessive hissing sounds and using a pump spray bottle to apply a soapy water solution, while observing for excessive soapy bubbles at the locations listed below:
    - All air induction system hose clamps.
    - Air cleaner outlet duct.

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- Charge air cooler inlet and outlet hoses and ducts.
- Charge air cooler.
- Intake manifold gaskets and seals.
- **If an air leaks exists**

  Repair or replace the affected gasket, seal, clamp or component as necessary and repeat step 1.

- **Go to next step: If no air leaks exist**

2. All OK

CHARGE AIR COOLER DIAGNOSIS (SMOKE 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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Circuit/System Description

The purpose of the Induction System Smoke Test is to aid in finding an air leak anywhere in the induction system including the crankcase ventilation system.

Reference Information

Special Tools

- **GE-41413-A** Evaporative Emission System Tester (EEST)
- **GE-41413-311** Brass Cone Adapter
- **GE-41413-SPT** High Intensity White Light

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)** .

Smoke Test Application

1. Ignition OFF, disconnect the E45 Positive Crankcase Ventilation Heater from the air cleaner outlet duct, refer to **Air Cleaner Outlet Duct Replacement** .
2. Remove the air cleaner element, refer to **Air Cleaner Element Replacement** . Place a disposable plastic bag over the air outlet in the air cleaner housing.
3. Connect the **GE-41413-A** to the **GE-41413-311** .
4. Wrap a shop towel around the **GE-41413-311** to create a seal, and place the **GE-41413-311** into the opening for the PCV heater in the air cleaner outlet duct.
5. Apply smoke continuously while moving all duct work, pipes, and tubes.

NOTE:

- **To improve the visibility of the smoke exiting the engine, illuminate the suspected leak area with the GE-41413-SPT and observe the area from different angles.**
- **Commanding the intake air flow valve closed with a scan tool can help to increase the volume of smoke within the CAC and induction tubes.**

6. Verify smoke is not visible exiting the engine, including the components listed below:
   - All air induction system hose clamps.
   - Air cleaner outlet duct.
   - Charge air cooler inlet and outlet hoses.
   - Charge air cooler.

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- Intake manifold gaskets and seals.
- Mass airflow sensor.
- Positive crankcase ventilation hoses/pipes/tubes.
- Positive crankcase ventilation oil separator.
- **If smoke is visible**

  Repair or replace the affected gasket, seal, clamp or component as necessary and repeat step 5.

- **Go to next step: If smoke is not visible**

7. Refer to Charge Air Cooler Diagnosis (Leak Test)Charge Air Cooler Diagnosis (Smoke Test) and perform the Charge Air Cooler Diagnosis (Induction System Air Leak Test).

CONTAMINANTS-IN-FUEL DIAGNOSIS

Fungi and other microorganisms can survive and multiply in diesel fuel if water is present. The fungi can be present in any part of the fuel handling system. These fungi grow into long strings and will form into large globules. The growths appear slimy and are usually black, green, or brown. The fungi may grow anywhere in the fuel but are most plentiful where diesel fuel and water meet. Service station tanks may contain fungi that could be pumped into a vehicle during refueling.

Fungi use the fuel as their main energy supply and need only trace amounts of water and minerals. As they grow and multiply, they change fuel into water, sludge, acids, and products of metabolism. The most common symptom is fuel filter plugging, however various metal fuel system components including fuel sender assembly, pipes, fuel injectors, and fuel injection pump can corrode.

WARNING: **Avoid physical contact with the biocides in order to avoid personal injury.**

If fungi have caused fuel system contamination, use a diesel fuel biocide to sterilize the fuel system. Do not exceed the dosage recommended on the label. Discontinue the use of a biocide when towing a trailer due to possible engine power loss. It is permissible to have biocide in the fuel when starting to tow, but do not add any biocide while towing.

Water or other like contaminates in fuel will also create driveability concerns and loss of engine power. If water is present in the fuel system, the fuel cannot cool and lubricate the components, causing overheating, rust and corrosion. This can result in component failure. Water can enter the fuel system in several ways, either through a contaminated refueling source, or through long term condensation the vehicle fuel tanks.

Like fungi and water, gasoline contamination will cause driveability concerns and a possible hard starting or a no start condition if the overall content is large enough. Gasoline raises the API rating and reduces cooling and lubrication, resulting in possible component failure.

It is acceptable to use diesel fuel containing up to 20 percent bio-diesel. Bio-diesel is produced from vegetable oils or animal fat that have been chemically modified to reduce the possibility of damage to the fuel system and engine components. Concentrations greater than B20 fuels or the use of unmodified bio-oils blended into diesel fuel at any concentration is not recommended and may cause driveability concerns or component failure.

Because of the cleansing properties of bio-diesel, switching from straight diesel to a bio-diesel blend can prematurely restrict the fuel filter with normal deposits in the fuel system. A fuel filter replacement might be required sooner than the recommended interval.

Diesel Fuel Containing Red Dye in the United States and Canada

The Governments of the United States and Canada impose an excise tax on diesel fuel. However, certain fuel uses are tax-exempt or subject to a reduced rate. These uses include: heating, farming, off-road vehicles, use by state or local governments or non-profit educational organizations, and boats engaged in fishing or transportation.

The red dye is added to ensure diesel fuels with high sulfur content are not used for on-road vehicles and to ensure tax-exempt diesel fuel is not used for taxable purposes. After 2012, the only diesel fuel

produced containing high-sulfur in the United States and Canada is heating oil.

The use of red diesel fuel will not cause any problems with the fuel or exhaust aftertreatment systems.

Inspecting for Fuel Contaminants

1. Test the fuel specific gravity and record the results. Refer to **Fuel Specific Gravity Testing**
2. Remove the fuel filter and inspect the inside area of the fuel filter for dirt, water deposits, microbial contamination, or other debris.
3. Drain the fuel filter into an approved clear container and allow the contents to settle. Observe the container for contaminant separation.

NOTE: **The presence of water or gasoline in diesel fuel may also cause damage to other fuel system components.**

4. If contaminants are present in the fuel or in any of the inspected areas, remove the fuel lines to the injectors and inspect the fuel injector return outlets and feed inlets for rust or corrosion.

- Replace the fuel injectors if rust or corrosion is present. Refer to **Fuel Injector Replacement** , and **Fuel System Cleaning** .
- If rust or corrosion was not present in the injectors, but contaminated fuel was present, refer to **Fuel System Cleaning** and attempt to start and run the engine after procedure is completed.
- If rust, corrosion or water is present, test the Water in Fuel Sensor for proper operation. Refer to **Water-in-Fuel Lamp Diagnosis**

CONTAMINANTS-IN-DIESEL EXHAUST FLUID DIAGNOSIS

Description

Maximum oxides of nitrogen (NOx) reduction efficiency of the selective catalyst reduction system requires the supply of diesel exhaust fluid (reductant). Consisting of a mixture of urea and deionized water, fresh reductant should be clear in color with an ammonia smell. Reductant designed for selective catalyst reduction systems should carry one or more of the following international certifications:

- DIN70700
- ISO 22241-1
- American Petroleum Institute (API) Certification

Inspecting for Contaminates

While contamination may result from any number of fluids, it's more likely that contamination will involve one the following common automotive fluids. As clean reductant is clear, contamination by any of these fluids will cause the reductant to exhibit a trace of color associated with a specific contaminate.

- Windshield washer solvent - orange, purple or blue
- Engine coolant - orange or green
- Engine oil - brown
- Transmission fluid - red or brown
- Diesel fuel - clear, yellow, green, red or brown

Clear fluid without the presence of an ammonia odor may indicate water or reductant diluted with water.

Reference Information

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 26568** Coolant and Battery Fluid Tester

OR

- **EN 50422** Diesel Exhaust Fluid Refractometer

Circuit/System Testing

WARNING: **Diesel Exhaust Fluid (DEF) is corrosive. Do not allow it to come in contact with your skin, eyes, or the finished surfaces of the vehicle. If exposed, it may cause skin and eye irritation. Wear skin and eye protection when handling. Inhalation may cause irritation to the upper respiratory tract. Store in a cool, well-ventilated area. For more safety information, see the label of the Diesel Exhaust Fluid container. Failure to follow this procedure may result in injury and/or vehicle damage.**

1. Test a sample of reductant by collecting about 150 ml (5 oz) from the reductant tank in a clear container. Observe the reductant sample. The reductant sample should have an ammonia smell and should be clear with no obvious coloration when held up to a light.
   - **If the sample does not have an ammonia smell or is discolored**
   1. If the sample is contaminated with engine coolant or windshield washer solvent, flush the reductant system.

      NOTE: **If the engine was never started and the sample is contaminated with diesel fuel, engine oil, transmission oil, or other petroleum-based product, only replace the emission reduction fluid tank and flush the emission reduction fluid tank opening filler.**

   2. If the engine has been started and the sample is contaminated with diesel fuel, engine oil, transmission oil, or other petroleum-based product, flush the emission reduction fluid tank opening filler with fresh reductant, and replace the following components:
   - Emission reduction fluid tank
   - Emission reduction fluid reservoir assembly
   - A38 Emission Reduction Fluid Pump Module
   - Q61 Emission Reduction Fluid Injector
   - Emission reduction fluid reduction injector supply pipe
   - **Go to next step: If the sample has an ammonia smell and is not discolored**
2. Test the reductant sample using one of the tools listed below:
   - **J 26568**

     OR

   - **EN 50422**
3. Verify the sample is within the range specified below:
   - **J 26568** - Between 1.310 and 1.3843 at 20Â°C (68Â°F)
   - **EN 50422** - Between 30% and 35%.
   - **If not within the specified range**

     Drain the remaining reductant and refill the tank with fresh reductant

   - **Go to next step: If within the specified range**
4. Perform the Reductant System Tamper Warning Service Bay Test with a scan tool.
5. Verify the test passes.
   - **If the test does not pass**

     Replace the reductant

   - **Go to next step: If the test passes**

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6. All OK.

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. Ignition Off, all vehicle systems Off, this may take up to 2 minutes.

NOTE: **The reductant and ambient air temperatures must be greater than -7Â°C (19Â°F) before proceeding with this procedure.**

5. Ignition On, command the Reductant System Leak Test On with a scan tool. Allow the pressure to build for at least 2 minutes.
6. Verify there are no leaks in the system.
   - **If a leak is found**

     Repair as necessary

   - **Go to next step: If no leaks are found**
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, to verify the DTC does not set.
   - **If a DTC sets**

     Refer to the **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a DTC does not set**
8. All OK.

DIESEL EXHAUST FLUID (DEF) WARNING STRATEGY (DEF LEVEL)

An adequate on-board supply of Diesel Exhaust Fluid (DEF) is critical for the reduction of exhaust Oxides of Nitrogen (NOx) levels within the Selective Catalyst Reduction (SCR) stage. This vehicle provides the driver with an elaborate series of prompts and warnings that are initiated when the DEF level falls below a calibrated value.

The Engine Control Module (ECM) monitors the DEF level and consumption rate in order to calculate an estimated range in miles remaining until the DEF reservoir is empty. DEF levels are detected by the 3-position solid-state DEF level sensor. Typically, DEF warnings begin once the estimated mileage falls below 1, 609 km (1, 000 mi). Once initiated, DEF warnings grow increasingly more serious as the remaining mileage decreases without a DEF refill. The vehicle's current DEF warning level is displayed on the scan tool as Reductant Level Warning Indicator Command Level 1 through Level 14.

Warning Level 1

Warning Level 1 is triggered when the DEF level falls below the top-most position of the DEF Level Sensor and the estimated range remaining is greater than 1609 km (1000 mi). No prompts or warnings are presented to the driver.

Warning Level 2

Warning Level 2 is triggered when the estimated range remaining falls below 1, 609 km (1, 000 mi) based on current DEF consumption rates. The Driver Information Center (DIC) displays the message Exhaust Fluid Range X MI, where X is the estimated range remaining in miles. This message remains on the DIC until acknowledged by the driver.

Warning Level 3

Warning Level 2 automatically advances to Warning Level 3 when the ECM detects an ignition On to ignition Off event. A level 3 warning remains active as long as the estimated range remaining is greater than 483 km (300 mi) based on current DEF consumption rates.

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Warning Level 4

Warning Level 4 is triggered when the estimated range remaining falls below 483 km (300 mi) based on current DEF consumption rates. The message Exhaust Fluid Range X MI, where X is the estimated range remaining in miles is displayed in the DIC. This message is also displayed at the beginning of each ignition cycle. This message remains on the DIC until acknowledged by the driver.

Warning Level 5

Warning Level 5 is triggered when the estimated range remaining is less than approximately 121 km (75 mi) based on current DEF consumption rates. The message Exhaust Fluid Low - Speed Limited Soon, is displayed on the DIC. This message is also displayed at the beginning of each ignition cycle. This message remains in the DIC until acknowledged by the driver.

Warning Level 6

Warning Level 6 is triggered when the estimated range remaining is less than approximately 0 km (0 mi) based on current DEF consumption rates. The driver will hear 4 chimes on entering Warning Level 6. The DIC displays the following messages:

For Non-Emergency vehicles and Emergency vehicles MY 2013 and older:

- Exhaust Fluid Empty Refill Now
- 644 km (400 miles) until 105 km/h (65 mph) Max Speed

For Emergency vehicles MY 2014 and newer:

- Exhaust Fluid Empty Refill Now
- 999 km (620 miles) until 105 km/h (65 mph) Max Speed

The messages are also displayed at the beginning of each ignition cycle. The Exhaust Fluid Empty Refill Now message remains on the DIC until acknowledged by the driver. The Max Speed mileage countdown until speed limitation will remain displayed in the DIC.

The DEF Indicator in the instrument panel is continuously illuminated. The vehicle remains in Warning Level 6 until the DEF reservoir is refilled or the first mileage countdown expires.

After the first mileage countdown expires, the system will advance from Warning Level 6 to Warning Level 7.

Warning Level 7

Warning Level 7 is active after the first mileage countdown expires. The driver will hear 4 chimes on entering Warning Level 7. The DIC displays the following messages:

- Exhaust Fluid Empty Refill Now
- Transitioning to 105 km/h (65 mph) Max Speed

The messages are alternately displayed every 5 seconds on the DIC. Exhaust Fluid Empty Refill Now remains on the DIC until acknowledged by the driver; however, the Transitioning to 105 km/h (65 mph) Max Speed remains displayed in the DIC.

The DEF Indicator in the instrument panel is continuously illuminated.

Vehicle speed limit is ramping down from Max Speed limit to the limit of 105 km/h (65 mph).

Warning Level 8

Warning Level 8 is triggered after the speed limit ramp-down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 8. The DIC displays the following messages:

- Exhaust Fluid Empty Refill Now
- Speed Limited to 105 km/h (65 mph)

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- 120 km (75 miles) until 89 km/h (55 mph) Max Speed

The messages are alternately displayed every 5 seconds on the DIC. The Exhaust Fluid Empty Refill Now message remains in the DIC until acknowledged by the driver and occurs every ignition cycle. The speed limited and mileage countdown for speed limitation remain displayed in the DIC

The DEF Indicator in the instrument panel is continuously illuminated. The vehicle remains in Warning Level 8 until the DEF reservoir is refilled or the second mileage countdown expires.

Vehicle speed is limited to 105 km/h (65 mph).

Warning Level 9

Warning Level 9 is triggered after the second mileage countdown expires without a refill of the DEF reservoir. The driver will hear 4 chimes on entering Warning Level 9. The DIC displays the following messages:

- Exhaust Fluid Empty Refill Now
- Transitioning to 89 km/h (55 mph) Max Speed

The messages are alternately displayed every 5 seconds on the DIC. Exhaust Fluid Empty Refill Now remains in the DIC until acknowledged by the driver; however, the Transitioning to 89 km/h (55 mph) Max Speed message remains displayed in the DIC.

The DEF Indicator in the instrument panel flashes continuously.

Vehicle speed limit is ramping down from 105 km/h (65 mph) Max Speed limit to 89 km/h (55 mph).

Warning Level 10

Warning Level 10 is triggered after the speed limit ramp-down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 10. The 4 chimes are repeated 2 more times during this ignition cycle. The DIC displays the following messages:

- Exhaust Fluid Empty Refill Now
- Speed Limited to 89 km/h (55 mph)
- 120 km (75 miles) until 7 km/h (4 mph) Max Speed

The messages are alternately displayed every 5 seconds in the DIC. Exhaust Fluid Empty Refill Now remains in the DIC until acknowledged by the driver; however, the speed limited and mileage countdown for speed limitation remain displayed in the DIC.

The DEF Indicator in the instrument panel flashes continuously. The vehicle remains in Warning Level 10 until the DEF reservoir is refilled or the third mileage countdown expires.

Vehicle speed is limited to 89 km/h (55 mph).

Warning Level 11

Warning Level 11 is not used.

Warning Level 12

Warning Level 12 is not used.

Warning Level 13

Warning Level 13 is triggered after the third mileage countdown expires without a refill of the DEF reservoir. The driver will hear 4 chimes on entering Warning Level 13. The DIC displays the following messages:

- Exhaust Fluid Empty Refill Now
- Transitioning to 7 km/h (4 mph) Max Speed

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The messages are alternately displayed every 5 seconds in the DIC. Exhaust Fluid Empty Refill Now remains in the DIC until acknowledged by the driver; however, the Transitioning to 7 km/h (4 mph) Max Speed message remains displayed in the DIC.

The DEF Indicator in the instrument panel flashes continuously. Vehicle speed limit is ramping down from 89 km/h (55 mph) max speed limit to 7 km/h (4 mph).

Warning Level 14

Warning Level 14 is triggered after the speed limit ramp-down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 14. The 4 chimes are repeated every 3 minutes. The DIC displays the following messages:

- Exhaust Fluid Empty Refill Now
- Speed Limited to 7 km/h (4 mph)

The messages are alternately displayed every 5 seconds in the DIC. Exhaust Fluid Empty Refill Now remains in the DIC until acknowledged by the driver; however, the Speed Limited to 7 km/h (4 mph) message remains displayed in the DIC.

The DEF Indicator in the instrument panel flashes continuously. The vehicle remains in Warning Level 14 until the DEF reservoir is refilled.

Vehicle speed is limited to 7 km/h (4 mph).

DIESEL EXHAUST FLUID (DEF) WARNING STRATEGY (DEF QUALITY)

A supply of clean, fresh Diesel Exhaust Fluid (DEF) is critical for optimum Selective Catalyst Reduction (SCR) efficiency. SCR efficiency is determined by monitoring the Nitrogen Oxide (NOx) sensors located upstream and downstream of the SCR. This vehicle provides the driver with an elaborate series of prompts and warnings that are initiated when the Engine Control Module (ECM) detects a drop in the SCR NOx reduction efficiency suggesting a diluted or contaminated DEF supply.

When contaminated or diluted DEF is suspected, the ECM initiates the DEF Quality warning process. Once initiated, DEF quality warnings grow increasingly more serious as the vehicle continues to be driven. The vehicle's current DEF quality warning status is displayed on the scan tool. When a drop in SCR efficiency is detected, the normally Off Reductant Field Quality Warning Indicator Command will display Warning Level 1 through Warning Level 11 depending on the number of miles driven. The series of DEF Quality Warnings alert the driver that DEF system service is urgently needed.

Warning Level 1

Warning Level 1 is triggered when the ECM first detects the SCR efficiency is below a calibrated value. The Driver Information Center (DIC) displays the following messages:

For Non-Emergency vehicles and Emergency vehicles MY 2013 and older:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- 160 km (99 miles) until 105 km/h (65 mph) Max Speed

For Emergency vehicles MY 2014 and newer:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- 999 km (620 miles) until 105 km/h (65 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the mileage countdown remains displayed in the DIC. The DEF Indicator in the instrument panel is illuminated.

Warning Level 2

Warning Level 2 is triggered after the first mileage countdown expires without a DEF fluid service. The driver will hear 4 chimes on entering Warning Level 2. The DIC displays the following messages:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- Transitioning to 105 km/h (65 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the Transitioning to 105 km/h (65 mph) Max Speed remains displayed in the DIC. The DEF Indicator in the instrument panel is illuminated. Vehicle speed limit is ramping down from max speed limit to the limit of 105 km/h (65 mph).

Warning Level 3

Warning Level 2 automatically advances to Warning Level 3 after speed limit ramp down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 3. The DIC displays the following messages:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- Speed Limited to 105 km/h (65 mph)
- 120 km (75 miles) Until 89 km/h (55 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the speed limitation and mileage countdown remains displayed on the DIC. The DEF Indicator in the instrument panel is illuminated.

Vehicle speed is limited to 105 km/h (65 mph).

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Warning Level 4

Warning Level 4 is triggered after the second mileage countdown expires without a DEF fluid service. The driver will hear 4 chimes on entering Warning Level 4. The DIC displays the following messages:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- Transitioning to 89 km/h (55 mph)

The messages alternate every 5 seconds until acknowledged by the driver; however, the Transitioning to 89 km/h (55 mph) remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously. Vehicle speed limit is ramping down from 105 km/h (65 mph) max speed limit to 89 km/h (55 mph).

Warning Level 5

Warning Level 5 is triggered after the speed limit ramp down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 5. The series of 4 chimes will repeat 3 additional times every 3 minutes. The DIC displays the following messages:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- Speed Limited to 89 km/h (55 mph)
- 120 km (75 miles) Until 7 km/h (4 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the speed limitation and mileage countdown remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously.

Vehicle speed is limited to 89 km/h (55 mph).

Warning Level 6

Warning Level 6 is not used.

Warning Level 7

Warning Level 7 is not used.

Warning Level 8

Warning Level 8 is not used.

Warning Level 9

Warning Level 9 is not used.

Warning Level 10

Warning Level 10 is triggered after the third mileage counter expires without a DEF fluid service. The driver will hear 4 chimes on entering Warning Level 10. The DIC displays the following messages:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- Transitioning to 7 km/h (4 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the Transitioning to 6 km/h (4 mph) Max Speed remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously. Vehicle speed limit is ramping down from 89 km/h (55 mph) max speed limit to 7 km/h (4 mph).

Warning Level 11

Warning Level 11 is triggered after the speed limit ramp down is complete or a key cycle. The driver will hear 4 chimes every 3 minutes on entering Warning Level 11. The series of 4 chimes will repeat every 3 minutes. The DIC displays the following messages:

- Exhaust Fluid Quality Poor
- Refer to Owner's Manual Now
- Speed Limited to 7 km/h (4 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the Speed Limited to 7 km (4 mph) Max Speed remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously.

Vehicle speed is limited to 7 km/h (4 mph).

DIESEL EXHAUST FLUID (DEF) WARNING STRATEGY (ANTI-TAMPERING)

The reductant system supplies the Selective Catalyst Reduction (SCR) stage of the vehicle's exhaust after treatment system with the Diesel Exhaust Fluid (DEF) required to reduce exhaust Oxides of Nitrogen (NOx) levels. The Engine Control Module (ECM) continuously monitors the performance of the reductant system during operation.

When the conditions associated with an attempt to disable reductant system operation are detected, the ECM activates the anti-tampering feature and presents the driver with a series of prompts and warnings.

Once initiated, anti-tampering warnings grow increasingly more serious as the vehicle continues to be driven. The vehicle's current warning status is displayed on the scan tool. When tampering is suspected, the normally Off Reductant System Malfunction Warning Indicator Command will display Warning Level 1 through Warning Level 11 depending on the number of miles driven. The series anti-tampering warnings alert the driver that reductant system service is urgently needed.

Warning Level 1

Warning Level 1 is triggered when the ECM first detects an abnormal value on a reductant system circuit. The Driver Information Center (DIC) displays the following messages:

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For Non-Emergency vehicles and Emergency vehicles MY 2013 and older:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- 160 km (99 miles) until 105 km/h (65 mph) Max Speed

For Emergency vehicles MY 2014 and newer:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- 999 km (620 miles) until 105 km/h (65 mph) Max Speed

The messages alternate every 5 seconds in the DIC until acknowledged by the driver; however, the mileage countdown message remains in the DIC. The DEF Indicator in the instrument panel is illuminated.

Warning Level 2

Warning Level 2 is triggered after the first mileage counter expires. The driver will hear 4 chimes on entering Warning Level 2. The DIC displays the following messages:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- Transitioning to 105 km/h (65 mph) Max Speed

The messages alternate every 5 seconds in the DIC until acknowledged by the driver; however, the Transitioning to 105 km/h (65 mph) Max Speed remains in the DIC. The DEF Indicator in the instrument panel is illuminated. Vehicle speed limit is ramping down from max speed limit to the limit of 105 km/h (65 mph).

Warning Level 3

Warning Level 2 automatically advances to Warning Level 3 after the speed limit ramp down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 3. The DIC displays the following messages:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- Speed Limited to 105 km/h (65 mph)
- 120 km (75 miles) Until 89 km/h (55 mph) Max Speed

The messages alternate every 5 seconds in the DIC until acknowledged by the driver; however, the Speed Limited to 105 km/h (65 mph) remains in the DIC. The DEF Indicator in the instrument panel is illuminated.

Vehicle speed is limited to 105 km/h (65 mph).

Warning Level 4

Warning Level 4 is triggered after the second mileage counter expires. The driver will hear 4 chimes on entering Warning Level 4. The DIC displays the following messages:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- Transitioning to 89 km/h (55 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the Transitioning to 89 km/h (55 mph) Max Speed remain displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously. Vehicle speed limit is ramping down from 105 km/h (65 mph) max speed limit to 89 km/h (55 mph).

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Warning Level 5

Warning Level 4 automatically advances to Warning Level 5 after speed limit ramp down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 5. The series of 4 chimes will repeat 3 times every 3 minutes during each ignition cycle until the vehicle is serviced. The DIC displays the following messages:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- Speed Limited to 89 km/h (55 mph)
- 120 km (75 miles) Until 7 km/h (4 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the speed limitation and mileage countdown remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously.

Vehicle speed is limited to 89 km/h (55 mph)

Warning Level 6

Warning Level 6 is not used

Warning Level 7

Warning Level 7 is not used

Warning Level 8

Warning Level 8 is not used

Warning Level 9

Warning Level 9 is not used

Warning Level 10

Warning Level 5 automatically advances to Warning Level 10 after third mileage counter expires or a key cycle. The driver will hear 4 chimes on entering Warning Level 10. The DIC displays the following messages:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- Transitioning to 7 km/h (4 mph)

The messages alternate every 5 seconds until acknowledged by the driver; however, the Transitioning to 7 km/h (4 mph) remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously. Vehicle speed limit is ramping down from 89 km/h (55 mph) max speed limit to 7 km/h (4 mph).

Warning Level 11

Warning Level 10 automatically advances to Warning Level 11 after speed limit ramp down is complete or a key cycle. The driver will hear 4 chimes on entering Warning Level 11. The series of 4 chimes will repeat every 3 minutes until the vehicle is serviced. The DIC displays the following messages:

- Service Exhaust Fluid System
- Refer to Owner's Manual Now
- Speed Limited to 7 km/h (4 mph)

The messages alternate every 5 seconds until acknowledged by the driver; however, the Speed Limited to 7 km/h (4 mph) remains displayed in the DIC. The DEF Indicator in the instrument panel flashes continuously.

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Vehicle speed is limited to 7 km/h (4 mph).

DIESEL EXHAUST FLUID (DEF) WARNING STRATEGY (EMISSION CONTROL)

The reductant system supplies the Selective Catalyst Reduction (SCR) stage of the vehicle's exhaust aftertreatment system with the Diesel Exhaust Fluid (DEF) required to reduce exhaust Oxides of Nitrogen (NOx) levels. The Engine Control Module (ECM) continuously monitors the performance of the emission system during operation

When the conditions associated with a fault in the emission system operation are detected, the ECM activates the emission control feature and presents the driver with a series of prompts and warnings.

Once initiated, emission control warnings grow increasingly more serious as the vehicle continues to be driven. The vehicle's current warning status is not displayed on the scan tool. The series emission control warnings alert the driver that EGR/SCR system service is urgently needed.

NOTE: **The Emission Control warning strategy is not used in model year 2014 and newer emergency vehicles.**

Warning Level 1

Warning Level 1 is triggered when the ECM first detects an EGR or SCR dosing inhibit fault. The Driver Information Center (DIC) displays the following messages:

- Service Emission System
- Refer to Owner's Manual Now
- 282 km (175 miles) until 105 km/h (65 mph) Max Speed

The messages alternate every 5 seconds and remain in the DIC until acknowledged by the driver, however the mileage countdown remains displayed in the DIC.

Warning Level 2

Warning Level 2 is triggered after the first mileage countdown expires without vehicle service. The driver will hear 4 chimes on entering Warning Level 2. The DIC displays the following messages:

- Service Emission System
- Refer to Owner's Manual Now
- Transitioning to 105 km/h (65 mph) Max Speed

The messages alternate every 5 seconds in the DIC until acknowledged by the driver.

Warning Level 3

Warning Level 2 automatically advances to Warning Level 3 after speed limit ramp down is complete or a key Off for at least 2 minutes. The driver will hear 4 chimes on entering Warning Level 3. The DIC displays the following messages:

- Service Emission System
- Refer to Owner's Manual Now
- Speed Limited to 105 km/h (65 mph)
- 120 km (75 miles) Until 89 km/h (55 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver; however, the Speed Limited to 105 km/h (65 mph), remains displayed in the DIC.

Vehicle speed is limited to 105 km/h (65 mph).

Warning Level 4

Warning Level 4 is not used.

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Warning Level 5

Warning Level 5 is not used.

Warning Level 6

Warning Level 6 is triggered when the second mileage countdown expires without vehicle service. The driver will hear 4 chimes on entering Warning Level 6. The DIC displays the following messages:

- Service Emission System
- Refer to Owner's Manual Now
- Transitioning to 89 km/h (55 mph) Max Speed

The messages alternate every 5 seconds until acknowledged by the driver.

Warning Level 7

Warning Level 6 automatically advances to Warning Level 7 after speed limit ramp down is complete or a key Off for at least 2 minutes. The driver will hear 4 chimes upon entering Warning Level 7. The series of 4 chimes will repeat every 3 minutes until the vehicle is serviced. The DIC displays the following messages:

- Service Emission System
- Refer to Owner's Manual Now
- Speed Limited to 89 km/h (55 mph)

The messages alternate every 5 seconds until acknowledged by the driver, however, the Speed Limited to 89 km/h (55 mph), remains displayed in the DIC.

DIESEL PARTICULATE FILTER (DPF) REGENERATION ENABLE

Description

A service regeneration of the diesel particulate filter (DPF) is required when the scan tool DPF Accumulation Status parameter displays 30 grams or more of accumulated soot. When commanded, the engine control module (ECM) controls the service regeneration as follows:

1. The exhaust system is warmed up for about 8 minutes. Engine speed is slowly increased to 2, 000 RPM and then to 2, 500 RPM.
2. Once the DPF reaches its calibrated regeneration temperature, the ECM maintains engine speed between 2, 000 - 2, 500 RPM for about 20 minutes until regeneration is complete, is cancelled by the technician, or is aborted due to abnormal conditions.
3. The ECM then slowly decreases engine speed to 1600 RPM, then to 800 RPM, and finally to normal idle speed over a 5 minute period. This is done to allow the DPF to cool down.

The following conditions must be met in order to enable DPF Service Regeneration:

- DTCs P2463 is the only active DTC.
- The battery voltage is greater than 10 V.
- The engine speed is between 500 - 2, 700 RPM.
- The vehicle speed is 0.
- The transmission is not in Drive or Reverse
- The exhaust gas temperature (EGT) sensors 1 is between 20 - 500Â°C (68 - 932Â°F).
- The exhaust gas temperature (EGT) sensors 3 is between 20 - 735Â°C (68 - 1, 355Â°F).
- The engine coolant temperature (ECT) sensor is greater than 70Â°C (158Â°F).
- The fuel temperature is less than 150Â°C (302Â°F).
- The BARO pressure is greater than 40 kPa (5.8 psi)
- The APP sensor is less than 1 percent.
- The diesel exhaust fluid temperature is greater than -7Â°C (+19Â°F).

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- The diesel exhaust fluid tank is not empty.
- The brake pedal and accelerator pedal are in the released position.
- The transmission is in Park or Neutral.

The DPF Service Regeneration will be terminated if any of the following conditions occur:

- The DPF Service Regeneration is commanded Off using the scan tool.
- The scan tool is disconnected from the vehicle.
- The vehicle is shifted out or Park or Neutral.
- The brake or accelerator pedal is applied.

Diagnostic Aids

The scan tool DPF Regeneration Inhibit reason parameter will display a reason for not enabling or aborting the DPF service regeneration. Refer to the reasons that are displayed and the corrective action for each reason.

Service Regeneration Unsuccessful

DPF Regeneration Parameters	Unsuccessful Regeneration - Number of Completed Regenerations Did Not Increment By One	Corrective Action For An Unsuccessful Regeneration
DPF Service Regeneration Inhibit Reason	APP - The APP position sensor indicated over 1 percent	Ensure the accelerator pedal was not applied during the service regeneration. • If the accelerator pedal was not applied, test the accelerator pedal position (APP) sensor.
	BPP Applied - The brake pedal position indicated Applied.	Ensure that the brake pedal was not applied during the service regeneration procedure. • If the brake pedal was not applied, test the brake pedal switch.
	NOTE: **The scan tool must remain connected to the data communication link (DCL) during the entire service regeneration procedure.** Device Control - The scan tool has interrupted service regeneration. A loss of communication between the scan tool and the vehicle has occurred.	• The scan tool Exit or Off soft key button was depressed. • Inspect for a poor connection at DCL.

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DPF Regeneration Parameters	Unsuccessful Regeneration - Number of Completed Regenerations Did Not Increment By One	Corrective Action For An Unsuccessful Regeneration
	DPF Temperature - DPF service regeneration temperatures are less than a calibrated threshold.	• Observe the DTC information. • Test for a degraded diesel oxidation catalyst (DOC). • Test for a skewed exhaust temperature sensor, EGT sensor 2.
	Ignition Voltage - Battery voltage was less than 11 V.	Test the battery and charging system for proper operation.
	None	Refer to the DPF Regeneration Status parameter
	Not in Park - Transmission gear selector is not in Park.	Ensure that the transmission gear selector remained in Park during the Service Regeneration procedure. • If the gear selector remained in the Park position, test the transmission range switch and circuits.
DPF Normal Regeneration Inhibit Reason	Regeneration Timed Out	A regeneration has timed out attempting a regeneration for greater than 90 minutes for this key cycle
	EGT 2 High	Exhaust temperature sensor 2 greater than 750Â°C (1382Â°F)
	EGT 1 High	Exhaust temperature 1 greater than 650Â°C (1202Â°F)
	DTC Set	An active DTC is set
	Axle Torque Limit	Torque Limiting is active to prevent an engine overheat condition
	Decel Too Long	A long decel condition of greater than 40 s was active
	Fuel Level	Fuel level is below 15%
	TC Temp Too High	Turbocharger temperature is too high
	TCM Override	A condition within the TCM is present
	Eng Run Time	Engine has not run long enough to complete a regeneration or has not warmed to operating temperature
	DLC Override	A scan tool is connected to the DLC
	Idle Spd Override	Vehicle is shifted into Park or Neutral while a normal regeneration is active

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Reference Information

Description and Operation

Exhaust Aftertreatment System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

DPF Service Regeneration

WARNING: **Tailpipe outlet exhaust temperature will be greater than 300Â°C (572Â°F) during this procedure. To help prevent personal injury or property damage from fire or burns, perform the following:**

1. **Do not connect any shop exhaust removal hoses to the vehicle tailpipe.**
2. **Park the vehicle outdoors and keep people, other vehicles, and combustible material away during this procedure.**
3. **Do not leave the vehicle unattended.**

WARNING: **To avoid extremely elevated exhaust temperatures, inspect and remove any debris or mud build up at the exhaust cooler located at the tailpipe.**

CAUTION: **Due to the elevated engine temperatures created while performing this procedure it is imperative to keep the front of vehicle in an open environment, with the hood open, away from any walls or buildings. This will ensure proper airflow across the radiator.**

NOTE:

- **If you were not referred to this procedure from another diagnostic, DO NOT perform the Service Regeneration.**
- **Do not refuel the vehicle during DPF Service Regeneration.**
- **The scan tool must remain connected to the data communication link (DCL) during the entire service regeneration procedure.**
- **Do not perform the DPF Service Regeneration if the diesel exhaust fluid temperature (DEF) is less than -7Â°C (+19Â°F).**
- **Fuel level should be greater 15% to ensure a successful regeneration.**

1. Ignition On.
2. Park the vehicle outside the repair facility and away from any obstacles.
3. With the vehicle in Park, use the throttle to increase the engine speed to 3000 RPM while looking for the speedometer to move slightly (greater than 1 mph). If this signal noise exists, inch the vehicle forward, place in park and repeat until there is no response seen from the speedometer. This will avoid a vehicle speed based interrupt of the service regeneration.
4. Place the transmission in Park and apply the parking brake.
5. Clear the DTCs with a scan tool before commanding a DPF Service Regeneration.
6. Observe the scan tool DPF Regenerations Completed parameter and record the value.
7. Open the hood.
8. Check the following fluid levels before and after this procedure:
    - Reductant
    - Engine oil

- Engine coolant
- Power steering
- Transmission

NOTE: **Step 10 only applies to 2013 through 2015 model year vehicle.**

9. Perform the Ambient Air Temperature Reset with a scan tool if the vehicle has been driven in an outside temperature below -5Â°C (+23Â°F).
10. Select the DPF Service Regeneration in the Output Controls menu and follow the instruction on the scan tool.

NOTE: **If a scan tool message of Oil Temperature Out Of Range is displayed once a service regeneration is commanded, disregard the message and command the service regeneration procedure.**

11. Command the DPF Service Regeneration On with a scan tool.
    - If the service regeneration failed to start, repair the vehicle for the condition indicated by the scan tool DPF Regen Inhibit Reason parameter. Refer to the Service Regeneration Unsuccessful table.
12. When the service regeneration is complete, the DPF Regeneration Status parameter will display Complete and the DPF Regenerations Completed parameter will increment by 1 from the value previously recorded.
    - If the service regeneration failed to start, repair the vehicle for the condition indicated by the scan tool DPF Regen Inhibit Reason parameter. Refer to the Service Regeneration Unsuccessful table.

NOTE: **DTC P202E may set after a DPF Service Regeneration. The excessive exhaust temperatures created during a DPF Service Regeneration causes the diesel exhaust fluid (DEF) to crystallize. The crystallize reductant will cause the Q61 Emission Reduction Fluid Injector to stick. Idling the engine for 15 minutes will cause the reductant to liquefy and un-stick the injector.**

13. Allow the engine to cool by idling for an additional 15 minutes. Command the Reductant Injector On and Off several times with a scan tool.
14. Clear the DTCs with a scan tool.
15. Ignition Off for 90 s.

Repair Instructions

Perform the **Diagnostic Repair Verification** .

Refer to **Oxidation Catalytic Converter Replacement (LH7)** .

REDUCTANT INJECTION QUANTITY 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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Circuit/System Description

The selective catalytic reduction (SCR) system reduces oxides of nitrogen (NOx) emissions by injecting a metered amount of diesel exhaust fluid (DEF) or reductant into the exhaust gas stream entering the SCR catalyst. Within the SCR catalyst, the reductant reacts with the NOx to form nitrogen, carbon dioxide, and water vapor. Upstream and downstream NOx sensors provide the engine control module (ECM) with engine-out and tailpipe-out NOx levels. The ECM varies the amount of reductant added by varying the reductant injector duty-cycle in response to changes in engine-out NOx levels.

The ECM supplies voltage to the reductant injector on the injector high control circuit. The ECM turns On the reductant injector by grounding the low control circuit of the injector.

Diagnostic Aids

It is common for reductant to crystallize over the nozzle of the reductant injector. The crystals will dissolve with use and the reductant injector will resume full functionality. The Reductant Quantity test may need to be performed multiple times to dissolve the crystallized reductant before diagnosing the reductant injector for performance issues.

Reference Information

Schematic Reference

- **Diesel Exhaust Fluid (DEF) Warning Strategy (DEF Level)Diesel Exhaust Fluid (DEF) Warning Strategy (DEF Quality)Diesel Exhaust Fluid (DEF) Warning Strategy (Anti-tampering)Diesel Exhaust Fluid (DEF) Warning Strategy (Emission Control)**
- **Engine Controls Wiring Schematics 1.6L (LH7)**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Exhaust Aftertreatment System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EN 50422 Emission Reduction Fluid Test Kit

J 45873 Fuel Return Volume Test Kit

Circuit/System Testing

WARNING: **Diesel Exhaust Fluid (DEF) is corrosive. Do not allow it to come in contact with your skin, eyes, or the finished surfaces of the vehicle. If exposed, it may cause skin and eye irritation. Wear skin and eye protection when handling. Inhalation may cause irritation to the upper respiratory tract. Store in a cool, well-ventilated area. For more safety information, see the label of the Diesel Exhaust Fluid container. Failure to follow this procedure may result in injury and/or vehicle damage.**

NOTE:

- **Do not perform this diagnostic procedure unless you were sent here from another diagnostic procedure.**

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- **Do not perform the Reductant Quantity Test if the reductant temperature is colder than -7Â°C (19.5Â°F).**
- **The Reductant Quantity Test may need to be run multiple times to dissolve crystallized reductant and to restore proper flow pattern.**
- **The NOx Catalyst Reductant-Load Adaptive Value can affect the quantity of reductant in the Reductant Injector Quantity Test. To reset this value and ensure the accuracy of the test, the scan tool NOx Catalyst Reductant Loading Reset must be performed prior to performing this test.**
- **Once the injector begins cycling, the Reductant Quantity Test takes approximately 5 minutes to run and the ECM will end the test after approximately 14 minutes.**

1. Perform the scan tool **NOx Catalyst Reductant Loading Reset**

NOTE: **The gasket for the Q61 Emission Reduction Fluid Injector must be replaced when the injector is removed from the exhaust pipe.**

2. Remove the Q61 Emission Reduction Fluid Injector from the exhaust leaving the harness connector and reductant line connected.
3. Position the Q61 Emission Reduction Fluid Injector nozzle towards one of the graduated scale container from the **EN 50422** .

NOTE: **It may take up to two minutes for the injector to begin cycling.**

4. Command the Reductant Quantity Test On with a scan tool. Observe the injector spray pattern. 3 individual streams and atomization or mist of reductant should be observed.
   - **If the function does not perform as specified**
   1. Inspect the Q61 Emission Reduction Fluid Injector lines for damage or restrictions or for being plugged.
      - If a condition is found, repair as necessary
      - If no condition is found, replace the Q61 Emission Reduction Fluid Injector
   - **Go to next step: If the function performs as specified**
5. When the test completes, verify an injector flow of between 40 and 50 ml of fluid into the container.
   - **If not between 40 and 50 ml**
   1. Disconnect the Q61 Emission Reduction Fluid Injector from the supply line.
   2. Position the Q61 Emission Reduction Fluid Injector supply line towards the graduated scale container.

NOTE: **The Reductant Injection Quantity Test runs for approximately 5 minutes when turned on and cannot be stopped with the scan tool. The step below is performed using the scan tool Reductant System Leak Test control function.**

   3.
   4. Command the Reductant System Leak Test On with a scan tool.
   5. Command the Reductant System Leak Test Off when the supply line has flowed 40 ml.
   6. Verify 40 ml has flowed within 1 minute.
      - If not the specified value
      1. Inspect the Q61 Emission Reduction Fluid Injector supply line for damage or restrictions.
         - If a condition is found, repair or replace as necessary.
         - If no condition is found, replace the A38 Emission Reduction Fluid Supply Pump Module

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- If the specified value

7. Replace the Q61 Emission Reduction Fluid Injector.
- **Go to next step: If between 40 and 50 ml**

6. Return to referring document.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- Refer to **Emission Reduction Fluid Injector Replacement (AWD)** **Emission Reduction Fluid Injector Replacement (FWD)**
- Refer to **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (FWD)** **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Front AWD)** **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Rear AWD)**
- Refer to **Emission Reduction Fluid Supply Pump Module Replacement**

REDUCTANT SYSTEM MALFUNCTION SERVICE BAY TEST

Description

A Reductant System Malfunction Warning Service Bay Test is required when the Exhaust Fluid Quality Poor message is displayed on the driver information center (DIC). The Reductant System Malfunction Warning Service Bay Test is used to verify proper operation of the reductant system and clear the Diesel Exhaust Fluid Quality warning after the condition causing the warning has been repaired.

Conditions for Running

The following conditions must be met in order to enable the scan tool Reductant System Malfunction Warning Service Bay Test:

- Battery voltage is greater than 11 V.
- No DTCs are set.
- Vehicle speed is 0 km/h (MPH).
- Engine coolant temperature (ECT) sensor is between 60-100Â°C (140-212Â°F).
- Barometric pressure is greater than 70 kPa (10.2 PSI).
- Ambient air temperature is greater than -30Â°C (-22Â°F).
- Reductant temperature is greater than -7Â°C (19Â°F) and not frozen.
- Reductant level must be greater than 33%.
- Fuel temperature is less than 80Â°C (176Â°F).
- Engine is running.
- Brake pedal and accelerator pedal are in the released position.
- Clutch pedal (if equipped) is in the released position.
- Transmission is in Park or Neutral.
- Diesel particulate filter (DPF) regeneration is not active.
- Fuel tank is not empty.

Diagnostic Aids

The Reductant System Malfunction Warning Service Bay Test will not be allowed or will be terminated if any of the conditions listed below occur.

Reductant System Malfunction Warning Service Bay Test Inhibit Reason	Corrective action
Brake Pedal Applied	Verify the brake pedal was not applied during the Reductant System Malfunction Warning Service Bay

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	Test. If the pedal was not applied, test the brake pedal position sensor.
Clutch Pedal Applied	Verify the clutch pedal was not applied during the Reductant System Malfunction Warning Service Bay Test. If the pedal was not applied, test the clutch pedal position sensor.
APP	Verify the accelerator pedal was not applied during the Reductant System Malfunction Warning Service Bay Test. If the pedal was not applied, test the accelerator pedal position sensor.
Transmission must be in Park or Neutral	Verify the transmission gear selector remained in Park or Neutral during the Reductant System Malfunction Warning Service Bay Test. If the gear selector remained in Park or Neutral, test the transmission range switch and circuits.
Vehicle speed too high	Vehicle speed must be 0 km/h (0 MPH)
Battery Voltage Exceeds Limits	Battery voltage must be greater than 11 V
Engine Coolant Temperature Out of Range	Coolant temperature must be between 60 - 100Â°C (140 - 212Â°F)
Incorrect Power Mode	Verify ignition is in Run position
Soot Accumulation Out of Range	Perform the Diesel Particulate Filter (DPF) Service Regeneration
Activation Timer Has Expired	Verify that engine and exhaust system are at operating temperature
Engine Speed Out of Range	Engine must be running
Exhaust Gas Temperature Out of Range	Exhaust system must be at operating temperature and engine must be operating properly
Diesel Particulate Filter Regeneration is Active	Diesel particulate filter must not be in regeneration mode
Fault Active	Repair the fault using the appropriate diagnostic procedure
Unable to build sufficient reductant pressure	Verify reductant fluid level and proper operation of the reductant pump assembly
Reductant System Pressure Out of Range	Verify proper operation of the reductant pump assembly
Vehicle Speed Fault	Repair the fault using the appropriate diagnostic procedure
Transmission gear data is not valid	Check the transmission gear switch
Air Flow Out of Range	Check the engine induction system
NOx Sensor Operating Conditions not reached.	Verify that engine and exhaust system are at operating temperature and NOx sensor heaters are operating
NOx Sensor 1 NOx concentration out of range	Verify proper operation of NOx Sensor 1. If NOx Sensor 1 is operating correctly, increasing engine load by turning on the A/C, headlights, seat heaters, etc. may help increase NOx concentration.

Reference Information

Description and Operation

Exhaust Aftertreatment System Description

Scan Tool Reference

Control Module References for scan tool information.

Reductant System Malfunction Service Bay Test

NOTE:

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- **If the reductant level warning status is at level 4 or higher, fill the DEF tank and perform the Reductant Fluid Tank Level Reset procedure.**
- **The scan tool must remain connected to the data link connector (DLC) during the entire Reductant System Malfunction Warning Service Bay Test.**
- **Do not perform the Reductant System Malfunction Service Bay Test if the diesel exhaust fluid (DEF) temperature is less than -7Â°C (19Â°F).**
- **If the nitrogen oxides catalytic converter has been replaced, perform the Diesel Particulate Filter Service Regeneration before performing the Reductant System Malfunction Service Bay Test.**

1. Verify DEF tank is full and not in reductant warning level restriction.
   - **If the reductant system is in restriction**

     Fill the DEF tank and perform the scan tool Reductant Fluid Tank Level Reset procedure.

   - **Go to next step: If the reductant system is not in restriction**
2. Perform the Ambient Air Temperature Reset with a scan tool if the vehicle has been driven in an outside temperature below -5Â°C (+23Â°F).
3. Engine idling and at operating temperature, observe the DTC information with a scan tool. Verify there are no DTCs set.
   - **If a DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a DTC is not set**
4. Disconnect scan tool.
5. Ignition Off for 2 minutes.

NOTE: **Do not apply accelerator pedal after starting engine, otherwise the test will fail and will need to return to step 1 of the test.**

6. Start engine.
7. Engine idling, connect scan tool and select the scan tool Reductant System Malfunction Service Bay Test in the Output Controls menu and follow the instructions.

NOTE: **If the Reductant System Malfunction Service Bay Test reaches its time limit without reporting passed or failed and the Exhaust Fluid Quality Poor message is still displayed, a second Reductant System Malfunction Service Bay Test will be necessary**

8. Command the Reductant System Malfunction Service Bay Test On with a scan tool. The Reductant System Malfunction Service Bay Test should start and run.
9. The Reductant System Malfunction Service Bay Test is complete when the Exhaust Fluid Quality Poor message turns Off.
   - **If the DIC message does not clear**
   1. Command a second Reductant System Malfunction Service Bay Test On with a scan tool.
   - If the DIC message does not clear after the second test, a condition with the system still exists
   - **Go to next step: If the DIC message clears**
10. All OK.

REDUCTANT SYSTEM TAMPER SERVICE BAY TEST

Description

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A Reductant System Tamper Warning Service Bay Test is required when the Service Emission System message or Service Exhaust Fluid System message is displayed on the driver information center (DIC). The Reductant System Tamper Warning Service Bay Test is used to verify proper operation of the reductant system and clear the Diesel Exhaust Fluid Anti-Tampering Warning after the condition causing the warning has been repaired.

Conditions for Running

The following conditions must be met in order to enable the scan tool Reductant System Tamper Warning Service Bay Test:

- No DTCs are set.
- Battery voltage is greater than 11 V.
- Vehicle speed is 0 km/h (MPH).
- Engine coolant temperature (ECT) sensor is between 60-100Â°C (140-212Â°F).
- Barometric pressure is greater than 70 kPa (10.2 PSI).
- Ambient air temperature is greater than -30Â°C (-22Â°F).
- Reductant temperature is greater than -20Â°C (-4Â°F) and not frozen.
- Reductant level must be greater than 33%.
- Fuel temperature is less than 80Â°C (176Â°F).
- SCR catalyst temperature is less than 300Â°C (572Â°F).
- Brake pedal and accelerator pedal are in the released position.
- Clutch pedal (if equipped) is in the released position.
- Transmission is in Park or Neutral.
- Diesel particulate filter (DPF) regeneration is not active.
- Fuel tank is not empty.

Diagnostic Aids

The Reductant System Tamper Warning Service Bay Test will not be allowed or will be terminated if any of the conditions listed below occur.

Reductant System Tamper Warning Service Bay Test Inhibit Reason	Corrective action
Brake Pedal Applied	Verify the brake pedal was not applied during the Reductant System Tamper Warning Service Bay Test. If the pedal was not applied, test the brake pedal position sensor.
Clutch Pedal Applied	Verify the clutch pedal was not applied during the Reductant System Tamper Warning Service Bay Test. If the pedal was not applied, test the clutch pedal position sensor.
APP	Verify the accelerator pedal was not applied during the Reductant System Tamper Warning Service Bay Test. If the pedal was not applied, test the accelerator pedal position sensor.
Transmission must be in Park or Neutral	Verify the transmission gear selector remained in Park or Neutral during the Reductant System Tamper Warning Service Bay Test. If the gear selector remained in Park or Neutral, test the transmission range switch and circuits.
Vehicle speed too high	Vehicle speed must be 0 km/h (0 MPH)
Battery Voltage Exceeds Limits	Battery voltage must be greater than 11 V
Engine Coolant Temperature Out of Range	Coolant temperature must be between 60 - 100Â°C (140 - 212Â°F)
Incorrect Power Mode	Verify ignition is in Run position
Soot Accumulation Out of Range	Perform the Diesel Particulate Filter (DPF) Service

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	Regeneration
Activation Timer Has Expired	Ensure engine and exhaust system are at operating temperature
Engine Speed Out of Range	Engine must be running
Exhaust Gas Temperature Out of Range	Exhaust system must be at operating temperature and engine must be operating properly
Diesel Particulate Filter Regeneration is Active	Diesel particulate filter must not be in regeneration mode
Fault Active	Repair the fault using the appropriate diagnostic procedure
Vehicle Speed Fault	Repair the fault using the appropriate diagnostic procedure
Transmission gear data is not valid	Check the transmission gear switch
Air Flow Out of Range	Check the engine induction system
Engine Position Information Invalid	Repair the fault using the appropriate diagnostic procedure
Vehicle Speed DTC Present	Repair the fault using the appropriate diagnostic procedure

Reference Information

Description and Operation

Exhaust Aftertreatment System Description

Scan Tool Reference

Control Module References for scan tool information.

Reductant System Tamper Warning Service Bay Test

NOTE:

- **If the reductant level warning status is at level 4 or higher, fill the DEF tank and perform the Reductant Fluid Tank Level Reset procedure.**
- **The scan tool must remain connected to the data link connector (DLC) during the entire Reductant System Tamper Warning Service Bay Test.**
- **Do not perform the Reductant System Tamper Warning Service Bay Test if the diesel exhaust fluid (DEF) temperature is less than -7Â°C (19Â°F).**

1. Verify DEF tank is full and not in reductant warning level restriction.
   - **If the reductant system is in restriction**

     Fill the DEF tank and perform the scan tool Reductant Fluid Tank Level Reset procedure.

   - **Go to next step: If the reductant system is not in restriction**
2. Perform the Ambient Air Temperature Reset with a scan tool if the vehicle has been driven in an outside temperature below -5Â°C (+23Â°F).
3. Engine idling and at operating temperature, observe the DTC information with a scan tool. Verify there are no DTCs set.
   - **If a DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If a DTC is not set**
4. Disconnect scan tool.

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5. Ignition Off for 2 minutes.

NOTE: **Do not apply accelerator pedal after starting engine, otherwise the test will fail and will need to return to step 1 of the test.**

6. Ignition on.
7. Connect the scan tool and select the scan tool Reductant System Tamper Warning Service Bay Test in the Output Controls menu and follow the instructions.

NOTE: **If the Reductant System Tamper Warning Service Bay Test reaches its time limit without reporting passed or failed and the Service Emission System or the Service Exhaust System message is still displayed, a second Reductant System Tamper Warning Service Bay Test will be necessary**

8. Command the Reductant System Tamper Warning Service Bay Test On with a scan tool. The Reductant System Tamper Warning Service Bay Test should start and run for up to 20 minutes.
9. The Reductant System Tamper Warning Service Bay Test is complete when the Service Emission System message or Service Exhaust System message turns Off.
    - **If the DIC message does not clear**
    1. Command a second Reductant System Tamper Warning Service Bay Test On with a scan tool.
    - If the DIC message does not clear after the second test, a condition with the system still exists.
    - **Go to next step: If the DIC message clears**
10. All OK.

FUEL HEATER DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Circuit/System Description

Ignition voltage is supplied to the coil side of the fuel heater relay whenever the ignition is On. The Engine Control Module (ECM) provides a ground to control the fuel heater relay. When the ECM is commanding the fuel heater On, the voltage of the control circuit should be low, near 0 V. When the ECM is commanding the fuel heater Off, the voltage of the control circuit should be high, near battery voltage.

Reference Information

Schematic Reference

Engine Controls Wiring Schematics 1.6L (LH7)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Fuel System Description

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Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Command the Fuel Heater Relay On and Off with a scan tool. Verify that you hear or feel the KR22 Fuel Heater Relay click.
   - ***If a click is not heard or felt***

     Refer to **DTC P2687-P2689**

   - ***Go to next step: If a click is heard or felt***
3. Verify with a scan tool that the Fuel Temperature Sensor parameter slowly starts to rise when the fuel heater relay is commanded On.
   - ***If the fuel temperature does not start to rise***

     Refer to Circuit/System Testing

   - ***Go to next step: If the fuel temperature rises***
4. All OK

Circuit/System Testing

1. Ignition Off.
2. Disconnect the harness connector at the E11A Fuel Heater/Water in Fuel Sensor.
3. Connect a test lamp between voltage supply circuit terminal 2 and ground.
4. Ignition On.
5. Command the Fuel Heater On and Off with a scan tool. Verify the test lamp turns on and off.
   - ***If the test lamp is always Off***

   1. Ignition Off.
   2. Remove the KR22 Fuel Heater Relay from X50A Fuse Block-Underhood.
   3. Verify that a test lamp illuminates between the fuel heater relay voltage supply circuit terminal 5 and ground.
      - If the test lamp is always Off

      1. Verify the fuse is good and there is voltage at the fuse.
         - If fuse is open, replace the fuse and repair the short to ground in the circuit.
         - If no voltage is present, repair the open/high resistance in the circuit.

      - If test lamp illuminates
   4. Test for infinite resistance between the fuel heater voltage supply circuit terminal 2 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   5. Test for less than 2 Ω in the fuel heater voltage supply circuit end to end.

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- If greater than 2 Ω, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the KR22 Fuel Heater Relay.

- ***If the test lamp is always On***

1. Ignition Off.
2. Remove the KR22 Fuel Heater Relay from X50A Fuse Block-Underhood.
3. Ignition On.
4. Test for less then 1 V between the fuel heater voltage supply circuit terminal 2 and ground.
    - If 1 V or greater, repair the short to voltage in the circuit.
    - If less than 1 V, replace the KR22 Fuel Heater Relay.

- ***Go to next step: If the test lamp turns On and Off***

6. Test for less than 10 Ω between the fuel heater ground circuit terminal 4 and ground.
    - ***If 10 Ω or greater***

      Repair the open/high resistance in the circuit

    - ***Go to next step: If less than 10 Ω***
7. Replace the E11A Fuel Heater/Water in Fuel Sensor.

Component Testing

1. Ignition OFF.
2. Remove the KR22 Fuel Heater Relay from X50A Fuse Block-Underhood.
3. Test for 70 - 110 Ω between terminals 1 and 2.
    - ***If not between 70 - 110 Ω***

      Replace the KR22 Fuel Heater Relay.

    - ***Go to next step: If between 70 - 110 Ω***
4. Test for infinite resistance between the following terminals:
    - 3 and 1
    - 3 and 5
    - 3 and 2
    - 2 and 5
    - ***If less than infinite resistance***

      Replace the KR22 Fuel Heater Relay.

    - ***Go to next step: If infinite resistance***
5. Install a 20 A fused jumper wire between relay terminal 2 and 12 V.
6. Install a jumper wire between relay terminal 1 and ground.
7. Test for less than 2 Ω between terminals 3 and 5.
    - ***If 2 Ω or greater***

      Replace the KR22 Fuel Heater Relay.

    - ***Go to next step: If 2 Ω or less***
8. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- For E11A Fuel Heater/Water in Fuel Sensor replacement refer to: **Fuel Filter Assembly Replacement (AWD)** **Fuel Filter Assembly Replacement (FWD)**
- Refer to **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**

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FUEL INJECTOR BALANCE TEST WITH SCAN TOOL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Circuit/System Description

The fuel injector balance test is performed when a misfire, knock, excessive smoke, or rough running condition exists with no electrical DTCs. This test uses the Fuel Injector Balance and Compression Tests to identify cylinders that are not producing the designed power output. During the Fuel Injector Balance portion of the test, the ECM turns OFF individual injectors while the engine is running. The ECM adjusts for the drop in engine RPM during cancellation and may not change on the scan tool display. The lack of power at the cancelled cylinder will feel like a misfiring cylinder or vibration. If a fuel injector is turned OFF and there is a no difference felt when compared to the other cylinders, that cylinder is identified with the concern. The Compression Test will identify a mechanical issue with a cylinder.

Circuit/System Verification

NOTE: **If not referred to this test from another diagnostic, do not perform this procedure.**

1. Ignition On.
2. Verify that no DTCs are set except for DTC P0300-P0308
   - **If any other DTCs are set.**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If no other DTCs are set**

   NOTE: **The Cylinder Power Balance test disables each fuel injector for 30 s when activated.**

3. Perform the scan tool Cylinder Power Balance test.
4. Verify an equally noticeable engine vibration and power difference exist with each cylinder cancellation.
   - **If one or more cylinders do not have a noticeable difference during cancellation**

     Refer to Circuit/System Testing.

   - **Go to next step: If all cylinders have an equally noticeable difference during cylinder cancellation.**
5. All OK.

Circuit/System Testing

1. Perform the engine compression test. Refer to **Engine Compression Test** .
   - **If one or more of the cylinders indicate low compression**

     Refer to: **Symptoms - Engine Mechanical**

   - **Go to next step: If all cylinders indicate normal compression**

   NOTE: **During replacement of the injectors, inspect the inlet and outlet fittings for corrosion or contamination. Refer to Contaminants-in-Fuel Diagnosis.**

2. Replace the appropriate Q17 Fuel Injector on the cylinders that did not have a noticeable differences during cancellation.

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Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Fuel Injector Replacement**

INSPECTION/MAINTENANCE SYSTEM CHECK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Circuit/System Description

The purpose of the inspection maintenance (I/M) complete system set procedure is to satisfy the enabled criteria necessary to execute all of the I/M system monitors. When all system monitors are completed, the Inspection/Maintenance System Status or Data indicators are set to YES. Perform this procedure when more than one of the Inspection/Maintenance System Status or Data indicators are set to NO.

Conditions for Updating the I/M System Status

NOTE: **New vehicles may not report an Inspection/Maintenance System Check pass or fail status for certain post catalyst oxygen sensor or heated oxygen sensor 2 diagnostics prior to 700 miles. After replacing a catalytic converter on a vehicle with greater than 700 miles, it may require up to an additional 700 miles to prevent a false failure status.**

Each system monitor requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a DTC. A system monitor completes when either all DTCs comprising the monitor have run and passed, or any DTC comprising the monitor has illuminated the malfunction indicator lamp (MIL). Once the monitor completes, the Inspection/Maintenance System Status or Data will indicate YES in the Completed or Value column. For example, when the Misfire Monitoring System Status display indicates YES, all of the misfire components have been diagnosed. The Inspection/Maintenance System Status or Data will indicate NO in the Completed or Value column when any of the required DTCs for that system have not run. The following is a list of conditions that would set the Inspection/Maintenance System Status or Data indicators to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the system monitor.
- 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.

Monitored Emission Control Systems

The OBD II system monitors all emission control systems that are on-board, but not all vehicles have a full complement of emission control systems. For example, a vehicle may not be equipped with exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following:

- Comprehensive component monitoring - Emission related inputs and outputs
- EGR system
- Misfire monitoring
- Catalyst monitoring
- Diesel Particulate Filter
- Exhaust after-treatment
- Fuel system
- Boost system

For the specific DTCs required for each system, refer to **Inspection/Maintenance (I/M) System DTC Table**.

Circuit/System Verification

1. Verify that all Inspection/Maintenance System Status or Data indicators report YES, and that no I/M Test DTCs are present.
    - **If any I/M Test DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **Go to next step: If no I/M Test DTCs are set**
2. All OK.

Circuit/System Testing

NOTE: **Many DTC related repairs will instruct the technician to clear the DTC information. Clearing the DTC will reset the Inspection/Maintenance System Status or Data indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.**

1. Verify no I/M DTCs are present.
    - **If an I/M DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing.**

      Refer to **Inspection/Maintenance (I/M) System DTC Table**.

    - **Go to next step: If no I/M DTCs are set**
2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.
    - **If a control module re-program or other repair is required,**

      Perform the **Inspection/Maintenance Complete System Set Procedure** after repair.

    - **Go to next step: If no repair is required**
3. Observe the Inspection/Maintenance System Status or Data indicators.
    - **If any Inspection/Maintenance System Status or Data indicators report NO**

      Perform the **Inspection/Maintenance Complete System Set Procedure**.

    - **Go to next step: If no Inspection/Maintenance System Status or Data indicators report NO**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Circuit/System Description

The purpose of the inspection maintenance (I/M) complete system set procedure is to satisfy the enabled criteria necessary to execute all of the I/M system monitors. When all system monitors are completed,

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the Inspection/Maintenance System Status or Data indicators are set to YES. Perform this procedure when more than one of the Inspection/Maintenance System Status or Data indicators are set to NO.

Conditions for Updating the I/M System Status

NOTE: **New vehicles may not report an Inspection/Maintenance System Check pass or fail status for certain post catalyst oxygen sensor or heated oxygen sensor 2 diagnostics prior to 700 miles. After replacing a catalytic converter on a vehicle with greater than 700 miles, it may require up to an additional 700 miles to prevent a false failure status.**

Each system monitor requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a DTC. A system monitor completes when either all DTCs comprising the monitor have run and passed, or any DTC comprising the monitor has illuminated the malfunction indicator lamp (MIL). Once the monitor completes, the Inspection/Maintenance System Status or Data will indicate YES in the Completed or Value column. For example, when the Misfire Monitoring System Status display indicates YES, all of the misfire components have been diagnosed. The Inspection/Maintenance System Status or Data will indicate NO in the Completed or Value column when any of the required DTCs for that system have not run. The following is a list of conditions that would set the Inspection/Maintenance System Status or Data indicators to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the system monitor.
- 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.

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Monitored Emission Control Systems

The OBD II system monitors all emission control systems that are on-board, but not all vehicles have a full complement of emission control systems. For example, a vehicle may not be equipped with exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following:

- Comprehensive component monitoring - Emission related inputs and outputs
- EGR system
- Misfire monitoring
- Catalyst monitoring
- Diesel Particulate Filter
- Exhaust after-treatment
- Fuel system
- Boost system

For the specific DTCs required for each system, refer to **Inspection/Maintenance (I/M) System DTC Table**.

Circuit/System Verification

1. Verify that all Inspection/Maintenance System Status or Data indicators report YES, and that no I/M Test DTCs are present.
   - **If any I/M Test DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **Go to next step: If no I/M Test DTCs are set**
2. All OK.

Circuit/System Testing

NOTE: **Many DTC related repairs will instruct the technician to clear the**

DTC information. Clearing the DTC will reset the Inspection/Maintenance System Status or Data indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.

1. Verify no I/M DTCs are present.
   - **If an I/M DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing.**

     Refer to **Inspection/Maintenance (I/M) System DTC Table**.

   - **Go to next step: If no I/M DTCs are set**
2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.
   - **If a control module re-program or other repair is required,**

     Perform the **Inspection/Maintenance Complete System Set Procedure** after repair.

   - **Go to next step: If no repair is required**
3. Observe the Inspection/Maintenance System Status or Data indicators.
   - **If any Inspection/Maintenance System Status or Data indicators report NO**

     Perform the **Inspection/Maintenance Complete System Set Procedure**.

   - **Go to next step: If no Inspection/Maintenance System Status or Data indicators report NO**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE

System	DTCs Required to Set System Status to YES
If an I/M System Status indicator did NOT update to YES during the **Inspection/Maintenance Complete System Set Procedure**, review each indicator and reference this table to determine each DTC associated with the I/M System Status Indicator. Each DTC listed below has specific conditions that must be met for the diagnostic to run. Included within the conditions are additional DTCs which, if set, may inhibit the DTCs listed below from running. Reviewing and operating the vehicle within the Conditions for Running for each DTC listed below will allow the I/M System Status Indicators to transition to YES.	
Boost System	• **DTC P0234, P0299, or P2263** • **DTC P026A**
Catalyst	**DTC P0421**
DPF	• **DTC P144E or P144F** • **DTC P2002** • **DTC P2459**

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System	DTCs Required to Set System Status to YES
EGR/CMP	• DTC P0401 or P0402 • DTC P0403, P0490, P1402, P1407, or P140F • DTC P0404-P0406 • DTC P042E or P042F • DTC P140B or P140C • DTC P2457
Exhaust Aftertreatment	DTC P20EE, P249D, or P249E
Exhaust Gas Sensor	• DTC P1004, P119D-P119F, P11BE, P11BF, P11C0, P11C7, P11C8, P11D0-P11D2, P11D5, P11D8, P11D9, P11DA, P11DC, P11FC-P11FF, P22A0, P22A1, P22A3-P22A9, or P22FE • DTC P115E, P115F, P1160, P116A-P116F, P1192-P1194, P119A-P119C, P11C5, P11C6, P11CC, P11D3, P11DB, P2202, P2203, or P2205-P2211 • DTC P1474-P1479, P147B, or P1488 • DTC P220A or P220B • DTC P2297 or P2A00 • DTC P24B0-P24B6, P24C7, P24D0, or P24D1 • DTC P2627 or P2628
Fuel System	• DTC P01CB-P01CF or P01D0-P01D2 • DTC P0087, P0089, P228C, P228D, or P2293
Misfire	DTC P0300

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2018 ENGINE PERFORMANCE

Engine Controls And Fuel - 1.6L (LH7) Diesel - Repair Instructions - Equinox & Terrain

REPAIR INSTRUCTIONS

DIESEL PARTICULATE FILTER (DPF) SERVICE REGENERATION

Circuit/System Description

A service regeneration of the diesel particulate filter (DPF) is required when the scan tool DPF Accumulation Status parameter displays 30 grams or more of accumulated soot. When commanded, the engine control module (ECM) controls the service regeneration as follows:

1. The exhaust system is warmed up for about 8 min. Engine speed is slowly increased to 2 000 RPM and then to 2 500 RPM.
2. Once the DPF reaches its calibrated regeneration temperature, the ECM maintains engine speed between 2 000 - 2 500 RPM for about 20 min until regeneration is complete, is cancelled by the technician, or is aborted due to abnormal conditions.
3. The ECM then slowly decreases engine speed to 1 600 RPM, then to 800 RPM, and finally to normal idle speed over a 5 min period. This is done to allow the DPF to cool down.

The DPF Service Regeneration will be terminated if any of the following conditions occur:

- The DPF Service Regeneration is commanded OFF using the scan tool
- The scan tool is disconnected from the vehicle

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Conditions for Running

The following conditions must be met in order to enable DPF Service Regeneration:

- DTCs P2463 is the only active DTC.
- The battery voltage is greater than 10 V.
- The engine speed is between 500 - 2 700 RPM.
- The vehicle speed is 0.
- The transmission is not in Drive or Reverse
- The exhaust gas temperature sensors 1 is between 20 - 500Â°C (68 - 932Â°F).
- The exhaust gas temperature sensors 3 is between 20 - 735Â°C (68 - 1, 355Â°F).
- The engine coolant temperature sensor is greater than 70Â°C (158Â°F).
- The fuel temperature is less than 150Â°C (302Â°F).
- The BARO pressure is greater than 40 kPa (5.8 PSI)
- The APP sensor is less than 1%.
- The diesel exhaust fluid temperature is greater than -7Â°C (+19Â°F).
- The diesel exhaust fluid tank is not empty.
- The brake pedal and accelerator pedal are in the released position.
- The transmission is in Park or Neutral.

Diagnostic Aids

The scan tool DPF Regeneration Inhibit reason parameter will display a reason for not enabling or aborting the DPF service regeneration. Refer to the reasons that are displayed and the corrective action for each reason.

Service Regeneration Unsuccessful

DPF Regeneration Parameters	Unsuccessful Regeneration - Number of Completed Regenerations Did Not Increment By One	Corrective Action For An Unsuccessful Regeneration
DPF Service Regeneration Inhibit Reason	APP - The APP position sensor indicated over 1%	Ensure the accelerator pedal was not applied during the service regeneration. • If the accelerator pedal was not applied, test the accelerator pedal position (APP) sensor.
	BPP Applied - The brake pedal position indicated Applied.	Ensure that the brake pedal was not applied during the service regeneration procedure. • If the brake pedal was not applied, test the brake pedal switch.
	NOTE: **The scan tool must remain connected to the data communication link during the entire service regeneration procedure.** Device Control - The scan tool has interrupted service regeneration. A loss of communication between the scan tool and the vehicle has occurred.	• The scan tool Exit or OFF soft key button was depressed. • Inspect for a poor connection at data communication link.
	DPF Temperature - DPF service regeneration temperatures are less than a calibrated threshold.	• Observe the DTC information. • Test for a degraded diesel oxidation catalyst (DOC). • Test for a skewed exhaust temperature sensor, EGT sensor 2.
	Ignition Voltage - Battery voltage was less than 11 V.	Test the battery and charging system for proper operation.
	None	Refer to the DPF Regeneration Status parameter
	Not in Park - Transmission gear selector is not in Park.	Ensure that the transmission gear selector remained in Park during the Service Regeneration procedure. • If the gear selector remained in the Park position, test the transmission range switch and circuits.

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DPF Regeneration Parameters	Unsuccessful Regeneration - Number of Completed Regenerations Did Not Increment By One	Corrective Action For An Unsuccessful Regeneration
DPF Normal Regeneration Inhibit Reason	Regen Timed Out	A regeneration has timed out attempting a regeneration for greater than 90 min for this key cycle
	EGT 2 High	Exhaust temperature sensor 2 greater than 750Â°C (1 382Â°F)
	EGT 1 High	Exhaust temperature 1 greater than 650Â°C (1 202Â°F)
	DTC Set	An active DTC is set
	Axle Torque Limit	Torque Limiting is active to prevent an engine overheat condition
	Decel Too Long	A long decel condition of greater than 40 s was active
	Fuel Level	Fuel level is below 15%
	TC Temp Too High	Turbocharger temperature is too high
	TCM Override	A condition within the TCM is present
	Eng Run Time	Engine has not run long enough to complete a regeneration or has not warmed to operating temperature
	DLC Override	A scan tool is connected to the DLC
	Idle Spd Ovride	Vehicle is shifted into Park or Neutral while a normal regeneration is active

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

DPF Service Regeneration

WARNING: **Tailpipe outlet exhaust temperature will be greater than 300Â°C (572Â°F) during this procedure. To help prevent personal injury or property damage from fire or burns, perform the following:**

1. **Do not connect any shop exhaust removal hoses to the vehicle tailpipe.**
2. **Park the vehicle outdoors and keep people, other vehicles, and combustible material away during this procedure.**
3. **Do not leave the vehicle unattended.**

WARNING: **To avoid extremely elevated exhaust temperatures, inspect and remove any debris or mud build up at the exhaust cooler located at the tailpipe.**

CAUTION: **Due to the elevated engine temperatures created while performing this procedure it is imperative to keep the front of vehicle in an open**

environment, with the hood open, away from any walls or buildings. This will ensure proper airflow across the radiator.

NOTE:

- **If you were not referred to this procedure from another diagnostic, DO NOT perform the Service Regeneration.**
- **Do not refuel the vehicle during DPF Service Regeneration.**
- **The scan tool must remain connected to the data communication link during the entire service regeneration procedure.**
- **Do not perform the DPF Service Regeneration if the diesel exhaust fluid temperature (DEF) is less than -7Â°C (+19Â°F).**
- **Fuel level should be greater 15% to ensure a successful regeneration.**

1. Ignition ON.
2. Verify there are no DTCs set, except DTC P2463.
   - **If another DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **Go to next step: If another DTC is not set**

NOTE: **Due to elevated exhaust temperatures it is necessary to remove Front Compartment Insulator**

3.
4. With the vehicle in Park, use the throttle to increase the engine speed to 3 000 RPM while looking for the speedometer to move slightly (greater than 1 mph). If this signal noise exists, inch the vehicle forward, place in park and repeat until there is no response seen from the speedometer. This will avoid a vehicle speed based interrupt of the service regeneration.
5. Place the transmission in Park and apply the parking brake.
6. Clear the DTCs with a scan tool before commanding a DPF Service Regeneration.
7. Observe the scan tool DPF Regenerations Completed parameter and record the value.
8. Open the hood.
9. Check the following fluid levels before and after this procedure:
   - Reductant
   - Engine oil
   - Engine coolant
   - Power steering
   - Transmission
10. Select the DPF Service Regeneration in the Output Controls menu and follow the instruction on the scan tool.

NOTE: **If a scan tool message of Oil Temperature Out Of Range is displayed once a service regeneration is commanded, disregard the message and command the service regeneration procedure.**

11. Command the DPF Service Regeneration ON with a scan tool.
    - **If the service regeneration failed to start**

      verify with a scan tool that the DPF Reg Inhibit Reason parameter on the scan tool to identify the Reg Inhibit Reason and refer to the Service Regeneration Unsuccessful table in Diagnostic Aids.

    - **Go to next step: If the service regeneration starts**

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12. When the service regeneration is complete, the DPF Regeneration Status parameter will display Complete and the DPF Regenerations Completed parameter will increment by 1 from the value previously recorded.
    - **If the service regeneration did not complete, was aborted, or the Regeneration Completed did not increment**

      Refer to the Service Regeneration Unsuccessful table in Diagnostic Aids

    - **Go to next step: If the Service Regeneration completed**

    NOTE: **DTC P202E may set after a DPF Service Regeneration. The excessive exhaust temperatures created during a DPF Service Regeneration causes the diesel exhaust fluid (DEF) to crystallize. The crystallized reductant will cause the Q61 emission reduction fluid injector to stick. Idling the engine for 15 min will cause the reductant to liquefy and un-stick the injector.**

13. Allow the engine to cool by idling for an additional 10 min. Command the Reductant Injector ON and OFF several times with a scan tool.
14. Clear the DTCs with a scan tool.
15. Ignition OFF for 90 s.

Repair Instructions

Perform the **Diagnostic Repair Verification** .

Refer to **Exhaust Front Pipe Replacement (LH7)** .

BARO SENSOR RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

For an overview of the component/system, refer to: **Engine Control Module Description**

This procedure resets the control module learned values of the component/system: Barometric Pressure Sensor - Airflow Adaptive Values

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

This procedure is required when the following component has been repaired, replaced, removed, or serviced:

- B75C Multifunction Intake Air Sensor
- K20 Engine Control Module

Conditions for Running the Procedure

- DTC P00C7, P2227-P2230, P227B-P227E = Not set
- Engine = Off
- Ignition = On

Reference Information

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Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: BARO Sensor Reset
7. Follow the instructions on the scan tool.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

CATALYST RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: Oxidation Catalytic Converter

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced: Oxidation Catalytic Converter - Replaced

Conditions for Running the Procedure

Ignition = Run/Crank

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: Catalyst Reset

NOTE: **The scan tool does not display the learn/reset status.**

7. Follow the instructions on the scan tool. - The procedure will complete within 10 s

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8. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

CRANKSHAFT POSITION VARIATION LEARN

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

The crankshaft position sensor variation or reluctor ring learn is used to calculate reference period errors caused by slight tolerance variations in the crankshaft and the crankshaft position sensor. The calculated error allows the ECM to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wider range of engine speed and load. The compensation values are stored in ECM memory after a learn procedure has been performed.

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced:

- B26 Crankshaft Position Sensor
- Any repair which disturbs the alignment between the components: B26 Crankshaft Position Sensor & Crankshaft
- Crankshaft
- Crankshaft Balancer
- Engine Assembly

Conditions for Running the Procedure

- DTC P0117, P0118, P0335, P0336 = Not set
- ECT = Greater than 60Â°C (140Â°F)
- Ignition Voltage = Greater than 11 V

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Verify there are no other DTCs set, except for DTC P0300-P0308, P0315.
    - **If any other DTCs are set**

      Refer to: **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **Go to next step: If no other DTCs are set**
3. Select: Module Diagnostics
4. Select: Engine Control Module
5. Select: Configuration/Reset Functions
6. Select: Learn Functions

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7. Select: Crankshaft Position Variation Learn
8. Follow the instructions on the scan tool.

   Verify the scan tool procedure was successful.

   - **If the procedure was not successful and first time here**
   1. Ignition/Vehicle - Off
   2. Verify the following conditions do not exist:
   - B26 Crankshaft Position Sensor & Reluctor Ring - Foreign material passing between the components/Incorrect air gap
   - Battery Voltage - Low
   - Crankshaft Bearing - Worn
   - Crankshaft - Excessive runout/Visible Damage
   - Reluctor Ring - Misaligned/Visible Damage
   - Signal circuit @ B26 Crankshaft Position Sensor - Electromagnetic Interference
     - If a condition exists - Repair or replace as necessary
     - If no condition exists - Repeat step 1
   - **If the procedure was not successful and performed 4 times or less**

     Repeat step 6

   - **If the procedure was not successful and performed 5 times**

     Replace the component: K20 Engine Control Module

   - **Go to next step: If the procedure was successful**
9. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

For control module replacement, programming, and setup refer to: **Control Module References**

DPF PRESSURE SENSOR RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced: B154 Diesel Particulate Filter Exhaust Differential Pressure Sensor - Replaced

Conditions for Running the Procedure

Ignition = Run/Crank

Reference Information

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Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: DPF Pressure Sensor Reset

NOTE: **The scan tool does not display the learn/reset status.**

7. Follow the instructions on the scan tool. - The procedure will complete within 10 s

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

DPF RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: Exhaust Particulate Filter

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced: Exhaust Particulate Filter - Replaced

Conditions for Running the Procedure

- Engine = Not Running
- Ignition = Run/Crank

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: DPF Reset

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NOTE: **The scan tool does not display the learn/reset status.**

7. Follow the instructions on the scan tool. - The procedure will complete within 10 s

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

EXHAUST GAS TEMPERATURE SENSOR RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: B131 Exhaust Temperature Sensor @ Diesel Particulate Filter - Inlet

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced: B131 Exhaust Temperature Sensor - Replaced

Conditions for Running the Procedure

Ignition = Run/Crank

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: Exhaust Gas Temperature Sensor Reset

NOTE: **The scan tool does not display the learn/reset status.**

7. Follow the instructions on the scan tool. - The procedure will complete within 10 s

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

FUEL FILTER LIFE RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

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Description

This procedure resets the control module learned values of the component/system: Fuel Filter

When to Perform the Procedure

Perform this procedure when the following component has been serviced:

- K20 Engine Control Module - Replaced
- Fuel Filter - Replaced

Conditions for Running the Procedure

Ignition = Run/Crank

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: Fuel Filter Life Reset
7. Follow the instructions on the scan tool.

Without Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Transmission in Park

NOTE: **The Fuel Filter Life will only display on the DIC if the Ignition is On, the vehicle is in Service Mode, and the gear selector is in Park.**

3. Display the Fuel Filter Life Remaining on the DIC. If the vehicle does not have DIC buttons, use the trip odometer reset stem.
4. Press and hold the SET/RESET button on the DIC, or the trip odometer reset stem if the vehicle does not have DIC buttons, for more than two seconds. The Fuel Filter Life Remaining will change to 100 percent.
5. Verify the procedure was successful.
   - **If the procedure was not successful**

     Refer to: Step 1

   - **Go to next step: If the procedure was successful**
6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

FUEL INJECTION SMALL QUANTITY LEARN

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**

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- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure triggers the control module to learn the values of the component: Q17 Fuel Injector - All

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced:

- B47B Fuel Rail Pressure Sensor - Replaced
- K20 Engine Control Module - Replaced
- Q17 Fuel Injector - Replaced

Conditions for Running the Procedure

- Accelerator Pedal = Released
- BARO = In Range
- Clutch Pedal Switch = Released
- DPF Regeneration = No
- DTC Present = No
- Engine Coolant Temperature = Operating temperature
- Engine = Running
- Engine Speed = Idle
- Fuel Temperature Sensor = In Range
- Generator F-Terminal Signal = In Range
- HVAC Controls = Off
- Ignition Voltage = In Range
- Intake Air Temperature Sensor = In Range
- Learn Procedure Already Performed This Ignition Cycle = No
- Transmission Fluid Temperature = In Range
- Transmission = Park/Neutral
- Vehicle Speed = 0 km/h (0 MPH)

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Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Learn Functions
6. Select: Fuel Injection Small Quantity Learn
7. Follow the instructions on the scan tool. - The procedure will complete within 5 min

   Verify the scan tool procedure was successful.

   - **If the procedure was not successful**

Refer to: Step 1

- **Go to next step: If the procedure was successful**

8. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

FUEL INJECTION SMALL QUANTITY LEARNING ODOMETER RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: Q17 Fuel Injector

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced: K20 Engine Control Module - Unsuccessful Programming Recovery

Conditions for Running the Procedure

Ignition/Vehicle = On & Engine = Off

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: Fuel Injection Small Quantity Learning Odometer Reset
7. Follow the instructions on the scan tool. - The procedure will complete within 10 s

   Verify the scan tool procedure was successful.

   - **If the procedure was not successful**

     Refer to: Step 1

   - **Go to next step: If the procedure was successful**

8. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

FUEL INJECTOR FLOW RATE PROGRAMMING

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Circuit/System Description

The control functions for the fuel injection system are integrated in the ECM. Each injectors flow rate information, or injection quantity adjustment flow rate numbers, and cylinder position are stored in the memory of the ECM. The fuel injector flow rate programming must be done when any of the following procedures are performed:

- The ECM is replaced.
- A fuel injector is replaced.

Injector Flow Rate Programming

1. Ignition OFF
2. Record all the injection quantity adjustment codes from the corresponding cylinder from each injector that is being replaced or from all injectors if the ECM was replaced.

   NOTE: If replacing injectors, enter the injection quantity adjustment code from the new injector or injectors. If ECM is being replaced, enter the injection quantity adjustment code from the original injectors.

3. Perform the scan tool Injector Flow Rate Programming and follow the instructions on the screen.

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. Ignition OFF for 60 s.
4. Ignition ON, engine OFF.
5. Clear the DTCs.
6. 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.

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FUEL TRIM RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: Q17 Fuel Injector

When to Perform the Procedure

Perform this procedure when the following component has been serviced: Q17 Fuel Injector

Conditions for Running the Procedure

- Engine = Off
- Ignition = On

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: Fuel Trim Reset
7. Follow the instructions on the scan tool.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

HIGH PRESSURE FUEL CORRECTION RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: G18 High Pressure Fuel Pump

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced:

- G18 High Pressure Fuel Pump - Replaced
- Q17 Fuel Injector - Replaced
- Q18 Fuel Pressure Regulator - Replaced
- Fuel Rail - Replaced

Conditions for Running the Procedure

Ignition = Run/Crank

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: High Pressure Fuel Correction Reset

NOTE: **The scan tool does not display the learn/reset status.**

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7. Follow the instructions on the scan tool. - The procedure will complete within 10 s

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

NOX CATALYST REDUCTANT LOADING RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: Reductant System

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced:

- A38 Reductant Pump and Sensor Assembly - Replaced
- B75 Mass Air Flow Sensor - Replaced
- B131 Exhaust Temperature Sensor - Replaced
- B195A Nitrogen Oxides Sensor 1 - Replaced
- B195B Nitrogen Oxides Sensor 2 - Replaced
- Q61 Reductant Injector - Replaced
- Nitrogen Oxides Catalytic Converter - Replaced

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Conditions for Running the Procedure

- Engine = Off
- Ignition = Run/Crank

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: NOx Catalyst Reductant Loading Reset

NOTE: **The scan tool does not display the learn/reset status.**

7. Follow the instructions on the scan tool. - The procedure will complete within 10 s

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

NOX CATALYST RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: Exhaust Aftertreatment System

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced: Nitrogen Oxides Catalytic Converter - Replaced

Conditions for Running the Procedure

- Engine = Not Running
- Ignition = Run/Crank

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: NOx Catalyst Reset

NOTE: **The scan tool does not display the learn/reset status.**

7. Follow the instructions on the scan tool. - The procedure will complete within 10 s

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

NOX SENSOR 1 RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: B195A Nitrogen Oxides Sensor 1

When to Perform the Procedure

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NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced: B195A Nitrogen Oxides Sensor 1 - Replaced

Conditions for Running the Procedure

Ignition = Run/Crank

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: NOx Sensor 1 Reset

NOTE: **The scan tool does not display the learn/reset status.**

7. Follow the instructions on the scan tool. - The procedure will complete within 10 s

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

NOX SENSOR 2 RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: B195B Nitrogen Oxides Sensor 2

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced: B195B Nitrogen Oxides Sensor 2 - Replaced

Conditions for Running the Procedure

Ignition = Run/Crank

Reference Information

Scan Tool Reference

Control Module References

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With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: NOx Sensor 2 Reset

NOTE: **The scan tool does not display the learn/reset status.**

7. Follow the instructions on the scan tool. - The procedure will complete within 10 s

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

REDUCTANT FLUID TANK LEVEL RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: Reductant System

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced:

- A38 Reductant Pump and Sensor Assembly - Replaced
- A39 Reductant Tank - Replaced

Conditions for Running the Procedure

- Ignition = Run/Crank
- Reductant Tank Level - Actual & Calculated = Do not match

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: Reductant Fluid Tank Level Reset

NOTE: **The scan tool does not display the learn/reset status.**

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7. Follow the instructions on the scan tool. - The procedure will complete within 10 s

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

REDUCTANT SYSTEM DATA RESET

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**

Description

This procedure resets the control module learned values of the component/system: Exhaust Aftertreatment System

When to Perform the Procedure

NOTE: **Failure to perform this procedure may result in poor system performance, DTCs being set, or customer dissatisfaction.**

Perform this procedure when the following component has been serviced: K20 Engine Control Module - Replaced

Conditions for Running the Procedure

- Engine = Not Running
- Ignition = Run/Crank

Reference Information

Scan Tool Reference

Control Module References

With Scan Tool

1. Ignition - On/Vehicle - In Service Mode
2. Select: Module Diagnostics
3. Select: Engine Control Module
4. Select: Configuration/Reset Functions
5. Select: Reset Functions
6. Select: Reductant System Data Reset

NOTE: **The scan tool does not display the learn/reset status.**

7. Follow the instructions on the scan tool. - The procedure will complete within 10 s

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

WIRE TO WIRE REPAIR - ENGINE CONTROLS AND FUEL

Special Tools

- **EL-38125-10** Splice Sleeve Crimping Tool (non GMNA)
- **J-38125-5A** Ultra Torch Special Tool
- **J-38125-8** Splice Sleeve Crimping Tool (GMNA)

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For equivalent regional tools, refer to **Special Tools** .

WARNING: **In order to reduce the risk of personal injury, loss of high voltage isolation to ground and higher system impedance, do not attempt to repair any HV wiring, connector, or terminal that is damaged. High voltage coaxial type cables are not repairable. Never attempt to repair a coaxial type cable. The entire cable/harness or component must be replaced. In order to maintain system integrity and personal safety, never attempt to repair any high voltage wiring, cables, or terminals. Performing this procedure on high voltage circuits may result in serious injury or death.**

NOTE: **If the wiring harness internal to the transmission is damaged, the wiring harness must be replaced. The use of splice sleeves in an attempt to repair the internal transmission wires, connectors, or terminals could result in performance issues.**

NOTE: **Do not splice wires in Door Harness Grommets.**

NOTE: **The DuraSeal splice sleeves have the following 2 critical features:**

- **A special heat shrink sleeve environmentally seals the splice. The heat shrink sleeve contains a sealing adhesive inside.**
- **A cross hatched (knurled) core crimp provides the necessary low resistance contact integrity for these sensitive, low energy circuits.**

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Use only DuraSeal splice sleeves to form a one-to-one splice on all types of insulation except high voltage and specialty cables. Use DuraSeal splice sleeves where there are special requirements such as moisture sealing. Follow the instructions below in order to splice copper wire using DuraSeal splice sleeves.

Splice Sleeve Selection

Splice Sleeve Color	Crimp Tool Nest Color		Wire Gauge mm^2 /(AWG)
	3 Crimp Nests	4 Crimp Nests	
Salmon (Yellow-Pink) 19300089	Red (1) or Red/Green (1)	Red (2)	0.22 - 0.8/(18 - 26)
Blue 19168447	Blue (2)	Blue (3)	1.0 - 2.0/(14 - 16)
Yellow 19168448	Yellow (3)	Yellow (4)	3.0 - 5.0/(10 - 12)

NOTE: **You must perform the following procedures in the listed order. Repeat the procedure if any wire strands are damaged. You must obtain a clean strip with all of the wire strands intact.**

1. Open the harness by removing any tape:
   - Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in order to avoid wire insulation damage.
   - Use the DuraSeal splice sleeves on all types of insulation except Tefzel and coaxial.
   - Do not use the crimp and DuraSeal splice sleeve to form a splice with more than 2 wires coming together.
2. Cut as little wire off the harness as possible. You may need the extra length of wire in order to change the location of a splice.

   Adjust splice locations so that each splice is at least 40 mm (1.5 in) away from the other splices, harness branches, or connectors.

3. Strip the insulation:

- When adding a length of wire to the existing harness, use the same size wire as the original wire.
- Perform one of the following items in order to find the correct wire size:
  - Find the wire on the schematic and convert to regional wiring gauge size.
  - If you are unsure of the wire size, begin with the largest opening in the wire stripper and work down until achieving a clean strip of the insulation.
- Strip approximately 5.0 mm (0.20 in) of insulation from each wire to be spliced.
- Do not nick or cut any of the strands. Inspect the stripped wire for nicks or cut strands.
- 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.

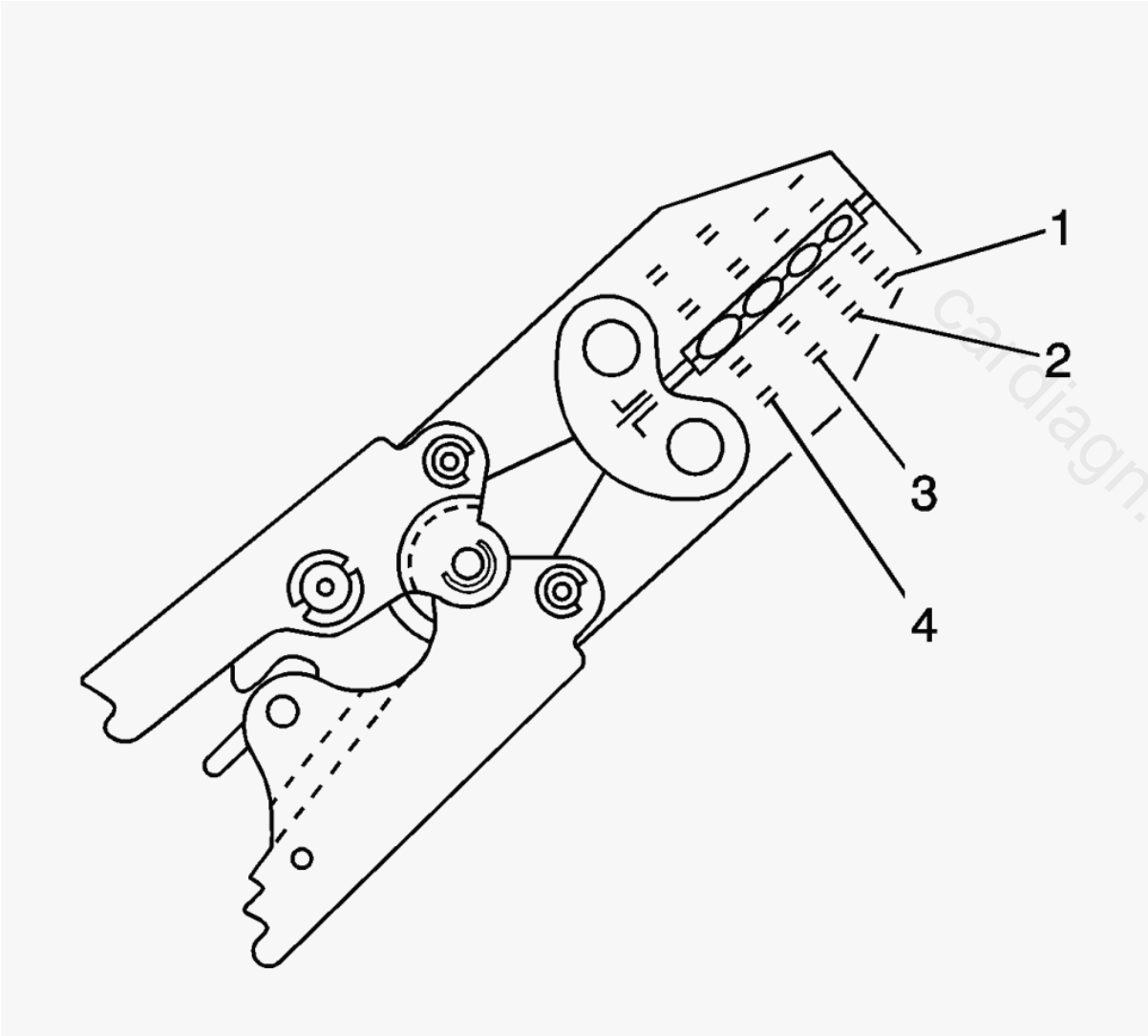

Fig. 1: Splice Sleeve Crimping Tool With 4 Crimp Nests
Courtesy of GENERAL MOTORS COMPANY

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.

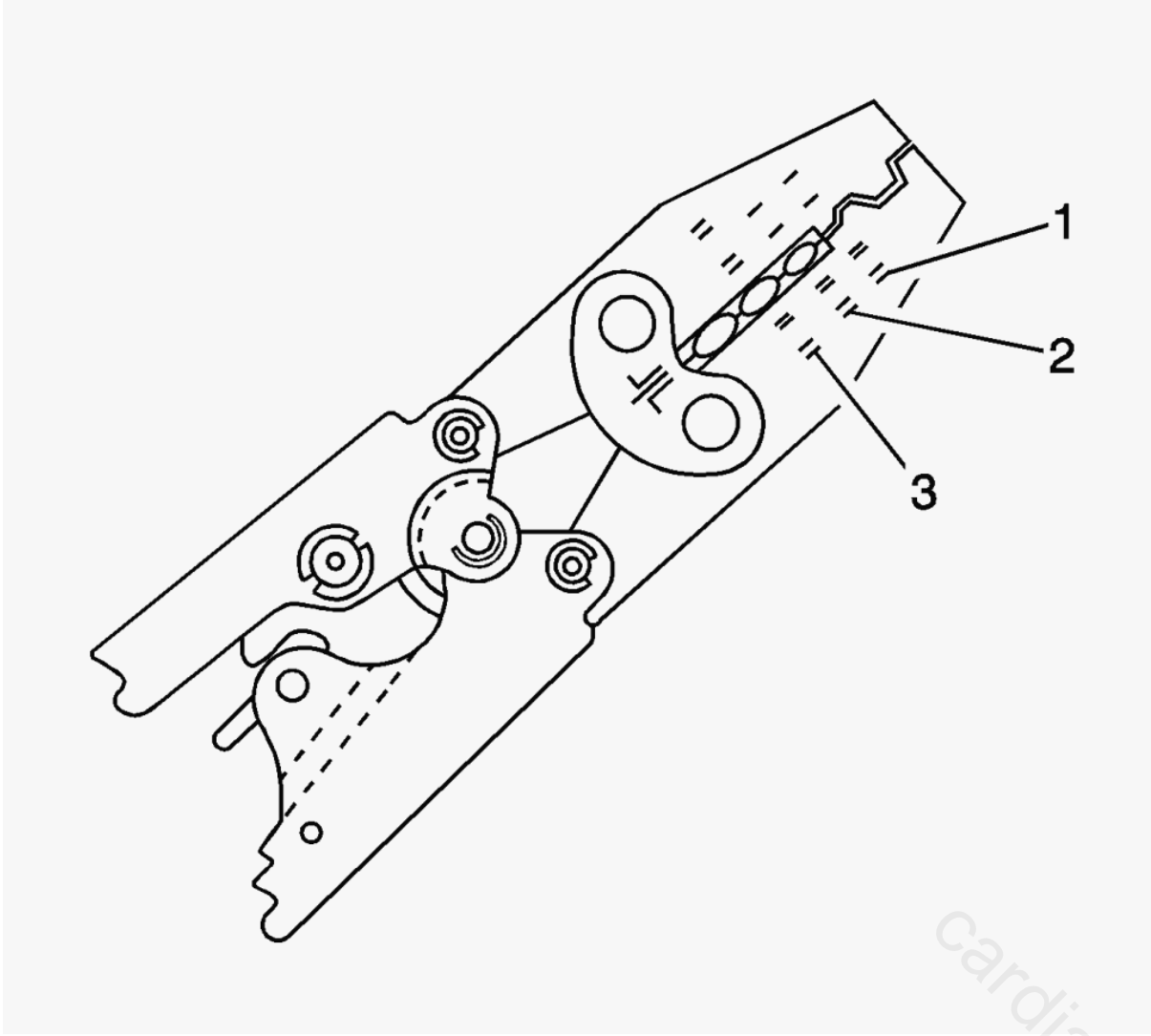

Fig. 2: Splice Sleeve Crimping Tool With 3 Crimp Nests
Courtesy of GENERAL MOTORS COMPANY

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).

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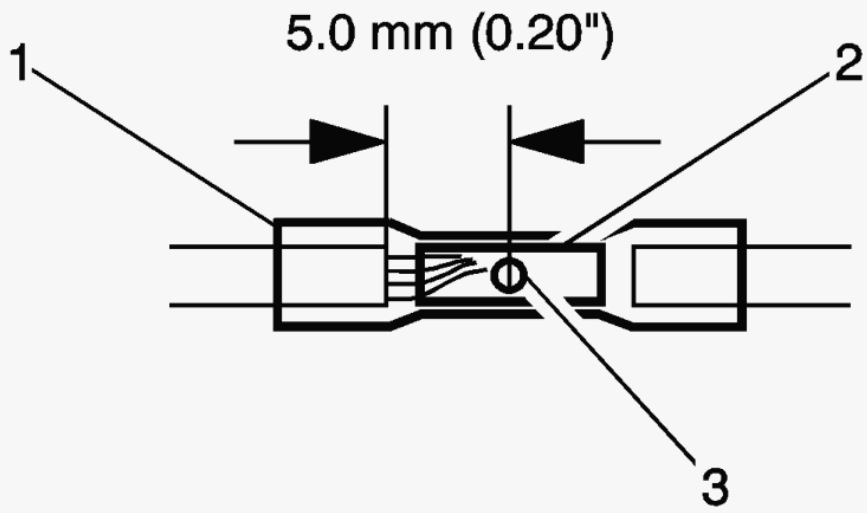

Fig. 3: Identifying DuraSeal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

9. Place the DuraSeal splice sleeve in the nest. Ensure that the crimp falls midway between the end of the barrel and the stop. The sleeve has a stop (3) in the middle of the barrel (2) in order to prevent the wire (1) from going further. Close the hand crimper handles slightly in order to firmly hold the DuraSeal splice sleeve in the proper nest.

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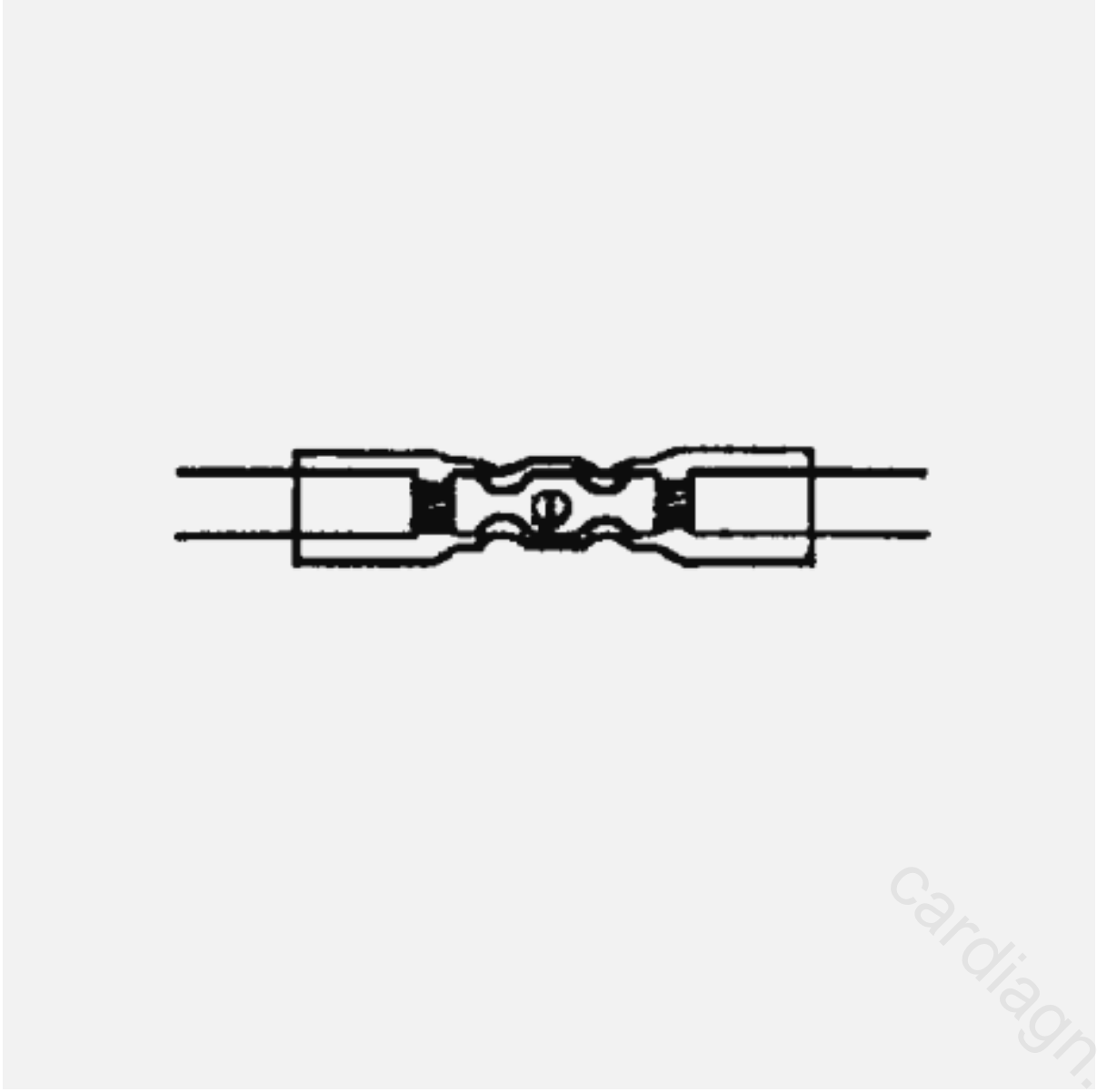

Fig. 4: Crimped DuraSeal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

10. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different gauges.
11. Tightly close the handles of the crimp tool until the crimper handles open when released.

    The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Repeat steps 4 and 6 for the opposite end of the splice.

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Fig. 5: Heated Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

12. Using the heat torch, apply heat to the crimped area of the barrel.
13. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
    - The tubing will shrink completely as the heat is moved along the insulation.
    - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

Weatherpack™ Wiring Repair

NOTE: **Some replacement pigtail connectors may be delivered without the terminated leads installed into the connector. For Weatherpack™ connectors, all terminated leads included in the package should to be installed into the connector. If the connector end view shows that a terminal is not occupied, the extra terminated lead(s) need to be installed and the end(s) sealed using a DuraSeal splice sleeve and taped back into the harness.**

1. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different gauges.

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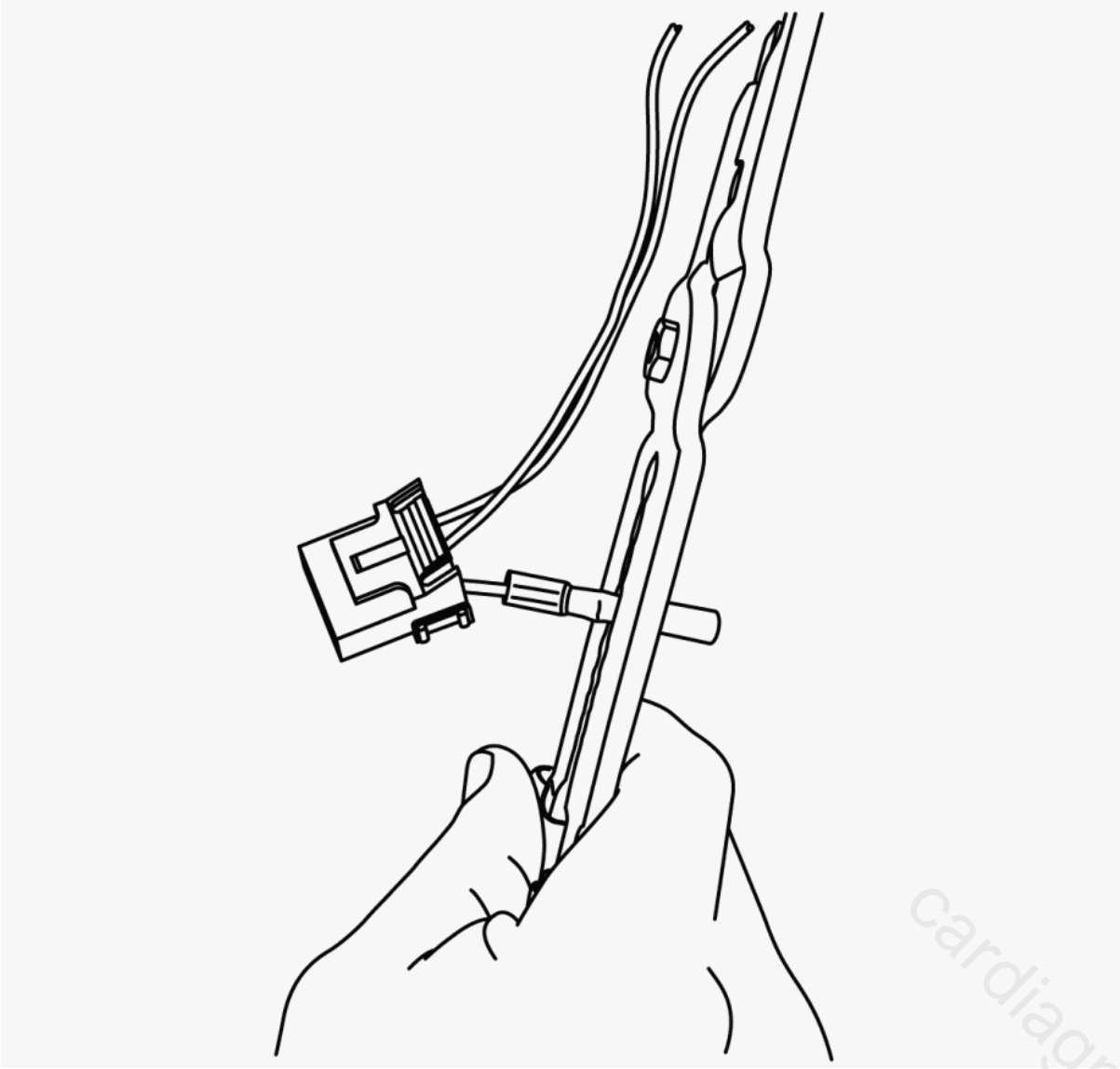

Fig. 6: Tightly Close Handles Of Crimp Tool
Courtesy of GENERAL MOTORS COMPANY

2. Tightly close the handles of the crimp tool until the crimper handles open when released.

   The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Holding the DuraSeal with one hand gently tug on the wire to ensure it is crimped in the DuraSeal.

3. Using the heat torch, apply heat to the crimped area of the barrel.

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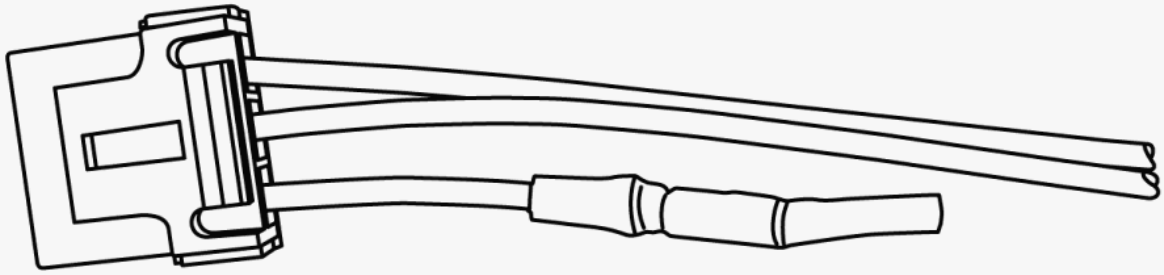

Fig. 7: Heat To Crimped Area Of Barrel
Courtesy of GENERAL MOTORS COMPANY

4. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
    - The tubing will shrink completely as the heat is moved along the insulation.
    - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

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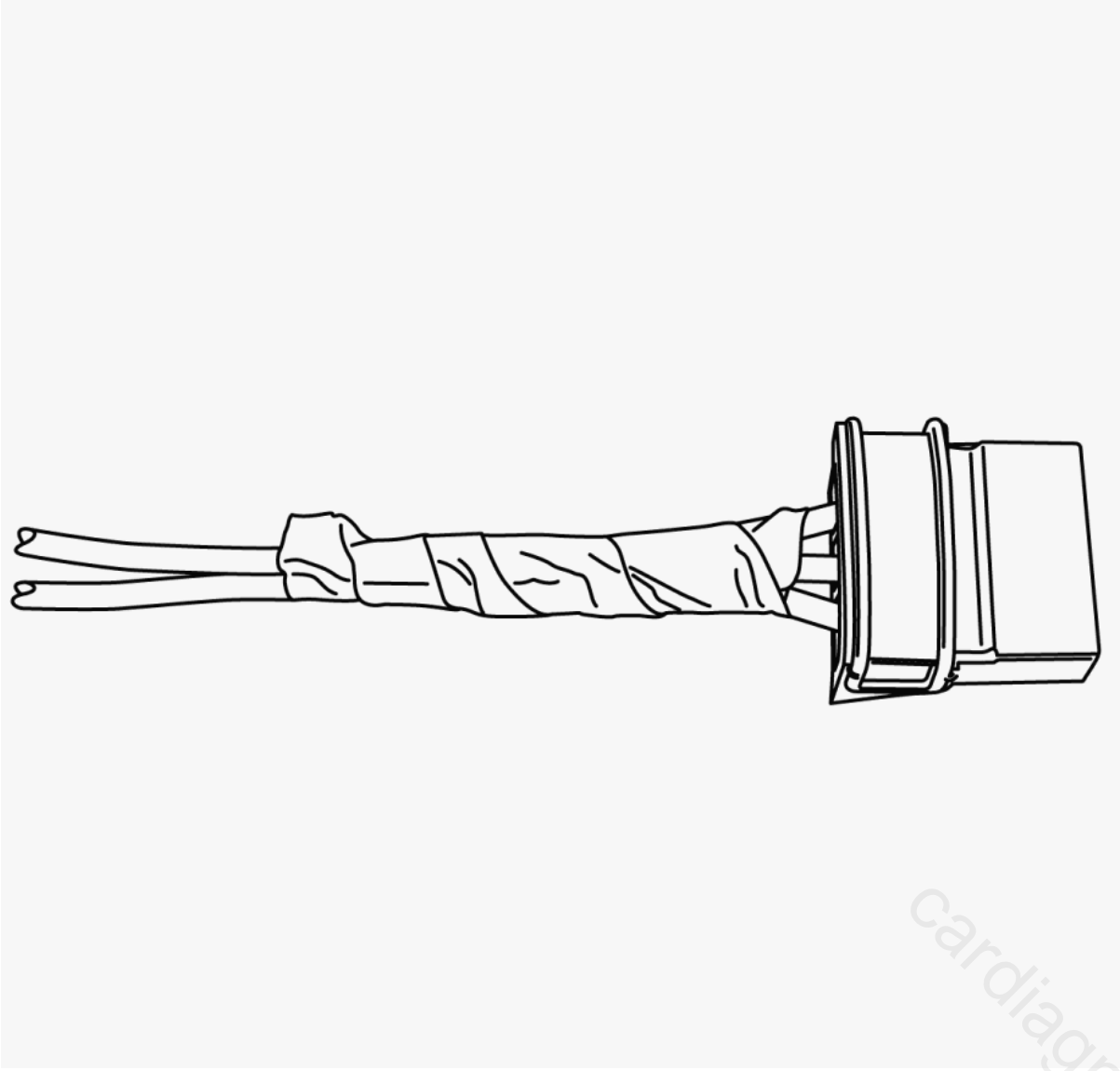

Fig. 8: Taping Extra Terminated Leads Back Into Harness
Courtesy of GENERAL MOTORS COMPANY

5. Tape the extra terminated lead(s) back into the harness.

High Temperature Wiring Repairs

Use the following procedures to perform high temperature wiring repairs:

1. Center the high temperature SCT1 shrink tube over the DuraSeal splice sleeve.
2. Using the heat torch, apply heat to the high temperature heat shrink tubing.
3. Gradually move the heat from the center to the open end of the tubing:
   - The tubing will shrink completely as the heat is moved along the insulation.
   - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.
4. Replace any reflective tape and clips that may have been removed during the repair.

CONNECTOR RECONNECTION - ENGINE CONTROLS AND FUEL

Special Tools

EL-35616 Terminal Test Probe Kit

For equivalent regional tools, refer to **Special Tools** .

When the condition is not currently present, but is indicated in DTC history, the cause may be intermittent. An intermittent may also be the cause when there is a customer complaint, but the symptom cannot be duplicated. Refer to the Symptom Table of the system that is suspect of causing the condition before trying to locate an intermittent condition.

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Most intermittent conditions are caused by faulty electrical connections or wiring. Inspect for the following items:

- Loose, corroded, or painted terminal stud/fastener
- Wiring broken inside the insulation
- Poor connection between the male and female terminal at a connector
- A terminal not seated all the way into the connector body
- Poor terminal to wire connection - Some conditions which fall under this description are poor crimps, poor solder joints, crimping over the wire insulation rather than the wire itself, and corrosion in the wire to terminal contact area, etc.
- Pierced or damaged insulation can allow moisture to enter the wiring causing corrosion. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.
- Wiring which has been pinched, cut, or its insulation rubbed through may cause an intermittent open or short as the bare area touches other wiring or parts of the vehicle.
- Wiring that comes in contact with hot or exhaust components
- Refer to **Inducing Intermittent Fault Conditions** in order to duplicate the conditions required, in order to verify the customer concern.
- Refer to **Testing for Electrical Intermittents** for test procedures to detect intermittent open, high resistance, short to ground, and short to voltage conditions.
- Refer to **Scan Tool Snapshot Procedure** for advanced intermittent diagnosis and Vehicle Data Recorder operation.

Testing for Terminal Fretting

Some intermittent conditions can be caused by wire terminal fretting corrosion. Fretting corrosion is a build-up of insulating, oxidized wear debris that can form when there is a small motion between electrical contacts. The oxidized wear debris can pile up enough at the electrical contact spots that the electrical resistance across the connection increases. Movement between the contacting surfaces as small as 10 to 100 microns can cause fretting. To put this in perspective, a sheet of paper is about 100 microns thick, so fretting motion is small and hard to see. Vibration and thermal expansion/contraction are the main sources that create fretting motion. Since vehicles vibrate and can experience large temperature swings, they are a good source for fretting motion. Tin, copper, nickel, and iron surfaces are all susceptible to fretting corrosion. Fretting corrosion can be difficult to see but it looks like small, dark smudges on the terminals contact surface.

To correct a fretting condition disconnect the suspect connector and add dielectric grease/lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to both sides of the connector terminals. Then reconnect the connector and wipe away any excess lubricant. This will correct the additional terminal contact resistance due to the terminal fretting corrosion.

Testing for Proper Terminal Contact

It is important to test terminal contact at the component and any inline connectors before replacing a suspect component. Mating terminals must be inspected to ensure good terminal contact. A poor connection between the male and female terminal at a connector may be the result of contamination or deformation.

Contamination may be caused by the connector halves being improperly connected. A missing or damaged connector seal, damage to the connector itself, or exposing the terminals to moisture and dirt can also cause contamination. Contamination, usually in the underhood or underbody connectors, leads to terminal corrosion, causing an open circuit or intermittently open circuit.

Deformation is caused by probing the mating side of a connector terminal without the proper adapter. Always use the **EL-35616** kit when probing connectors. Other causes of terminal deformation are improperly joining the connector halves, or repeatedly separating and joining the connector halves. Deformation, usually to the female terminal contact tang, can result in poor terminal contact causing an open or intermittently open circuit.

Testing for Proper Terminal Contact in Bussed Electrical Centers

It is very important to use the correct test adapter when testing for proper terminal contact of fuses and relays in a bussed electrical center. Use the **EL-35616** kit to test for proper terminal contact. Failure to use the **EL-35616** kit can result in improper diagnosis of the bussed electrical center.

Follow the procedure below in order to test terminal contact:

1. Separate the connector halves.
2. Visually inspect the connector halves for contamination. Contamination may result in a white or green build-up within the connector body or between terminals. This causes high terminal resistance, intermittent contact, or an open circuit. An underhood or underbody connector that shows signs of contamination should be replaced in its entirety: terminals, seals, and connector body.
3. Using an equivalent male terminal/terminated lead, verify that the retention force is significantly different between a known good terminal and the suspect terminal. Replace the female terminal in question.

Flat Wire Connectors

There are no serviceable parts for flat wire connectors on the harness side or the component side.

Follow the procedure below in order to test terminal contact:

1. Remove the component in question.
2. Visually inspect each side of the connector for signs of contamination. Avoid touching either side of the connector as oil from your skin may be a source of contamination as well.
3. Visually inspect the terminal bearing surfaces of the flat wire circuits for splits, cracks, or other imperfections that could cause poor terminal contact. Visually inspect the component side connector to ensure that all of the terminals are uniform and free of damage or deformation.
4. Insert the appropriate adapter into the flat wire harness connector in order to test the circuit in question.

Control Module/Component Voltage and Grounds

Poor voltage or ground connections can cause widely varying symptoms.

- Test all control module voltage supply circuits. Many vehicles have multiple circuits supplying voltage to a control module. Other components in the system may have separate voltage supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the voltage source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Operate the component to test the ability of the circuit to carry sufficient current. Refer to **Circuit Testing** , and Power Distribution Wiring Schematics .
- Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point (screw or stud). Inspect the connections at the component and in splice packs, where applicable. Operate the component to test the ability of the circuit to carry sufficient current. Refer to **Circuit Testing** , and Ground Distribution Wiring Schematics .

Temperature Sensitivity

- An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/connection is cold, or only when the component/connection is hot.
- Freeze Frame, Failure Records, Snapshot, or Vehicle Data Recorder data may help with this type of intermittent condition, where applicable.
- If the intermittent is related to heat, review the data for a relationship with the following:
  - High ambient temperatures
  - Underhood/engine generated heat
  - Circuit generated heat due to a poor connection, or high electrical load

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    - Higher than normal load conditions, towing, etc.
- If the intermittent is related to cold, review the data for the following:
    - Low ambient temperatures - In extremely low temperatures, ice may form in a connection or component. Inspect for water intrusion.
    - The condition only occurs on a cold start.
    - The condition goes away when the vehicle warms up.
- Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
- If temperature is suspected of causing an intermittent fault condition, attempt to duplicate the condition. Refer to **Inducing Intermittent Fault Conditions** in order to duplicate the conditions required.

Electromagnetic Interference and Electrical Noise

Some electrical components/circuits are sensitive to electromagnetic interference or other types of electrical noise. Inspect for the following conditions:

- A mis-routed harness that is too close to high voltage/high current devices such as secondary ignition components, motors, generator etc. - These components may induce electrical noise on a circuit that could interfere with normal circuit operation.
- Electrical system interference caused by a malfunctioning relay, or a control module driven solenoid or switch - These conditions can cause a sharp electrical surge. Normally, the condition will occur when the malfunctioning component is operating.
- Installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. - These accessories may create interference in other circuits while operating and the interference would disappear when the accessory is not operating. Refer to **Checking Aftermarket Accessories** .
- Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode.
- The generator may be allowing AC noise into the electrical system.

Incorrect Control Module

- There are only a few situations where reprogramming a control module is appropriate:
    - A new service control module is installed.
    - A control module from another vehicle is installed.
    - Revised software/calibration files have been released for this vehicle.

NOTE: **DO NOT re-program the control module with the SAME software/calibration files that are already present in the control module. This is not an effective repair for any type of concern.**

- Verify that the control module contains the correct software/calibration. If incorrect programming is found, reprogram the control module with the most current software/calibration. Refer to **Control Module References** for replacement, setup, and programming.

ENGINE CONTROL MODULE REPLACEMENT

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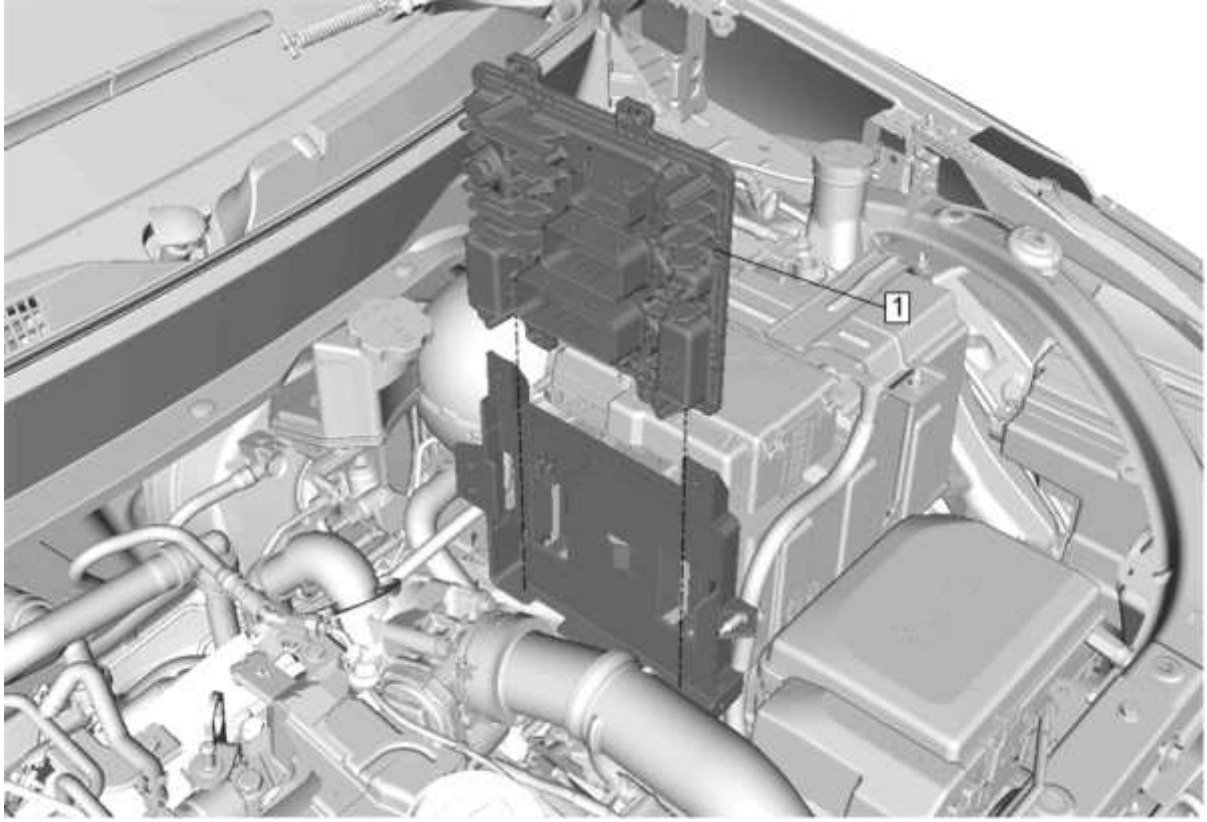

Fig. 9: Engine Control Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)** 2. Remove Charge Air Cooler Outlet Air Tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement**	

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Callout	Component Name
1	Engine Control Module **WARNING:** **Refer to Safety Glasses Warning .** **CAUTION:** **Always turn the ignition off when installing or removing the ECM connectors in order to prevent damage to the components.** **CAUTION:** • **Turn the ignition OFF when installing or removing the control module connectors and disconnecting or reconnecting the power to the control module (battery cable, powertrain control module (PCM)/engine control module (ECM)/transaxle control module (TCM) pigtail, control module fuse, jumper cables, etc.) in order to prevent internal control module damage.** • **Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control module, using battery booster cables, or when charging the vehicle battery.** • **In order to prevent any possible electrostatic discharge damage to the control module, do no touch the connector pins or the soldered components on the circuit board.** • **Remove any debris from around the control module connector surfaces before servicing the control module. Inspect the control module connector gaskets when diagnosing or replacing the control module. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the control module.** • **The replacement control module must be programmed.** **Procedure** 1. Use a suitable tool to pry back the locking tabs and remove the engine control module from the bracket. 2. Disconnect the electrical connectors from the engine control module. 3. If replacing the engine control module, it is necessary to reprogram the replacement module. 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.**

ENGINE CONTROL MODULE BRACKET REPLACEMENT

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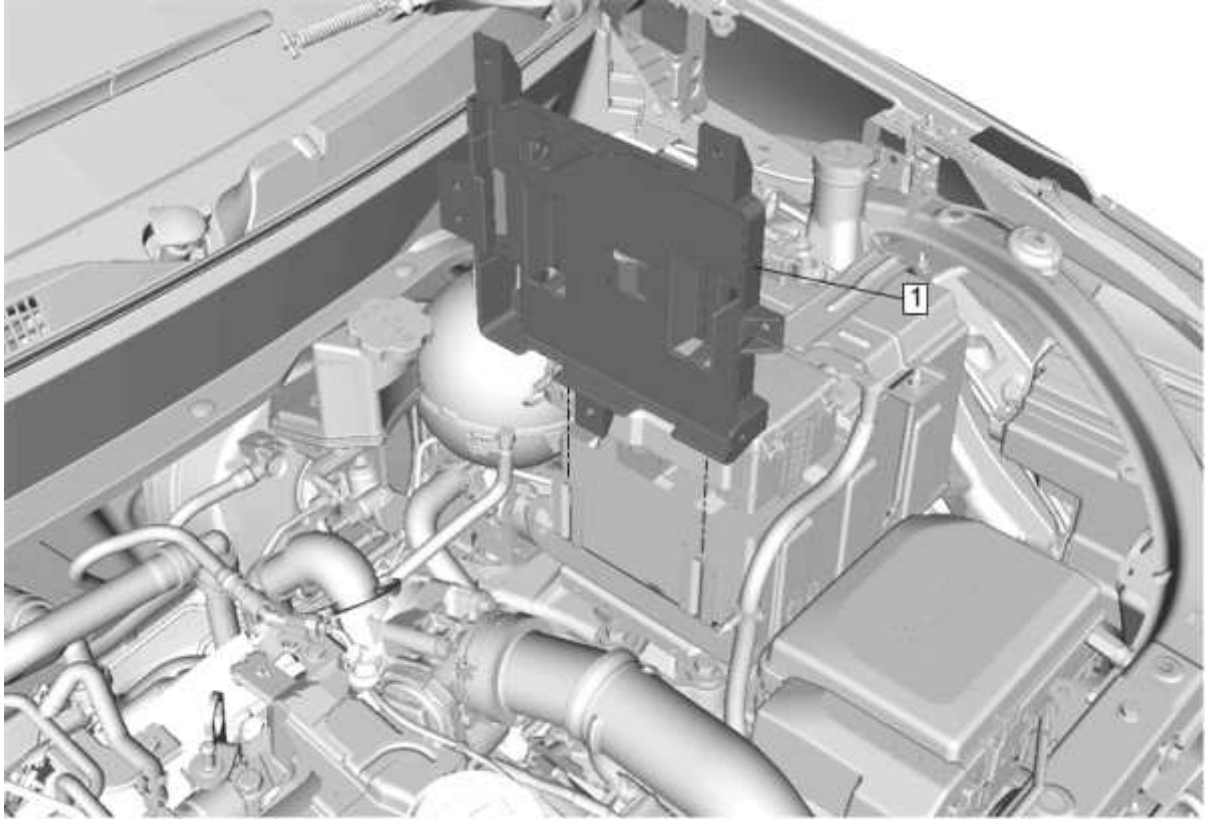

Fig. 10: Engine Control Module Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove Engine Control Module. Refer to **Engine Control Module Replacement** 2. Reposition away Engine Coolant Air Bleed Hose @ Engine Control Module Bracket. Refer to **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Exhaust Gas Recirculation Cooler Housing and Radiator LH7)** 3. Remove wiring harness from engine control module bracket.	
1	Engine Control Module Bracket **Procedure** Release retaining tab to remove bracket from battery tray.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT (FWD)

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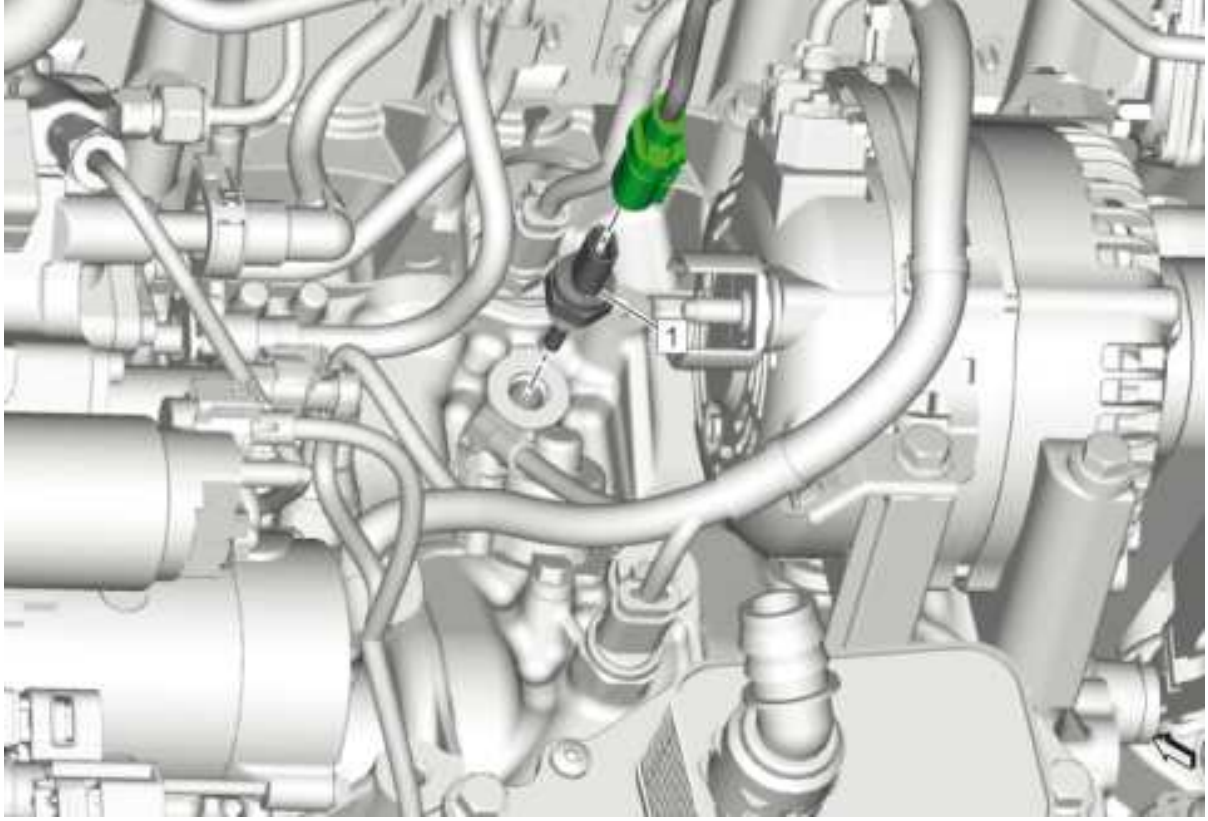

Fig. 11: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Allow sufficient time for the engine to cool before removing the ECT sensor. A hot engine may cause an excessive coolant loss or a personal injury.** **CAUTION:** **Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.** **Preliminary Procedures** 1. Disconnect Battery Negative Cable. Refer to Battery Negative Cable Disconnection and Connection (KL9) 2. Remove Exhaust Front Pipe. Refer to Exhaust Front Pipe Replacement (LH7) 3. Drain cooling system. Refer to Cooling System Draining and Filling (GE 47716) Cooling System Draining and Filling (Static)	
1	Engine Coolant Temperature Sensor **CAUTION:** **Refer to Component Fastener Tightening Caution** **Procedure** Disconnect the engine coolant temperature sensor electrical connector. **Tighten** 45 N.m (33 lb ft)

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT (AWD)

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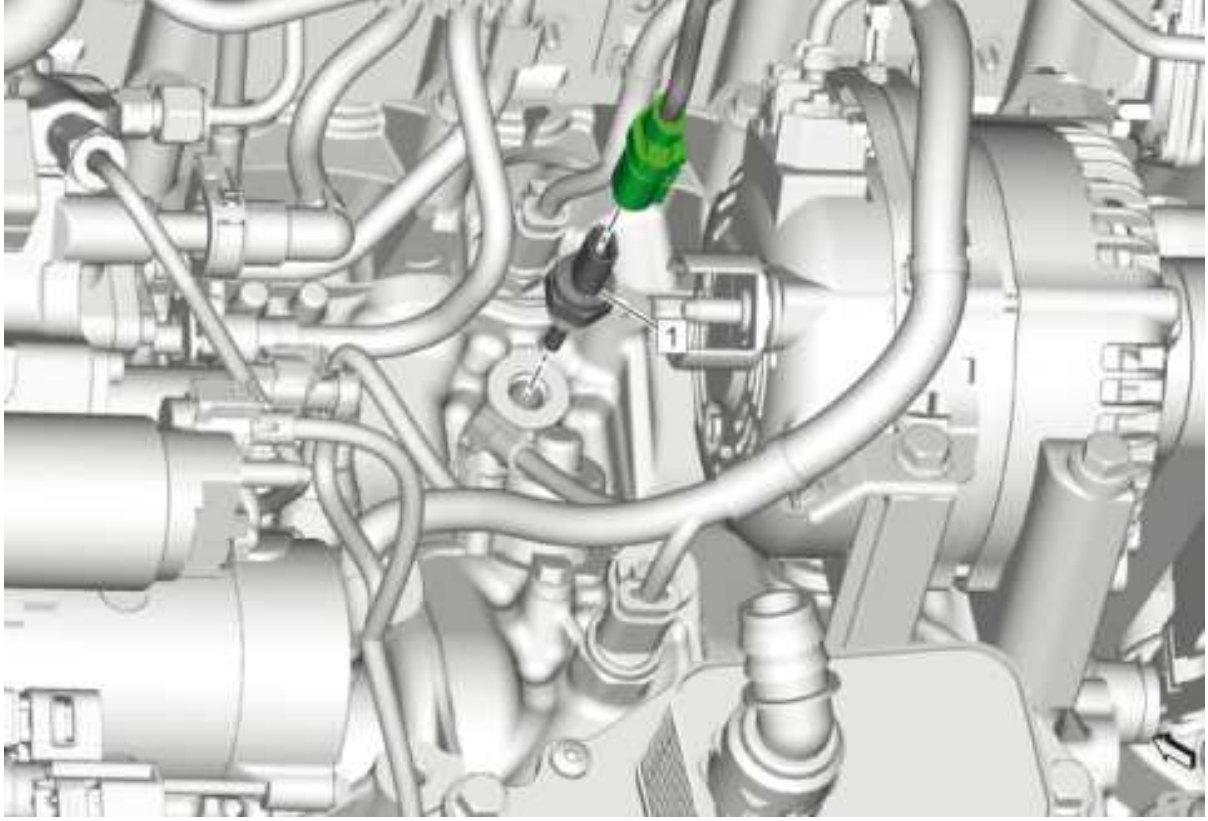

Fig. 12: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Allow sufficient time for the engine to cool before removing the ECT sensor. A hot engine may cause an excessive coolant loss or a personal injury.** **CAUTION:** **Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.** **Preliminary Procedures** 1. Disconnect Battery Negative Cable. Refer to Battery Negative Cable Disconnection and Connection (KL9) 2. Drain cooling system. Refer to Cooling System Draining and Filling (GE 47716) Cooling System Draining and Filling (Static) 3. Remove Power Transfer Unit Case. Refer to Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)	
1	Engine Coolant Temperature Sensor **CAUTION:** **Refer to Component Fastener Tightening Caution** **Procedure** Disconnect the engine coolant temperature sensor electrical connector. **Tighten** 45 N.m (33 lb ft)

AIR CLEANER ASSEMBLY REPLACEMENT

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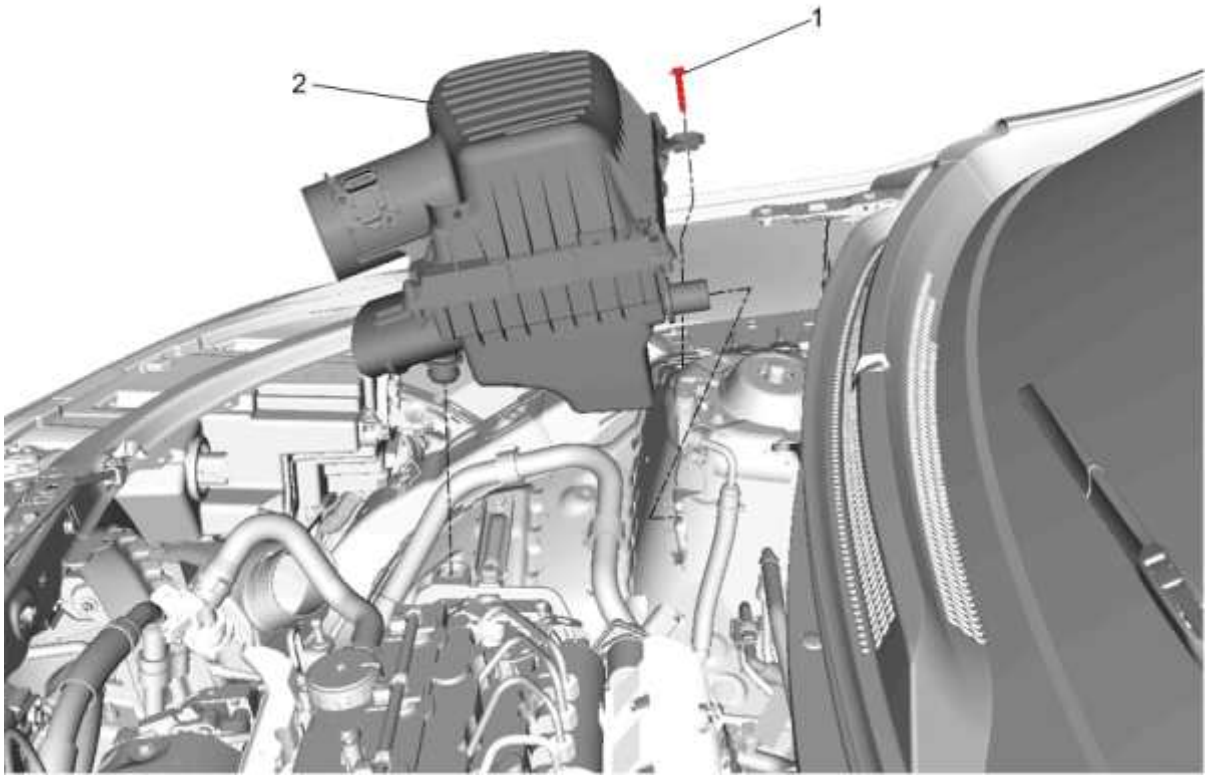

Fig. 13: Air Cleaner Assembly And Fastener
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove Air Cleaner Outlet Duct. Refer to **Air Cleaner Outlet Duct Replacement** 2. Remove Intake Air Duct. Refer to **Intake Air Duct Replacement** 3. Disconnect the electrical connector.	
1	Air Cleaner Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Air Cleaner Assembly **Procedure** 1. Remove the air cleaner housing from the retainers. 2. Remove wiring harness from air cleaner assembly. 3. Transfer parts as necessary.

AIR CLEANER ELEMENT REPLACEMENT

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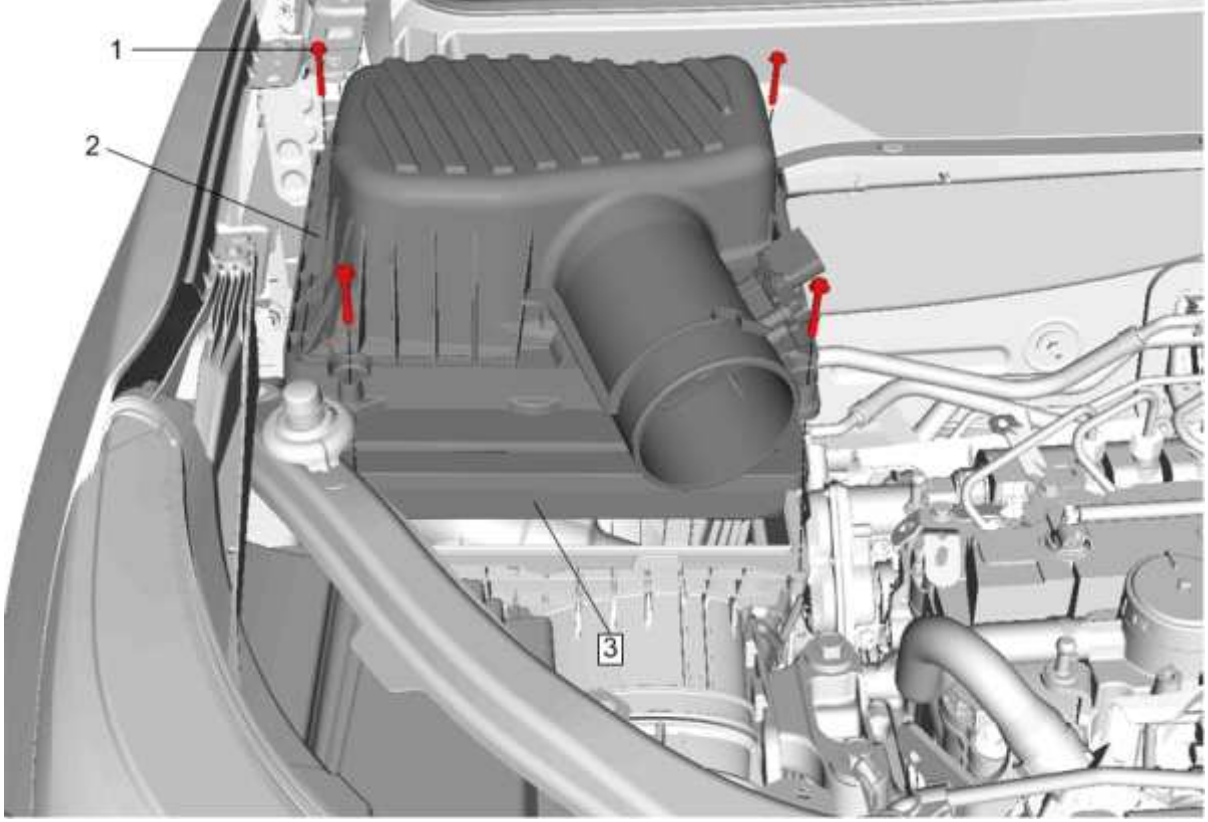

Fig. 14: Air Cleaner Element
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove Air Cleaner Outlet Duct. Refer to **Air Cleaner Outlet Duct Replacement** 2. Disconnect the electrical connector. 3. Remove wiring harness from air cleaner upper housing.	
1	Air Cleaner Upper Housing Bolt (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 4 N.m (35 lb in)
2	Air Cleaner Upper Housing
3	Air Cleaner Element

AIR CLEANER OUTLET DUCT REPLACEMENT

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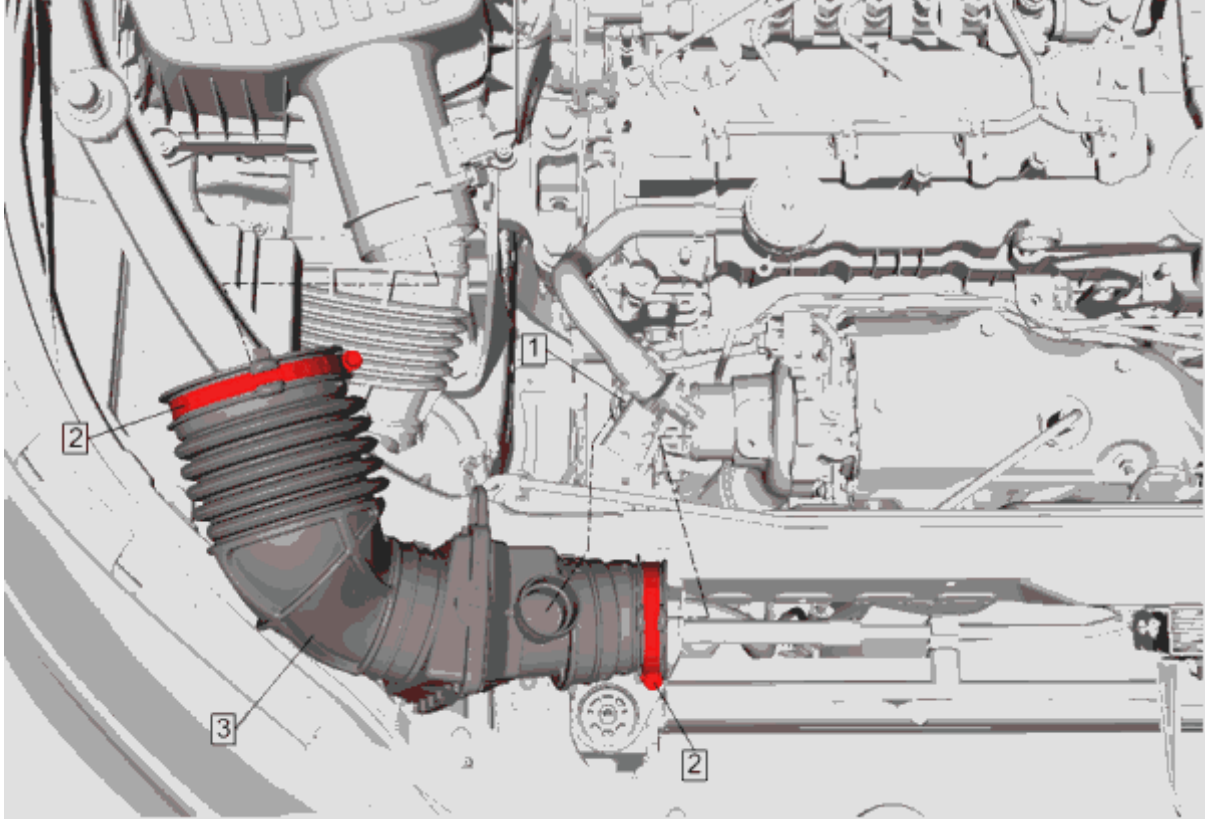

Fig. 15: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Positive Crankcase Ventilation Heater **Procedure** Disconnect Positive Crankcase Ventilation Heater @ Air Cleaner Outlet Duct
2	Air Cleaner Outlet Duct Clamp (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 3.5 N.m (31 lb in)
3	Air Cleaner Outlet Duct **Procedure** Remove wiring harness from air cleaner outlet duct.

INTAKE AIR BAFFLE REPLACEMENT

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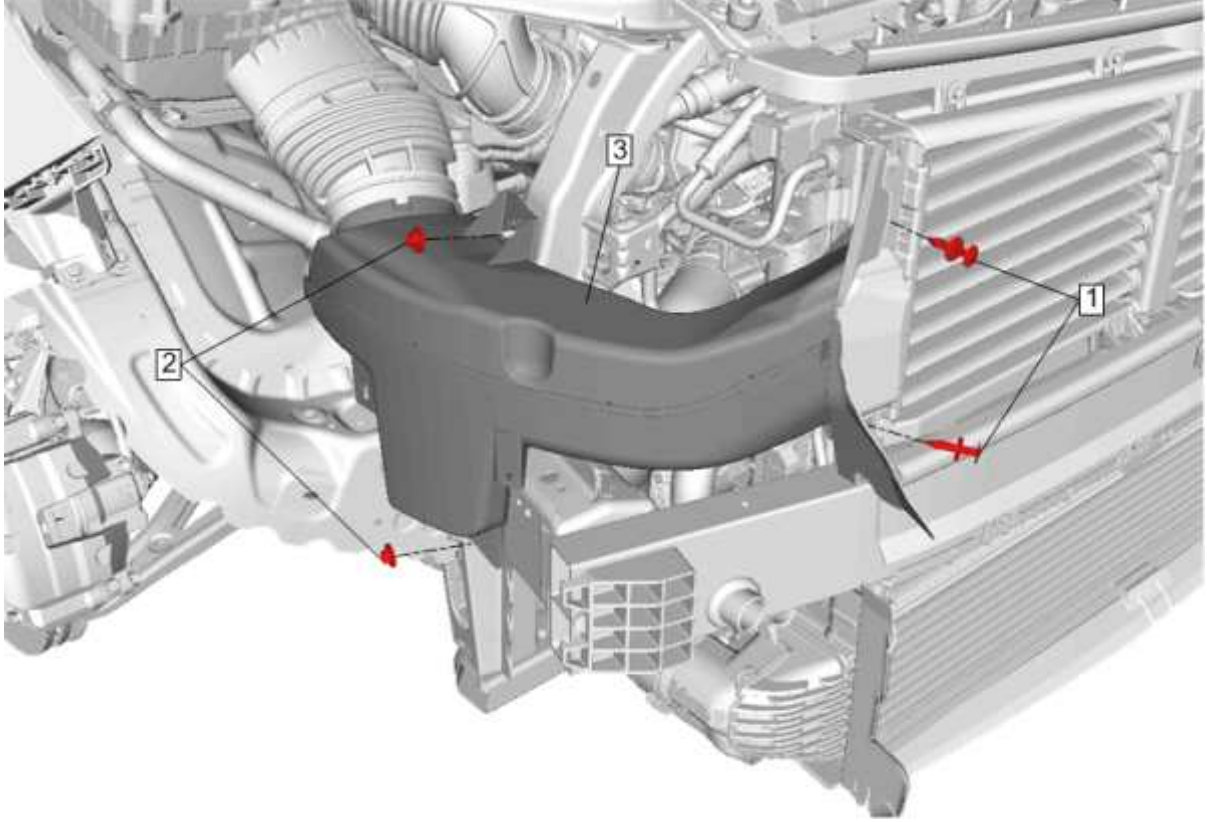

Fig. 16: Intake Air Baffle
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Headlamp. Refer to Headlamp Replacement (Chevrolet) Headlamp Replacement (GMC)	
1	Intake Air Baffle Retainer (Qty: 2)
2	Front Intake Air Duct Nut (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
3	Intake Air Baffle **Procedure** Remove wiring harness retainers from intake air baffle.

INTAKE AIR DUCT REPLACEMENT

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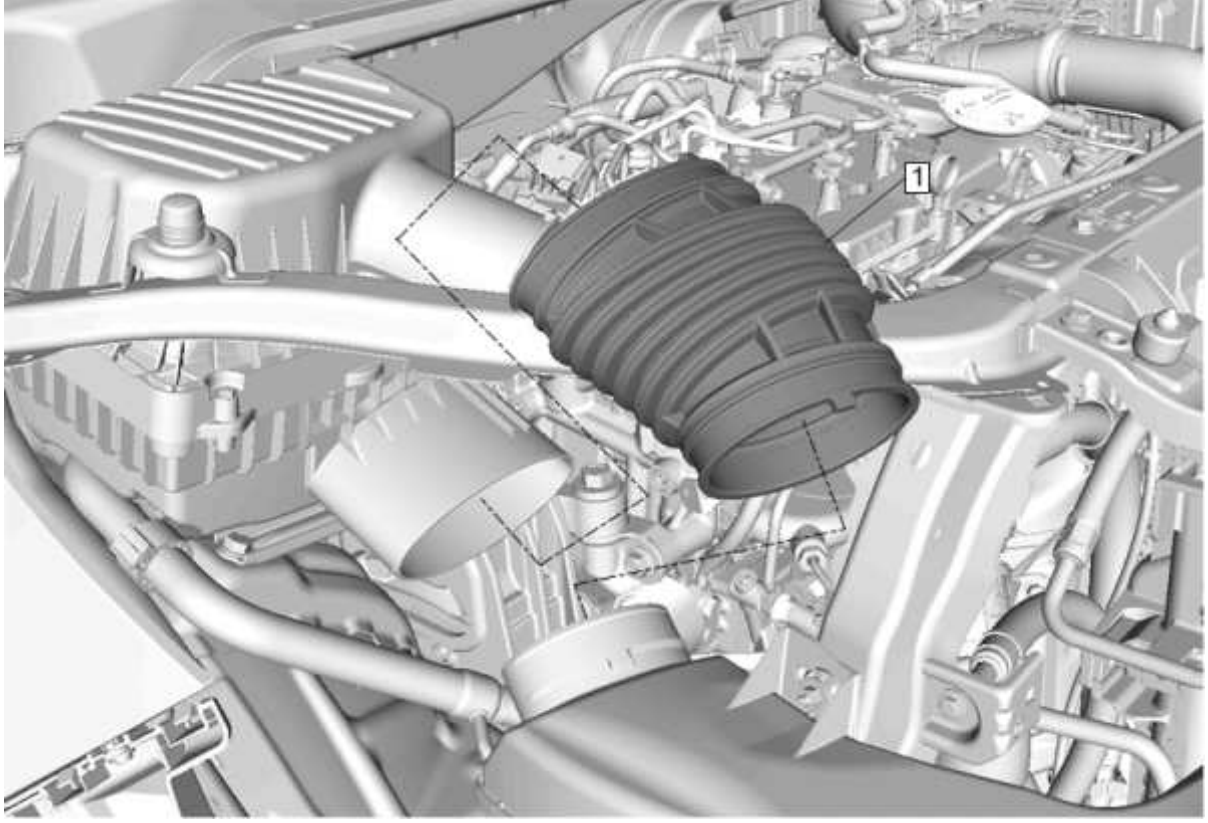

Fig. 17: Intake Air Duct
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Air Cleaner Outlet Duct. Refer to **Air Cleaner Outlet Duct Replacement**	
1	Intake Air Duct

INTAKE AIR PRESSURE AND TEMPERATURE SENSOR REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

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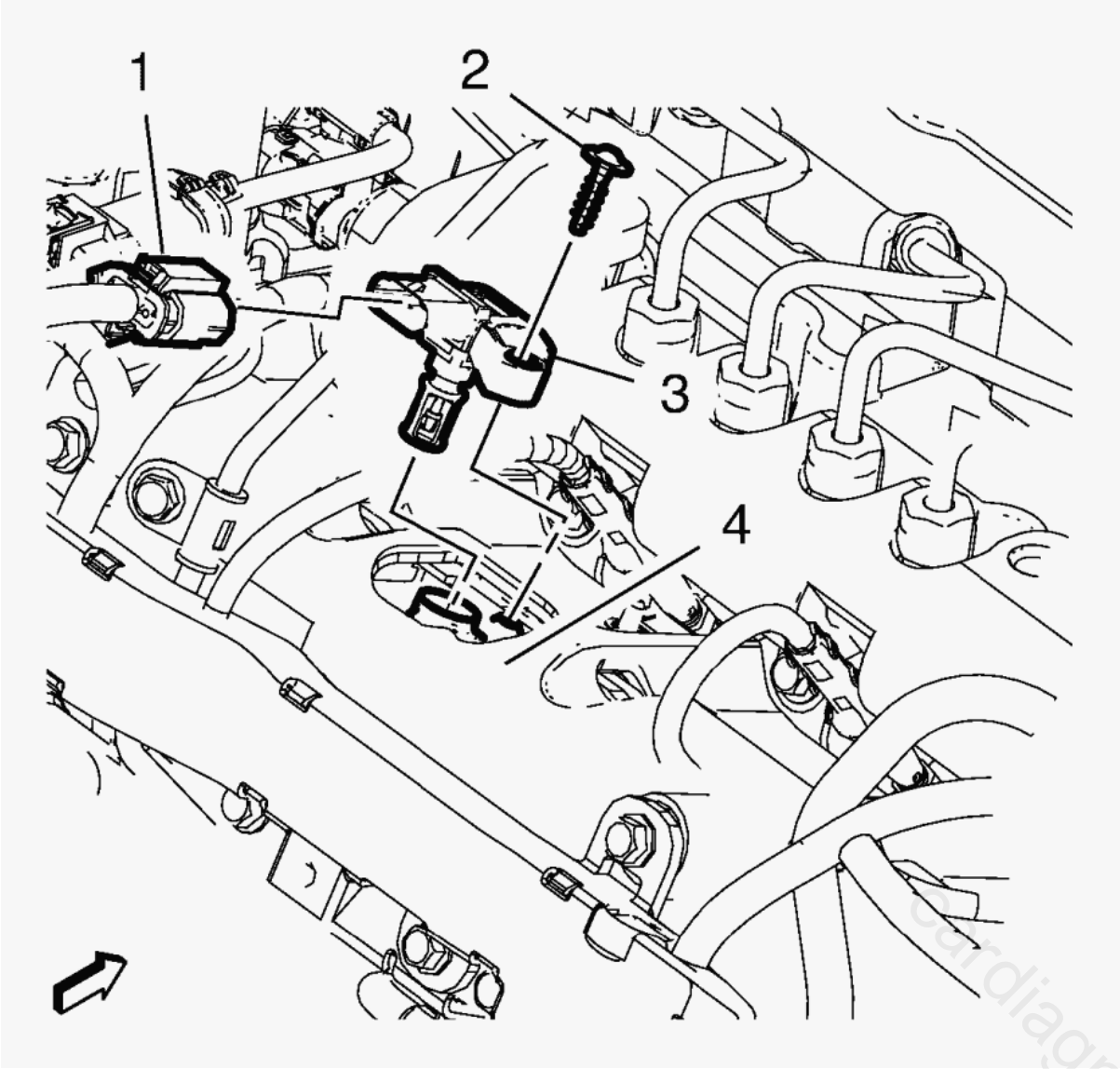

Fig. 18: Intake Air Pressure And Temperature Sensor, Bolt And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the electrical connector (1) from the intake air pressure and temperature sensor (3).
4. Remove the intake air pressure and temperature sensor bolt (2).
5. Remove the intake air pressure and temperature sensor (3) from intake manifold (4).

Installation Procedure

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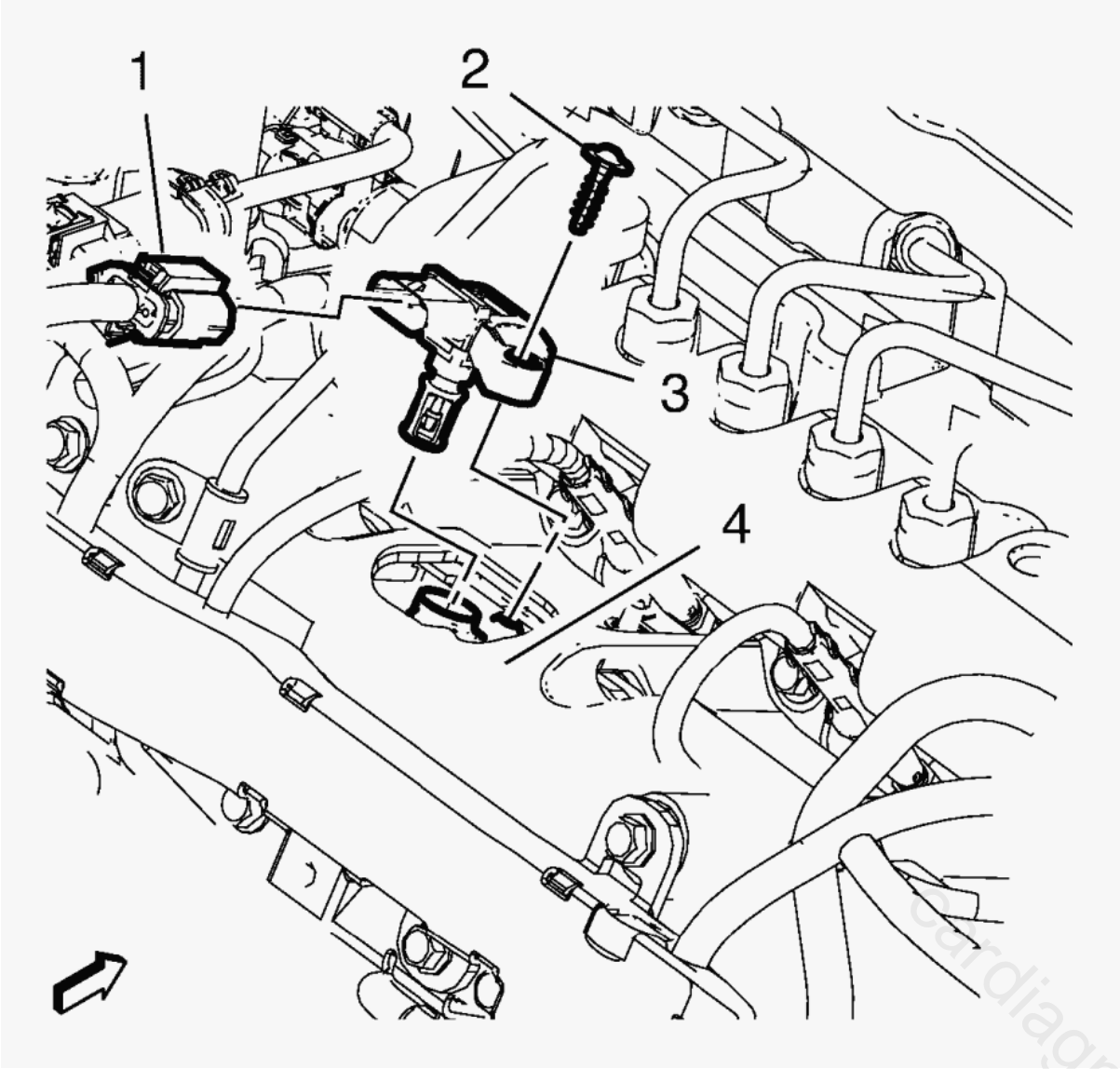

Fig. 19: Intake Air Pressure And Temperature Sensor, Bolt And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Install the intake air pressure and temperature sensor (3) to the intake manifold (4).

CAUTION: **Refer to Fastener Caution .**

2. Install the bolt (2) to intake air pressure and temperature sensor (3) and tighten to 1.6 N.m (14 lb in).
3. Connect the wiring harness plug (2) to the intake air pressure and temperature sensor (3).
4. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
5. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

MASS AIRFLOW SENSOR REPLACEMENT

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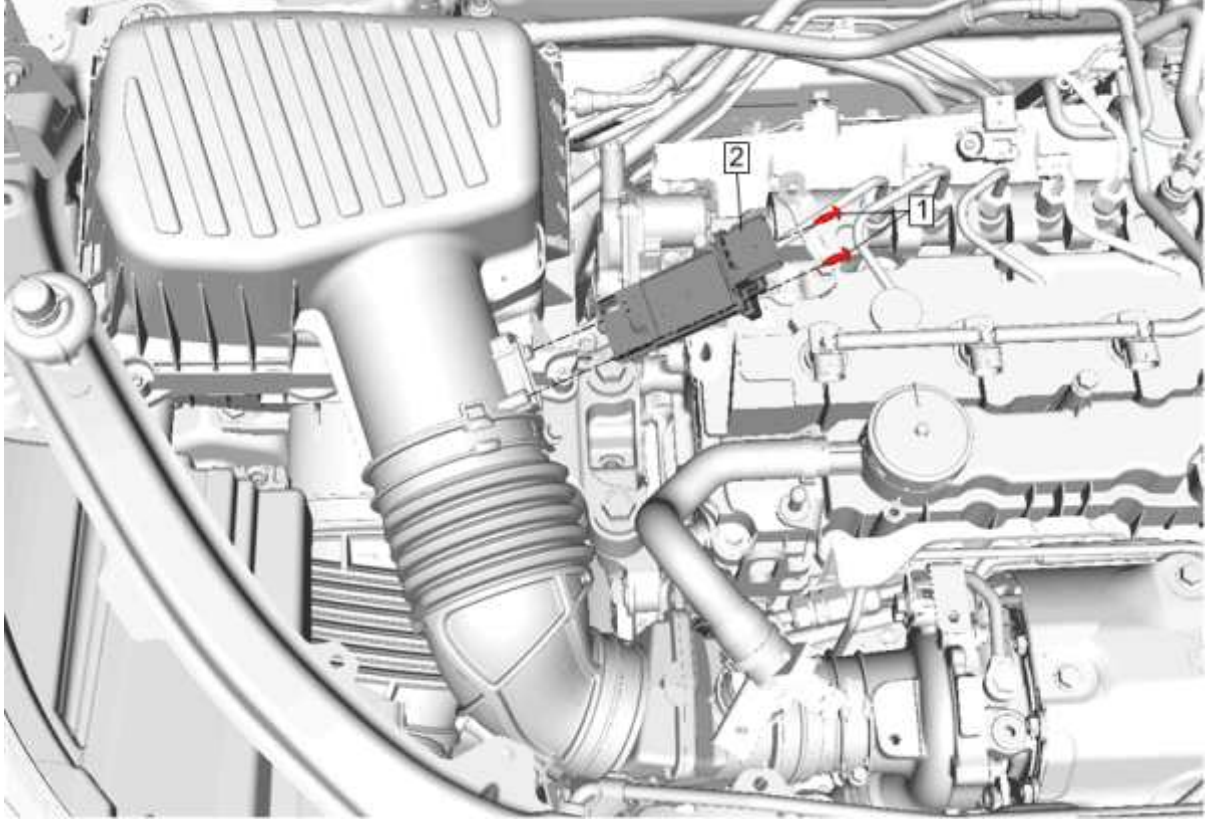

Fig. 20: Mass Airflow Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Mass Airflow Sensor Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 4 N.m (35 lb in)
2	Mass Airflow Sensor **Procedure** Disconnect the electrical connector.

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

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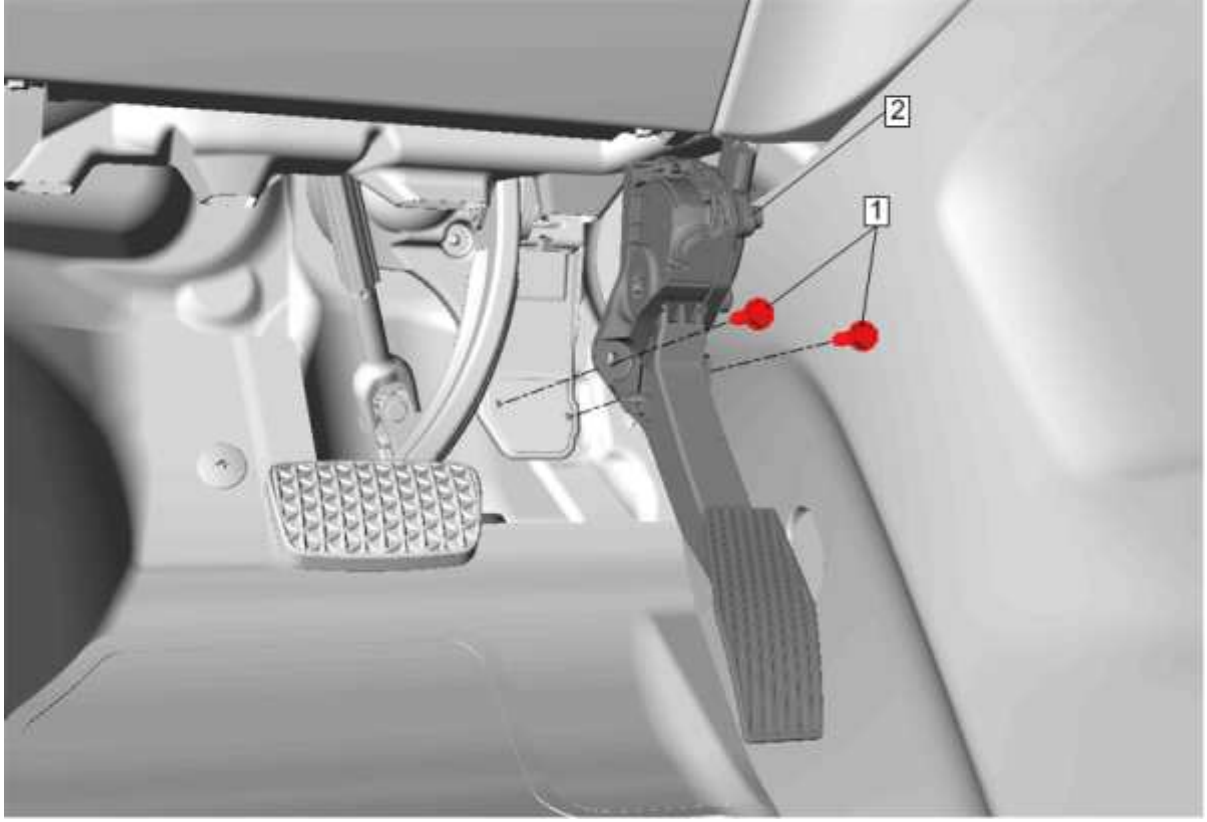

Fig. 21: Accelerator Pedal Position Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Accelerator Pedal Position Sensor Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Accelerator Pedal Position Sensor **Procedure** Disconnect the electrical connector.

THROTTLE BODY ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

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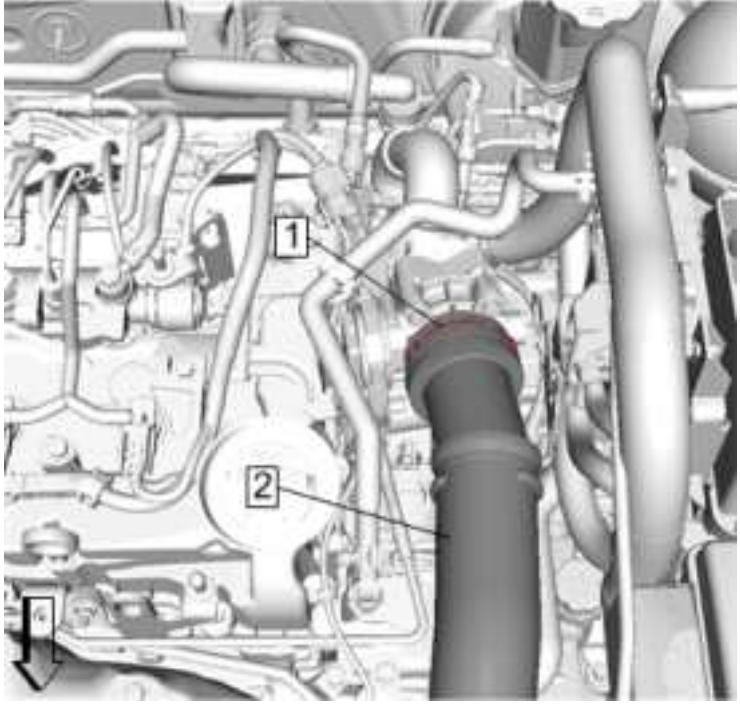

Fig. 22: Charge Air Cooler Outlet Air Tube And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

2. Remove Charge Air Cooler Outlet Air Tube (2) @ Throttle Body. Refer to **Charge Air Cooler Outlet Air Tube Replacement**

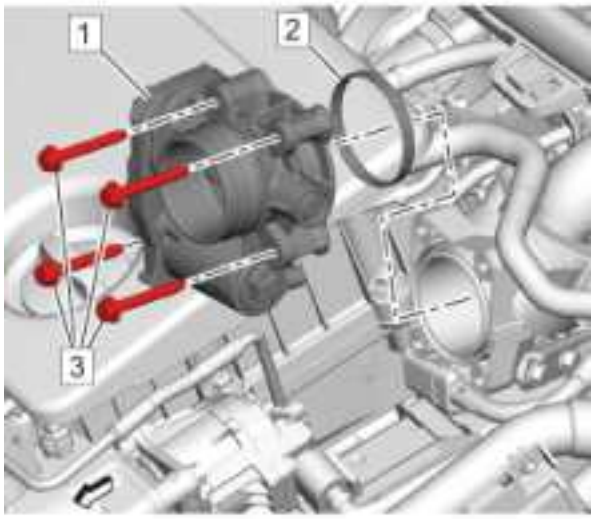

Fig. 23: Throttle Body, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Remove Throttle Body Bolts (3) (Qty: 4)

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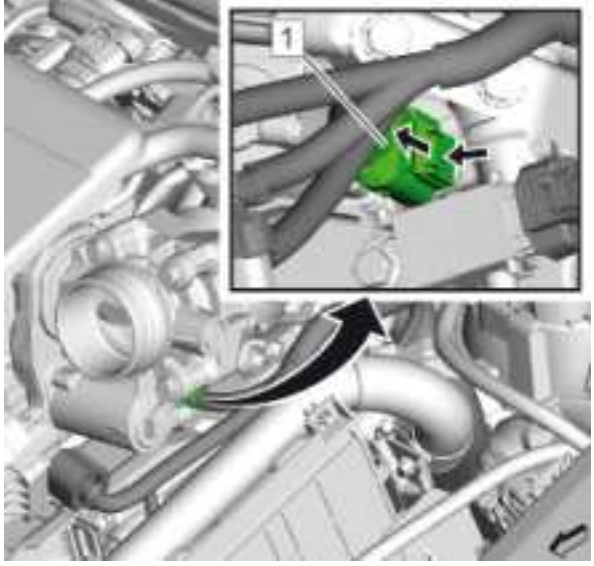

Fig. 24: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connector. (1)
5. Remove the throttle body. (1)
6. Remove and DISCARD the throttle body gasket. (2)

Installation Procedure

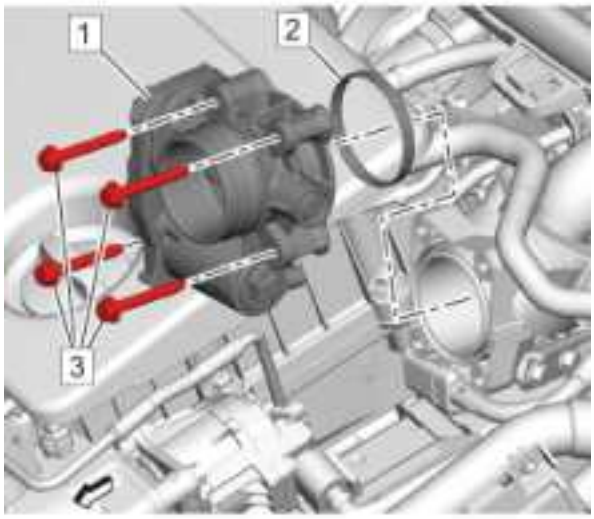

Fig. 25: Throttle Body, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW throttle body gasket. (2)
2. Install the throttle body. (1)

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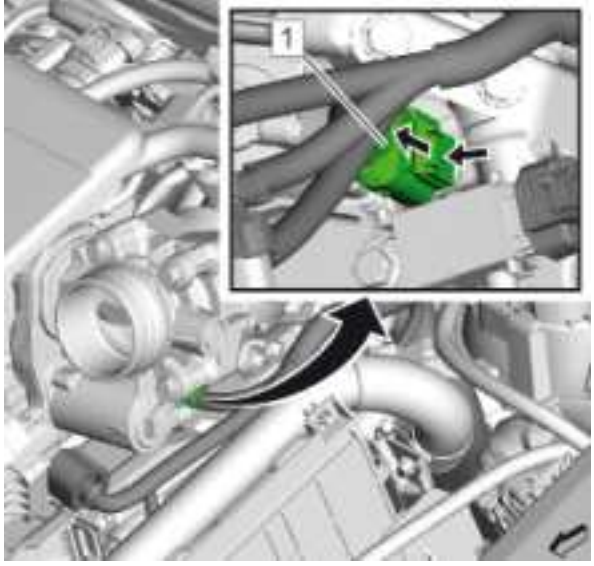

Fig. 26: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect the electrical connector. (1)

CAUTION: **Refer to Fastener Caution**

4. Install and tighten Throttle Body Bolts (3) (Qty: 4) to 10 N.m (89 lb in)

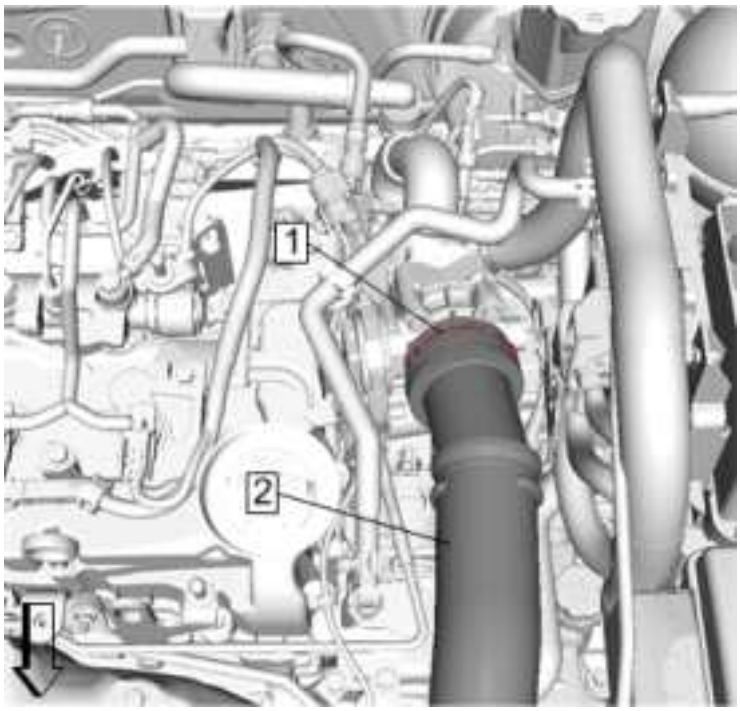

Fig. 27: Charge Air Cooler Outlet Air Tube And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

5. Install Charge Air Cooler Outlet Air Tube (2) @ Throttle Body. Refer to Charge Air Cooler Outlet Air Tube Replacement
6. Install Intake Manifold Cover. Refer to Intake Manifold Cover Replacement
7. When the replacement is completed, use a scan tool to perform the appropriate reset functions. Refer to Control Module References

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Removal Procedure

WARNING: **Refer to Diesel/Gasoline Vapors Warning .**

NOTE: **If servicing a fuel system, insure the fuel pressure has been relieved.**

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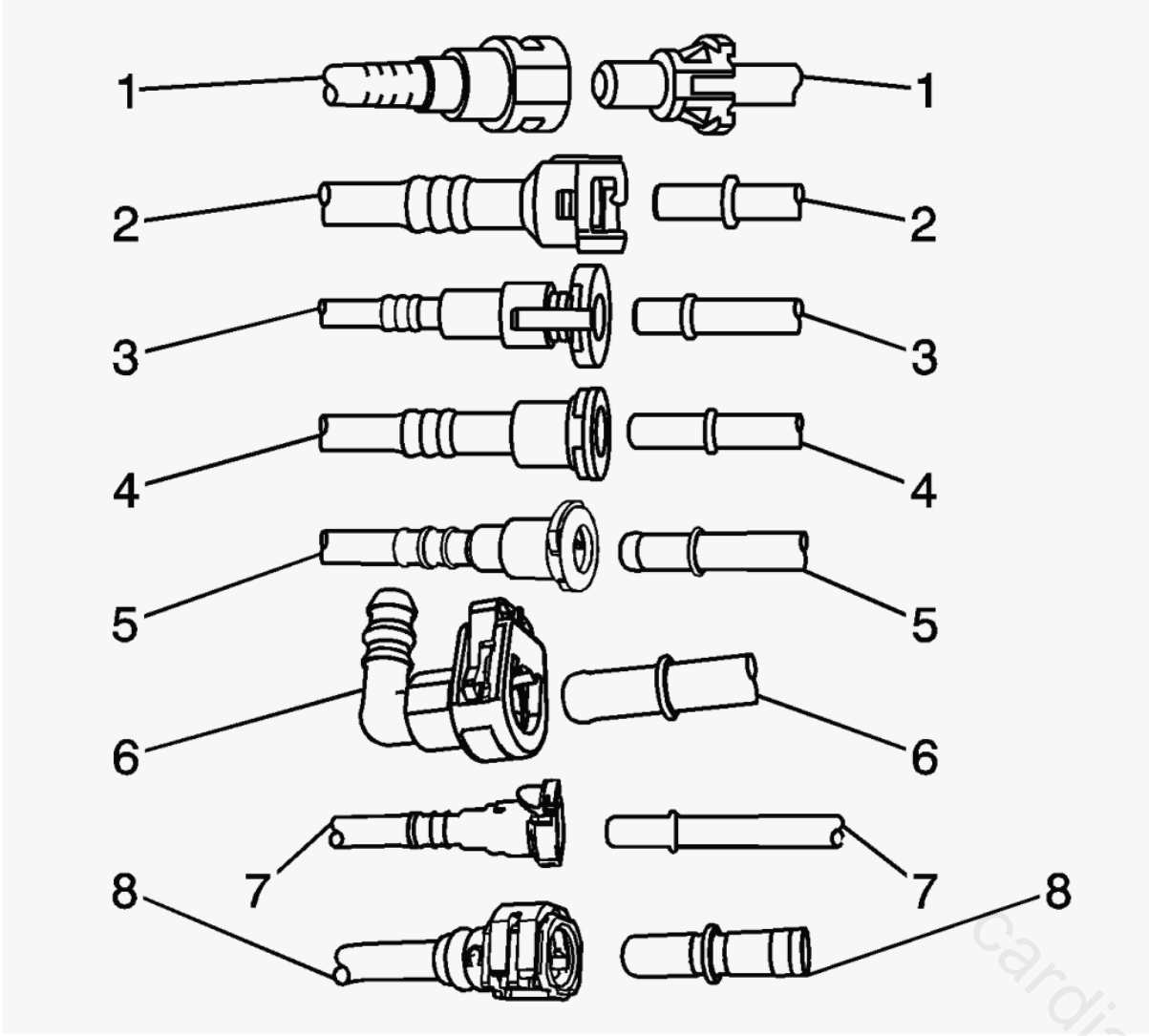

Fig. 28: Identifying Plastic Collar Quick Connect Fitting Types
Courtesy of GENERAL MOTORS COMPANY

NOTE: **There are several types of plastic collar fuel and evaporative emission quick connect fittings used on this vehicle.**

- **Bartholomew (1)**
- **Q Release (2)**
- **Squeeze to Release (3)**
- **Sliding Retainer (4)**
- **Global Connect (5)**
- **TI Loc (6)**
- **Safe Lock (7)**
- **Plastic Connector (8)**

The following instructions apply to all of these types of plastic collar quick connect fittings except where indicated.

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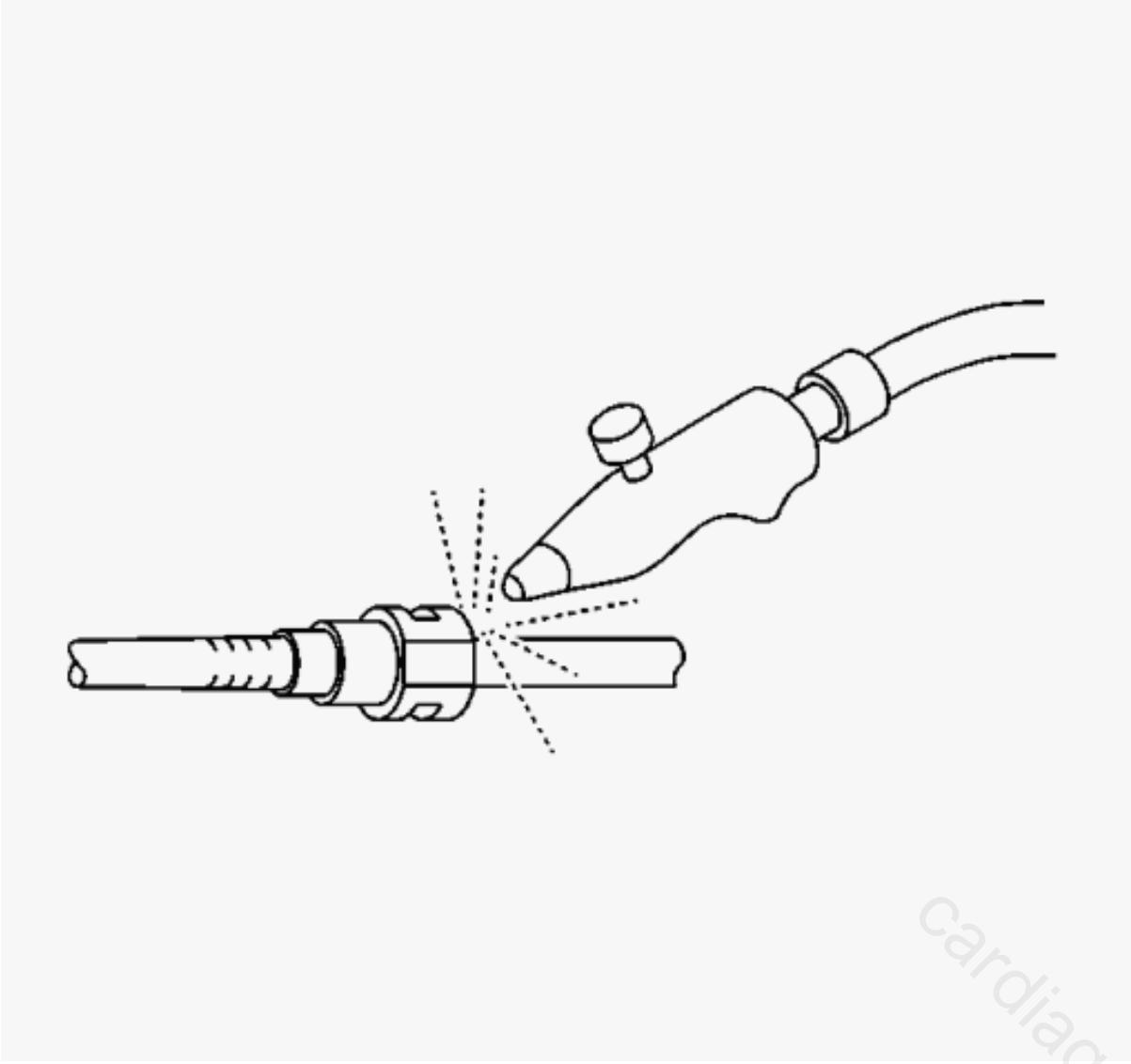

Fig. 29: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.**

1. Using compressed air, blow any dirt out of the quick-connect fitting.

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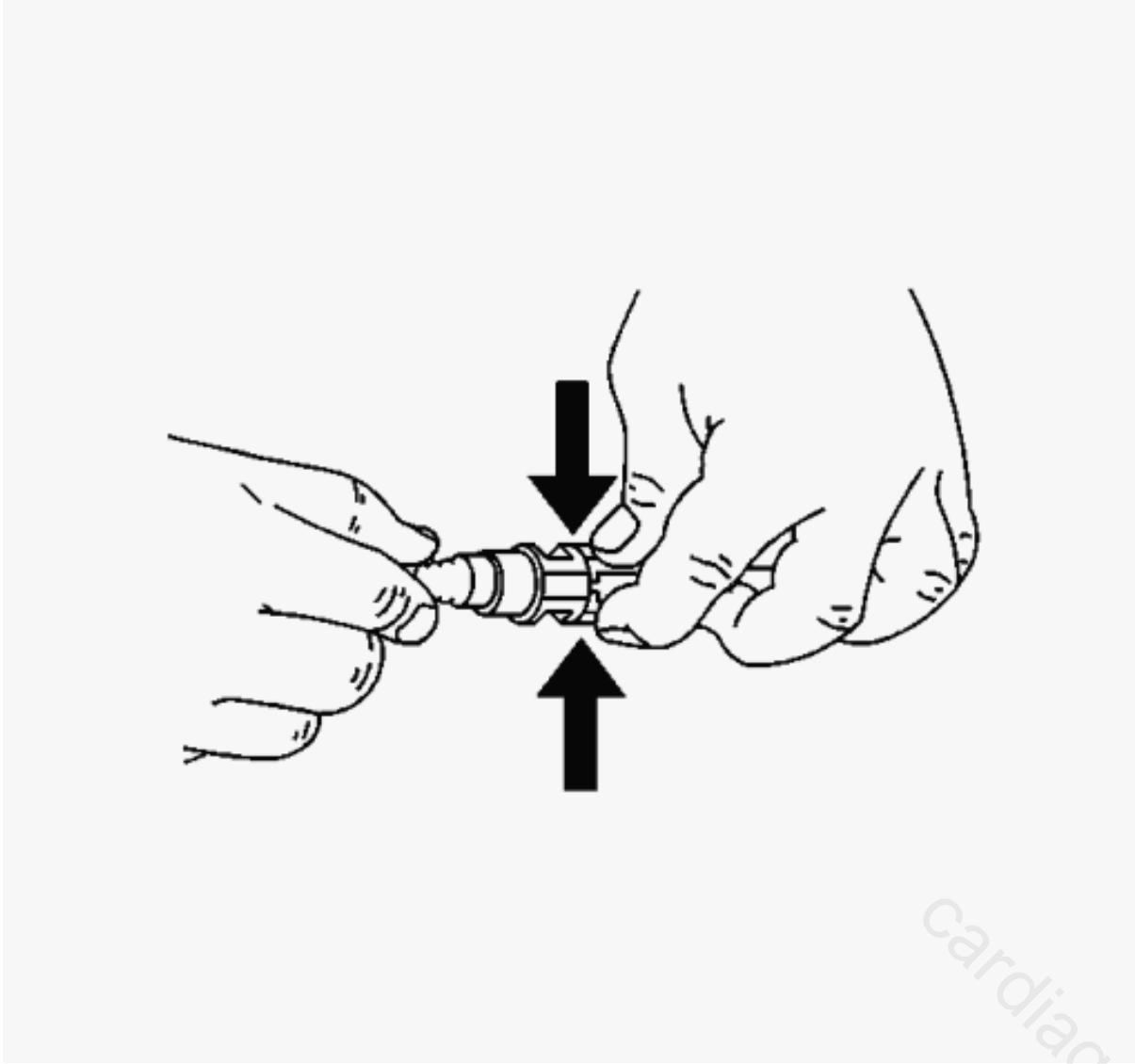

Fig. 30: Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

2. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick-connect fitting release tabs.

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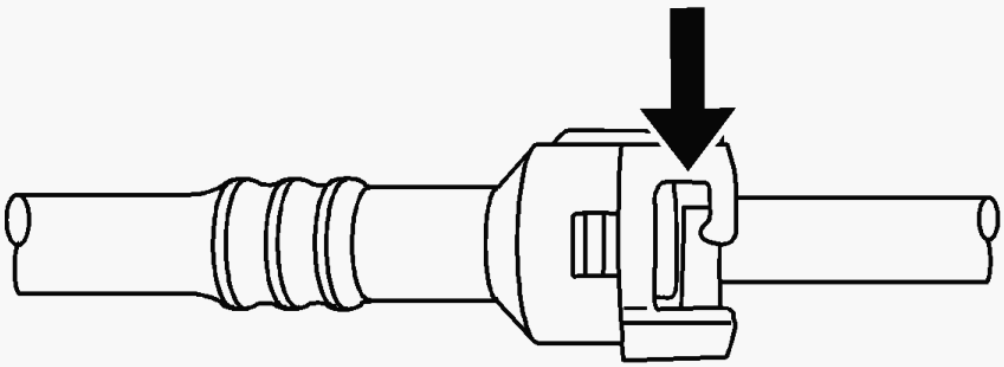

Fig. 31: Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

3. This step applies to Q Release style connectors ONLY. Release the fitting by Pushing the tab toward the other side of the slot in the fitting.

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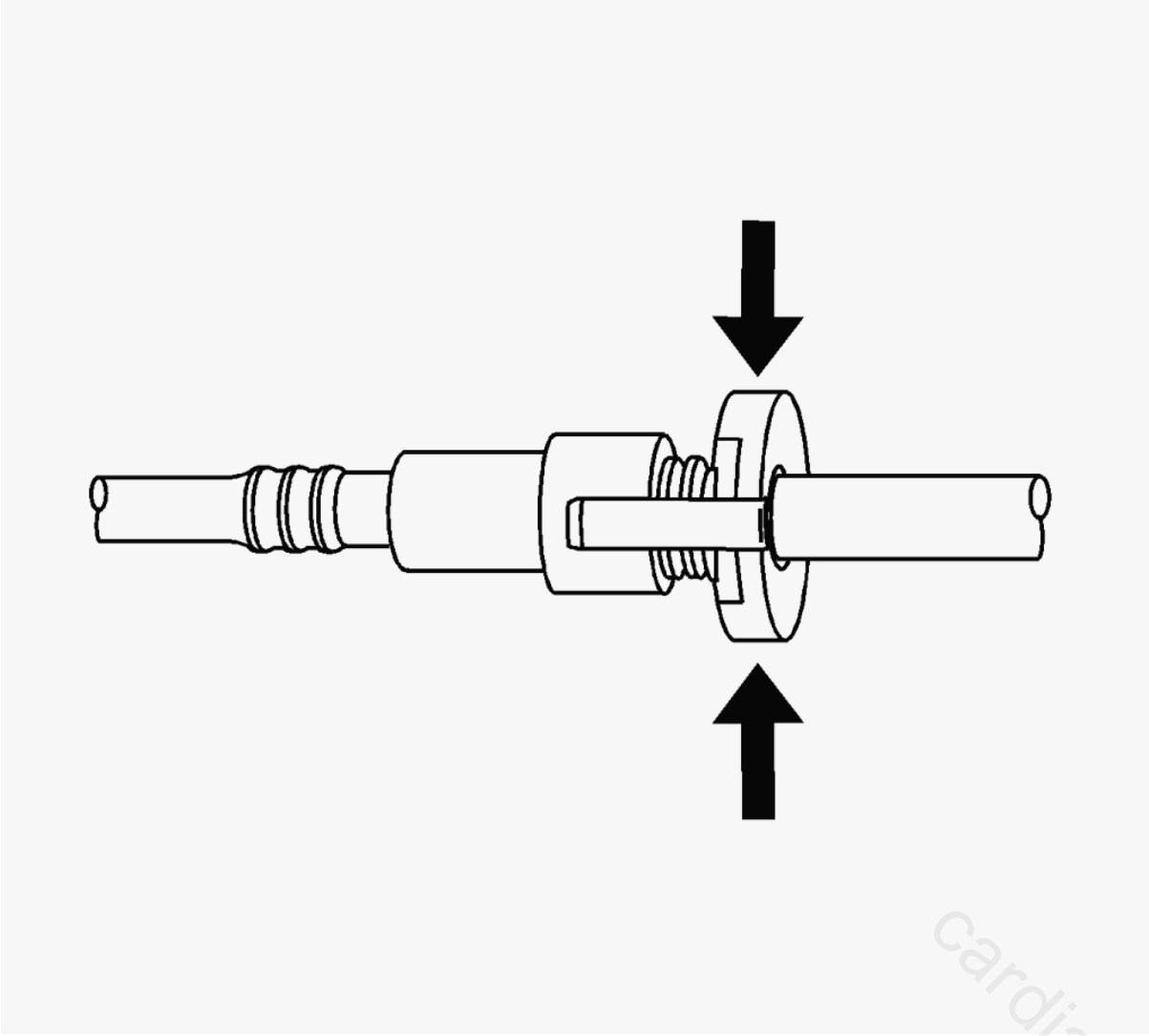

Fig. 32: Squeeze To Release Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

4. This step applies to Squeeze to Release style connectors ONLY. Squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick-connect fitting.

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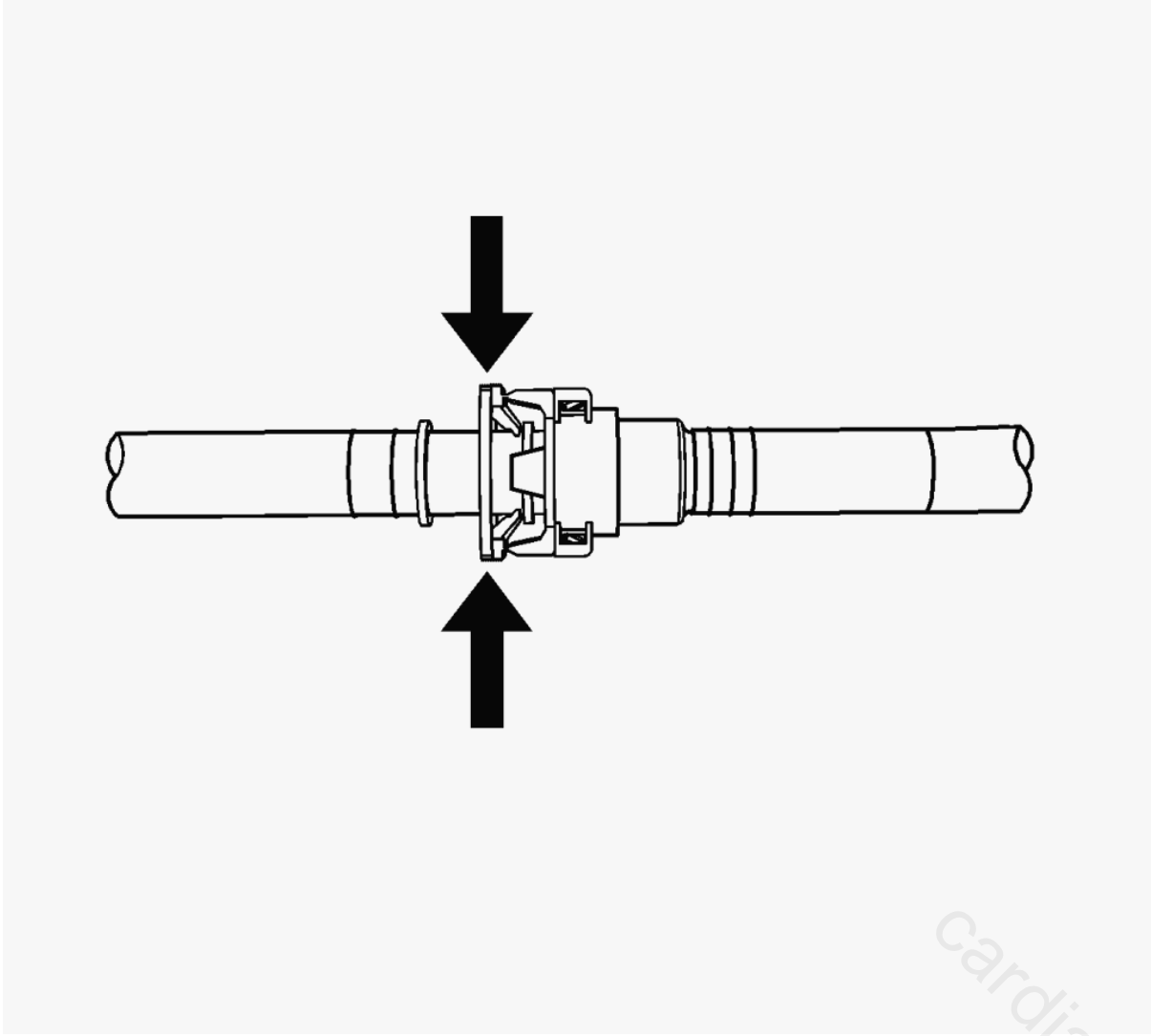

Fig. 33: Pushing In Male Side Of Connector - Squeeze To Release
Courtesy of GENERAL MOTORS COMPANY

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.

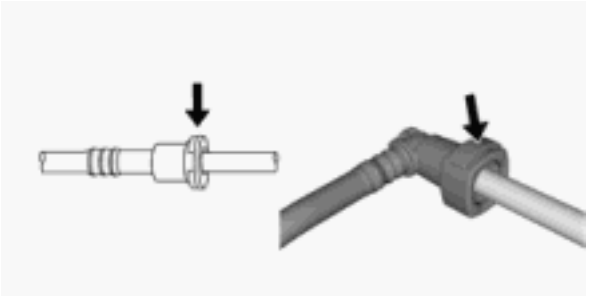

Fig. 34: Identifying Variants Of Sliding Retainer Style Connectors
Courtesy of GENERAL MOTORS COMPANY

NOTE: **There are two variants of sliding retainer style connectors shown above, both have the same release and installation procedure.**

6. This step applies to Sliding Retainer style connectors ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab doesn't move try pressing the tab in from the opposite side. The tab will only move in one direction.

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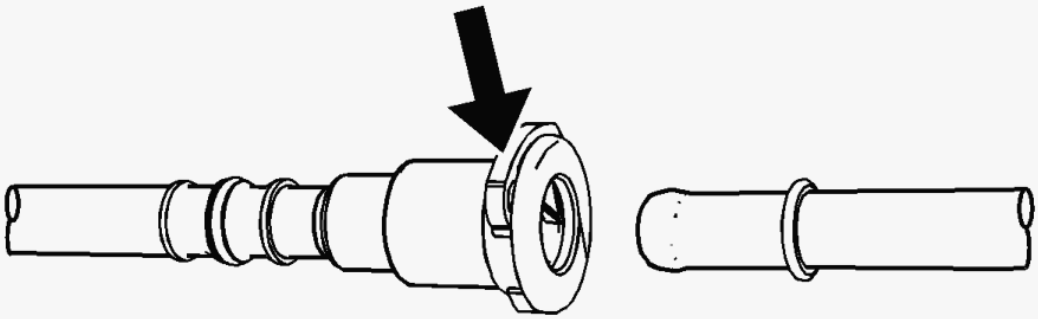

Fig. 35: Global Connector Style
Courtesy of GENERAL MOTORS COMPANY

7. This step applies to the Global Connector style only. Push the connector toward the tube in order to release the pressure. Press and hold down the release mechanism, and pull the connector straight out.

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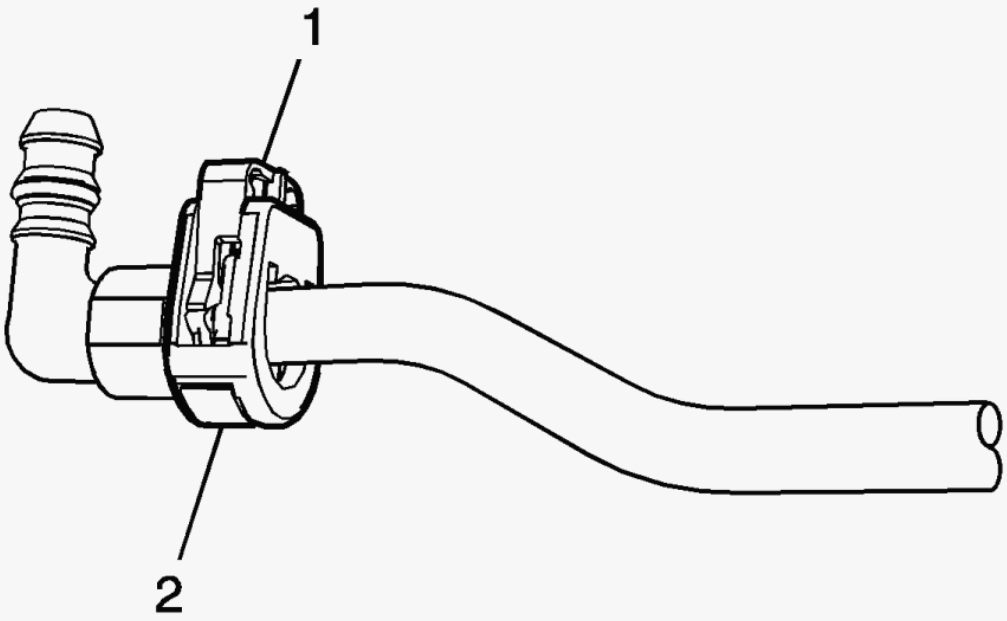

Fig. 36: Redundant Latch And Release Mechanism - TI Loc Style
Courtesy of GENERAL MOTORS COMPANY

8. This step applies to the TI Loc style only. Push the connector toward the tube in order to release the pressure. Release the redundant latch (1) with two fingers or a flat bladed tool. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.

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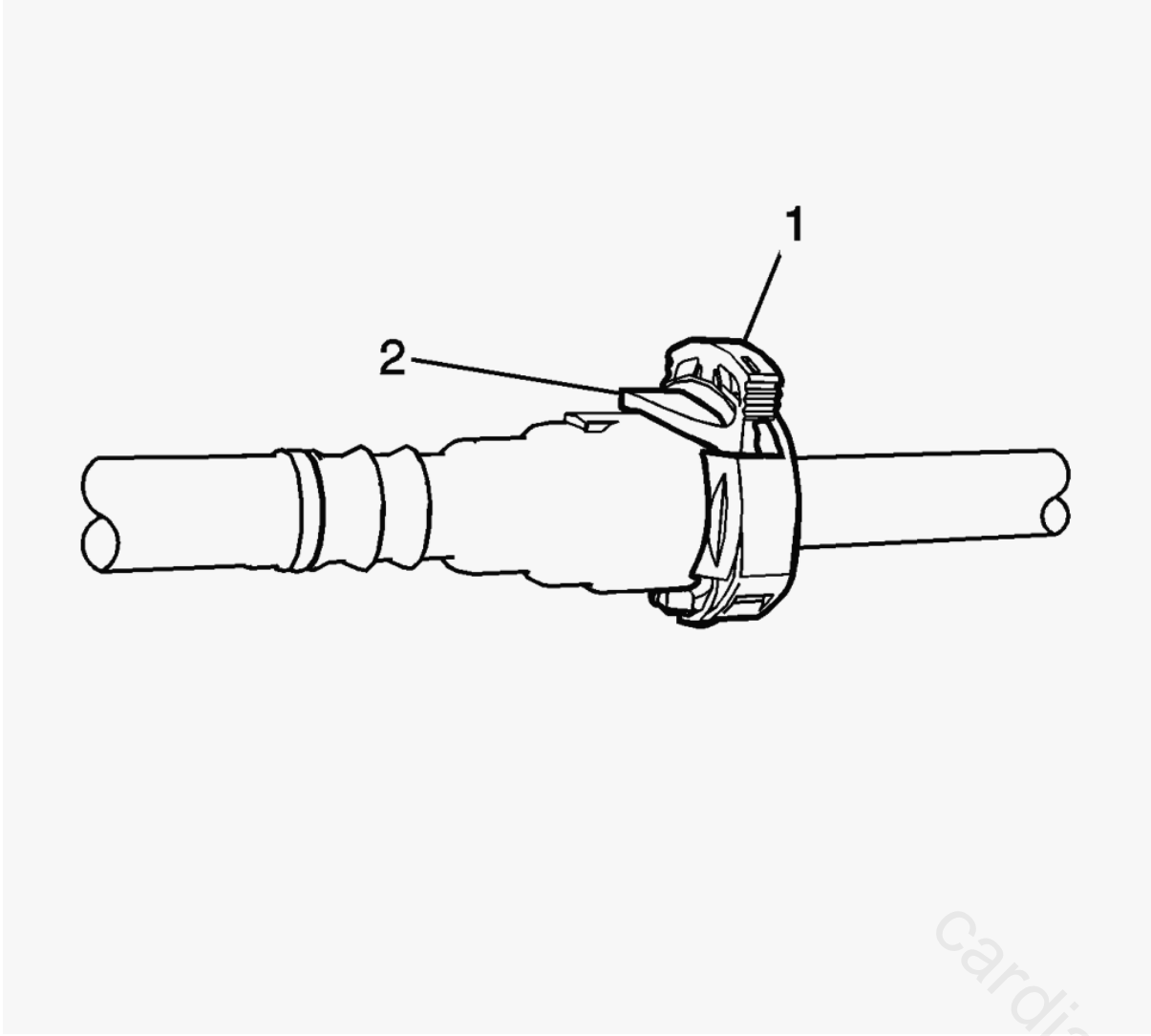

Fig. 37: Second Latch And Release Mechanism - Safe Lock Style
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Relieving Fuel Pressure Warning .**

9. This step applies to the Safe Lock style only. Push the connector toward the tube in order to release the pressure. Release the second latch (1) with two fingers. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.

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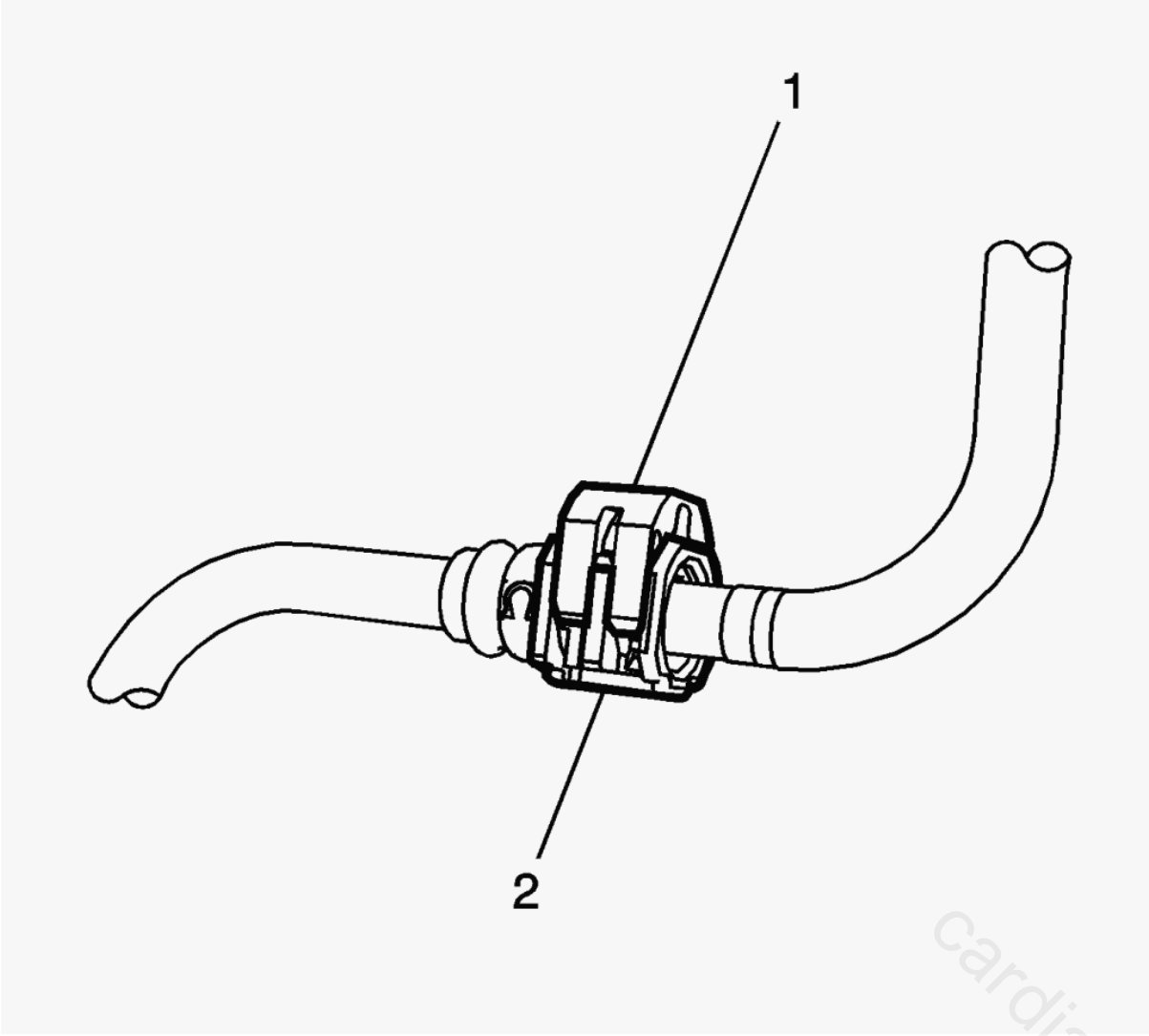

Fig. 38: Latch And Connector - Plastic Connector Style 8
Courtesy of GENERAL MOTORS COMPANY

10. This step applies to the Plastic Connector style 8, push the connector toward the tube in order to release the pressure. Press the latch (1) inward in order to release the pipe, while pulling the connector (2) straight out.
11. Using a clean shop towel, wipe off the male pipe end.
12. Inspect both ends of the fitting for dirt and burrs.
13. Clean or replace components as necessary.

Installation Procedure

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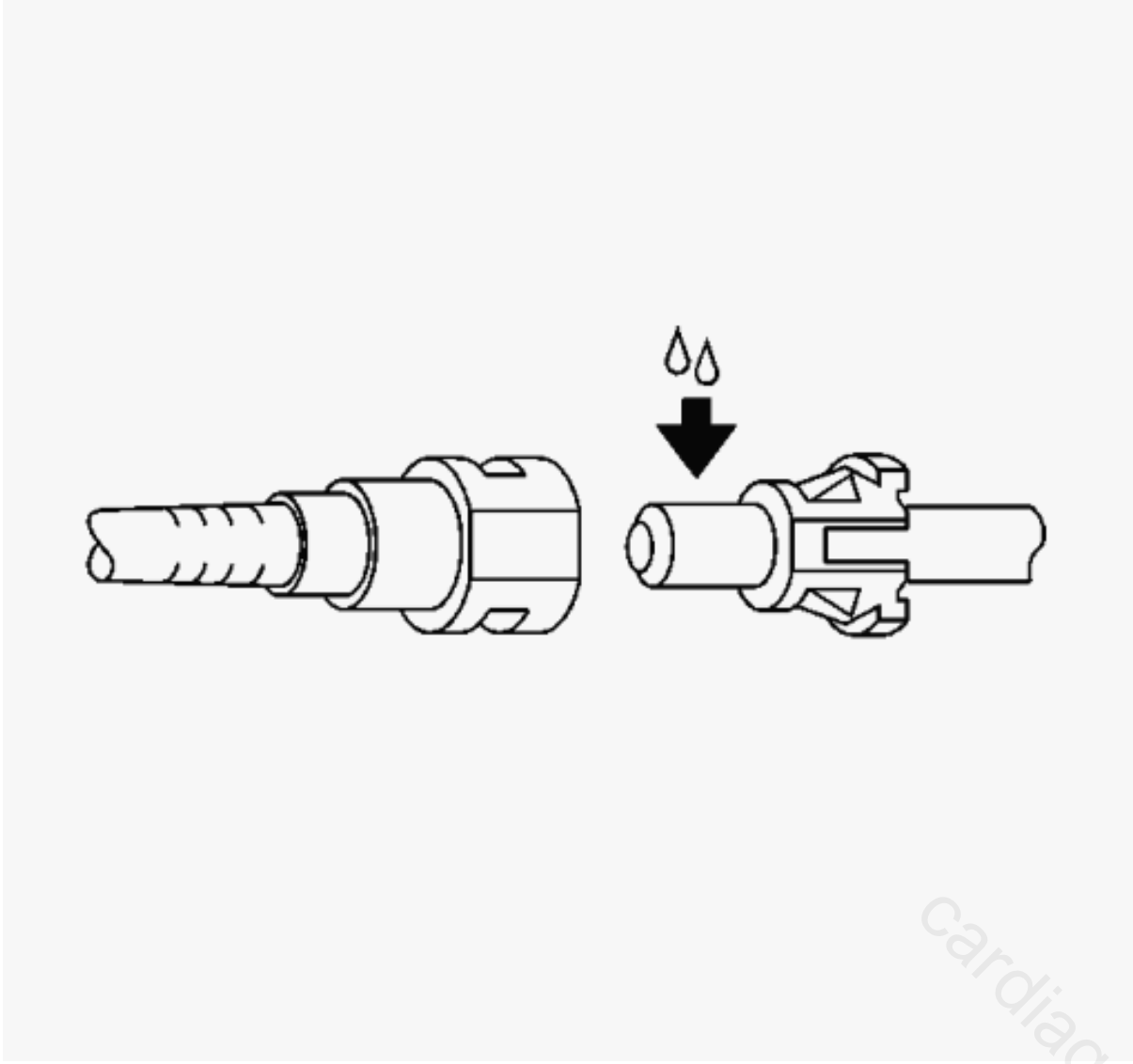

Fig. 39: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.**

1. Apply a few drops of clean engine oil to the male pipe end.

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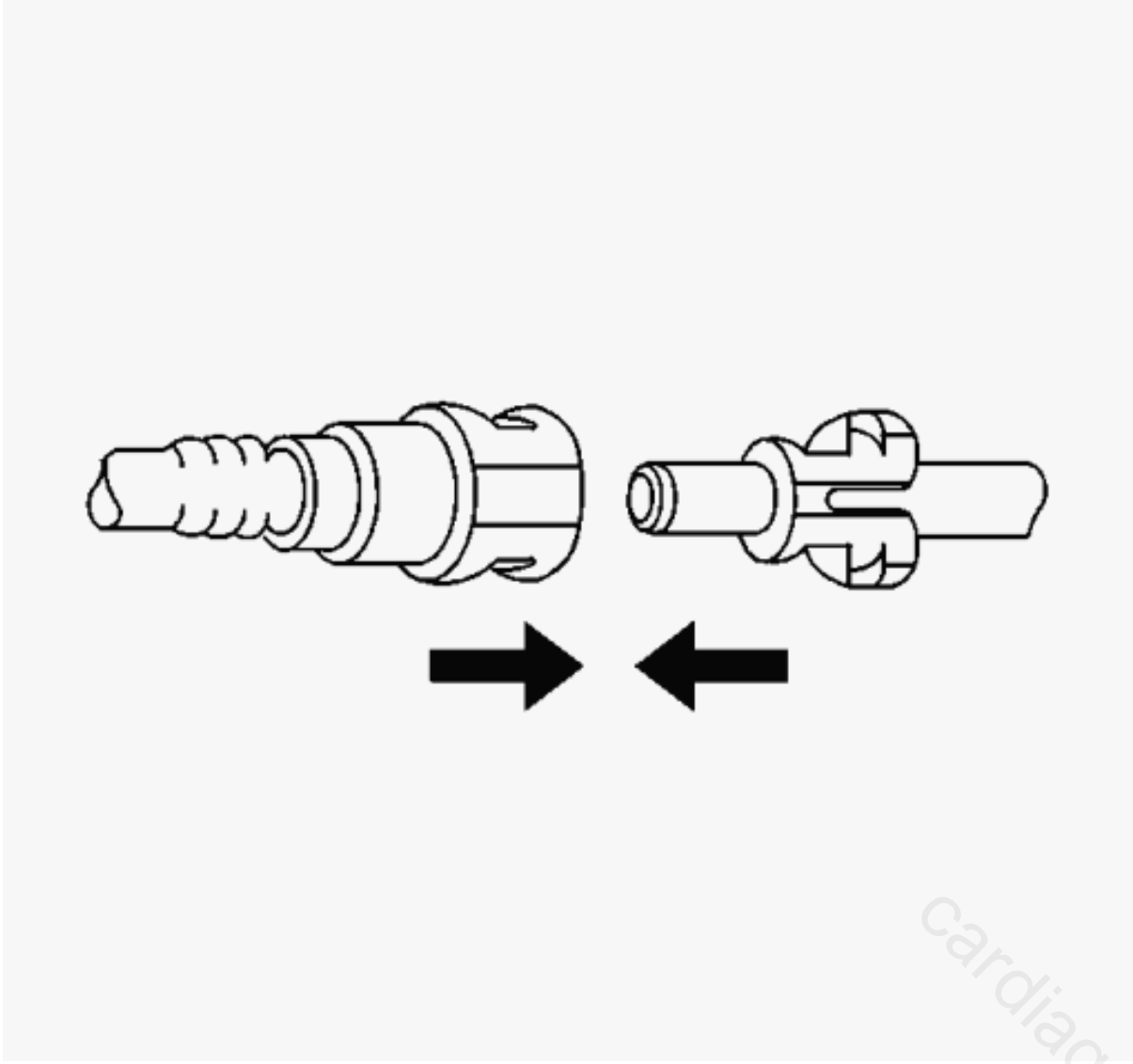

Fig. 40: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the quick-connect fitting together in order to cause the retaining feature to snap into place.

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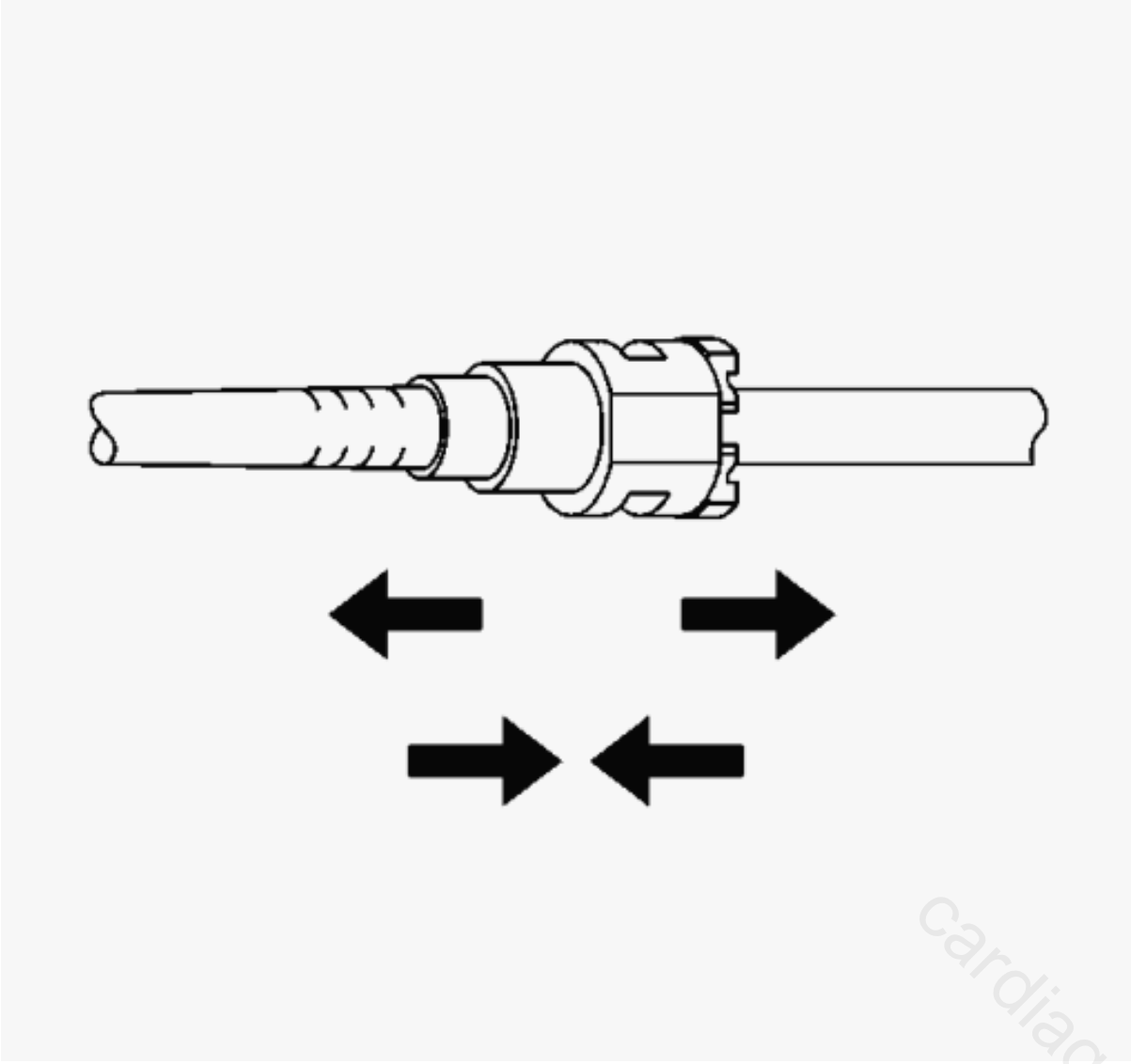

Fig. 41: Ensuring Quick-Connect Fitting Is Secure
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

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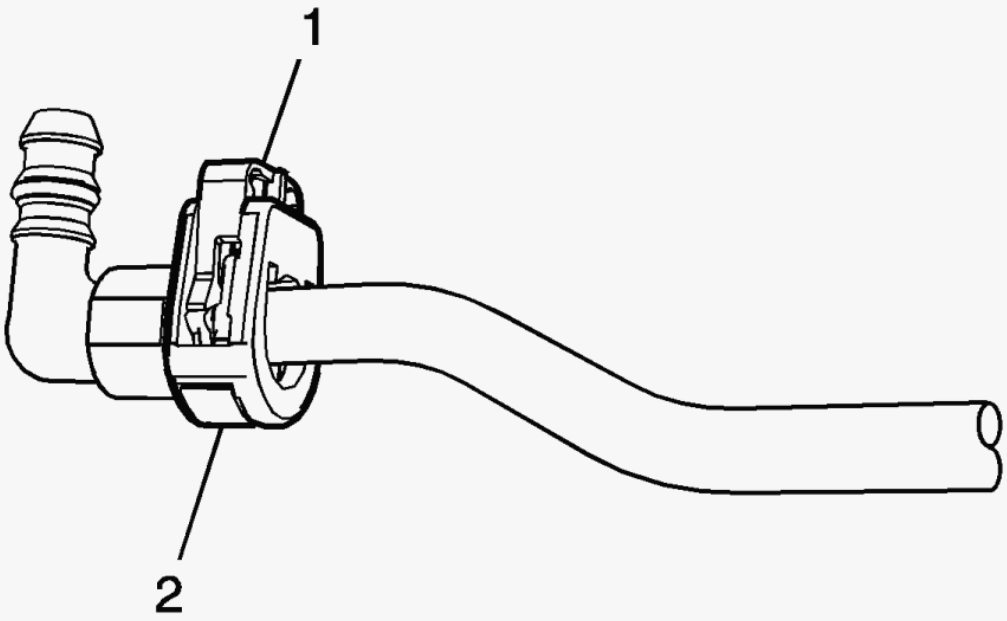

Fig. 42: Redundant Latch And Release Mechanism - TI Loc Style
Courtesy of GENERAL MOTORS COMPANY

4. Insert the tube in the connector until the retainer snaps in place.
5. Push down on the redundant latch (1) until it is fully engaged and snapped into position.

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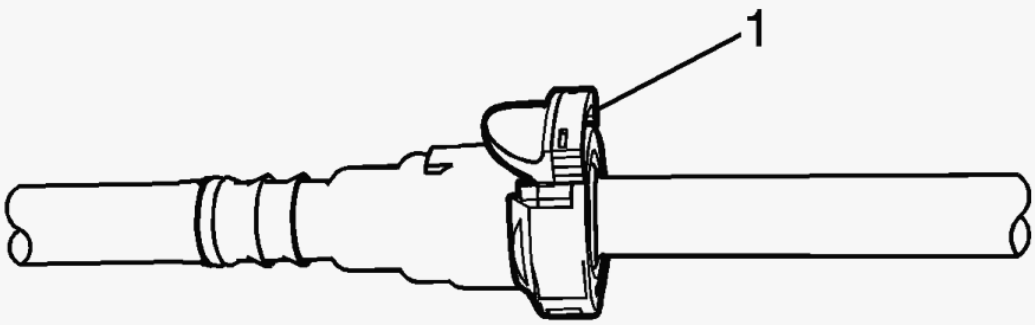

Fig. 43: Second Latch - Safe Lock Style
Courtesy of GENERAL MOTORS COMPANY

6. Insert the tube in the connector until the retainer snaps in place.
7. Push down on the second latch (1) in order to secure the connection.

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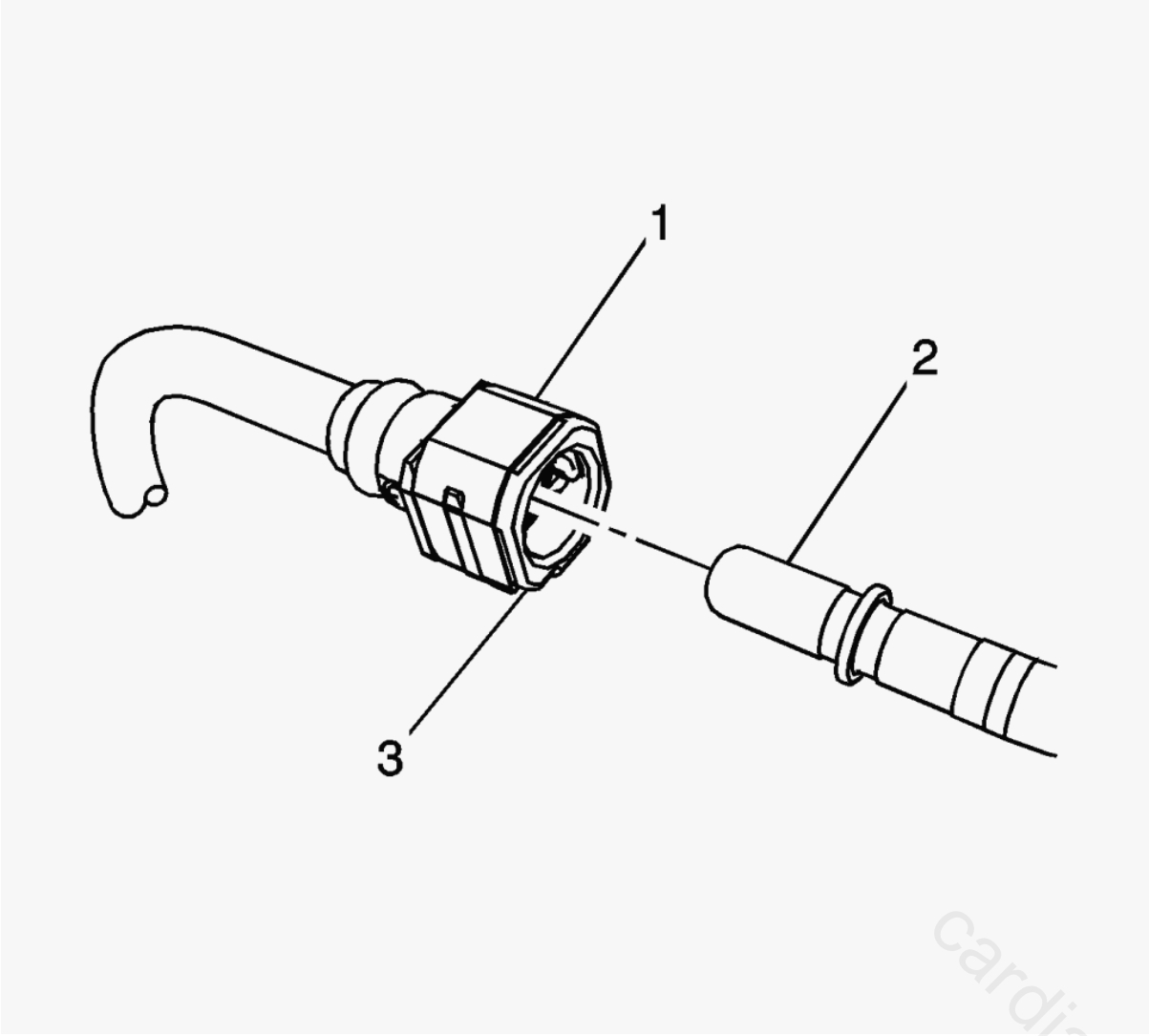

Fig. 44: Latch And Connector - Plastic Connector Type 8
Courtesy of GENERAL MOTORS COMPANY

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.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

- **CH-41769** Fuel Line Disconnect Tool Set
- **CH-44581** Fuel Line Disconnect Tool

For equivalent regional tools, refer to Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools) .

Removal Procedure

WARNING: **Refer to Diesel/Gasoline Vapors Warning .**

1. Relieve the fuel system pressure before servicing any fuel system connection.

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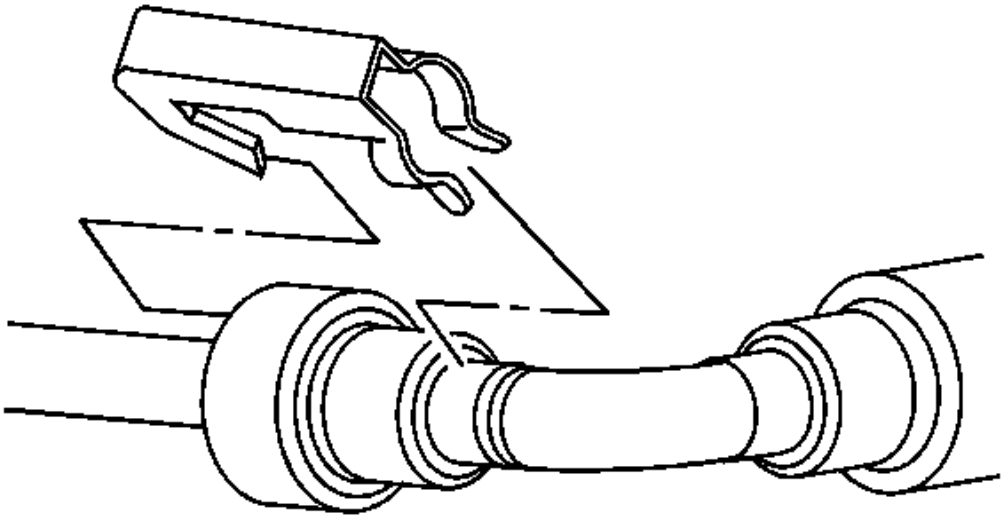

Fig. 45: Quick-Connect Fitting Retainer (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Remove the retainer from the quick-connect fitting.

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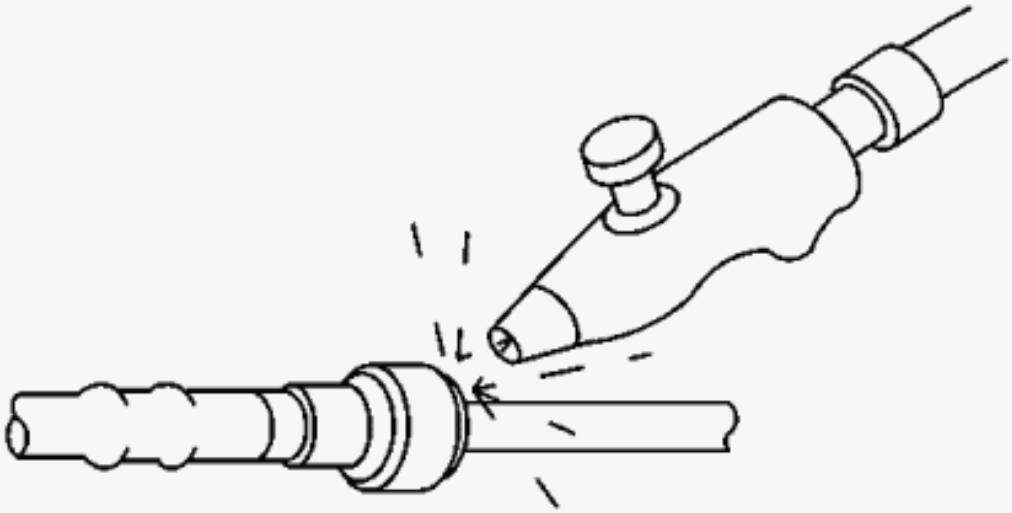

Fig. 46: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.**

3. Blow dirt out of the fitting using compressed air.

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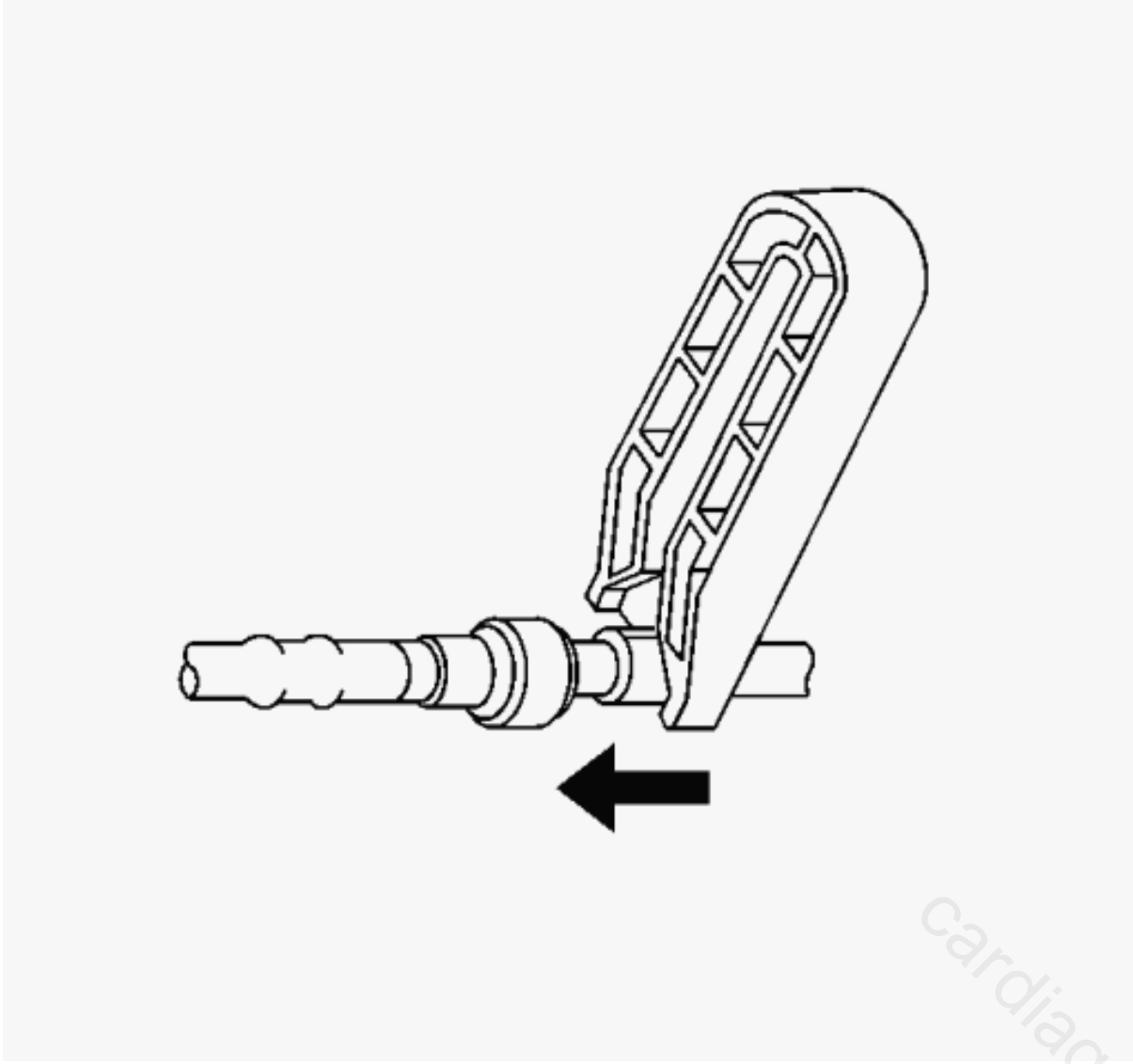

Fig. 47: Releasing Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

4. Depending on the fuel line size and ability to access the fitting, choose the appropriate tool: **CH-41769** fuel line disconnect tool set or **CH-44581** fuel line disconnect tool. Insert the **CH-41769** fuel line disconnect tool set or **CH-44581** fuel line disconnect tool into the female connector, then push inward to release the locking tabs.

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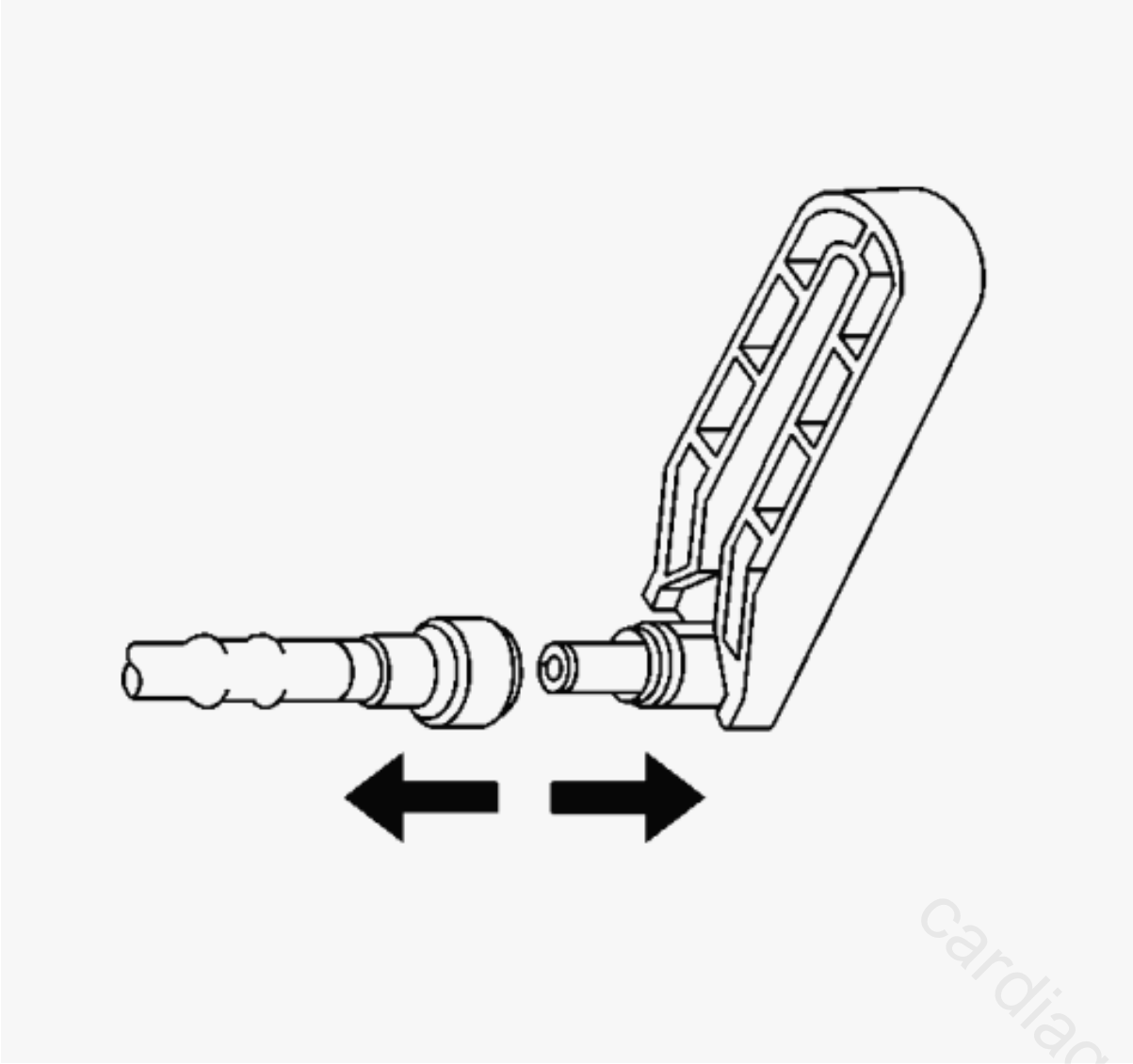

Fig. 48: Pulling Connection Apart (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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.

   Clean or replace the components as required.

Installation Procedure

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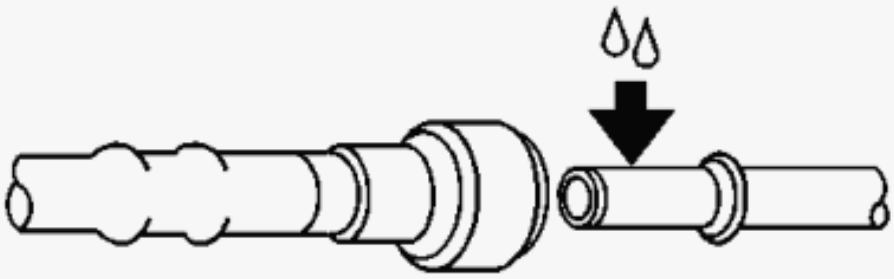

Fig. 49: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: **In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends.**

This will ensure proper reconnection and prevent a possible fuel leak.

During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

1. Apply a few drops of clean engine oil to the male pipe end.

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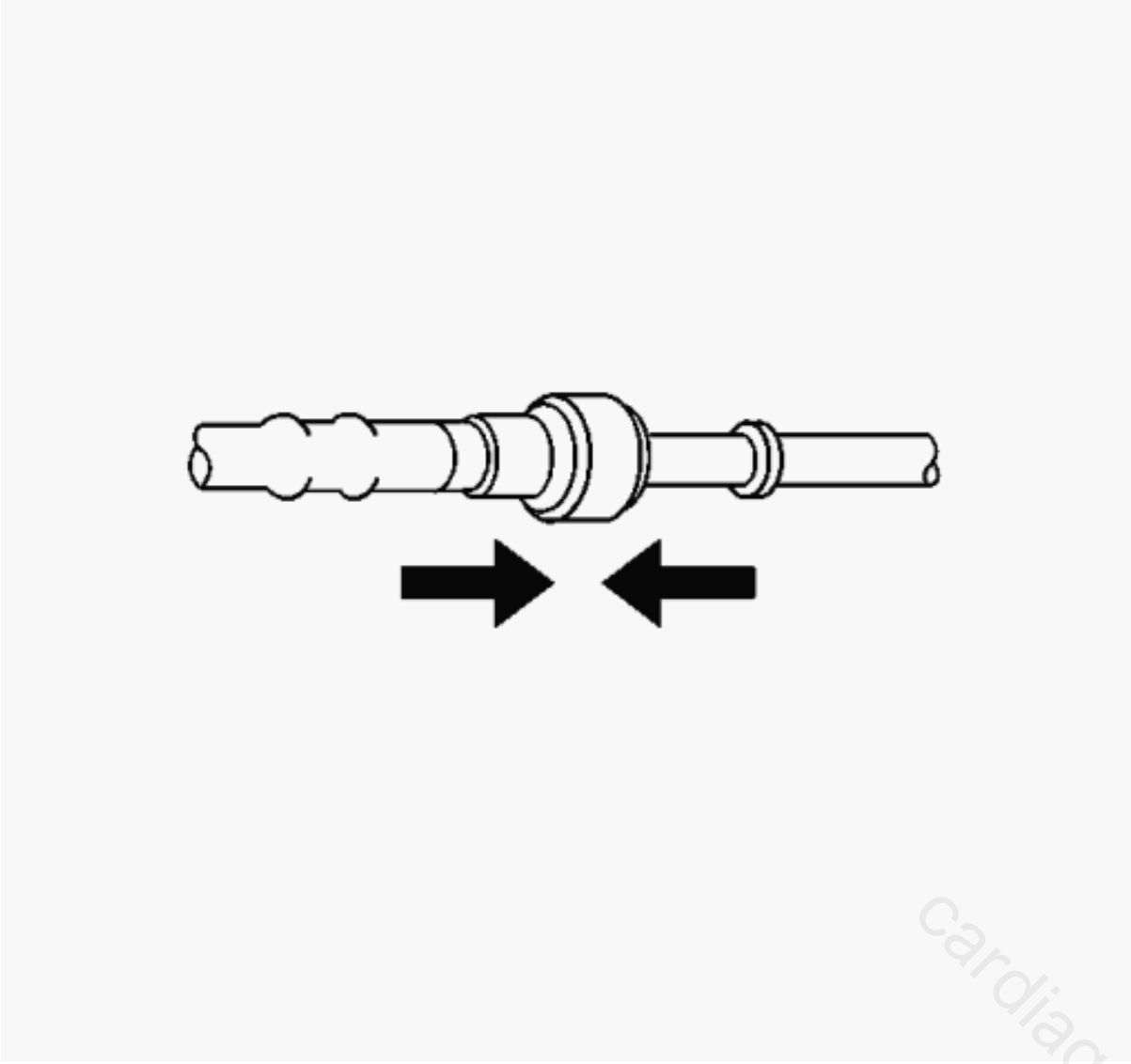

Fig. 50: Pushing Connectors Together (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the quick-connect fitting together in order to snap the retaining tabs into place.

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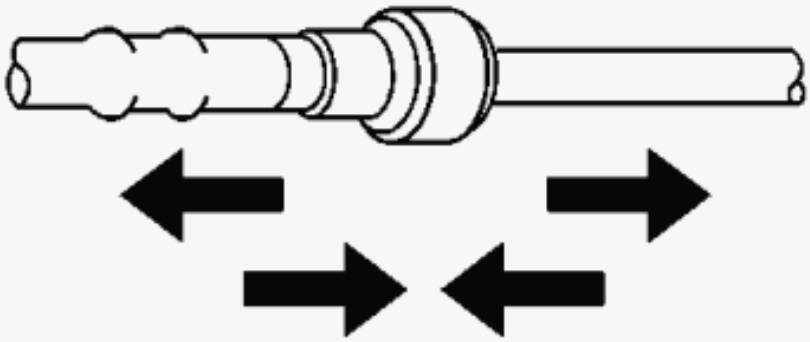

Fig. 51: Ensuring Connection Is Secure (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

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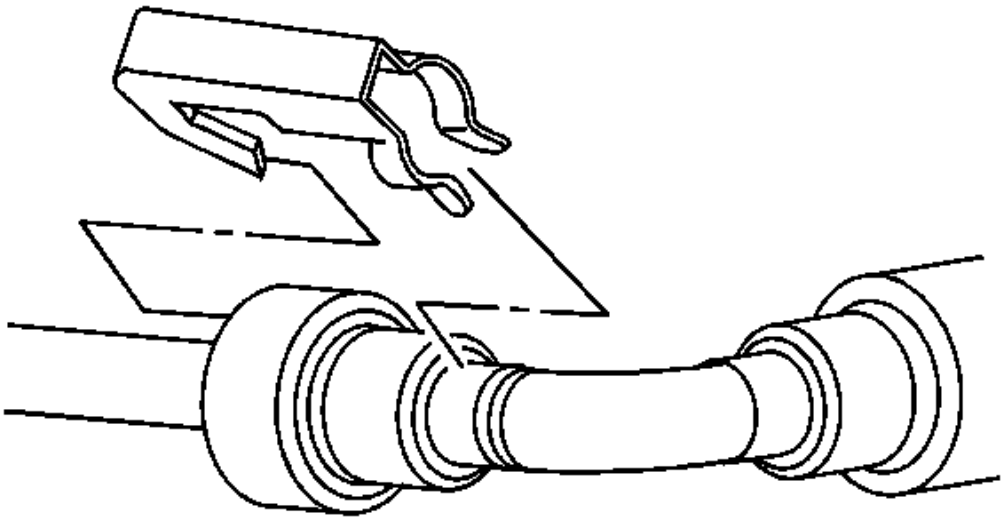

Fig. 52: Quick-Connect Fitting Retainer (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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.

FUEL SYSTEM PRIMING

NOTE: **For the fuel system to work properly, air cannot be in the fuel lines. If air gets in, the engine may not start and the fuel lines will need to be primed before operating the vehicle.**

If air is present, the following may have happened:

- **The vehicle ran out of fuel.**
- **The filter was removed.**
- **The fuel lines were removed or disconnected.**
- **The fuel filter water drain valve was opened while the engine was running.**

If one or more of the above occurred, air has entered the fuel system and you will need to prime the system prior to operating the vehicle.

1. Prior to priming the engine, ensure that the following has been completed:

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- There is fuel in the fuel tank.
- The fuel filter has been installed and properly tightened.
- The fuel lines are properly connected.

2. With the engine off, press and hold ENGINE START/STOP button without applying the brake for five seconds to place the vehicle in Service Mode. Wait approximately five seconds and press ENGINE START/STOP again to turn it off. Complete this step three times while the engine is off.
3. Press and hold ENGINE START/STOP button while applying the brake for a maximum of 40 seconds at a time, with five seconds between attempts, until the engine starts. If the engine tries to run, but does not run smoothly, increase the RPM's slightly by using the accelerator pedal. This will help force air through the system.
4. Repeat Step 3 if the engine stalls and will not restart.
5. Once engine starts and runs, allow it to idle for a few minutes to make sure air is purged from fuel system.
6. Stop engine.

FUEL FILTER ASSEMBLY REPLACEMENT (AWD)

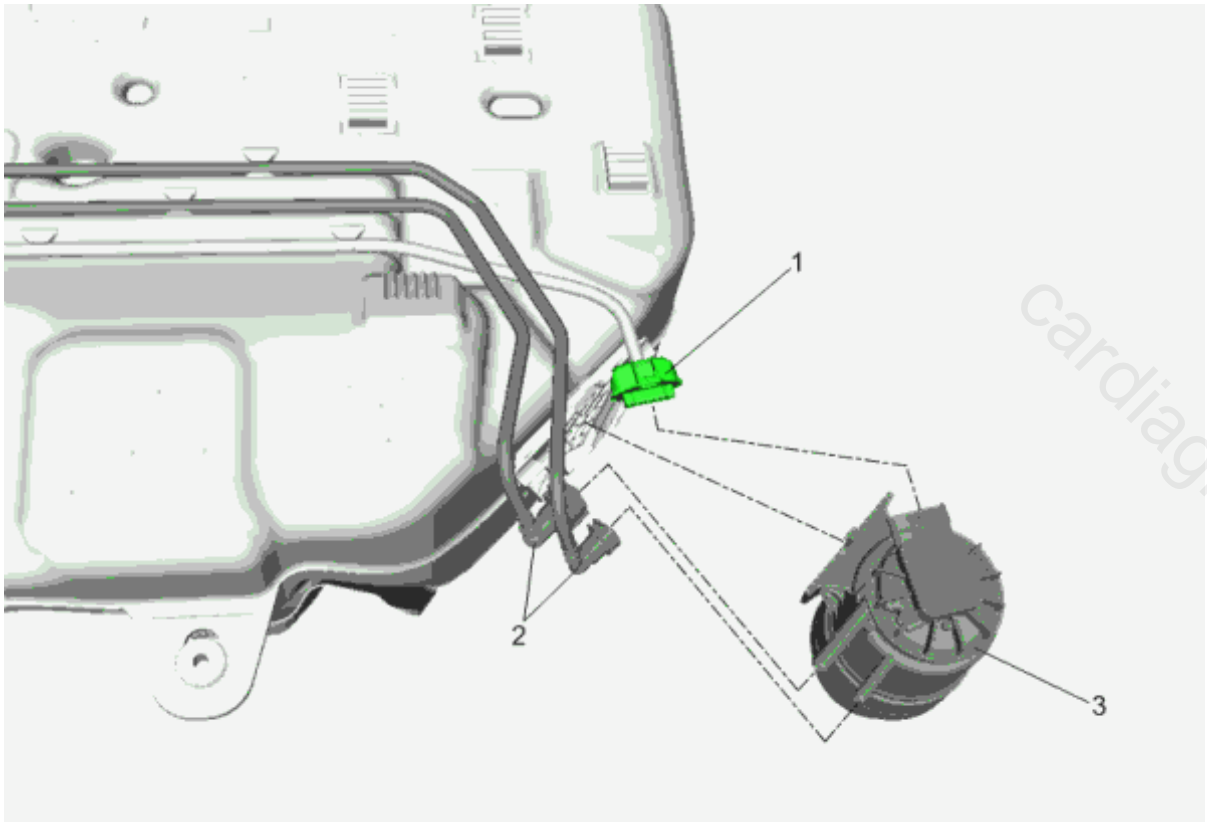

Fig. 53: Fuel Filter Assembly (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (AWD)	
1	Electrical Connector
2	Fuel Hose (Qty: 2) **Procedure** Disconnect the fuel hoses from the fuel filter assembly. Refer to Plastic Collar Quick Connect Fitting Service

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Callout	Component Name
2	Fuel Filter Assembly **Procedure** 1. Release retaining tab and slide fuel filter assembly up to remove. 2. Reset fuel filter life monitor only is assembly is replaced with a new assembly. Refer to **Fuel Filter Life Reset**

FUEL FILTER ASSEMBLY REPLACEMENT (FWD)

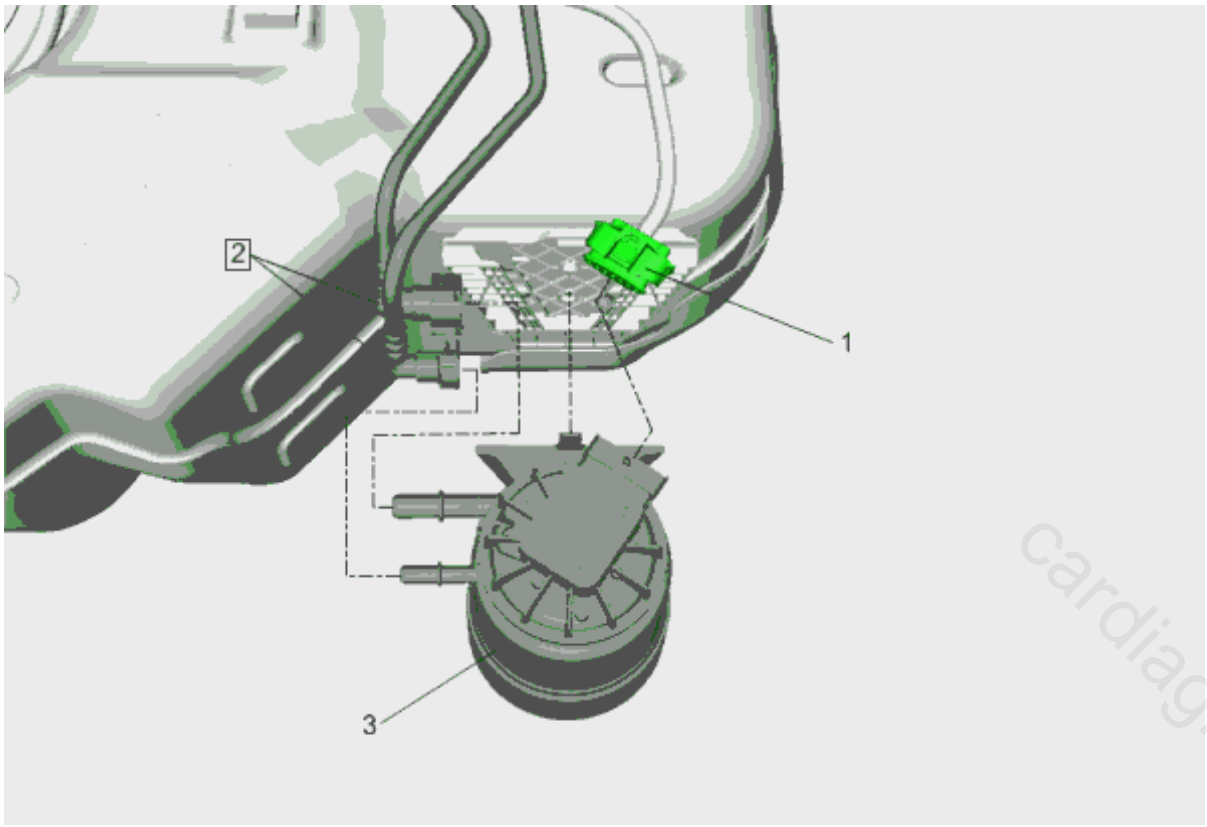

Fig. 54: Fuel Filter Assembly (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedure** Remove Fuel Tank. Refer to **Fuel Tank Replacement (FWD)**
1	Electrical Connector
2	Fuel Hose (Qty: 2) **Procedure** Disconnect the fuel hoses from the fuel filter assembly. Refer to **Plastic Collar Quick Connect Fitting Service**
3	Fuel Filter Assembly **Procedure** 1. Release retaining tab and slide fuel filter assembly up to remove. 2. Reset fuel filter life monitor only is assembly is replaced with a new assembly. Refer to **Fuel Filter Life Reset**

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FUEL FILTER REPLACEMENT (AWD)

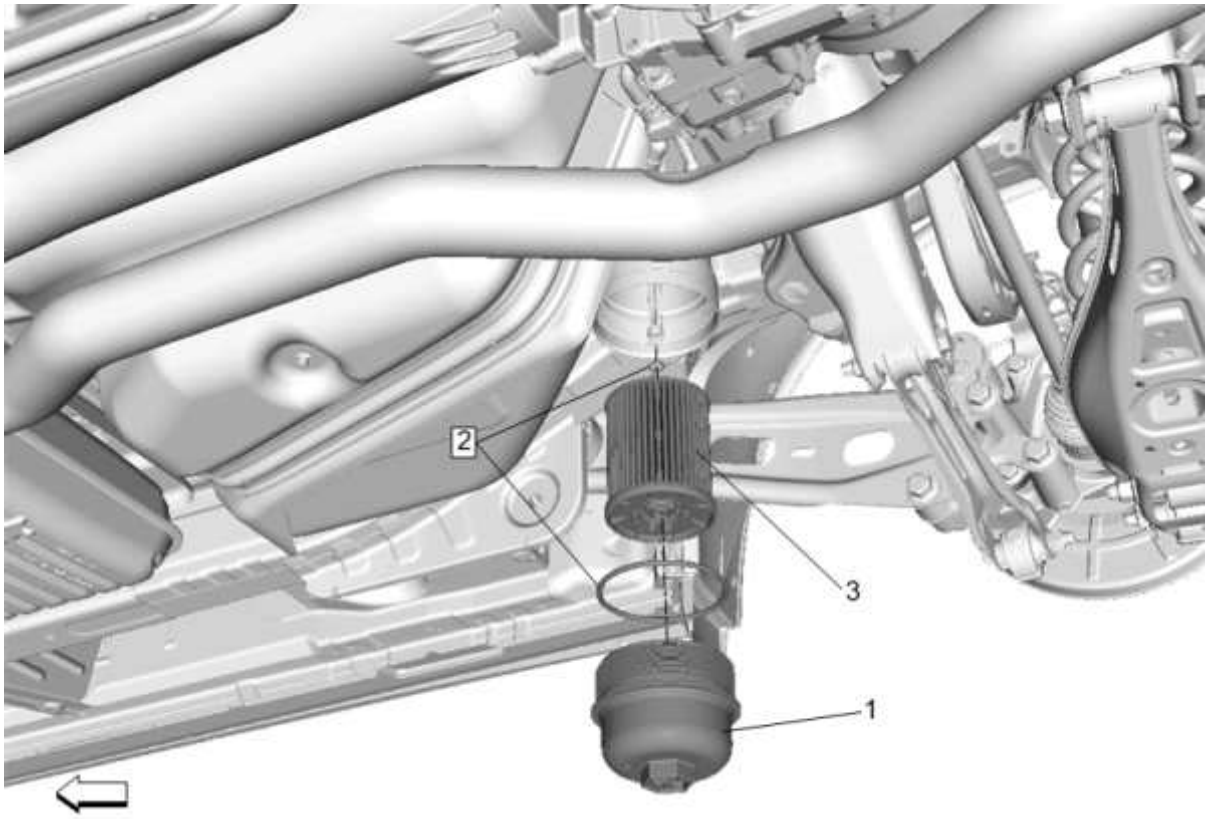

Fig. 55: Fuel Filter (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedure** Drain the fuel from the fuel filter. Refer to Water-in-Fuel Draining
1	Fuel/Water Separator Reservoir **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten** 25 N.m (18 lb ft)
2	Fuel Filter Seal (Qty: 2) **NOTE:** **Install NEW seal.**
3	Fuel Filter **Procedure** 1. Prime the fuel system. Refer to Fuel System Priming 2. Inspect for fuel leaks. 3. Reset fuel filter life monitor. Refer to Fuel Filter Life Reset

FUEL FILTER REPLACEMENT (FWD)

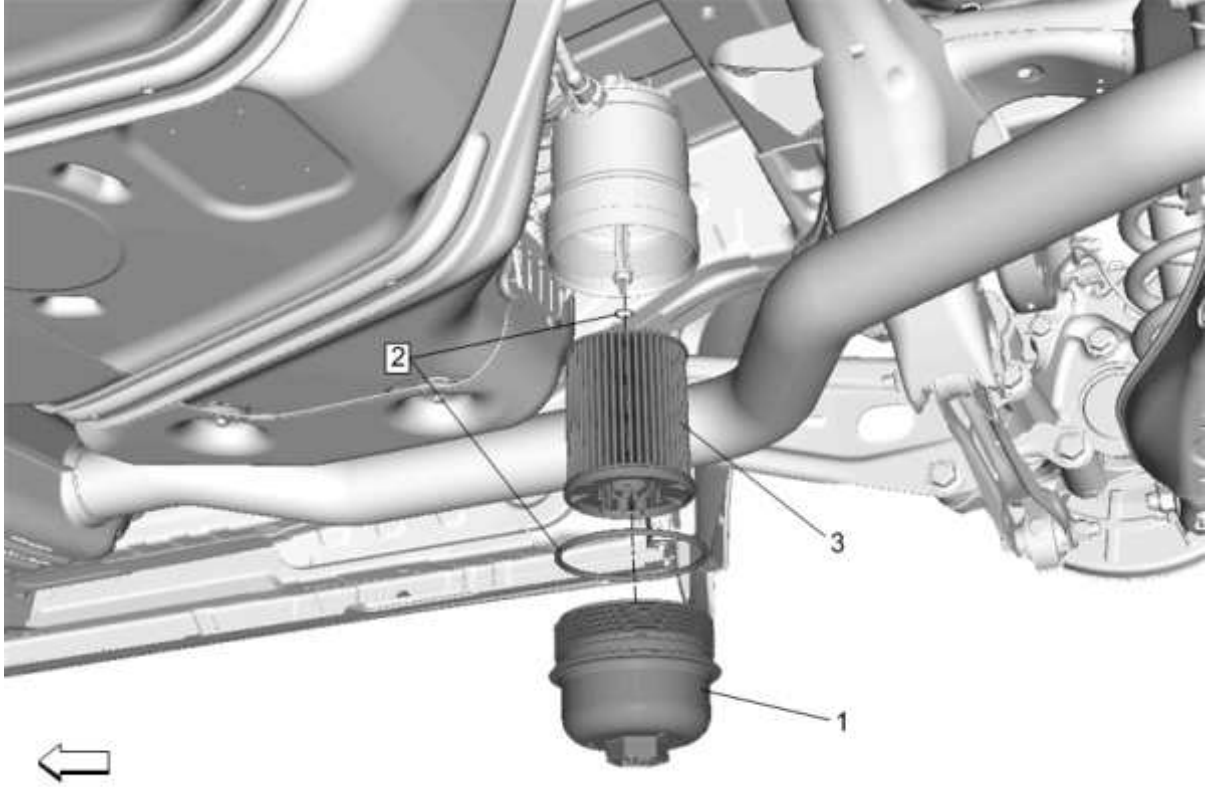

Fig. 56: Fuel Filter (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Drain the fuel from the fuel filter. Refer to Water-in-Fuel Draining
1	Fuel/Water Separator Reservoir **CAUTION:** Refer to Component Fastener Tightening Caution . **Tighten** 25 N.m (18 lb ft)
2	Fuel Filter Seal (Qty: 2) **NOTE:** **Install NEW seal.**
3	Fuel Filter **Procedure** 1. Prime the fuel system. Refer to Fuel System Priming 2. Inspect for fuel leaks. 3. Reset fuel filter life monitor. Refer to Fuel Filter Life Reset

FUEL PUMP TO FUEL FILTER HOSE REPLACEMENT (AWD)

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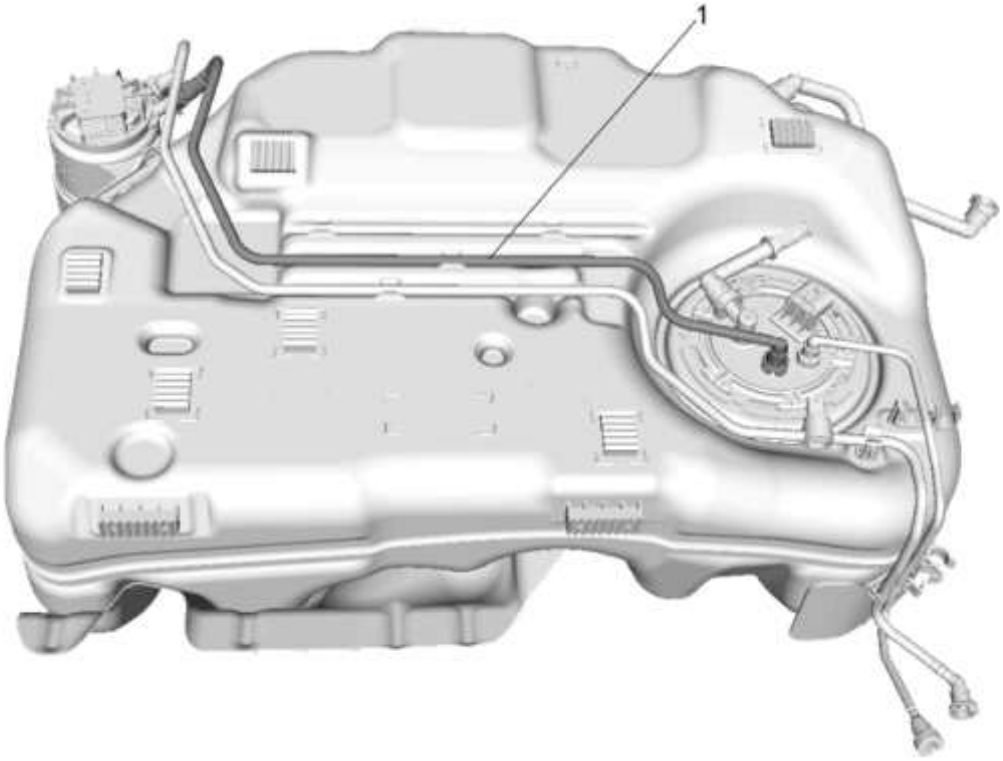

Fig. 57: Fuel Pump To Fuel Filter Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (AWD)	
1	Fuel Pump to Fuel Filter Hose **Procedure** Disconnect the fuel pump to fuel filter hose. Refer to Plastic Collar Quick Connect Fitting Service

FUEL PUMP TO FUEL FILTER HOSE REPLACEMENT (FWD)

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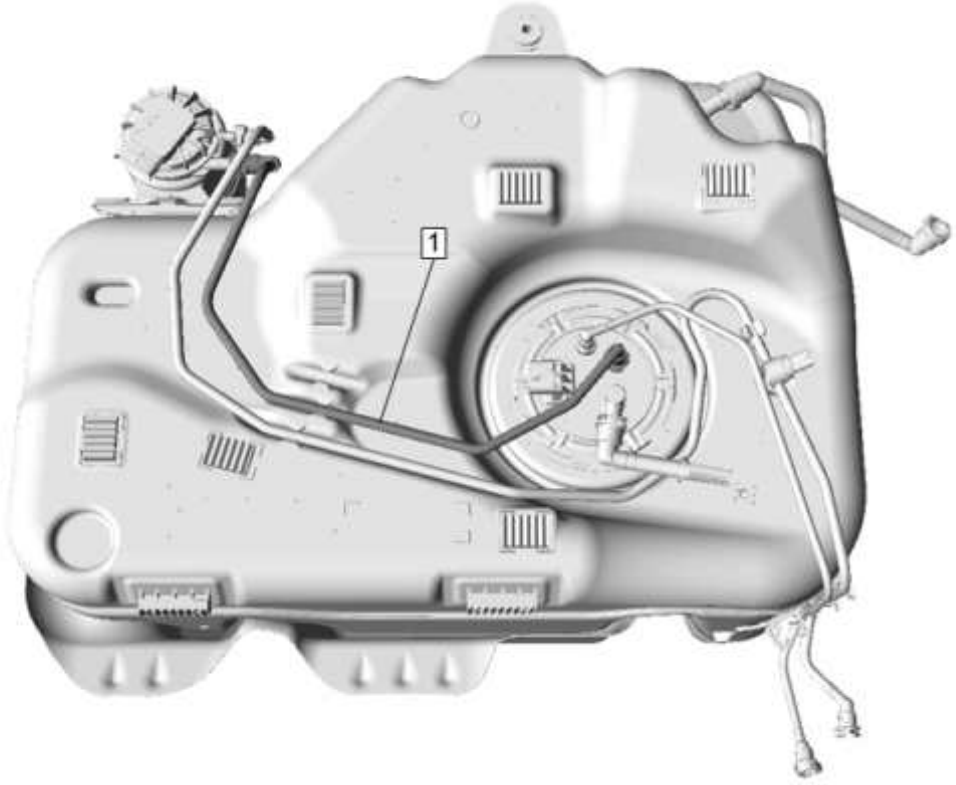

Fig. 58: Fuel Pump To Fuel Filter Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (FWD)	
1	Fuel Pump to Fuel Filter Hose **Procedure** Disconnect the fuel pump to fuel filter hose. Refer to Plastic Collar Quick Connect Fitting Service

WATER-IN-FUEL DRAINING

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle
2. Attach a small piece of hose to the fuel filter drain plug.
3. Place an approved fuel-resistant container under the fuel filter.

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Fig. 59: Fuel Filter Drain Plug
Courtesy of GENERAL MOTORS COMPANY

4. Open the fuel filter drain plug (1) until the water contaminated fuel seeps from the fuel filter drain plug.
5. With the engine off, press and hold ENGINE START/STOP button without applying the brake for five seconds to place the vehicle in Service Mode. Wait approximately five seconds, and then press ENGINE START/STOP again to turn it off. This operation will enhance water flow out of the filter. Repeat step until only diesel fuel is visible.

CAUTION: **Refer to Component Fastener Tightening Caution .**

6. Tighten the fuel filter drain plug to 1.6 N.m (14 lb in).
7. Remove the container and hose.
8. Start the engine and let it run for a few minutes. During the draining process, air may have entered the fuel system. If the engine stalls, the fuel system may need to be primed. Refer to **Fuel System Priming**
9. Inspect for fuel leaks.

FUEL TANK DRAINING

Special Tools

CH 45004 Fuel Tank Siphon Hose

WARNING: **Refer to Diesel/Gasoline Vapors Warning .**

WARNING: **Refer to Safety Glasses Warning .**

1. Remove the fuel fill cap.

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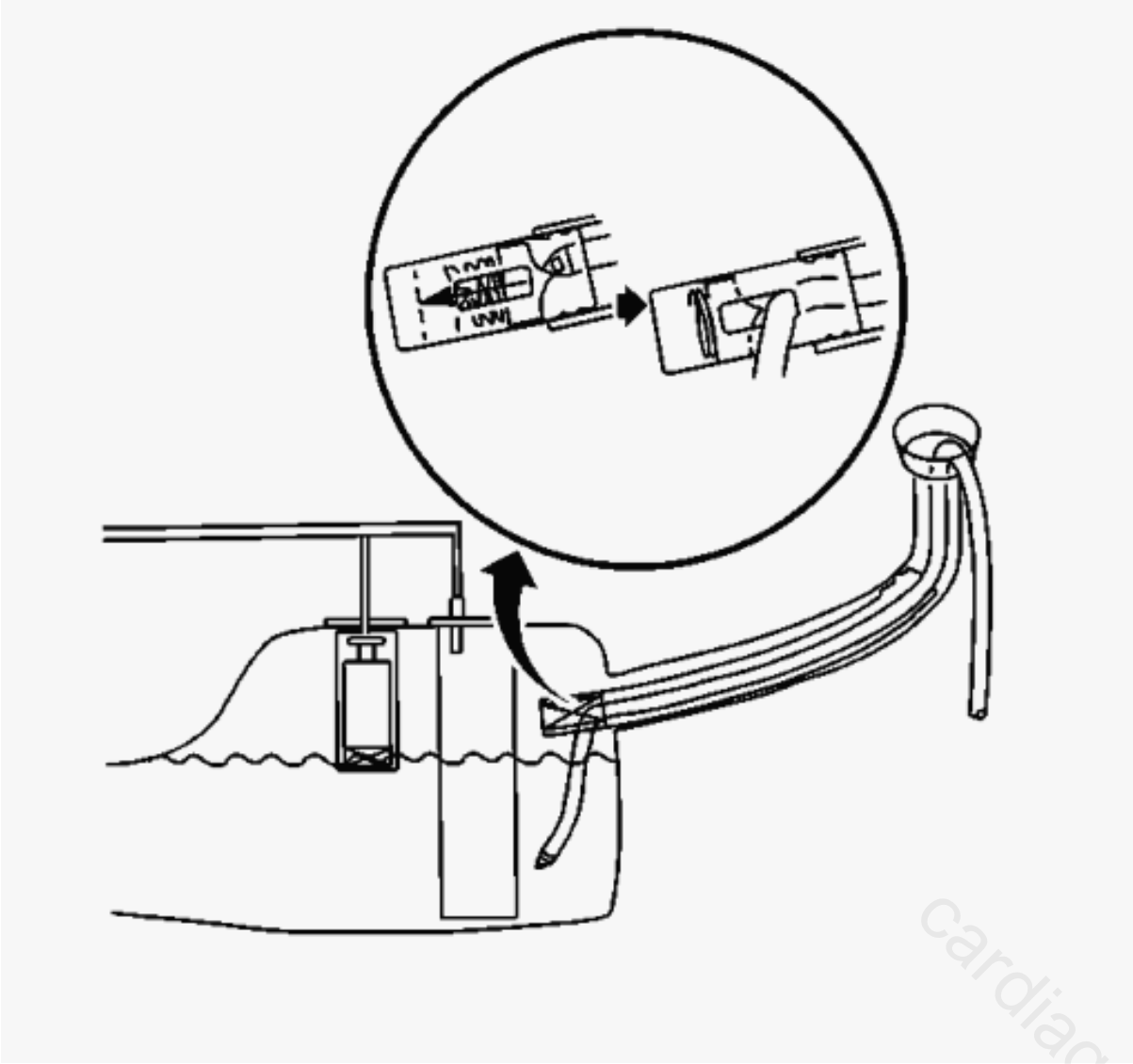

Fig. 60: Fuel Tank Draining Procedure
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Lubricate the fuel drain hose with Transjel Lubricant or equivalent to aid in hose insertion.**

2. Insert the **CH 45004** hose into the fuel tank filler pipe.
3. Attach the **CH 45004** hose to a hand or air operated pump device.
4. Using a hand or air operated pump drain as much fuel from the tank as possible.

FUEL TANK FILLER HOSE REPLACEMENT (AWD)

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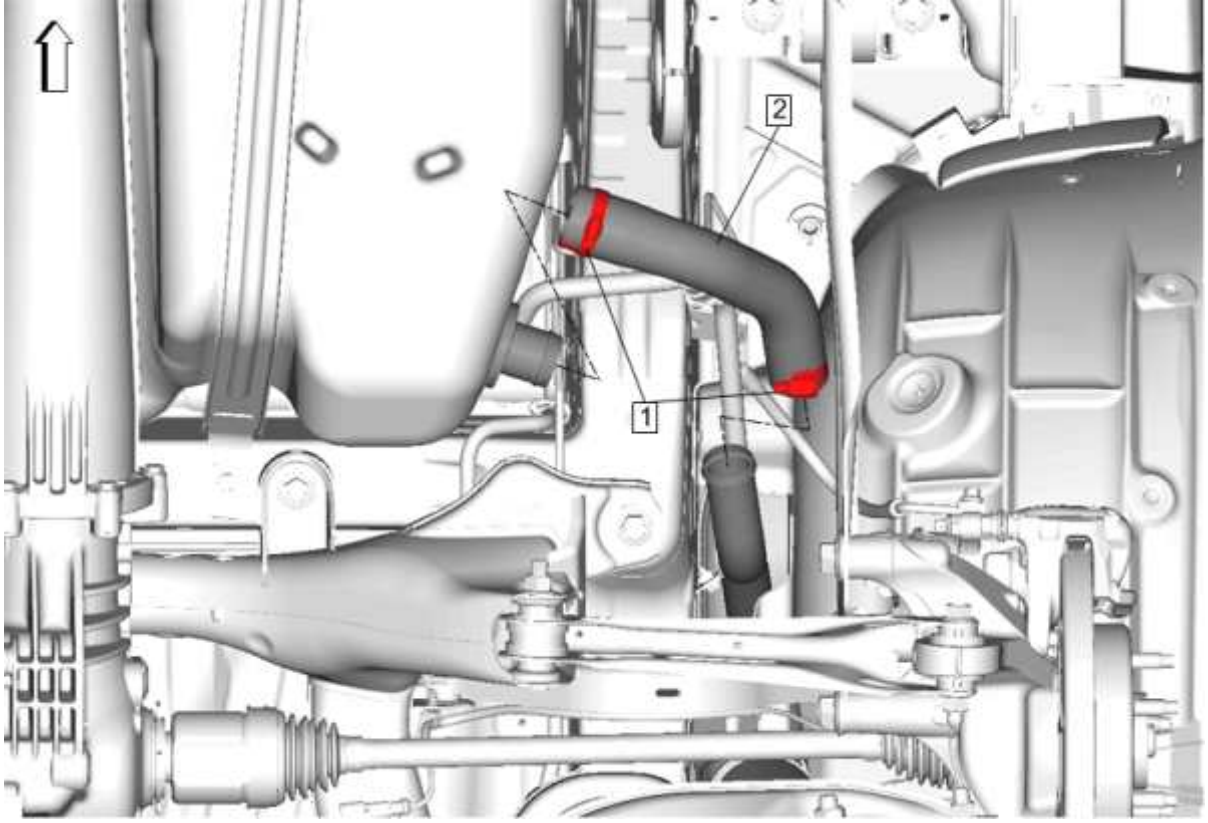

Fig. 61: Fuel Tank Filler Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain fuel tank. Refer to **Fuel Tank Draining** 2. Raise and support vehicle. Refer to **Lifting and Jacking the Vehicle**	
1	Fuel Tank Filler Hose Clamp (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 4 N.m (35 lb in)
2	Fuel Tank Filler Hose

FUEL TANK FILLER HOSE REPLACEMENT (FWD)

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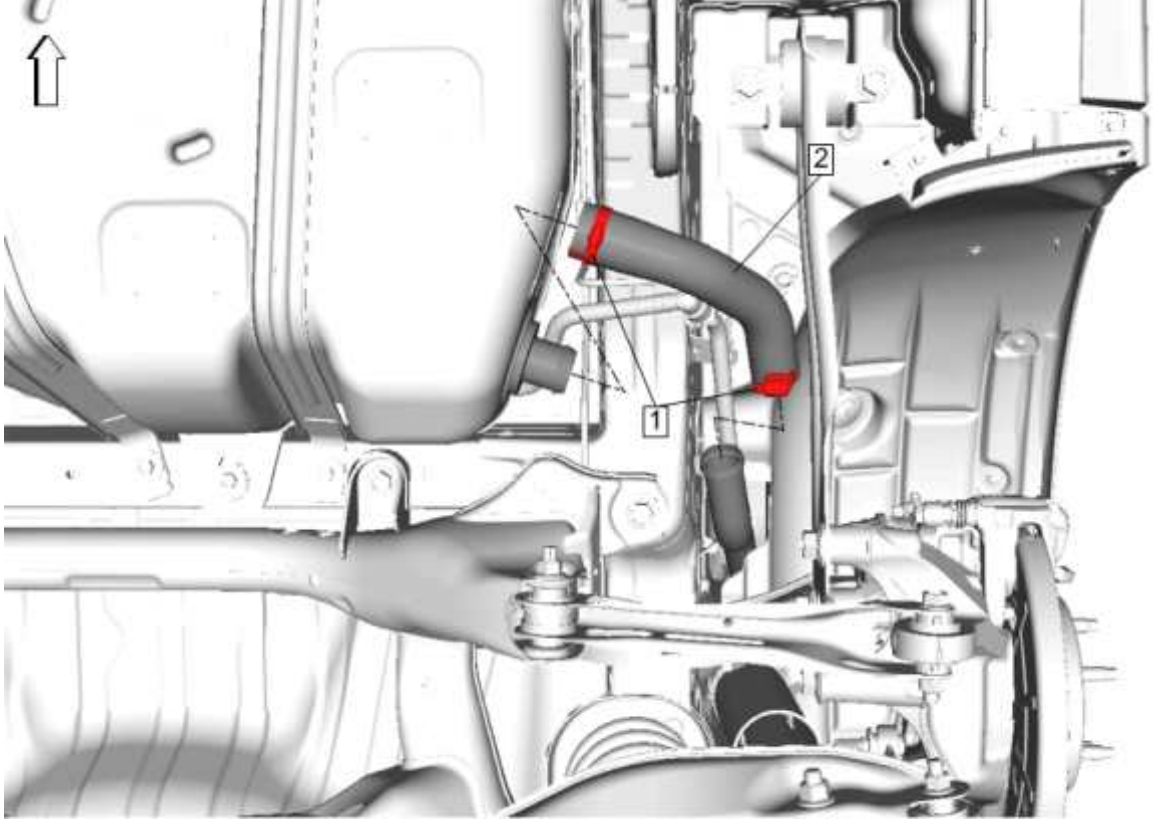

Fig. 62: Fuel Tank Filler Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain fuel tank. Refer to Fuel Tank Draining 2. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle	
1	Fuel Tank Filler Hose Clamp (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 4 N.m (35 lb in)
2	Fuel Tank Filler Hose

FUEL TANK REPLACEMENT (AWD)

Removal Procedure

WARNING: **Refer to Diesel/Gasoline Vapors Warning .**

WARNING: **Refer to Safety Glasses Warning .**

1. Drain the fuel tank. Refer to Fuel Tank Draining
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle
3. Remove Underbody Rear Air Deflector. Refer to Underbody Rear Air Deflector Replacement (All Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel)
4. Remove Exhaust Muffler Assembly. Refer to Exhaust Muffler Replacement (LH7)
5. Remove Driveline Torque Tube. Refer to Driveline Torque Tube Replacement

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Fig. 63: Fuel Tank Fuel Pump Module Wiring Harness, Fuel Pump Fuel Return Hose And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect Fuel Tank Fuel Pump Module Wiring Harness (1) (Qty: 2)
7. Disconnect Fuel Pump Fuel Return Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
8. Disconnect Fuel Pump Fuel Feed Hose (3). Refer to **Plastic Collar Quick Connect Fitting Service**

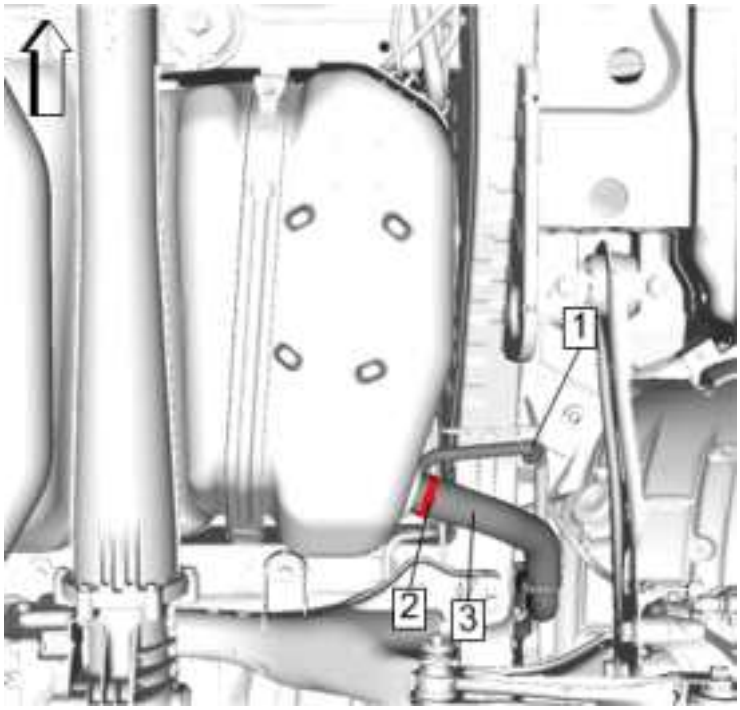

Fig. 64: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect Fuel Tank Vent Hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**
10. Remove Fuel Tank Filler Hose Clamp (2)
11. Remove Fuel Tank Filler Hose (3)

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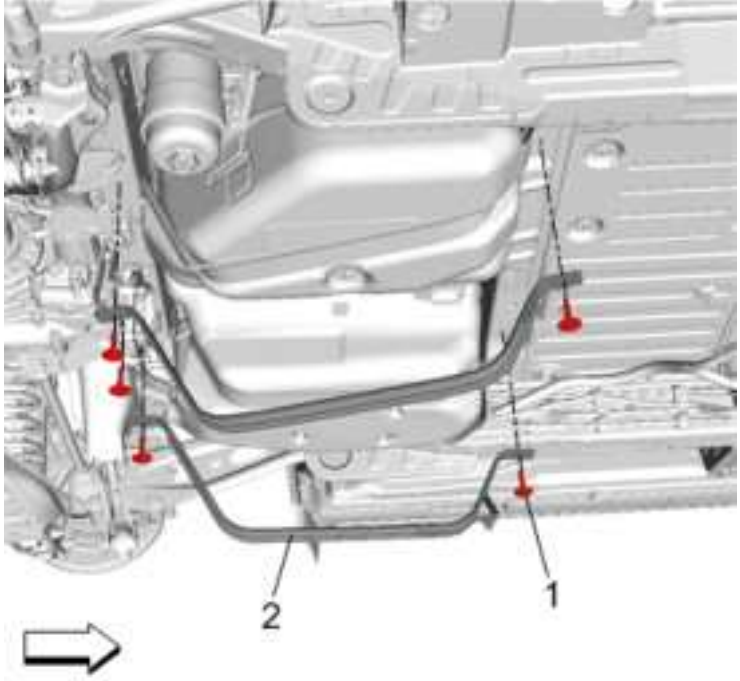

Fig. 65: Fuel Tank Straps And Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Place a suitable adjustable jack under the fuel tank.
13. Remove Fuel Tank Strap Bolts (1) (Qty: 5)
14. Remove Fuel Tank Straps (2) (Qty: 2)

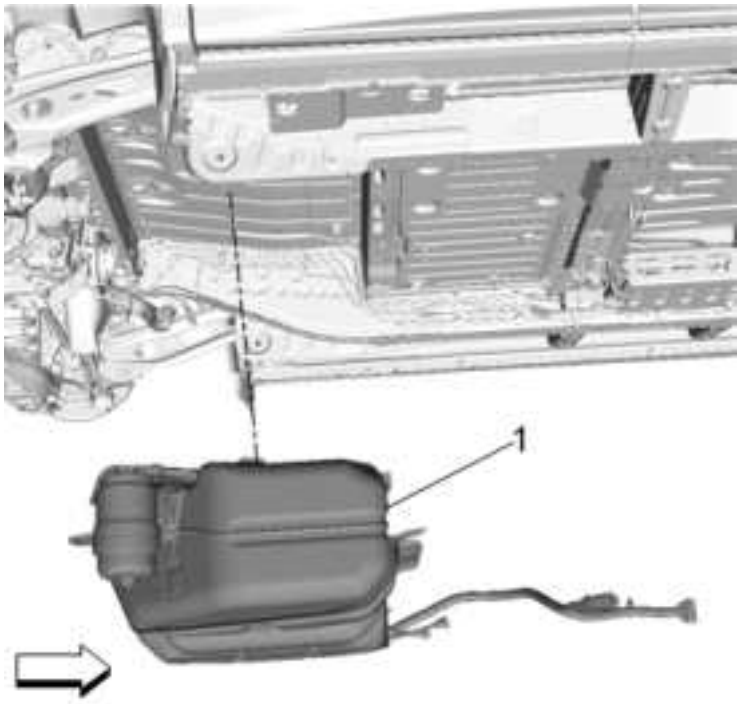

Fig. 66: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

15. Remove Fuel Tank (1)
16. If replacing fuel tank transfer parts as necessary.

Installation Procedure

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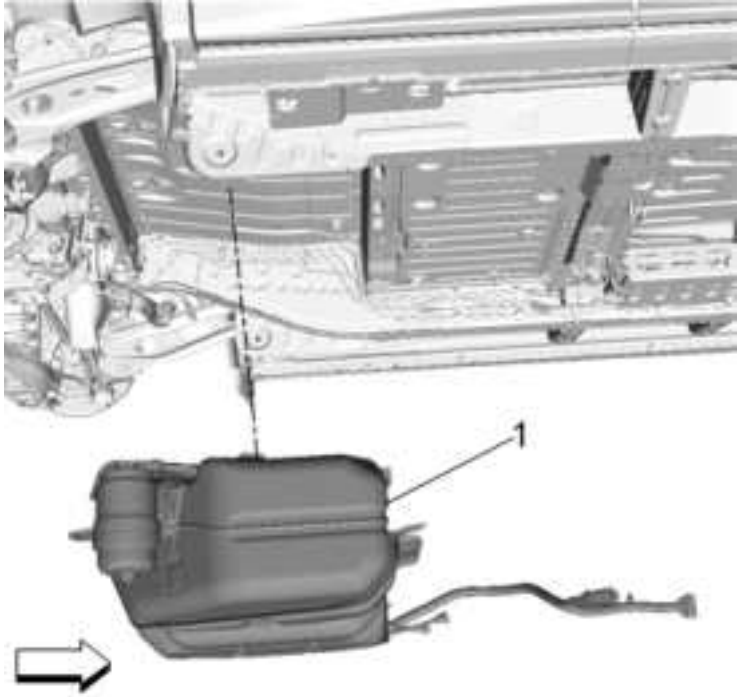

Fig. 67: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

1. Place a suitable adjustable jack under the fuel tank.
2. Install Fuel Tank (1)

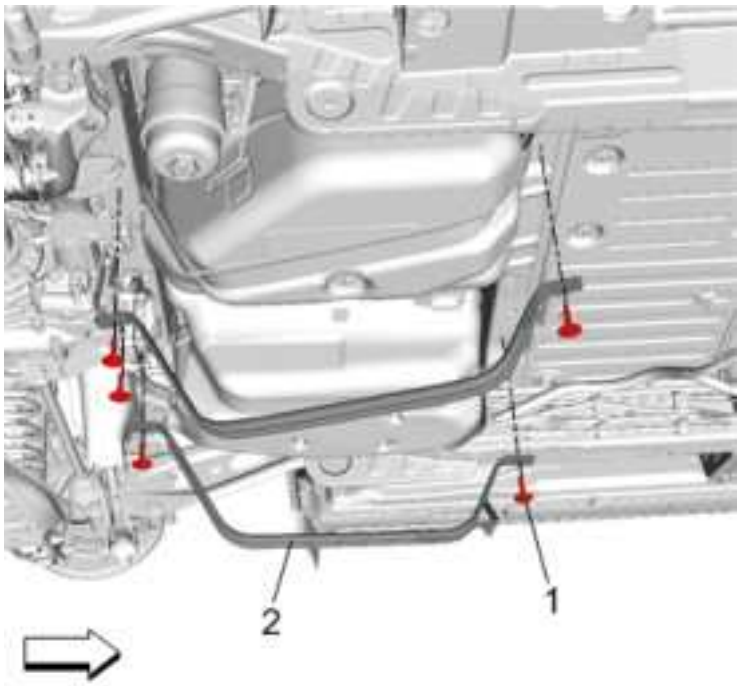

Fig. 68: Fuel Tank Straps And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install Fuel Tank Straps (2) (Qty: 2)

CAUTION: **Refer to Fastener Caution .**

4. Install and tighten Fuel Tank Strap Bolts (1) (Qty: 5) to 22 N.m (16 lb ft)

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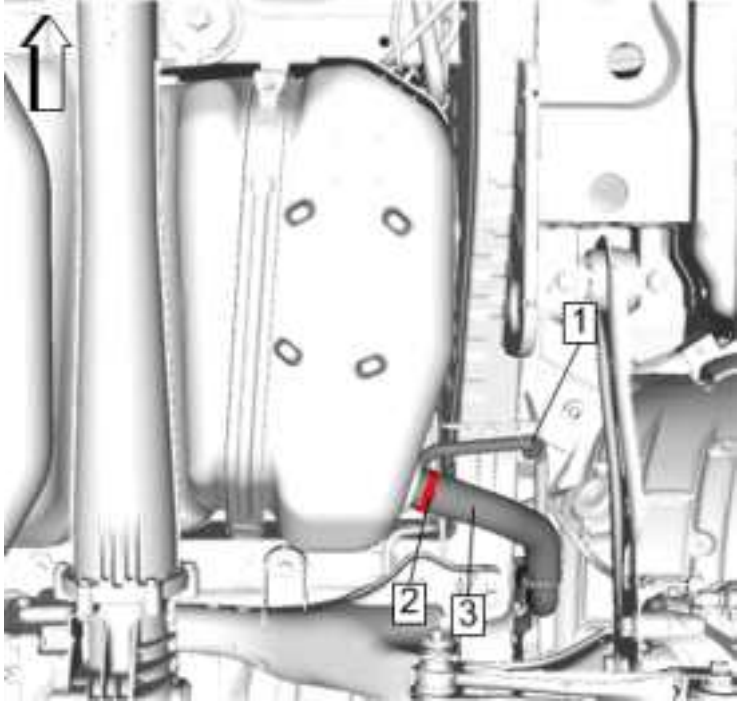

Fig. 69: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Install Fuel Tank Filler Hose (3)
6. Install and tighten Fuel Tank Filler Hose Clamp (2) and tighten to 4 N.m (35 lb in)
7. Connect Fuel Tank Vent Hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**

Fig. 70: Fuel Tank Fuel Pump Module Wiring Harness, Fuel Pump Fuel Return Hose And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

8. Connect Fuel Pump Fuel Feed Hose (3). Refer to **Plastic Collar Quick Connect Fitting Service**
9. Connect Fuel Pump Fuel Return Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
10. Connect Fuel Tank Fuel Pump Module Wiring Harness (1) (Qty: 2)
11. Install Driveline Torque Tube. Refer to **Driveline Torque Tube Replacement**
12. Install Exhaust Muffler Assembly. Refer to **Exhaust Muffler Replacement (LH7)**
13. Install Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (All Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

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14. Lower the vehicle.
15. Refill the fuel tank.
16. Prime the fuel system. Refer to **Fuel System Priming**
17. Inspect for fuel leaks.

FUEL TANK REPLACEMENT (FWD)

Removal Procedure

WARNING: Refer to **Diesel/Gasoline Vapors Warning** .

WARNING: Refer to **Safety Glasses Warning** .

1. Drain the fuel tank. Refer to **Fuel Tank Draining**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
3. Remove Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (Front Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**
4. Remove Exhaust Muffler Assembly. Refer to **Exhaust Muffler Replacement (LH7)**

Fig. 71: Fuel Tank Fuel Pump Module Wiring Harness, Fuel Pump Fuel Return Hose And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect Fuel Tank Fuel Pump Module Wiring Harness (1) (Qty: 2)
6. Disconnect Fuel Pump Fuel Return Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
7. Disconnect Fuel Pump Fuel Feed Hose (3). Refer to **Plastic Collar Quick Connect Fitting Service**

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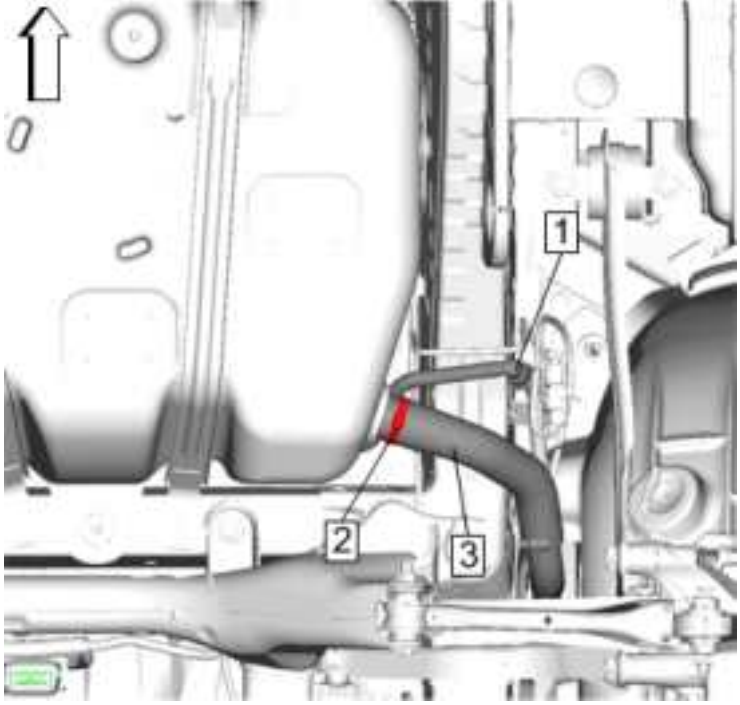

Fig. 72: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect Fuel Tank Vent Hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**
9. Remove Fuel Tank Filler Hose Clamp (2)
10. Remove Fuel Tank Filler Hose (3)

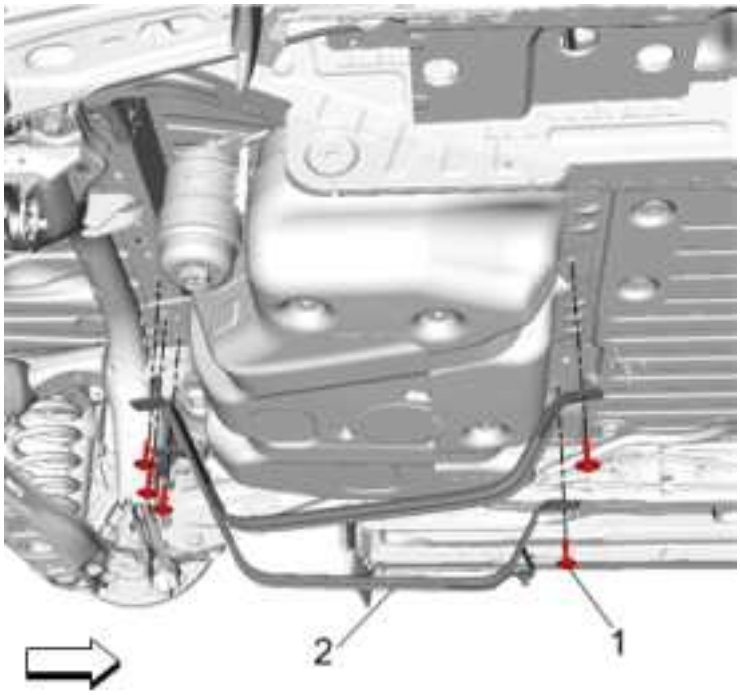

Fig. 73: Fuel Tank Straps And Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Place a suitable adjustable jack under the fuel tank.
12. Remove Fuel Tank Strap Bolts (1) (Qty: 5)
13. Remove Fuel Tank Straps (2) (Qty: 2)

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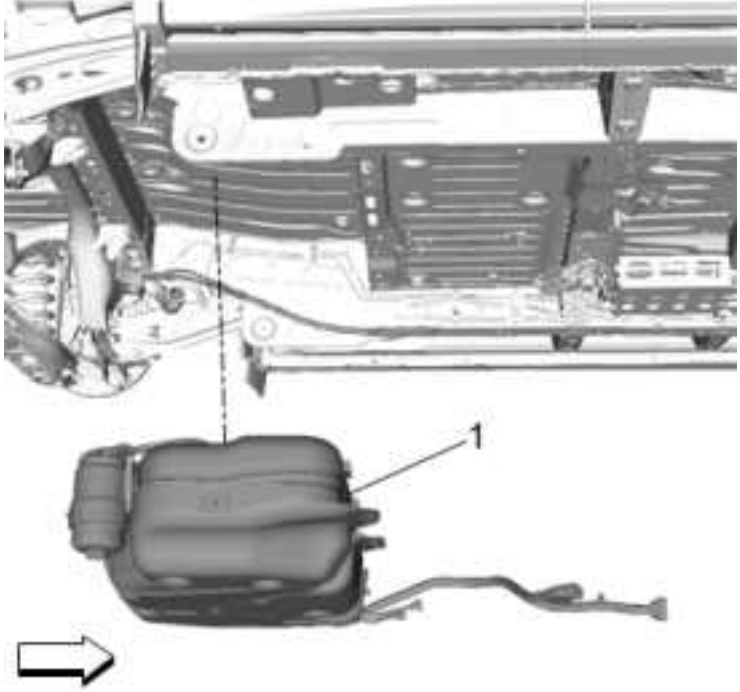

Fig. 74: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

14. Remove Fuel Tank (1)
15. If replacing fuel tank transfer parts as necessary.

Installation Procedure

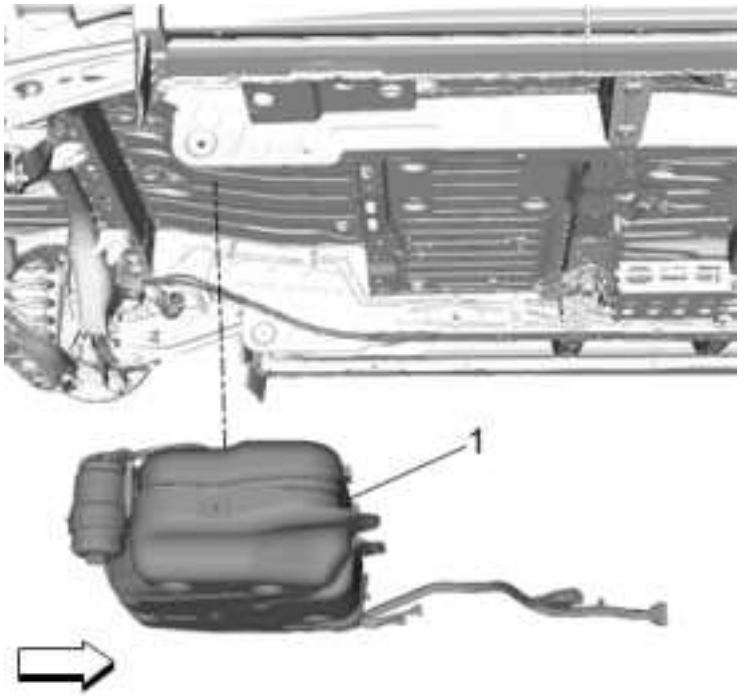

Fig. 75: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

1. Place a suitable adjustable jack under the fuel tank.
2. Install Fuel Tank (1)

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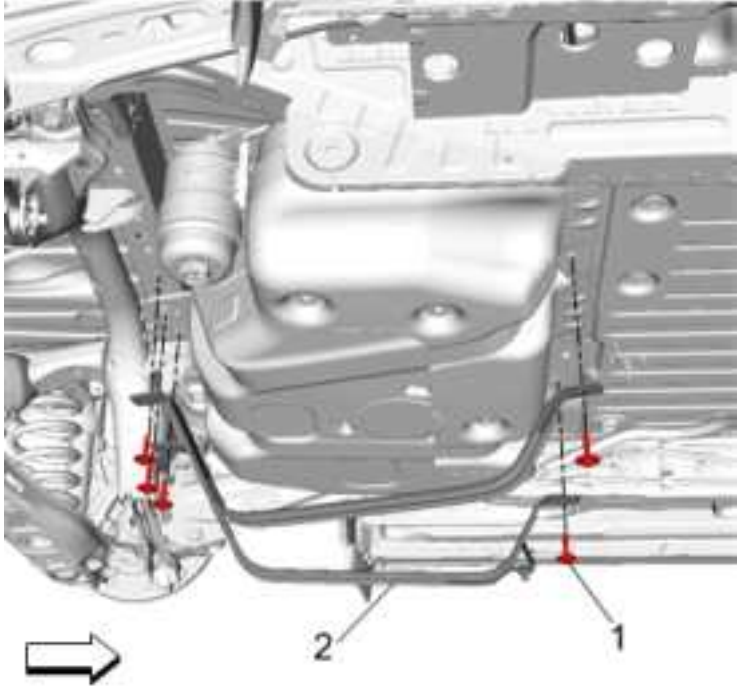

Fig. 76: Fuel Tank Straps And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install Fuel Tank Straps (2) (Qty: 2)

CAUTION: **Refer to Fastener Caution .**

4. Install and tighten Fuel Tank Strap Bolts (1) (Qty: 5) to 22 N.m (16 lb ft)

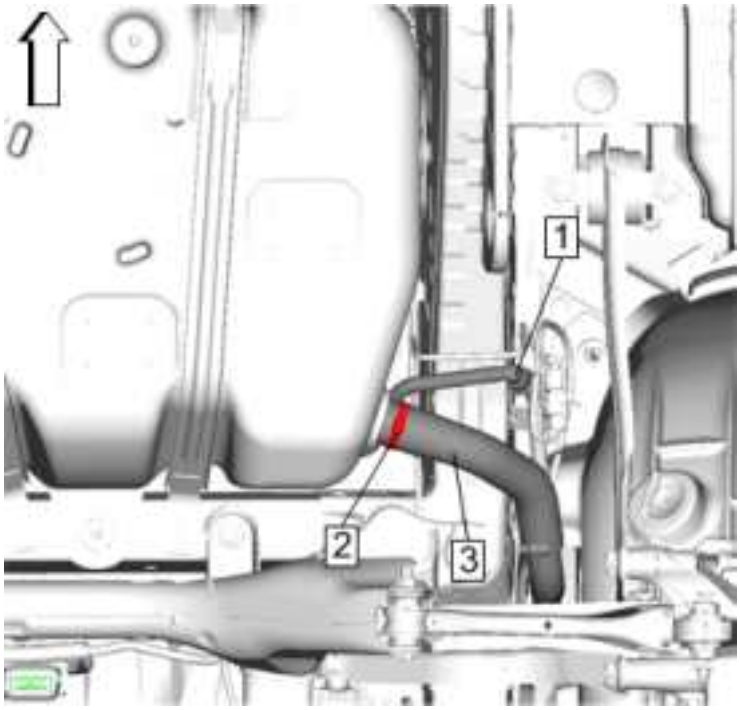

Fig. 77: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Install Fuel Tank Filler Hose (3)
6. Install and tighten Fuel Tank Filler Hose Clamp (2) to 4 N.m (35 lb in)
7. Connect Fuel Tank Vent Hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**

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Fig. 78: Fuel Tank Fuel Pump Module Wiring Harness, Fuel Pump Fuel Return Hose And Fuel Pump Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

8. Connect Fuel Pump Fuel Feed Hose (3). Refer to **Plastic Collar Quick Connect Fitting Service**
9. Connect Fuel Pump Fuel Return Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
10. Connect Fuel Tank Fuel Pump Module Wiring Harness (1) (Qty: 2)
11. Install Exhaust Muffler Assembly. Refer to **Exhaust Muffler Replacement (LH7)**
12. Install Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (Front Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**
13. Lower the vehicle.
14. Refill the fuel tank.
15. Prime the fuel system. Refer to **Fuel System Priming**
16. Inspect for fuel leaks.

FUEL TANK SHIELD REPLACEMENT (AWD)

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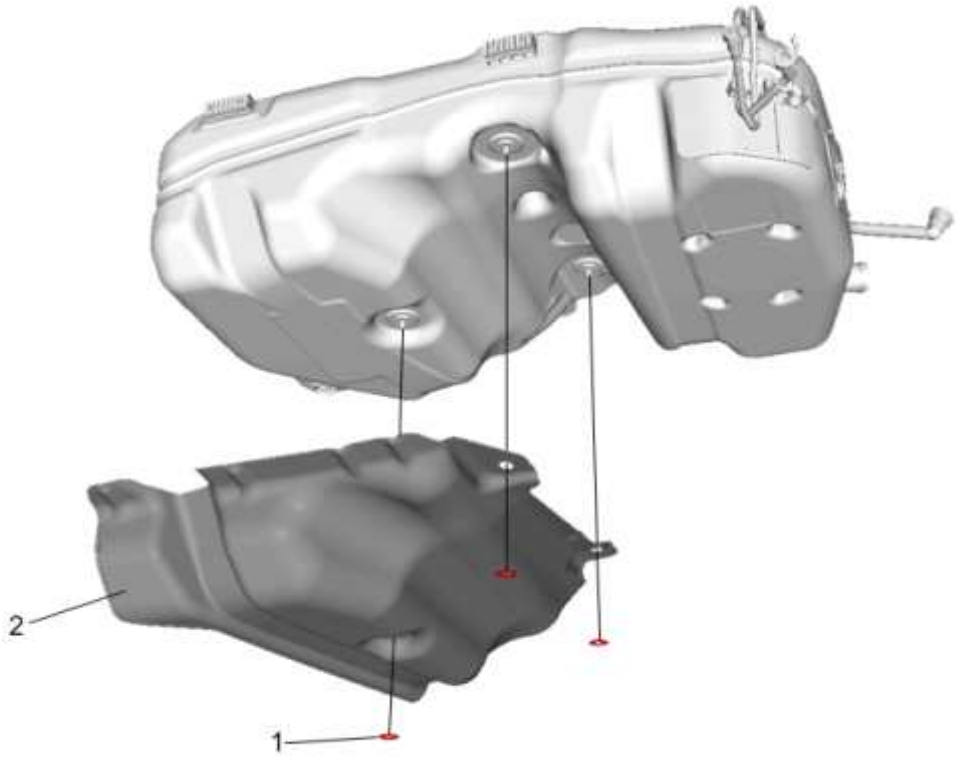

Fig. 79: Fuel Tank Shield (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (AWD)	
1	Fuel Tank Shield Retainer (Qty: 3)
2	Fuel Tank Shield

FUEL TANK SHIELD REPLACEMENT (FWD)

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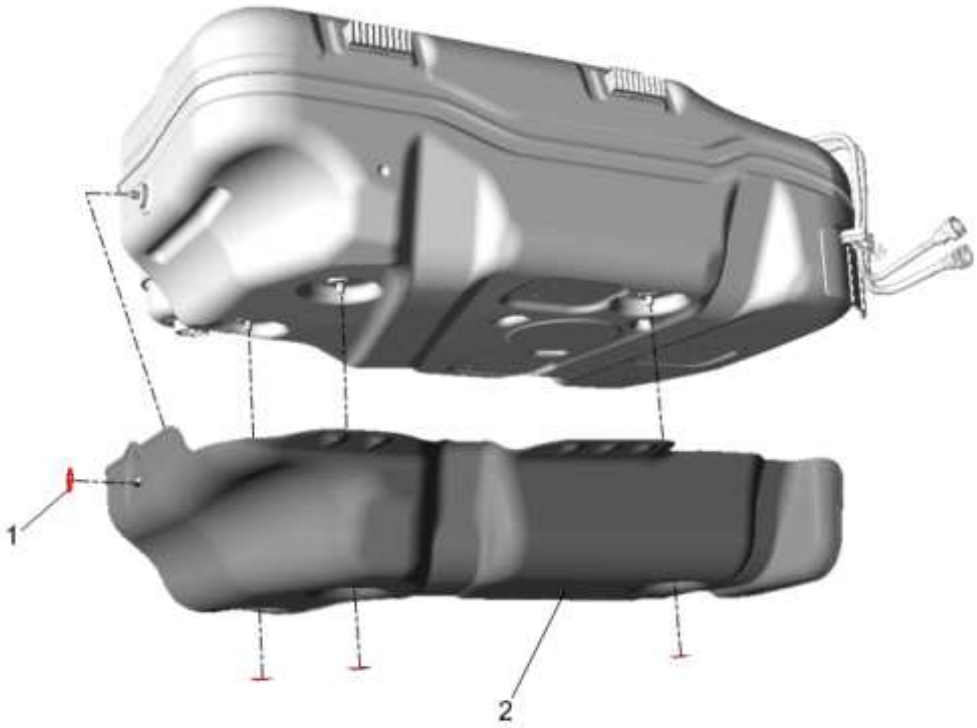

Fig. 80: Fuel Tank Shield (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (FWD)	
1	Fuel Tank Shield Retainer (Qty: 4)
2	Fuel Tank Shield

FUEL TANK VENT REPLACEMENT (AWD)

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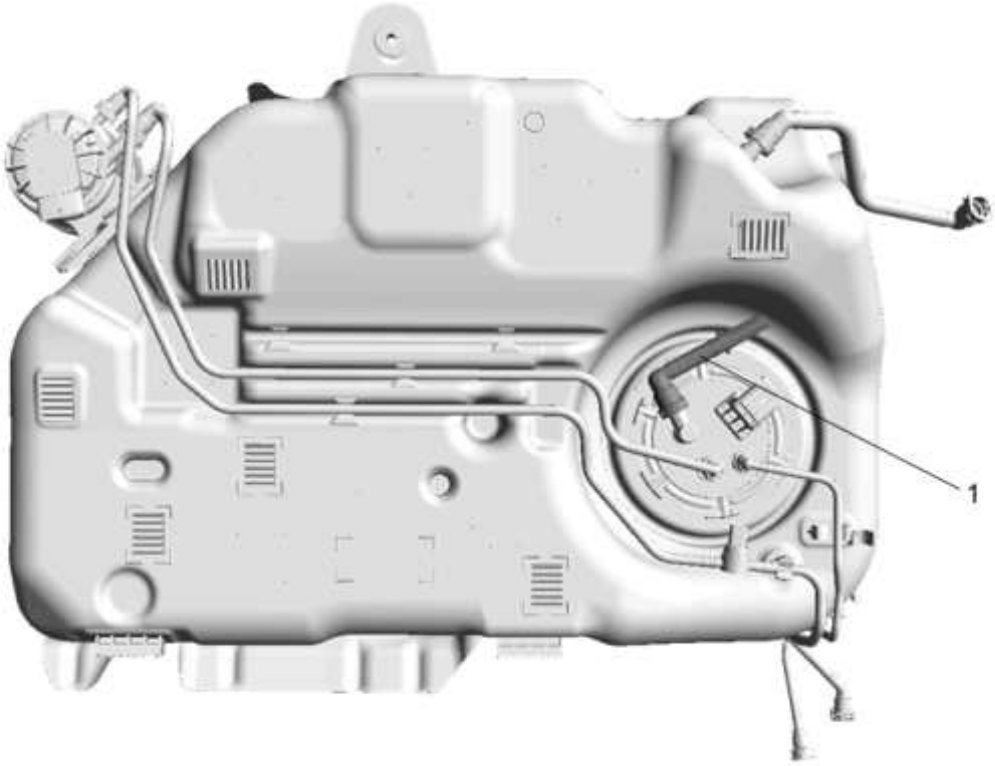

Fig. 81: Fuel Tank Vent (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (AWD)	
1	Fuel Tank Vent **Procedure** Disconnect the fuel tank vent. Refer to Plastic Collar Quick Connect Fitting Service

FUEL TANK VENT REPLACEMENT (FWD)

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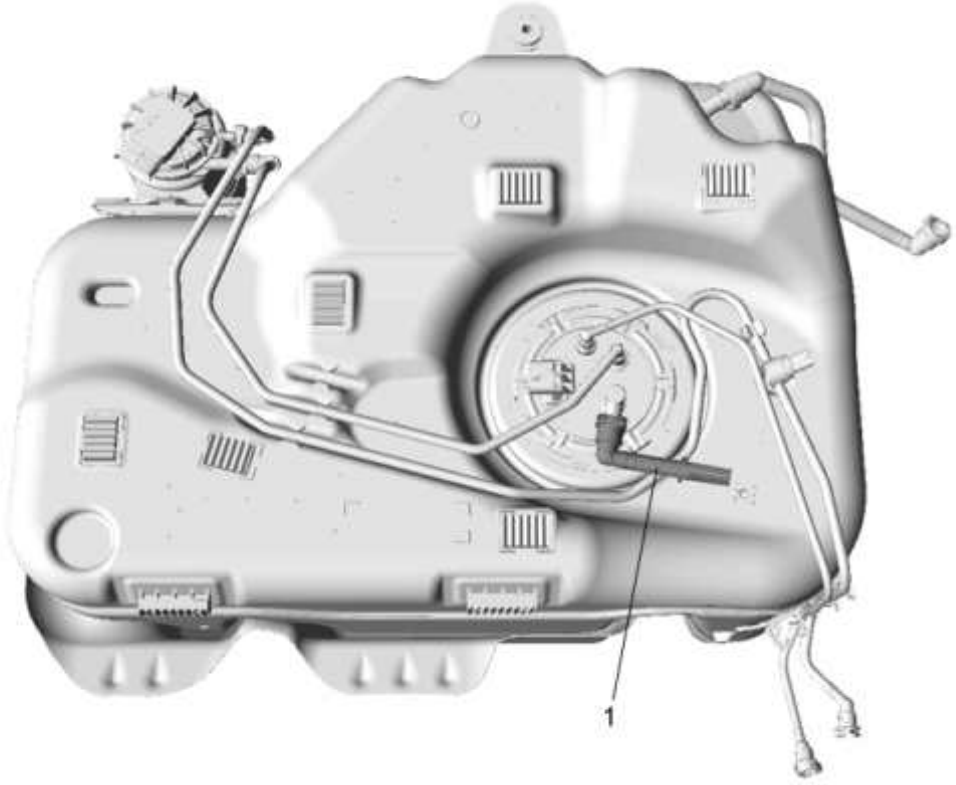

Fig. 82: Fuel Tank Vent (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (FWD)	
1	Fuel Tank Vent **Procedure** Disconnect the fuel tank vent. Refer to Plastic Collar Quick Connect Fitting Service

FUEL TANK VENT HOSE REPLACEMENT (FWD)

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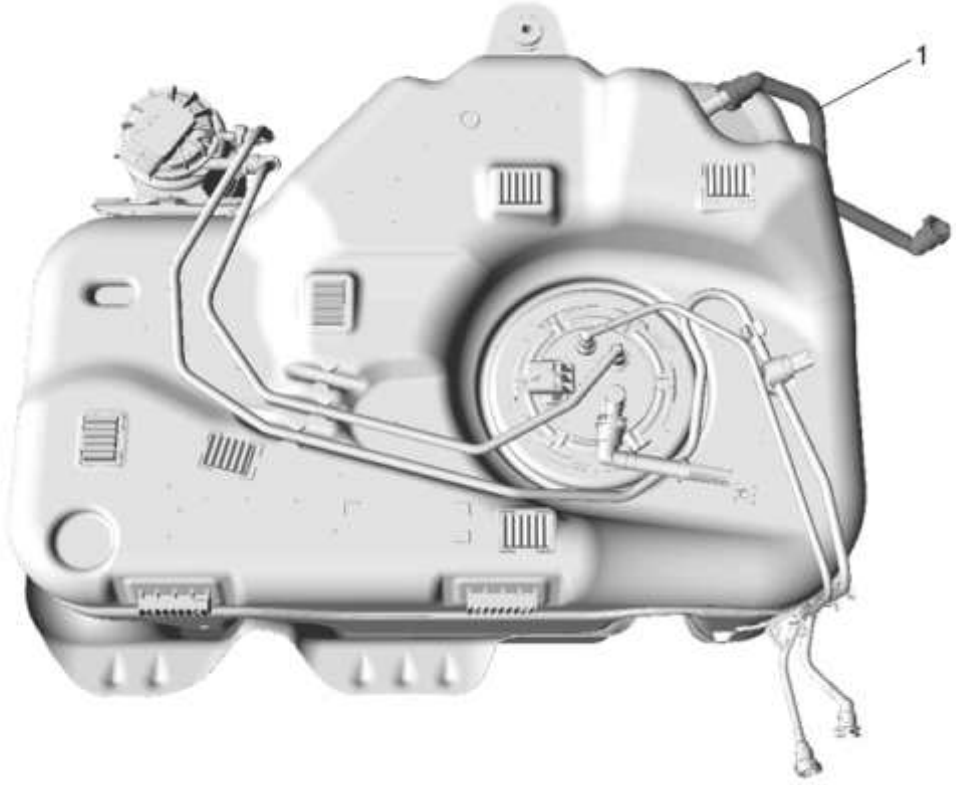

Fig. 83: Fuel Tank Vent Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (FWD)	
1	Fuel Tank Vent Hose **Procedure** Disconnect the fuel tank vent hose. Refer to Plastic Collar Quick Connect Fitting Service

FUEL TANK VENT HOSE REPLACEMENT (AWD)

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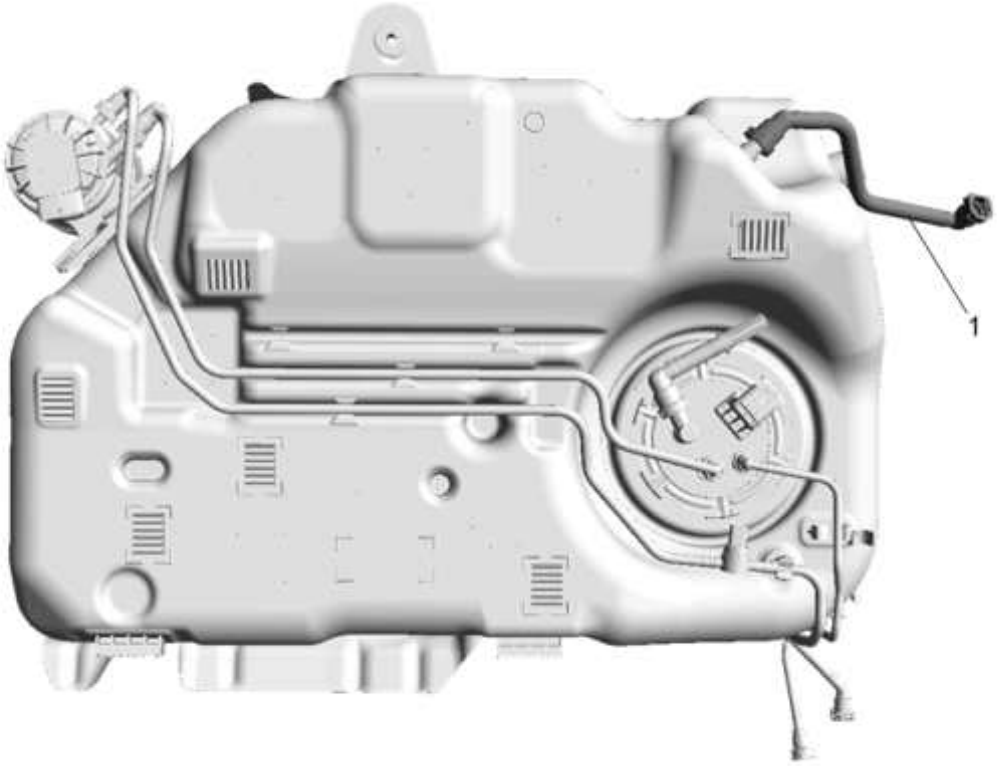

Fig. 84: Fuel Tank Vent Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (AWD)	
1	Fuel Tank Vent Hose **Procedure** Disconnect the fuel tank vent hose. Refer to Plastic Collar Quick Connect Fitting Service

FUEL TANK FUEL PUMP MODULE REPLACEMENT (FWD)

Special Tools

CH 52075 Fuel Sender Lock Ring Wrench

Equivalent regional tools: Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools)

Removal Procedure

WARNING: Refer to Diesel/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Remove Fuel Tank. Refer to Fuel Tank Replacement (FWD)

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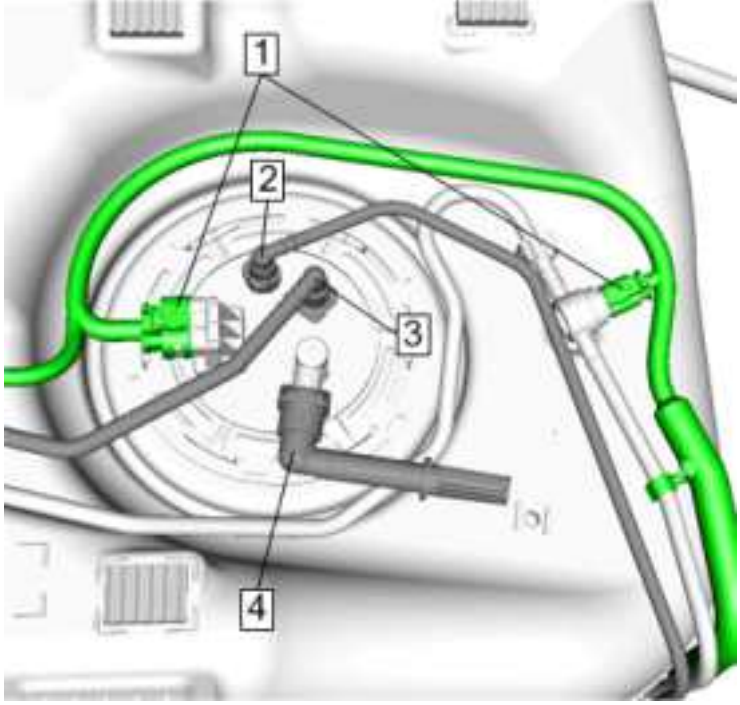

Fig. 85: Electrical Connectors, Fuel Pump Fuel Return Hose, Fuel Pump To Fuel Filter Hose And Fuel Tank Vent
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Electrical Connectors (1) (Qty: 2)
3. Disconnect Fuel Pump Fuel Return Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
4. Disconnect Fuel Pump to Fuel Filter Hose (3). Refer to **Plastic Collar Quick Connect Fitting Service**
5. Disconnect Fuel Tank Vent (4). Refer to **Plastic Collar Quick Connect Fitting Service**

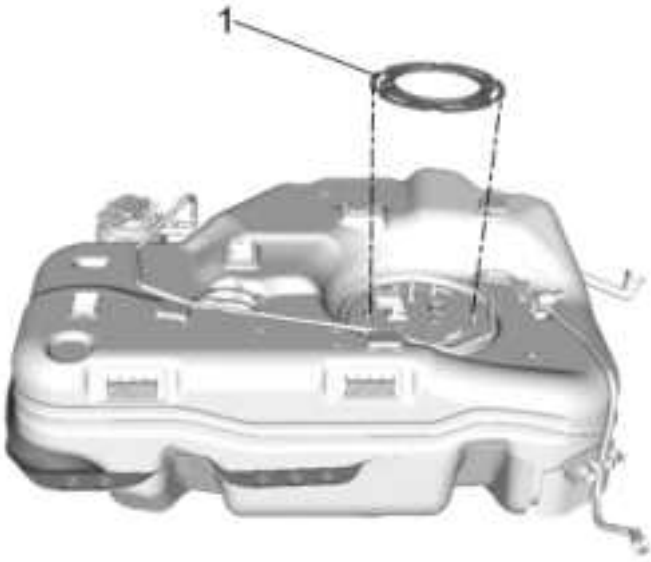

Fig. 86: Fuel Pump Lock Ring
Courtesy of GENERAL MOTORS COMPANY

6. Remove Fuel Pump Lock Ring (1) - **CH 52075** Fuel Sender Lock Ring Wrench

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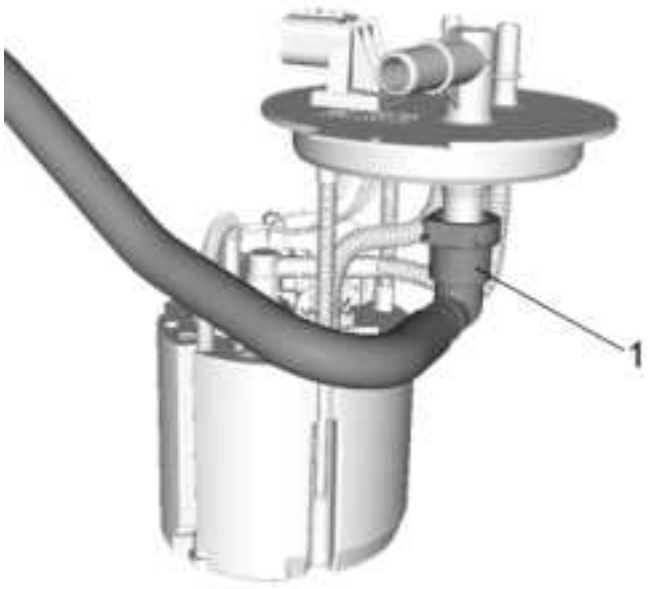

Fig. 87: Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Fuel Tank Vent Hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**

Fig. 88: Fuel Tank Fuel Pump Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

8. Remove Fuel Tank Fuel Pump Module (1)
9. Remove and DISCARD O-Ring (2)

Installation Procedure

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Fig. 89: Fuel Tank Fuel Pump Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW O-Ring (2)
2. Install Fuel Tank Fuel Pump Module (1)

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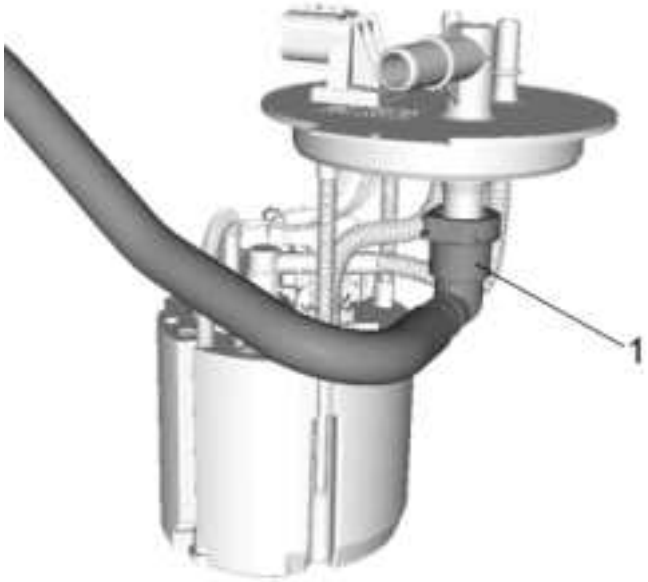

Fig. 90: Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

3. Connect Fuel Tank Vent Hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**

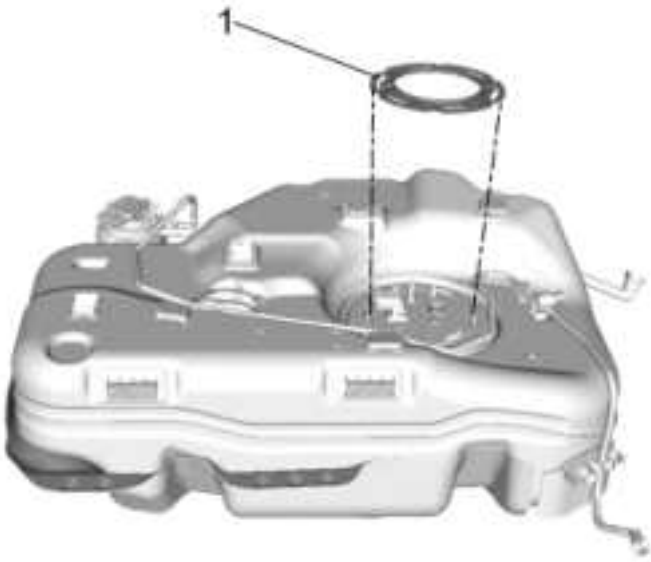

Fig. 91: Fuel Pump Lock Ring
Courtesy of GENERAL MOTORS COMPANY

4. Install Fuel Pump Lock Ring (1) - **CH 52075** Fuel Sender Lock Ring Wrench

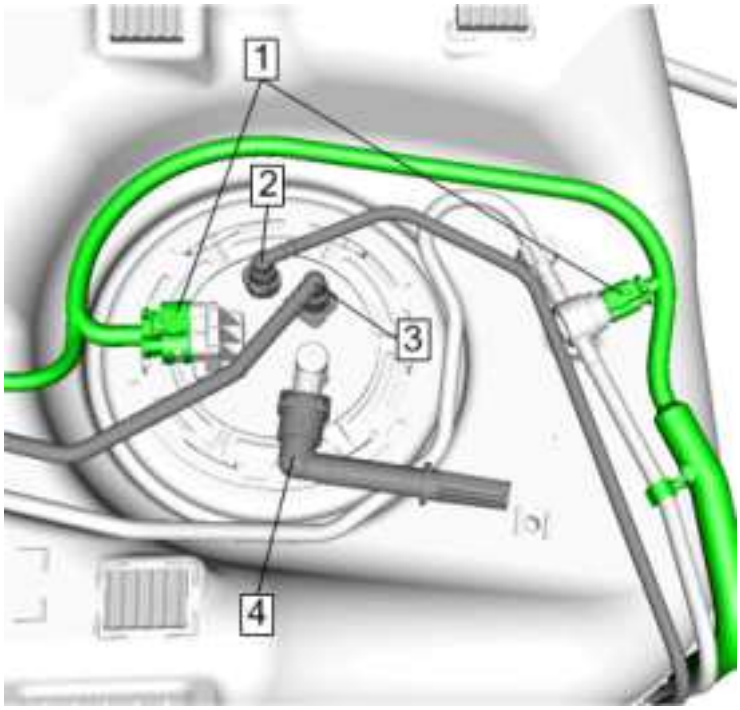

Fig. 92: Electrical Connectors, Fuel Pump Fuel Return Hose, Fuel Pump To Fuel Filter Hose And Fuel Tank Vent
Courtesy of GENERAL MOTORS COMPANY

5. Connect Fuel Tank Vent (4). Refer to **Plastic Collar Quick Connect Fitting Service**
6. Connect Fuel Pump to Fuel Filter Hose (3). Refer to **Plastic Collar Quick Connect Fitting Service**
7. Connect Fuel Pump Fuel Return Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
8. Connect Electrical Connectors (1) (Qty: 2)
9. Install Fuel Tank. Refer to **Fuel Tank Replacement (AWD)**

FUEL TANK FUEL PUMP MODULE REPLACEMENT (AWD)

Special Tools

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CH 52075 Fuel Sender Lock Ring Wrench

Equivalent regional tools: Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools)

Removal Procedure

WARNING: **Refer to Diesel/Gasoline Vapors Warning .**

WARNING: **Refer to Safety Glasses Warning .**

1. Remove Fuel Tank. Refer to Fuel Tank Replacement (AWD)

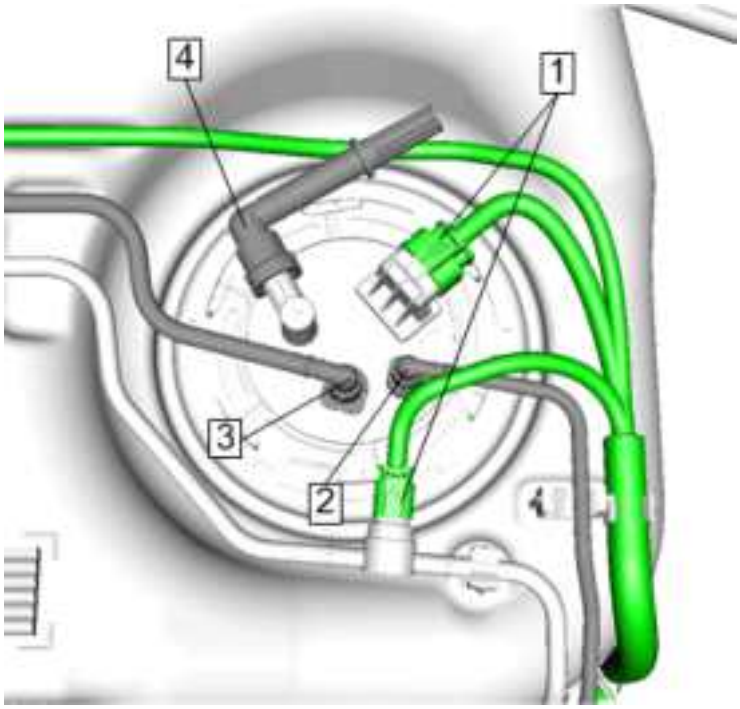

Fig. 93: Electrical Connectors, Fuel Pump Fuel Return Hose, Fuel Pump To Fuel Filter Hose And Fuel Tank Vent
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Electrical Connectors (1) (Qty: 2)
3. Disconnect Fuel Pump Fuel Return Hose (2). Refer to Plastic Collar Quick Connect Fitting Service
4. Disconnect Fuel Pump to Fuel Filter Hose (3). Refer to Plastic Collar Quick Connect Fitting Service
5. Disconnect Fuel Tank Vent (4). Refer to Plastic Collar Quick Connect Fitting Service

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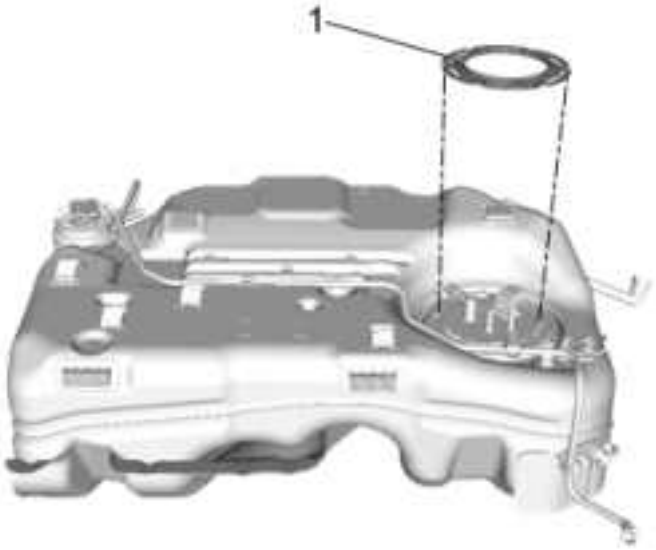

Fig. 94: Fuel Pump Lock Ring
Courtesy of GENERAL MOTORS COMPANY

6. Remove Fuel Pump Lock Ring (1) - **CH 52075** Fuel Sender Lock Ring Wrench

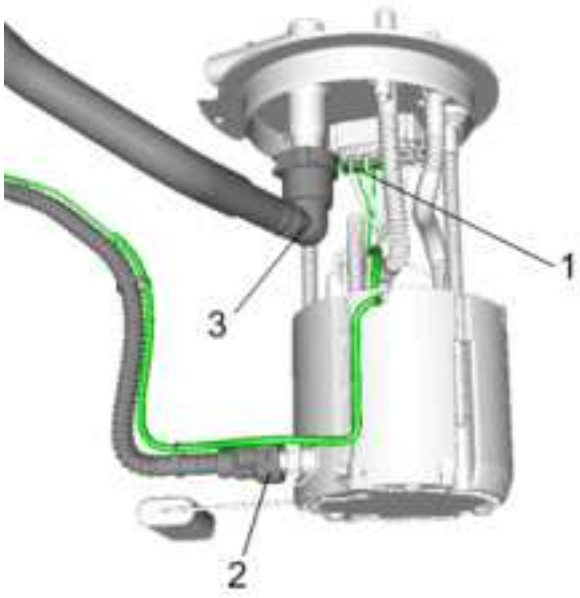

Fig. 95: Electrical Connector, Transfer Hose And Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Electrical Connector (1)
8. Disconnect Transfer Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
9. Disconnect Fuel Tank Vent Hose (3). Refer to **Plastic Collar Quick Connect Fitting Service**

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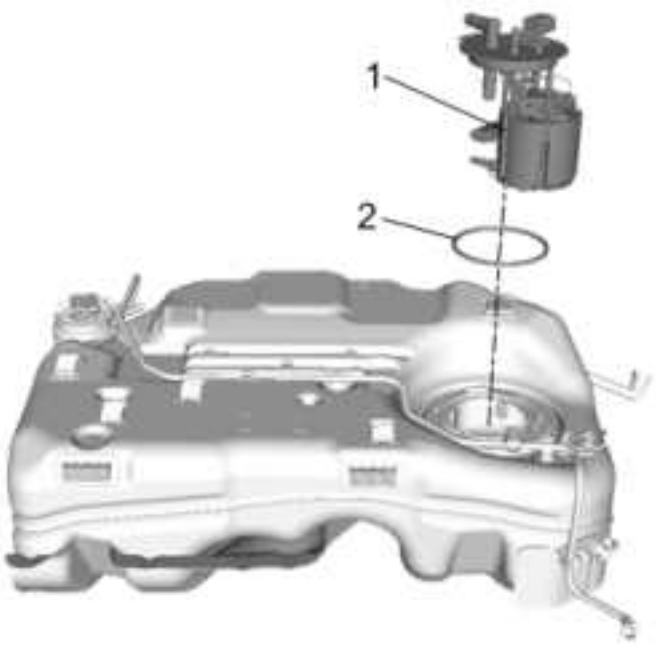

Fig. 96: Fuel Tank Fuel Pump Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

10. Remove Fuel Tank Fuel Pump Module (1)
11. Remove and DISCARD O-Ring (2)

Installation Procedure

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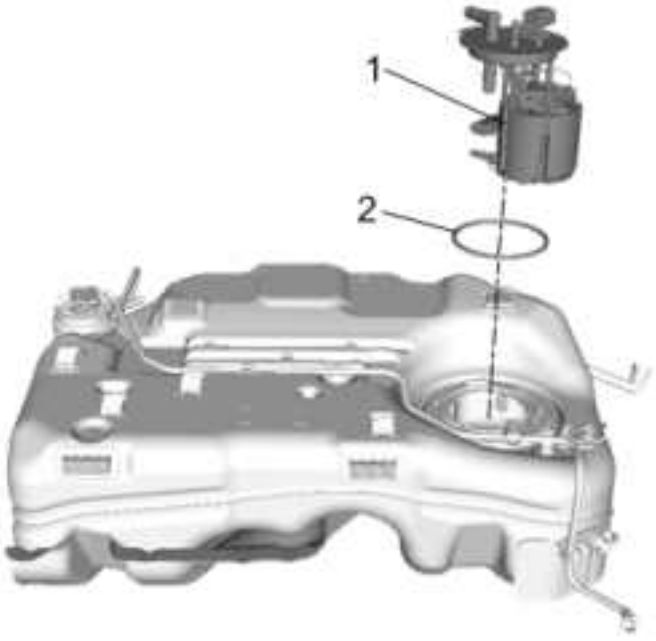

Fig. 97: Fuel Tank Fuel Pump Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW O-Ring (2)
2. Install Fuel Tank Fuel Pump Module (1)

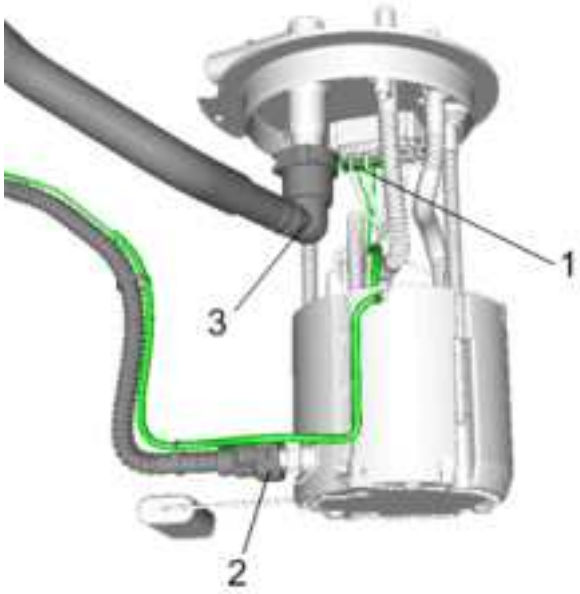

Fig. 98: Electrical Connector, Transfer Hose And Fuel Tank Vent Hose
Courtesy of GENERAL MOTORS COMPANY

3. Connect Fuel Tank Vent Hose (3). Refer to **Plastic Collar Quick Connect Fitting Service**
4. Connect Transfer Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
5. Connect Electrical Connector (1)

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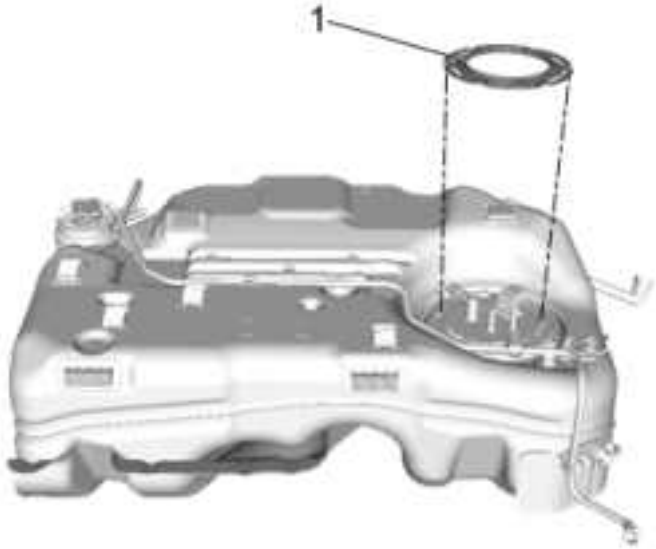

Fig. 99: Fuel Pump Lock Ring
Courtesy of GENERAL MOTORS COMPANY

6. Install Fuel Pump Lock Ring (1) - **CH 52075** Fuel Sender Lock Ring Wrench

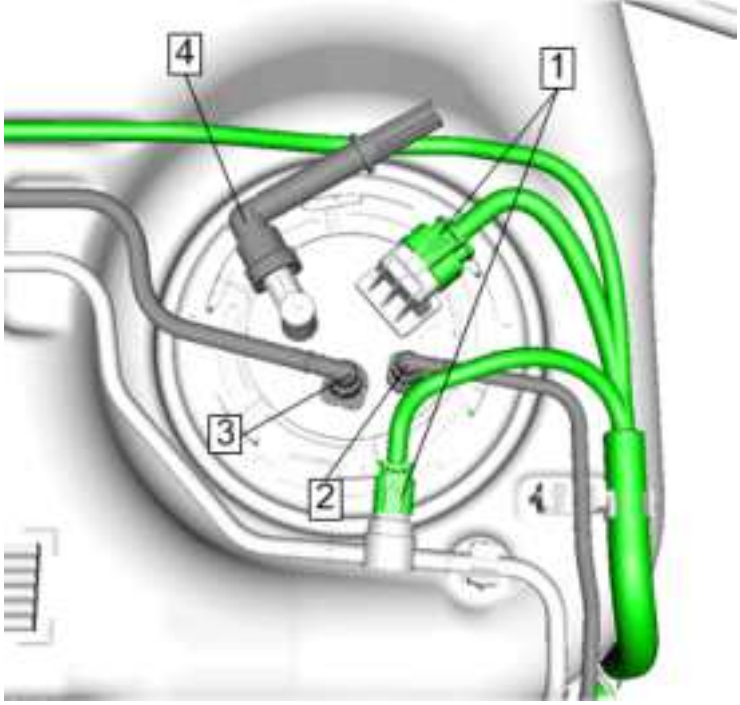

Fig. 100: Electrical Connectors, Fuel Pump Fuel Return Hose, Fuel Pump To Fuel Filter Hose And Fuel Tank Vent
Courtesy of GENERAL MOTORS COMPANY

7. Connect Fuel Tank Vent (4). Refer to **Plastic Collar Quick Connect Fitting Service**
8. Connect Fuel Pump to Fuel Filter Hose (3). Refer to **Plastic Collar Quick Connect Fitting Service**
9. Connect Fuel Pump Fuel Return Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
10. Connect Electrical Connectors (1) (Qty: 2)
11. Install Fuel Tank. Refer to **Fuel Tank Replacement (AWD)**

FUEL TANK FILLER PIPE REPLACEMENT

Removal Procedure

WARNING: **Refer to Diesel/Gasoline Vapors Warning .**

WARNING: **Refer to Safety Glasses Warning .**

1. Remove Fuel Tank Filler Pipe Housing. Refer to **Fuel Tank Filler Pipe Housing Replacement (Equinox)** **Fuel Tank Filler Pipe Housing Replacement (Terrain)**
2. Remove Rear Wheelhouse Liner-Left Side. Refer to **Rear Wheelhouse Liner Replacement- Left Side (Equinox)** **Rear Wheelhouse Liner Replacement- Left Side (Terrain)**
3. Drain the fuel tank below the fuel tank filler pipe. Refer to **Fuel Tank Draining**

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Fig. 101: Fuel Tank Filler Pipe Ground Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove Fuel Tank Filler Pipe Ground Bolt (1)

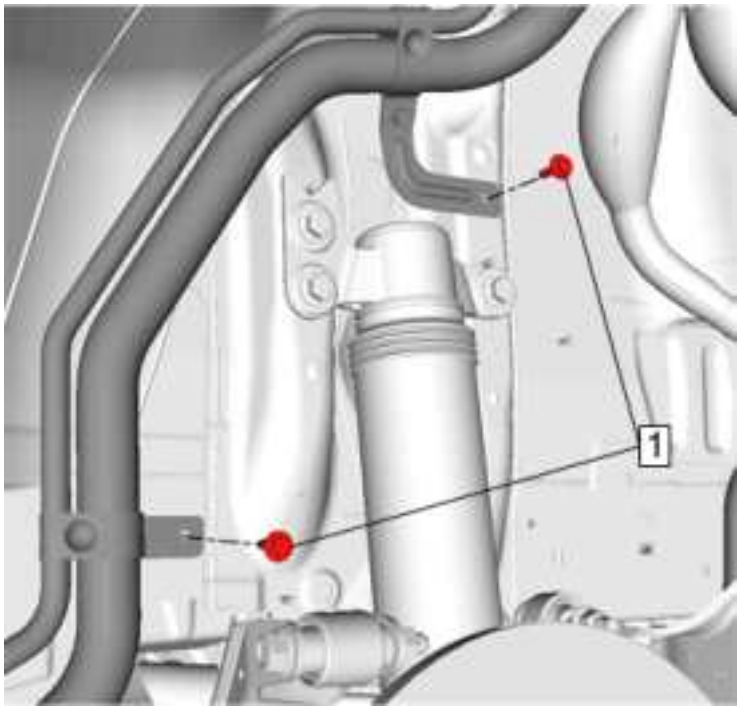

Fig. 102: Fuel Tank Filler Pipe Ground Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove Fuel Tank Filler Pipe Ground Bolts (1) (Qty: 2)

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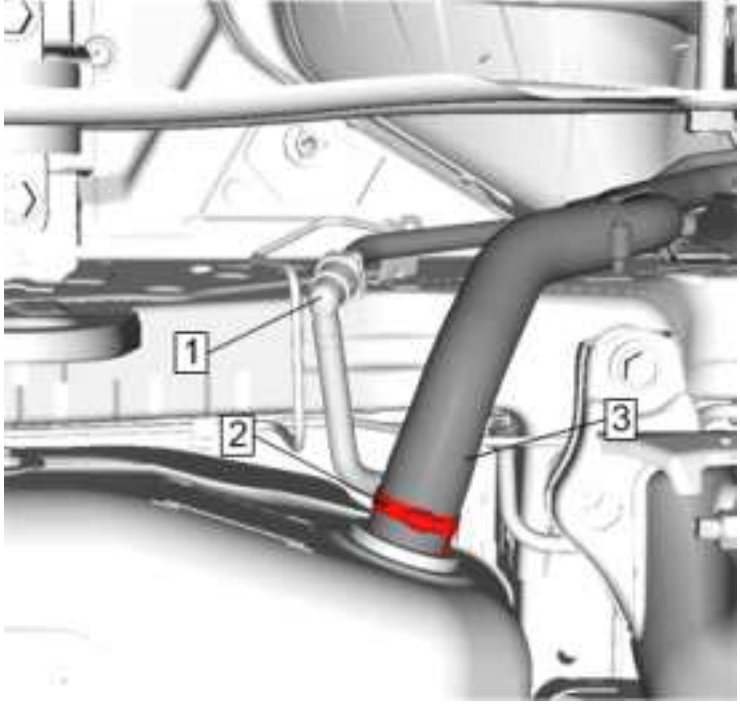

Fig. 103: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect Fuel Tank Vent Hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**
7. Remove Fuel Tank Filler Hose Clamp (2)
8. Remove Fuel Tank Filler Hose (3)

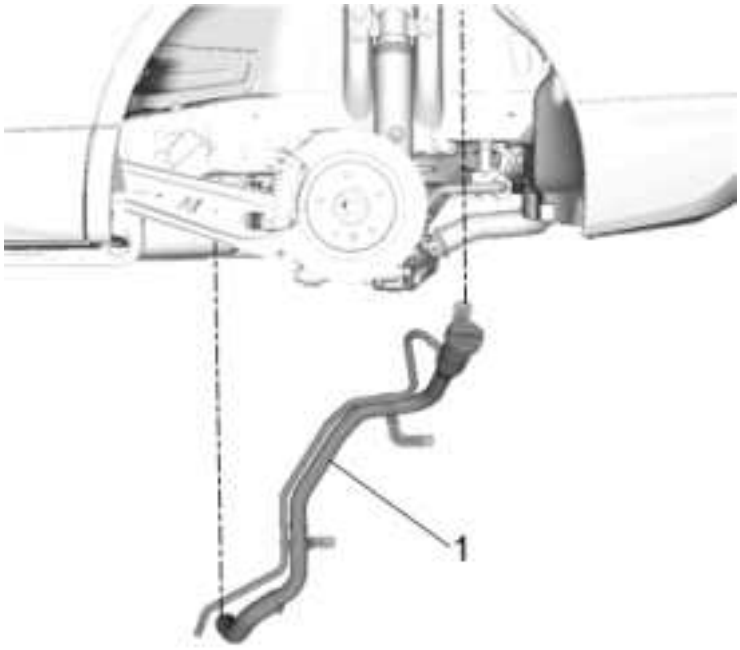

Fig. 104: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

9. Remove Fuel Tank Filler Pipe (1)

Installation Procedure

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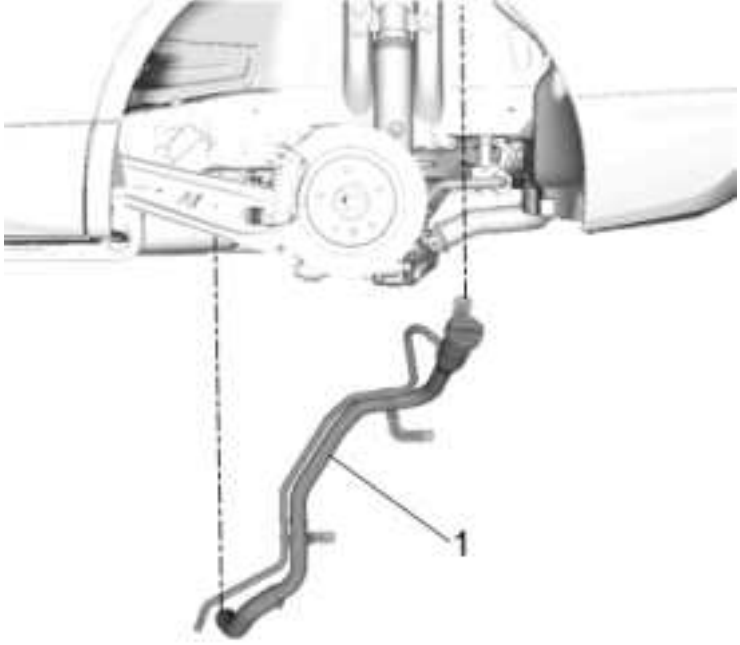

Fig. 105: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Install Fuel Tank Filler Pipe (1)

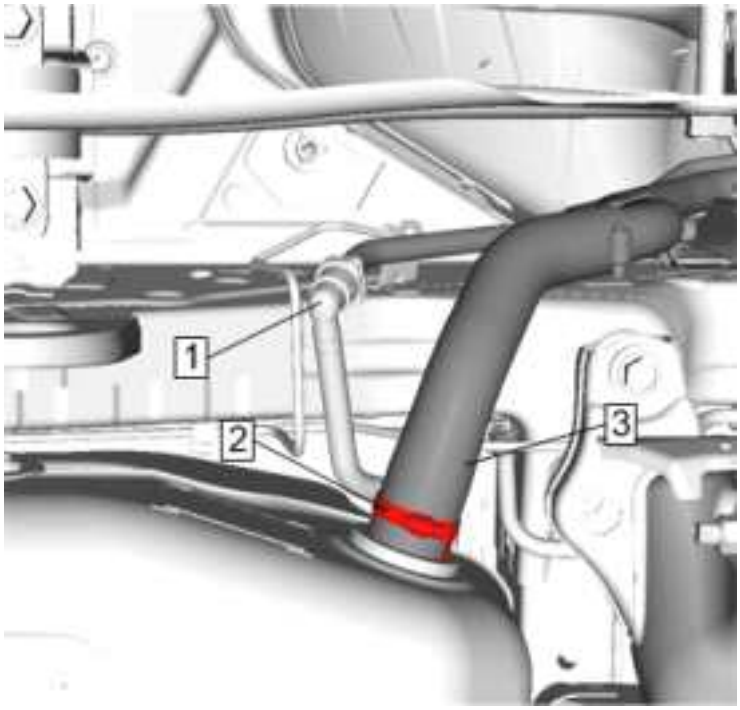

Fig. 106: Fuel Tank Vent Hose, Fuel Tank Filler Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

2. Install Fuel Tank Filler Hose (3)

CAUTION: **Refer to Fastener Caution .**

3. Install and tighten Fuel Tank Filler Hose Clamp (2) to 4 N.m (35 lb in)
4. Connect Fuel Tank Vent Hose (1). Refer to **Plastic Collar Quick Connect Fitting Service**

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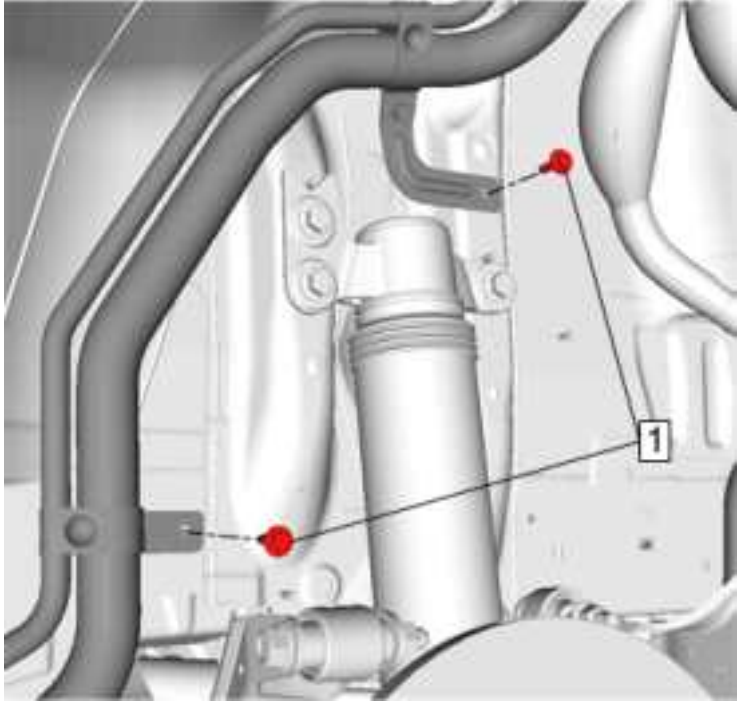

Fig. 107: Fuel Tank Filler Pipe Ground Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install and tighten Fuel Tank Filler Pipe Ground Bolts (1) (Qty: 2) to 9 N.m (80 lb in)

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Fig. 108: Fuel Tank Filler Pipe Ground Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Install and tighten Fuel Tank Filler Pipe Ground Bolt (1) to 9 N.m (80 lb in)
7. Install Rear Wheelhouse Liner-Left Side. Refer to **Rear Wheelhouse Liner Replacement- Left Side (Equinox)** **Rear Wheelhouse Liner Replacement- Left Side (Terrain)**
8. Install Fuel Tank Filler Pipe Housing. Refer to **Fuel Tank Filler Pipe Housing Replacement (Equinox)** **Fuel Tank Filler Pipe Housing Replacement (Terrain)**
9. Fill the fuel tank.

FUEL LEVEL SENSOR REPLACEMENT (AWD)

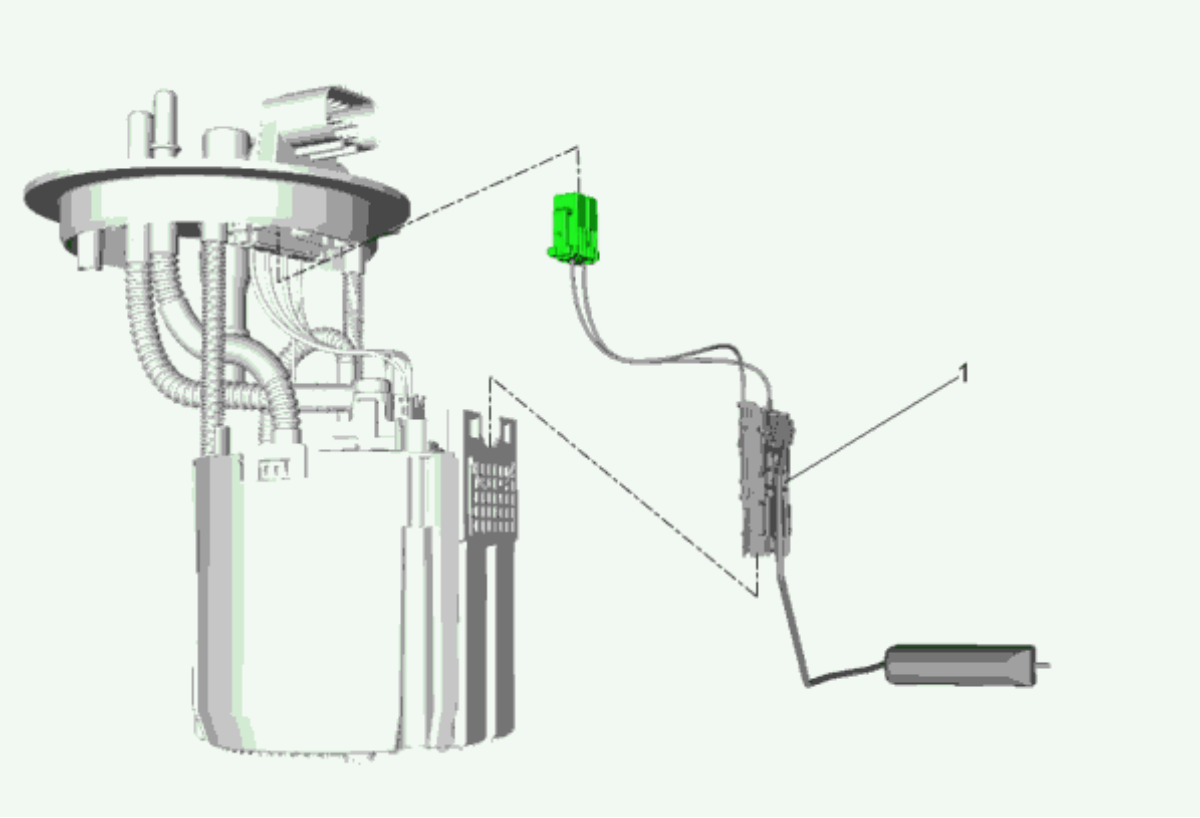

Fig. 109: Fuel Level Sensor (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank Fuel Pump Module. Refer to Fuel Tank Fuel Pump Module Replacement (AWD)	
1	Fuel Level Sensor **Procedure** 1. Release tabs and slide fuel level sensor up to remove. 2. Disconnect the electrical connector.

FUEL LEVEL SENSOR REPLACEMENT (FWD)

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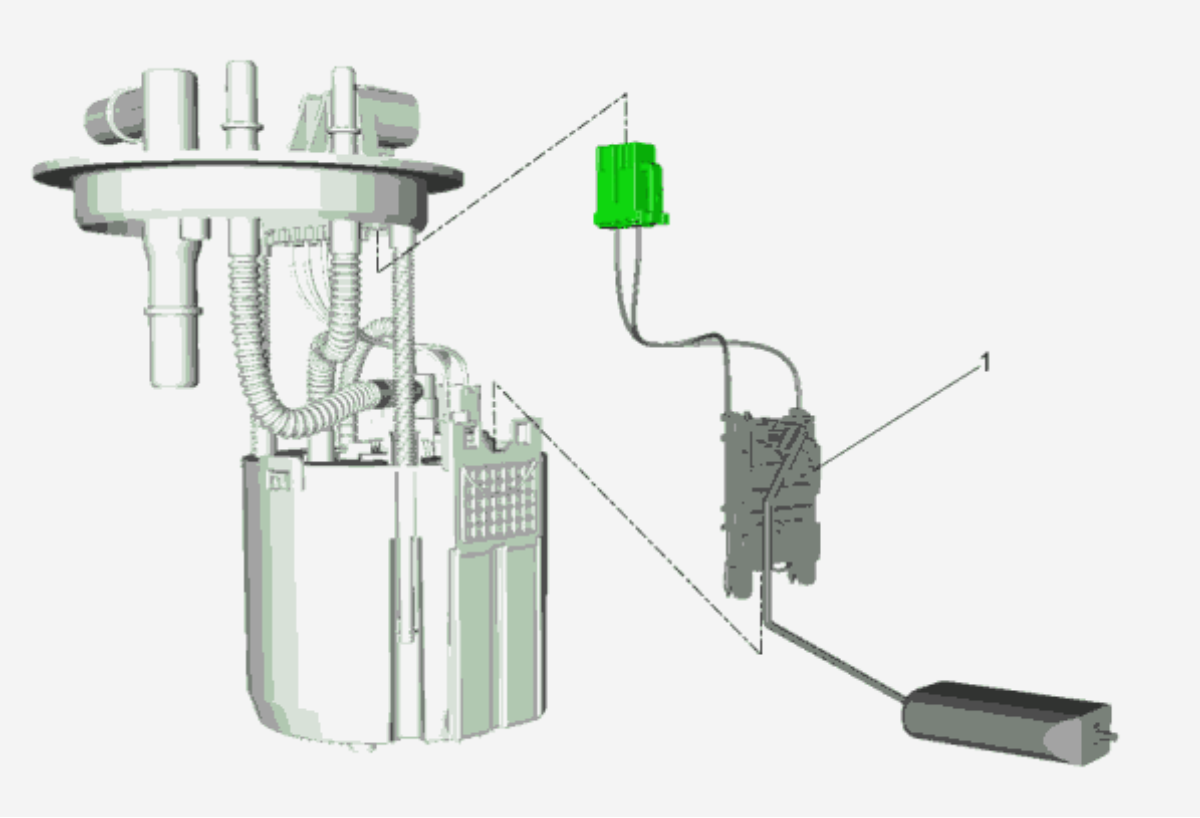

Fig. 110: Fuel Level Sensor (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank Fuel Pump Module. Refer to Fuel Tank Fuel Pump Module Replacement (FWD)	
1	Fuel Level Sensor **Procedure** 1. Release tabs and slide fuel level sensor up to remove. 2. Disconnect the electrical connector.

FUEL COOLER REPLACEMENT (AWD)

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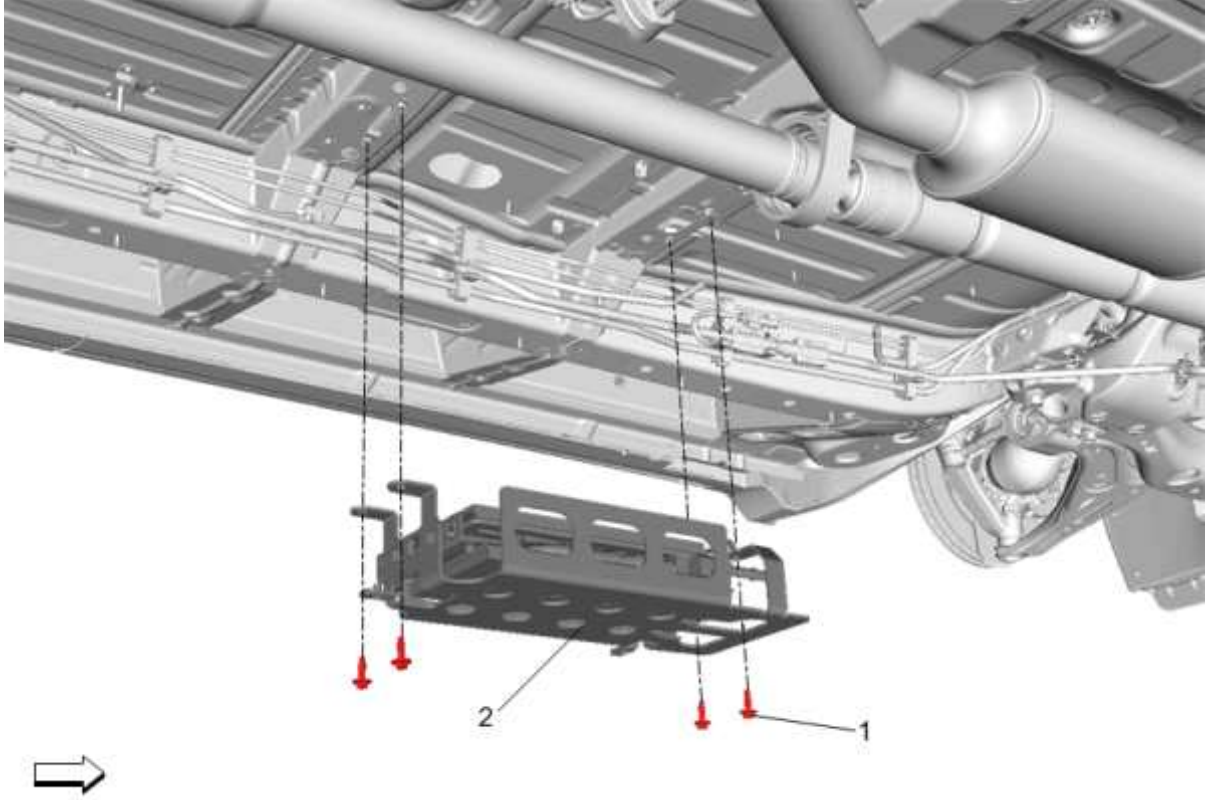

Fig. 111: Fuel Cooler (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedures** 1. Remove Fuel Pump Power Control Module Bracket. Refer to Fuel Pump Power Control Module Bracket Replacement (AWD) 2. Disconnect the fuel return pipes (Qty: 2). Refer to Metal Collar Quick Connect Fitting Service	
1	Fuel Cooler Bolt (Qty: 4) **CAUTION:** Refer to Fastener Caution . **Tighten** 9 N.m (80 lb in)
2	Fuel Cooler

FUEL COOLER REPLACEMENT (FWD)

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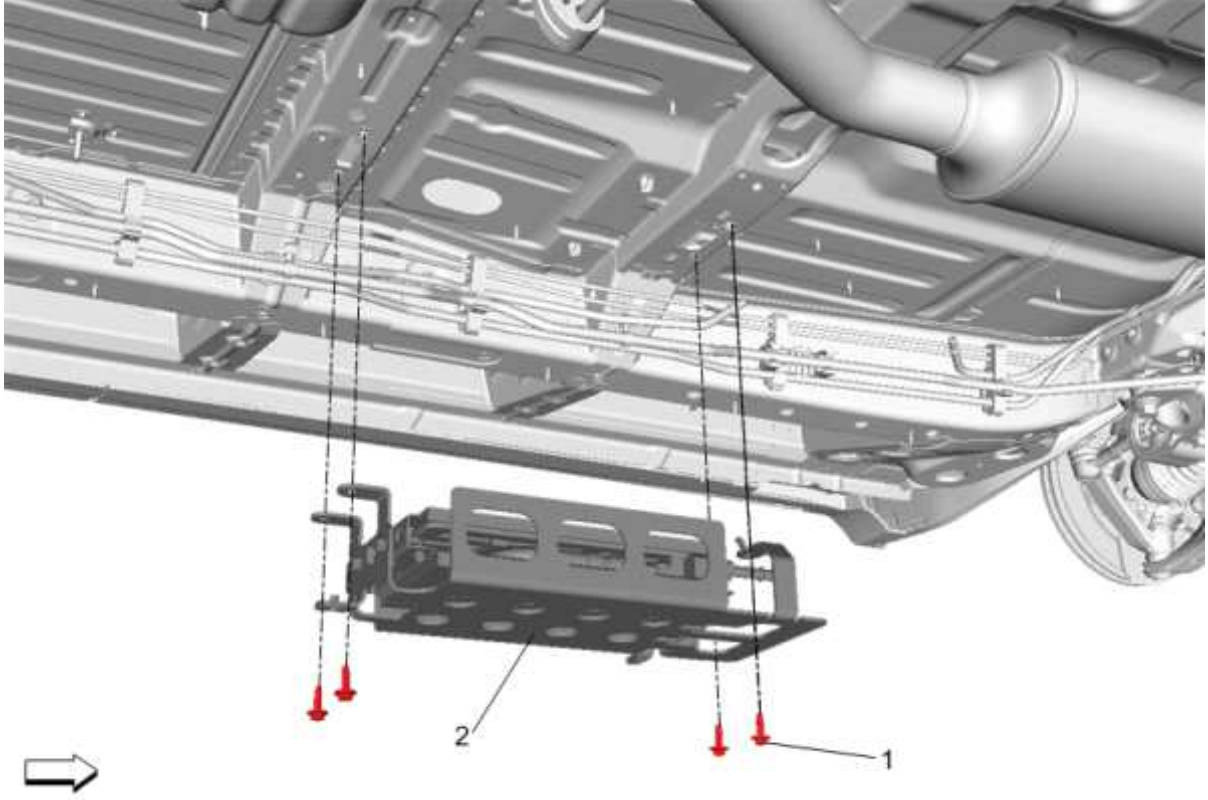

Fig. 112: Fuel Cooler (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	WARNING: **Refer to Diesel/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedures** 1. Remove Fuel Pump Power Control Module Bracket. Refer to **Fuel Pump Power Control Module Bracket Replacement (FWD)** 2. Disconnect the fuel return pipes (Qty: 2). Refer to **Metal Collar Quick Connect Fitting Service** 3. Remove the wiring harness from the fuel cooler. (Qty: 2)
1	Fuel Cooler Bolt (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Fuel Cooler

FUEL PUMP FUEL FEED HOSE REPLACEMENT (AWD)

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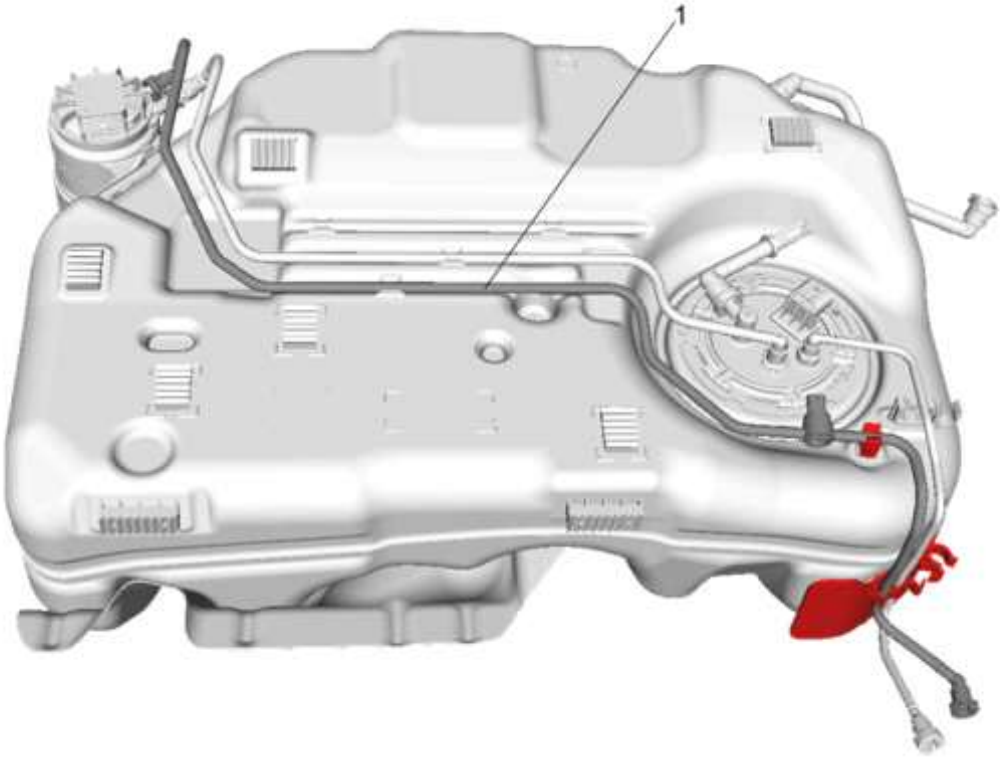

Fig. 113: Fuel Pump Fuel Feed Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (AWD)	
1	Fuel Pump Fuel Feed Hose **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the fuel pump fuel feed hose and remove from retainers. Refer to Plastic Collar Quick Connect Fitting Service

FUEL PUMP FUEL FEED HOSE REPLACEMENT (FWD)

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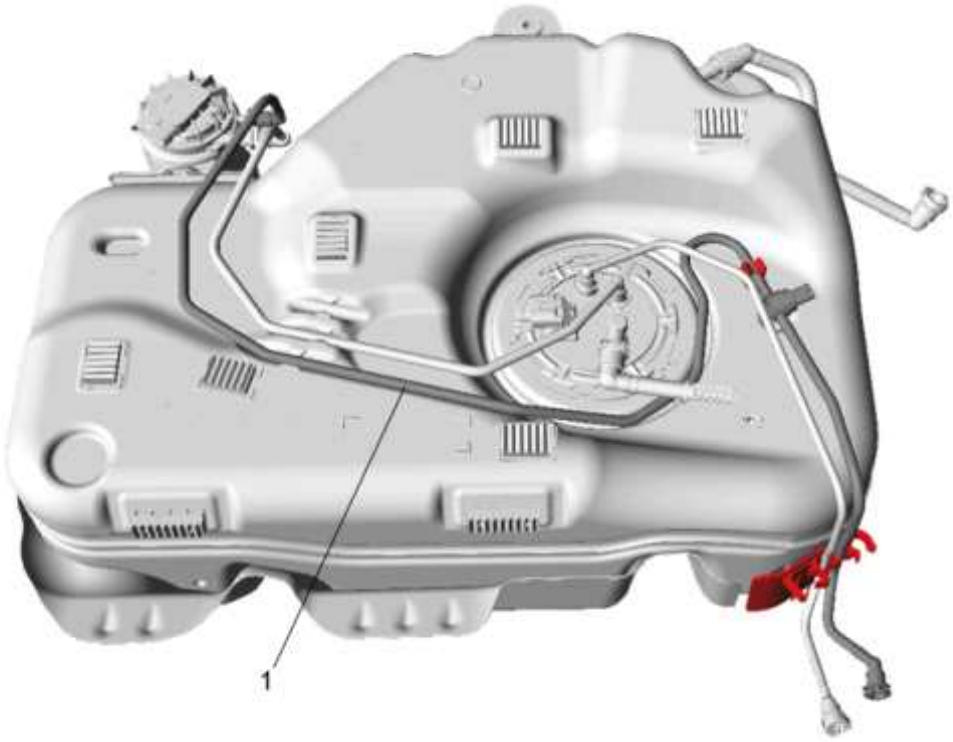

Fig. 114: Fuel Pump Fuel Feed Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (FWD)	
1	Fuel Pump Fuel Feed Hose **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the fuel pump fuel feed hose and remove from retainers. Refer to Plastic Collar Quick Connect Fitting Service

FUEL PUMP FUEL RETURN HOSE REPLACEMENT (AWD)

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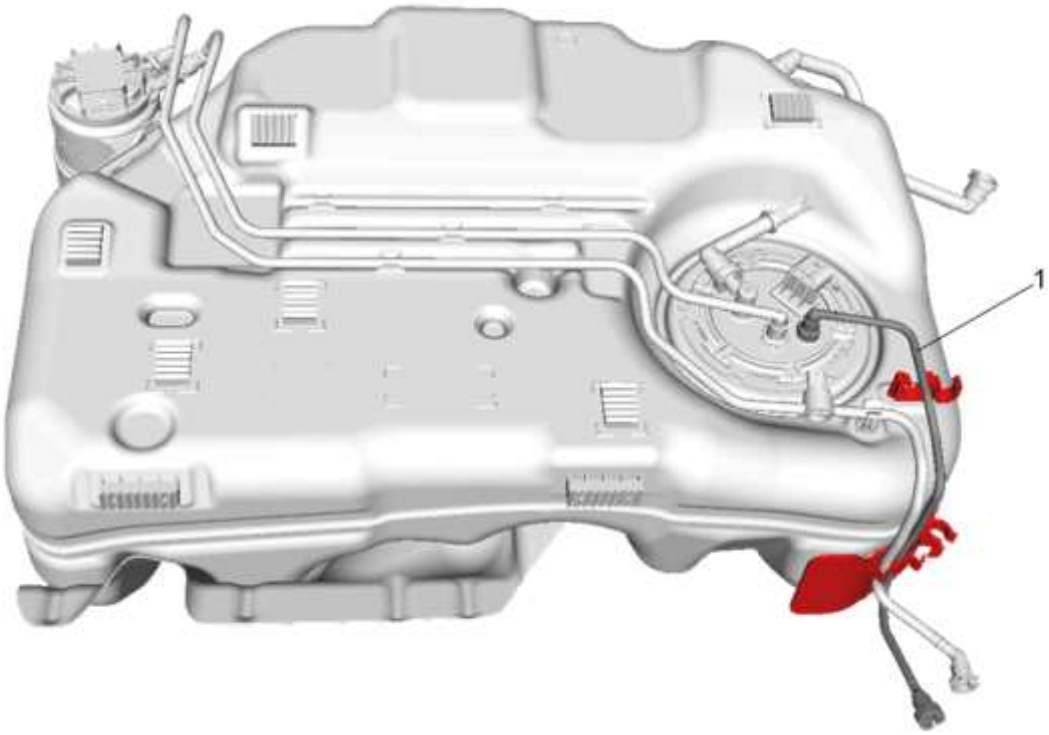

Fig. 115: Fuel Pump Fuel Return Hose (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (AWD)	
1	Fuel Pump Fuel Return Hose **Procedure** Disconnect the fuel pump fuel return hose and remove from retainers. Refer to Plastic Collar Quick Connect Fitting Service

FUEL PUMP FUEL RETURN HOSE REPLACEMENT (FWD)

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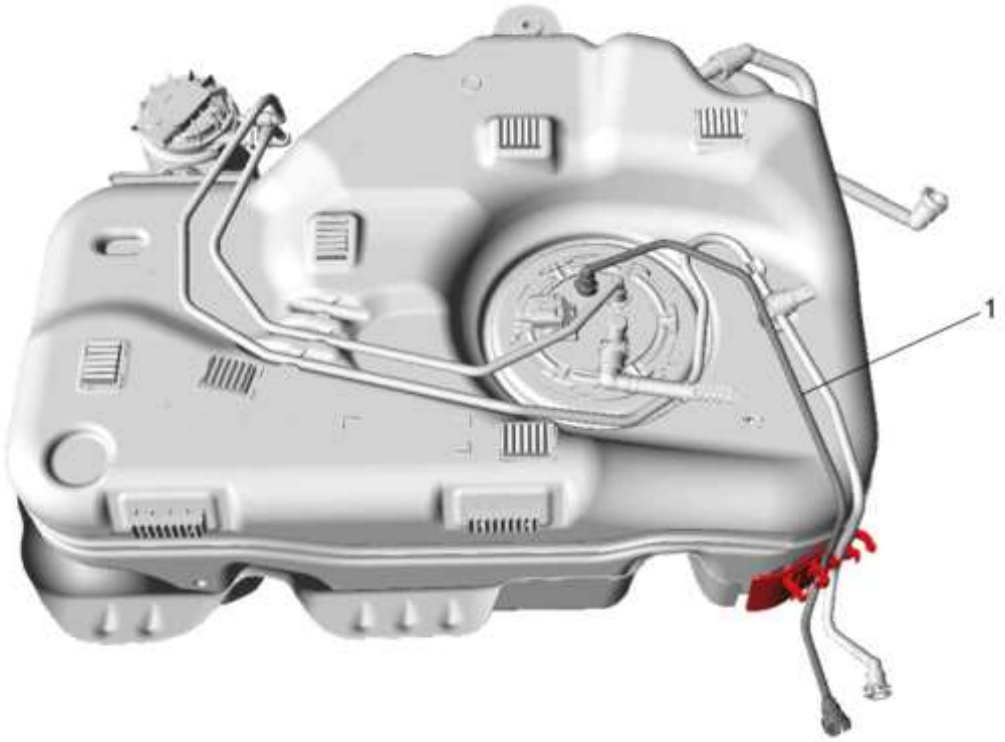

Fig. 116: Fuel Pump Fuel Return Hose (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (FWD)	
1	Fuel Pump Fuel Return Hose **Procedure** Disconnect the fuel pump fuel return hose and remove from retainers. Refer to Plastic Collar Quick Connect Fitting Service

FUEL FEED FRONT PIPE REPLACEMENT

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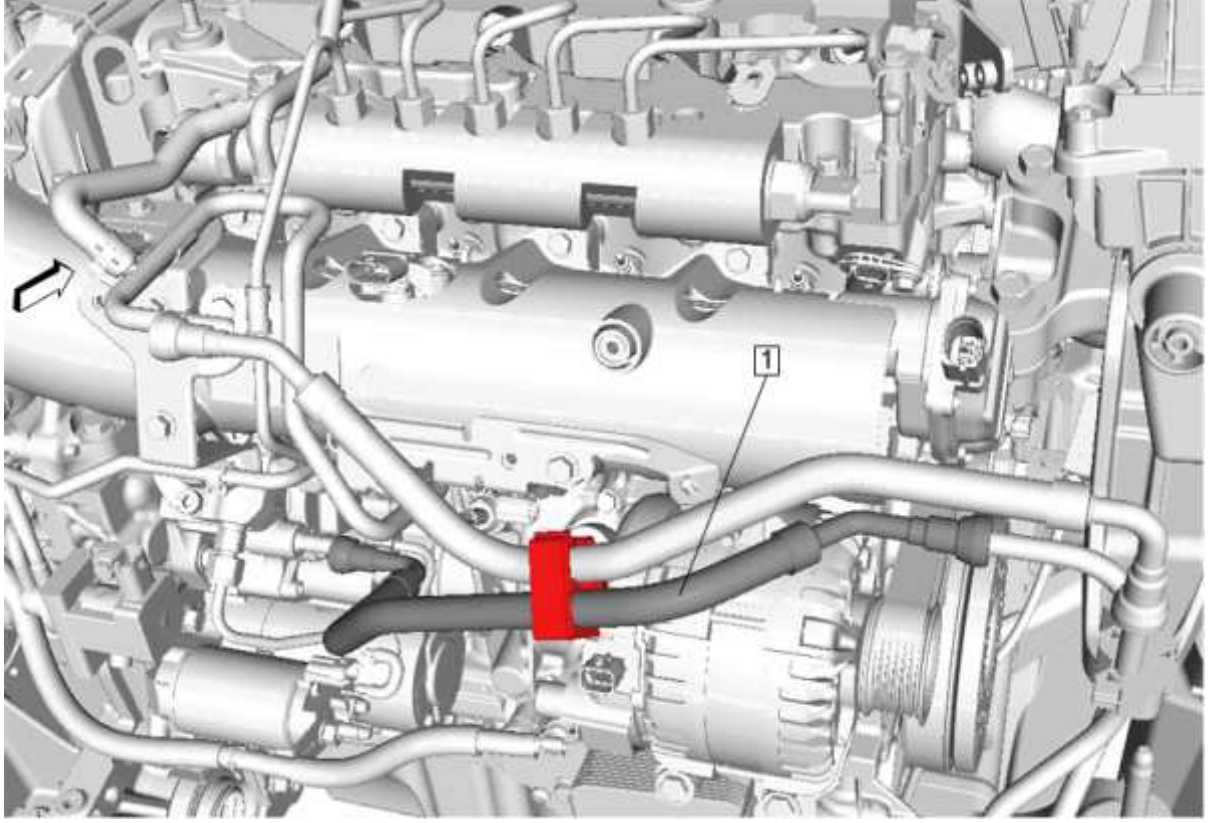

Fig. 117: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedures** 1. Remove Intake Manifold Cover. Refer to Intake Manifold Cover Replacement 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle	
1	Fuel Feed Front Pipe **Procedure** 1. Disconnect the fuel feed front pipe and remove from retainer. Refer to Metal Collar Quick Connect Fitting Service 2. Prime the fuel system. Refer to Fuel System Priming 3. Pressurize fuel system and check for fuel leaks.

FUEL RETURN FRONT PIPE REPLACEMENT

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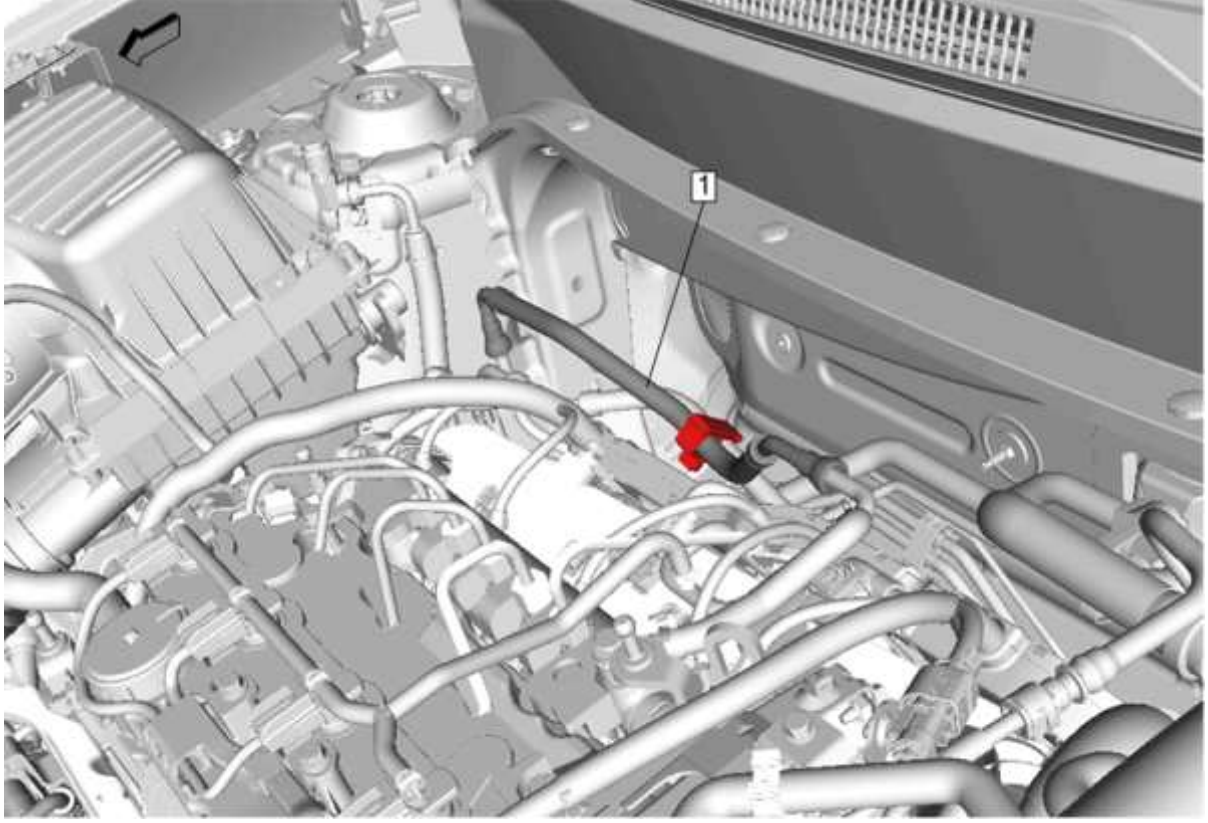

Fig. 118: Fuel Return Front Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Intake Manifold Cover. Refer to Intake Manifold Cover Replacement	
1	Fuel Return Front Pipe **Procedure** 1. Disconnect the fuel return front pipe and remove from retainer. Refer to Metal Collar Quick Connect Fitting Service 2. Pressurize fuel system and check for fuel leaks.

FUEL FEED PIPE REPLACEMENT (FWD)

Removal Procedure

WARNING: Refer to Diesel/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Disconnect Fuel Feed Front Pipe. Refer to Fuel Feed Front Pipe Replacement

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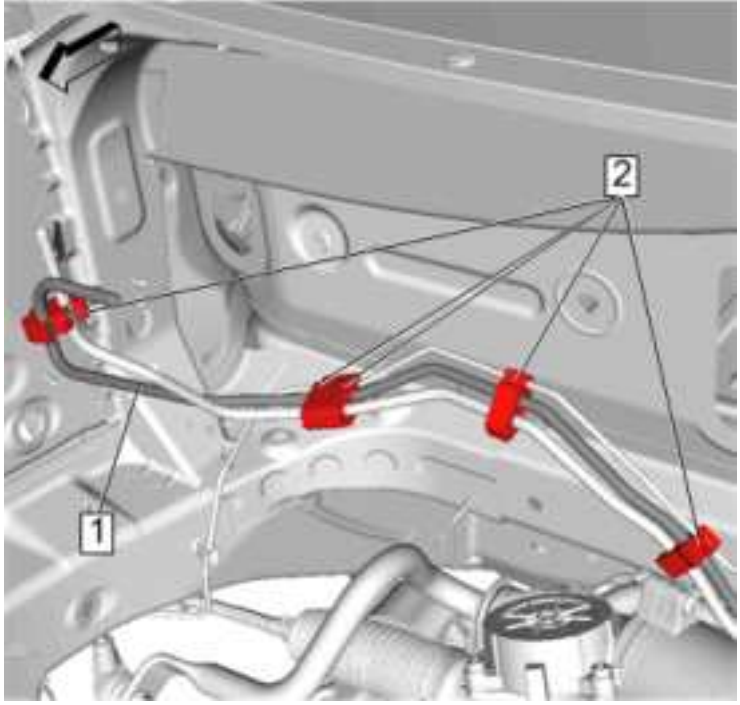

Fig. 119: Fuel Feed Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Remove Fuel Feed Pipe (1) @ Retainers (2) (Qty: 5)

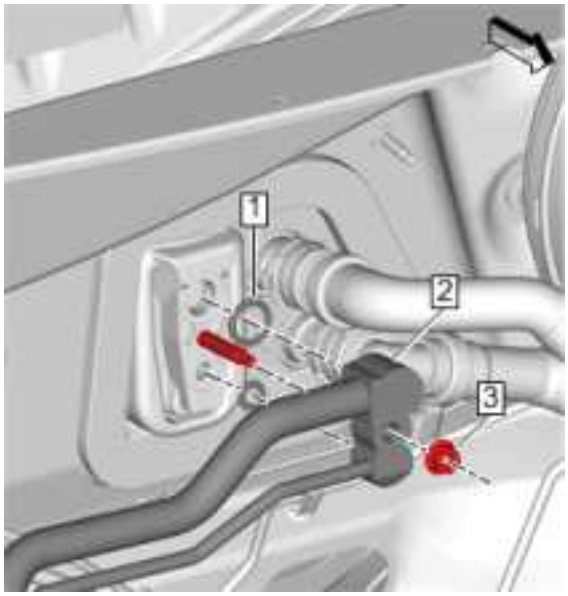

Fig. 120: Air Conditioning Refrigerant Heat Exchanger, Nut And Seals
Courtesy of GENERAL MOTORS COMPANY

3. Remove Air Conditioning Refrigerant Heat Exchanger (2). Refer to **Air Conditioning Refrigerant Heat Exchanger Replacement (LH7)**
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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Fig. 121: Drivetrain And Front Suspension Cradle
Courtesy of GENERAL MOTORS COMPANY

5. Lower drivetrain and front suspension cradle (1) as necessary in order to remove the fuel feed pipe from the vehicle. Refer to **Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive)**

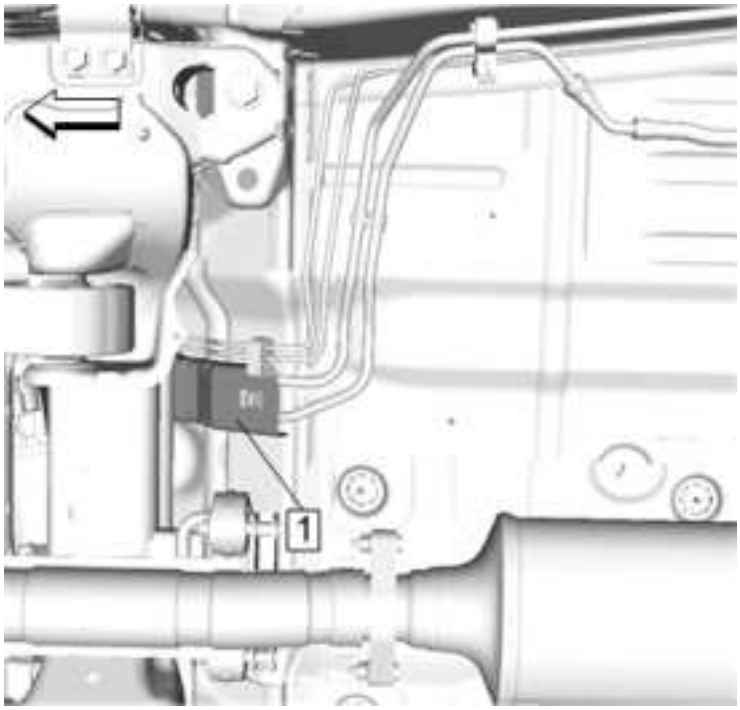

Fig. 122: Shield
Courtesy of GENERAL MOTORS COMPANY

6. Remove Shield (1)

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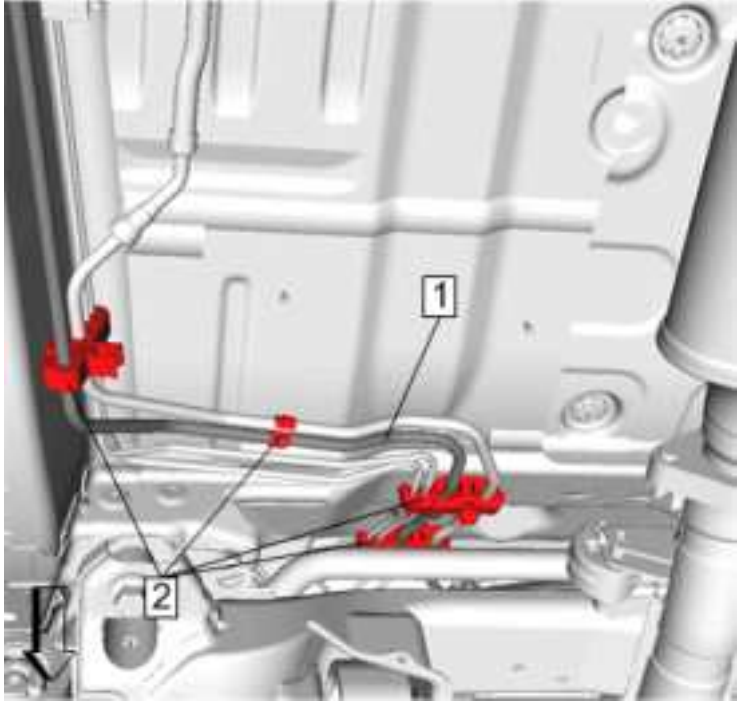

Fig. 123: Fuel Feed Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

7. Remove Fuel Feed Pipe (1) @ Retainers (2) (Qty: 4)
8. {If equipped} Remove Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (Front Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

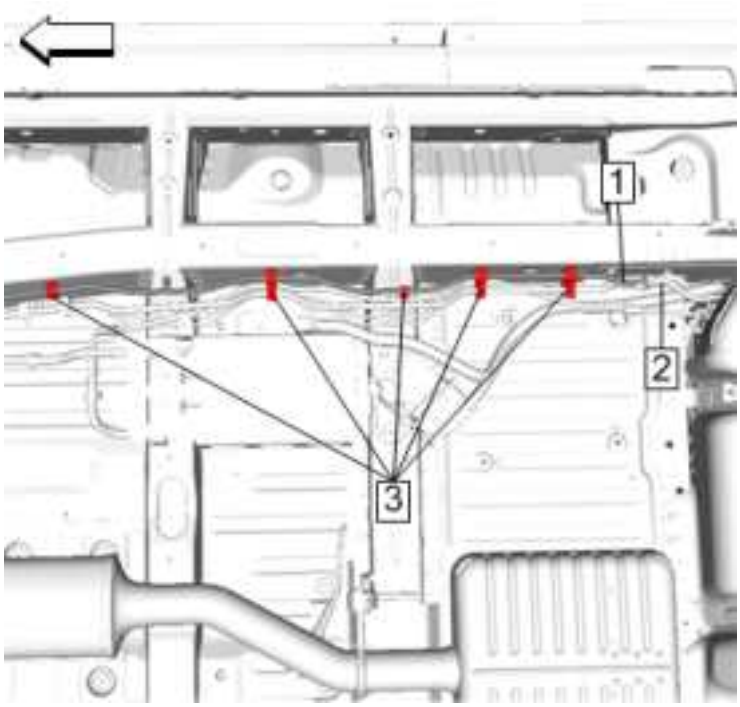

Fig. 124: Fuel Feed Pipe, Fuel Pump Fuel Feed Hose And Retainers
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect Fuel Feed Pipe (1) @ Fuel Pump Fuel Feed Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
10. Fuel Feed Pipe (1) @ Retainers (3) (Qty: 5)
11. Remove fuel feed pipe (1) from the vehicle.

Installation Procedure

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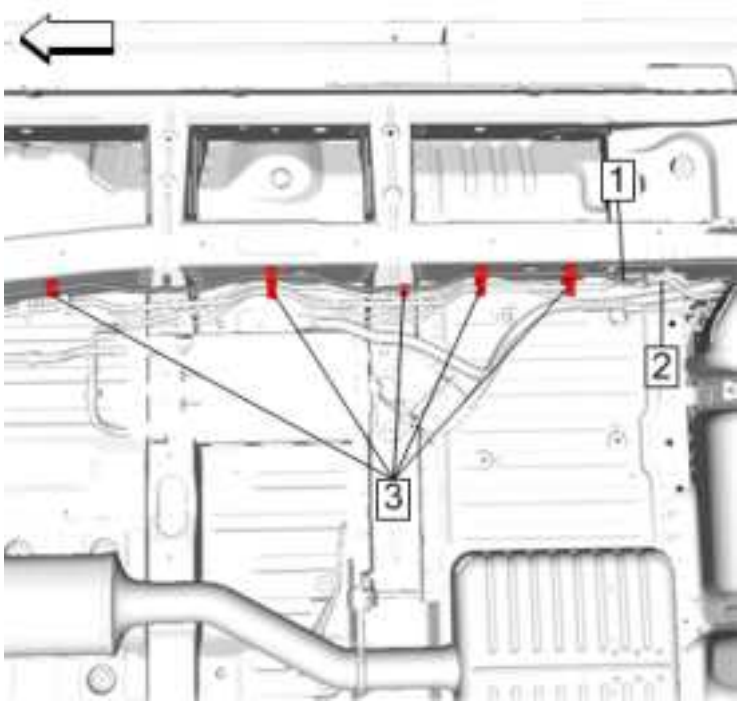

Fig. 125: Fuel Feed Pipe, Fuel Pump Fuel Feed Hose And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install fuel feed pipe (1) into the vehicle.
2. Install Fuel Feed Pipe (1) @ Retainers (3) (Qty: 5)
3. Connect Fuel Feed Pipe (1) @ Fuel Pump Fuel Feed Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
4. {If equipped} Install Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (Front Wheel Drive)**

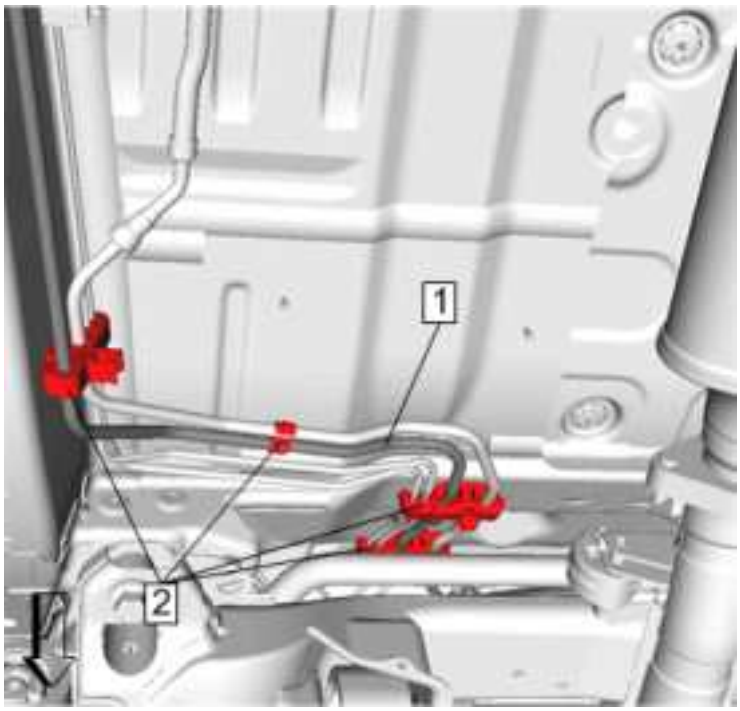

Fig. 126: Fuel Feed Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

5. Install Fuel Feed Pipe (1) @ Retainers (2) (Qty: 4)

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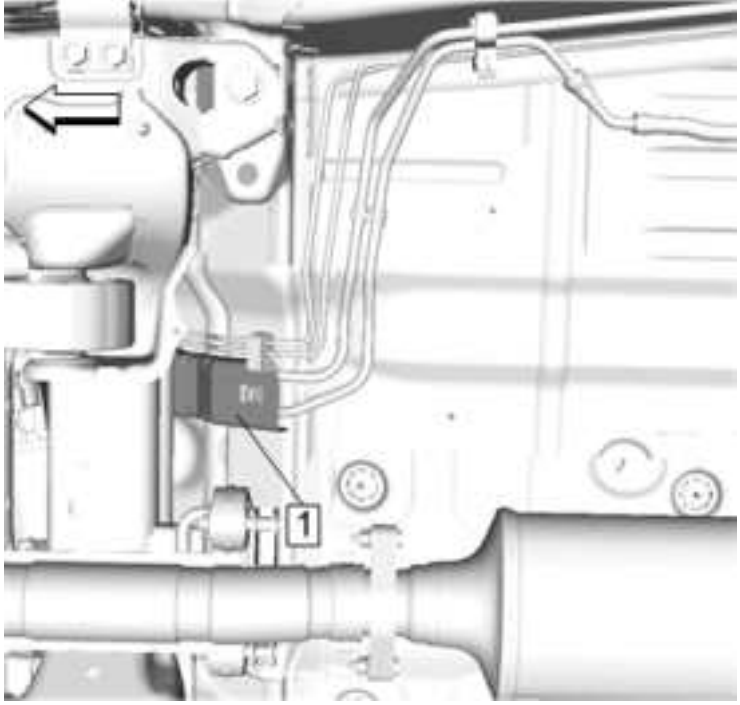

Fig. 127: Shield
Courtesy of GENERAL MOTORS COMPANY

6. Install Shield (1)

Fig. 128: Drivetrain And Front Suspension Cradle
Courtesy of GENERAL MOTORS COMPANY

7. Install Drivetrain and Front Suspension Cradle (1). Refer to **Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive)**
8. Lower the vehicle.

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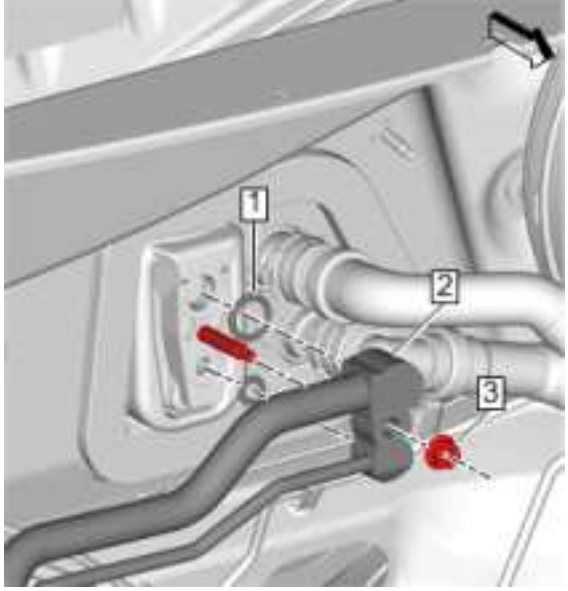

Fig. 129: Air Conditioning Refrigerant Heat Exchanger, Nut And Seals
Courtesy of GENERAL MOTORS COMPANY

9. Install Air Conditioning Refrigerant Heat Exchanger (2). Refer to **Air Conditioning Refrigerant Heat Exchanger Replacement (LH7)**

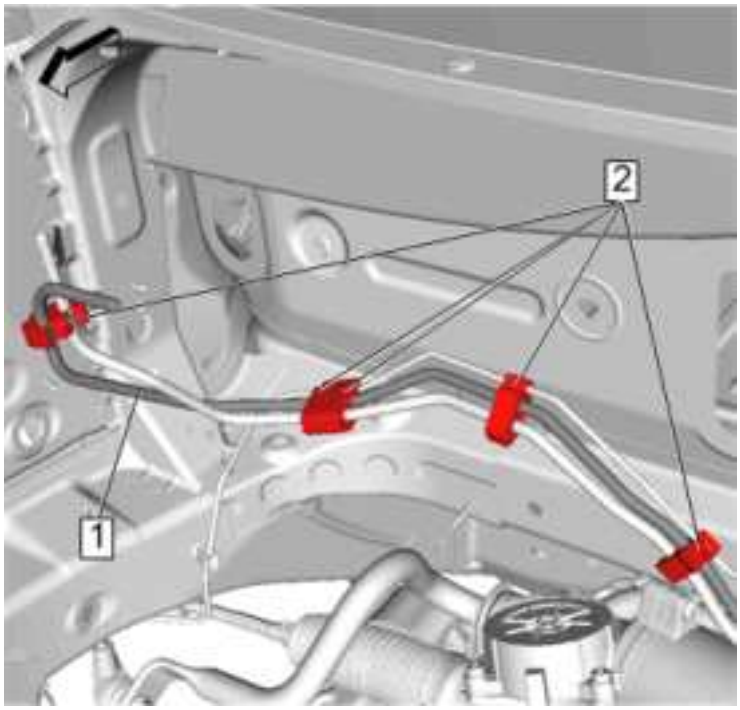

Fig. 130: Fuel Feed Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

10. Install Fuel Feed Pipe (1) @ Retainers (2) (Qty: 5)
11. Connect Fuel Feed Front Pipe. Refer to **Fuel Feed Front Pipe Replacement**
12. Prime the fuel system. Refer to **Fuel System Priming**
13. Pressurize fuel system and check for fuel leaks.

FUEL FEED PIPE REPLACEMENT (AWD)

Removal Procedure

WARNING: **Refer to Diesel/Gasoline Vapors Warning .**

WARNING: **Refer to Safety Glasses Warning .**

1. Disconnect Fuel Feed Front Pipe. Refer to **Fuel Feed Front Pipe Replacement**

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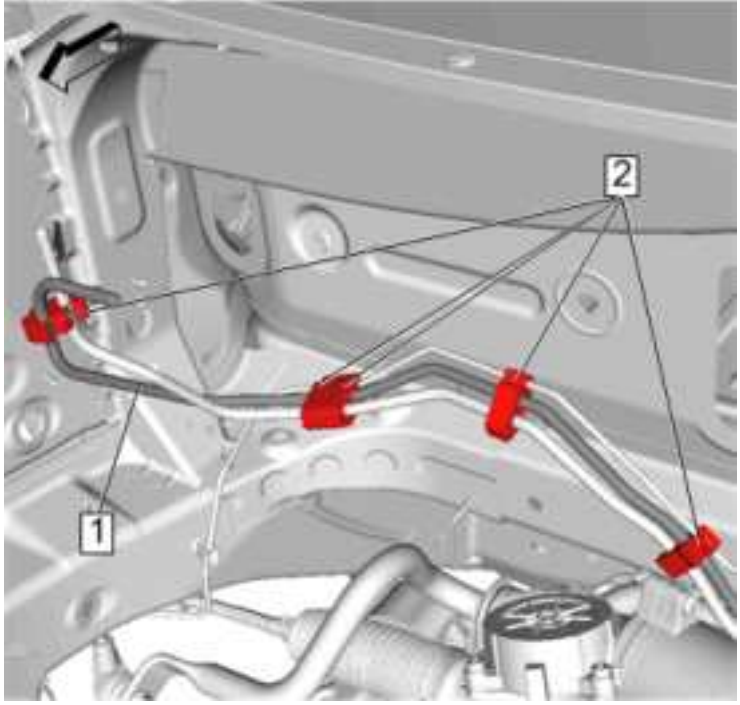

Fig. 131: Fuel Feed Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Remove Fuel Feed Pipe (1) @ Retainers (2) (Qty: 5)

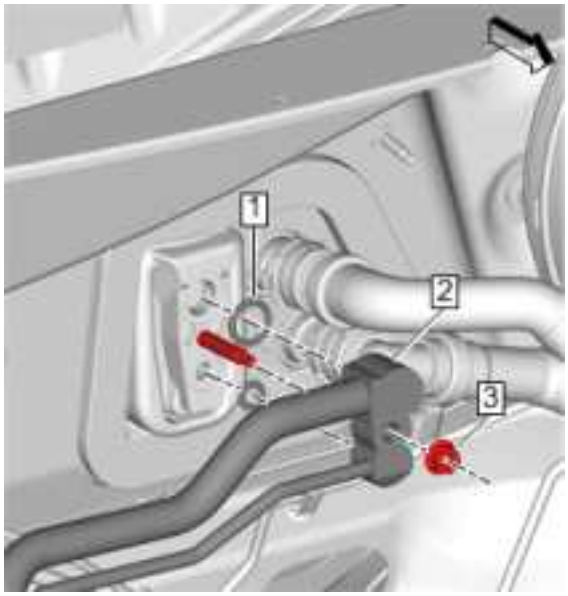

Fig. 132: Air Conditioning Refrigerant Heat Exchanger, Nut And Seals
Courtesy of GENERAL MOTORS COMPANY

3. Remove Air Conditioning Refrigerant Heat Exchanger (2). Refer to **Air Conditioning Refrigerant Heat Exchanger Replacement (LH7)**
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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Fig. 133: Drivetrain And Front Suspension Cradle
Courtesy of GENERAL MOTORS COMPANY

5. Lower drivetrain and front suspension cradle (1) as necessary in order to remove the fuel feed pipe from the vehicle. Refer to **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)**

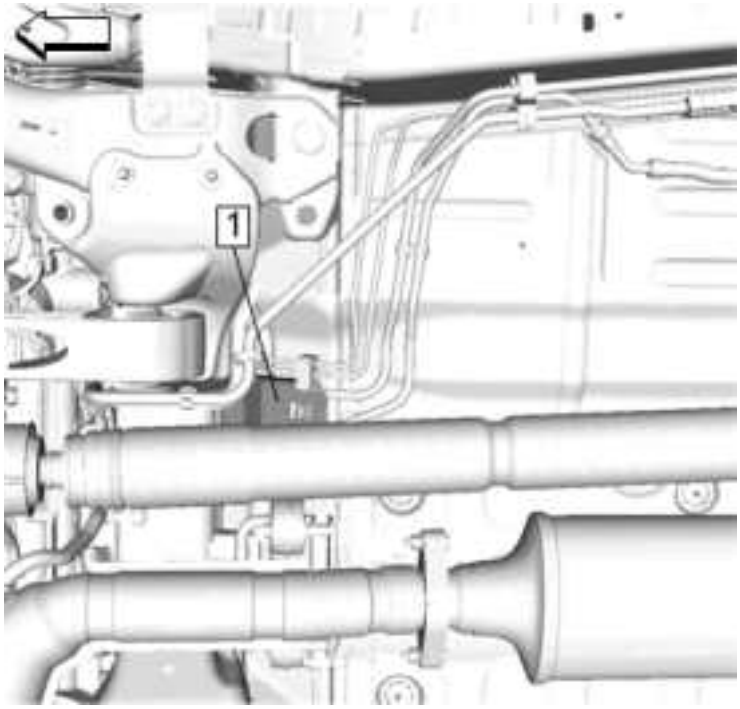

Fig. 134: Shield
Courtesy of GENERAL MOTORS COMPANY

6. Remove Shield (1)

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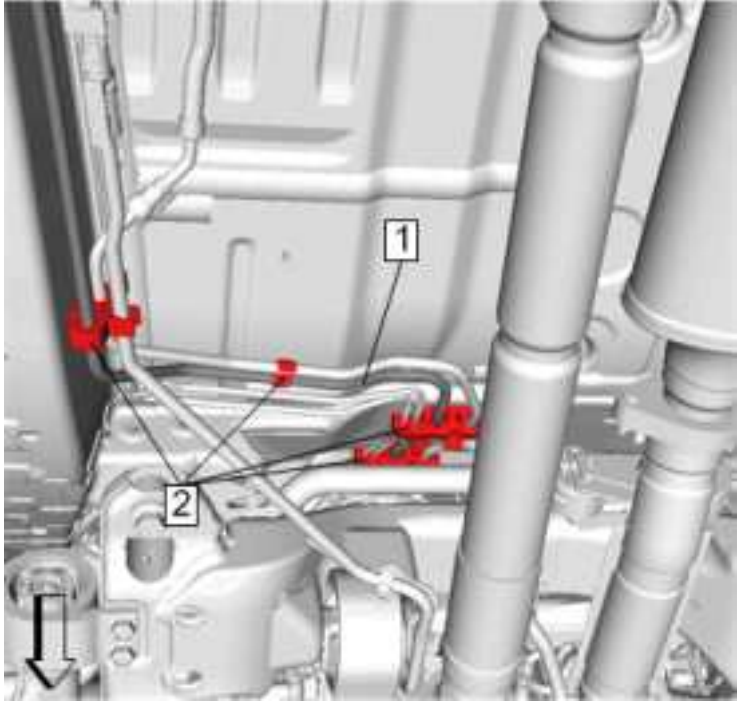

Fig. 135: Fuel Feed Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

7. Remove Fuel Feed Pipe (1) @ Retainers (2) (Qty: 4)
8. Remove Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (All Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

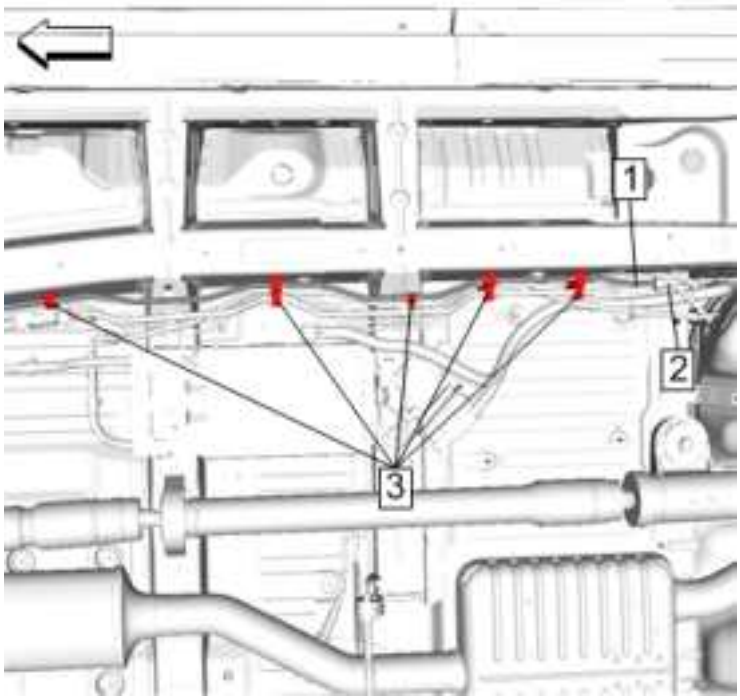

Fig. 136: Fuel Feed Pipe, Fuel Pump Fuel Feed Hose And Retainers
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect Fuel Feed Pipe (1) @ Fuel Pump Fuel Feed Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
10. Remove Fuel Feed Pipe (1) @ Retainers (3) (Qty: 5)
11. Remove fuel feed pipe (1) from the vehicle.

Installation Procedure

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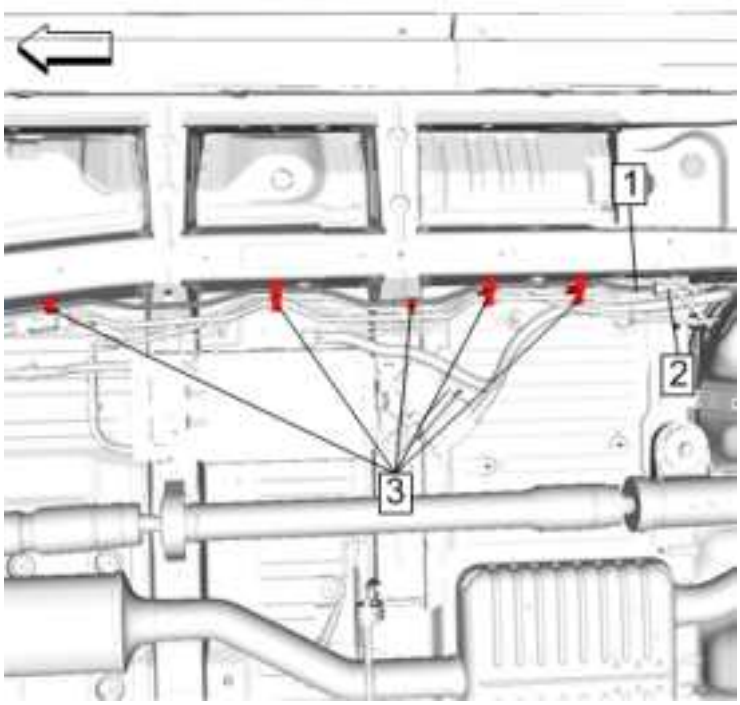

Fig. 137: Fuel Feed Pipe, Fuel Pump Fuel Feed Hose And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install fuel feed pipe (1) into the vehicle.
2. Install Fuel Feed Pipe (1) @ Retainers (3) (Qty: 5)
3. Connect Fuel Feed Pipe (1) @ Fuel Pump Fuel Feed Hose (2). Refer to **Plastic Collar Quick Connect Fitting Service**
4. Install Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (All Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

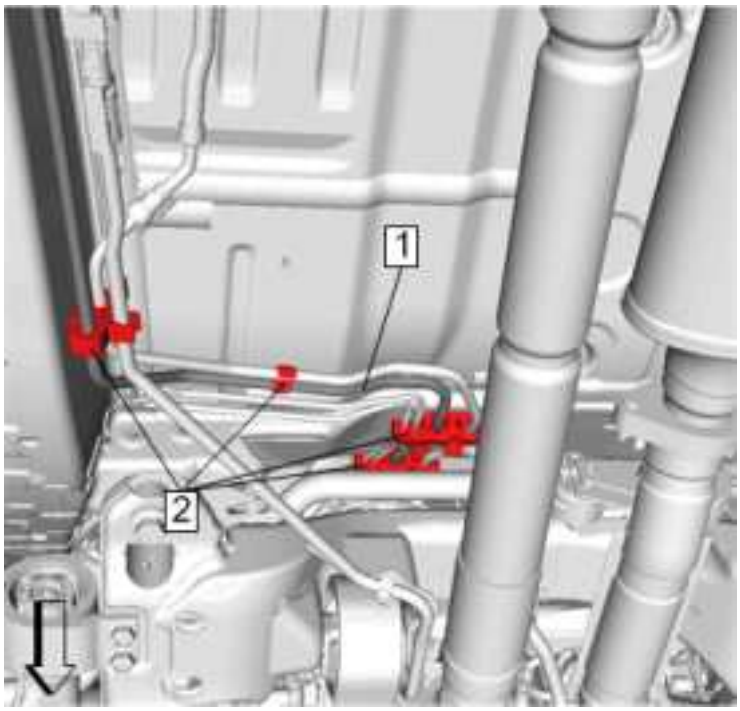

Fig. 138: Fuel Feed Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

5. Install Fuel Feed Pipe (1) @ Retainers (2) (Qty: 4)

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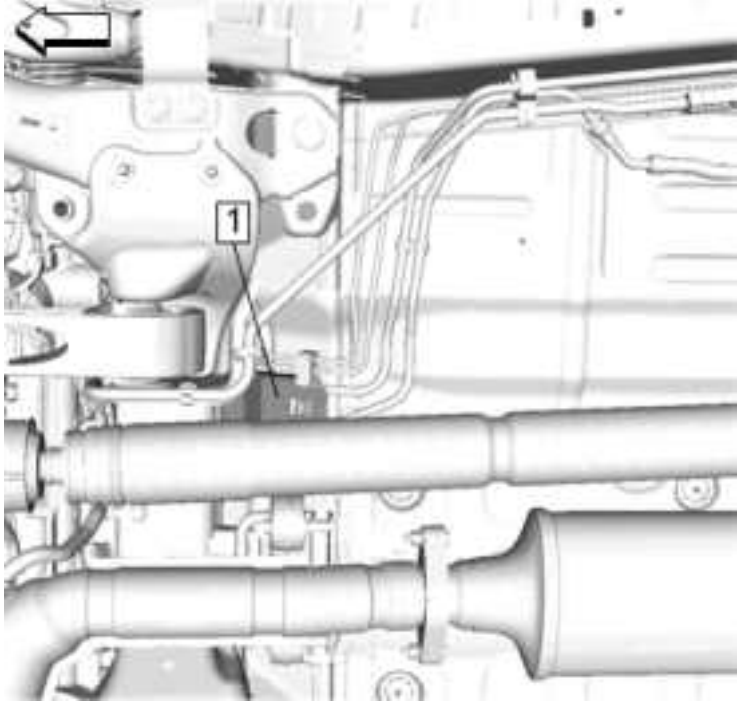

Fig. 139: Shield
Courtesy of GENERAL MOTORS COMPANY

6. Install Shield (1)

Fig. 140: Drivetrain And Front Suspension Cradle
Courtesy of GENERAL MOTORS COMPANY

7. Install Drivetrain and Front Suspension Cradle (1). Refer to **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)**
8. Lower the vehicle.

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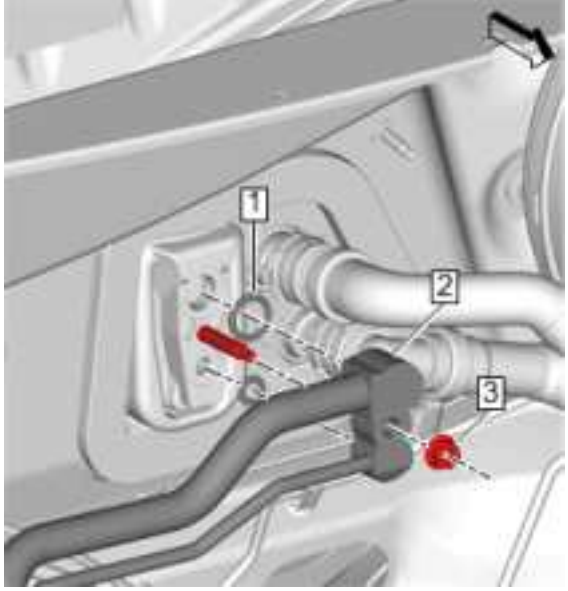

Fig. 141: Air Conditioning Refrigerant Heat Exchanger, Nut And Seals
Courtesy of GENERAL MOTORS COMPANY

9. Install Air Conditioning Refrigerant Heat Exchanger (2). Refer to **Air Conditioning Refrigerant Heat Exchanger Replacement (LH7)**

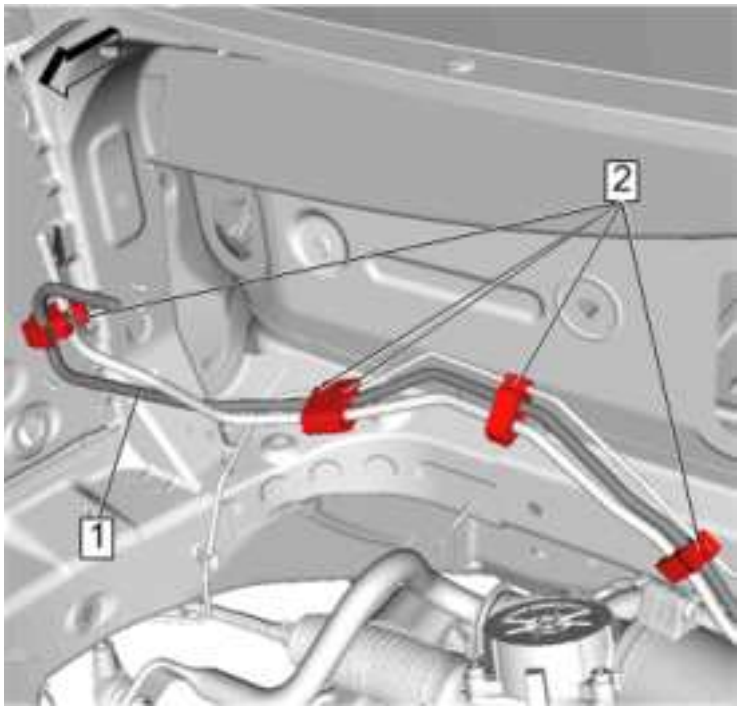

Fig. 142: Fuel Feed Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

10. Install Fuel Feed Pipe (1) @ Retainers (2) (Qty: 5)
11. Connect Fuel Feed Front Pipe. Refer to **Fuel Feed Front Pipe Replacement**
12. Prime the fuel system. Refer to **Fuel System Priming**
13. Pressurize fuel system and check for fuel leaks.

FUEL RETURN PIPE REPLACEMENT (COOLER TO REAR PIPE AWD)

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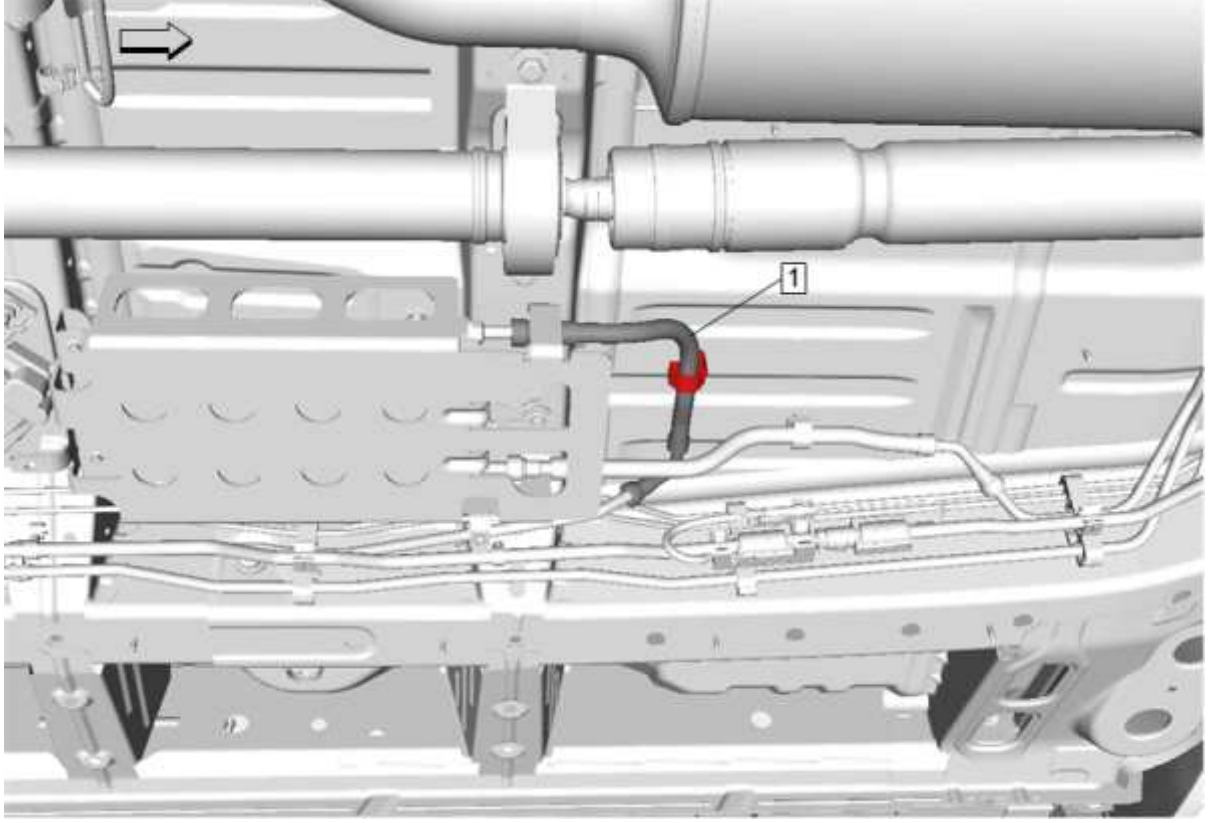

Fig. 143: Fuel Return Pipe (Cooler To Rear Pipe AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Underbody Rear Air Deflector. Refer to Underbody Rear Air Deflector Replacement (All Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel)	
1	Fuel Return Pipe **Procedure** 1. Disconnect the fuel return pipe and remove from retainer. Refer to Metal Collar Quick Connect Fitting Service 2. Pressurize fuel system and check for fuel leaks.

FUEL RETURN PIPE REPLACEMENT (COOLER TO REAR PIPE FWD)

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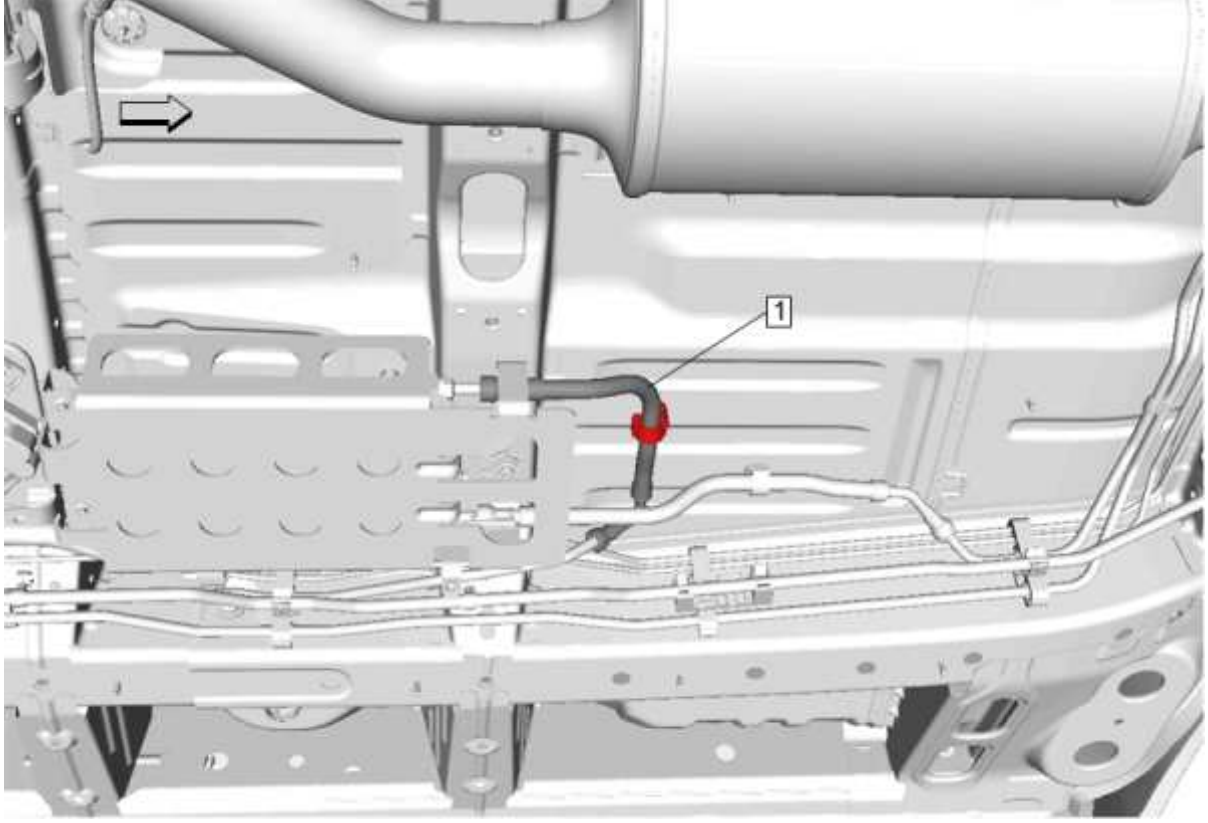

Fig. 144: Fuel Return Pipe (Cooler To Rear Pipe FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** {If equipped} Remove Underbody Rear Air Deflector. Refer to Underbody Rear Air Deflector Replacement (Front Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel)	
1	Fuel Return Pipe **Procedure** 1. Disconnect the fuel return pipe and remove from retainer. Refer to Metal Collar Quick Connect Fitting Service 2. Pressurize fuel system and check for fuel leaks.

FUEL RETURN PIPE REPLACEMENT (COOLER TO FRONT PIPE AWD)

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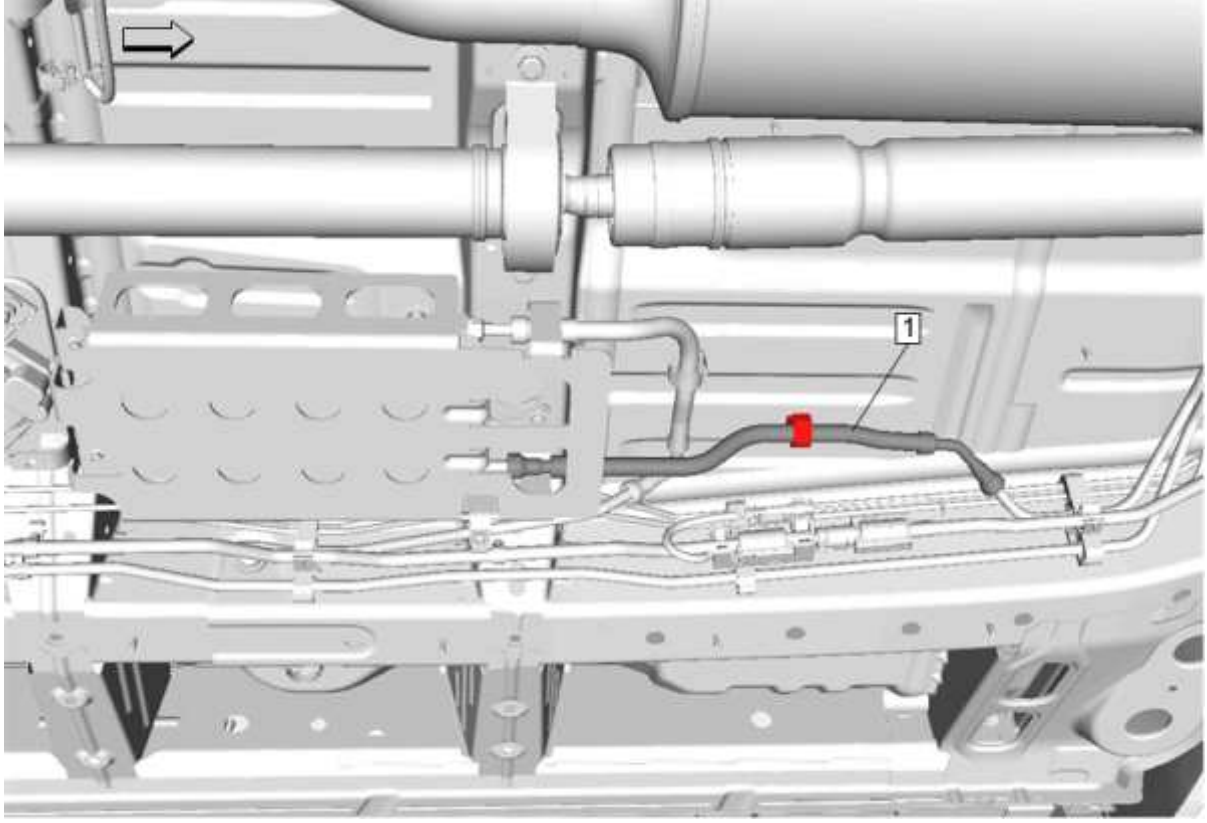

Fig. 145: Fuel Return Pipe (Cooler To Front Pipe AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Underbody Rear Air Deflector. Refer to Underbody Rear Air Deflector Replacement (All Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel)	
1	Fuel Return Pipe **Procedure** 1. Disconnect the fuel return pipe and remove from retainer. Refer to Metal Collar Quick Connect Fitting Service 2. Pressurize fuel system and check for fuel leaks.

FUEL RETURN PIPE REPLACEMENT (COOLER TO FRONT PIPE FWD)

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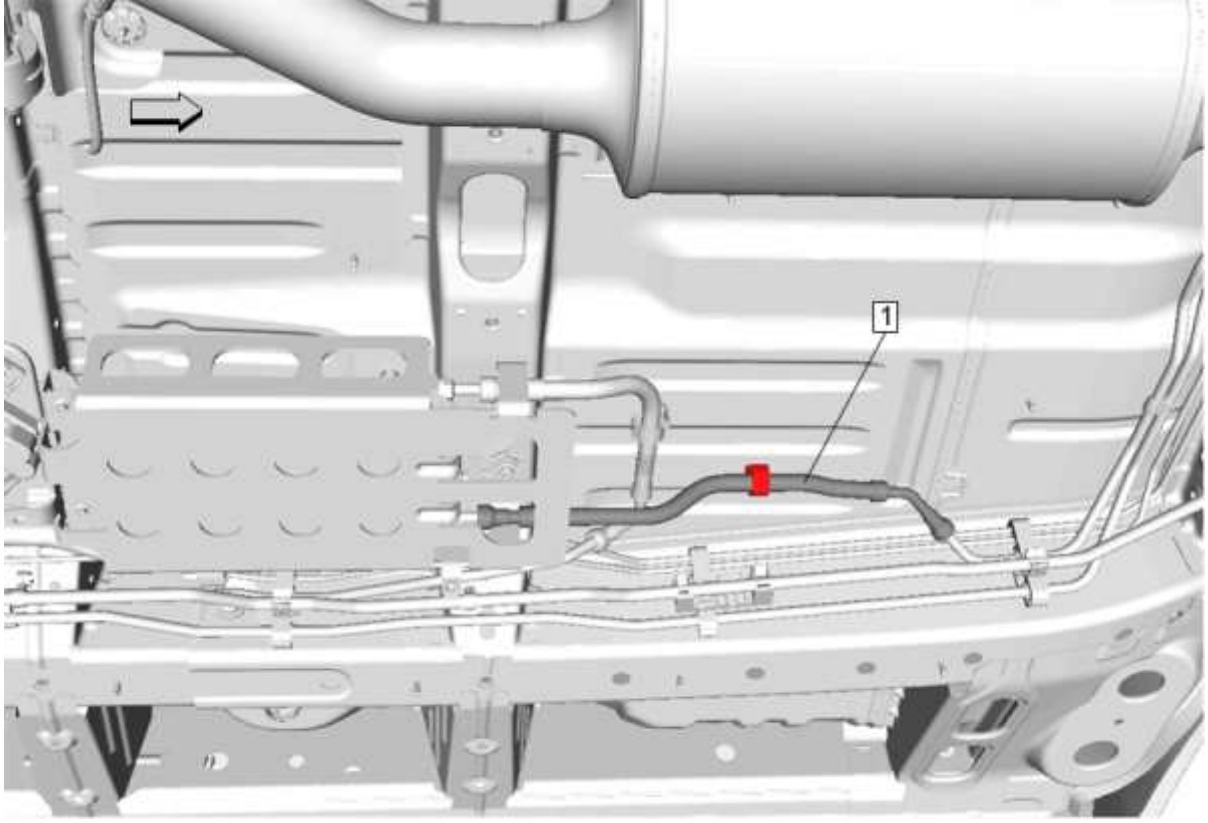

Fig. 146: Fuel Return Pipe (Cooler To Front Pipe FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** {If equipped} Remove Underbody Rear Air Deflector. Refer to Underbody Rear Air Deflector Replacement (Front Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel)	
1	Fuel Return Pipe **Procedure** 1. Disconnect the fuel return pipe and remove from retainer. Refer to Metal Collar Quick Connect Fitting Service 2. Pressurize fuel system and check for fuel leaks.

FUEL RETURN PIPE REPLACEMENT (CHASSIS AWD)

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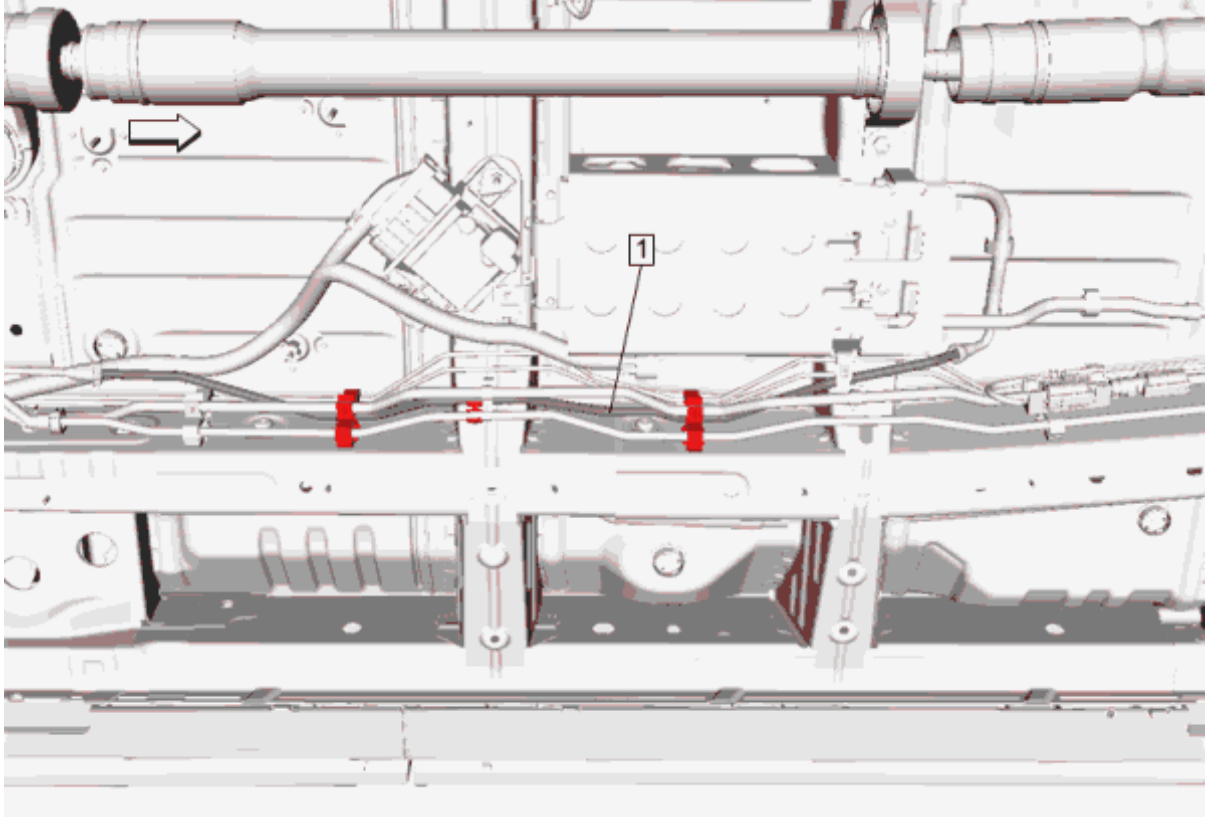

Fig. 147: Fuel Return Pipe (Chassis AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Underbody Rear Air Deflector. Refer to Underbody Rear Air Deflector Replacement (All Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel)	
1	Fuel Return Pipe **Procedure** 1. Disconnect the fuel return pipe and remove from retainers. Refer to Metal Collar Quick Connect Fitting Service, and Plastic Collar Quick Connect Fitting Service 2. Pressurize fuel system and check for fuel leaks.

FUEL RETURN PIPE REPLACEMENT (CHASSIS FWD)

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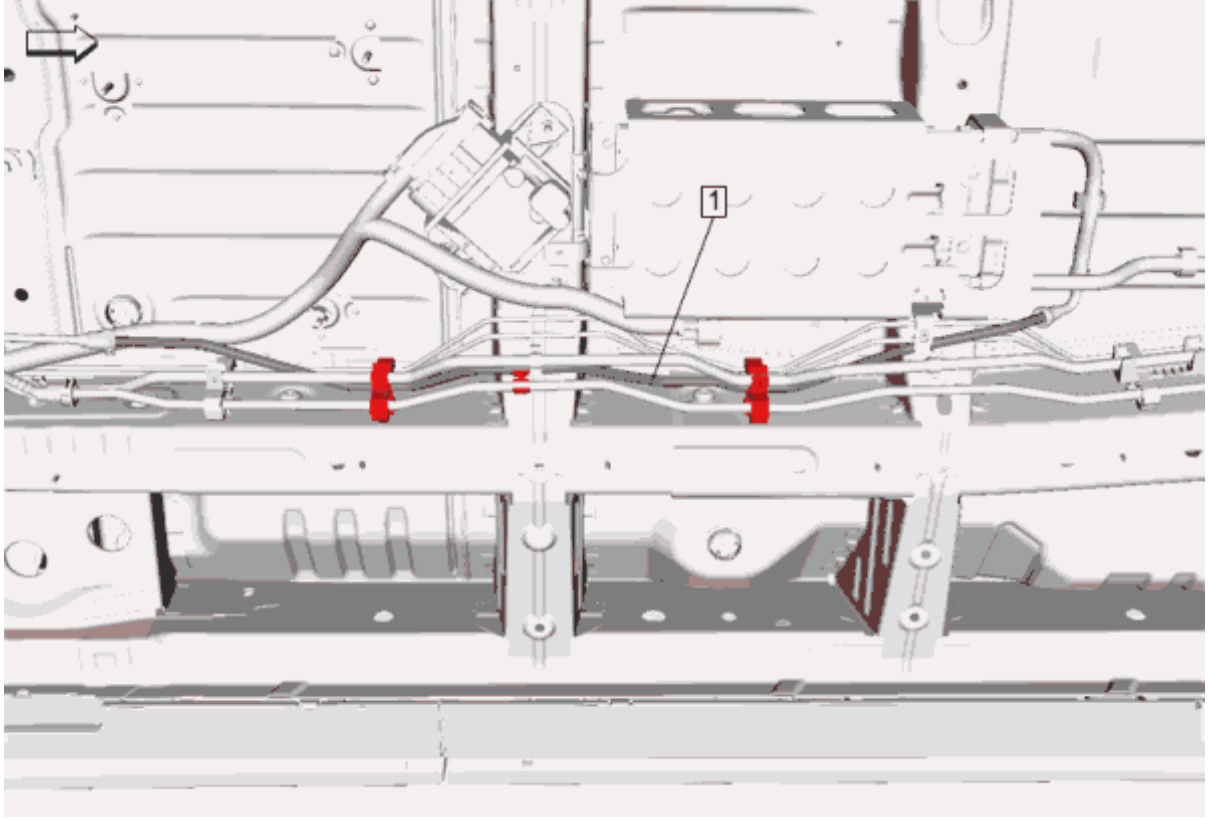

Fig. 148: Fuel Return Pipe (Chassis FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Underbody Rear Air Deflector. Refer to Underbody Rear Air Deflector Replacement (Front Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel)	
1	Fuel Return Pipe **Procedure** 1. Disconnect the fuel return pipe and remove from retainers. Refer to Metal Collar Quick Connect Fitting Service, and Plastic Collar Quick Connect Fitting Service 2. Pressurize fuel system and check for fuel leaks.

FUEL RETURN PIPE REPLACEMENT (ENGINE TO PIPE FWD)

Removal Procedure

WARNING: Refer to Diesel/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Disconnect Fuel Return Front Pipe. Refer to Fuel Return Front Pipe Replacement

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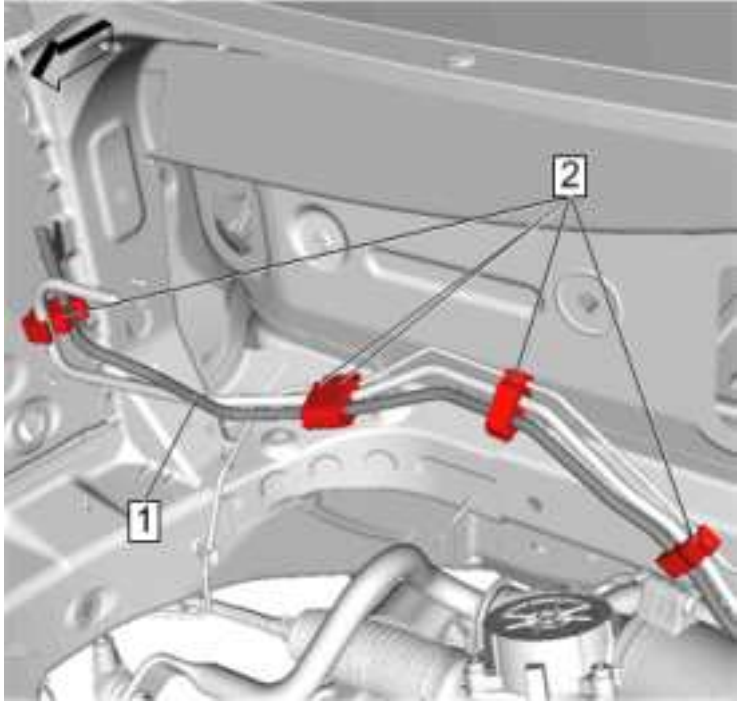

Fig. 149: Fuel Return Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Remove Fuel Return Pipe (1) @ Retainers (2) (Qty: 5)

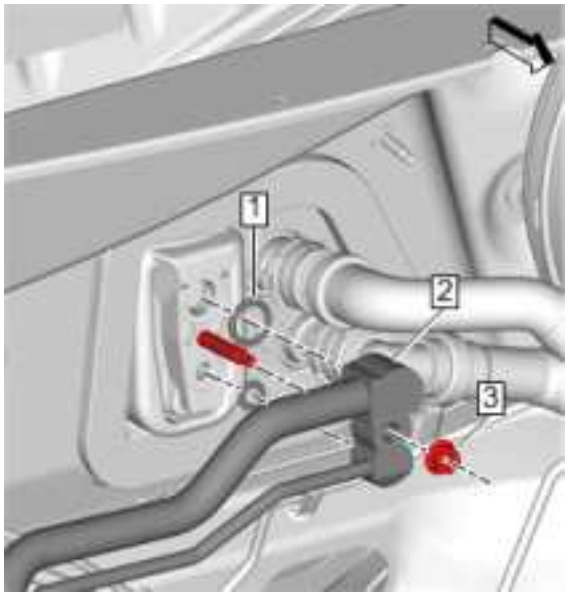

Fig. 150: Air Conditioning Refrigerant Heat Exchanger, Nut And Seals
Courtesy of GENERAL MOTORS COMPANY

3. Remove Air Conditioning Refrigerant Heat Exchanger (2). Refer to **Air Conditioning Refrigerant Heat Exchanger Replacement (LH7)**
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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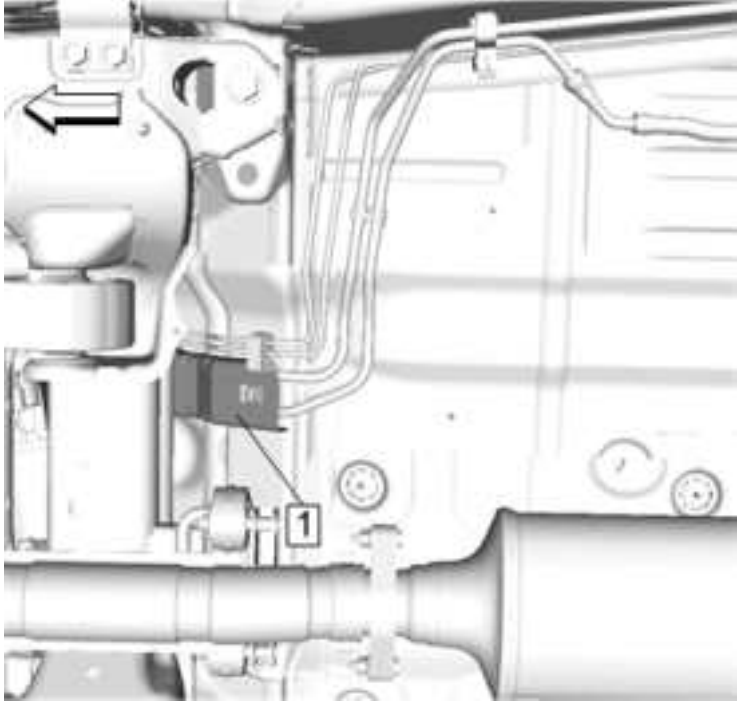

Fig. 151: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Remove Shield (1)
6. {If equipped} Remove Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (Front Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

Fig. 152: Drivetrain And Front Suspension Cradle
Courtesy of GENERAL MOTORS COMPANY

7. Lower drivetrain and front suspension cradle (1) as necessary in order to remove the fuel return pipe from the vehicle. Refer to **Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive)**

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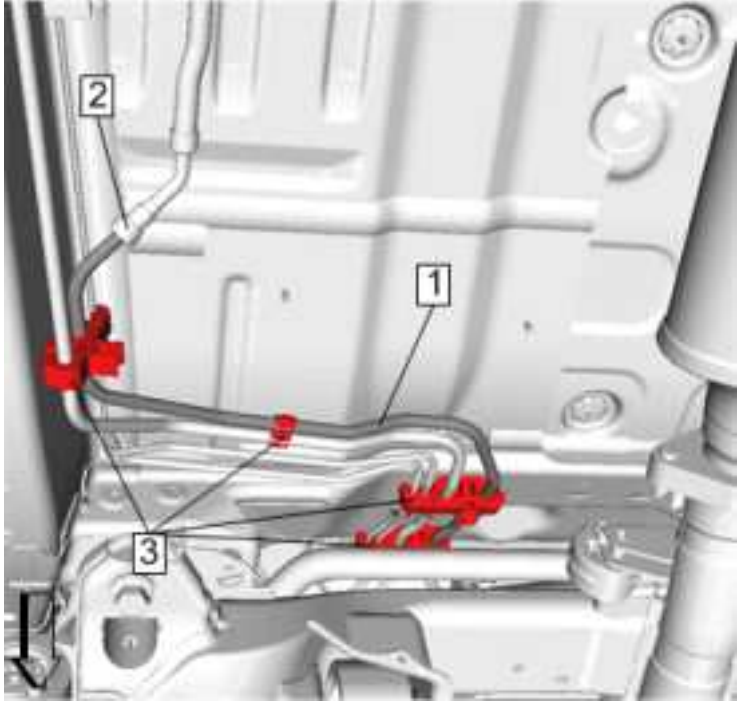

Fig. 153: Fuel Return Pipes And Retainers
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect Fuel Return Pipe (1) @ Fuel Return Pipe (2). Refer to **Metal Collar Quick Connect Fitting Service**
9. Remove Fuel Return Pipe (1) @ Retainers (3) (Qty: 4)
10. Remove fuel return pipe (1) from the vehicle.

Installation Procedure

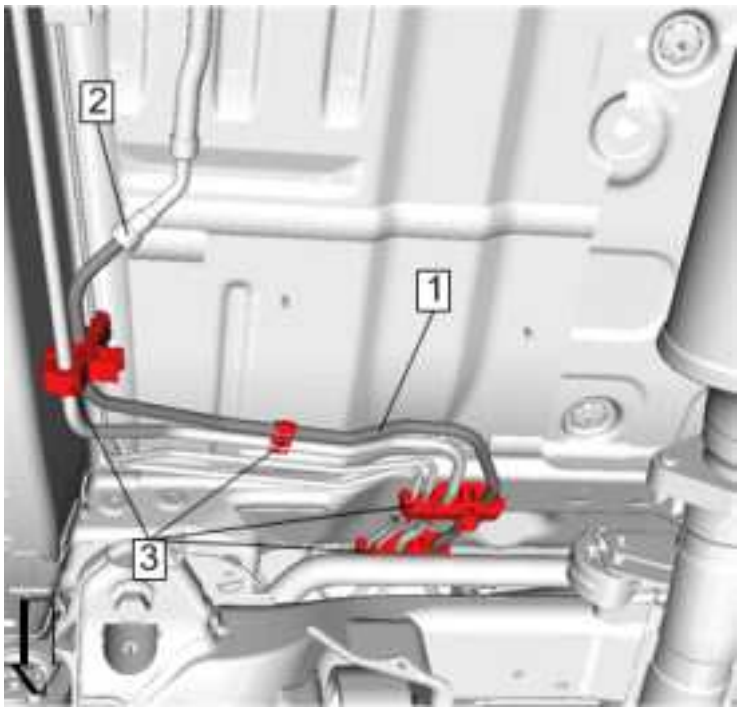

Fig. 154: Fuel Return Pipes And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel return pipe (1) into the vehicle.
2. Install Fuel Return Pipe (1) @ Retainer (3) (Qty: 4)
3. Connect Fuel Return Pipe (1) @ Fuel Return Pipe (2). Refer to **Metal Collar Quick Connect Fitting Service**

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Fig. 155: Drivetrain And Front Suspension Cradle
Courtesy of GENERAL MOTORS COMPANY

4. Install Drivetrain and Front Suspension Cradle (1). Refer to **Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive)**
5. {If equipped} Install Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (Front Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

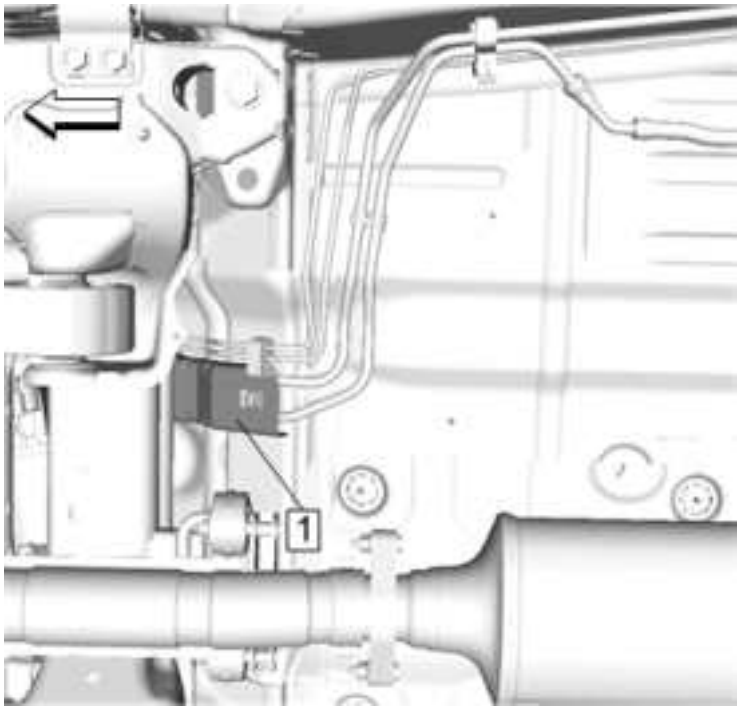

Fig. 156: Shield
Courtesy of GENERAL MOTORS COMPANY

6. Install Shield (1)
7. Lower the vehicle.

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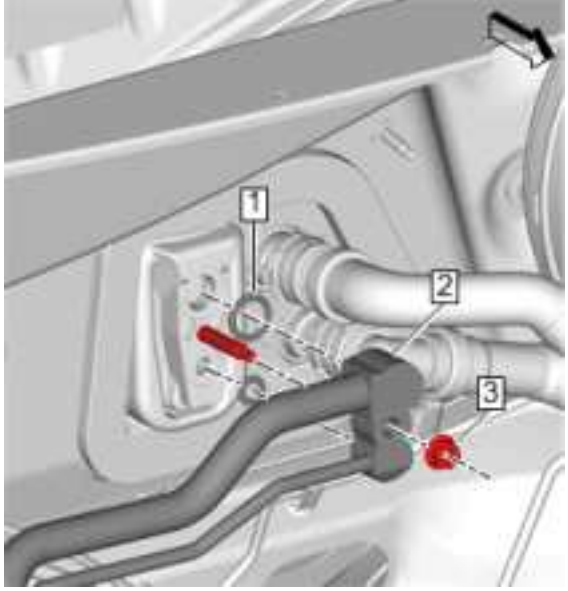

Fig. 157: Air Conditioning Refrigerant Heat Exchanger, Nut And Seals
Courtesy of GENERAL MOTORS COMPANY

8. Install Air Conditioning Refrigerant Heat Exchanger (2). Refer to **Air Conditioning Refrigerant Heat Exchanger Replacement (LH7)**

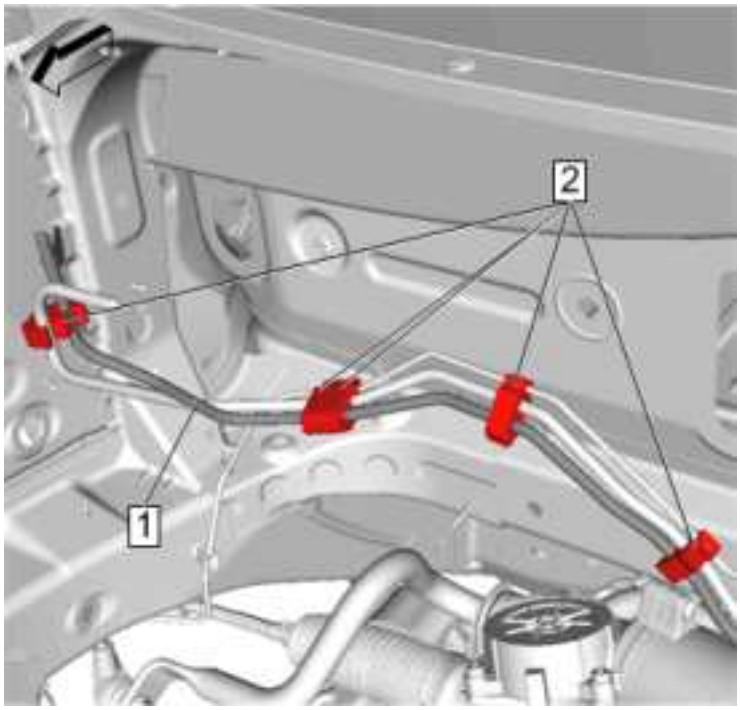

Fig. 158: Fuel Return Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

9. Install Fuel Return Pipe (1) @ Retainers (2) (Qty: 5)
10. Connect Fuel Return Front Pipe. Refer to **Fuel Return Front Pipe Replacement**
11. Pressurize fuel system and check for fuel leaks.

FUEL RETURN PIPE REPLACEMENT (ENGINE TO PIPE AWD)

Removal Procedure

WARNING: Refer to **Diesel/Gasoline Vapors Warning** .

WARNING: Refer to **Safety Glasses Warning** .

1. Disconnect Fuel Return Front Pipe. Refer to **Fuel Return Front Pipe Replacement**

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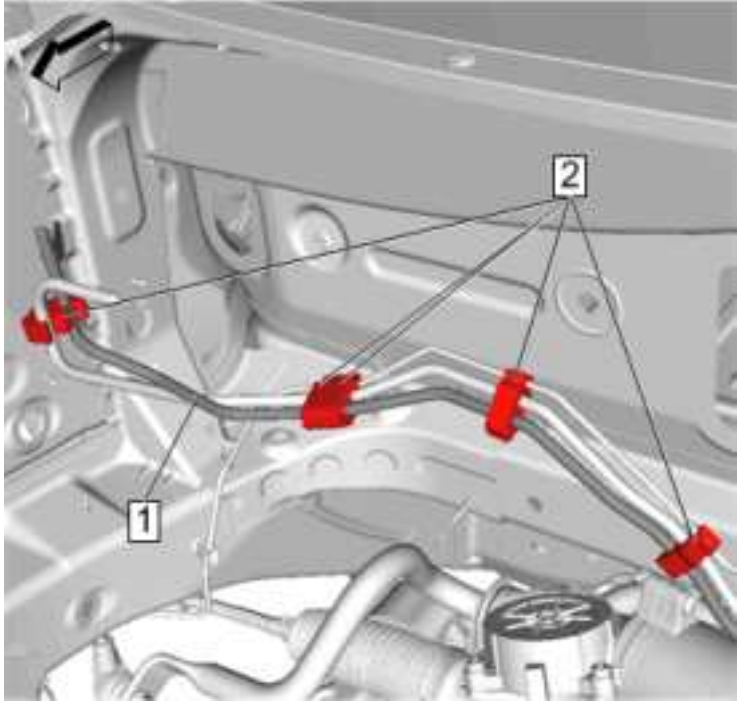

Fig. 159: Fuel Return Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Remove Fuel Return Pipe (1) @ Retainer (2) (Qty: 5)

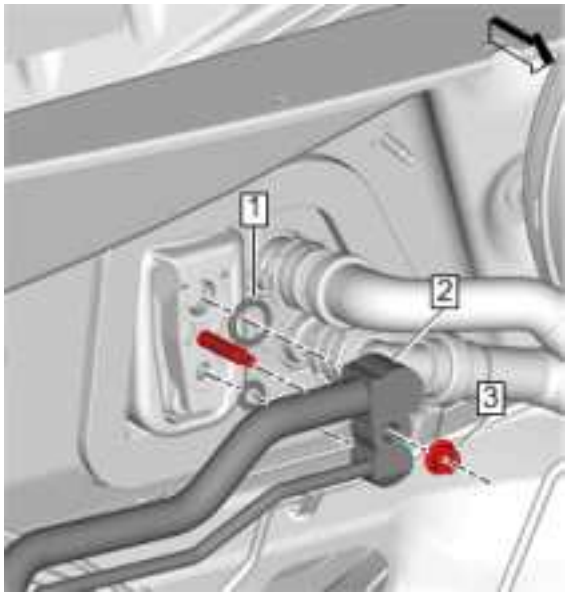

Fig. 160: Air Conditioning Refrigerant Heat Exchanger, Nut And Seals
Courtesy of GENERAL MOTORS COMPANY

3. Remove Air Conditioning Refrigerant Heat Exchanger (2). Refer to **Air Conditioning Refrigerant Heat Exchanger Replacement (LH7)**
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

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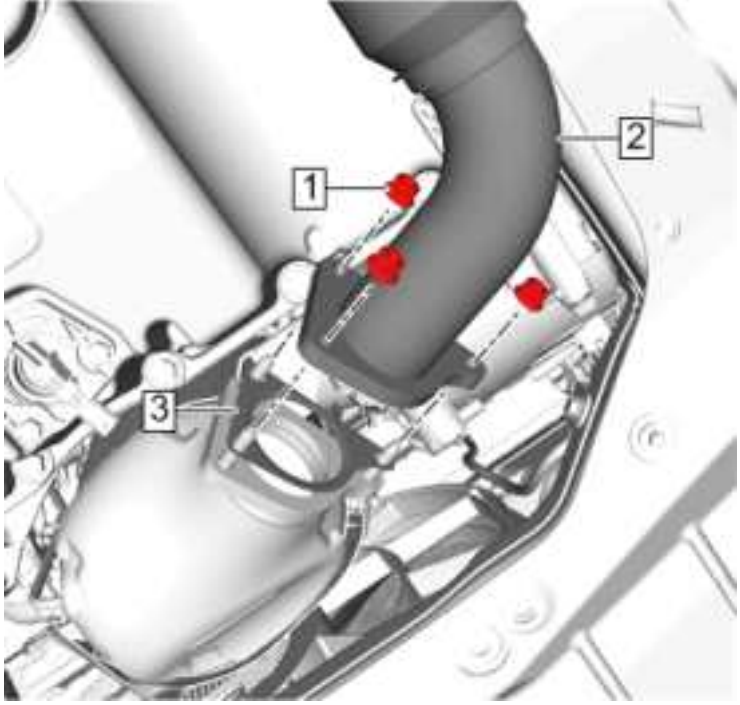

Fig. 161: Exhaust Front Pipe, Nut And Gasket
Courtesy of GENERAL MOTORS COMPANY

5. Remove Exhaust Front Pipe (2). Refer to **Exhaust Front Pipe Replacement (LH7)**

Fig. 162: Intermediate Shaft Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove lower steering shaft bolt (1) and remove steering shaft from steering rack. Refer to **Intermediate Steering Shaft Replacement (Equinox)** **Intermediate Steering Shaft Replacement (Terrain)**

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Fig. 163: Drivetrain And Front Suspension Cradle
Courtesy of GENERAL MOTORS COMPANY

7. Lower drivetrain and front suspension cradle (1) as necessary in order to remove the fuel return pipe from the vehicle. Refer to **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)**

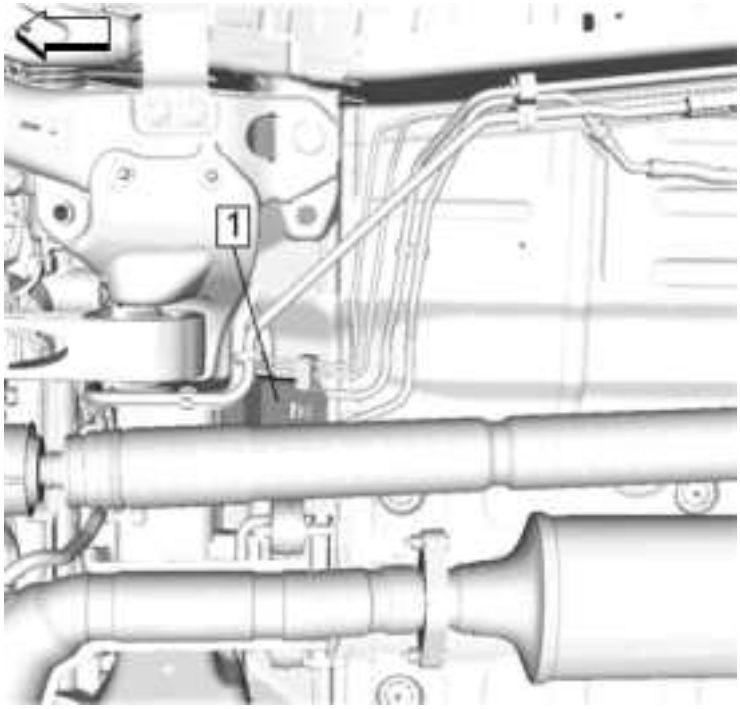

Fig. 164: Shield
Courtesy of GENERAL MOTORS COMPANY

8. Remove Shield (1)
9. {If equipped} Remove Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (All Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

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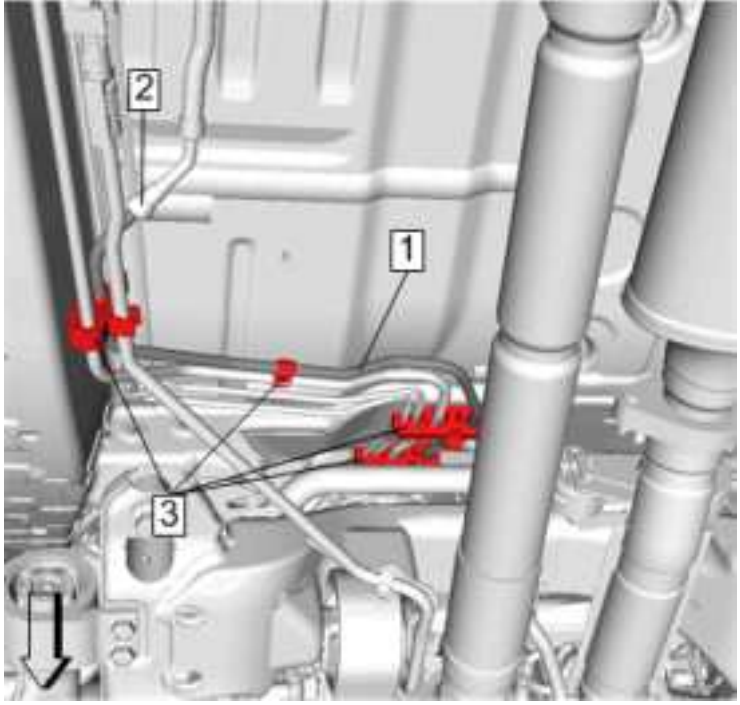

Fig. 165: Fuel Return Pipes And Retainers
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect Fuel Return Pipe (1) @ Fuel Return Pipe (2). Refer to **Metal Collar Quick Connect Fitting Service**
11. Remove Fuel Return Pipe (1) @ Retainers (3) (Qty: 4)
12. Remove fuel return pipe (1) from the vehicle.

Installation Procedure

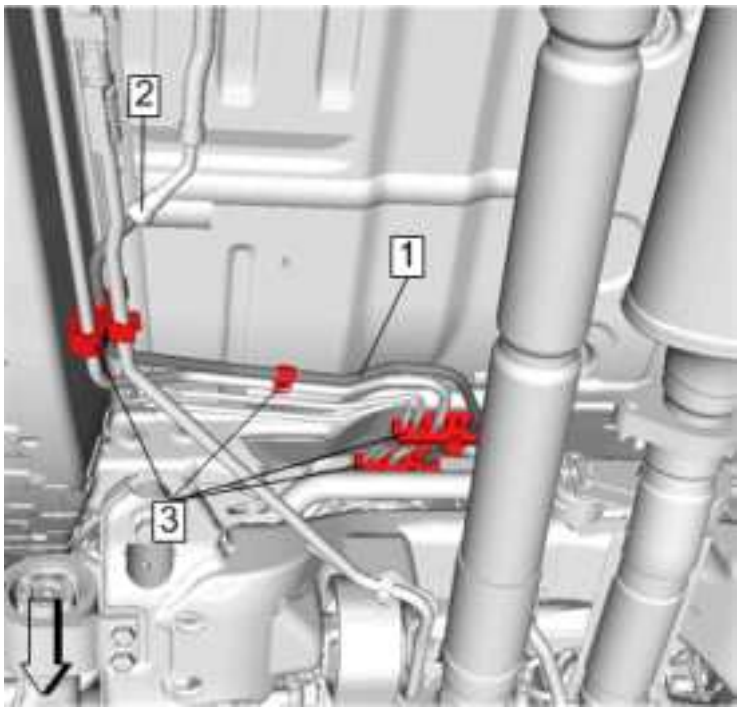

Fig. 166: Fuel Return Pipes And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel return pipe (1) into the vehicle.
2. Install Fuel Return Pipe (1) @ Retainers (3) (Qty: 4)
3. Connect Fuel Return Pipe (1) @ Fuel Return Pipe (2). Refer to **Metal Collar Quick Connect Fitting Service**
4. {If equipped} Install Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (All Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

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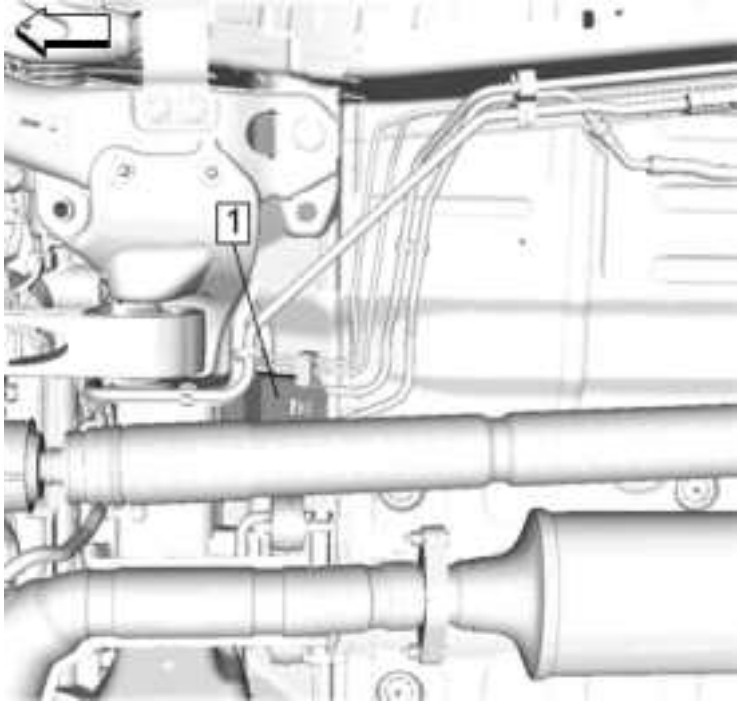

Fig. 167: Shield
Courtesy of GENERAL MOTORS COMPANY

5. Install Shield (1)

Fig. 168: Drivetrain And Front Suspension Cradle
Courtesy of GENERAL MOTORS COMPANY

6. Install Drivetrain and Front Suspension Cradle (1). Refer to **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)**

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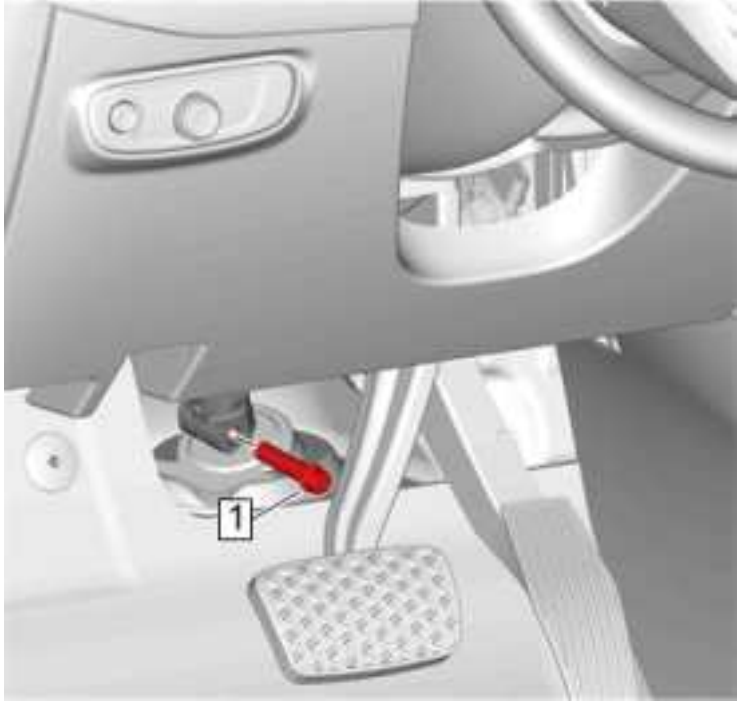

Fig. 169: Intermediate Shaft Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install lower steering shaft bolt (1) after installing steering shaft to steering rack. Refer to **Intermediate Steering Shaft Replacement (Equinox)** **Intermediate Steering Shaft Replacement (Terrain)**

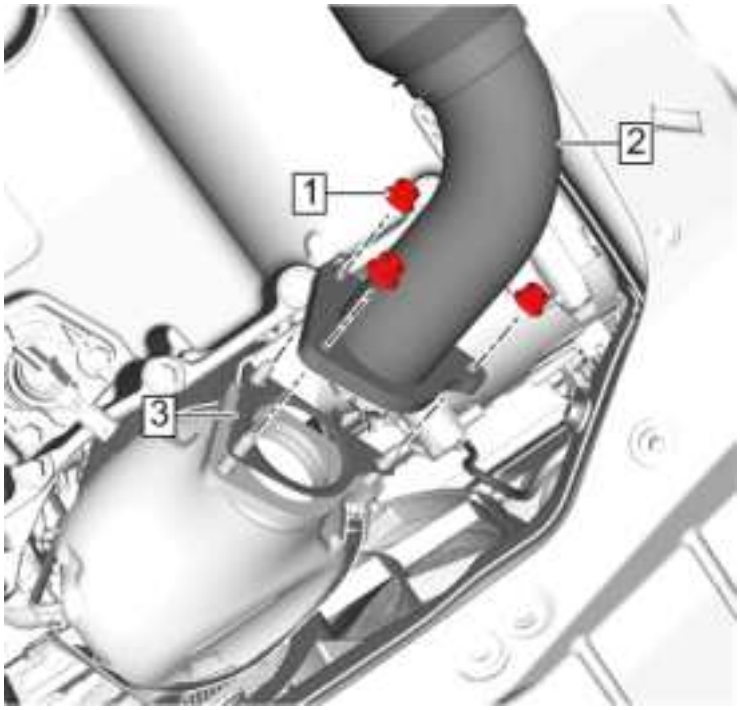

Fig. 170: Exhaust Front Pipe, Nut And Gasket
Courtesy of GENERAL MOTORS COMPANY

8. Install Exhaust Front Pipe (2). Refer to **Exhaust Front Pipe Replacement (LH7)**
9. Lower the vehicle.

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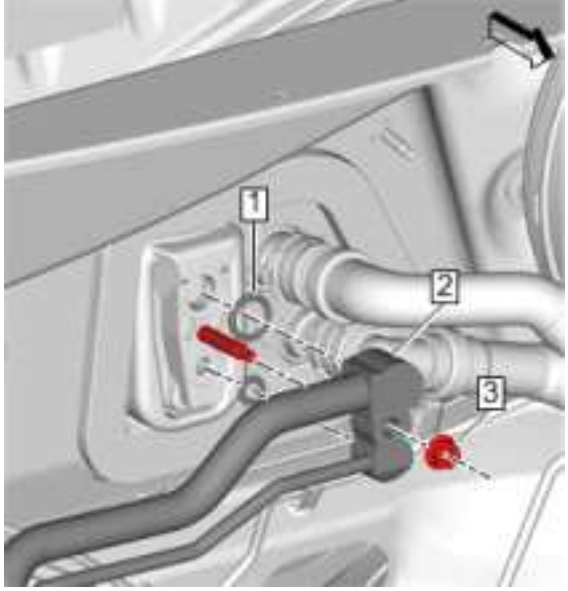

Fig. 171: Air Conditioning Refrigerant Heat Exchanger, Nut And Seals
Courtesy of GENERAL MOTORS COMPANY

10. Install Air Conditioning Refrigerant Heat Exchanger (2). Refer to **Air Conditioning Refrigerant Heat Exchanger Replacement (LH7)**

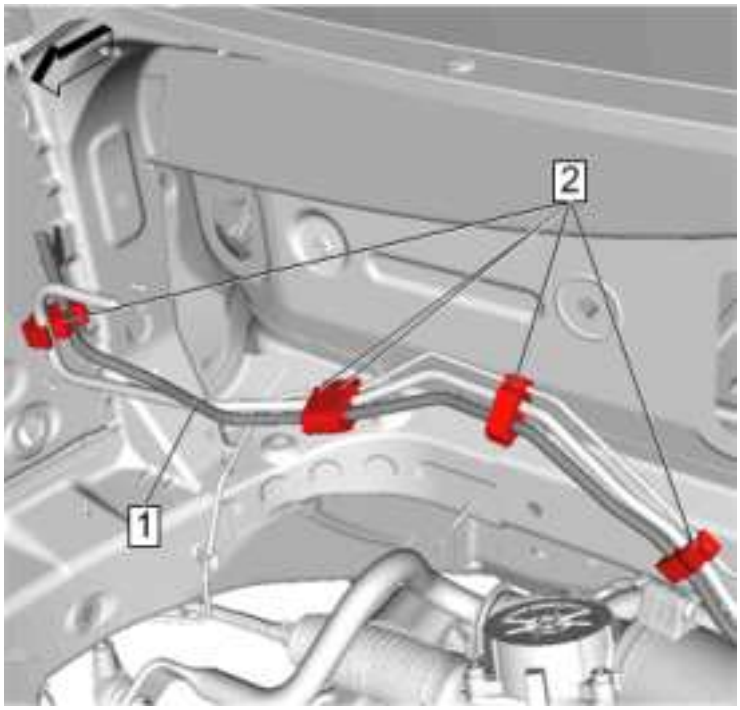

Fig. 172: Fuel Return Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

11. Install Fuel Return Pipe (1) @ Retainers (2) (Qty: 5)
12. Connect Fuel Return Front Pipe. Refer to **Fuel Return Front Pipe Replacement**
13. Pressurize fuel system and check for fuel leaks.

FUEL INJECTION FUEL FEED PIPE REPLACEMENT - FUEL INJECTION PUMP TO FUEL RAIL

Removal Procedure

WARNING: **Refer to Diesel/Gasoline Vapors Warning**

WARNING: **Refer to Safety Goggles and Fuel Warning**

CAUTION: **Clean all fuel pipe and hose connections and surrounding areas before disassembling to avoid possible contamination of the fuel system. Spray**

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the fuel pump module cam-lock ring tang with penetrating oil prior to attempting removal.

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

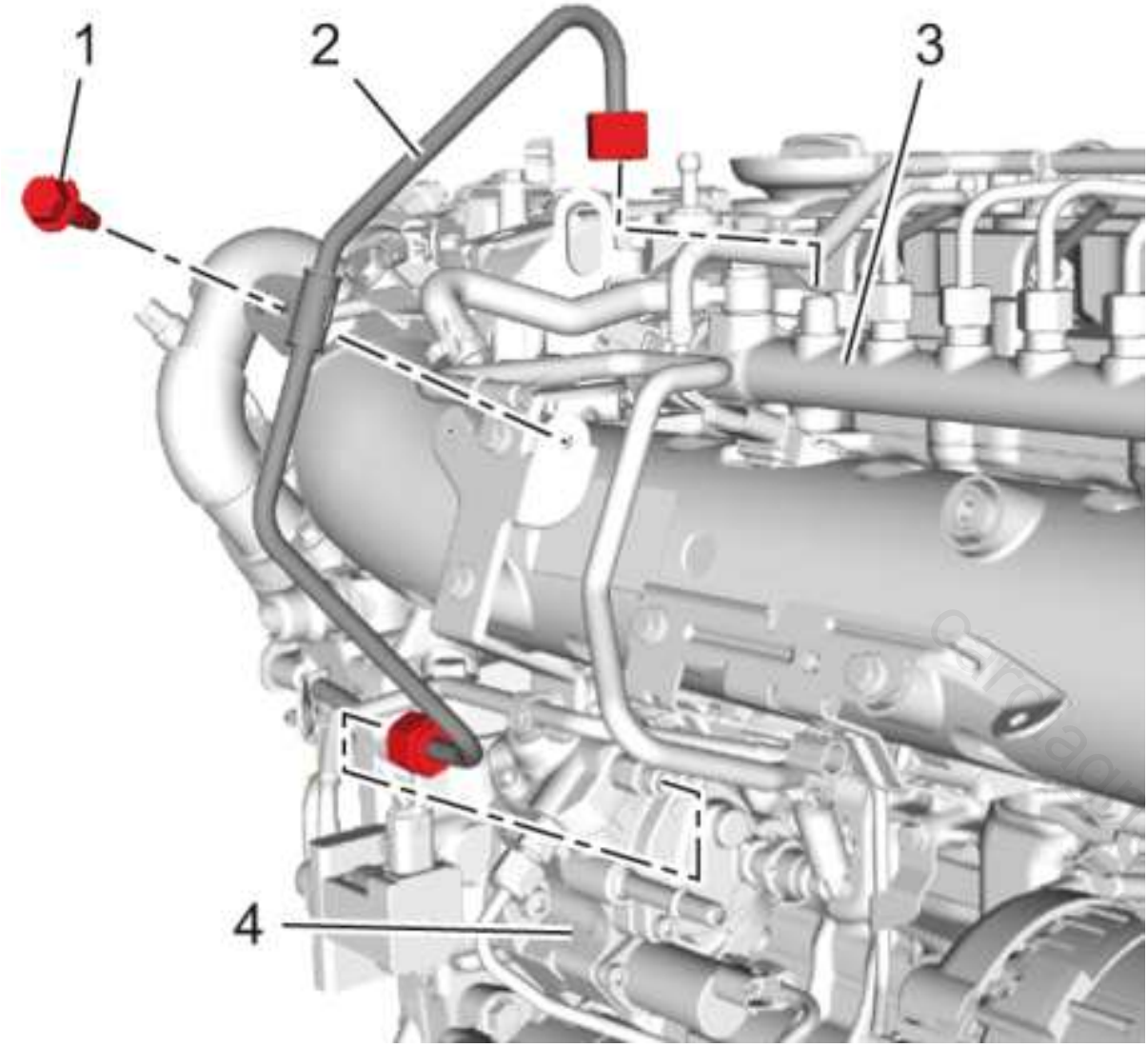

Fig. 173: Fuel Injection Fuel Feed Pipe And Components - Fuel Injection Pump to Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

3. Remove Fuel Injection Fuel Feed Pipe Bracket Bolt (1)
4. Loosen Fuel Injection Fuel Feed Pipe (2) @ Fuel Rail (3)

NOTE: **Counterhold at the fuel injection pump hexagon connector.**

5. Loosen Fuel Injection Fuel Feed Pipe (2) @ Fuel Injection Pump (4)
6. Remove and DISCARD Fuel Injection Fuel Feed Pipe (2)
7. Close the fuel rail using suitable closure plugs.

Installation Procedure

1. Remove the suitable closure plugs.

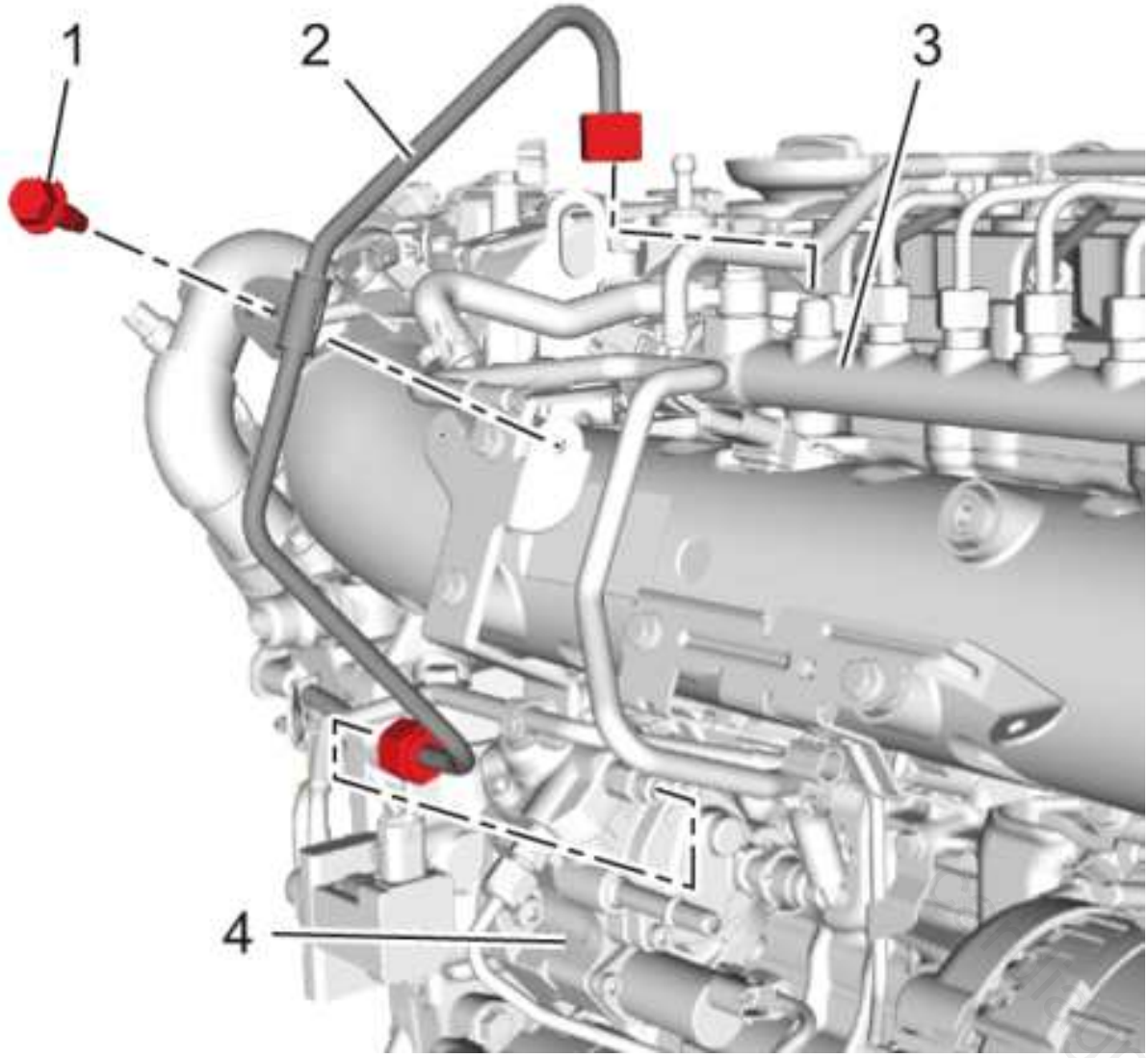

Fig. 174: Fuel Injection Fuel Feed Pipe And Components - Fuel Injection Pump to Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

2. Install New Fuel Injection Fuel Feed Pipe (2)

NOTE: **Counterhold at the fuel injection pump hexagon connector.**

3. Install Fuel Injection Fuel Feed Pipe (2) @ Fuel Injection Pump (4)
4. Install Fuel Injection Fuel Feed Pipe (2) @ Fuel Rail (3)

NOTE: **Counterhold at the fuel injection pump hexagon connector.**

CAUTION: **Refer to Fastener Caution**

5. Tighten Fuel Injection Fuel Feed Pipe (2) @ Fuel Injection Pump (4) to 28 N.m (21 lb ft)
6. Tighten Fuel Injection Fuel Feed Pipe (2) @ Fuel Rail (3) to 28 N.m (21 lb ft)
7. Install and tighten Fuel Injection Fuel Feed Pipe Bracket Bolt (1) to 9 N.m (80 lb in)
8. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
9. Check the fuel system for leaks. Refer to **Fuel Leak Diagnosis**
10. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

FUEL INJECTION FUEL FEED PIPE REPLACEMENT - FUEL RAIL TO FUEL INJECTOR

Removal Procedure

WARNING: **The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam**

component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

WARNING: **Refer to Safety Goggles and Fuel Warning**

WARNING: **Refer to Diesel/Gasoline Vapors Warning**

CAUTION: **Refer to Fuel Contamination Caution**

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

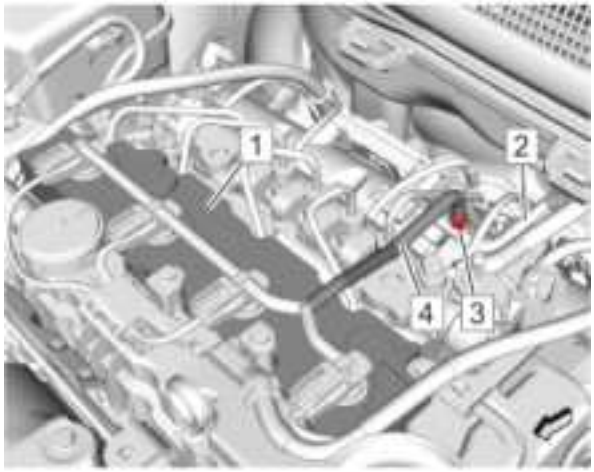

Fig. 175: Fuel Return Hose, Diesel Fuel Separator, Fuel Injector Insulator And Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Remove and DISCARD Clamp (3)
4. Disconnect Fuel Return Hose (4) @ Diesel Fuel Separator (2)
5. Remove Fuel Injector Insulator (1)

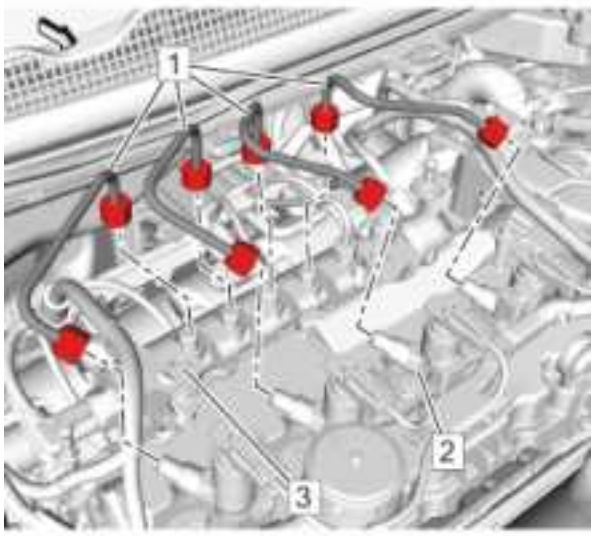

Fig. 176: Fuel Injection Fuel Feed Pipes, Fuel Rail And Fuel Injectors
Courtesy of GENERAL MOTORS COMPANY

6. Loosen Fuel Injection Fuel Feed Pipes (1) @ Fuel Injection Fuel Rail (3) (Qty: 4)
7. Loosen Fuel Injection Fuel Feed Pipes (1) @ Fuel Injectors (2) (Qty: 4)
8. Remove and DISCARD Fuel Injection Fuel Feed Pipes (1) (Qty: 4)

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Installation Procedure

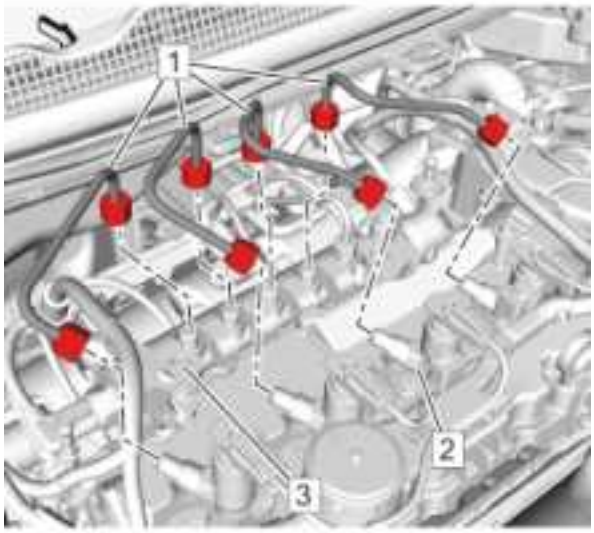

Fig. 177: Fuel Injection Fuel Feed Pipes, Fuel Rail And Fuel Injectors
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW Fuel Injection Fuel Feed Pipes (1) (Qty: 4)
2. Hand tighten Fuel Injection Fuel Feed Pipes (1) @ Fuel Injectors (2) (Qty: 4)
3. Hand tighten Fuel Injection Fuel Feed Pipes (1) @ Fuel Injection Fuel Rail (3) (Qty: 4)

CAUTION: **Refer to Fastener Caution**

4. Tighten Fuel Injection Fuel Feed Pipes (1) (Qty: 8) to 28 N.m (21 lb ft)

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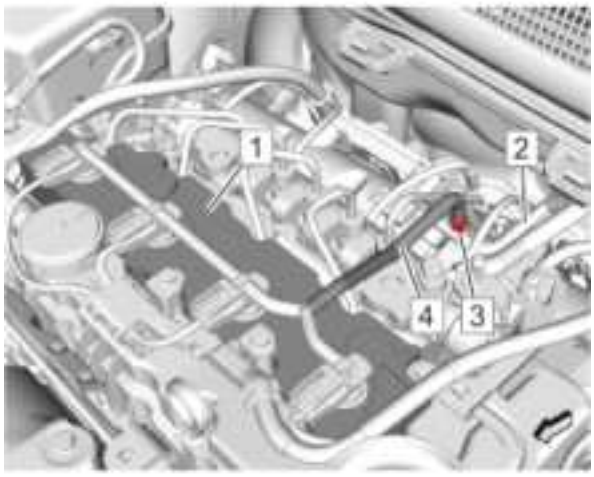

Fig. 178: Fuel Return Hose, Diesel Fuel Separator, Fuel Injector Insulator And Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Install Fuel Injector Insulator (1)
6. Connect Fuel Return Hose (4) @ Diesel Fuel Separator (2)
7. Install a NEW clamp. (3)
8. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
9. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

FUEL PRESSURE SENSOR REPLACEMENT

Removal Procedure

WARNING: **The noise cancelling foam component MUST be replaced if it has been**

exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

WARNING: **Refer to Safety Goggles and Fuel Warning**

WARNING: **Refer to Diesel/Gasoline Vapors Warning**

CAUTION: **Refer to Fuel Contamination Caution**

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

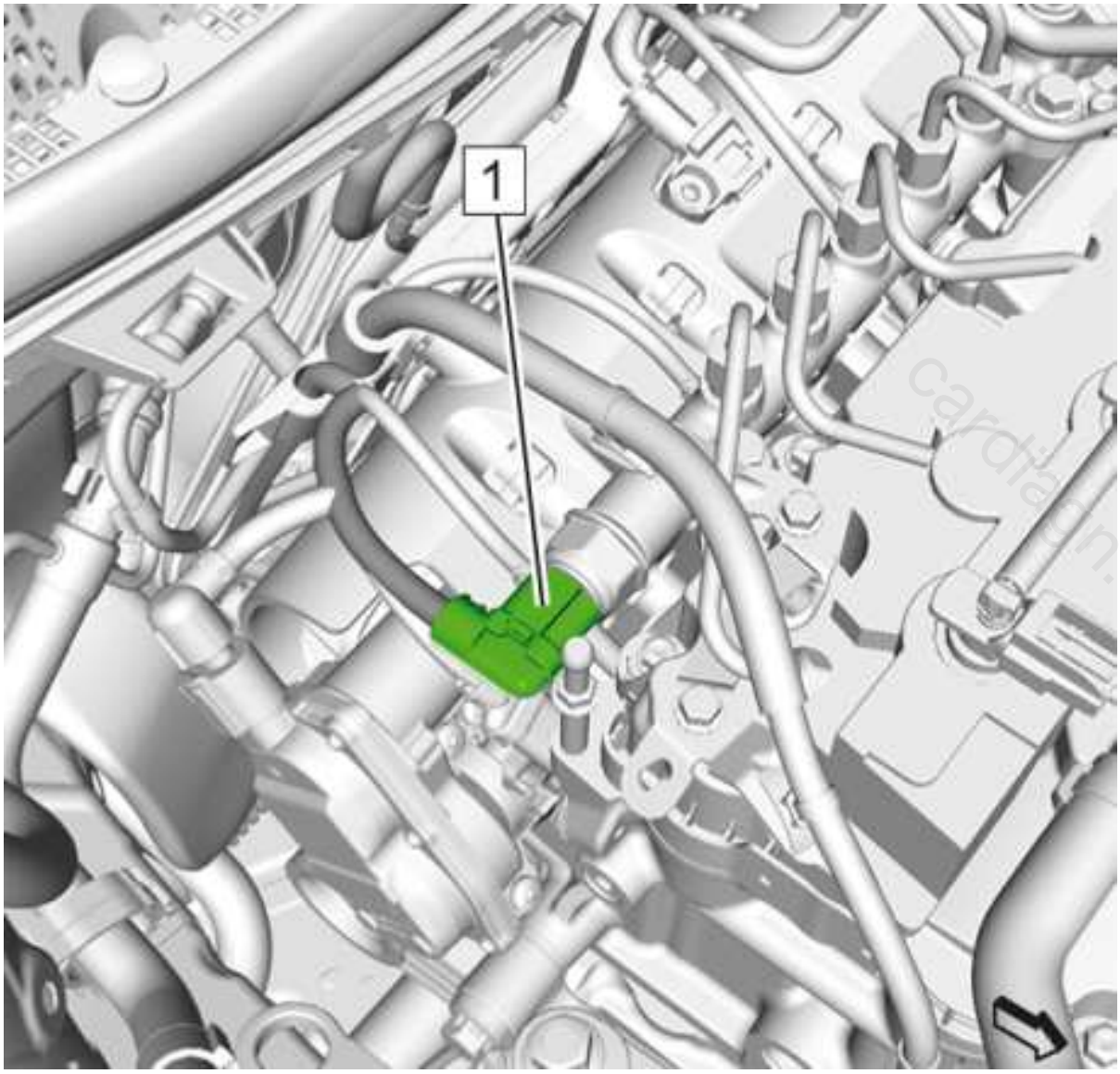

Fig. 179: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect Electrical Connector (1)

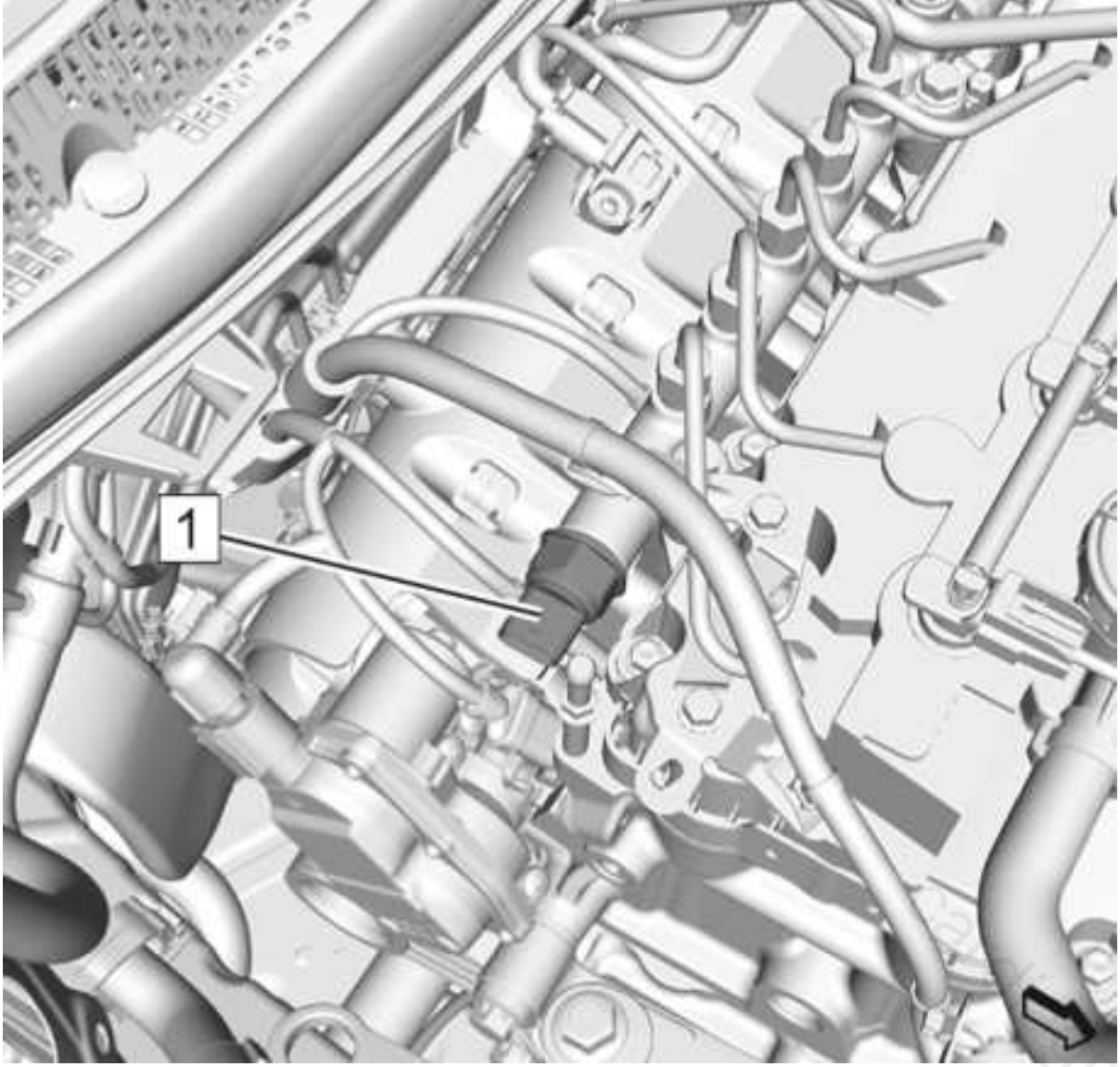

Fig. 180: Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD Fuel Pressure Sensor (1)

Installation Procedure

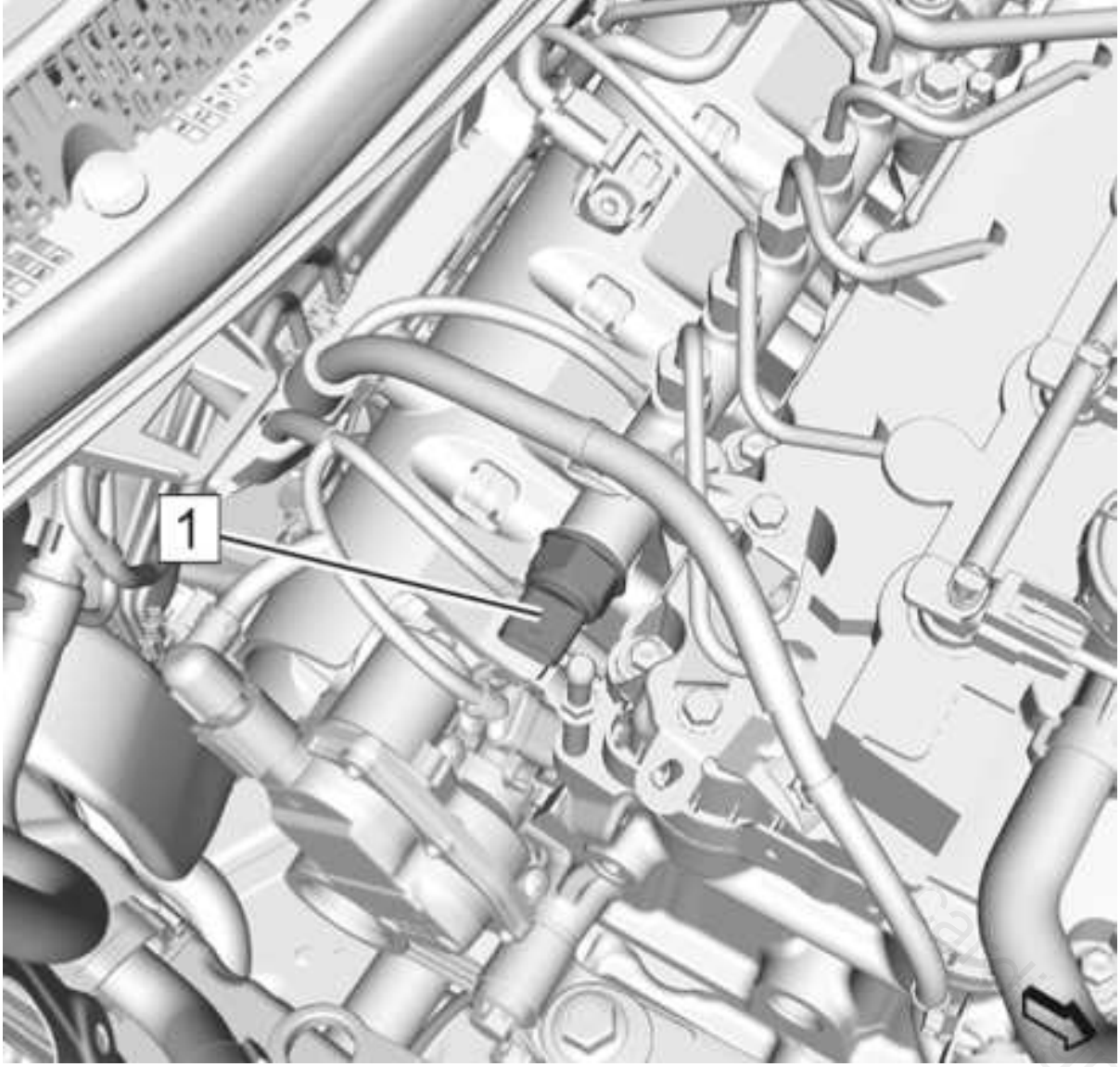

Fig. 181: Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW Fuel Pressure Sensor (1) - Hand tighten

CAUTION: **Refer to Component Fastener Tightening Caution**

2. Tighten Fuel Pressure Sensor (1) to 35 N.m (26 lb ft)

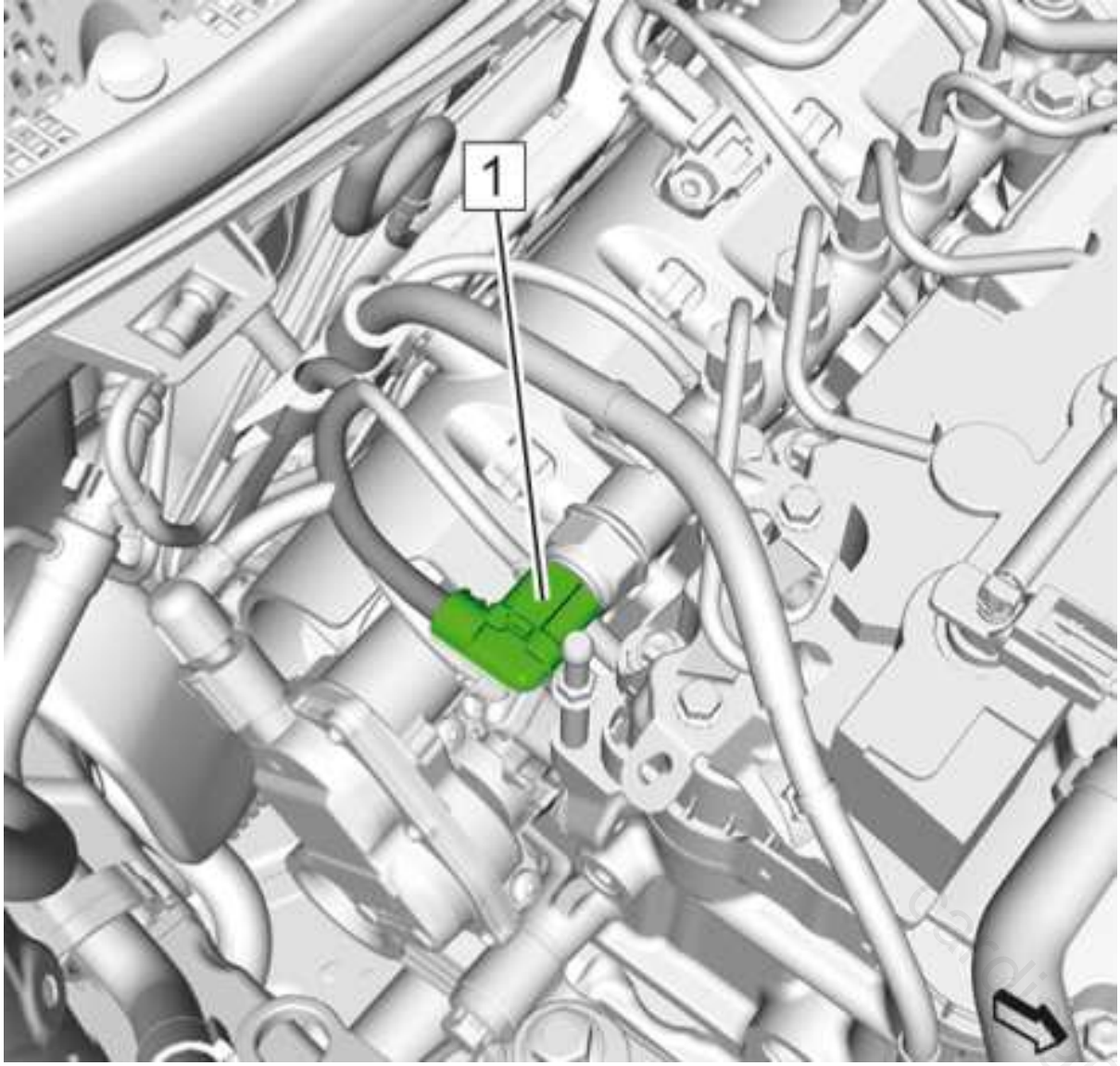

Fig. 182: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect Electrical Connector (1)
4. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
5. Start the engine and check for fuel leaks.
6. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
7. If replacing, perform the fuel injection small quantity learn. Refer to **Fuel Injection Small Quantity Learn**

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE (AWD)

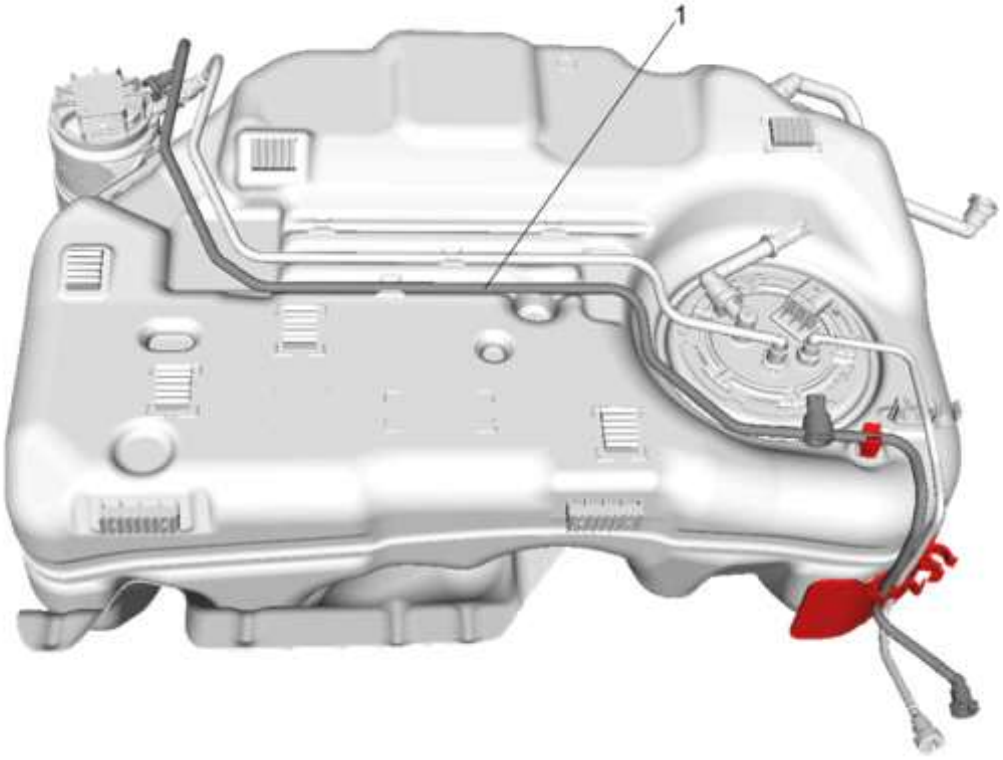

Fig. 183: Fuel Pressure Sensor - Fuel Feed Pipe (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (AWD)	
1	Fuel Pressure Sensor **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the fuel hose and remove from retainers. Refer to Plastic Collar Quick Connect Fitting Service **NOTE:** **Fuel pressure sensor is serviced as part of fuel hose assembly.**

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE (FWD)

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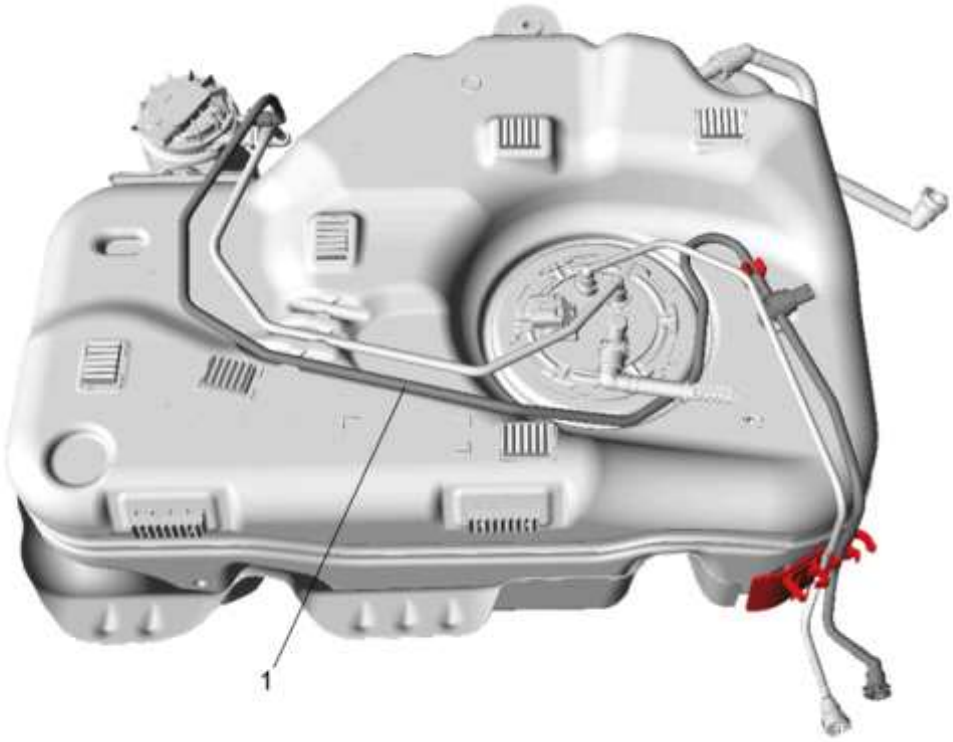

Fig. 184: Fuel Pressure Sensor - Fuel Feed Pipe (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Diesel/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Remove Fuel Tank. Refer to Fuel Tank Replacement (FWD)	
1	Fuel Pressure Sensor **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the fuel hose and remove from retainers. Refer to Plastic Collar Quick Connect Fitting Service **NOTE:** **Fuel pressure sensor is serviced as part of fuel hose assembly.**

FUEL SYSTEM CLEANING

Fungi and other microorganisms can survive and multiply in diesel fuel if water is present. The fungi can be present in any part of the fuel handling system. These fungi grow into long strings and will form into large globules. The growths appear slimy and are usually black, green, or brown. The fungi may grow anywhere in the fuel but are most plentiful where diesel fuel and water meet. As the fuel is agitated, when service station tanks are being filled, fungi are distributed throughout the tank and may be pumped into a vehicle.

Fungi use the fuel as their main energy supply and need only trace amounts of water and minerals. As they grow and multiply, they change fuel into water, sludge, acids, and products of metabolism. The most common symptom is fuel filter plugging; however, various metal components including the fuel sending unit, pipes, fuel injectors, and injection pump can corrode.

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WARNING: **Avoid physical contact with the biocides in order to avoid personal injury.**

If fungi have caused fuel system contamination, use a diesel fuel biocide to sterilize the fuel system. Do not exceed the dosage recommended on the label. Discontinue the use of a biocide when towing a trailer. It is permissible to have biocide in the fuel when starting to tow, but do not add any biocide while towing.

Steam cleaning may be necessary if most of the fungus growth cannot be removed with biocides.

The presence of water or gasoline in diesel fuel may also cause injection pump and nozzle damage.

This procedure checks for the presence of water and gasoline in diesel fuel that may cause injection pump and nozzle damage.

Remove and inspect the fuel filter element.

- If water, gasoline or fungi/bacteria are not present, end the inspection.
- If water or fungi/bacteria are present, proceed to Cleaning Water from the Fuel System.
- If gasoline is present, proceed to Cleaning Gasoline from the Fuel System.

Cleaning Water from the Fuel System

1. Disconnect the negative battery. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement (FWD)Fuel Tank Fuel Pump Module Replacement (AWD)**
3. Inspect the fuel tank and the fuel tank fuel pump module for rust, fungi or bacteria. If there is rust, replace the rusted components. If rust, fungi or bacteria is found in fuel tank fuel pump module, replace the fuel pump module.
4. Clean the inside of the fuel tank with hot water.
5. Use compressed air in order to dry the fuel tank.
6. Disconnect the ends of the following lines:
    - The fuel filter inlet line (both ends)
    - The fuel filter outlet line (both ends)
    - The fuel filter drain
    - The fuel return line (both ends)
    - The fuel feed pipe (both ends)
7. Inspect each of the pipes and lines.
8. Replace any rusted pipes.
9. Clean the inside of the fuel filter housing.
10. Dry the fuel filter housing with compressed air.
11. Dry the inside of each line with low pressure air.
12. Install a new fuel filter. Refer to **Fuel Filter Replacement (AWD)Fuel Filter Replacement (FWD)**
13. Install the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement (FWD)Fuel Tank Fuel Pump Module Replacement (AWD)**
14. Reconnect the following lines:
    - The fuel filter inlet line (both ends)
    - The fuel filter outlet line (both ends)
    - The fuel return line (tank end)
    - The fuel feed pipe (both ends)
15. Install the fuel tank into the vehicle. Refer to **Fuel Tank Replacement (AWD)Fuel Tank Replacement (FWD)**
16. Add clean diesel fuel to the tank until the tank is 1/4 full.

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17. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
18. Connect the fuel filter drain to a line that flows into a clean metal container.
19. Cycle the ignition or use a scan tool to command the fuel pump on until clean fuel flows from the fuel filter drain into a metal container.
20. Close the fuel filter drain and remove the bleeder hose. Refer to **Water-in-Fuel Draining**
21. Disconnect the crankshaft position sensor.
22. Install a hose on the chassis fuel return pipe and insert other end into a 7.6 liters (2 gallon) metal container.
23. Crank the engine for 15 second time intervals, with 1 minute cool-down periods. Continue until 3.8 liters (1 gallon) of fuel has passed into the container.
24. Connect the fuel return pipe.
25. Reconnect the crankshaft position sensor.
26. Start and run the engine.
27. Stop the engine.
28. Clean any fuel spillage from the engine.
29. Fill the fuel tank and add a biocide, if needed.
30. Clear the engine control module of any diagnostic trouble codes (DTCs).

Cleaning Gasoline from the Fuel System

1. Drain the fuel tank. For AWD applications remove the fuel tank to remove fuel from the auxiliary side of the tank. Refer to **Fuel Tank Replacement (AWD)Fuel Tank Replacement (FWD)**
2. Fill the fuel tank to 1/4 full.
3. Loosen the fuel filter drain and connect the filter to a hose that flows into a metal container.
4. Cycle the ignition or use a scan tool to command the fuel pump on until clean fuel flows from the fuel filter drain into the metal container.
5. Tighten the fuel filter drain and disconnect the hose. Refer to **Water-in-Fuel Draining**
6. Install a hose on the chassis fuel return pipe at the fuel tank, and insert the other end into a 7.6 liters (2 gallon) metal container.
7. Disconnect the crankshaft position sensor.
8. Crank the engine for 15 second time intervals, with 1 minute cool-down periods. Continue until 3.8 liters (1 gallon) of fuel has passed into the container.
9. Reconnect the fuel return pipe.
10. Reconnect the crankshaft position sensor.
11. Attempt to start and run the engine for 15 minutes. If the engine does not start, cycle the ignition on/off ten times to prime the fuel system.
12. Stop the engine.
13. Clean any fuel spillage from the engine.
14. Clear the engine of any diagnostic trouble codes (DTCs).

Fuel Tank Cleaning

NOTE:

- **Only use oil free compressed air to blow out the fuel pipes.**
- **Inspect the fuel tank internally and clean the fuel tank if you find a plugged fuel filter.**

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Drain the fuel tank. Refer to **Fuel Tank Draining**
3. Remove the fuel tank. Refer to **Fuel Tank Replacement (AWD)Fuel Tank Replacement (FWD)**
4. Remove the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement (FWD)Fuel Tank Fuel Pump Module Replacement (AWD)**

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5. Inspect the fuel pump inlet for dirt and debris. Replace the fuel pump if you find dirt or debris in the fuel pump inlet. Refer to **Fuel Tank Fuel Pump Module Replacement (FWD)Fuel Tank Fuel Pump Module Replacement (AWD)**
6. Locate a stand or fixture suitable to support the weight of the fuel tank and water.

NOTE:

- **When flushing the fuel tank, handle the fuel and water mixture as a hazardous material. Handle the fuel and water mixture in accordance with all applicable local, state and federal laws and regulations.**
- **Do not drill any access or drain holes in the fuel tank.**

7. Flush the fuel tank with running hot water for at least five minutes. Pour the water out of the fuel pump module opening. Rock the fuel tank in order to ensure that the removal of the water from the fuel tank is complete.
8. Using a high pressure wand, dry all interior tank surfaces. Tank should be tipped accordingly to facilitate removal of water. Assure pressurized air does not contain any contaminants.
9. Hand dry tank surfaces with a white towel to confirm dryness and cleanliness.
10. Install the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement (FWD)Fuel Tank Fuel Pump Module Replacement (AWD)**
11. Install the fuel tank. Refer to **Fuel Tank Replacement (AWD)Fuel Tank Replacement (FWD)**
12. Fill the tank with clean fuel.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT

Removal Procedure

WARNING: **The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.**

WARNING: **Refer to Safety Goggles and Fuel Warning**

WARNING: **Refer to Diesel/Gasoline Vapors Warning**

CAUTION: **Refer to Fuel Contamination Caution**

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

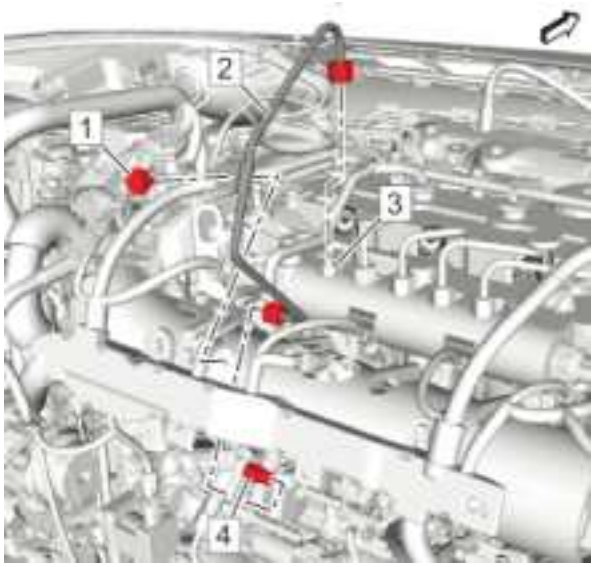

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Fig. 185: Fuel Injection Fuel Feed Pipe, Fuel Injection Pump, Fuel Injection Fuel Rail And Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove Fuel Injection Fuel Feed Pipe Bracket Bolt (1)

NOTE: **Counterhold at the fuel injection pump connector (4).**

4. Loosen Fuel Injection Fuel Feed Pipe (2) @ Fuel Injection Pump (4)
5. Loosen Fuel Injection Fuel Feed Pipe (2) @ Fuel Injection Fuel Rail (3)
6. Remove and DISCARD Fuel Injection Fuel Feed Pipe (2)
7. Close all open connections with suitable closure plugs.

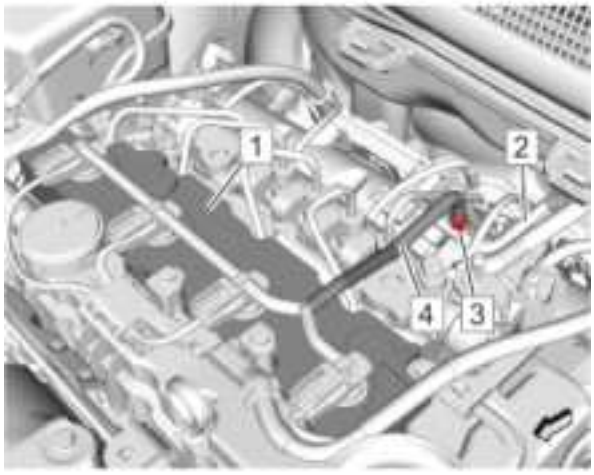

Fig. 186: Fuel Return Hose, Diesel Fuel Separator, Fuel Injector Insulator And Clamp
Courtesy of GENERAL MOTORS COMPANY

8. Remove and DISCARD Clamp (3)
9. Disconnect Fuel Return Hose (4) @ Diesel Fuel Separator (2)
10. Remove Fuel Injector Insulator (1)

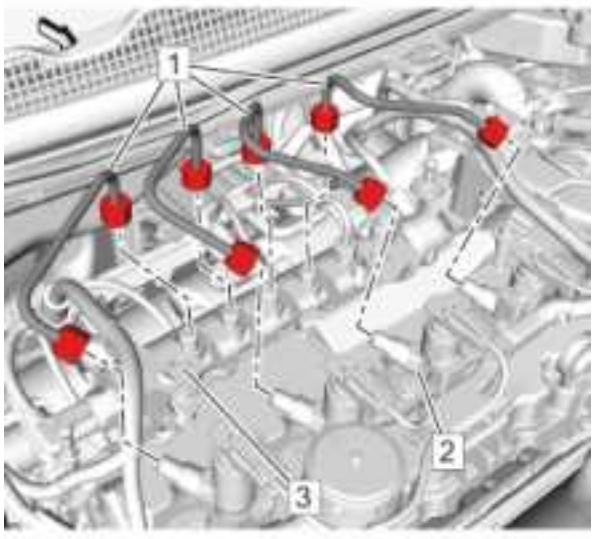

Fig. 187: Fuel Injection Fuel Feed Pipes, Fuel Rail And Fuel Injectors
Courtesy of GENERAL MOTORS COMPANY

11. Loosen Fuel Injection Fuel Feed Pipes (1) @ Fuel Injection Fuel Rail (3) (Qty: 4)
12. Loosen Fuel Injection Fuel Feed Pipes (1) @ Fuel Injector (2) (Qty: 4)
13. Remove and DISCARD Fuel Injection Fuel Feed Pipes (1) (Qty: 4)

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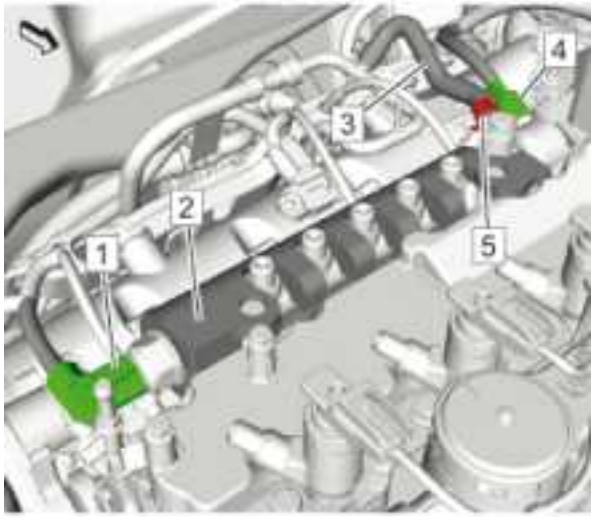

Fig. 188: Fuel Injection Fuel Rail Noise Shield, Diesel Fuel Separator Hose, Clamp And Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect the electrical connector:
    1. Fuel Pressure Sensor (1)
    2. Fuel Pressure Regulator (4)
15. Remove Fuel Injection Fuel Rail Noise Shield (2)
16. Remove Diesel Fuel Separator Hose Clamp (5)
17. Disconnect Diesel Fuel Separator Hose (3) @ Fuel Injection Fuel Rail

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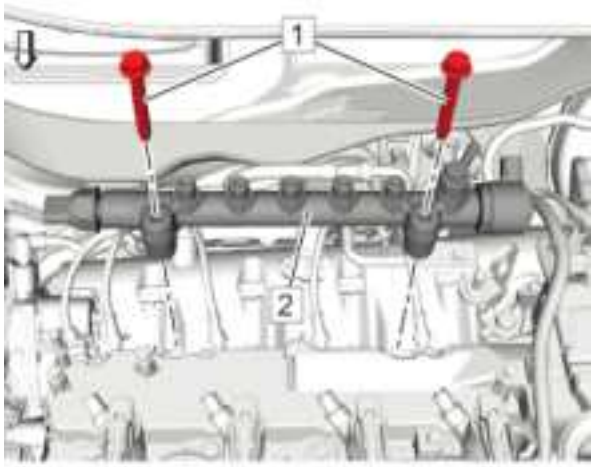

Fig. 189: Fuel Injection Fuel Rail And Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Remove Fuel Injection Fuel Rail Bolts (1) (Qty: 2)
19. Remove Fuel Injection Fuel Rail (2)

Installation Procedure

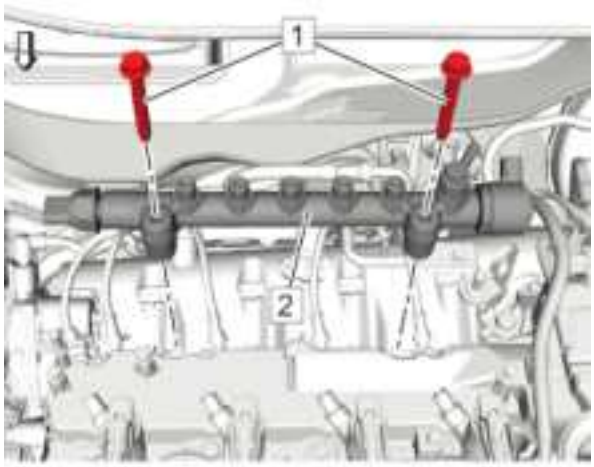

Fig. 190: Fuel Injection Fuel Rail And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Fuel Injection Fuel Rail (2)

CAUTION: **Refer to Fastener Caution**

2. Install and tighten Fuel Injection Fuel Rail Bolts (1) (Qty: 2) to 25 N.m (18 lb ft)

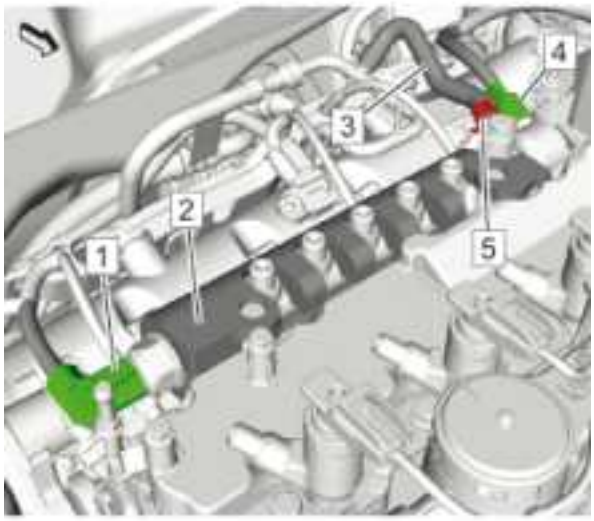

Fig. 191: Fuel Injection Fuel Rail Noise Shield, Diesel Fuel Separator Hose, Clamp And Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Connect Diesel Fuel Separator Hose (3) @ Fuel Injection Fuel Rail
4. Install Diesel Fuel Separator Hose Clamp (5)
5. Install Fuel Injection Fuel Rail Noise Shield (2)
6. Connect the electrical connector:
    1. Fuel Pressure Sensor (1)
    2. Fuel Pressure Regulator (4)

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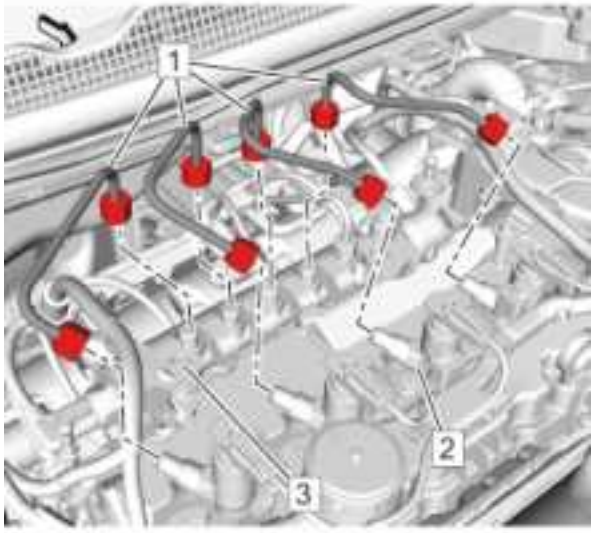

Fig. 192: Fuel Injection Fuel Feed Pipes, Fuel Rail And Fuel Injectors
Courtesy of GENERAL MOTORS COMPANY

7. Install NEW Fuel Injection Fuel Feed Pipes (1) (Qty: 4)
8. Hand Tighten Fuel Injection Fuel Feed Pipes (1) @ Fuel Injector (Qty: 4)
9. Hand tighten Fuel Injection Fuel Feed Pipes (1) @ Fuel Injection Fuel Rail (3) (Qty: 4)
10. Tighten Fuel Injection Fuel Feed Pipes (1) (Qty: 8) to 28 N.m (21 lb ft)

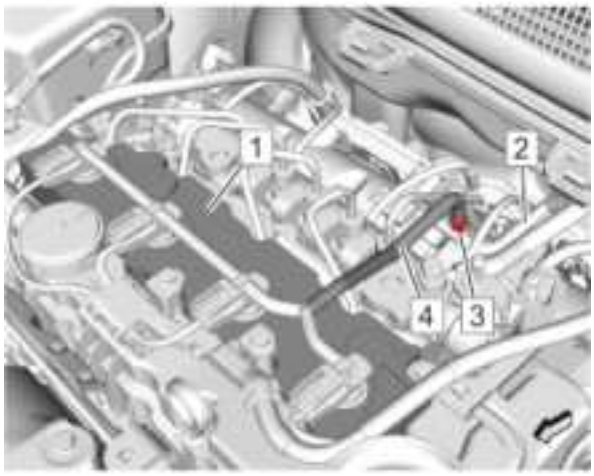

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Fig. 193: Fuel Return Hose, Diesel Fuel Separator, Fuel Injector Insulator And Clamp
Courtesy of GENERAL MOTORS COMPANY

11. Install Fuel Injector Insulator (1)
12. Connect Fuel Injector Fuel Return Hose (4) @ Diesel Fuel Separator (2)
13. Install a NEW clamp. (3)

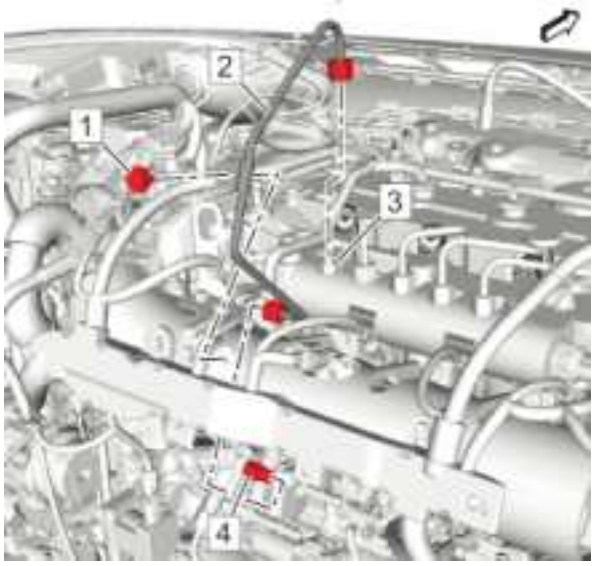

Fig. 194: Fuel Injection Fuel Feed Pipe, Fuel Injection Pump, Fuel Injection Fuel Rail And Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

14. Remove the suitable closure plugs from all connections.
15. Install NEW Fuel Injection Fuel Feed Pipe (2)
16. Hand tighten Fuel Injection Fuel Feed Pipe (2) @ Fuel Injection Fuel Rail (3)
17. Hand tighten Fuel Injection Fuel Feed Pipe (2) @ Fuel Injection Pump (4)

NOTE: **Counterhold at the fuel injection pump connector (4).**

18. Tighten Fuel Injection Fuel Feed Pipes (2) (Qty: 2) to 28 N.m (21 lb ft)
19. Install and tighten Fuel Injection Fuel Feed Pipe Bracket Bolt (1) to 9 N.m (80 lb in)
20. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
21. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
22. If replacing, perform the high pressure fuel correction reset. Refer to **High Pressure Fuel Correction Reset**

FUEL INJECTION PUMP THROTTLE SHAFT SEAL REPLACEMENT

Special Tools

EN-50885-1 Remover/Installer

EN-50885-2 Fixing Tool

Equivalent regional tools: **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

Removal Procedure

WARNING: **Refer to Diesel/Gasoline Vapors Warning**

WARNING: **Always wear safety goggles when working with fuel in order to protect the eyes from fuel splash.**

NOTE: **Be very thorough in terms of cleanliness when working in the fuel system. Malfunctions can also occur due to very small dirt particles. Prevent dirt from entering the fuel system by cleaning the hoses and plugging the pipes and lines upon removal. Store the components so that contaminants cannot enter.**

1. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
2. Remove the intake manifold. Refer to **Intake Manifold Replacement**

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3. Remove the engine control module bracket. Refer to **Engine Control Module Bracket Replacement**
4. Remove the auxiliary fluid accumulator. Refer to **Auxiliary Fluid Accumulator Replacement (Equinox)** **Auxiliary Fluid Accumulator Replacement (Terrain)**

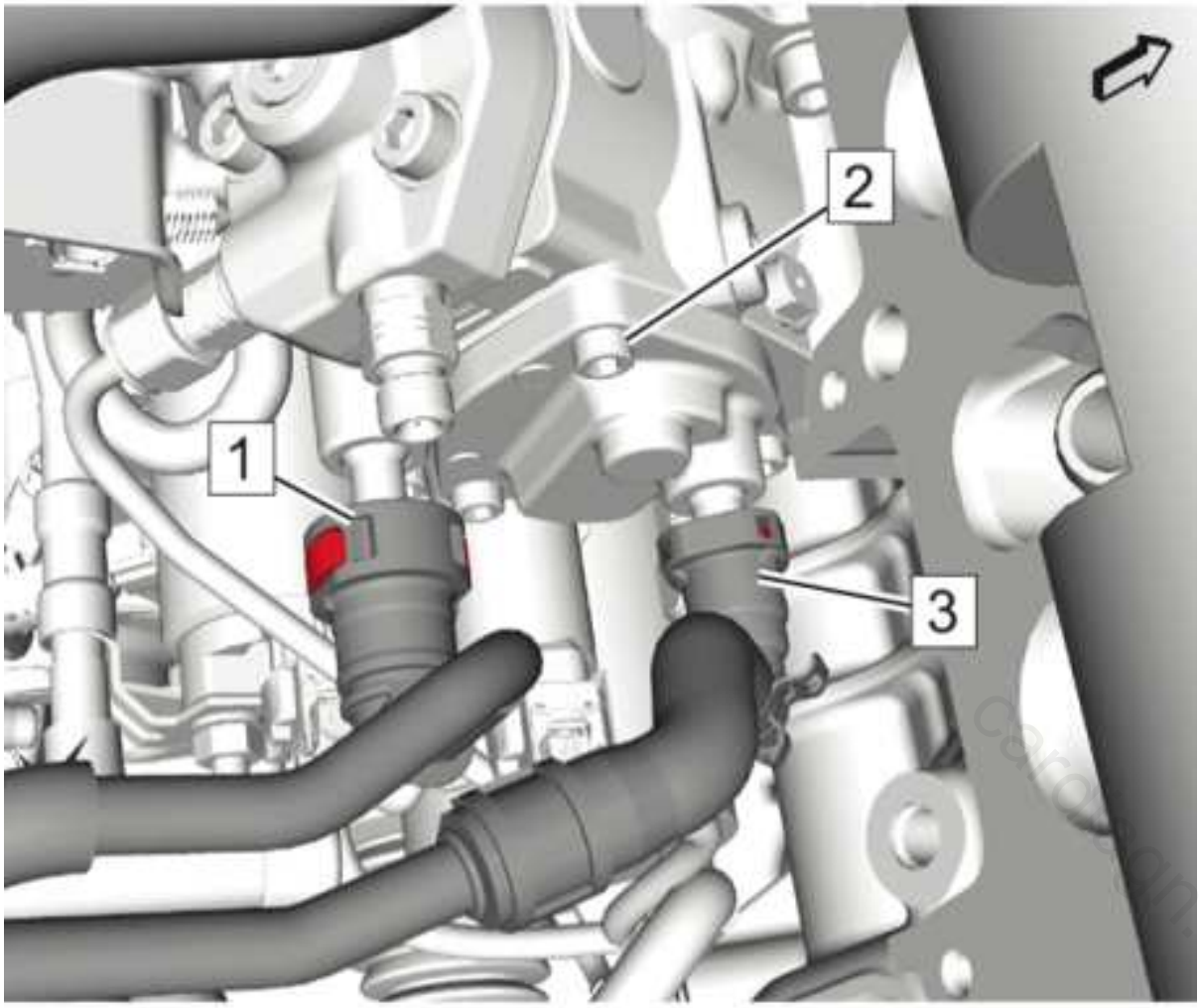

Fig. 195: Fuel Feed Pipe, Fuel Injection Pump And Diesel Fuel Separator
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect Fuel Feed Pipe (1) @ Fuel Injection Pump (2). Refer to **Plastic Collar Quick Connect Fitting Service**
6. Disconnect Diesel Fuel Separator (3) @ Fuel Injection Pump (2). Refer to **Plastic Collar Quick Connect Fitting Service**
7. Close all open connectors with suitable closure plug.

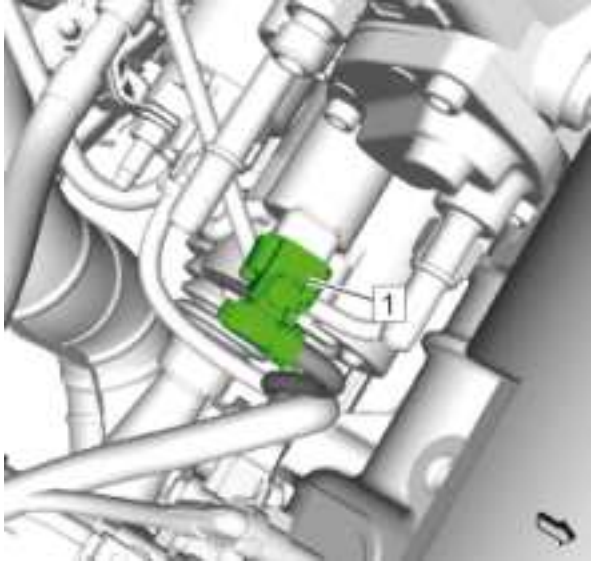

Fig. 196: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the electrical connector. (1)

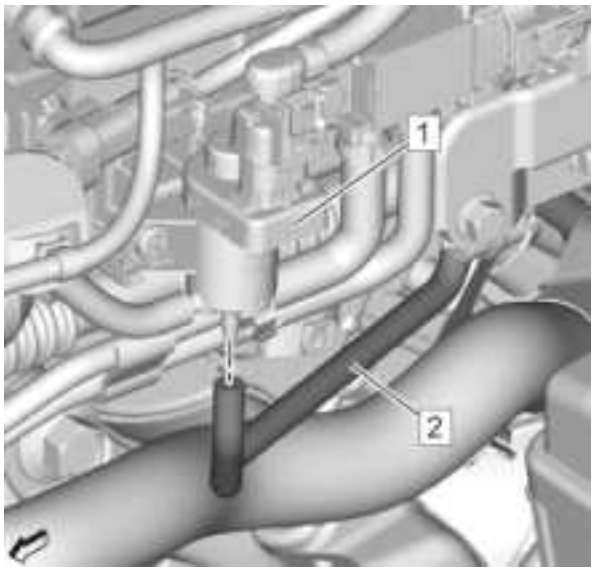

Fig. 197: Charge Air Bypass Regulator Solenoid Valve Inlet Tube And Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect Charge Air Bypass Regulator Solenoid Valve Inlet Tube (2) @ Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve (1)

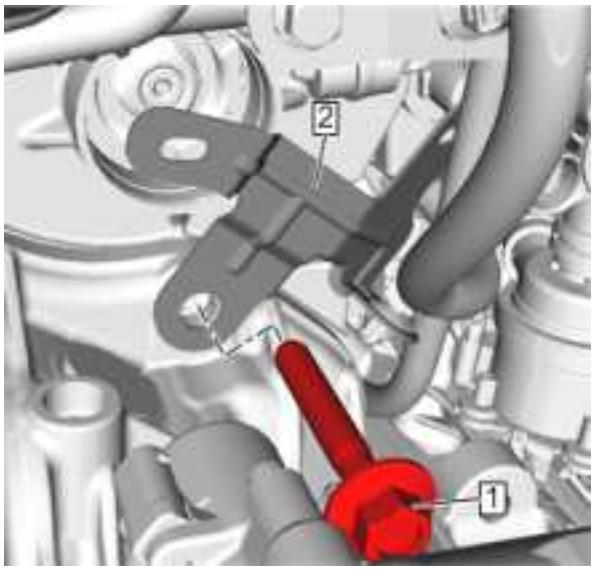

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Fig. 198: Engine Wiring Harness Bracket And Transmission Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove Transmission Bolt (1)
11. Reposition Engine Wiring Harness Bracket (2)

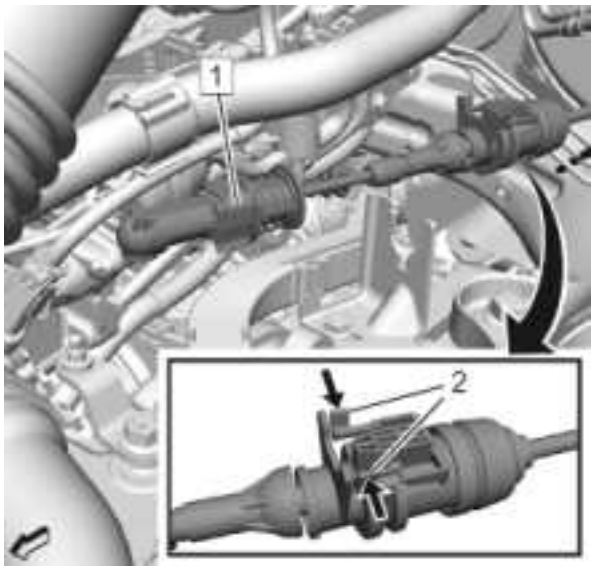

Fig. 199: Range Selector Lever Cable
Courtesy of GENERAL MOTORS COMPANY

12. Remove Range Selector Lever Cable (1) @ Range Selector Lever Cable Lever - Use a suitable tool.
13. Remove Range Selector Lever Cable (1) @ Transmission Range Selector Lever Cable Bracket

    Push (arrows) the tabs (2) to release the range selector lever cable.

14. Position aside Range Selector Lever Cable (1)

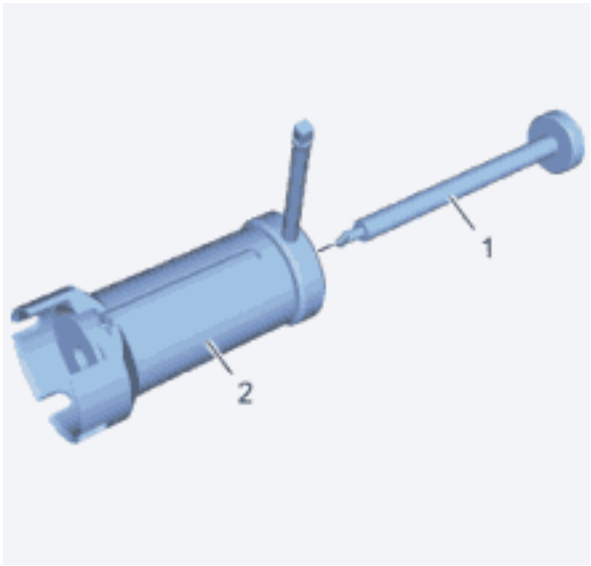

Fig. 200: Special Tools
Courtesy of GENERAL MOTORS COMPANY

15. Install the spike (1) to the **EN-50885-1** remover (2).

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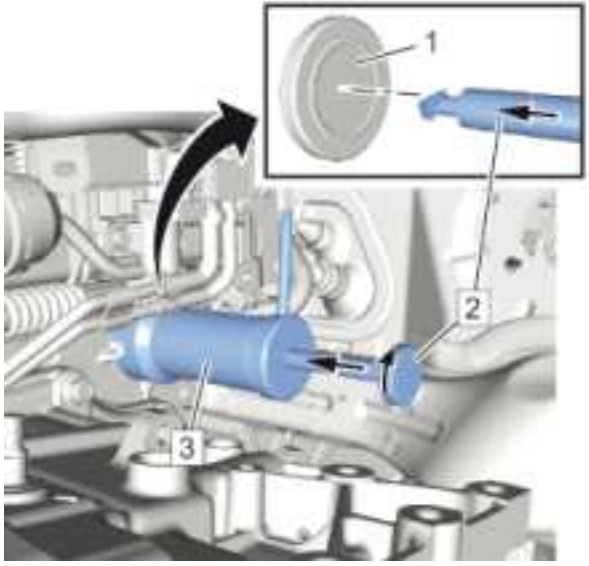

Fig. 201: Fuel Injection Pump Sprocket Access Hole Plug And Special Tools
Courtesy of GENERAL MOTORS COMPANY

16. Install **EN-50885-1** remover (3)
17. Press the spike (2) into the fuel injection pump sprocket access hole plug (1).
18. Turn the spike 90 degrees to secure it to the fuel injection pump sprocket access hole plug.

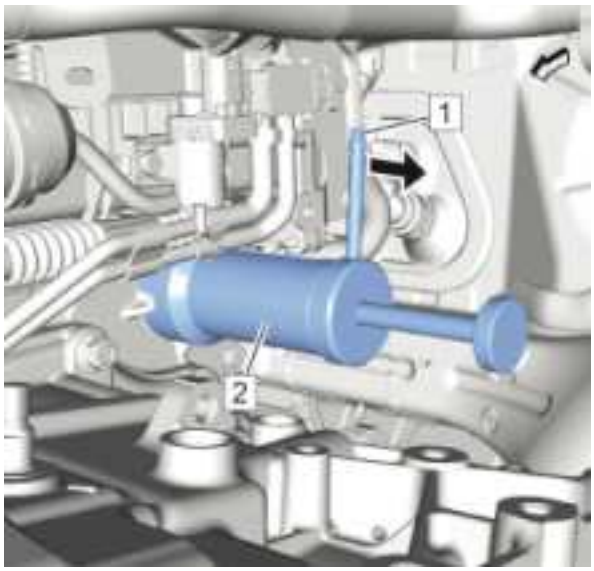

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Fig. 202: Fuel Injection Pump Sprocket Access Hole Plug And Special Tools
Courtesy of GENERAL MOTORS COMPANY

19. Remove the fuel injection pump sprocket access hole plug by exerting a strong pull at the handle (1) of the **EN-50885-1** remover (2).

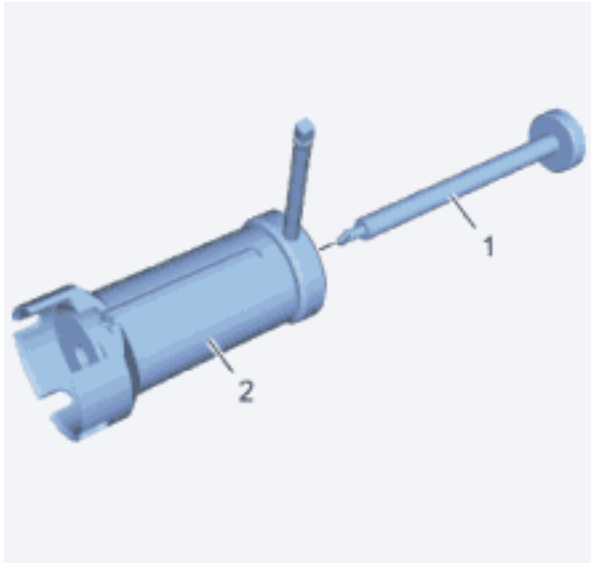

Fig. 203: Special Tools
Courtesy of GENERAL MOTORS COMPANY

20. Remove the spike (1) from the **EN-50885-1** remover (2).

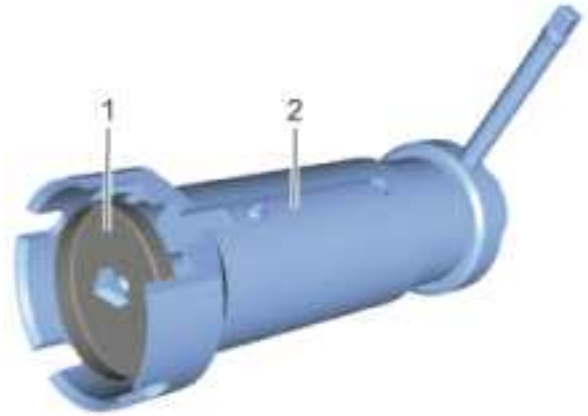

Fig. 204: Fuel Injection Pump Sprocket Access Hole Plug And Special Tool
Courtesy of GENERAL MOTORS COMPANY

21. Remove and DISCARD the fuel injection pump sprocket access hole plug (1) from the **EN-50885-1** remover (2).

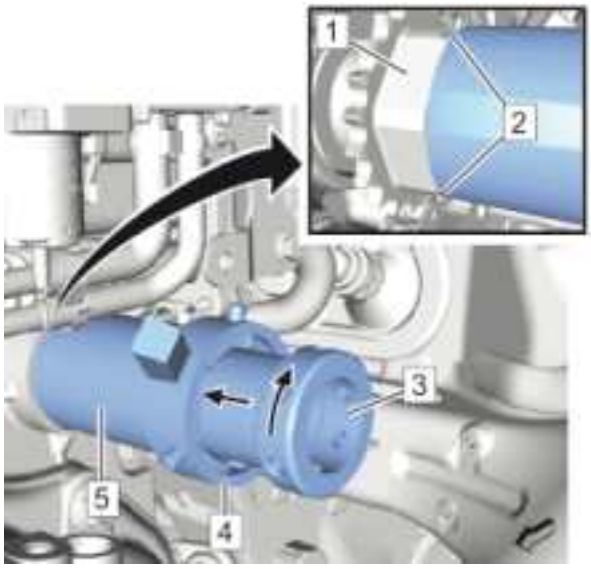

Fig. 205: Fuel Injection Pump Driven Sprocket, Tappets And Special Tools
Courtesy of GENERAL MOTORS COMPANY

22. Install **EN-50885-2** fixing tool (3)
    1. Install the housing (5) to the fuel injection pump driven sprocket. Ensure that the 3 tappets (2) mesh with the 3 slots of the fuel injection pump driven sprocket (1).
    2. Position the ring (4) to allow for installation of a 1/2 inch-drive extension.
    3. Screw the fixing tool (3) into the fuel injection pump driven sprocket.

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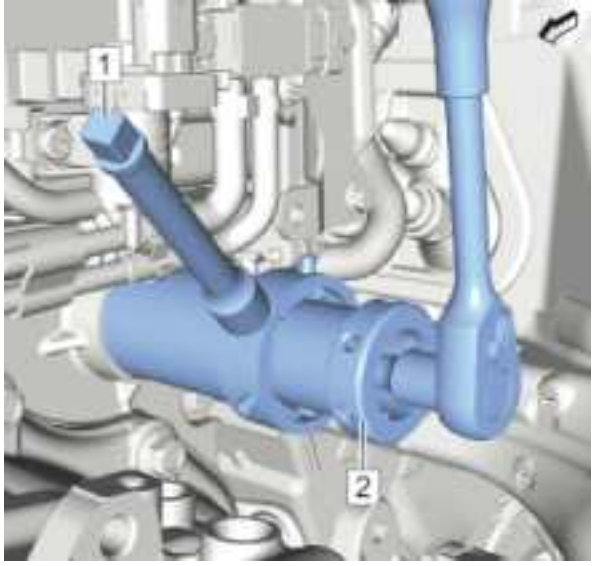

Fig. 206: Extension And Special Tool
Courtesy of GENERAL MOTORS COMPANY

23. Install a 1/2 inch-drive extension (1) to the **EN-50885-2** fixing tool (2) to counterhold.
24. Loosen Fuel Injection Pump Drive Pulley Nut

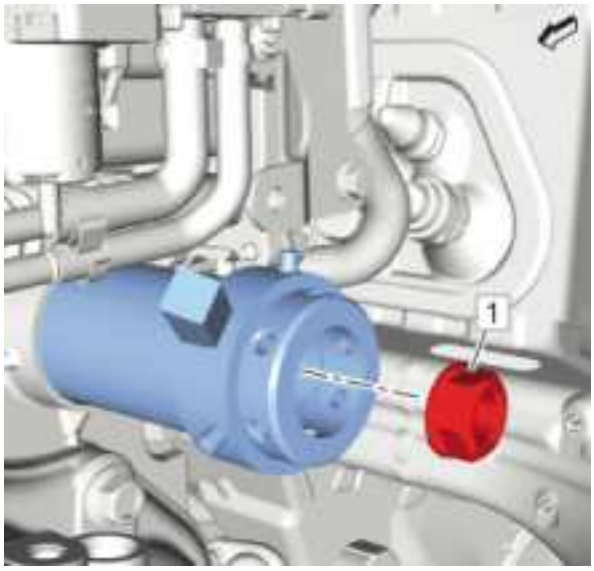

Fig. 207: Fuel Injection Pump Drive Pulley Nut
Courtesy of GENERAL MOTORS COMPANY

25. Remove Fuel Injection Pump Drive Pulley Nut (1)

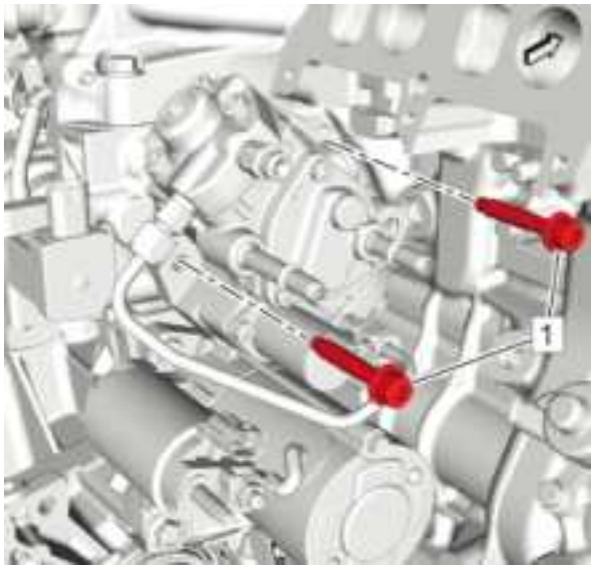

Fig. 208: Fuel Injection Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

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26. Remove Fuel Injection Pump Bolts (1) (Qty: 2)

Fig. 209: Special Tools
Courtesy of GENERAL MOTORS COMPANY

27. Install the pressure spindle (2) to the **EN-50885-2** fixing tool (1).

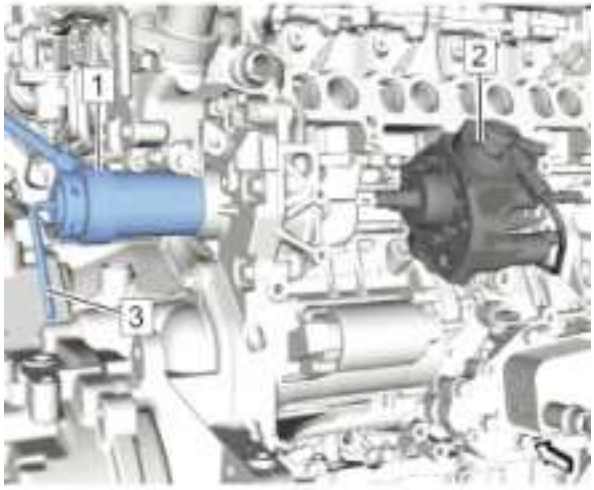

Fig. 210: Fuel Injection Pump And Special Tools
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **DO NOT press out the fuel injection pump with the pressure spindle. Doing so can result in damage to the fuel injection pump driven sprocket.**

28. Loosen the fuel injection fuel pump sprocket, by screwing in the pressure spindle with a hexagon socket wrench (3) into the **EN-50885-2** fixing tool (1) until the fuel injection pump sprocket is disengaged.
29. Remove Fuel Injection Pump (2)

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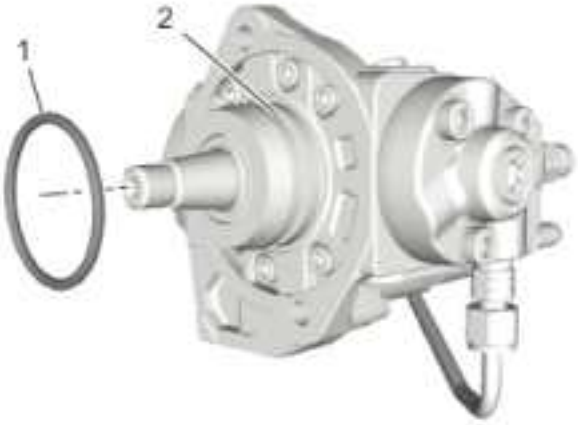

Fig. 211: Fuel Injection Pump Throttle Shaft Seal And Fuel Injection Pump Sealing Groove
Courtesy of GENERAL MOTORS COMPANY

30. Remove and DISCARD the fuel injection pump throttle shaft seal (1) from the fuel injection pump sealing groove (2).

Installation Procedure

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Fig. 212: Special Tools
Courtesy of GENERAL MOTORS COMPANY

1. Remove the pressure spindle (2) from the **EN-50885-2** fixing tool (1).

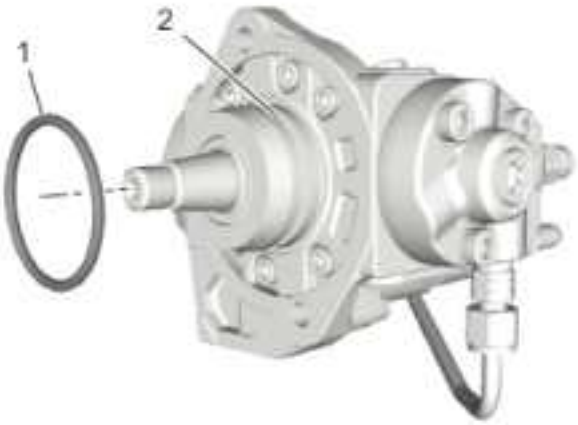

Fig. 213: Fuel Injection Pump Throttle Shaft Seal And Fuel Injection Pump Sealing Groove
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW fuel injection pump throttle shaft seal (1) to the fuel injection pump sealing groove (2).

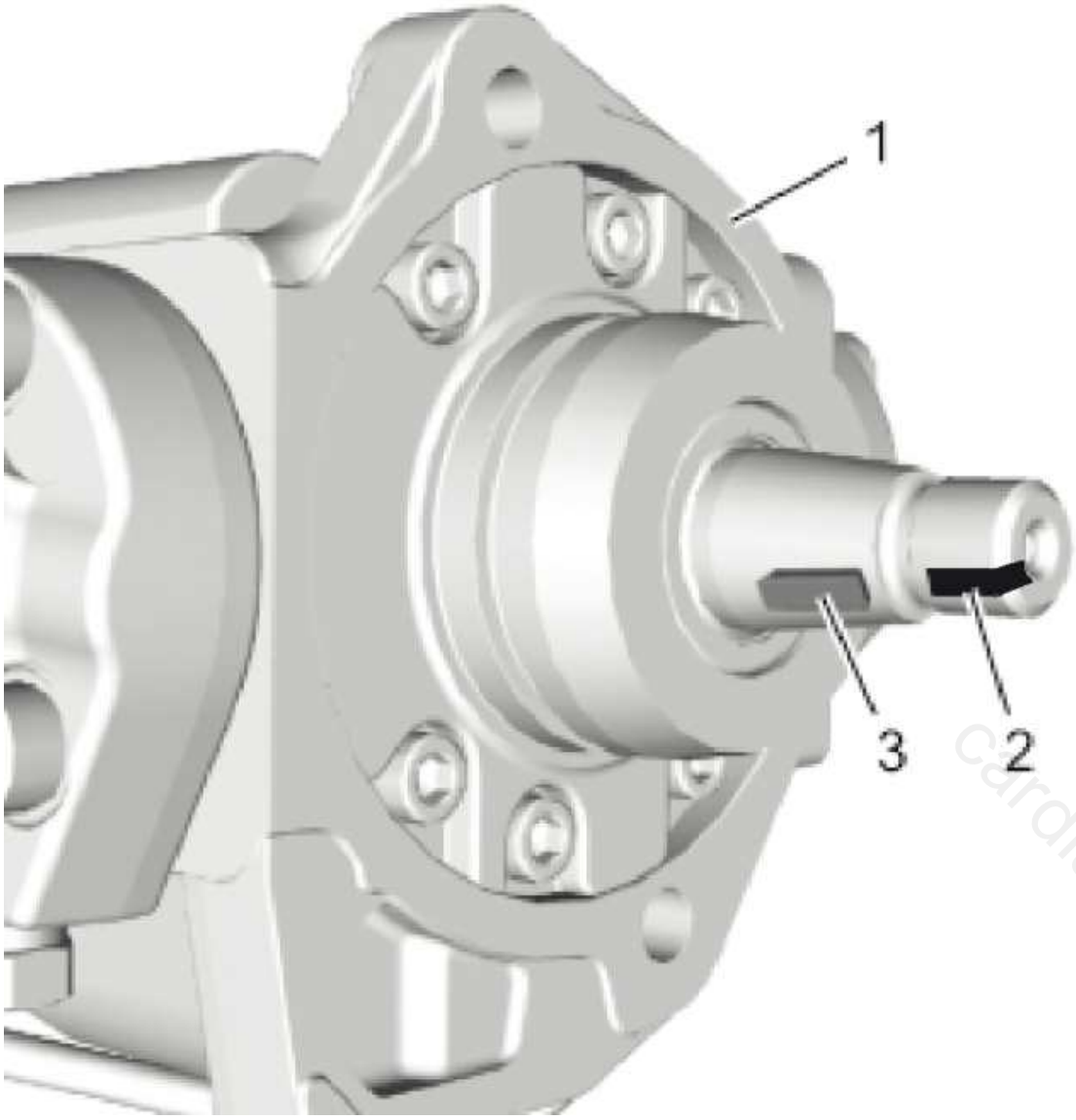

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Fig. 214: Mark Position Of Wedge With Paint Mark On End Of Fuel Injection Fuel Pump Shaft
Courtesy of GENERAL MOTORS COMPANY

3. Mark the position of the wedge (3) with a paint mark (2) on the end of the fuel injection fuel pump (1) shaft.

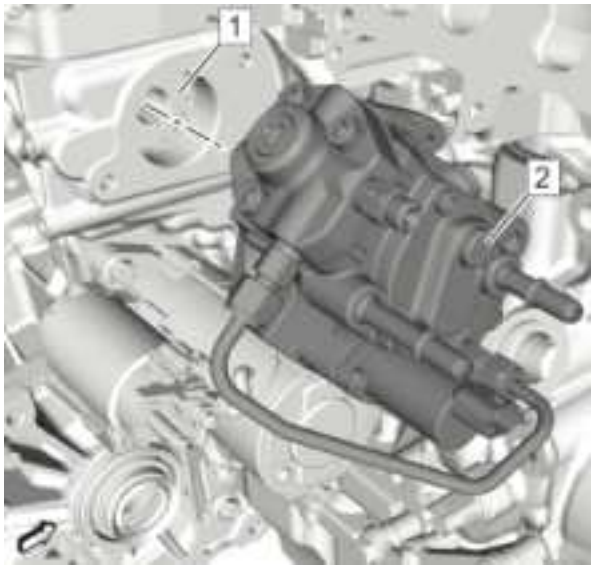

Fig. 215: Fuel Injection Pump, Fuel Injection Pump Sprocket And Sprocket Groove
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Position the fuel pump shaft in order to align the wedge with the fuel injection pump sprocket groove.**

4. Position the fuel injection pump (2) to the fuel injection pump sprocket and the sprocket groove (1).

Fig. 216: Fuel Injection Pump Sprocket, Paint Mark And Sprocket Groove
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use a mirror to see the fuel injection pump sprocket from the transmission side.**

5. Position the fuel injection pump to the fuel injection pump sprocket (2).
    1. Turn the fuel injection pump so that the paint mark (1) matches with the sprocket groove (3).
    2. Press in the fuel injection pump.

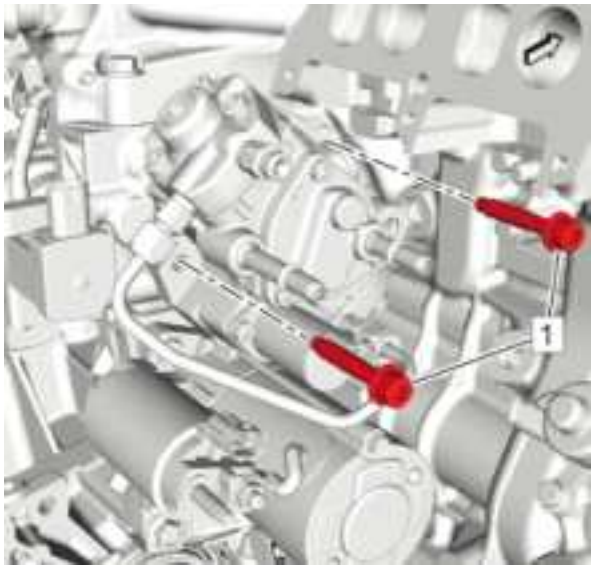

Fig. 217: Fuel Injection Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

6. Install and tighten Fuel Injection Pump Bolts (1) (Qty: 2) to 25 N.m (18 lb ft)

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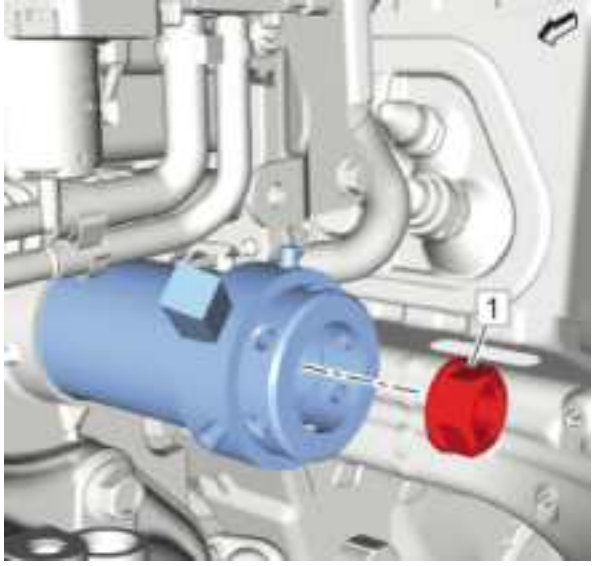

Fig. 218: Fuel Injection Pump Drive Pulley Nut
Courtesy of GENERAL MOTORS COMPANY

7. Install Fuel Injection Pump Drive Pulley Nut (1)

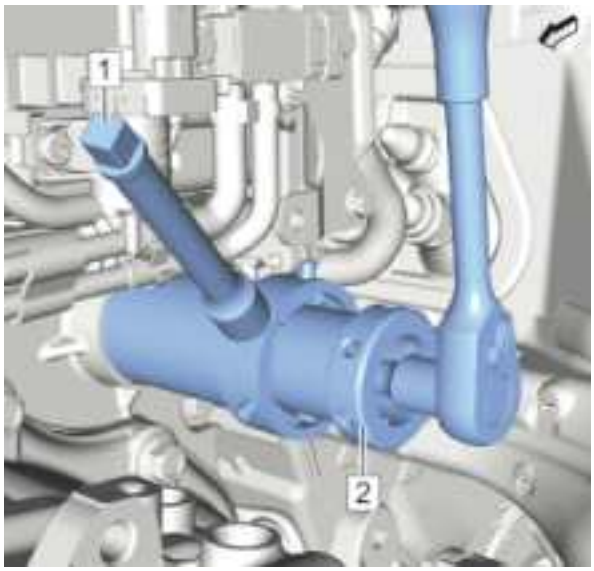

Fig. 219: Extension And Special Tool
Courtesy of GENERAL MOTORS COMPANY

8. Install a 1/2 inch-drive extension (1) to the **EN-50885-2** fixing tool (2) to counterhold.
9. Tighten Fuel Injection Pump Drive Pulley Nut to 64 N.m (47 lb ft)
10. Remove the 1/2 inch-drive extension (1).
11. Remove **EN-50885-2** fixing tool (2)

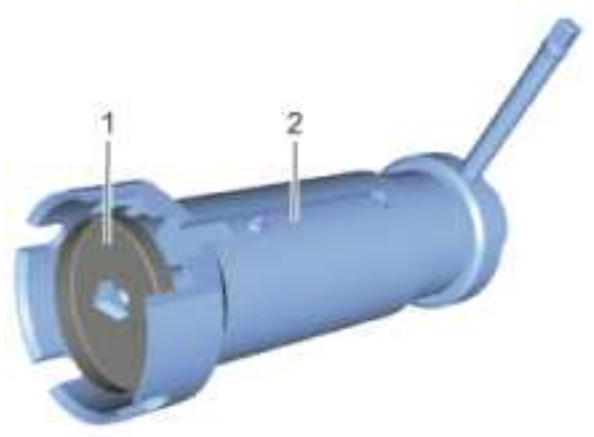

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Fig. 220: Fuel Injection Pump Sprocket Access Hole Plug And Special Tool
Courtesy of GENERAL MOTORS COMPANY

12. Install the NEW fuel injection pump sprocket access hole plug (1) onto the **EN-50885-1** installer (2).

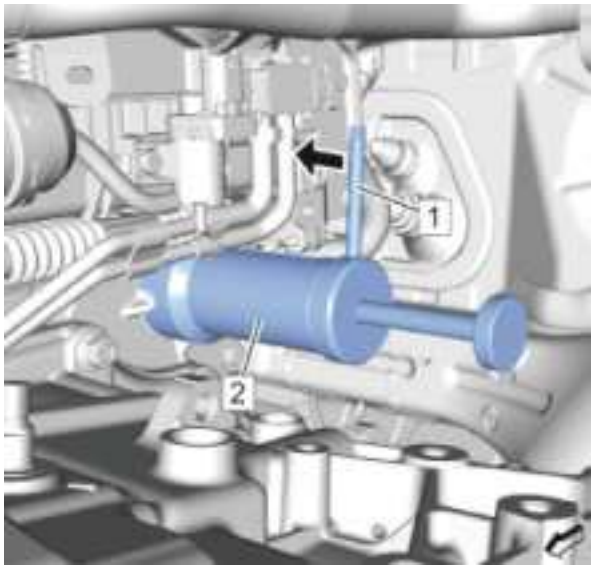

Fig. 221: Special Tools
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the EN-50885-1 installer on the timing chain lower housing rests against.**

13. Install the fuel injection pump sprocket access hole plug by hitting the handle (1) of the **EN-50885-1** installer (2).

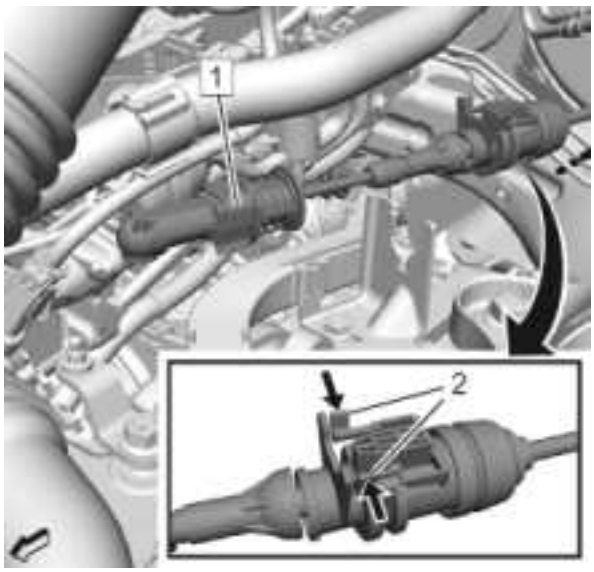

Fig. 222: Range Selector Lever Cable
Courtesy of GENERAL MOTORS COMPANY

14. Install Range Selector Lever Cable (1) @ Transmission Range Selector Lever Cable Bracket

    Push the range selector lever cable into the bracket.

15. Install Range Selector Lever Cable (1) @ Range Selector Lever Cable Lever

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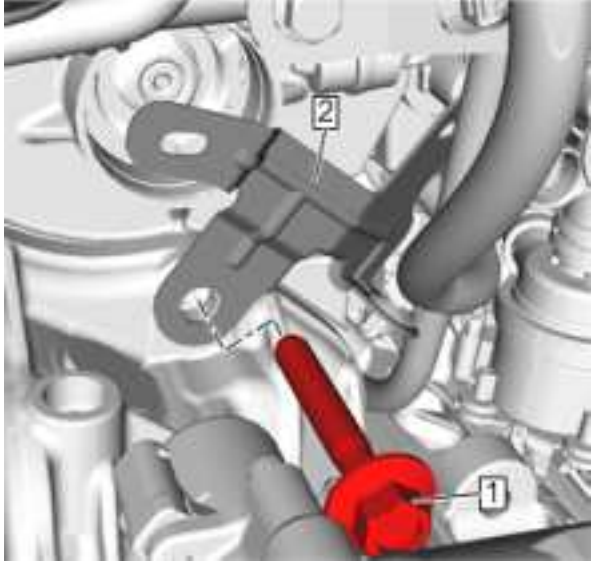

Fig. 223: Engine Wiring Harness Bracket And Transmission Bolt
Courtesy of GENERAL MOTORS COMPANY

16. Reposition Engine Wiring Harness Bracket (2)
17. Install and tighten Transmission Bolt (1) to 58 N.m (43 lb ft)

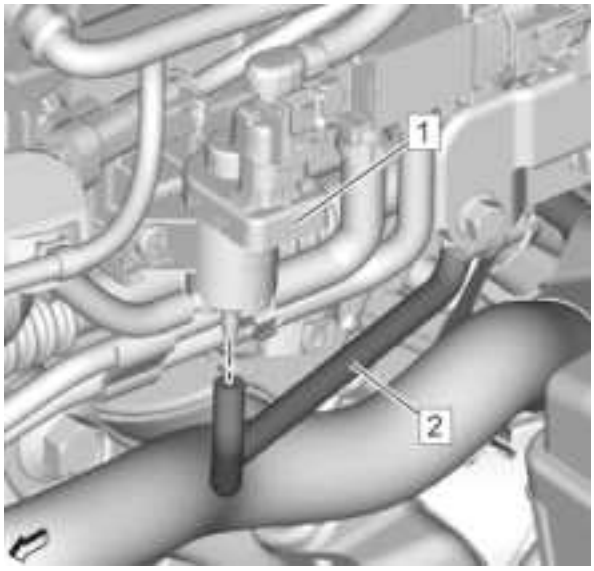

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Fig. 224: Charge Air Bypass Regulator Solenoid Valve Inlet Tube And Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

18. Connect Charge Air Bypass Regulator Solenoid Valve Inlet Tube (2) @ Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve (1)

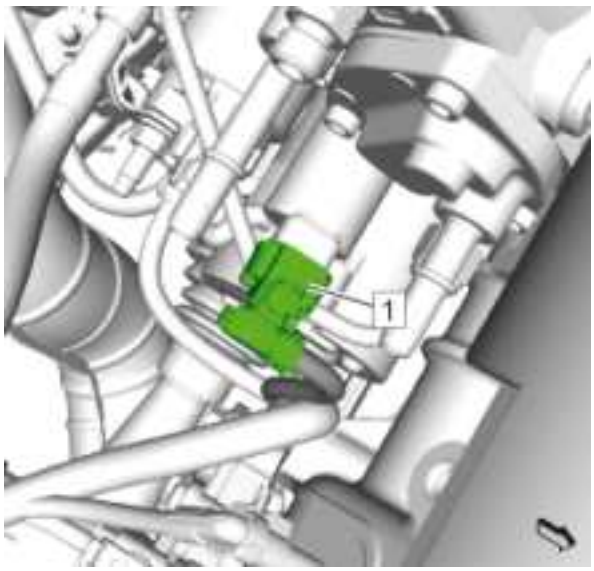

Fig. 225: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

19. Connect the electrical connector. (1)

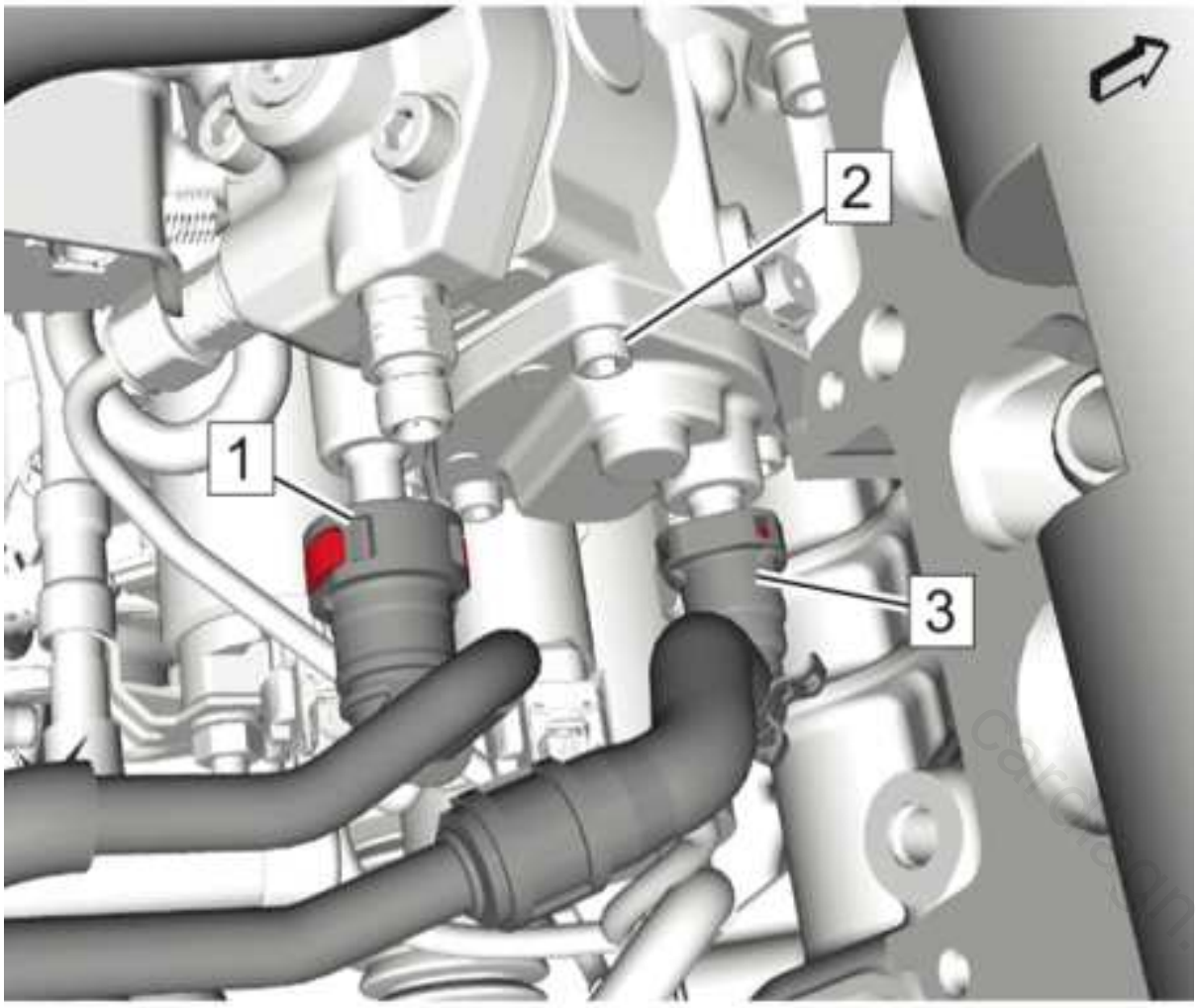

Fig. 226: Fuel Feed Pipe, Fuel Injection Pump And Diesel Fuel Separator
Courtesy of GENERAL MOTORS COMPANY

20. Connect Diesel Fuel Separator (3) @ Fuel Injection Pump (2). Refer to **Plastic Collar Quick Connect Fitting Service**
21. Connect Fuel Feed Pipe (1) @ Fuel Injection Pump (2). Refer to **Plastic Collar Quick Connect Fitting Service**
22. Install the intake manifold. Refer to **Intake Manifold Replacement**
23. Install the auxiliary fluid accumulator. Refer to **Auxiliary Fluid Accumulator Replacement (Equinox)** **Auxiliary Fluid Accumulator Replacement (Terrain)**
24. Install the engine control module. Refer to **Engine Control Module Bracket Replacement**
25. Check the fuel system for leaks. Refer to **Fuel Leak Diagnosis**
26. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

FUEL INJECTION PUMP REPLACEMENT

Special Tools

EN-50885-1 Remover/Installer

EN-50885-2 Fixing Tool

Equivalent regional tools: **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

Removal Procedure

WARNING: **Always wear safety goggles when working with fuel in order to protect the eyes from fuel splash.**

WARNING: **Refer to Diesel/Gasoline Vapors Warning**

NOTE: **Be very thorough in terms of cleanliness when working in the fuel system. Malfunctions can also occur due to very small dirt particles. Prevent dirt from entering the fuel system by cleaning the hoses and plugging the pipes and lines upon removal. Store the components so that contaminants cannot enter.**

1. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
2. Remove the intake manifold. Refer to **Intake Manifold Replacement**
3. Remove the engine control module bracket. Refer to **Engine Control Module Bracket Replacement**
4. Remove the auxiliary fluid accumulator. Refer to **Auxiliary Fluid Accumulator Replacement (Equinox)** **Auxiliary Fluid Accumulator Replacement (Terrain)**

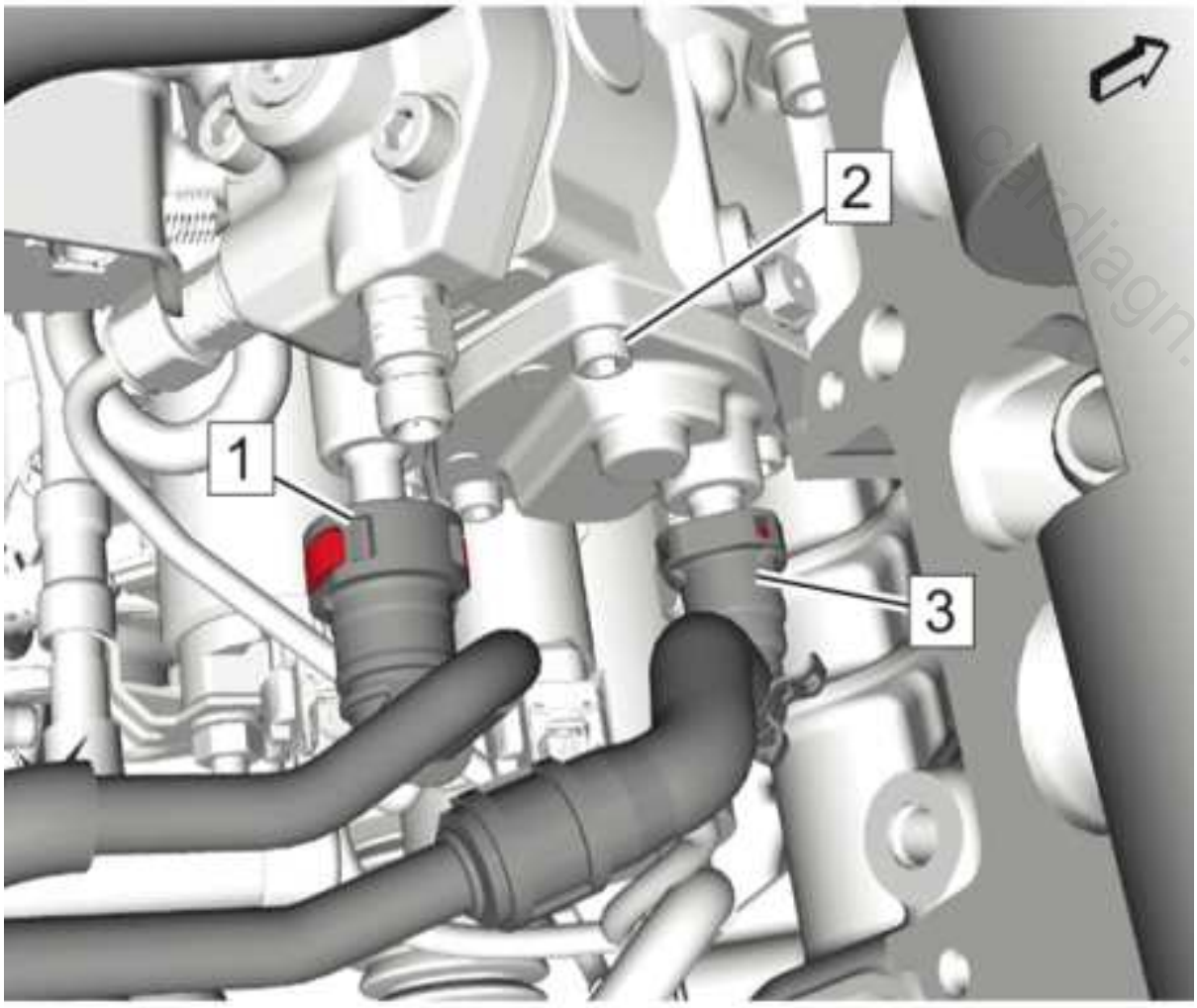

Fig. 227: Fuel Feed Pipe, Fuel Injection Pump And Diesel Fuel Separator
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect Fuel Feed Pipe (1) @ Fuel Injection Pump (2). Refer to **Plastic Collar Quick Connect Fitting Service**
6. Disconnect Diesel Fuel Separator (3) @ Fuel Injection Pump (2). Refer to **Plastic Collar Quick Connect Fitting Service**

7. Close all open connectors with suitable closure plugs.

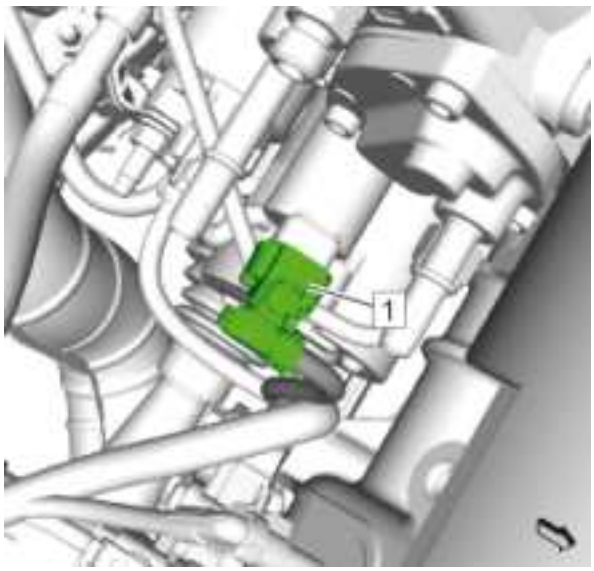

Fig. 228: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the electrical connector. (1)

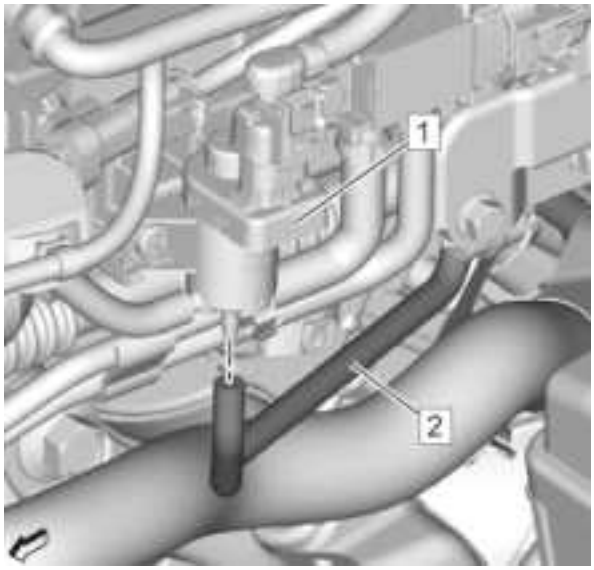

Fig. 229: Charge Air Bypass Regulator Solenoid Valve Inlet Tube And Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect Charge Air Bypass Regulator Solenoid Valve Inlet Tube (2) @ Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve (1)

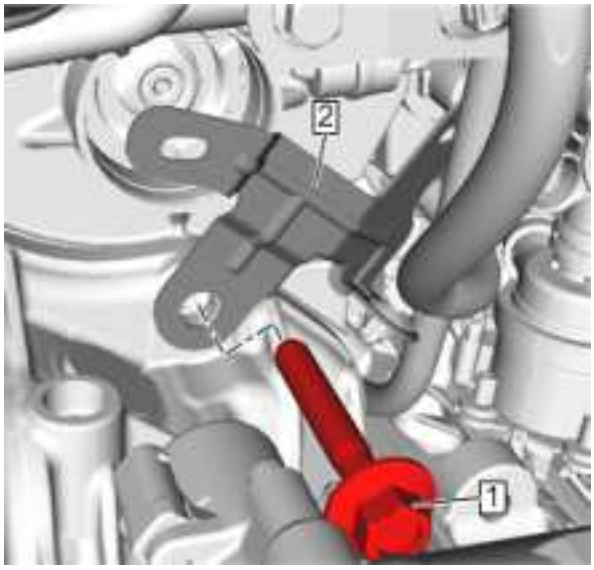

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Fig. 230: Engine Wiring Harness Bracket And Transmission Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove Transmission Bolt (1)
11. Reposition Engine Wiring Harness Bracket (2)

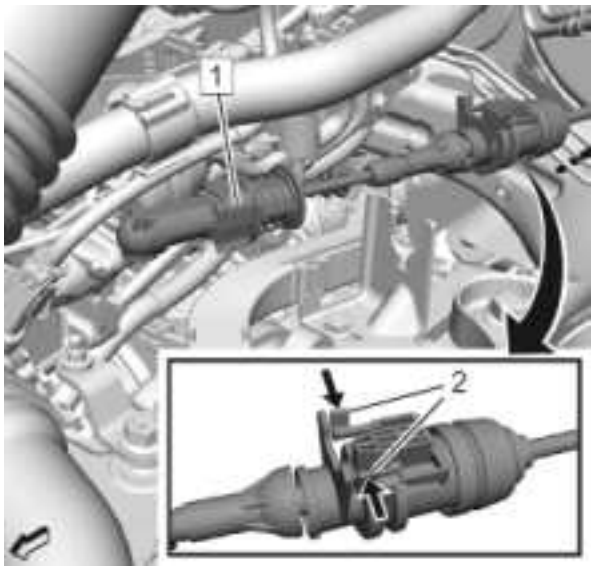

Fig. 231: Range Selector Lever Cable
Courtesy of GENERAL MOTORS COMPANY

12. Remove Range Selector Lever Cable (1) @ Range Selector Lever Cable Lever - Use a suitable tool.
13. Remove Range Selector Lever Cable (1) @ Transmission Range Selector Lever Cable Bracket

    Push (arrows) the tabs (2) to release the range selector lever cable.

14. Position aside Range Selector Lever Cable (1)

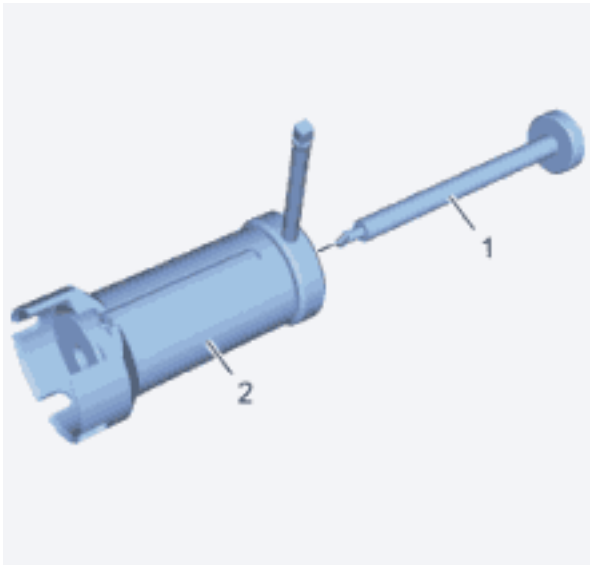

Fig. 232: Special Tools
Courtesy of GENERAL MOTORS COMPANY

15. Install the spike (1) to the **EN-50885-1** remover (2).

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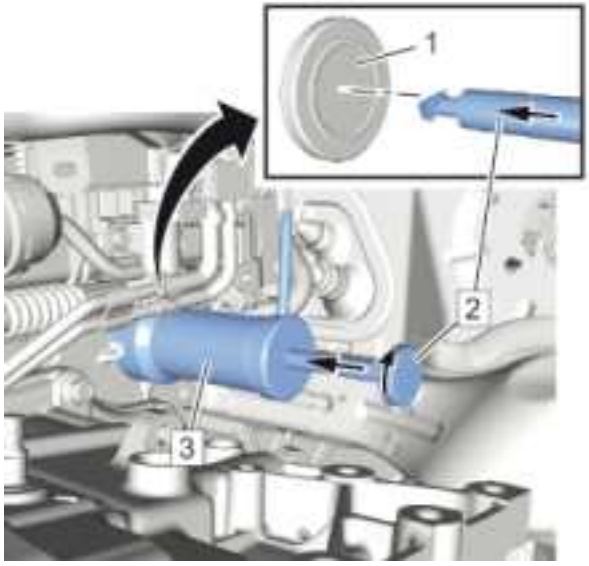

Fig. 233: Fuel Injection Pump Sprocket Access Hole Plug And Special Tools
Courtesy of GENERAL MOTORS COMPANY

16. Install **EN-50885-1** remover (3)
17. Press the spike (2) into the fuel injection pump sprocket access hole plug (1).
18. Turn the spike 90 degrees to secure it to the fuel injection pump sprocket access hole plug.

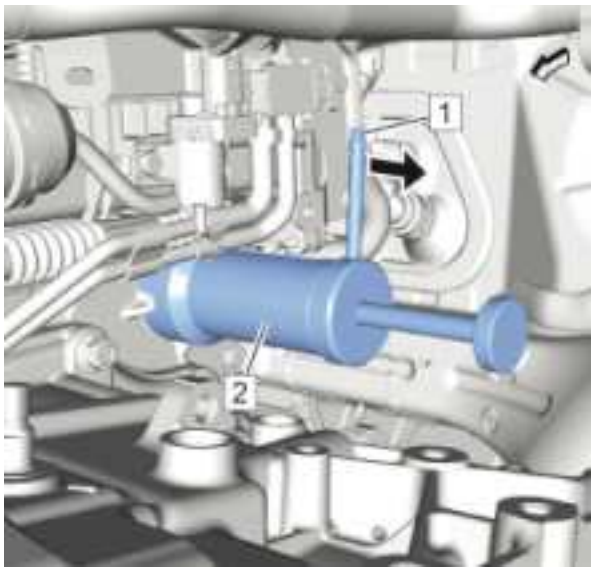

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Fig. 234: Fuel Injection Pump Sprocket Access Hole Plug And Special Tools
Courtesy of GENERAL MOTORS COMPANY

19. Remove the fuel injection pump sprocket access hole plug by exerting a strong pull at the handle (1) of the **EN-50885-1** remover (2).

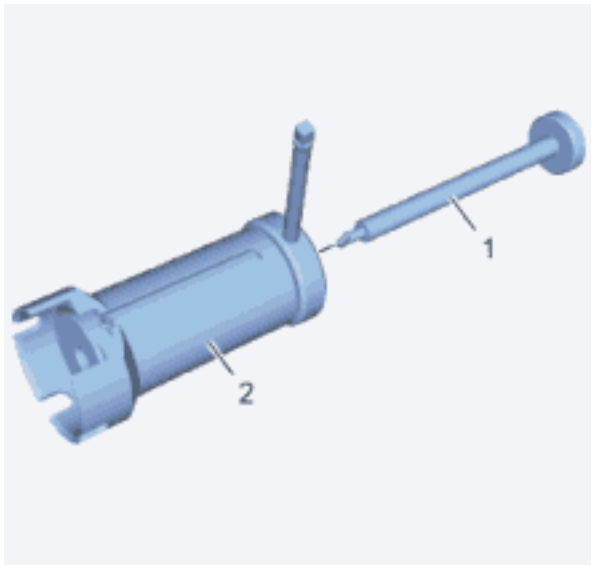

Fig. 235: Special Tools
Courtesy of GENERAL MOTORS COMPANY

20. Remove the spike (1) from the **EN-50885-1** remover (2).

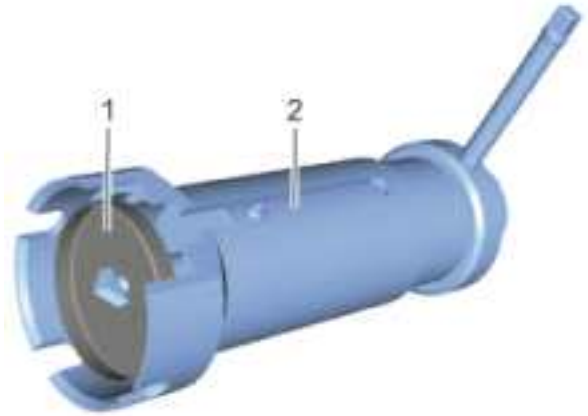

Fig. 236: Fuel Injection Pump Sprocket Access Hole Plug And Special Tool
Courtesy of GENERAL MOTORS COMPANY

21. Remove and DISCARD the fuel injection pump sprocket access hole plug (1) from the **EN-50885-1** remover (2).

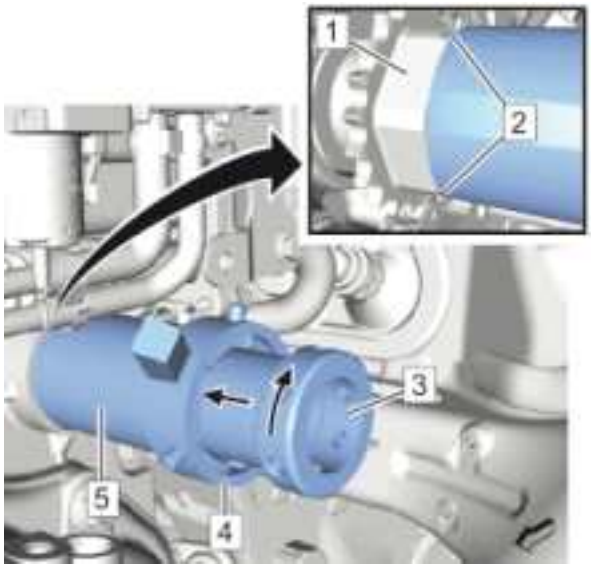

Fig. 237: Fuel Injection Pump Driven Sprocket, Tappets And Special Tools
Courtesy of GENERAL MOTORS COMPANY

22. Install **EN-50885-2** fixing tool (3)
    1. Install the housing (5) to the fuel injection pump driven sprocket. Ensure that the 3 tappets (2) mesh with the 3 slots of the fuel injection pump driven sprocket (1).
    2. Position the ring (4) to allow for installation of a 1/2 inch-drive extension.
    3. Screw the fixing tool (3) into the fuel injection pump driven sprocket.

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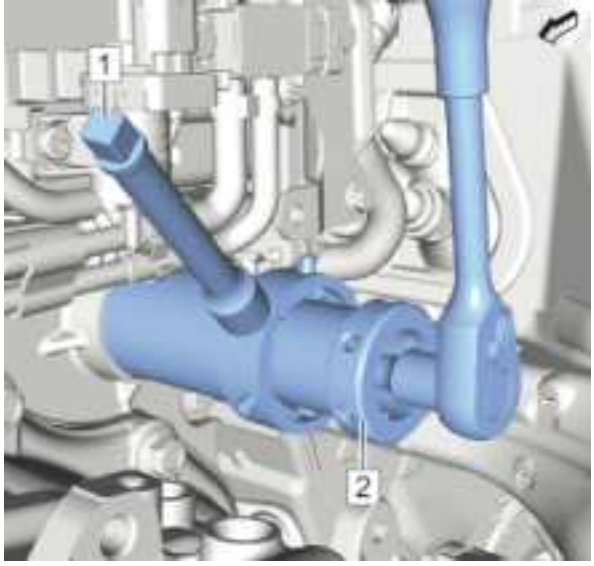

Fig. 238: Extension And Special Tool
Courtesy of GENERAL MOTORS COMPANY

23. Install a 1/2 inch-drive extension (1) to the **EN-50885-2** fixing tool (2) to counterhold.
24. Loosen Fuel Injection Pump Drive Pulley Nut

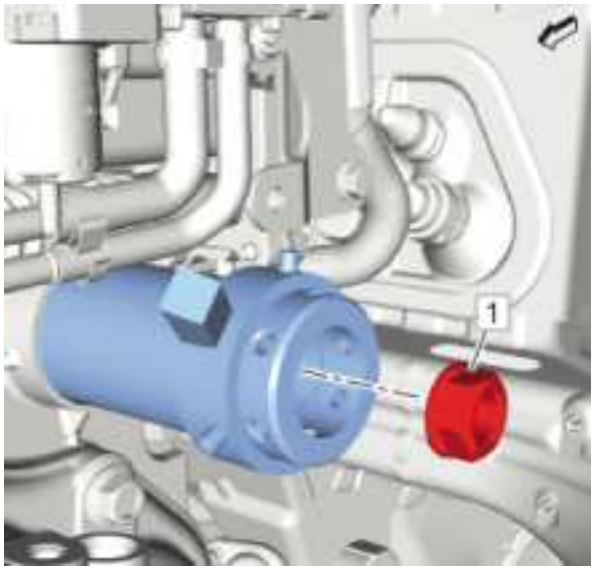

Fig. 239: Fuel Injection Pump Drive Pulley Nut
Courtesy of GENERAL MOTORS COMPANY

25. Remove Fuel Injection Pump Drive Pulley Nut (1)

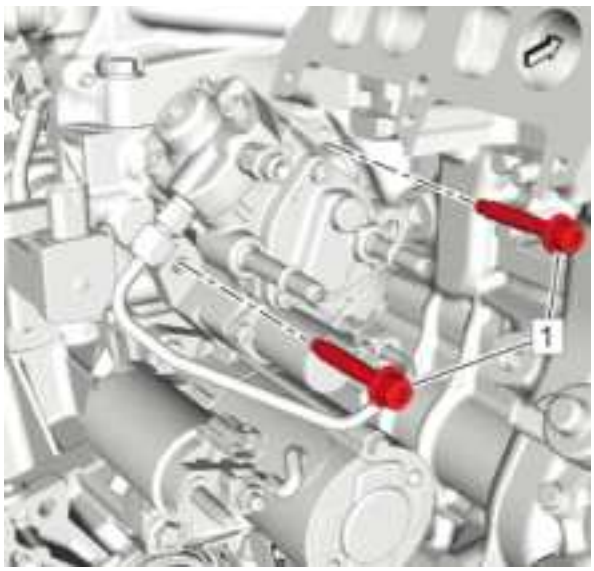

Fig. 240: Fuel Injection Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

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26. Remove Fuel Injection Pump Bolts (1) (Qty: 2)

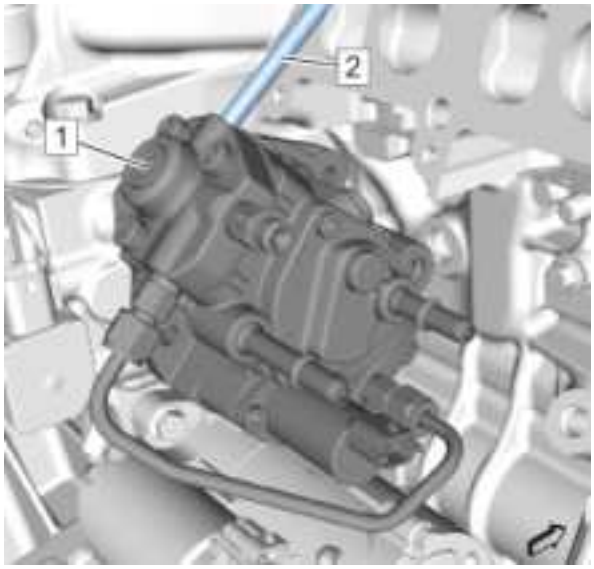

Fig. 241: Fuel Injection Pump And Suitable Aluminum Punch
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Only loosen the fuel injection fuel pump with light hammer blows if the fuel injection fuel pump should be replaced.**

27. Use a suitable aluminum punch (2).
28. Loosen the fuel injection pump (1) by light hammer blows on the punch.

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Fig. 242: Special Tools
Courtesy of GENERAL MOTORS COMPANY

29. Install the pressure spindle (2) to the **EN-50885-2** fixing tool (1).

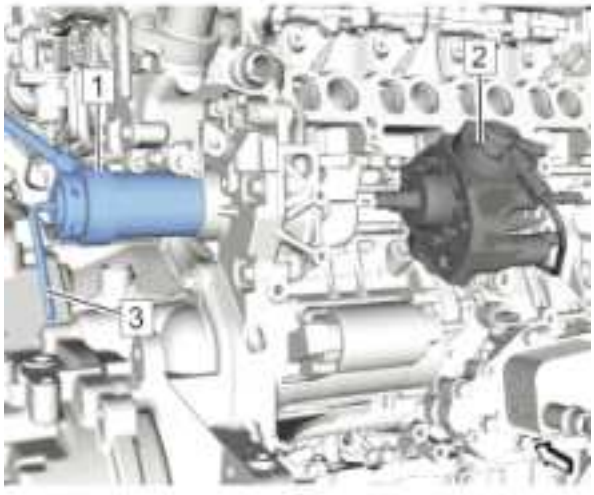

Fig. 243: Fuel Injection Pump And Special Tools
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **DO NOT press out the fuel injection pump with the pressure spindle. Doing so can result in damage to the fuel injection pump driven sprocket.**

30. Loosen the fuel injection fuel pump sprocket, by screwing in the pressure spindle with a hexagon socket wrench (3) into the **EN-50885-2** fixing tool (1) until the fuel injection pump sprocket is disengaged.
31. Remove Fuel Injection Pump (2)

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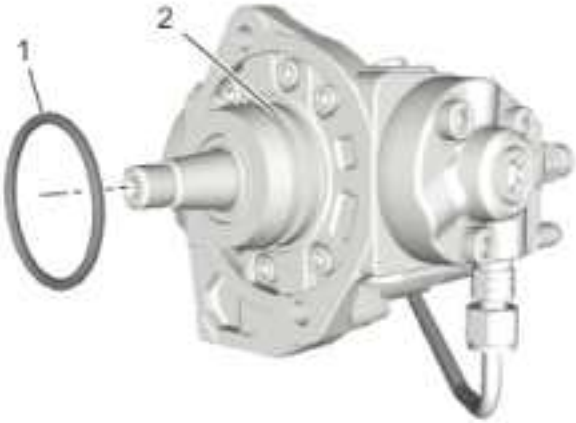

Fig. 244: Fuel Injection Pump Seal Ring And Fuel Injection Pump Sealing Groove
Courtesy of GENERAL MOTORS COMPANY

32. Remove and DISCARD the fuel injection pump seal ring (1) from the fuel injection pump sealing groove (2).

Installation Procedure

Fig. 245: Special Tools
Courtesy of GENERAL MOTORS COMPANY

1. Remove the pressure spindle (2) from the **EN-50885-2** fixing tool (1).

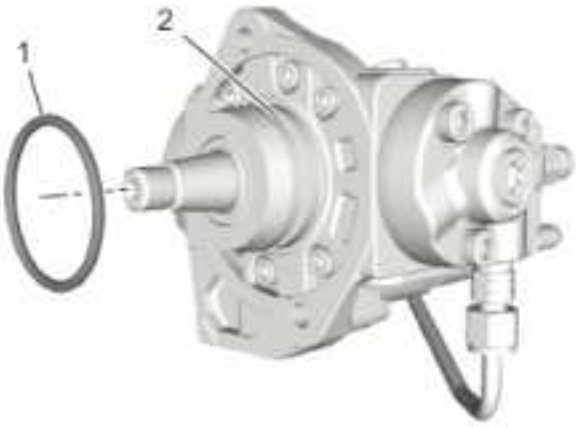

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Fig. 246: Fuel Injection Pump Seal Ring And Fuel Injection Pump Sealing Groove
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW fuel injection pump seal ring (1) to the fuel injection pump sealing groove (2).

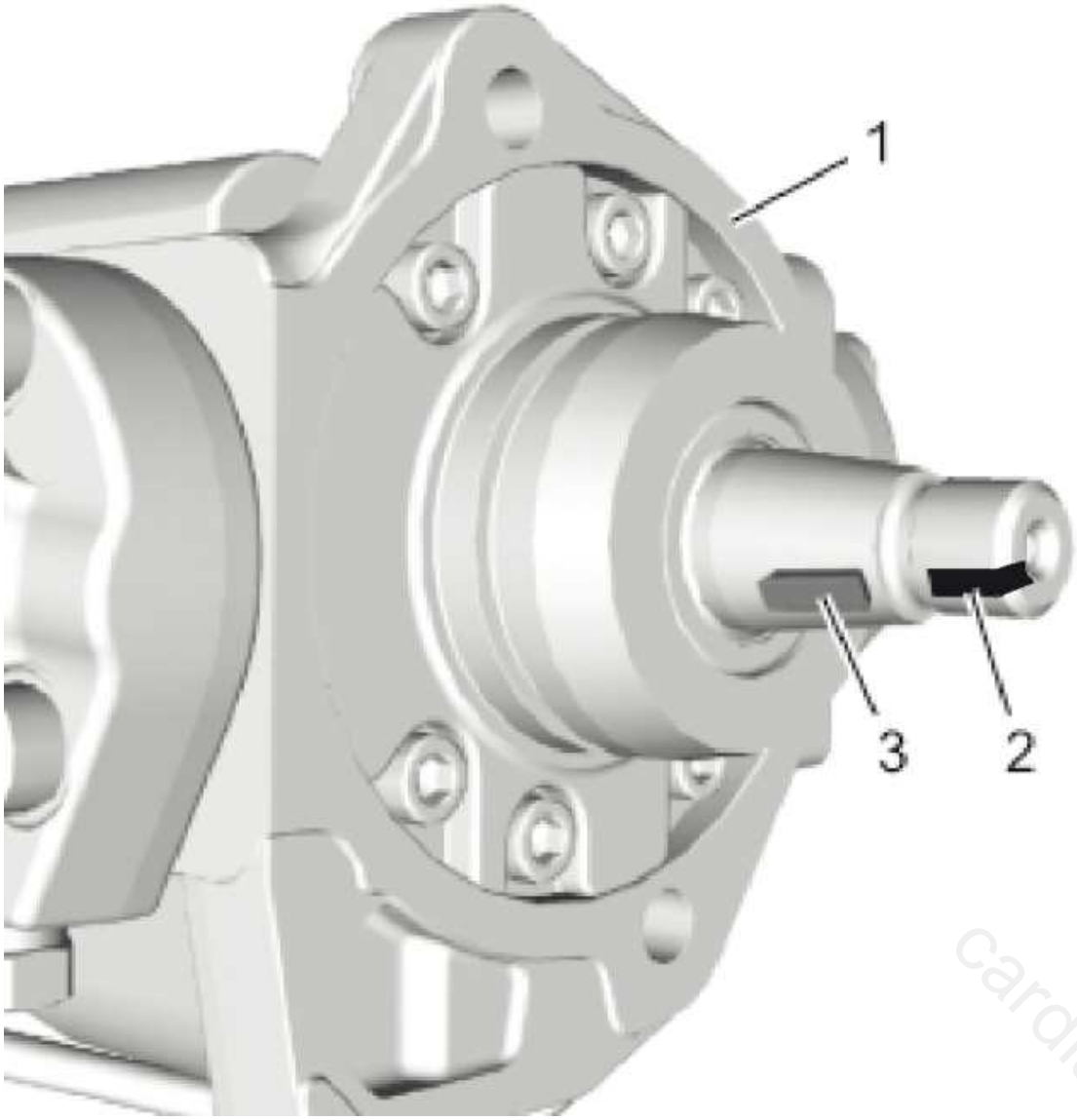

Fig. 247: Mark Position Of Wedge With Paint Mark On End Of Fuel Injection Fuel Pump Shaft
Courtesy of GENERAL MOTORS COMPANY

3. Mark the position of the wedge (3) with a paint mark (2) on the end of the shaft of the fuel injection fuel pump (1).

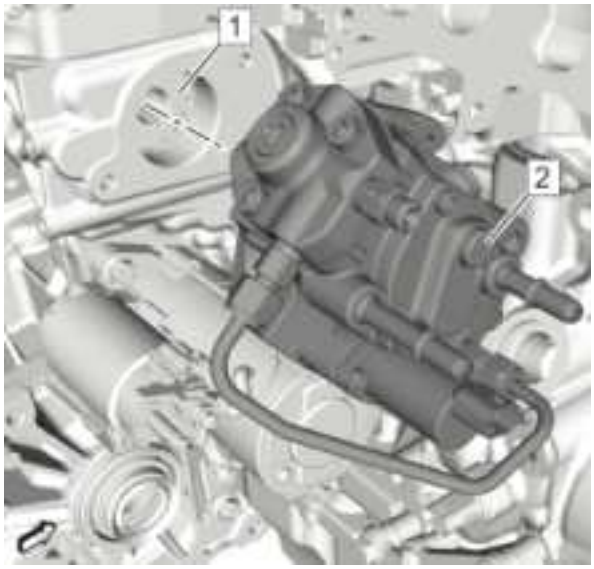

Fig. 248: Fuel Injection Pump, Fuel Injection Pump Sprocket And Sprocket Groove
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Position the fuel pump shaft in order to align the wedge with the fuel injection pump sprocket groove.**

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4. Position the fuel injection pump (2) to the fuel injection pump sprocket and the sprocket groove (1).

Fig. 249: Fuel Injection Pump Sprocket, Paint Mark And Sprocket Groove
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use a mirror to see the fuel injection pump sprocket from the transmission side.**

5. Position the fuel injection pump to the fuel injection pump sprocket (2).
    1. Turn the fuel injection pump so that the paint mark (1) matches with the sprocket groove (3).
    2. Press in the fuel injection pump.

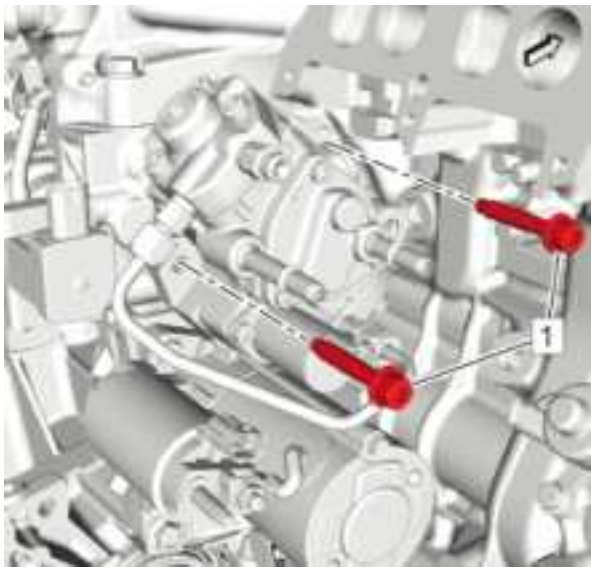

Fig. 250: Fuel Injection Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

6. Install and tighten Fuel Injection Pump Bolts (1) (Qty: 2) to 25 N.m (18 lb ft)

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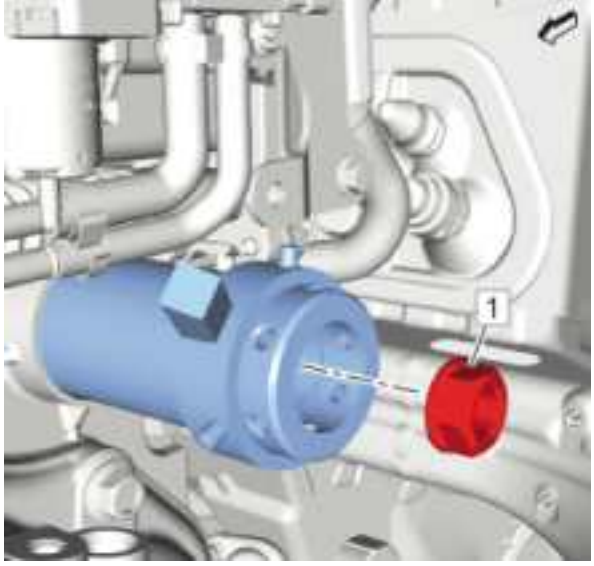

Fig. 251: Fuel Injection Pump Drive Pulley Nut
Courtesy of GENERAL MOTORS COMPANY

7. Install Fuel Injection Pump Drive Pulley Nut (1)

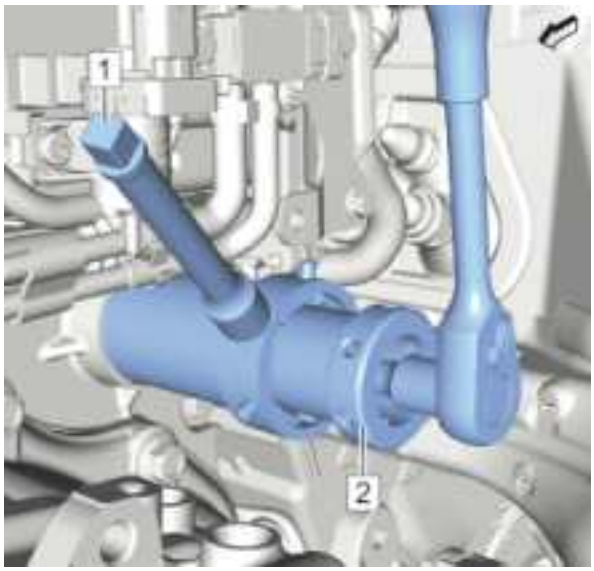

Fig. 252: Extension And Special Tool
Courtesy of GENERAL MOTORS COMPANY

8. Install a 1/2 inch-drive extension (1) to the **EN-50885-2** fixing tool (2) to counterhold.
9. Tighten Fuel Injection Pump Drive Pulley Nut to 64 N.m (47 lb ft)
10. Remove the 1/2 inch-drive extension (1).
11. Remove **EN-50885-2** fixing tool (2)

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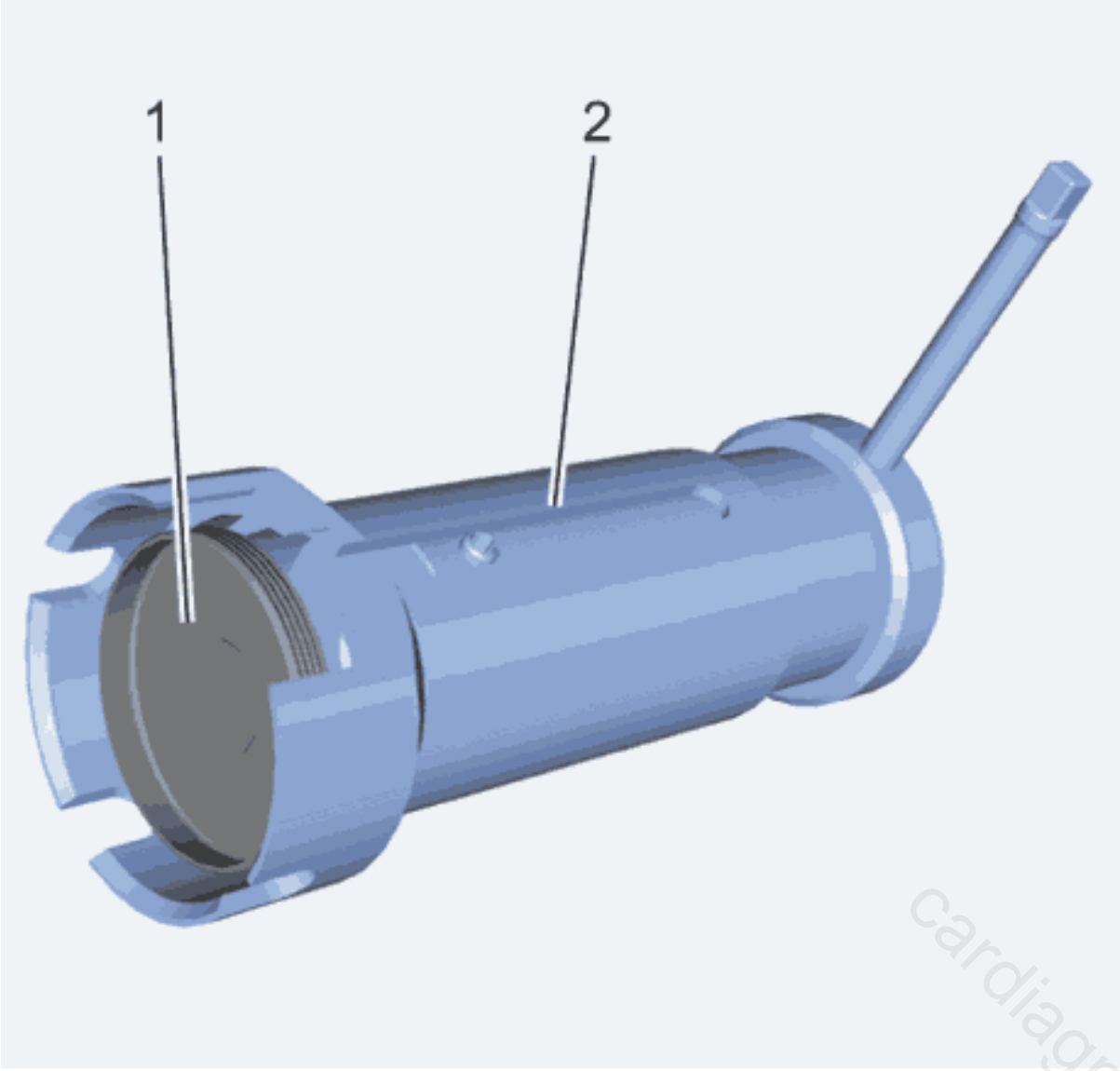

Fig. 253: Fuel Injection Pump Sprocket Access Hole Plug And Special Tool
Courtesy of GENERAL MOTORS COMPANY

12. Install the NEW fuel injection pump sprocket access hole plug (1) onto the **EN-50885-1** installer (2).

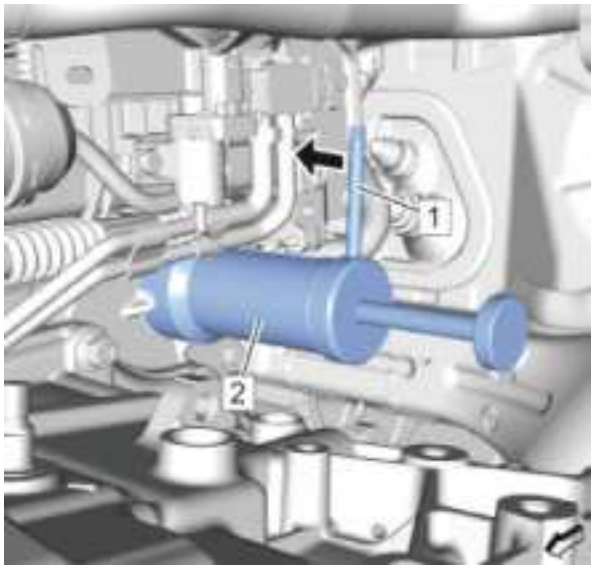

Fig. 254: Special Tools
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the EN-50885-1 installer on the timing chain lower housing rests against.**

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13. Install the fuel injection pump sprocket access hole plug by hitting the handle (1) of the **EN-50885-1** installer (2).

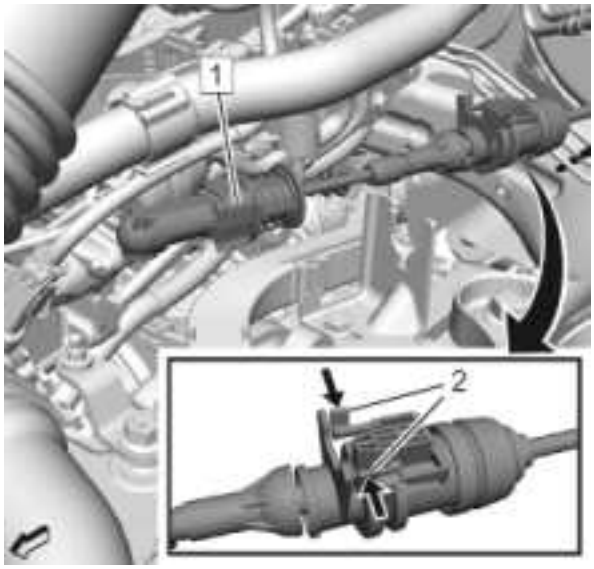

Fig. 255: Range Selector Lever Cable
Courtesy of GENERAL MOTORS COMPANY

14. Install Range Selector Lever Cable (1) @ Transmission Range Selector Lever Cable Bracket

    Push the range selector lever cable into the bracket.

15. Install Range Selector Lever Cable (1) @ Range Selector Lever Cable Lever

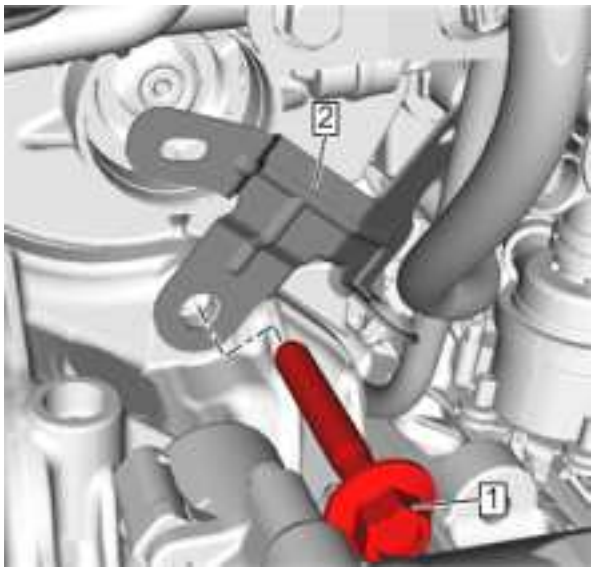

Fig. 256: Engine Wiring Harness Bracket And Transmission Bolt
Courtesy of GENERAL MOTORS COMPANY

16. Reposition Engine Wiring Harness Bracket (2)
17. Install and tighten Transmission Bolt (1) to 58 N.m (43 lb ft)

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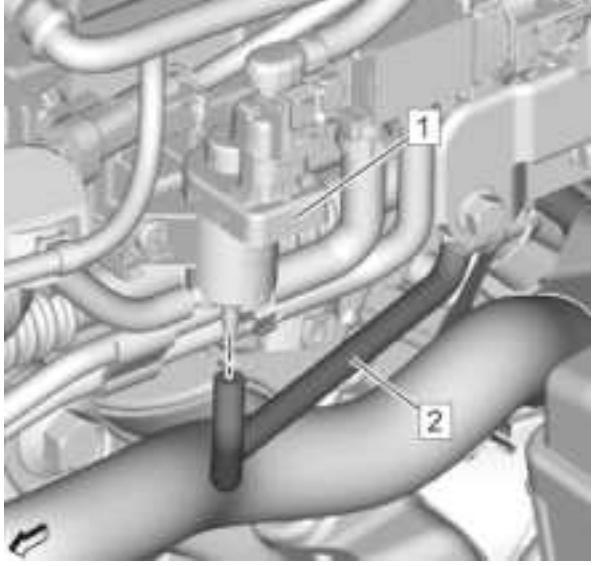

Fig. 257: Charge Air Bypass Regulator Solenoid Valve Inlet Tube And Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

18. Connect Charge Air Bypass Regulator Solenoid Valve Inlet Tube (2) @ Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve (1)

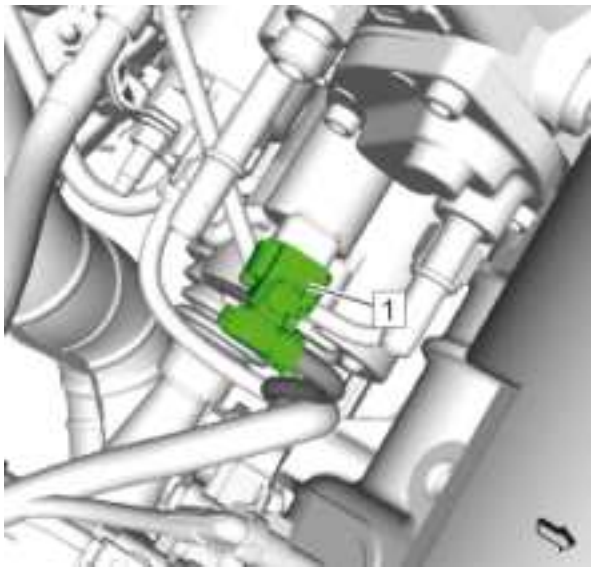

Fig. 258: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

19. Connect the electrical connector. (1)

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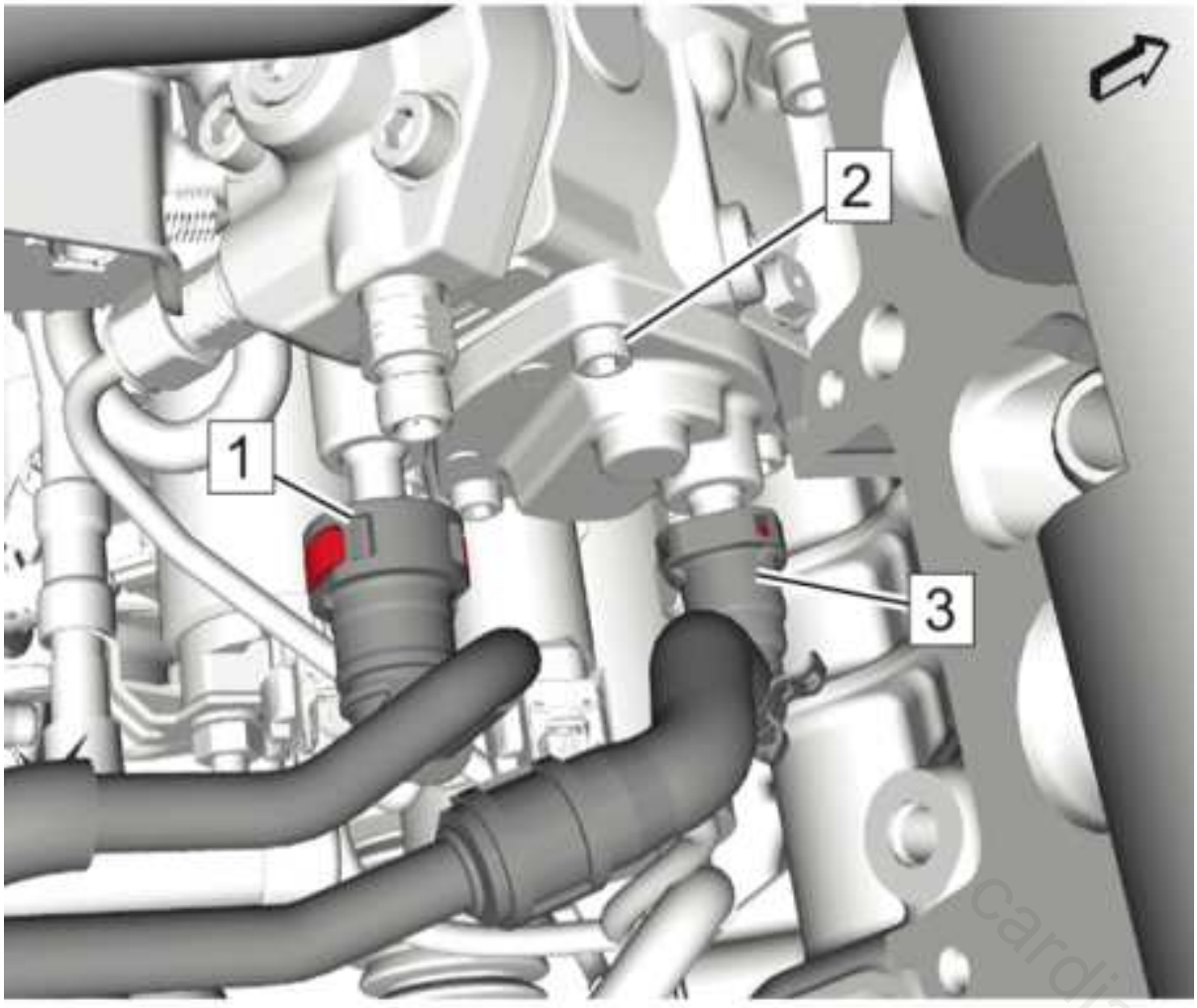

Fig. 259: Fuel Feed Pipe, Fuel Injection Pump And Diesel Fuel Separator
Courtesy of GENERAL MOTORS COMPANY

20. Remove the closure plugs from all connections.
21. Connect Diesel Fuel Separator (3) @ Fuel Injection Pump (2). Refer to **Plastic Collar Quick Connect Fitting Service**
22. Connect Fuel Feed Pipe (1) @ Fuel Injection Pump (2). Refer to **Plastic Collar Quick Connect Fitting Service**
23. Install the auxiliary fluid accumulator. Refer to **Auxiliary Fluid Accumulator Replacement (Equinox)** **Auxiliary Fluid Accumulator Replacement (Terrain)**
24. Install the intake manifold. Refer to **Intake Manifold Replacement**
25. Install the engine control module. Refer to **Engine Control Module Bracket Replacement**
26. Check the fuel system for leaks. Refer to **Fuel Leak Diagnosis**
27. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
28. If replacing, perform the high pressure fuel correction reset. Refer to **High Pressure Fuel Correction Reset**

FUEL INJECTION PUMP DRIVEN SPROCKET REPLACEMENT

Special Tools

EN-50885-2 Locking Tool

Equivalent regional tools: **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)** .

Removal Procedure

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1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)** .
2. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
3. Remove the camshaft timing chain. Refer to **Camshaft Timing Chain Replacement** .

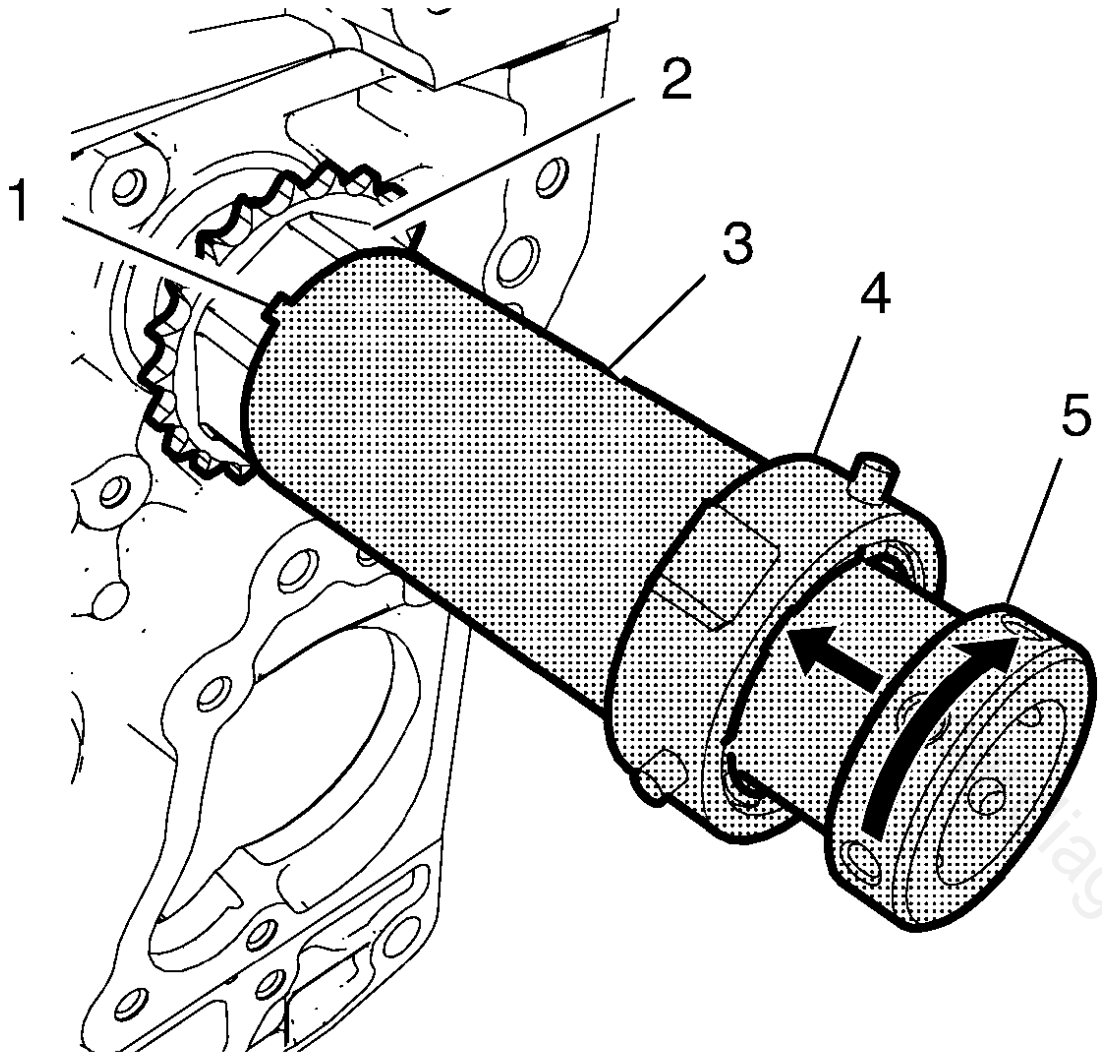

Fig. 260: Locking Tool Installed
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-50885-2** locking tool.
    1. Install the housing (3) to the fuel injection pump driven sprocket nut (2). Ensure that the 3 tappets (1) mesh with the 3 slots of the fuel injection pump driven sprocket nut.
    2. Position the ring (4) to allow for installation of a 1/2 inch-drive extension.
    3. Install the fixing tool (5) into the fuel injection pump driven sprocket nut.

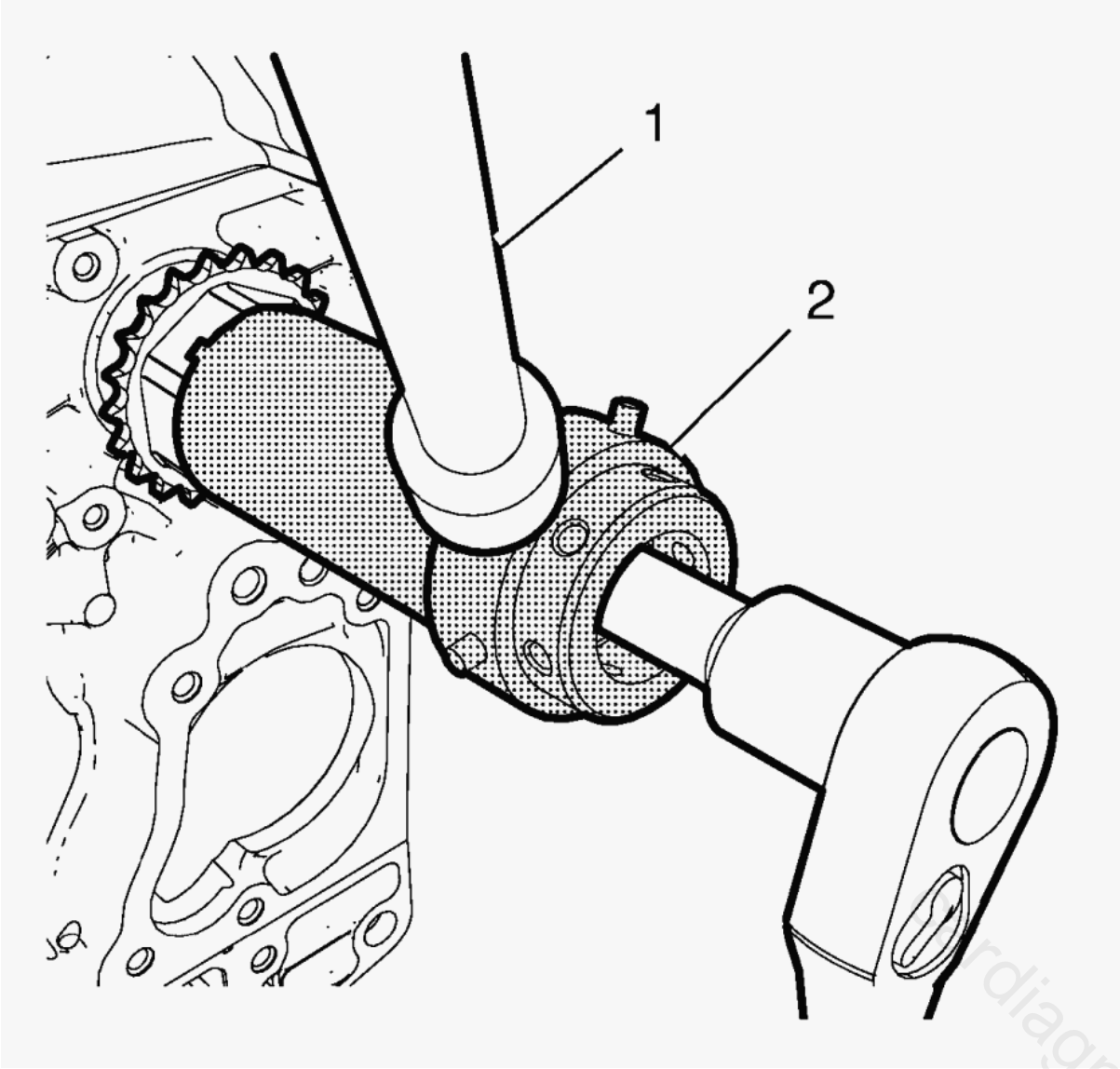

Fig. 261: Extension And Locking Tool
Courtesy of GENERAL MOTORS COMPANY

5. Install a 1/2 inch-drive extension (1) to the **EN-50885-2** locking tool (2) to counterhold.
6. Loosen the fuel injection pump driven sprocket nut.

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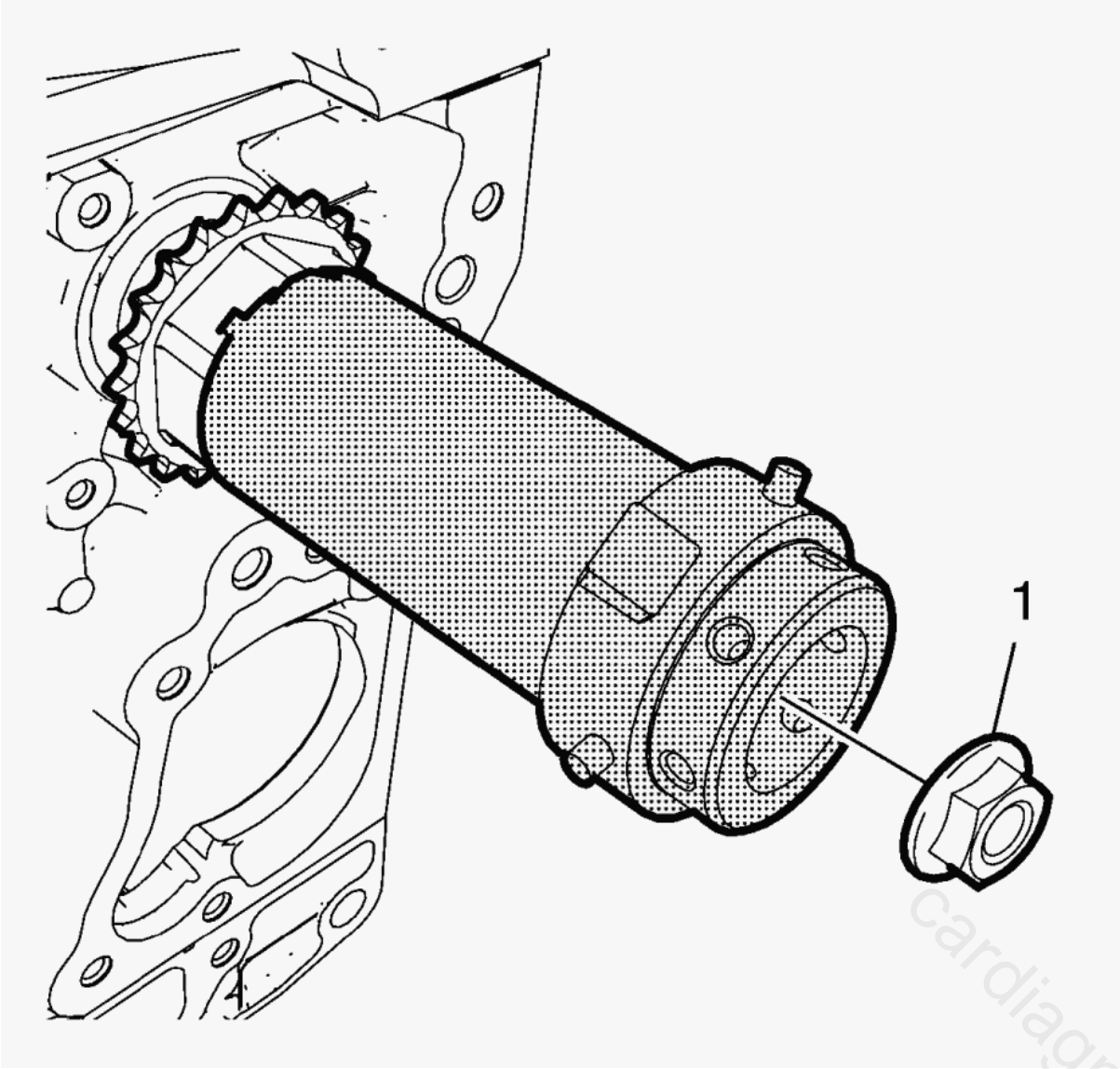

Fig. 262: Fuel Injection Pump Driven Sprocket Nut
Courtesy of GENERAL MOTORS COMPANY

7. Remove the fuel injection pump driven sprocket nut (1).

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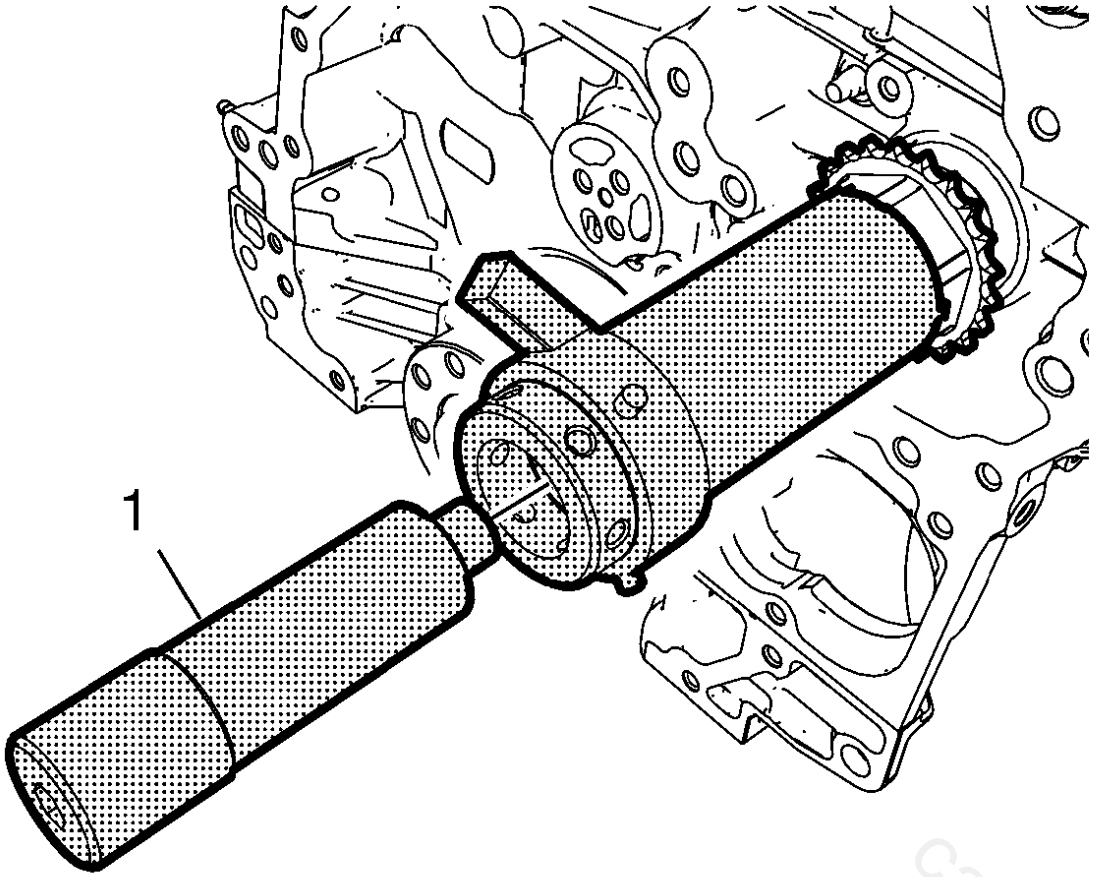

Fig. 263: Pressure Spindle And Locking Tool
Courtesy of GENERAL MOTORS COMPANY

8. Install the pressure spindle (1) to the **EN-50885-2** locking tool (2).

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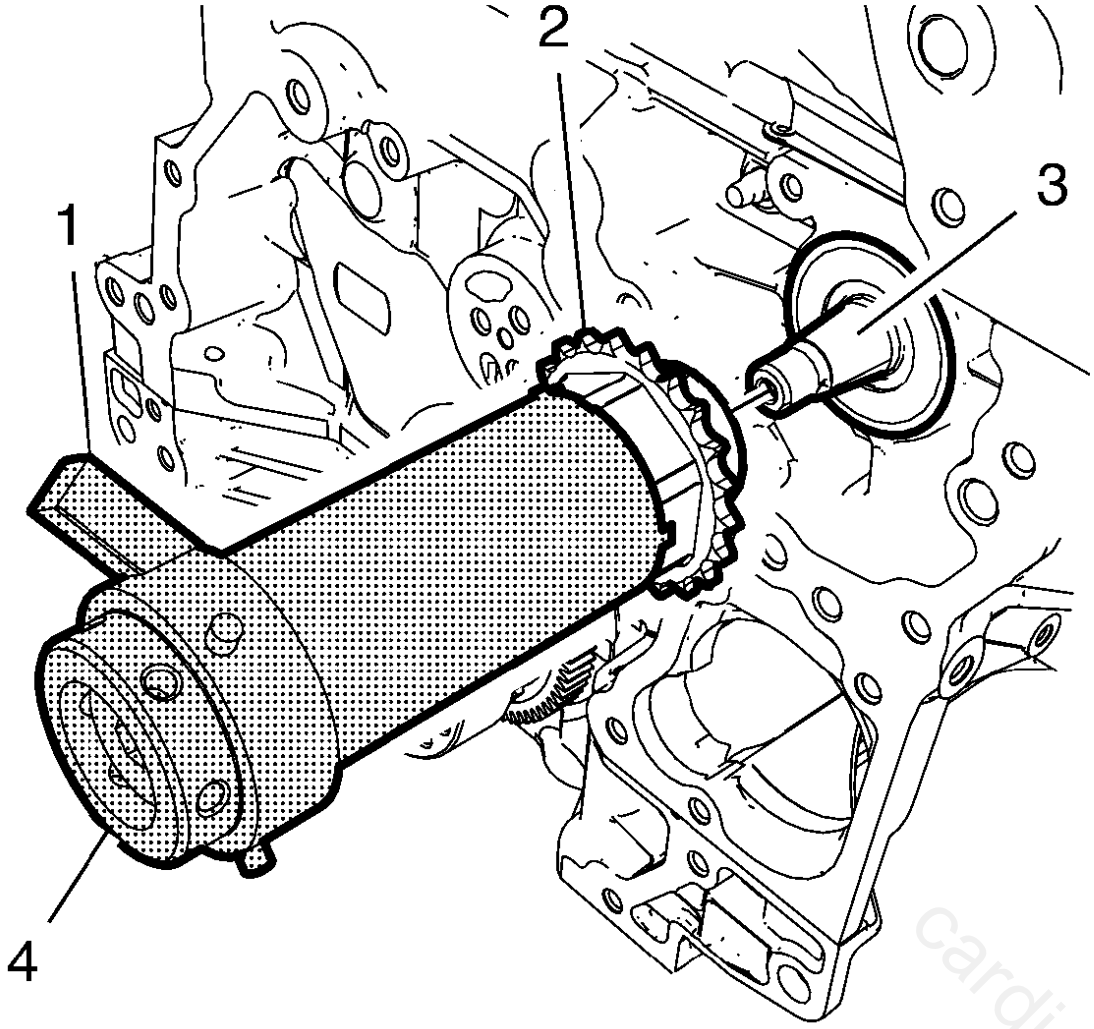

Fig. 264: Fuel Injection Pump Sprocket, Pressure Spindle And Locking Tool
Courtesy of GENERAL MOTORS COMPANY

9. Press out the fuel injection pump sprocket (2), by screwing in the pressure spindle (4) into the **EN-50885-2** fixing tool (1).
10. Remove the fuel injection fuel pump driven sprocket.
11. Remove the **EN-50885-2** fixing tool from the fuel injection pump driven sprocket.

Installation Procedure

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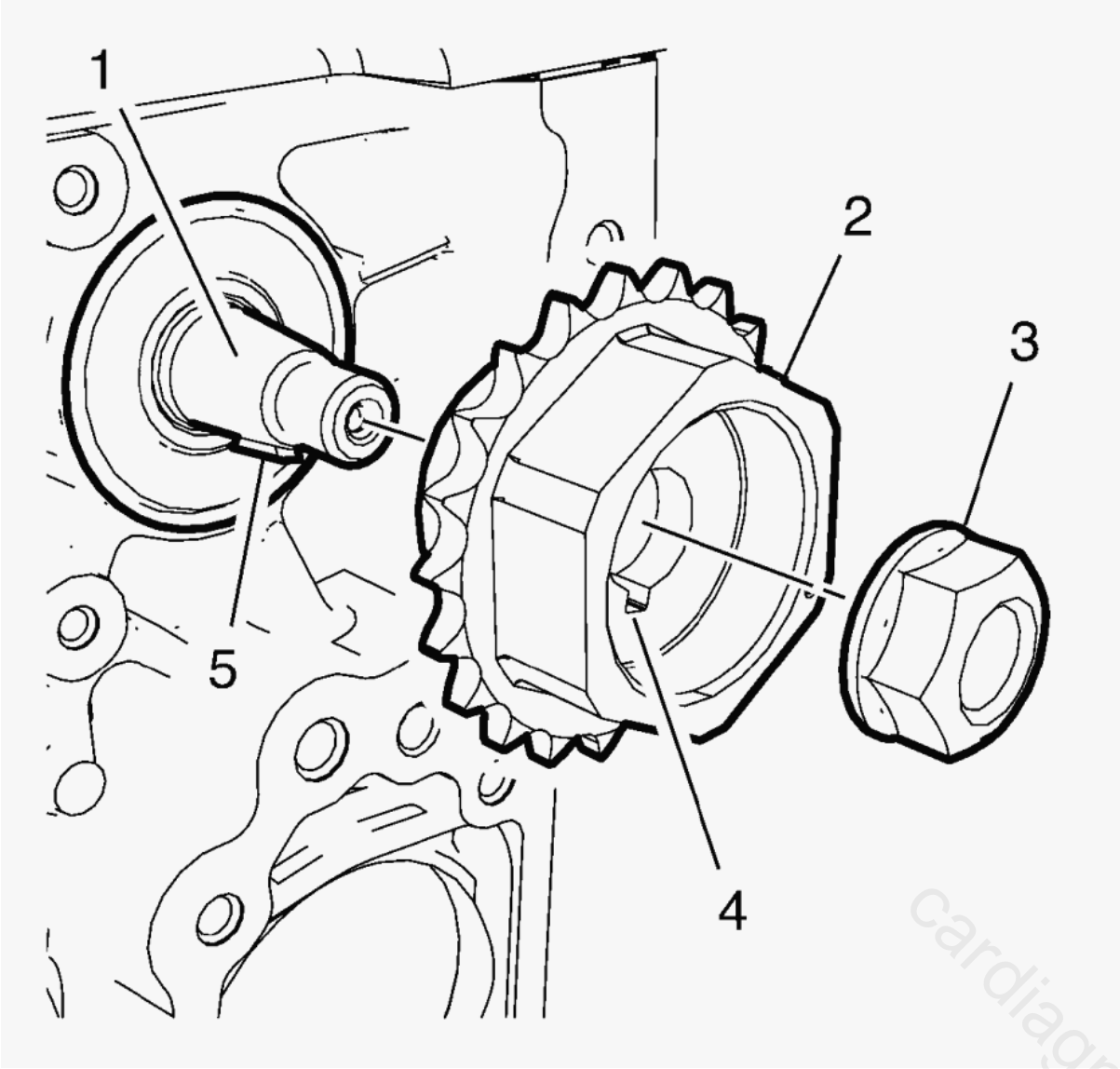

Fig. 265: Fuel Injection Pump, Driven Sprocket, Pump Shaft Wedge, Sprocket Groove And Nut
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel injection pump sprocket (2) to the fuel injection pump (1). Ensure the fuel injection pump shaft wedge (5) and the fuel injection pump driven sprocket groove (4) are aligned.
2. Pre-install the fuel injection pump driven sprocket nut (3).

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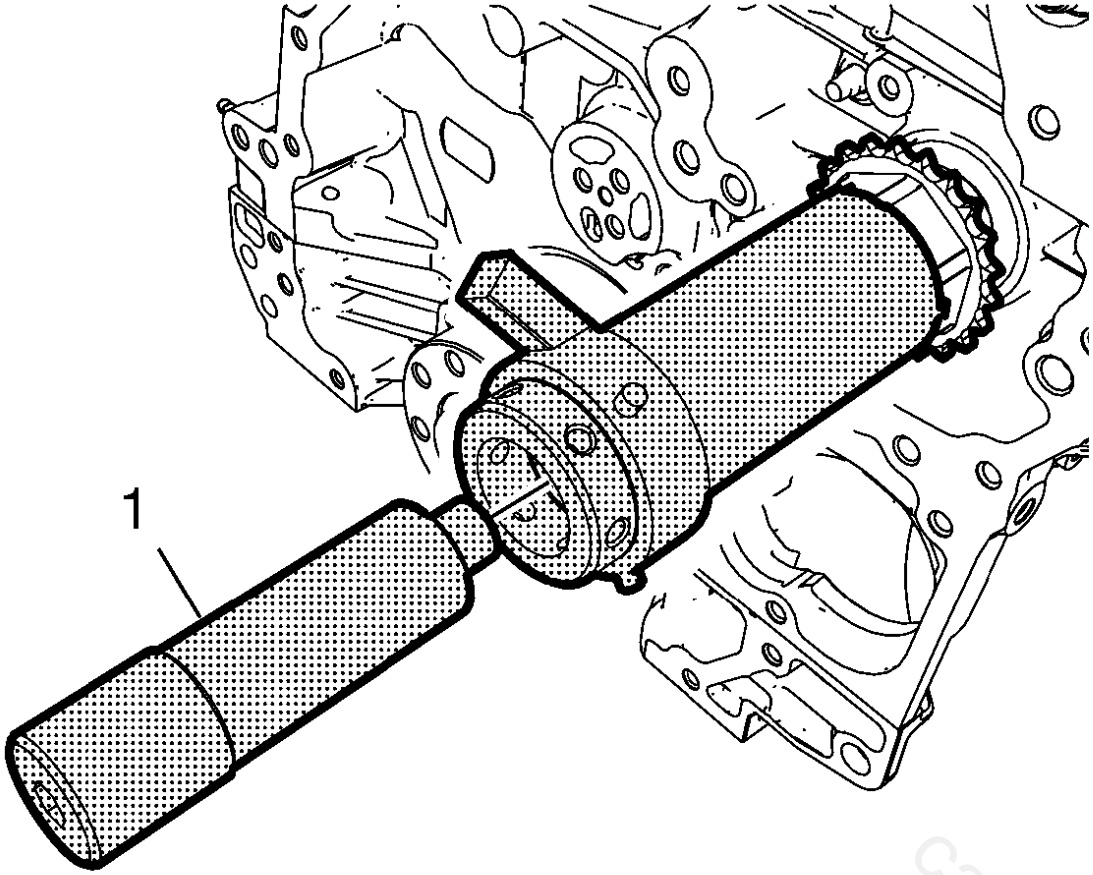

Fig. 266: Pressure Spindle And Locking Tool
Courtesy of GENERAL MOTORS COMPANY

3. Remove the pressure spindle (1) from the **EN-50885-2** locking tool (2).

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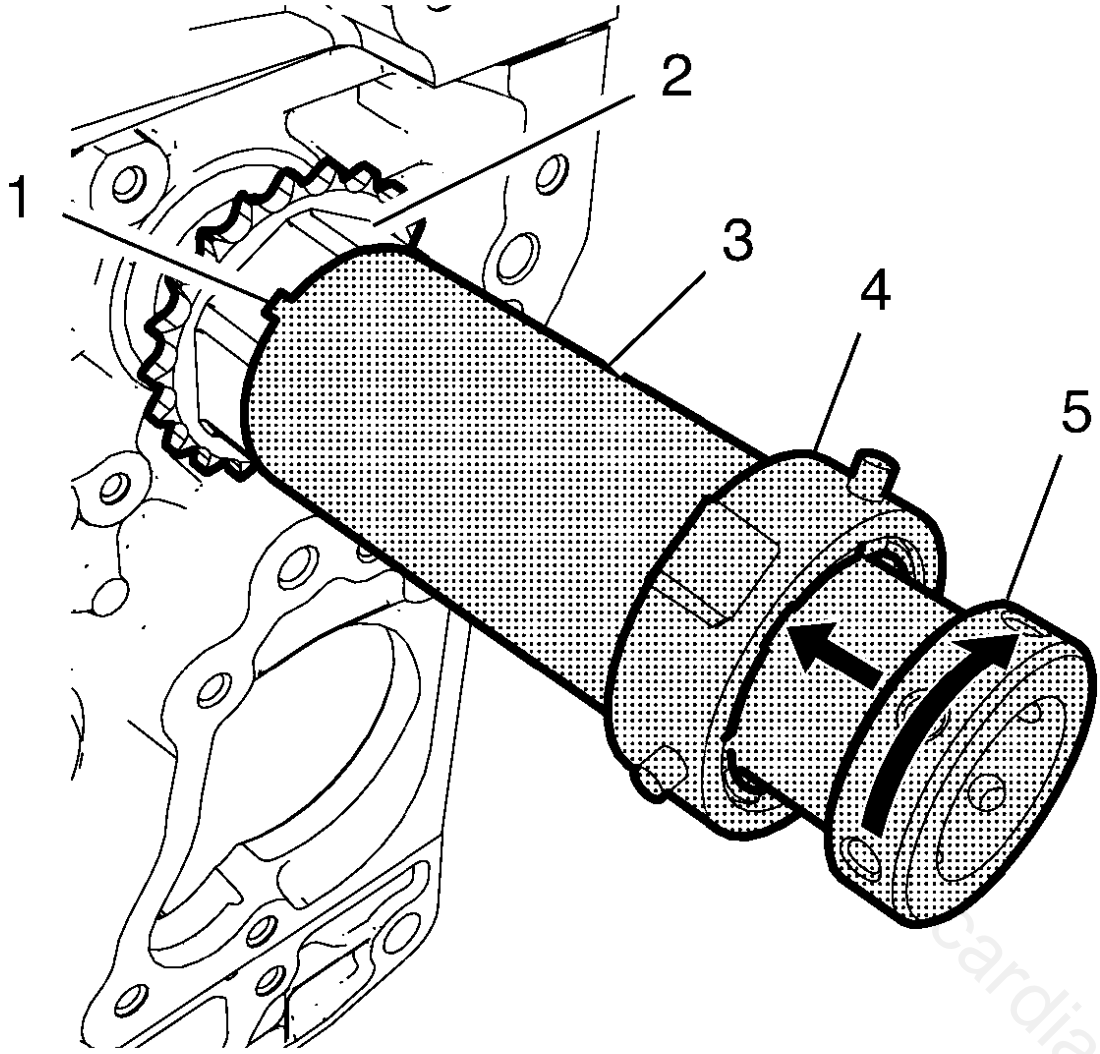

Fig. 267: Locking Tool Installed
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-50885-2** locking tool.
    1. Install the housing (3) to the fuel injection pump driven sprocket nut (2). Ensure that the 3 tappets (1) mesh with the 3 slots of the fuel injection pump driven sprocket nut.
    2. Position the ring (4) to allow for installation of a 1/2 inch-drive extension.
    3. Screw in the fixing tool (5) into the fuel injection pump driven sprocket nut.

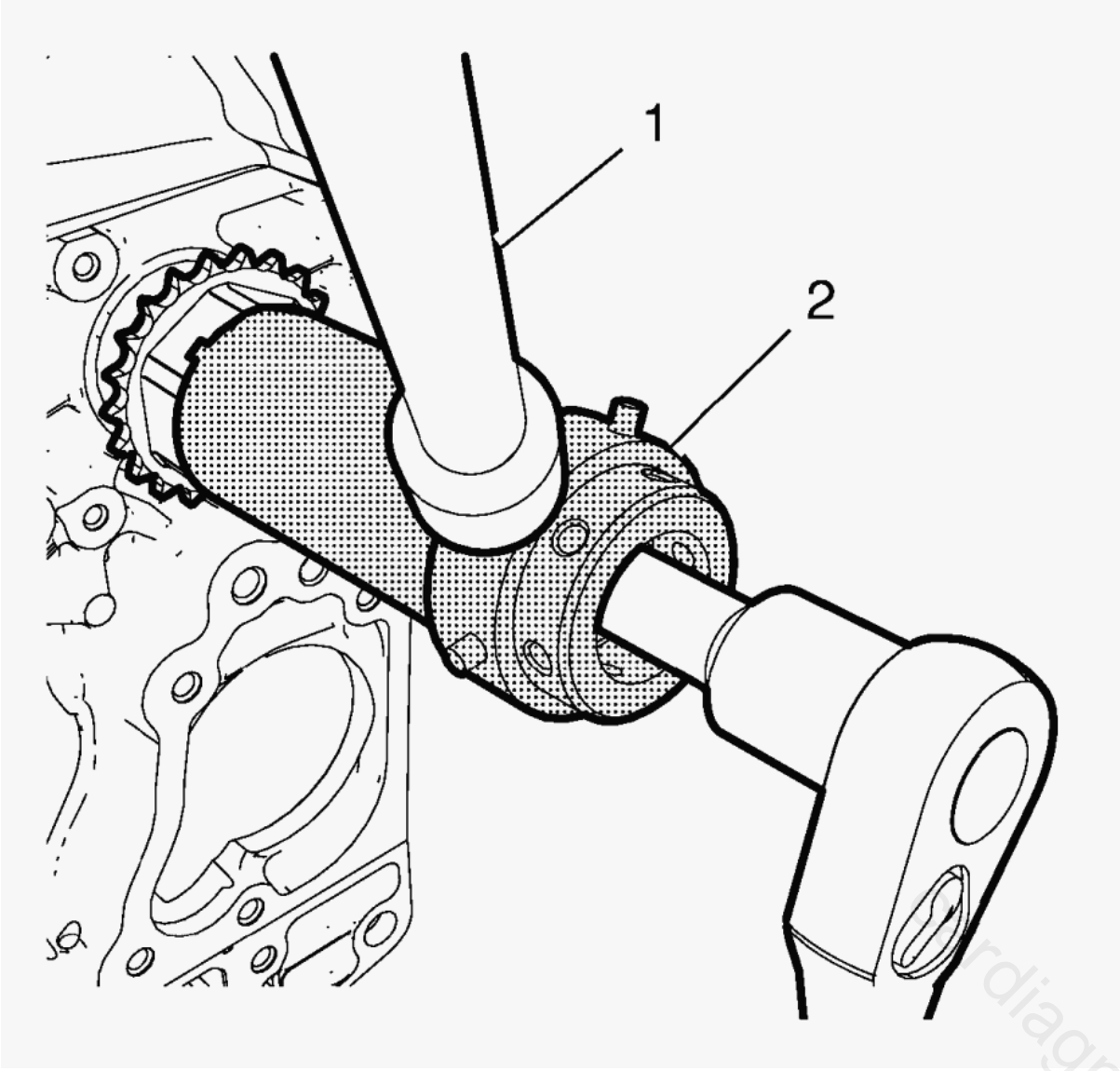

Fig. 268: Extension And Locking Tool
Courtesy of GENERAL MOTORS COMPANY

5. Install a 1/2 inch-drive extension (1) to the **EN-50885-2** locking tool (2) to counterhold.

CAUTION: **Refer to Fastener Caution .**

6. Tighten the fuel injection pump driven sprocket nut to 64 N.m (47 lb ft).
7. Remove the **EN-50885-2** locking tool.
8. Install the camshaft timing chain. Refer to **Camshaft Timing Chain Replacement** .
9. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
10. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)** .

FUEL INJECTOR REPLACEMENT

Special Tools

EN-45059 Angle Meter

EN-51146-1-3 Sliding Hammer

EN-51187 Injector Remover

Equivalent regional tools: **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

Removal Procedure

WARNING: **Refer to Diesel/Gasoline Vapors Warning**

WARNING: **Refer to Safety Goggles and Fuel Warning**

NOTE:

- **Be very thorough in terms of cleanliness when working in the fuel system. Malfunctions can also occur due to very small dirt particles. Prevent dirt from entering the fuel system by cleaning the hoses and plugging the pipes and lines upon removal. Store the components so that contaminants cannot enter.**
- **In order to reuse the injectors, mark the injectors so that they can be installed to the same cylinder.**

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

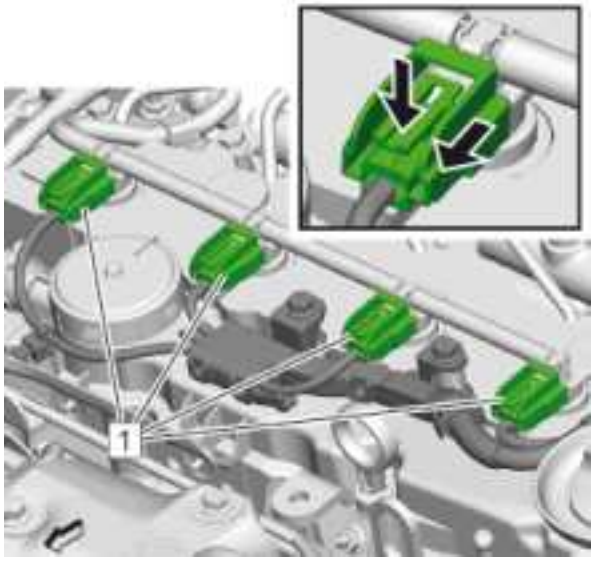

Fig. 269: Fuel Injector Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect Fuel Injector Electrical Connectors (1) (Qty: 4)

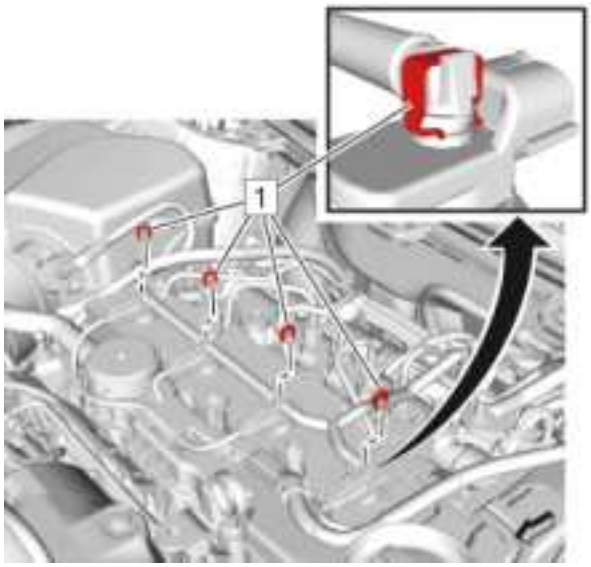

Fig. 270: Fuel Return Hose Clamps
Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD the 4 fuel return hose clamps (1).

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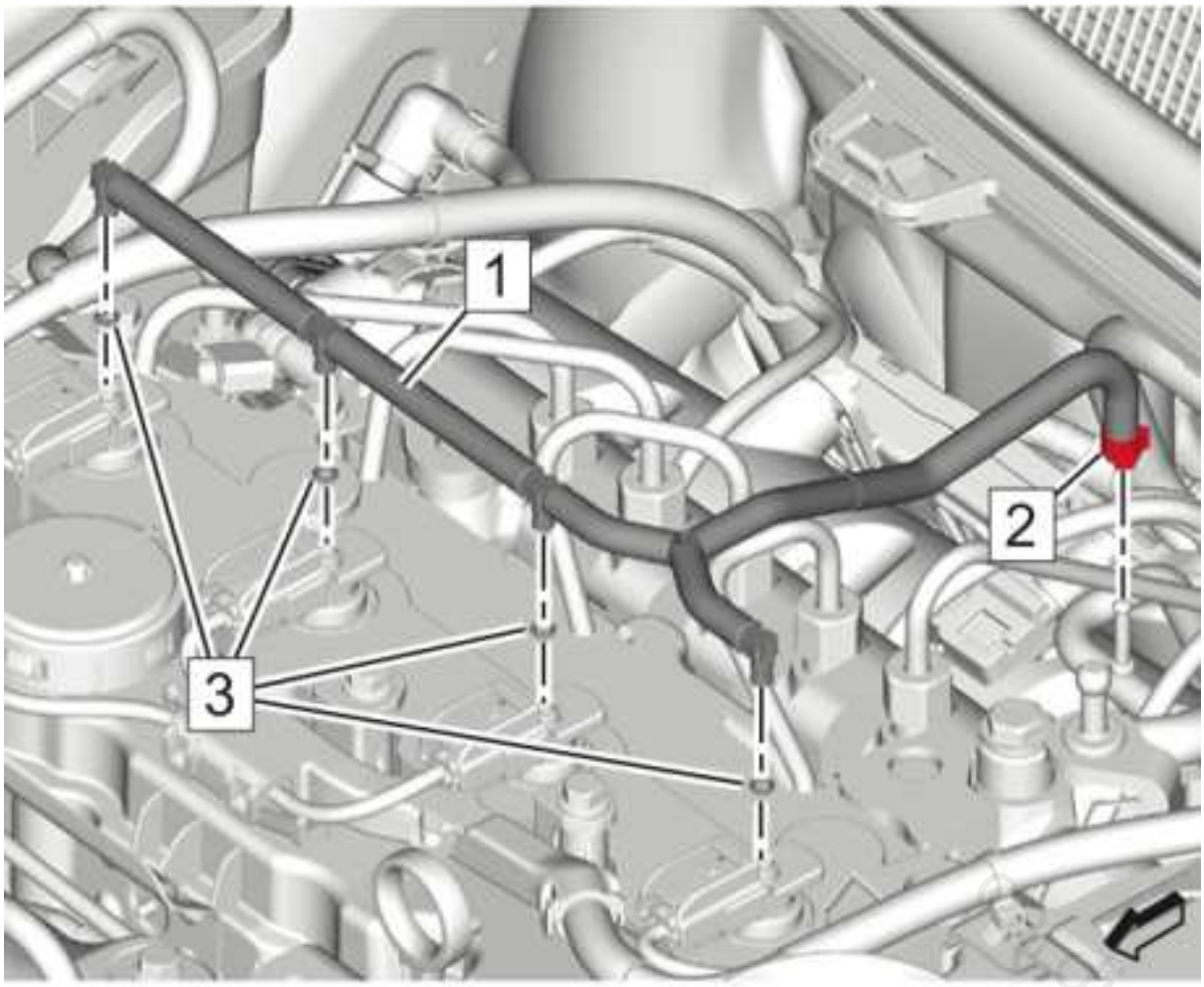

Fig. 271: Fuel Return Hose, Seals And Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Remove and DISCARD Clamp (2)
6. Disconnect Fuel Return Hose (1) @ Diesel Fuel Separator
7. Unclip Fuel Return Hose (1) @ Fuel Injector (Qty: 4)
8. Remove Fuel Return Hose (1)
9. Remove and DISCARD the seals. (3) (Qty: 4)

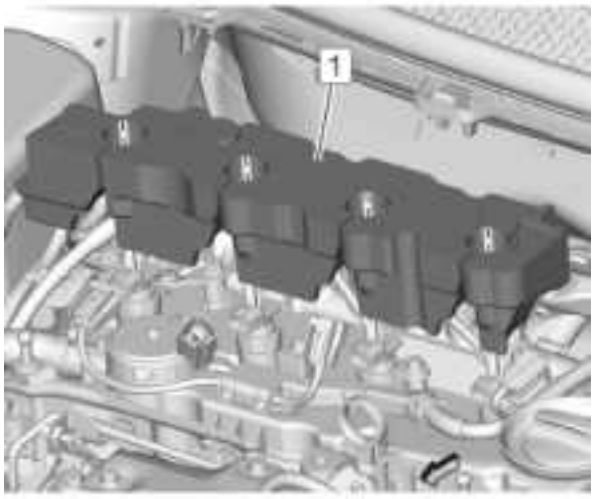

Fig. 272: Fuel Injector Insulator
Courtesy of GENERAL MOTORS COMPANY

10. Remove Fuel Injector Insulator (1)

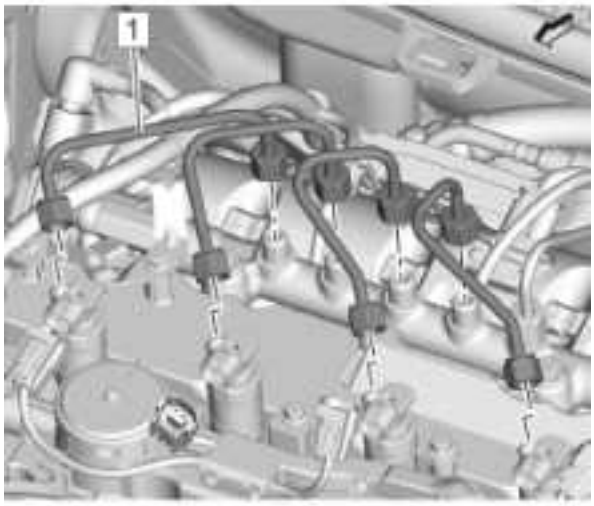

Fig. 273: Fuel Injection Fuel Feed Pipes
Courtesy of GENERAL MOTORS COMPANY

11. Remove and DISCARD Fuel Injection Fuel Feed Pipes (1) (Qty: 4)
12. Close all open connections, using suitable closure plugs.

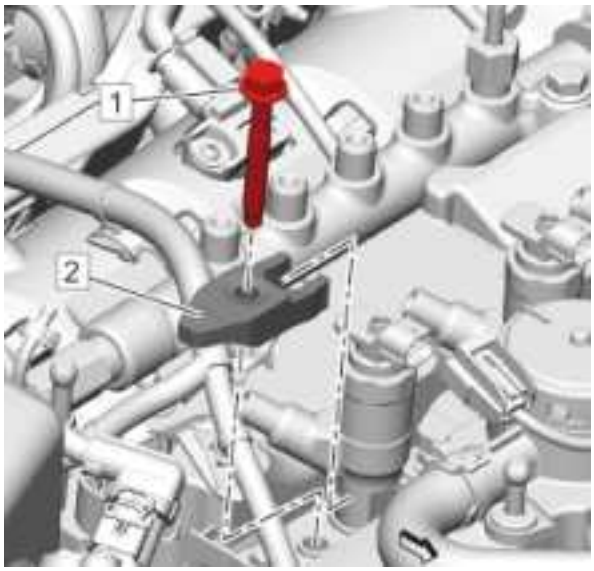

Fig. 274: Fuel Injector Brackets And Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove and DISCARD Fuel Injector Bracket Bolts (1) (Qty: 4)
14. Remove Fuel Injector Brackets (2) (Qty: 4)

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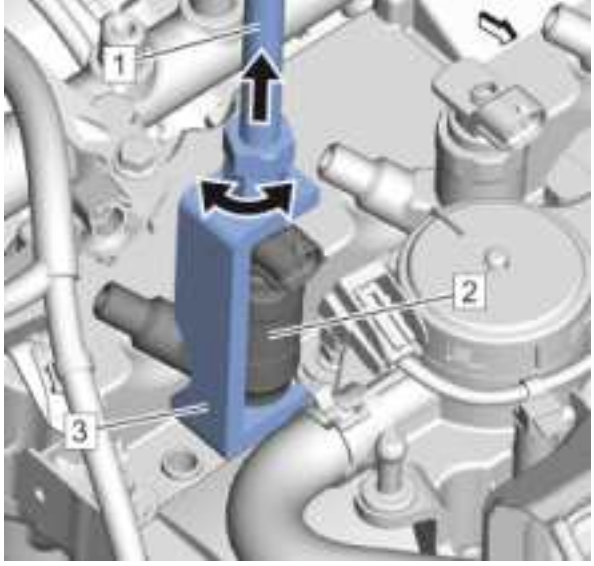

Fig. 275: Fuel Injector And Special Tools
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the injector can not be removed by hand, use the EN-51187 remover and remove the injector by turning at the hexagon.**

15. Pull out the 4 fuel injectors (2) with the **EN-51187** remover (3) along with the **EN-51146-1-3** sliding hammer (1).

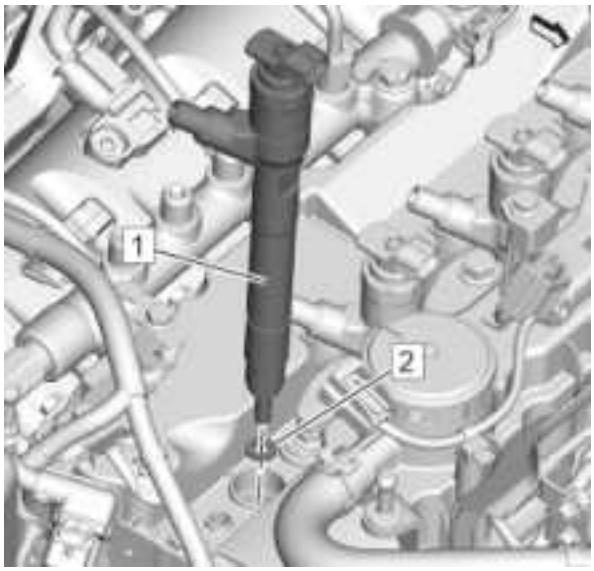

Fig. 276: Fuel Injectors And Washers
Courtesy of GENERAL MOTORS COMPANY

16. Remove Fuel Injectors (1) (Qty: 4)
17. Remove and DISCARD Fuel Injector Washers (2) (Qty: 4)
18. Protect the 4 fuel injector nozzles with suitable caps.

Installation Procedure

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Fig. 277: Cleaning Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to EN-47632 Cleaning Tool Rotation Caution**

1. Clean the 4 injector sealing surfaces in the cylinder head with a suitable cleaning tool (1) in the following procedure:
    1. First take the brush side to loosen the dirt.
    2. Accordingly take the sponge side to remove the dirt.

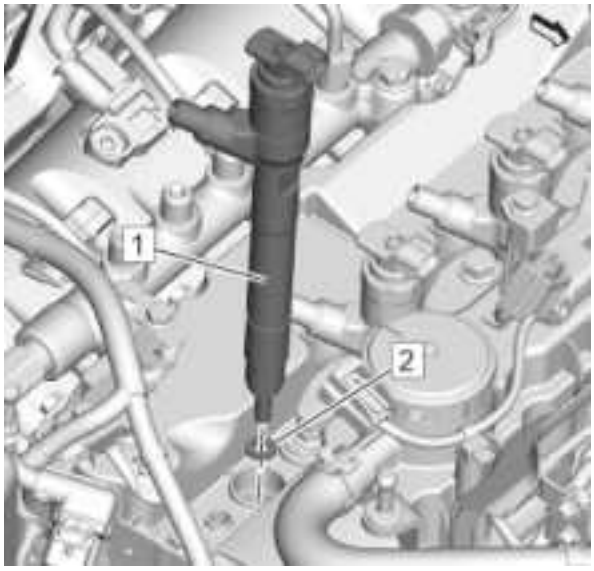

Fig. 278: Fuel Injectors And Washers
Courtesy of GENERAL MOTORS COMPANY

2. Remove the suitable caps from the 4 fuel injector nozzles.
3. Install NEW Fuel Injector Washers (2) (Qty: 4)
4. Install Fuel Injectors (1) (Qty: 4)

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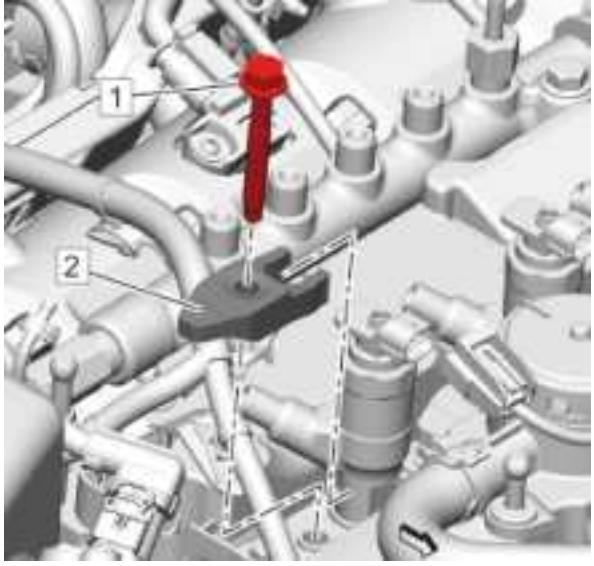

Fig. 279: Fuel Injector Brackets And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install Fuel Injector Brackets (2) (Qty: 4)
6. Install and hand tighten the 4 NEW fuel injector bracket bolts (1)

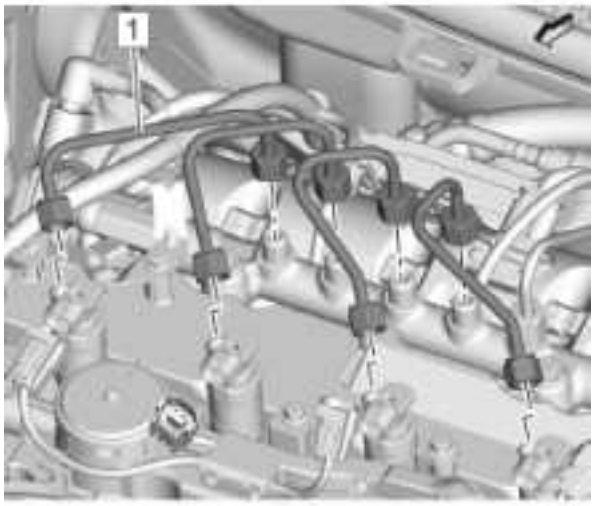

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Fig. 280: Fuel Injection Fuel Feed Pipes
Courtesy of GENERAL MOTORS COMPANY

7. Remove the suitable closure plugs.
8. Install NEW Fuel Injection Fuel Feed Pipes (1) (Qty: 4)
9. Hand tighten the 8 fuel injection fuel feed pipe nuts.

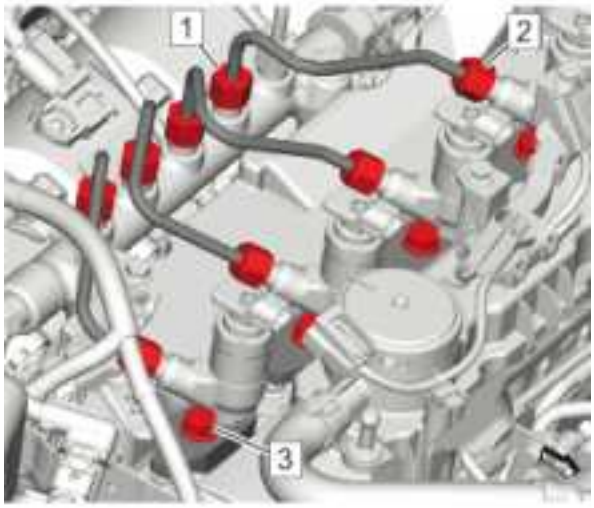

Fig. 281: Fuel Injector Bracket Bolt And Fuel Injection Fuel Feed Pipe Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

10. Tighten Fuel Injector Bracket Bolt (3) in sequence
    1. First Pass: 10 N.m (89 lb in)
    2. Final Pass: 60 degrees Use the special tool: **EN-45059** meter
11. Tighten the 4 fuel injection fuel feed pipe nuts (2) to the 4 fuel injectors to 28 N.m (21 lb ft).
12. Tighten the 4 fuel injection fuel feed pipe nuts (1) to the fuel rail to 28 N.m (21 lb ft).

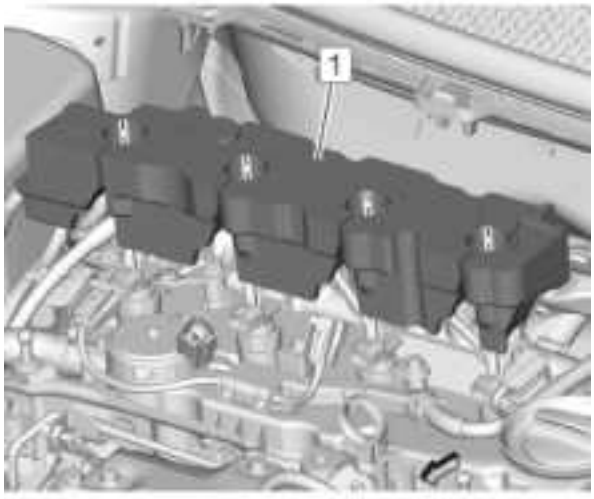

Fig. 282: Fuel Injector Insulator
Courtesy of GENERAL MOTORS COMPANY

13. Install Fuel Injector Insulator (1)

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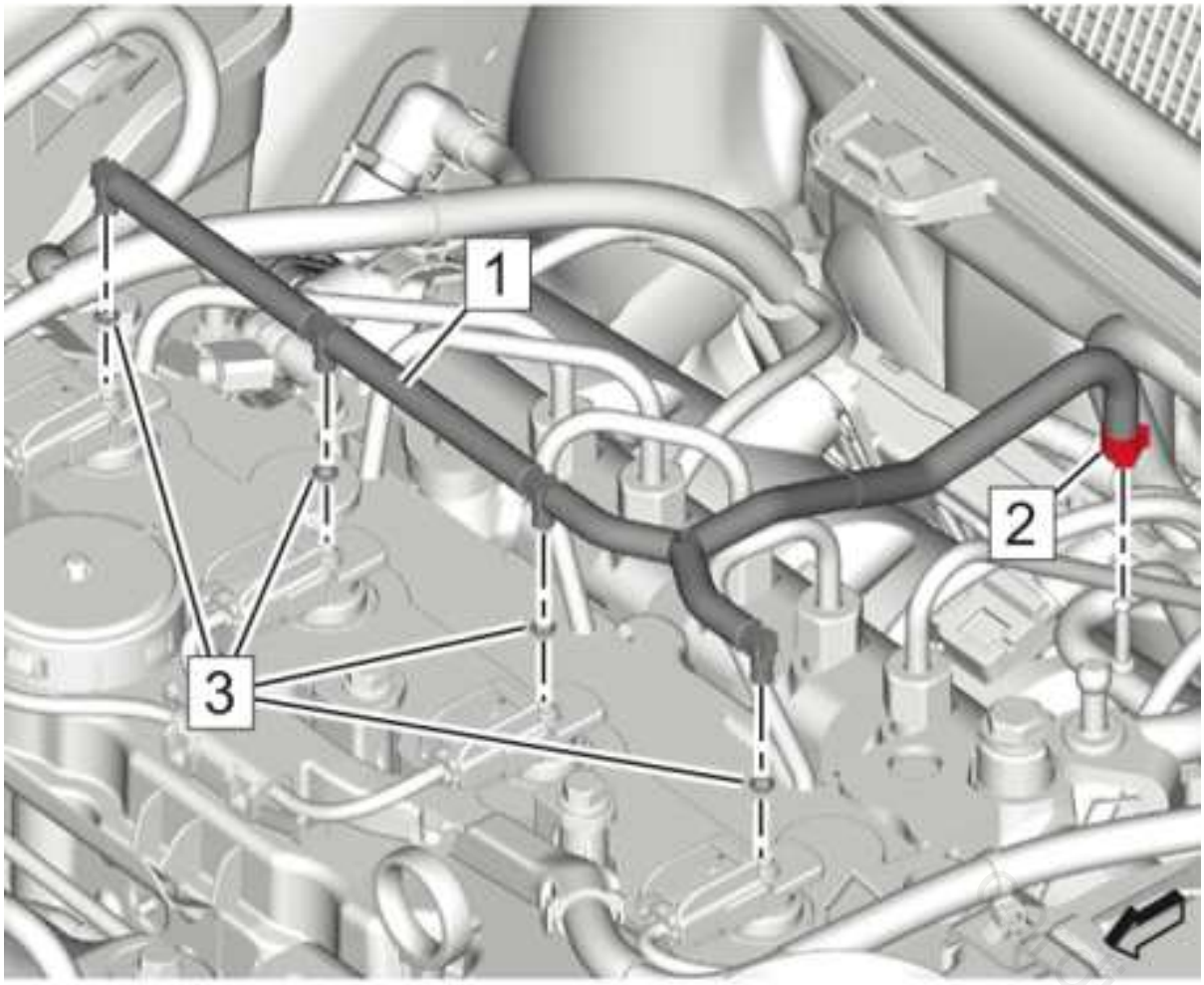

Fig. 283: Fuel Return Hose, Seals And Clamp
Courtesy of GENERAL MOTORS COMPANY

14. Install 4 NEW fuel injector fuel return hose seal rings (3).
15. Install Fuel Return Hose (1) @ Fuel Injector (Qty: 4)
16. Connect Fuel Return Hose (1) @ Diesel Fuel Separator
17. Install a NEW clamp. (2)

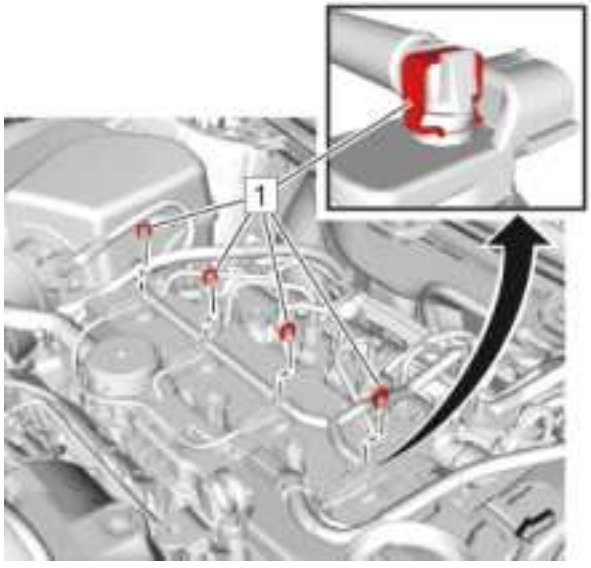

Fig. 284: Fuel Return Hose Clamps
Courtesy of GENERAL MOTORS COMPANY

18. Install 4 NEW fuel return hose clamps (1).

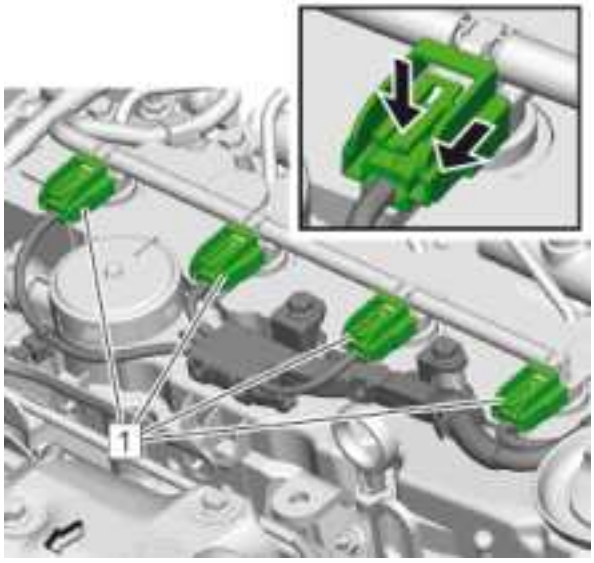

Fig. 285: Fuel Injector Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

19. Connect Fuel Injector Electrical Connectors (1) (Qty: 4)
20. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
21. Check the fuel system for leaks. Refer to **Fuel Leak Diagnosis** .
22. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
23. Perform the fuel injection small quantity learn. Refer to **Fuel Injection Small Quantity Learn**
24. Perform the fuel trim reset. Refer to **Fuel Trim Reset**
25. Perform the high pressure fuel correction reset. Refer to **High Pressure Fuel Correction Reset**
26. Perform the fuel injector flow rate programming. Refer to **Fuel Injector Flow Rate Programming**

FUEL INJECTION PUMP METERING VALVE REPLACEMENT

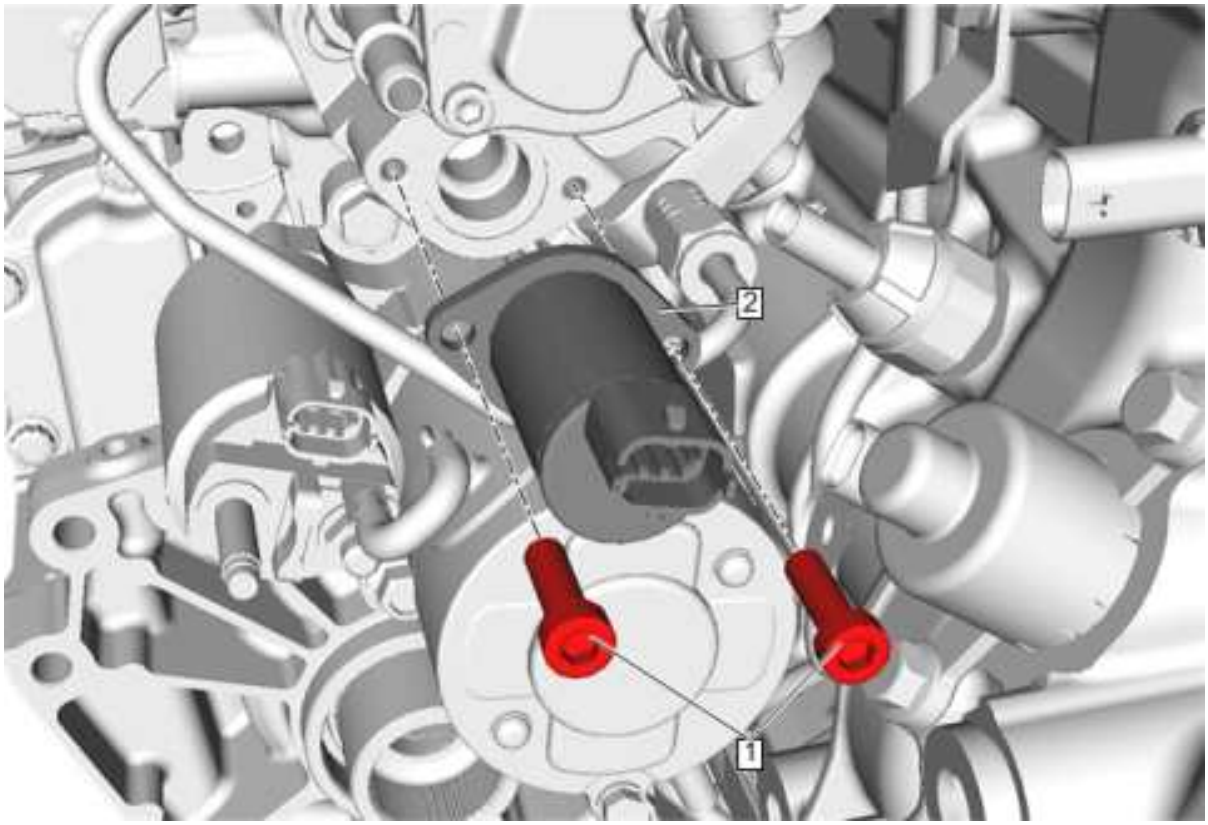

Fig. 286: Fuel Injection Pump Metering Valve
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
Preliminary Procedure Remove Intake Manifold. Refer to **Intake Manifold Replacement**	
1	Fuel Injection Pump Metering Valve Fastener (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Fuel Injection Pump Metering Valve **Procedure** 1. Disconnect Fuel Injection Pump Metering Valve Electrical Connector 2. Install a NEW O-ring seal. 3. If replacing, perform the high pressure fuel correction reset. Refer to **High Pressure Fuel Correction Reset**

FUEL PUMP POWER CONTROL MODULE REPLACEMENT (AWD)

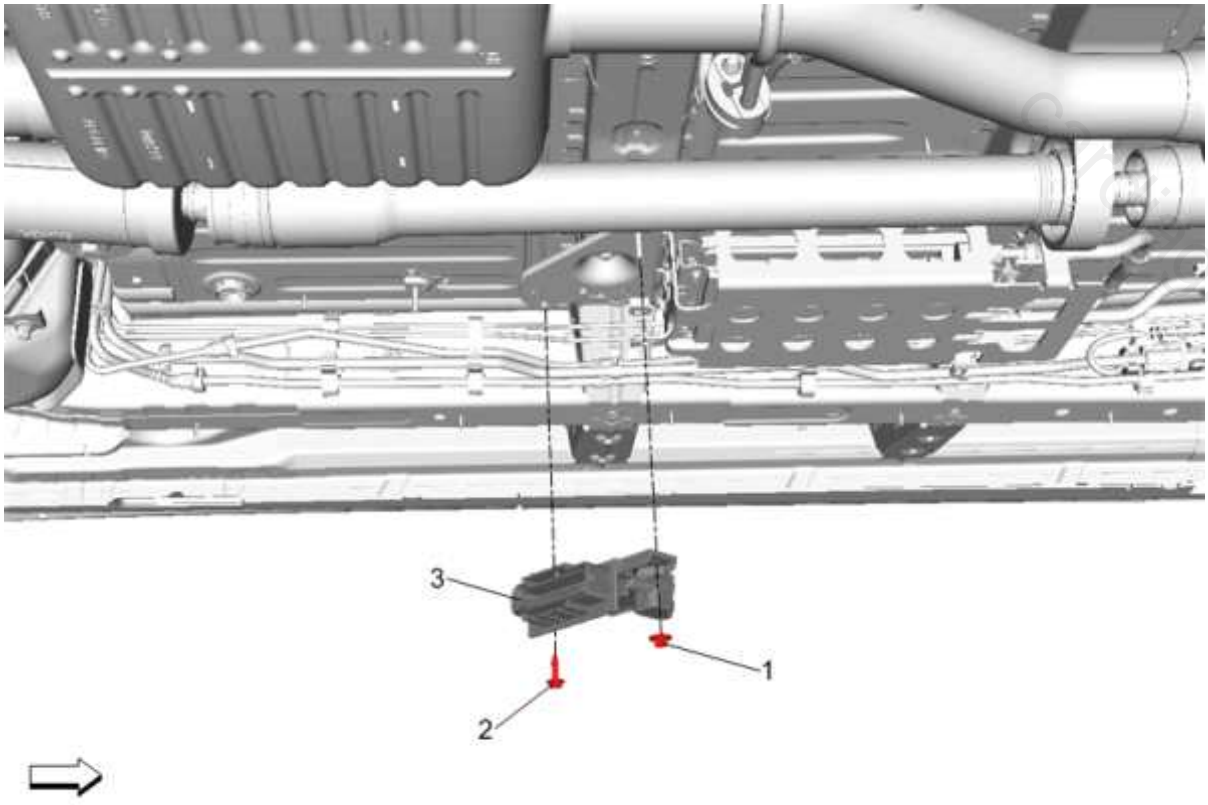

Fig. 287: Fuel Pump Power Control Module (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (All Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**	

Callout	Component Name
1	Fuel Pump Power Control Module Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Fuel Pump Power Control Module Bolt **Tighten** 9 N.m (80 lb in)
3	Fuel Pump Power Control Module **Procedure** 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Refer to **Control Module References**

FUEL PUMP POWER CONTROL MODULE REPLACEMENT (FWD)

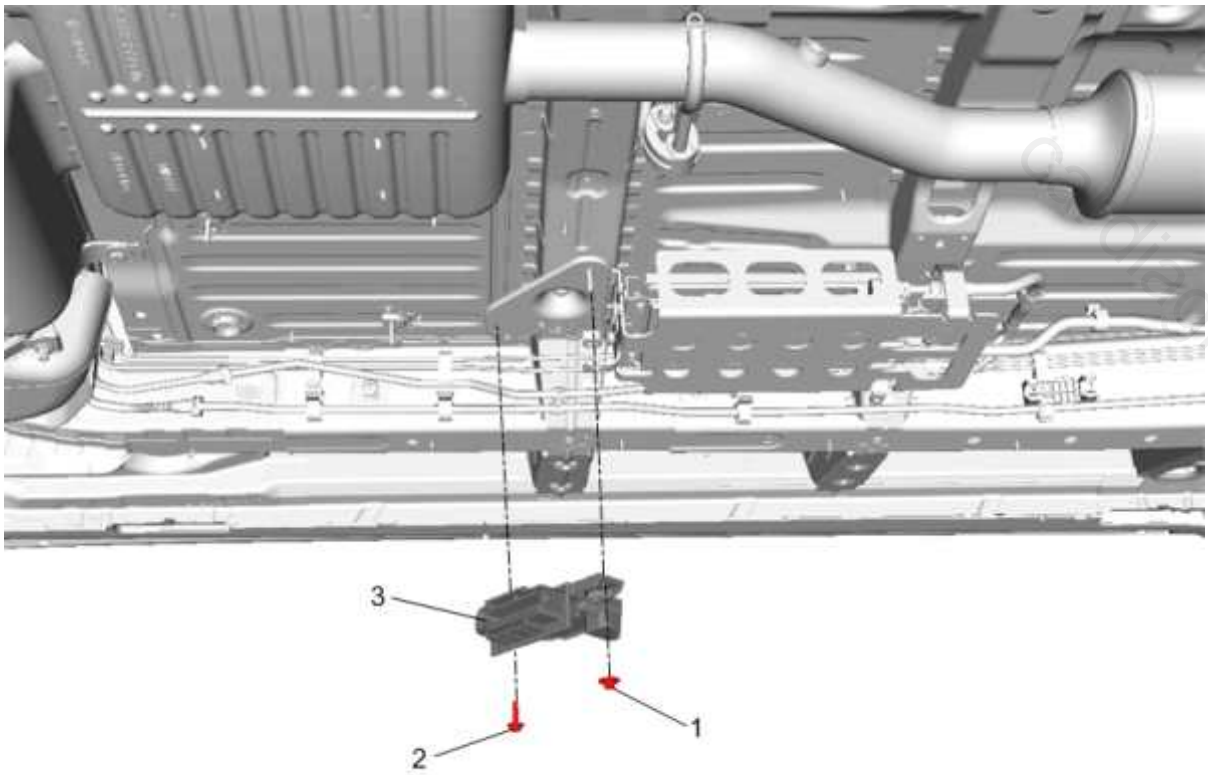

Fig. 288: Fuel Pump Power Control Module (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure {If equipped} Remove Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (Front Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**	
1	Fuel Pump Power Control Module Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)

Callout	Component Name
2	Fuel Pump Power Control Module Bolt **Tighten** 9 N.m (80 lb in)
3	Fuel Pump Power Control Module **Procedure** 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Refer to **Control Module References**

FUEL PUMP POWER CONTROL MODULE BRACKET REPLACEMENT (AWD)

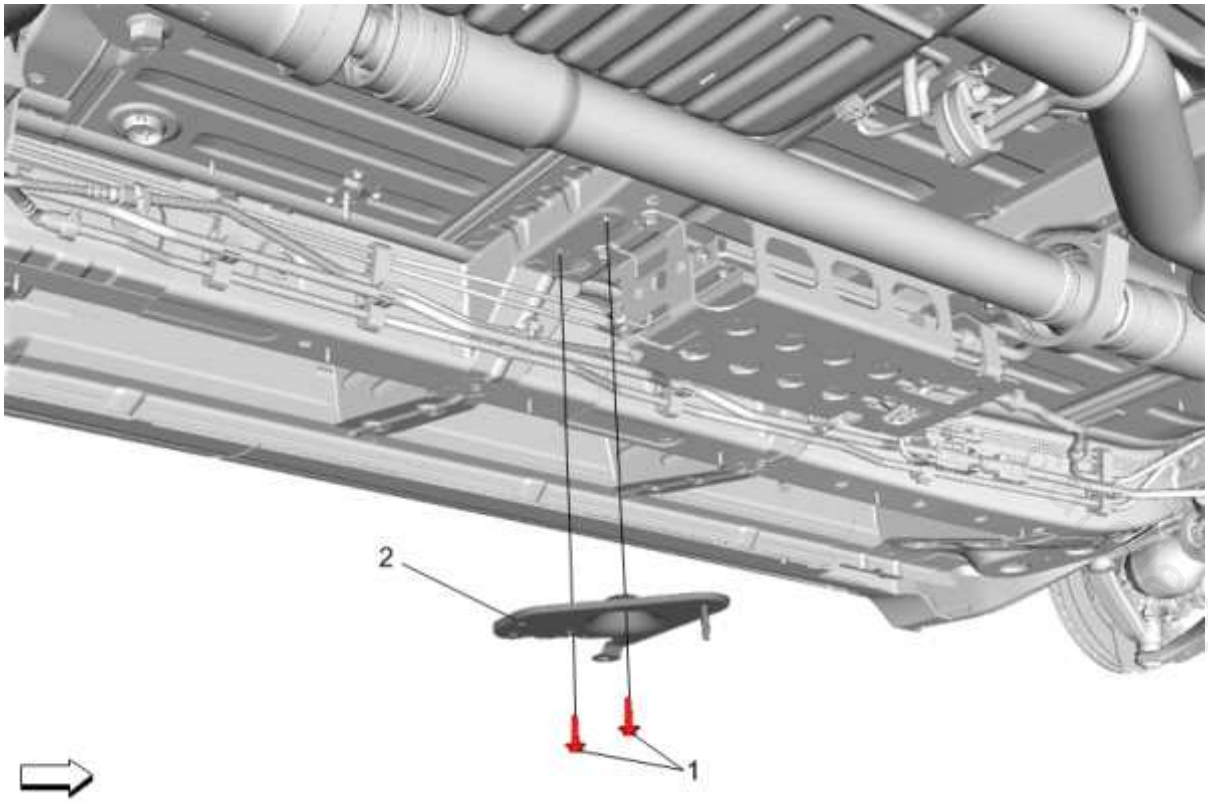

Fig. 289: Fuel Pump Power Control Module Bracket (AWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Fuel Pump Power Control Module. Refer to **Fuel Pump Power Control Module Replacement (AWD)**	
1	Fuel Pump Power Control Module Bracket Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Fuel Pump Power Control Module Bracket

FUEL PUMP POWER CONTROL MODULE BRACKET REPLACEMENT (FWD)

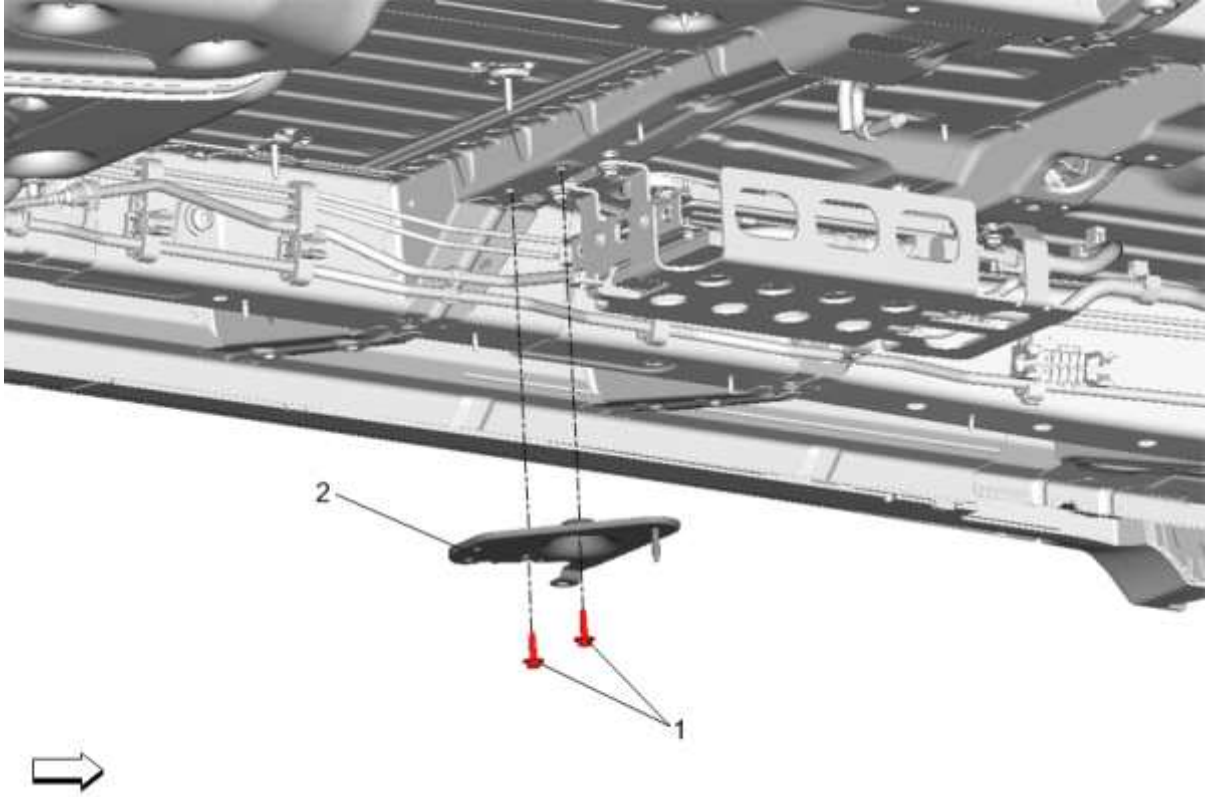

Fig. 290: Fuel Pump Power Control Module Bracket (FWD)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Fuel Pump Power Control Module. Refer to Fuel Pump Power Control Module Replacement (FWD)	
1	Fuel Pump Power Control Module Bracket Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Fuel Pump Power Control Module Bracket

DIESEL FUEL SEPARATOR REPLACEMENT

Special Tools

J-42572 CV Boot Clamp Pliers

Equivalent regional tools: Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools)

Removal Procedure

WARNING: **Refer to Safety Goggles and Fuel Warning**

WARNING: **Refer to Diesel/Gasoline Vapors Warning**

WARNING: **The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.**

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1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
3. Remove Fuel Injection Fuel Feed Pipe. Refer to **Fuel Injection Fuel Feed Pipe Replacement - Fuel Injection Pump to Fuel Rail**

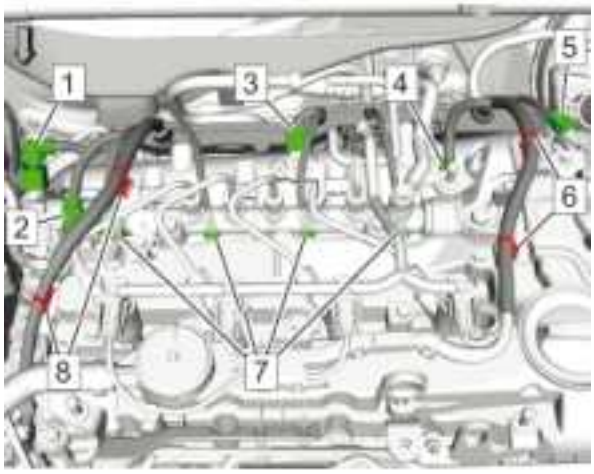

Fig. 291: Electrical Connectors And Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connectors:
    1. Intake Manifold Runner Control Valve Actuator (1)
    2. Fuel Rail Pressure Sensor (2)
    3. Intake Air Pressure and Temperature Sensor (3)
    4. Fuel Pressure Regulator (4)
    5. Exhaust Temperature Sensor - Position 1 (5)
    6. Glow Plugs (7) (Qty: 4)
5. Unclip Wiring Harness Retainers (6, 8) (Qty: 4)

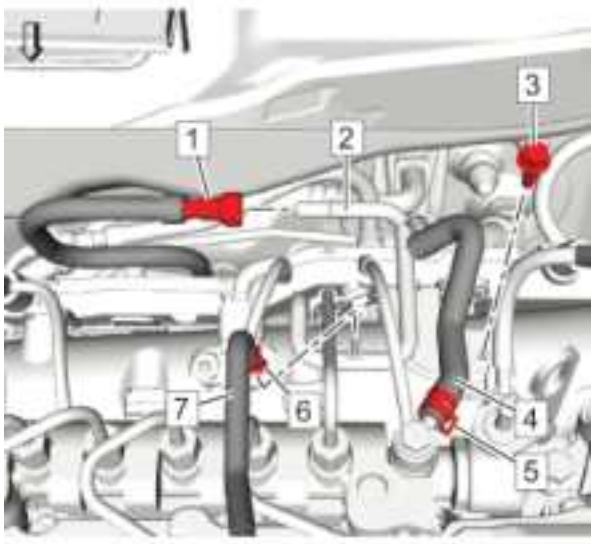

Fig. 292: Diesel Fuel Separator And Components
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect Fuel Return Front Pipe (1) @ Diesel Fuel Separator (2). Refer to **Metal Collar Quick Connect Fitting Service**
7. Close all open connections with the suitable closure plugs.
8. Disengage Diesel Fuel Separator Hose Clamp (5)
9. Disconnect Diesel Fuel Separator Hose (4) @ Fuel Rail

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10. Remove and DISCARD Clamp (6)
11. Disconnect Fuel Return Hose (7) @ Diesel Fuel Separator (2)
12. Remove Diesel Fuel Separator Bolt (3)

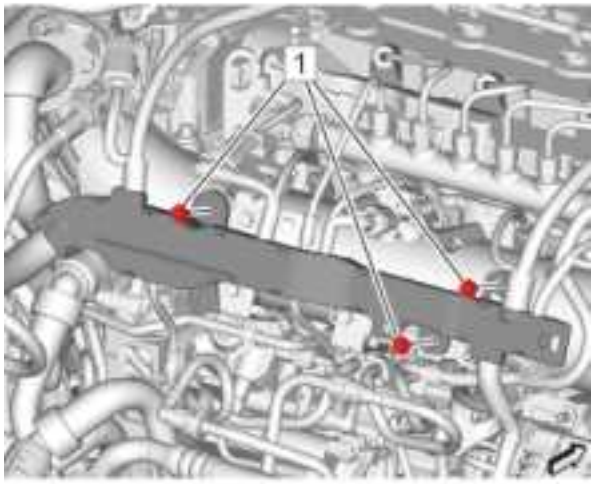

Fig. 293: Engine Wiring Harness Conduit Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove Engine Wiring Harness Conduit Bolts (1) (Qty: 3)

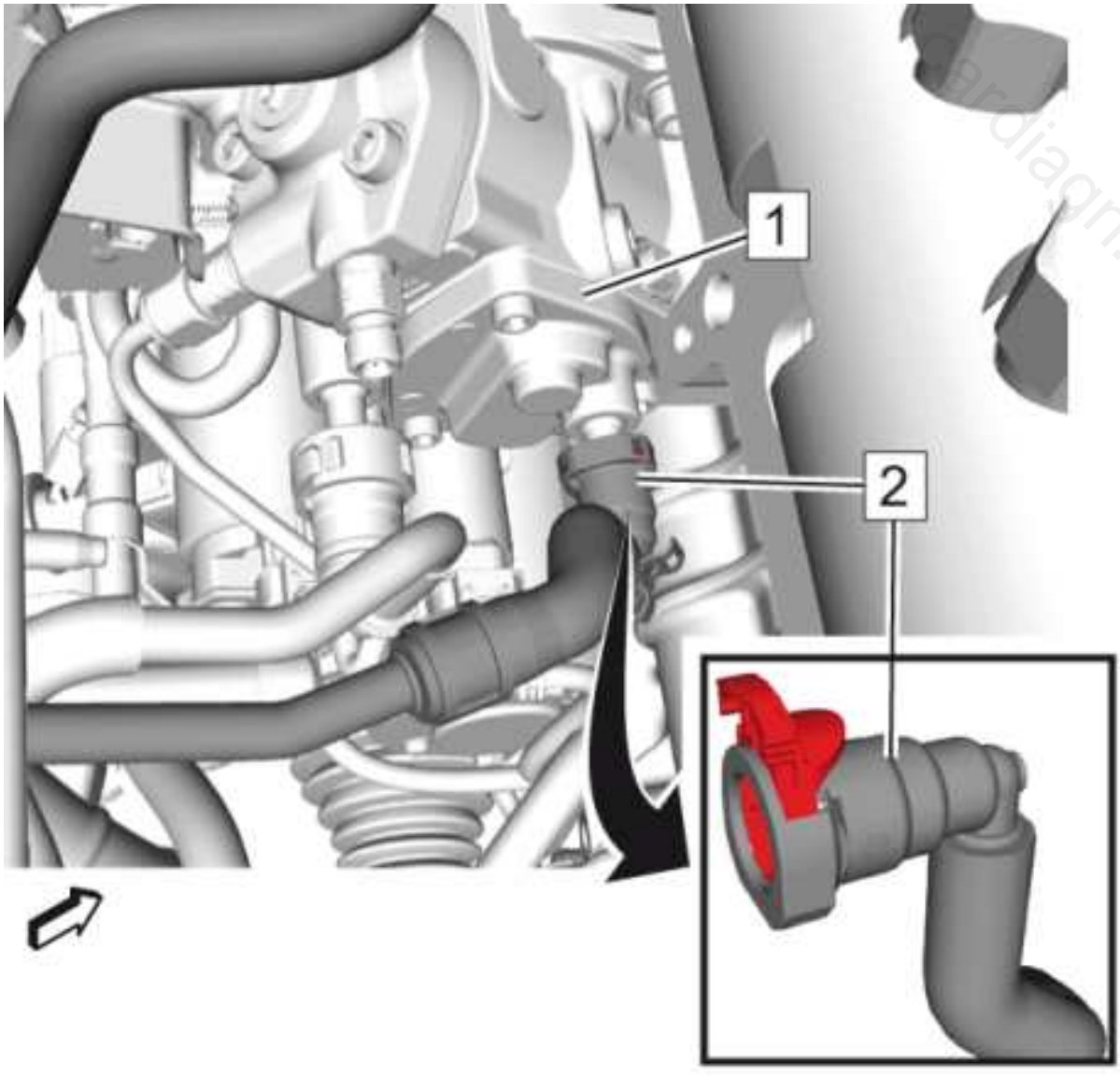

Fig. 294: Diesel Fuel Separator And Fuel Injection Pump
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect Diesel Fuel Separator (2) @ Fuel Injection Pump (1). Refer to **Plastic Collar Quick Connect Fitting Service**
15. Close all open connections with the suitable closure plugs.

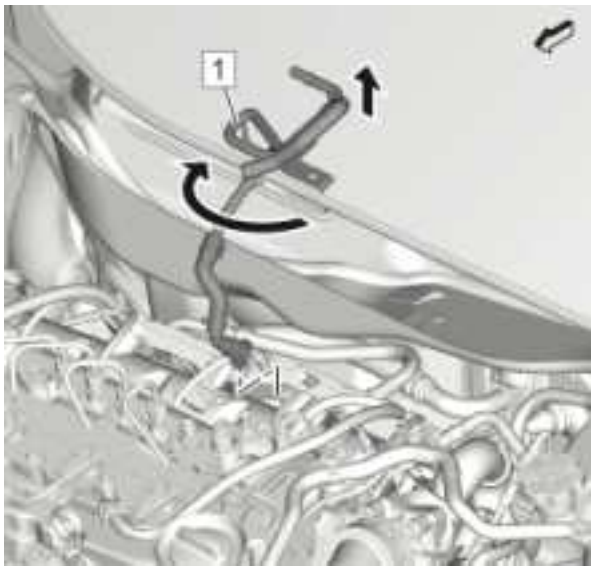

Fig. 295: Diesel Fuel Separator
Courtesy of GENERAL MOTORS COMPANY

16. Remove the diesel fuel separator (1) by rotating clockwise while pulling up the diesel fuel separator.

Installation Procedure

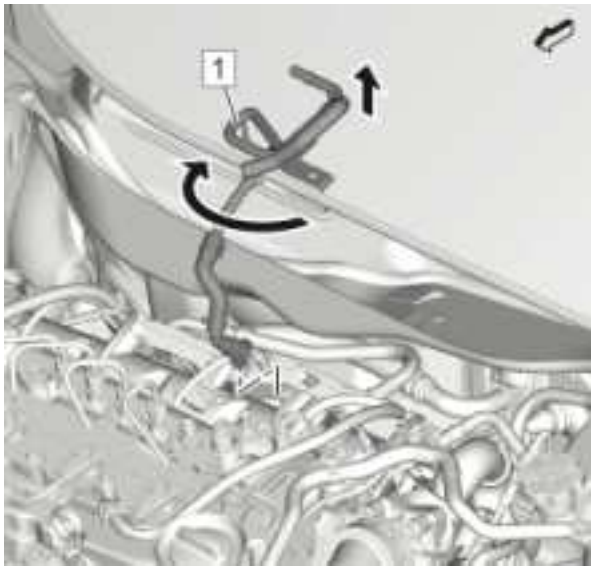

Fig. 296: Diesel Fuel Separator
Courtesy of GENERAL MOTORS COMPANY

1. Install Diesel Fuel Separator (1)

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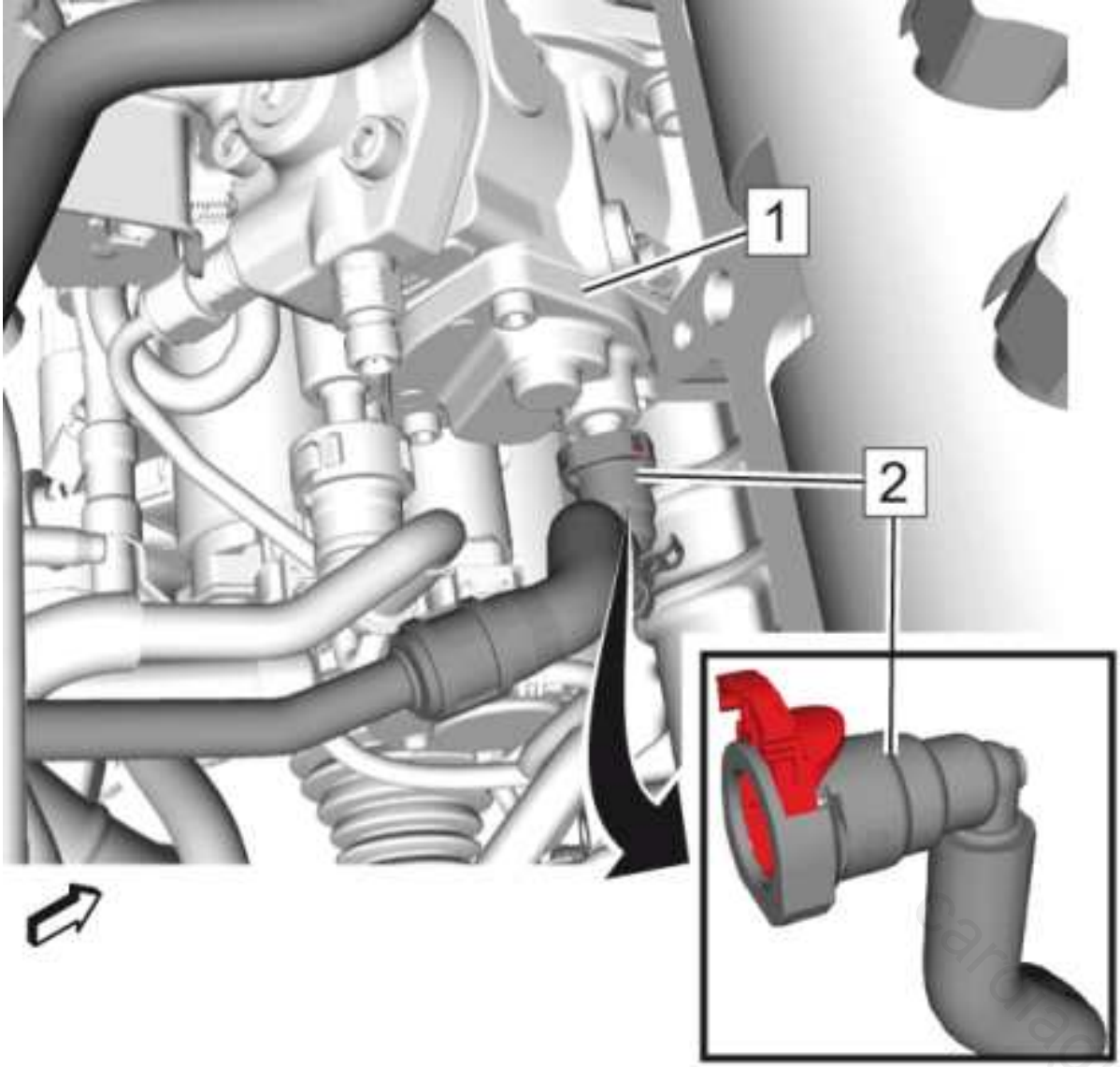

Fig. 297: Diesel Fuel Separator And Fuel Injection Pump
Courtesy of GENERAL MOTORS COMPANY

2. Remove the closure plugs from all connections.
3. Connect Diesel Fuel Separator (2) @ Fuel Injection Pump (1). Refer to **Plastic Collar Quick Connect Fitting Service**

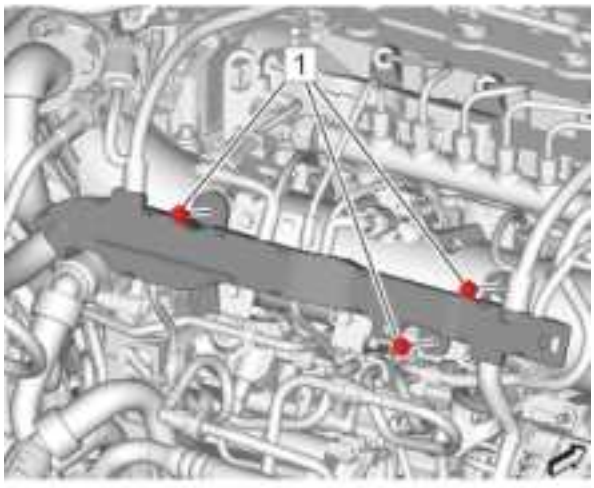

Fig. 298: Engine Wiring Harness Conduit Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution**

4. Install and tighten Engine Wiring Harness Conduit Bolts (1) (Qty: 3) to 9 N.m (80 lb in)

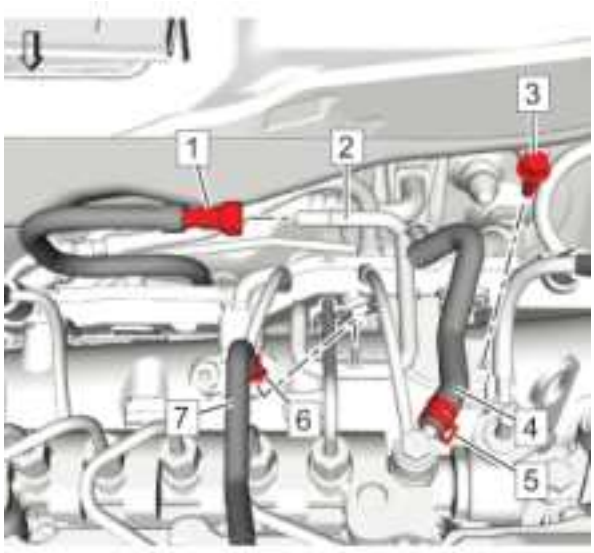

Fig. 299: Diesel Fuel Separator And Components
Courtesy of GENERAL MOTORS COMPANY

5. Install and tighten Diesel Fuel Separator Bolt (3) to 10 N.m (89 lb in)
6. Connect Fuel Injector Fuel Return Hose (7) @ Diesel Fuel Separator (2)
7. Install a NEW clamp. (6) - **J-42572** CV Boot Clamp Pliers
8. Connect Diesel Fuel Separator Hose (4) @ Fuel Rail
9. Engage Diesel Fuel Separator Hose Clamp (5)
10. Remove the closure plugs from all connections.
11. Connect Fuel Return Front Pipe (1) @ Diesel Fuel Separator (2). Refer to **Metal Collar Quick Connect Fitting Service**

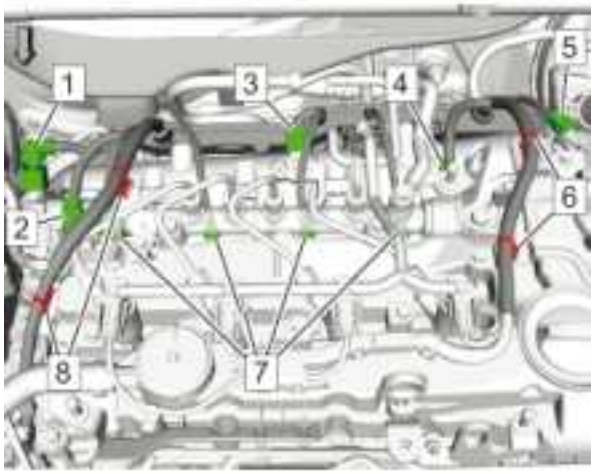

Fig. 300: Electrical Connectors And Retainers
Courtesy of GENERAL MOTORS COMPANY

12. Connect the electrical connectors:
    1. Intake Manifold Runner Control Valve Actuator (1)
    2. Fuel Rail Pressure Sensor (2)
    3. Intake Air Pressure and Temperature Sensor (3)
    4. Fuel Pressure Regulator (4)
    5. Exhaust Temperature Sensor - Position 1 (5)
    6. Glow Plugs (7) (Qty: 4)
13. Install Wiring Harness Retainers (6, 8) (Qty: 4)

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14. Install Fuel Injection Fuel Feed Pipe. Refer to **Fuel Injection Fuel Feed Pipe Replacement - Fuel Injection Pump to Fuel Rail**
15. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
16. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

GLOW PLUG REPLACEMENT

Removal Procedure

1. Disconnect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

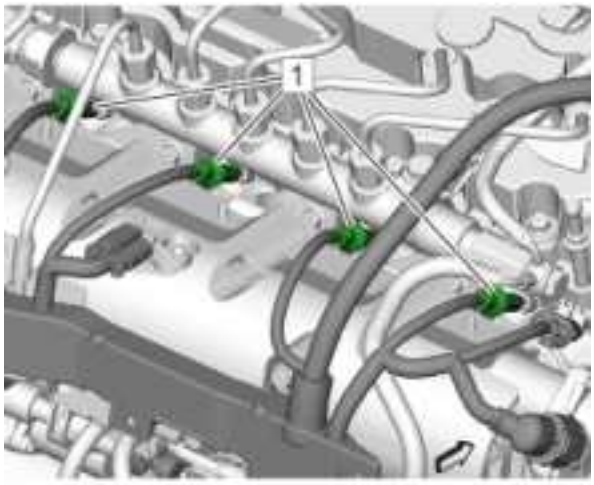

Fig. 301: Glow Plug Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect Glow Plug Electrical Connectors (1) (Qty: 4) @ Glow Plug
4. Clean around each of the glow plugs.

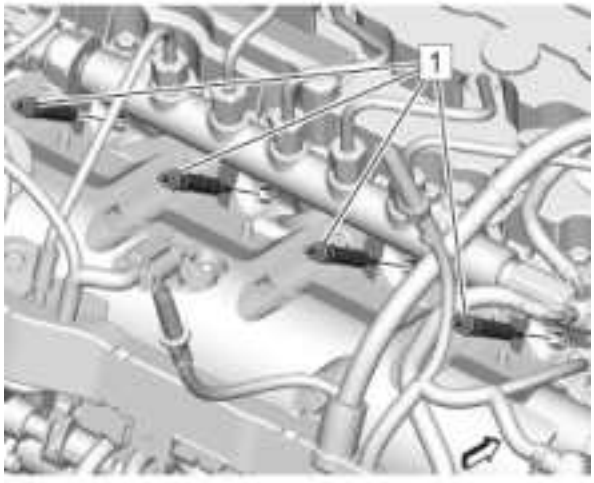

Fig. 302: Glow Plugs
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 4 glow plugs (1).

Installation Procedure

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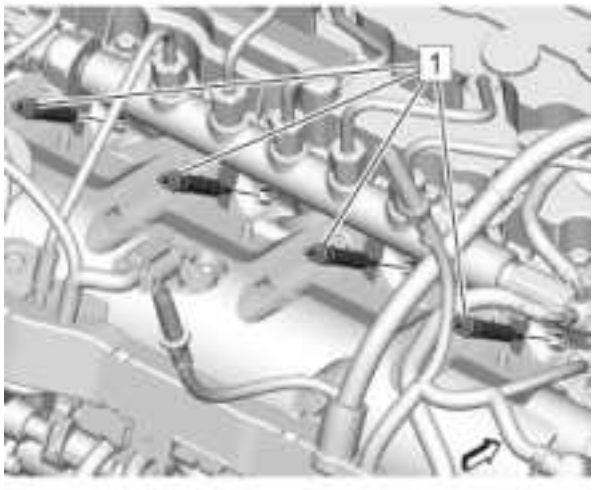

Fig. 303: Glow Plugs
Courtesy of GENERAL MOTORS COMPANY

NOTE: **To aid in hand starting glow plugs into their bores, a hose or tube with an inner diameter of 4 mm can be used as an extension when installed on the end of the glow plug.**

CAUTION: **Refer to Fastener Caution**

1. Install the 4 glow plugs (1) and tighten to 16.5 N.m (12 lb ft).

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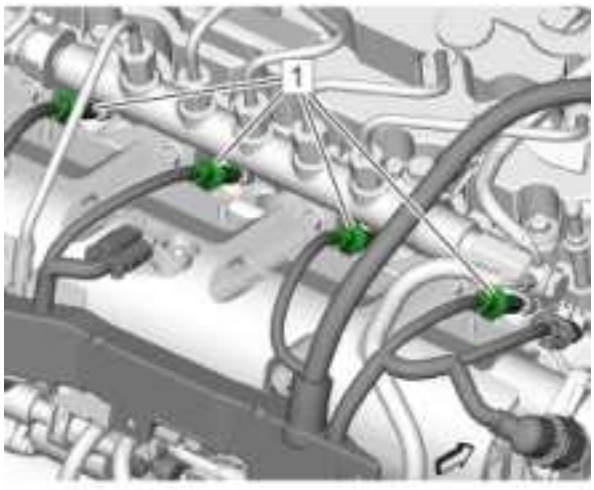

Fig. 304: Glow Plug Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

2. Connect Glow Plug Electrical Connectors (1) (Qty: 4) @ Glow Plug
3. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
4. Connect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

CRANKSHAFT POSITION SENSOR REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Exhaust Gas Recirculation Cooler Housing. Refer to **Exhaust Gas Recirculation Cooler Housing Replacement**

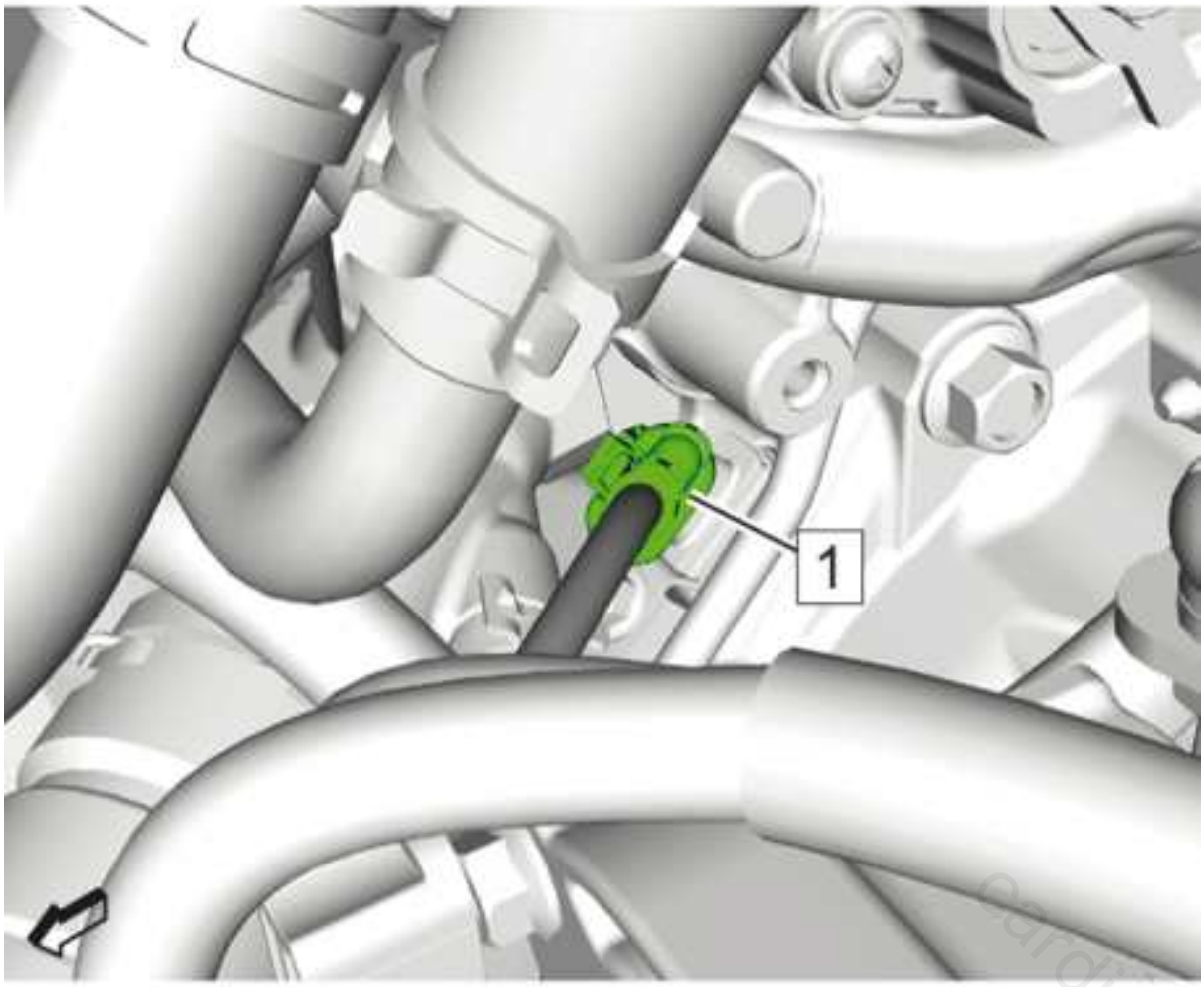

Fig. 305: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the electrical connector. (1)

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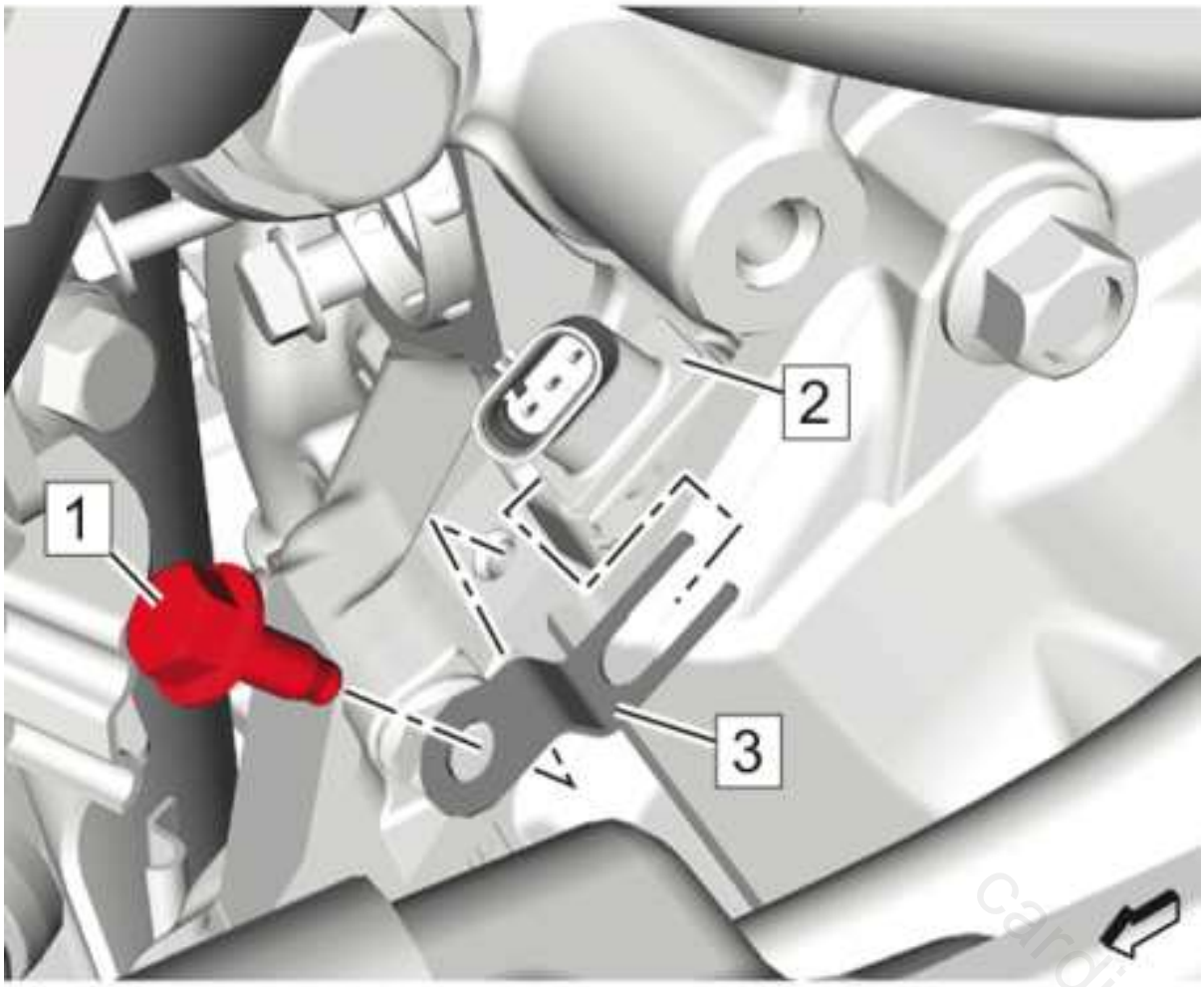

Fig. 306: Crankshaft Position Sensor, Bolt And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

4. Remove Crankshaft Position Sensor Bolt (1)
5. Remove Retainer Spring (3) @ Crankshaft Position Sensor (2)

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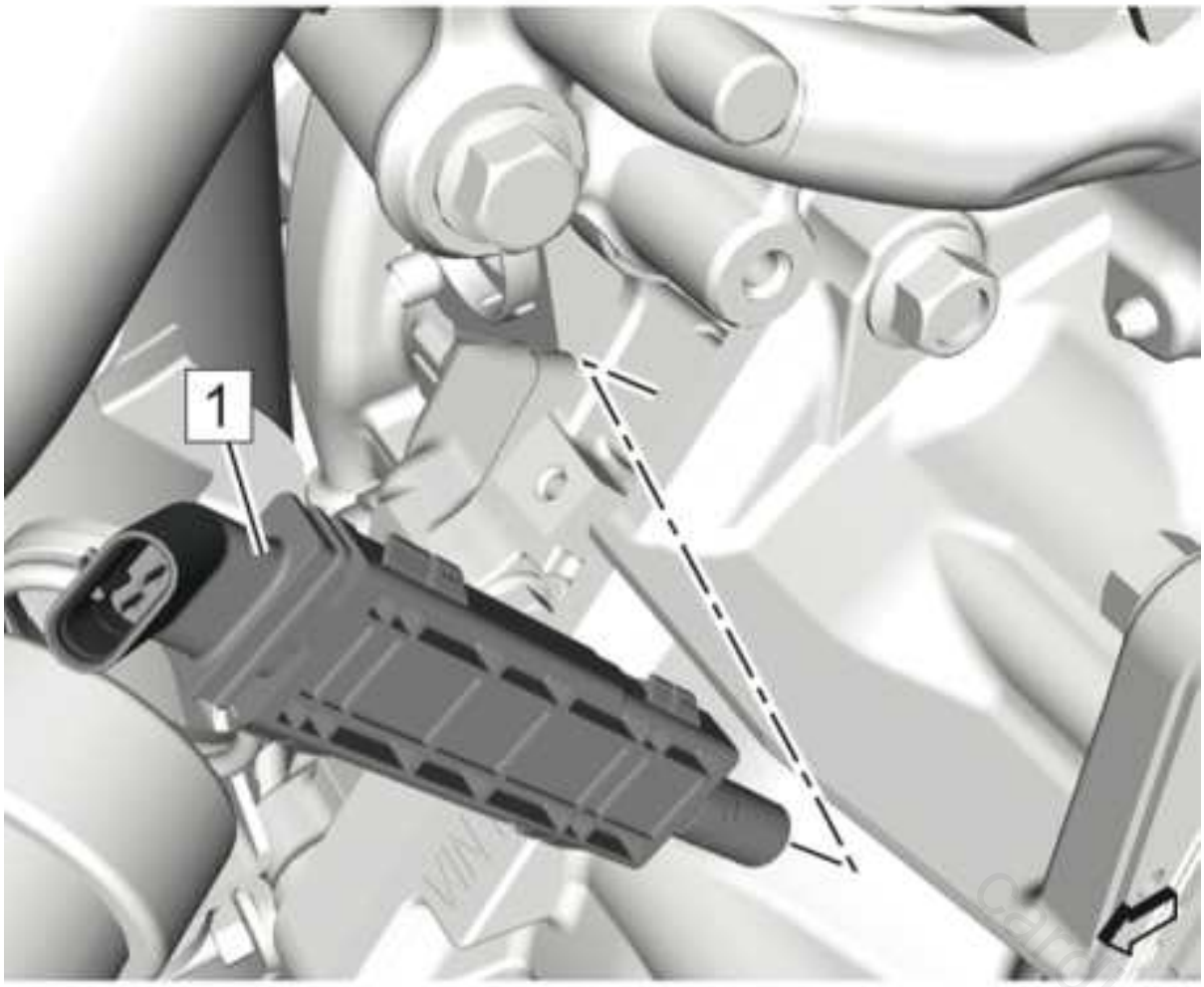

Fig. 307: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

6. Remove Crankshaft Position Sensor (1)

Installation Procedure

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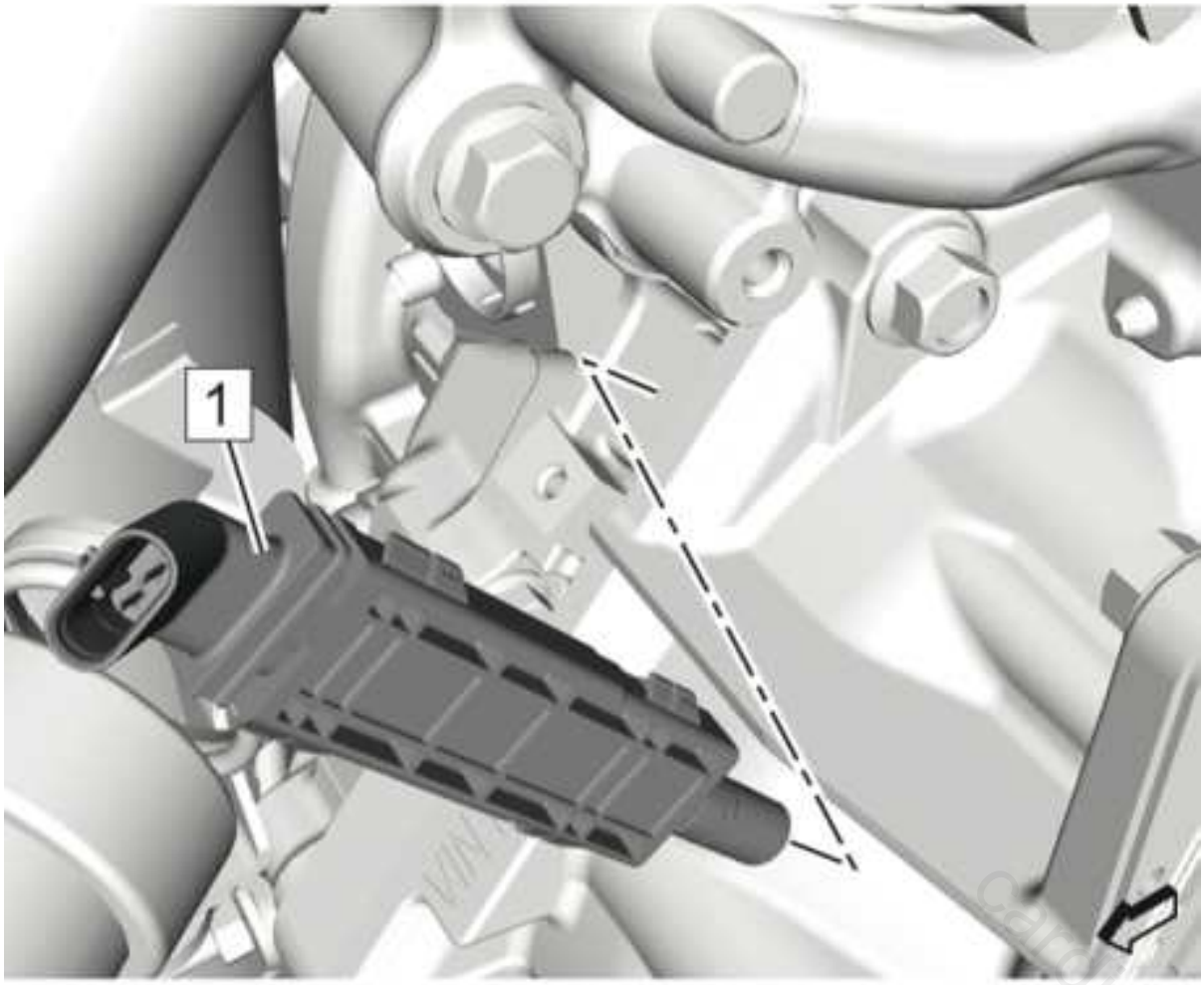

Fig. 308: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install Crankshaft Position Sensor (1)

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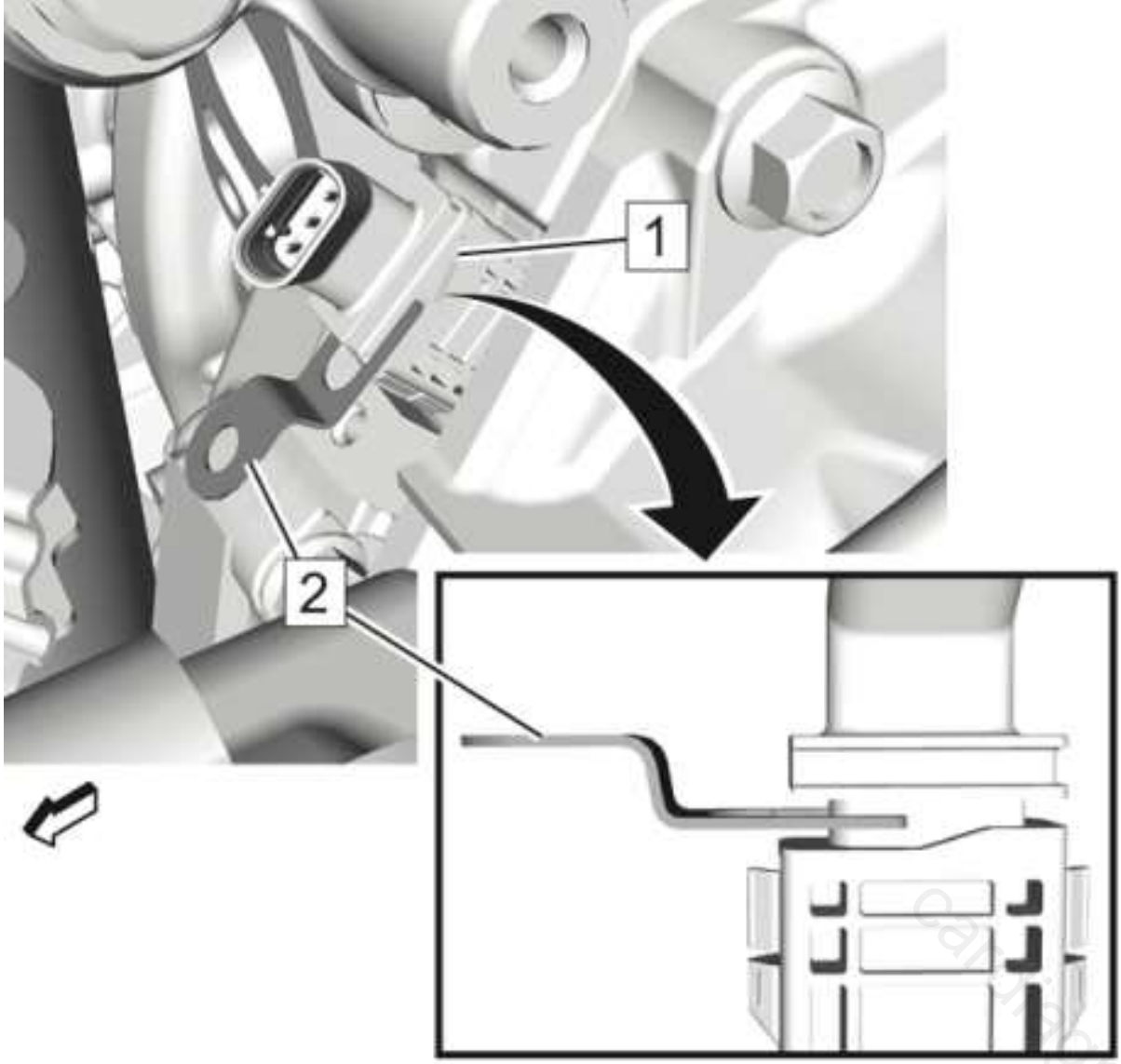

Fig. 309: Crankshaft Position Sensor Retainer Spring Into Correct Channel
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Slightly lift the crankshaft position sensor to install the retainer spring.**

2. Install the crankshaft position sensor retainer spring (2) into the correct channel (1) of the crankshaft position sensor.

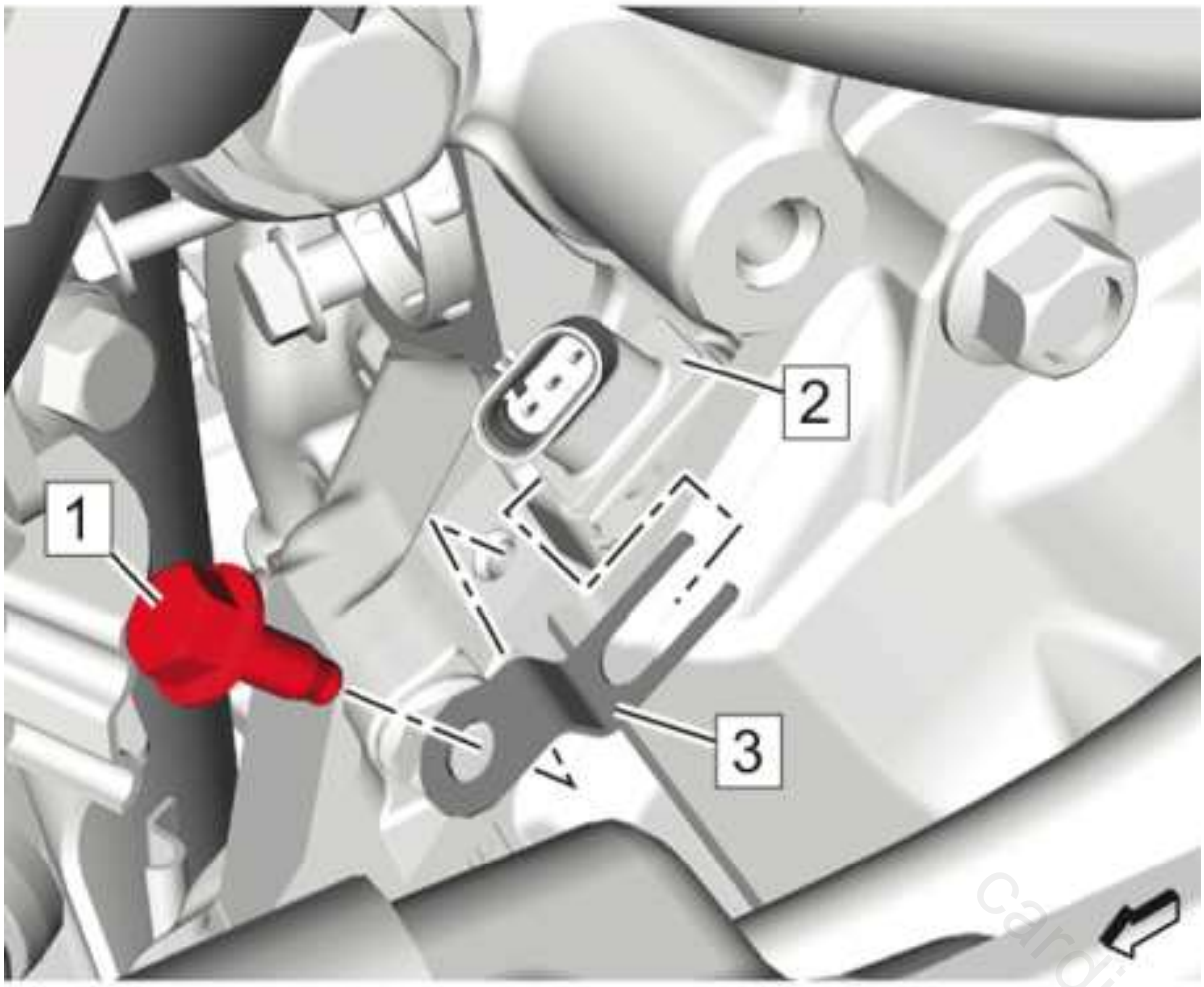

Fig. 310: Crankshaft Position Sensor, Bolt And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

3. Install and tighten Crankshaft Position Sensor Bolt (1) to 10 N.m (89 lb in)

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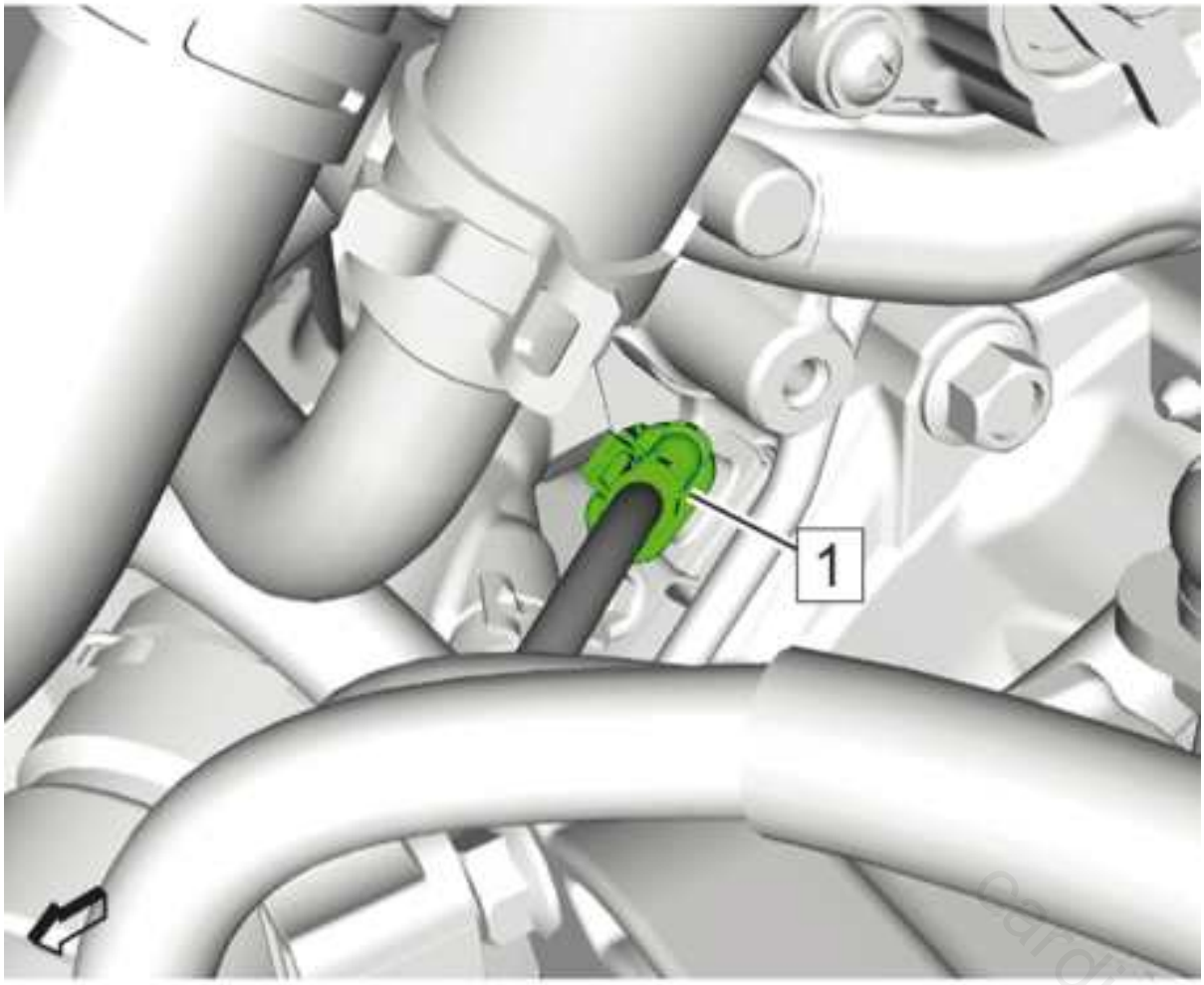

Fig. 311: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Connect the electrical connector. (1)
5. Install Exhaust Gas Recirculation Cooler Housing. Refer to **Exhaust Gas Recirculation Cooler Housing Replacement**
6. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
7. Perform the crankshaft position reluctor ring learn. Refer to **Crankshaft Position Variation Learn**

CAMSHAFT POSITION SENSOR REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

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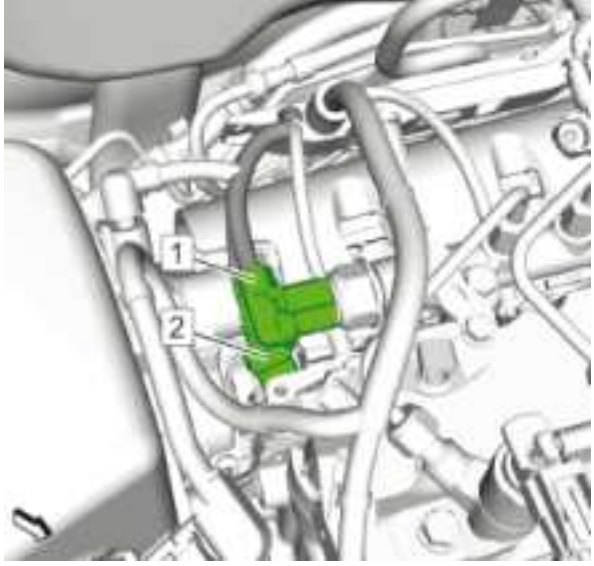

Fig. 312: Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the electrical connectors:
    1. Fuel Injection Fuel Rail Fuel Pressure Sensor (1)
    2. Camshaft Position Sensor (2)

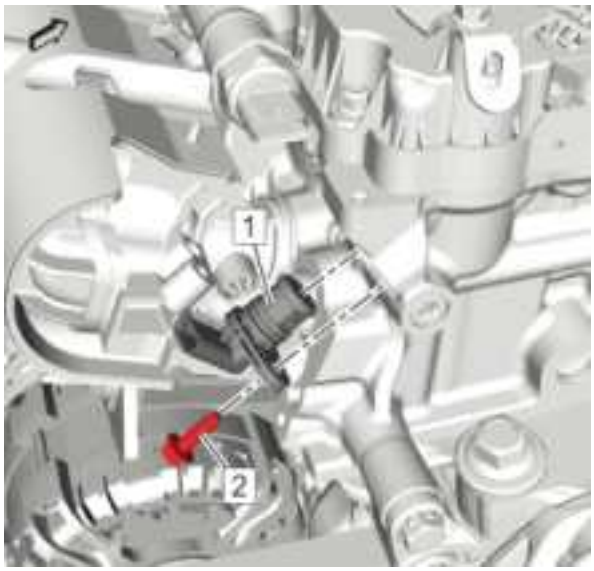

Fig. 313: Camshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove Camshaft Position Sensor Bolt (2)
5. Remove Camshaft Position Sensor (1)

Installation Procedure

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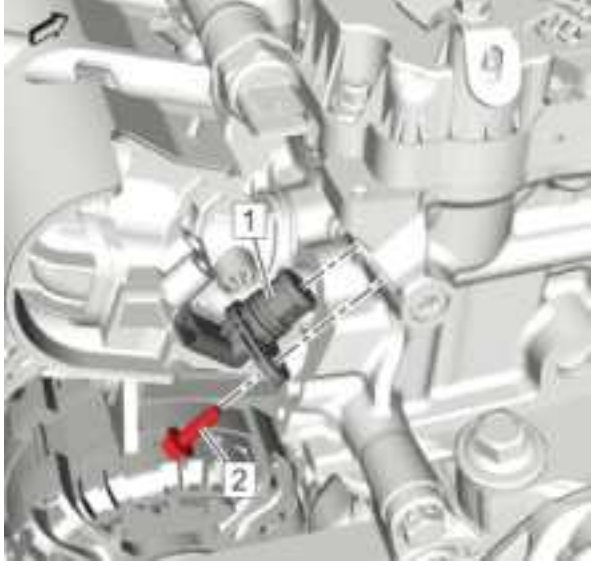

Fig. 314: Camshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install Camshaft Position Sensor (1)

CAUTION: **Refer to Fastener Caution**

2. Install and tighten Camshaft Position Sensor Bolt (2) to 10 N.m (89 lb in)

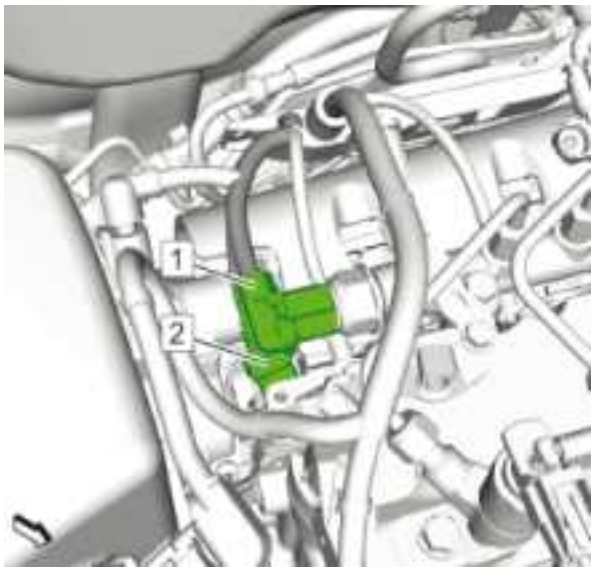

Fig. 315: Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Connect the electrical connector:
    1. Fuel Injection Fuel Rail Fuel Pressure Sensor (1)
    2. Camshaft Position Sensor (2)
4. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
5. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

EXHAUST TEMPERATURE SENSOR REPLACEMENT - POSITION 1

Removal Procedure

1. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

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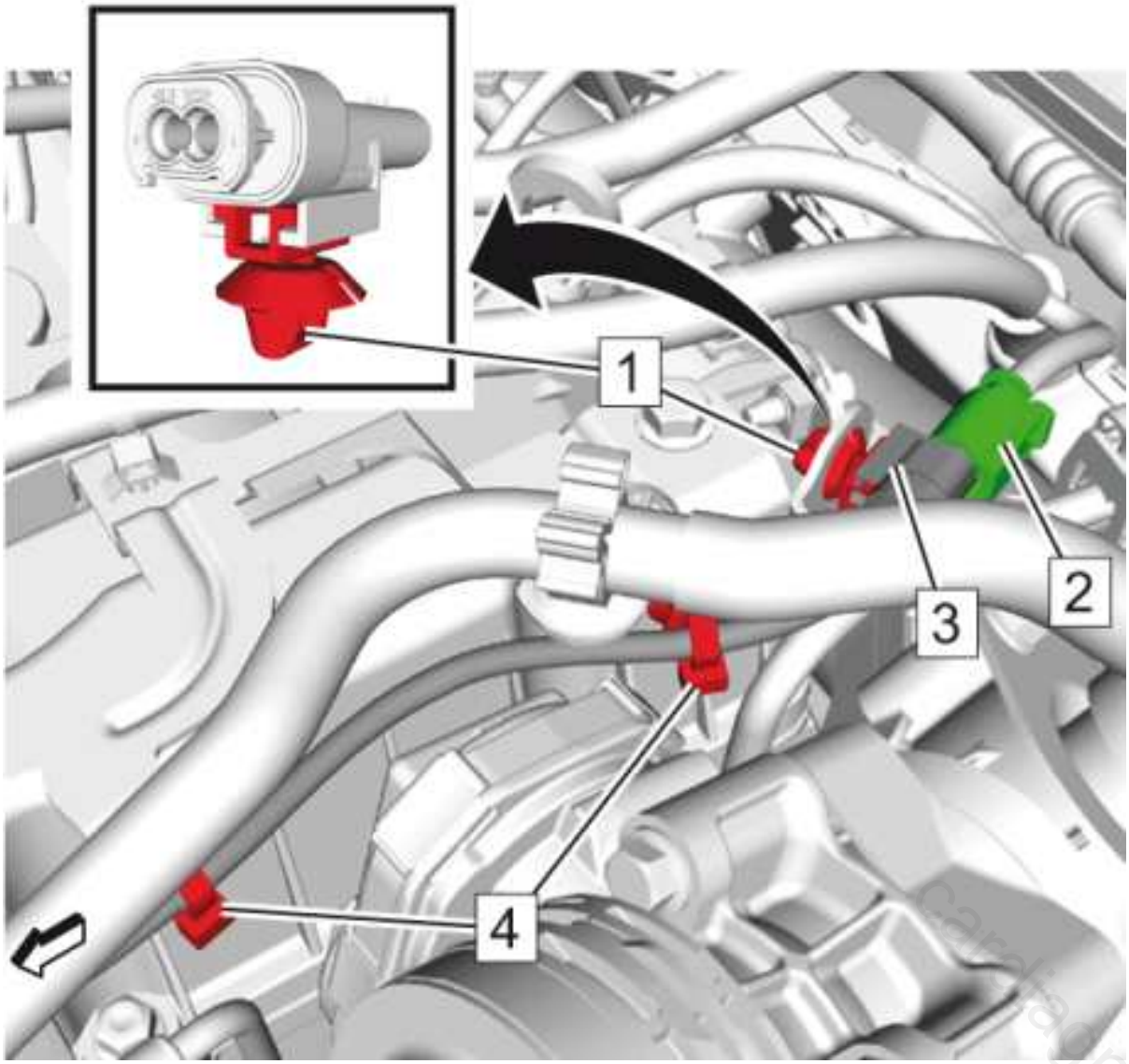

Fig. 316: Exhaust Temperature Sensor Electrical Connector And Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Exhaust Temperature Sensor Electrical Connector (2)
3. Remove Exhaust Temperature Sensor Electrical Connector (3) @ Wiring Harness Retainer (1)
4. Remove Wiring Harness Retainers (4) (Qty: 2)

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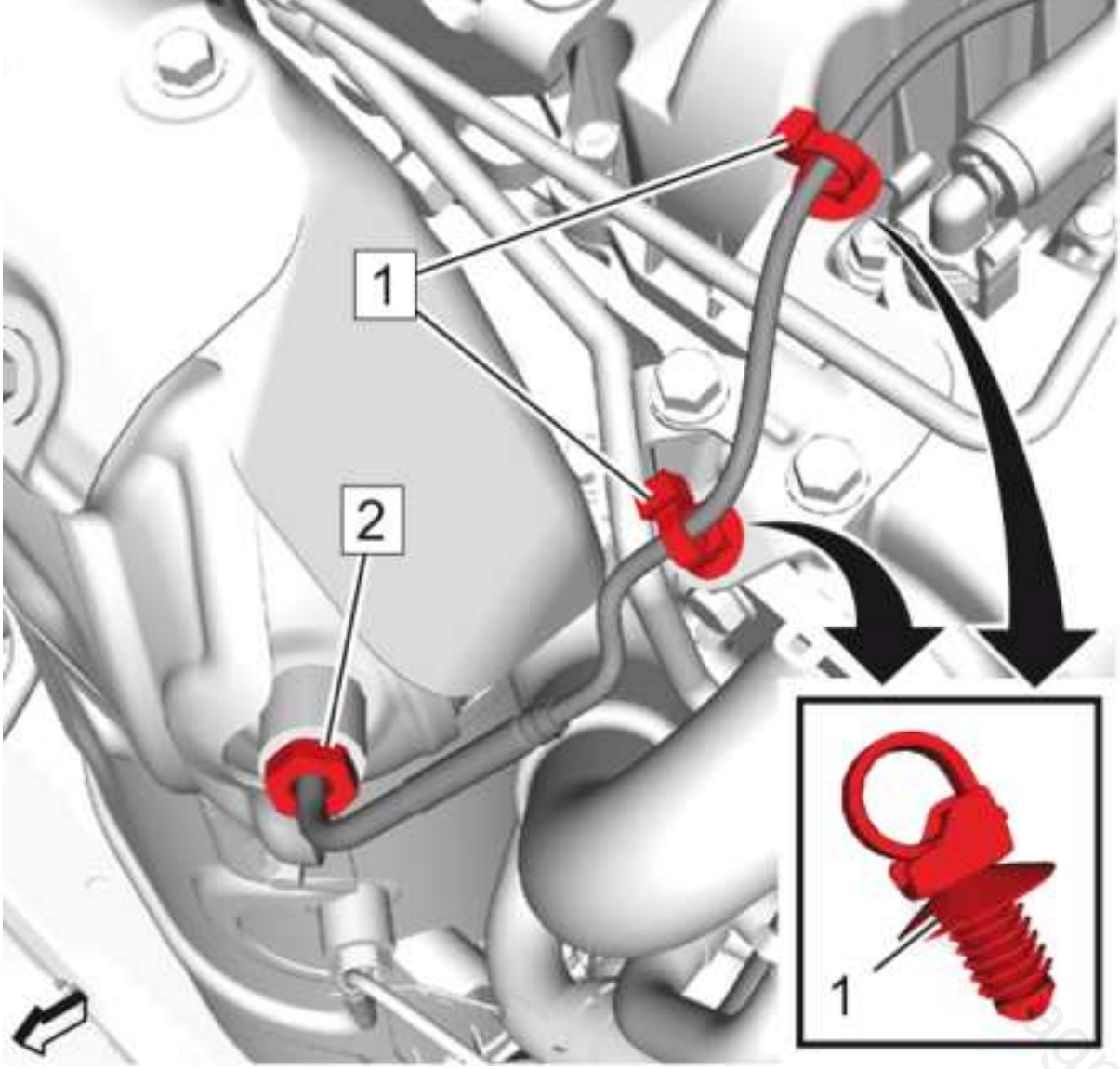

Fig. 317: Exhaust Temperature Sensor - Position 1 And Retainers
Courtesy of GENERAL MOTORS COMPANY

5. Remove Wiring Harness Retainers (1) (Qty: 2)
6. Remove Exhaust Temperature Sensor - Position 1 (2)

Installation Procedure

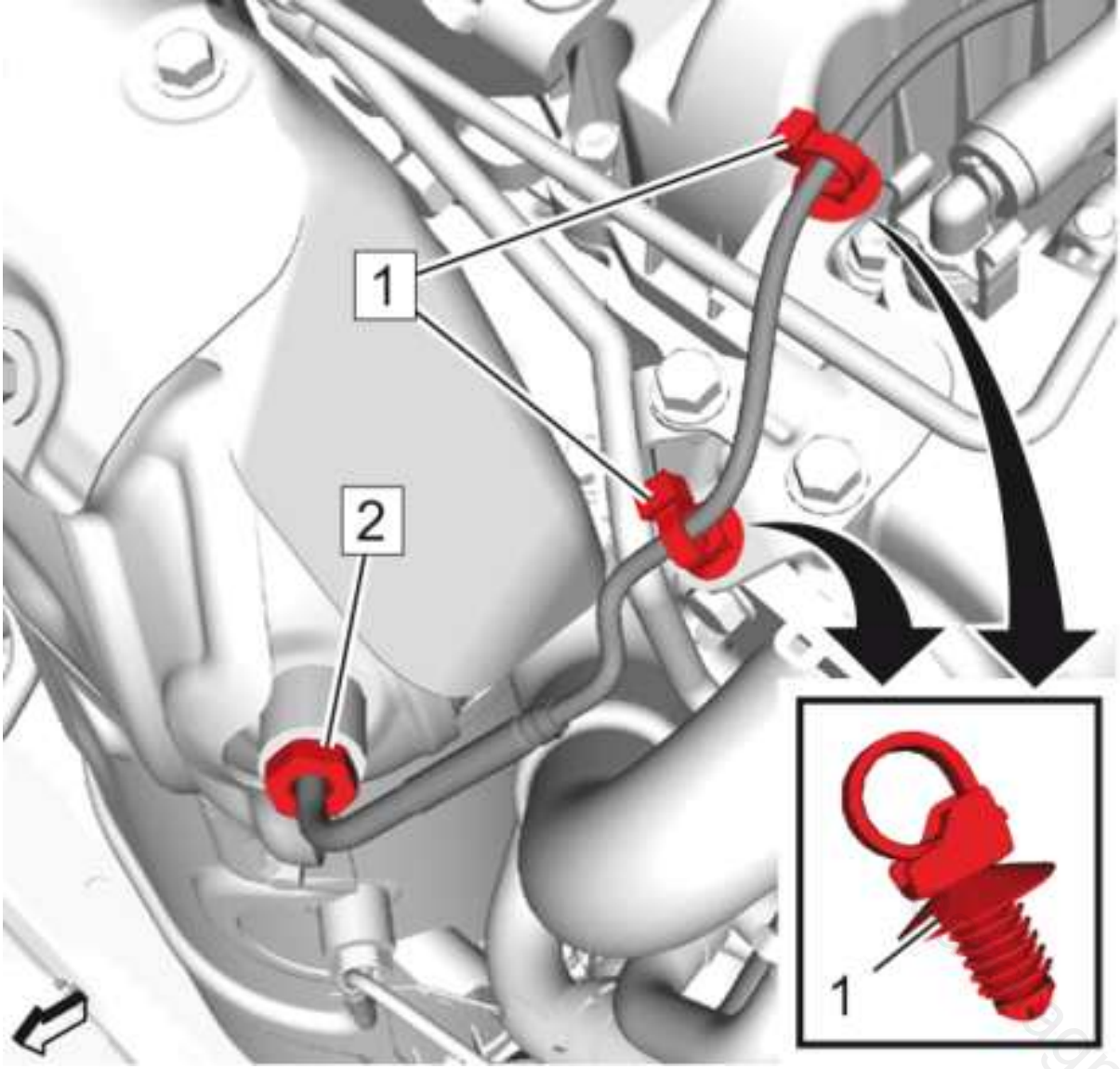

Fig. 318: Exhaust Temperature Sensor - Position 1 And Retainers
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener Tightening Caution**

1. Install and tighten Exhaust Temperature Sensor - Position 1 (2) to 45 N.m (33 lb ft)
2. Install Wiring Harness Retainers (1) (Qty: 2)

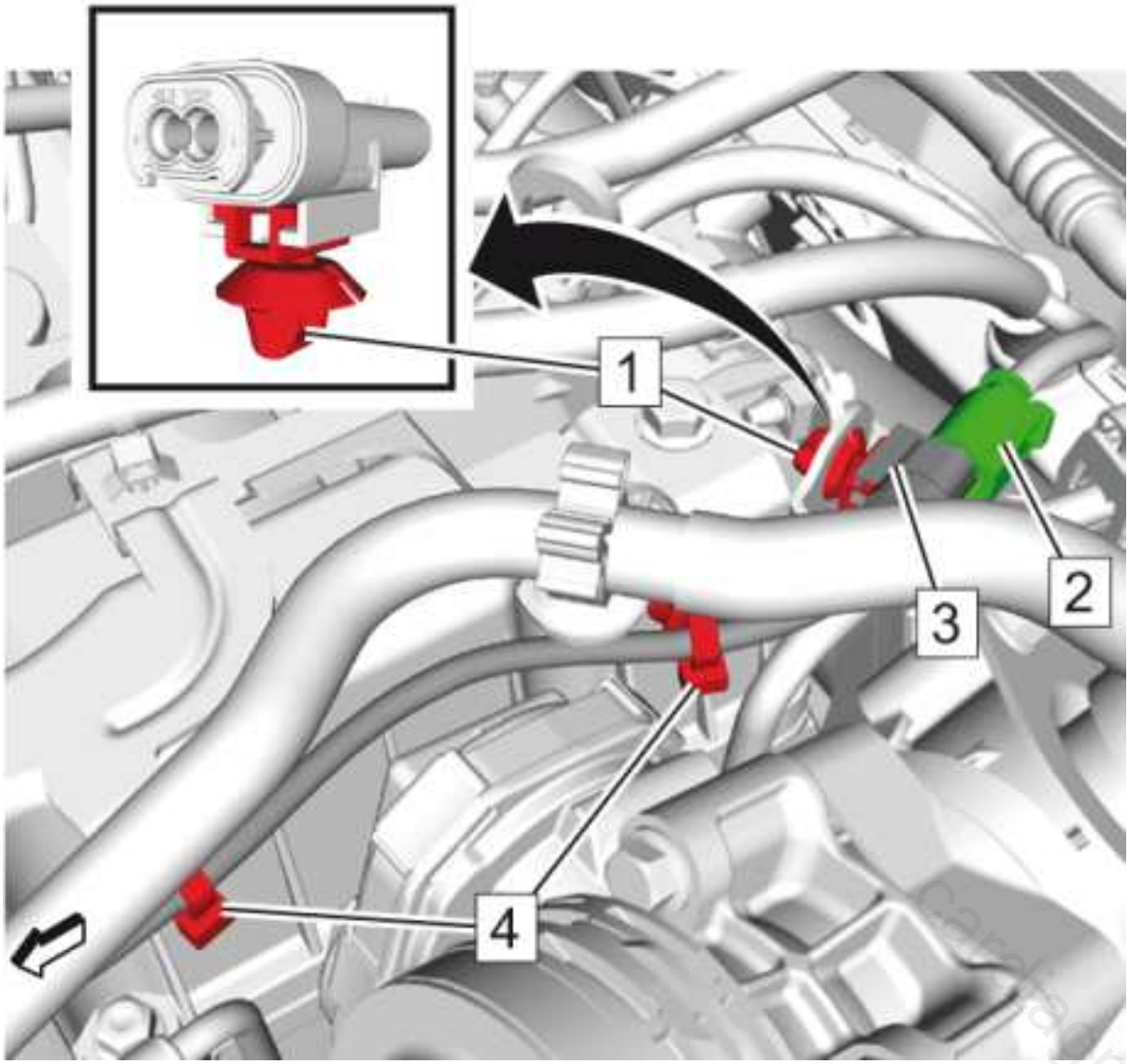

Fig. 319: Exhaust Temperature Sensor Electrical Connector And Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Install Wiring Harness Retainers (4) (Qty: 2)
4. Install Exhaust Temperature Sensor Electrical Connector (3) @ Wiring Harness Retainer (1)
5. Connect Exhaust Temperature Sensor Electrical Connector (2)
6. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
7. If replacing, perform the exhaust gas temperature sensor reset. Refer to **Exhaust Gas Temperature Sensor Reset**
8. If replacing, perform the NOx catalyst reductant loading reset. Refer to **NOx Catalyst Reductant Loading Reset**

EXHAUST TEMPERATURE SENSOR REPLACEMENT - POSITION 2

Removal Procedure

WARNING: **Refer to Exhaust Service Warning**

WARNING: **Refer to Protective Goggles and Glove Warning**

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

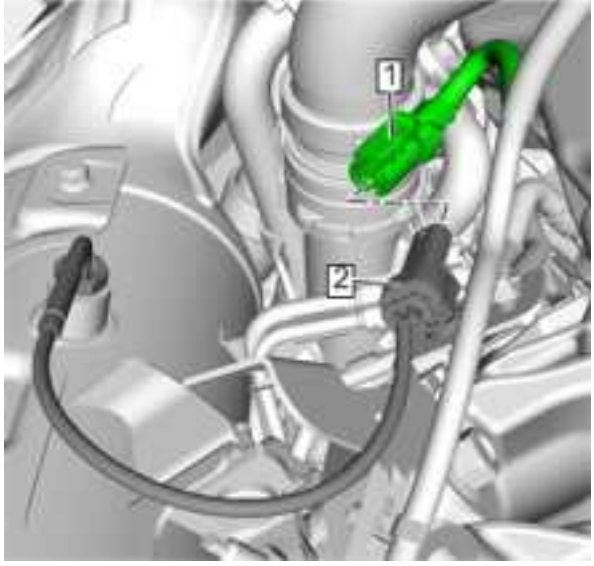

Fig. 320: Electrical Connector And Exhaust Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect Electrical Connector (1) @ Exhaust Temperature Sensor (2)

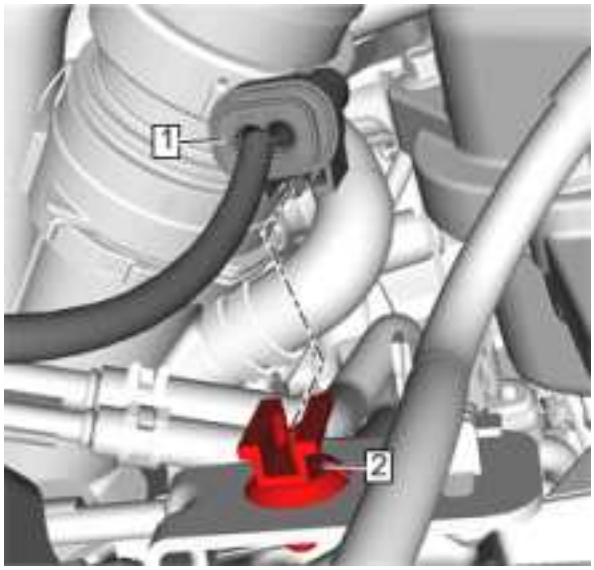

Fig. 321: Exhaust Temperature Sensor And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Unclip Exhaust Temperature Sensor (1) @ Retainer (2)

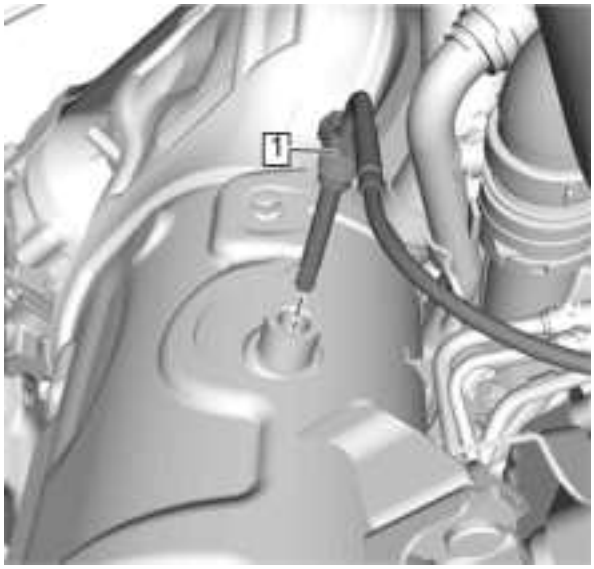

Fig. 322: Exhaust Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

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5. Remove Exhaust Temperature Sensor (1)

Installation Procedure

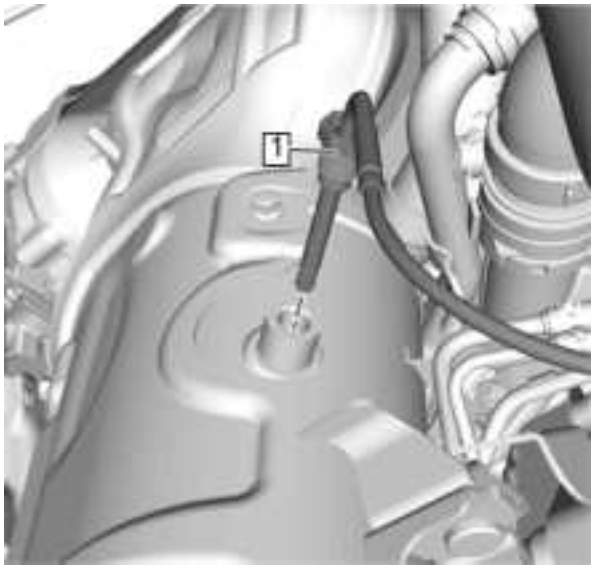

Fig. 323: Exhaust Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener Tightening Caution**

1. Install and tighten Exhaust Temperature Sensor (1) to 45 N.m (33 lb ft)

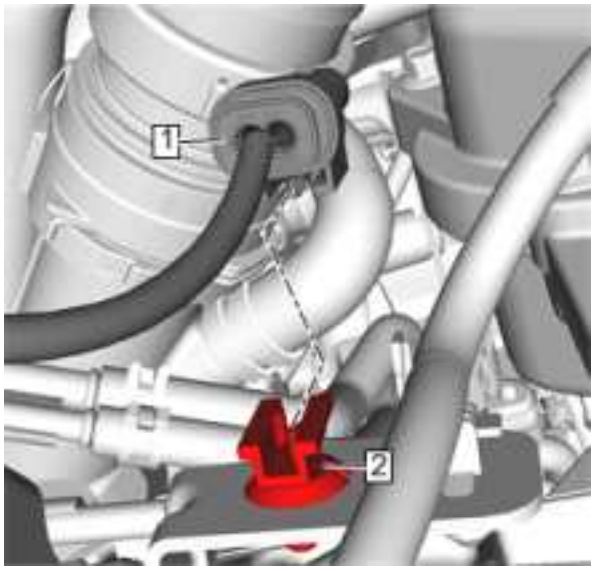

Fig. 324: Exhaust Temperature Sensor And Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Install Exhaust Temperature Sensor (1) @ Retainer (2)

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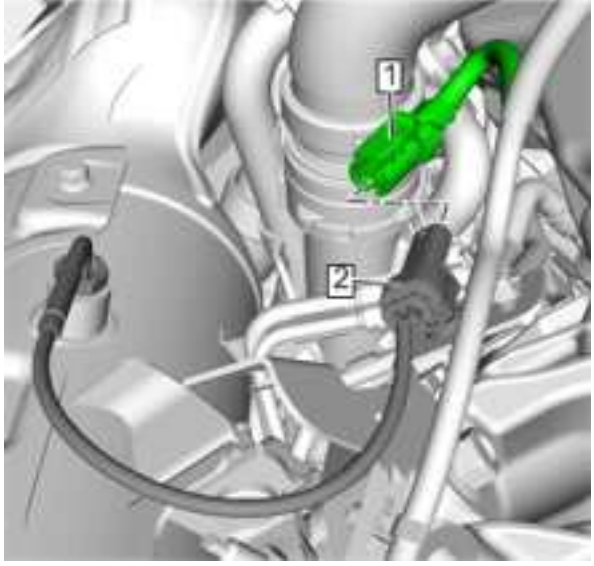

Fig. 325: Electrical Connector And Exhaust Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Connect Electrical Connector (1) @ Exhaust Temperature Sensor (2)
4. Remove the supports and lower the vehicle. Refer to **Lifting and Jacking the Vehicle**
5. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
6. If replacing, perform the exhaust gas temperature sensor reset. Refer to **Exhaust Gas Temperature Sensor Reset**
7. If replacing, perform the NOx catalyst reductant loading reset. Refer to **NOx Catalyst Reductant Loading Reset**

EXHAUST TEMPERATURE SENSOR REPLACEMENT - POSITION 3

Removal Procedure

WARNING: Refer to **Exhaust Service Warning**

1. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

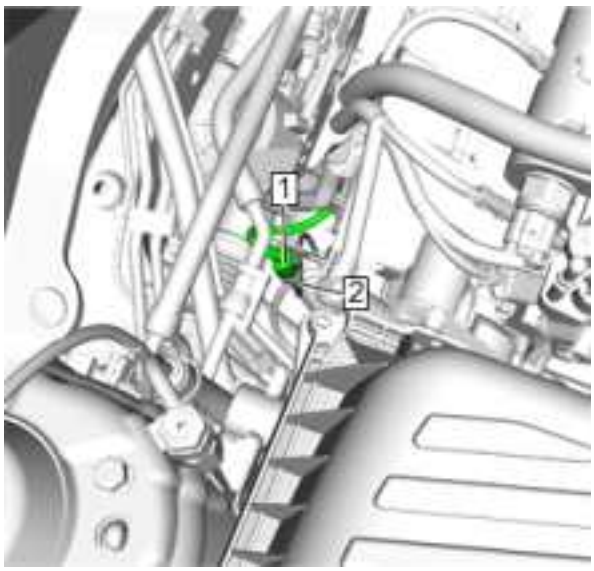

Fig. 326: Electrical Connector And Exhaust Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Electrical Connector (1) @ Exhaust Temperature Sensor (2)
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

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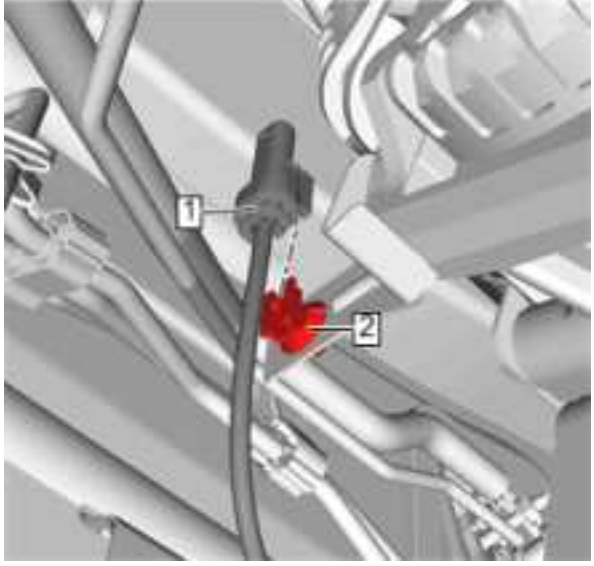

Fig. 327: Exhaust Temperature Sensor And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Unclip Exhaust Temperature Sensor (1) @ Retainer (2)

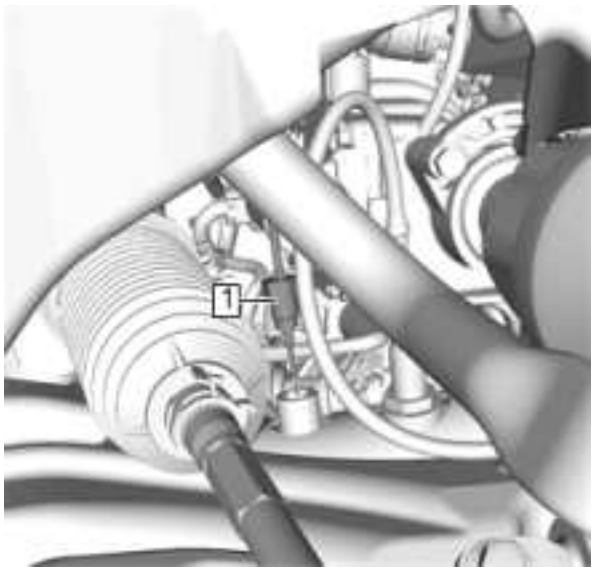

Fig. 328: Exhaust Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Remove Exhaust Temperature Sensor (1)

Installation Procedure

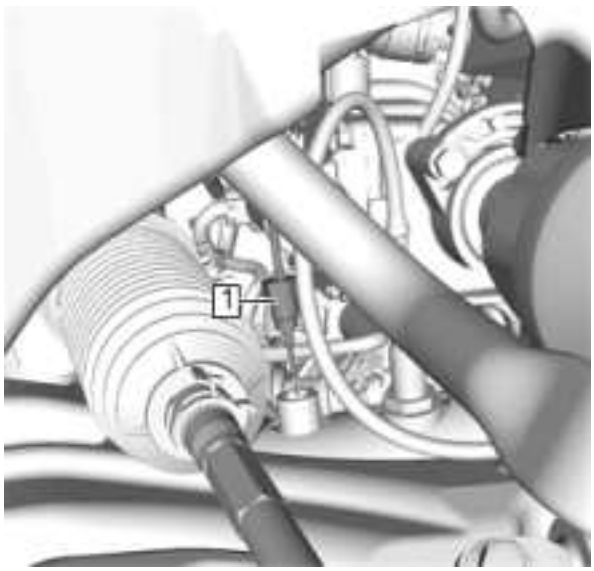

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Fig. 329: Exhaust Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution

1. Install and tighten Exhaust Temperature Sensor (1) to 45 N.m (33 lb ft)

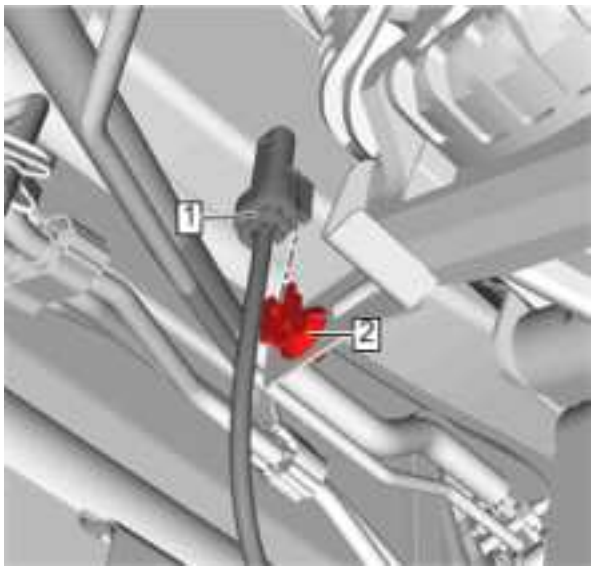

Fig. 330: Exhaust Temperature Sensor And Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Install Exhaust Temperature Sensor (1) @ Retainer (2)
3. Remove the supports and lower the vehicle. Refer to Lifting and Jacking the Vehicle

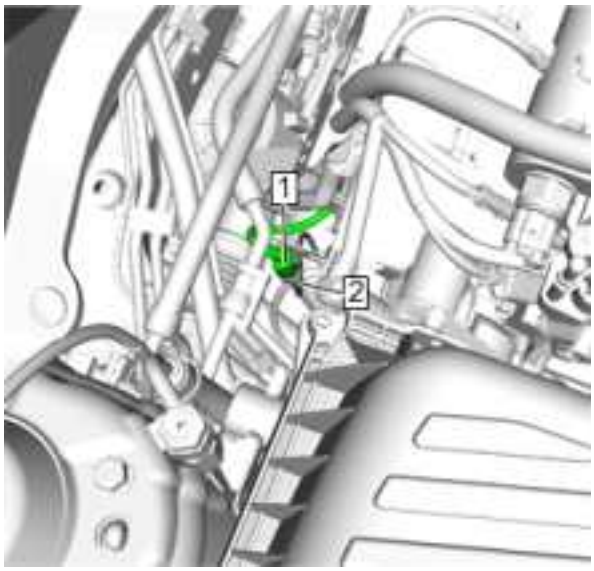

Fig. 331: Electrical Connector And Exhaust Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Connect Electrical Connector (1) @ Exhaust Temperature Sensor (2)
5. Install Intake Manifold Cover. Refer to Intake Manifold Cover Replacement
6. If replacing, perform the exhaust gas temperature sensor reset. Refer to Exhaust Gas Temperature Sensor Reset
7. If replacing, perform the NOx catalyst reductant loading reset. Refer to NOx Catalyst Reductant Loading Reset

EXHAUST PARTICULATE SENSOR REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection (KL9)

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2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
3. Remove the right front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation**

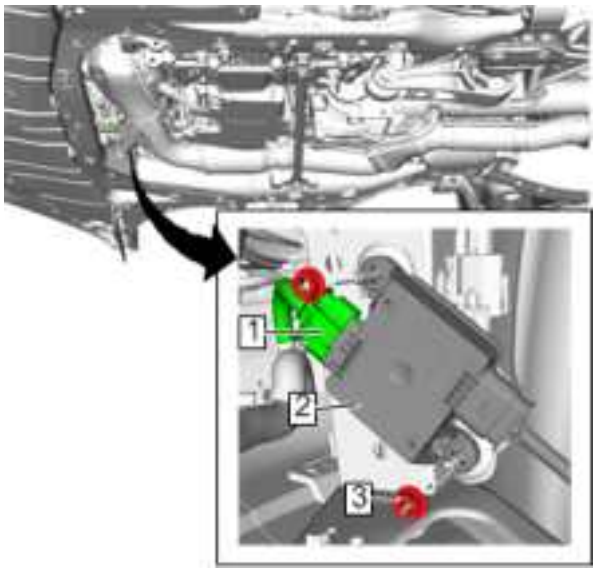

Fig. 332: Electrical Connector, Exhaust Particulate Sensor Control Module And Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Do not bend the exhaust flex pipe more than 10 degrees in any direction. Bending of more than 10 degrees or twisting in a range of Â± 0.5 degrees will damage the exhaust flex decoupler.**

4. Disconnect Electrical Connector (1) @ Exhaust Particulate Sensor Control Module (2)

NOTE: **Secure the exhaust particulate sensor control module from falling down in order to prevent a defect on the control module.**

5. Remove Exhaust Particulate Sensor Control Module Bracket Nuts (3) (Qty: 2)

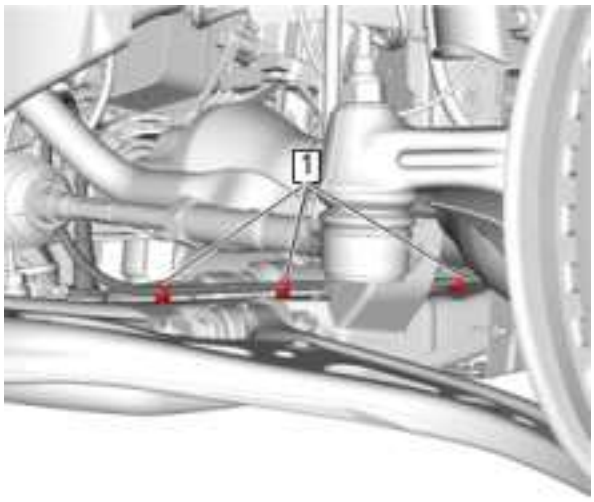

Fig. 333: Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

6. Remove Wiring Harness Retainers (1) (Qty: 3) @ Drivetrain and Front Suspension Cradle

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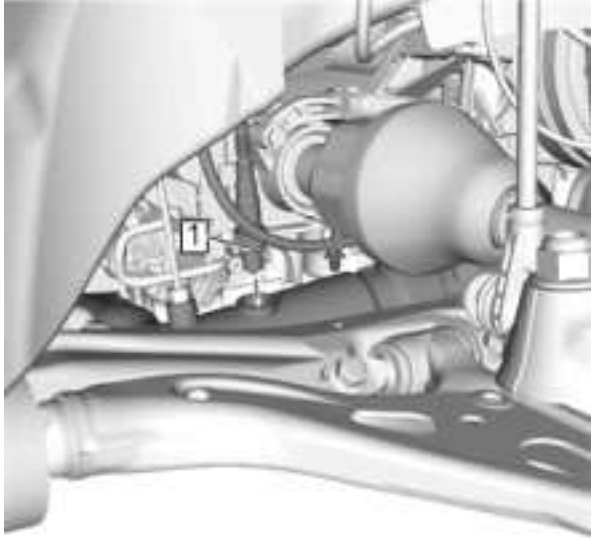

Fig. 334: Exhaust Particulate Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT bend the cable sharply at the base of either the sensing unit or sensor ECU in the final mounting position.**

7. Remove Exhaust Particulate Sensor (1)

Installation Procedure

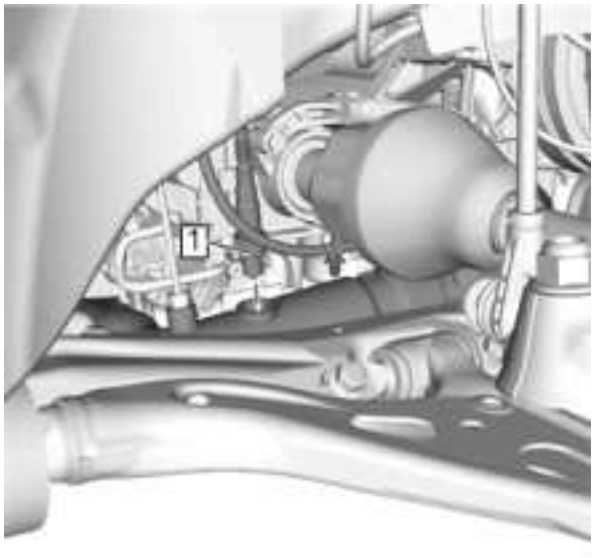

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Fig. 335: Exhaust Particulate Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Do not bend the exhaust flex pipe more than 10 degrees in any direction. Bending of more than 10 degrees or twisting in a range of Â± 0.5 degrees will damage the exhaust flex decoupler.**

CAUTION: **Refer to Component Fastener Tightening Caution**

NOTE: **Do NOT bend the cable sharply at the base of either the sensing unit or sensor ECU in the final mounting position.**

1. Install and tighten Exhaust Particulate Sensor (1) to 45 N.m (33 lb ft)

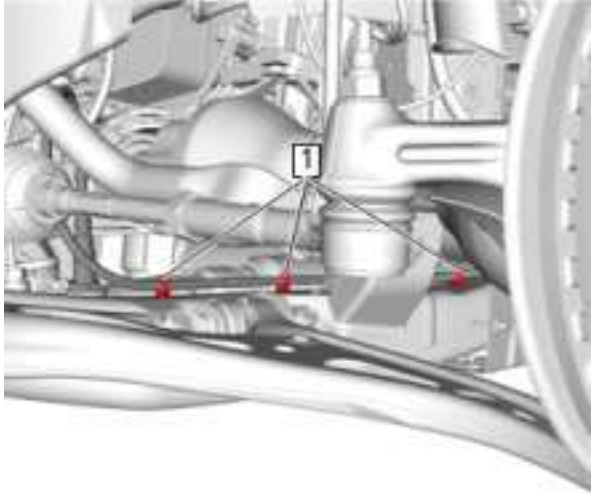

Fig. 336: Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Install Wiring Harness Retainers (1) (Qty: 3) @ Drivetrain and Front Suspension Cradle

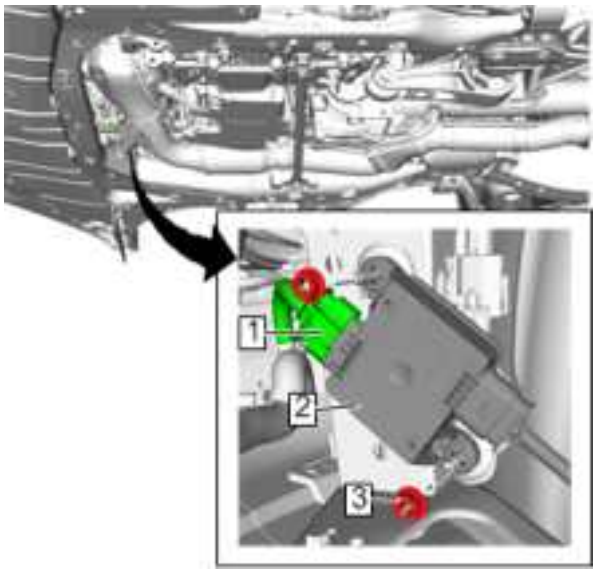

Fig. 337: Electrical Connector, Exhaust Particulate Sensor Control Module And Bracket Nuts
Courtesy of GENERAL MOTORS COMPANY

3. Install Exhaust Particulate Sensor Control Module (2)

CAUTION: **Refer to Fastener Caution .**

4. Install and tighten Exhaust Particulate Sensor Control Module Bracket Nuts (3) (Qty: 2) to 9 N.m (80 lb in)
5. Connect Electrical Connector (1) @ Exhaust Particulate Sensor Control Module (2)
6. Install the right front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation**
7. Remove the supports and lower the vehicle. Refer to **Lifting and Jacking the Vehicle**
8. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
9. When the replacement is completed, use a scan tool to perform the appropriate reset functions. Refer to **Control Module References**

EXHAUST PRESSURE DIFFERENTIAL SENSOR REPLACEMENT

Removal Procedure

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1. Remove Engine Control Module. Refer to **Engine Control Module Replacement**

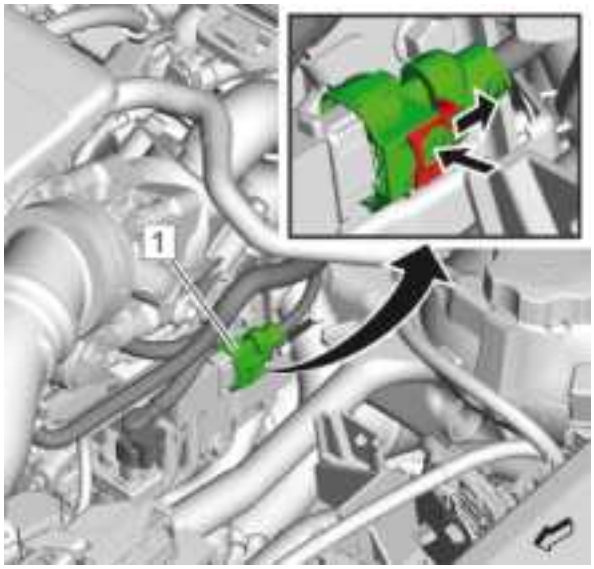

Fig. 338: Exhaust Pressure Differential Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Electrical Connector (1) @ Exhaust Pressure Differential Sensor

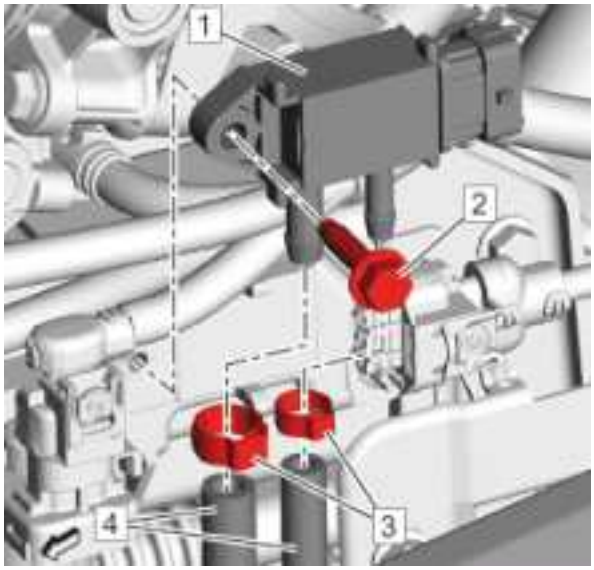

Fig. 339: Exhaust Pressure Differential Sensor, Bolt, Hoses And Clamps
Courtesy of GENERAL MOTORS COMPANY

3. Remove the exhaust pressure sensor hose clamps. (3) (Qty: 2)

NOTE: **Mind the difference hose diameters.**

4. Remove the exhaust pressure sensor hoses. (4) (Qty: 2)
5. Remove Exhaust Pressure Differential Sensor Bolt (2)
6. Remove Exhaust Pressure Differential Sensor (1)

Installation Procedure

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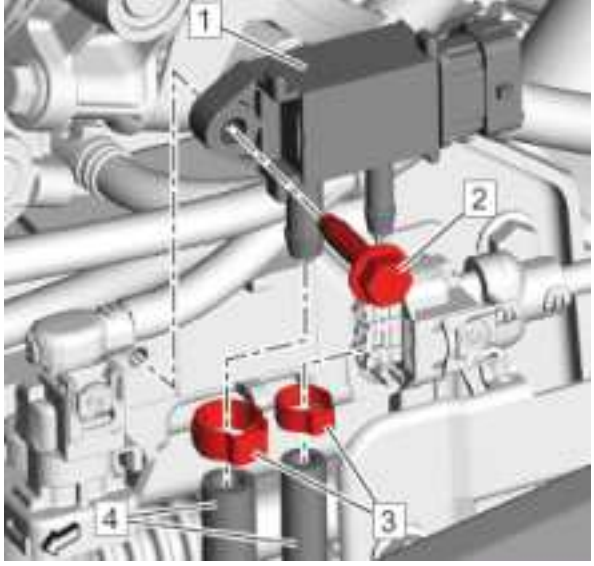

Fig. 340: Exhaust Pressure Differential Sensor, Bolt, Hoses And Clamps
Courtesy of GENERAL MOTORS COMPANY

1. Install Exhaust Pressure Differential Sensor (1)

CAUTION: **Refer to Fastener Caution**

2. Install and tighten Exhaust Pressure Differential Sensor Bolt (2) to 9 N.m (80 lb in)

NOTE: **Mind the difference hose diameters.**

3. Install Exhaust Pressure Sensor Hoses (4) (Qty: 2)
4. Install Exhaust Pressure Sensor Hose Clamps (1) (Qty: 3)

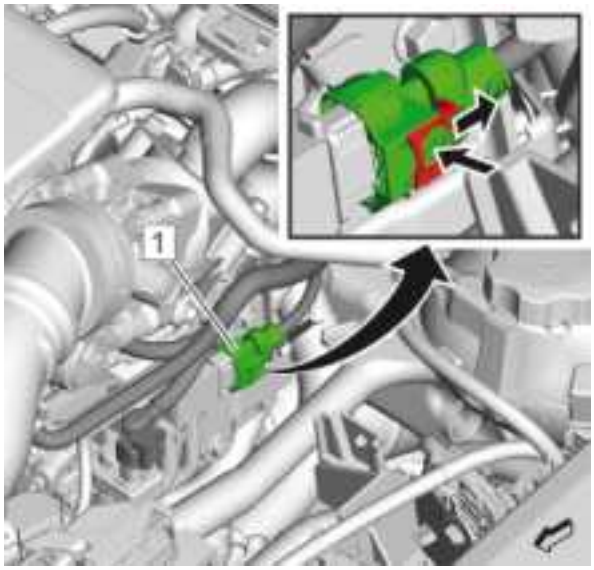

Fig. 341: Exhaust Pressure Differential Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Connect Electrical Connector (1) @ Exhaust Pressure Differential Sensor
6. Install Engine Control Module. Refer to **Engine Control Module Replacement**
7. If replacing, perform the DPF pressure sensor reset. Refer to **DPF Pressure Sensor Reset**

EXHAUST GAS RECIRCULATION VALVE REPLACEMENT

Removal Procedure

1. Remove the throttle body assembly. Refer to **Throttle Body Assembly Replacement**.

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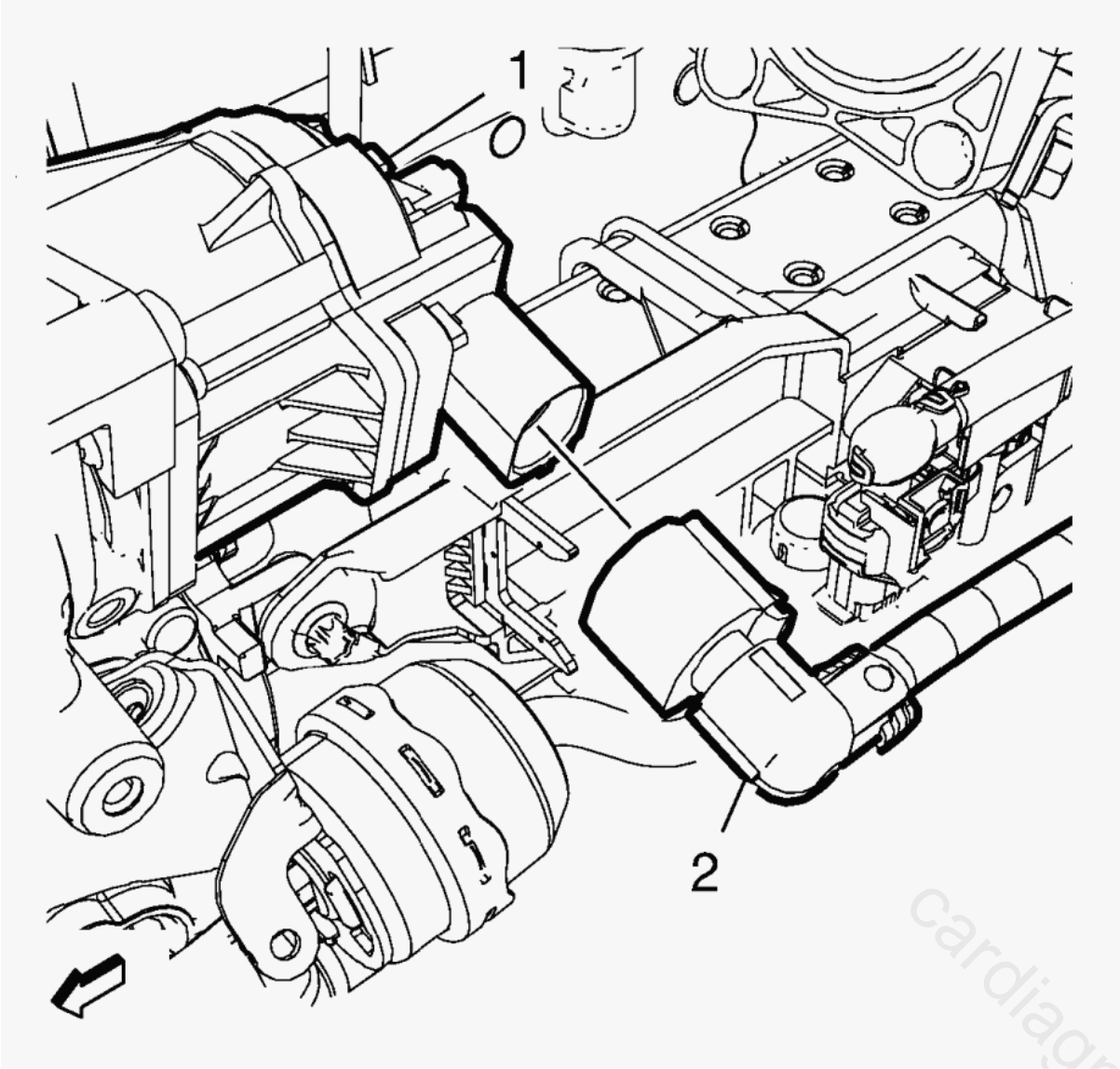

Fig. 342: Exhaust Gas Recirculation (EGR) Valve And Wiring Harness Plug
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the exhaust gas recirculation (EGR) valve wiring harness plug (2) from the EGR valve (1).

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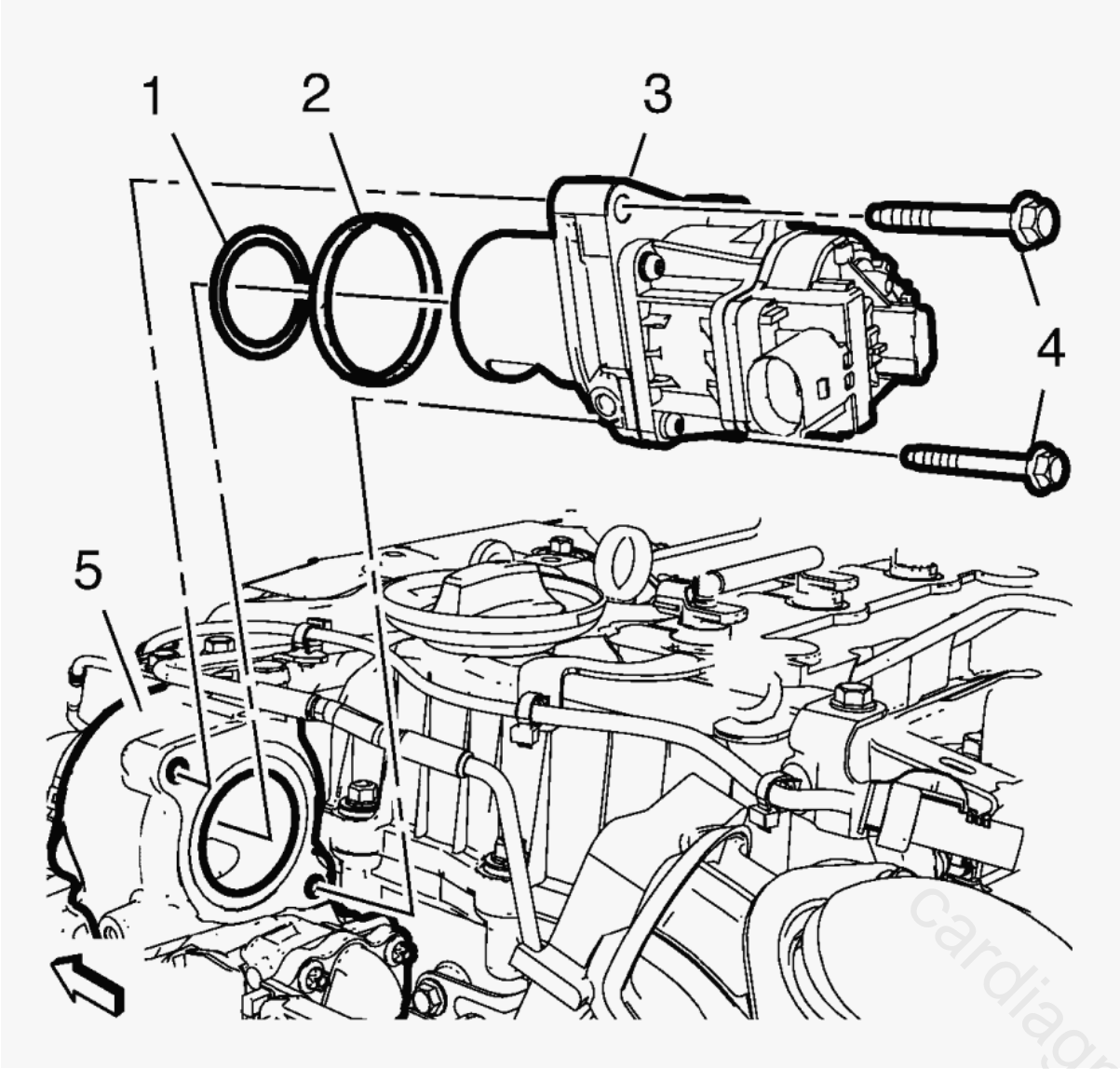

Fig. 343: EGR Valve, EGR Cooler Housing, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 2 EGR valve bolts (4).
4. Remove the EGR valve (3) from the EGR cooler housing (5).
5. Remove and DISCARD the EGR valve gasket (2).
6. Remove and DISCARD the EGR valve seat gasket (1).

Installation Procedure

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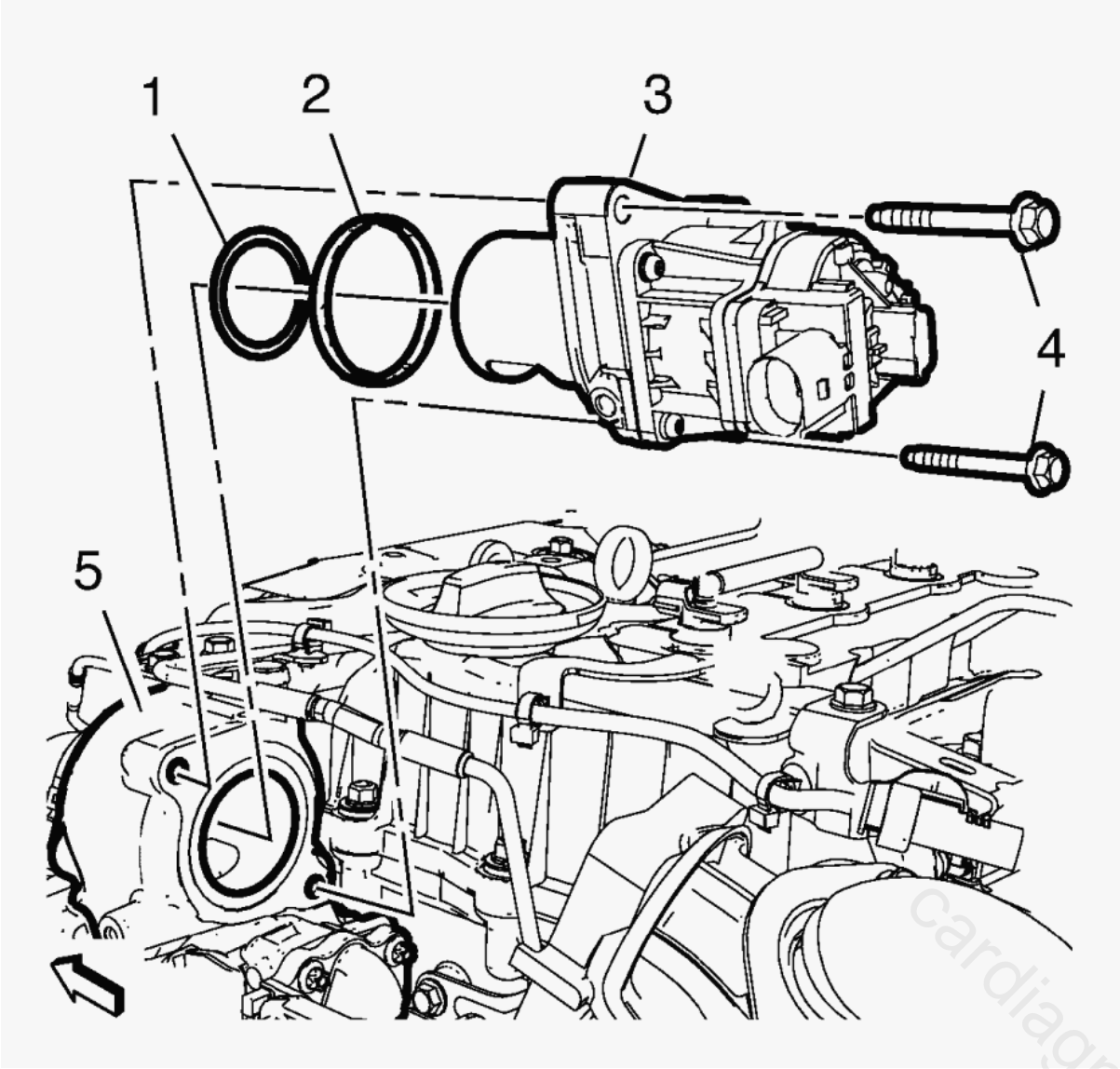

Fig. 344: EGR Valve, EGR Cooler Housing, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW EGR valve seat gasket (1) into the EGR cooler housing (5).
2. Install a NEW EGR valve gasket (2).
3. Install the EGR valve (3) to the EGR cooler housing (5).

CAUTION: **Refer to Fastener Caution .**

4. Install the 2 EGR valve bolts (4) and tighten to 10 N.m (89 lb in).

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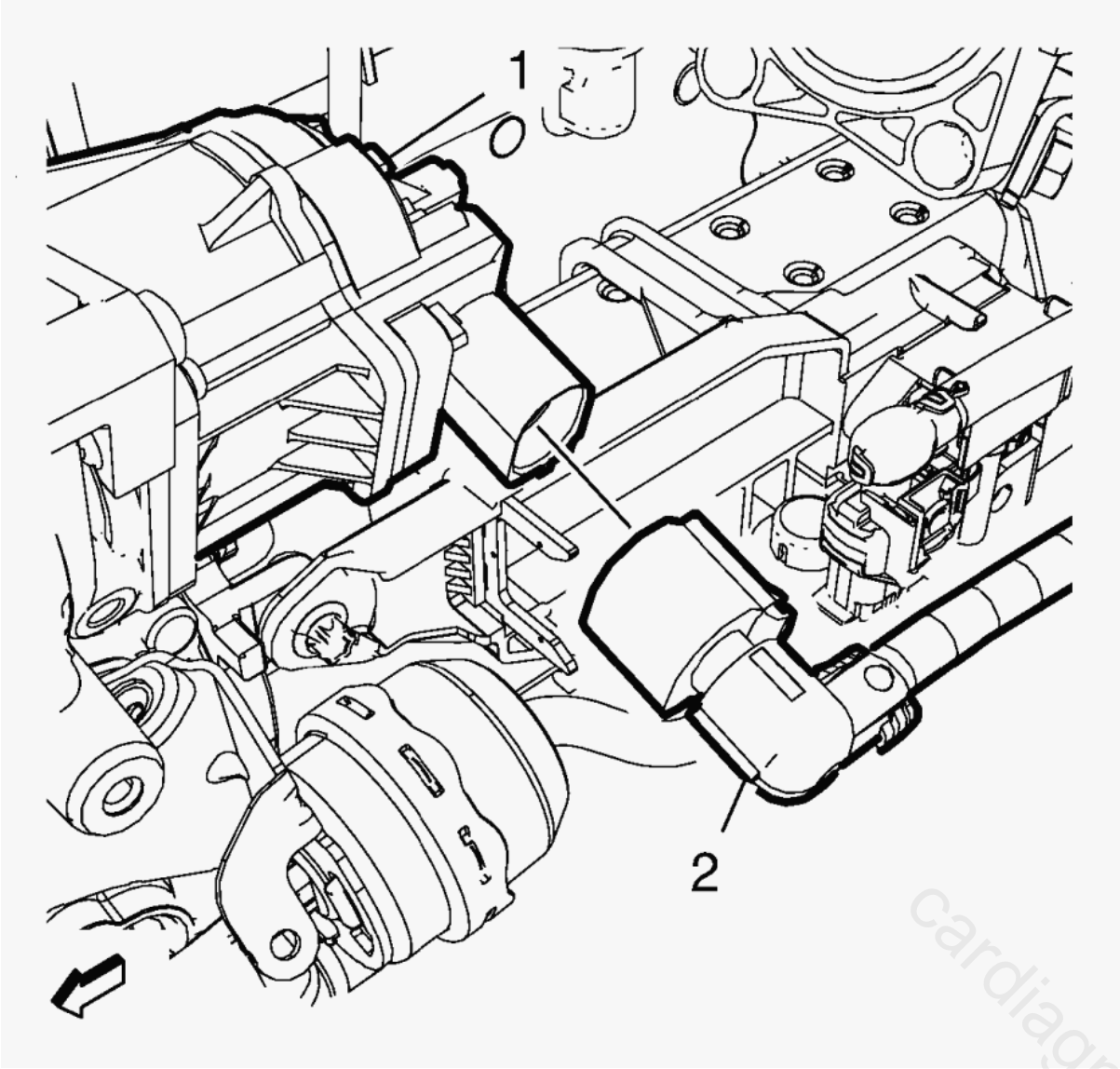

Fig. 345: Exhaust Gas Recirculation (EGR) Valve And Wiring Harness Plug
Courtesy of GENERAL MOTORS COMPANY

5. Connect the EGR valve wiring harness plug (2) to the EGR valve (1).
6. Install the throttle body assembly. Refer to **Throttle Body Assembly Replacement**.

EXHAUST GAS RECIRCULATION COOLER TEMPERATURE SENSOR REPLACEMENT - POSITION 1

Removal Procedure

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**

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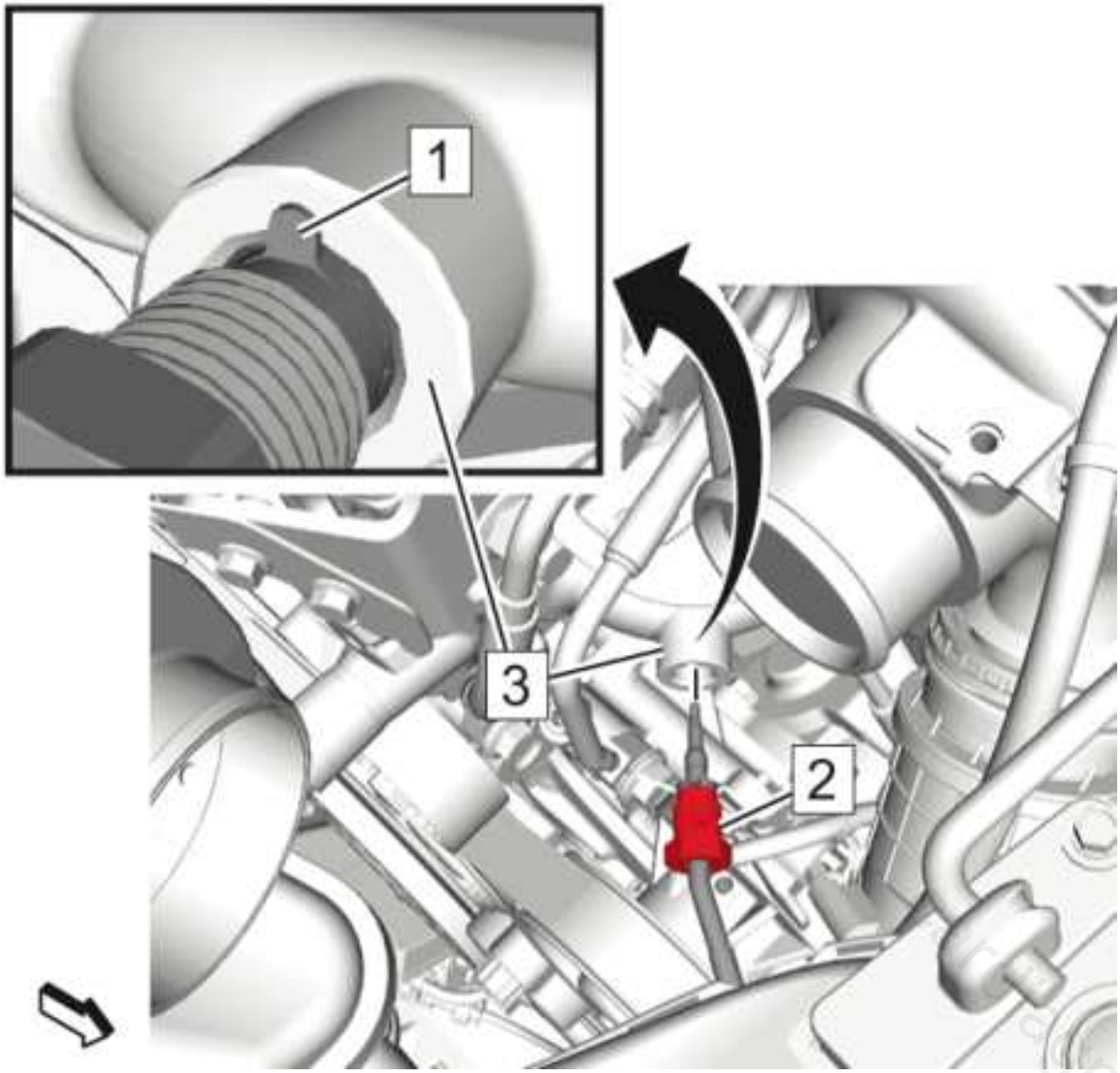

Fig. 346: Exhaust Gas Recirculation Cooler Temperature Sensor - Position 1 And Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

2. Remove Exhaust Gas Recirculation Cooler Temperature Sensor (2) @ Exhaust Manifold (3)
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

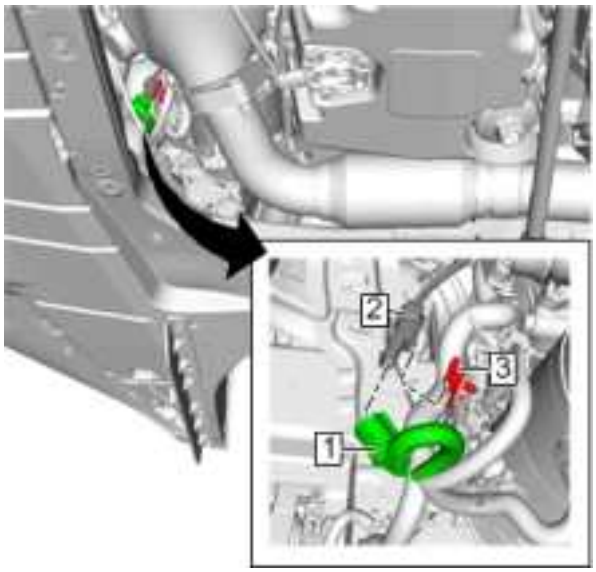

Fig. 347: Exhaust Gas Recirculation Cooler Temperature Sensor, Electrical Connector And Wiring Harness Clip
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Electrical Connector (1)

5. Unclip Exhaust Gas Recirculation Cooler Temperature Sensor Electrical Connector (2) @ Wiring Harness Clip (3)
6. Remove Exhaust Gas Recirculation Cooler Temperature Sensor (2)

Installation Procedure

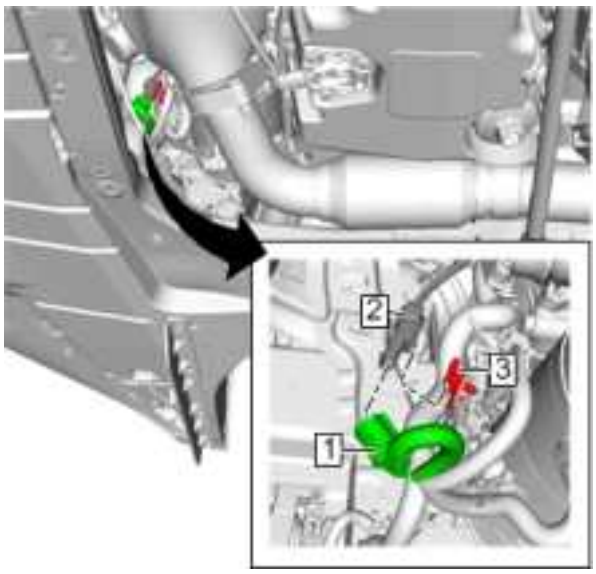

Fig. 348: Exhaust Gas Recirculation Cooler Temperature Sensor, Electrical Connector And Wiring Harness Clip
Courtesy of GENERAL MOTORS COMPANY

1. Install Exhaust Gas Recirculation Cooler Temperature Sensor (2)
2. Install Exhaust Gas Recirculation Cooler Temperature Sensor Electrical Connector (2) @ Wiring Harness Clip (3)
3. Connect Electrical Connector (1)
4. Remove the supports and lower the vehicle. Refer to **Lifting and Jacking the Vehicle**

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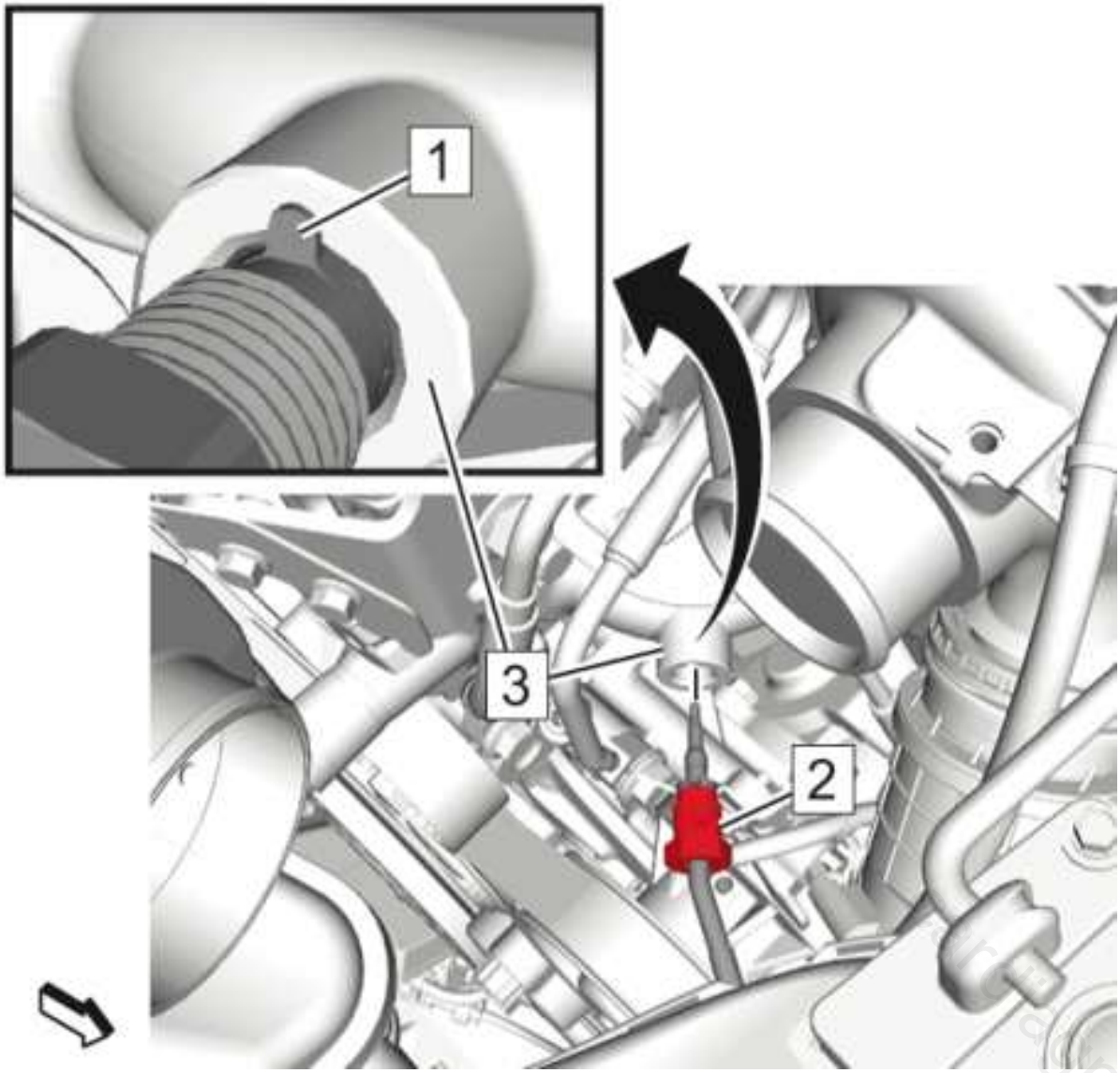

Fig. 349: Exhaust Gas Recirculation Cooler Temperature Sensor - Position 1 And Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The guide lug (1) must fit the groove.**

CAUTION: **Refer to Component Fastener Tightening Caution**

5. Install and tighten Exhaust Gas Recirculation Cooler Temperature Sensor (2) to 45 N.m (33 lb ft)
6. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**
7. If replacing, perform the exhaust gas temperature sensor reset. Refer to **Exhaust Gas Temperature Sensor Reset**
8. If replacing, perform the NOx catalyst reductant loading reset. Refer to **NOx Catalyst Reductant Loading Reset**

EXHAUST GAS RECIRCULATION COOLER TEMPERATURE SENSOR REPLACEMENT - POSITION 2

Removal Procedure

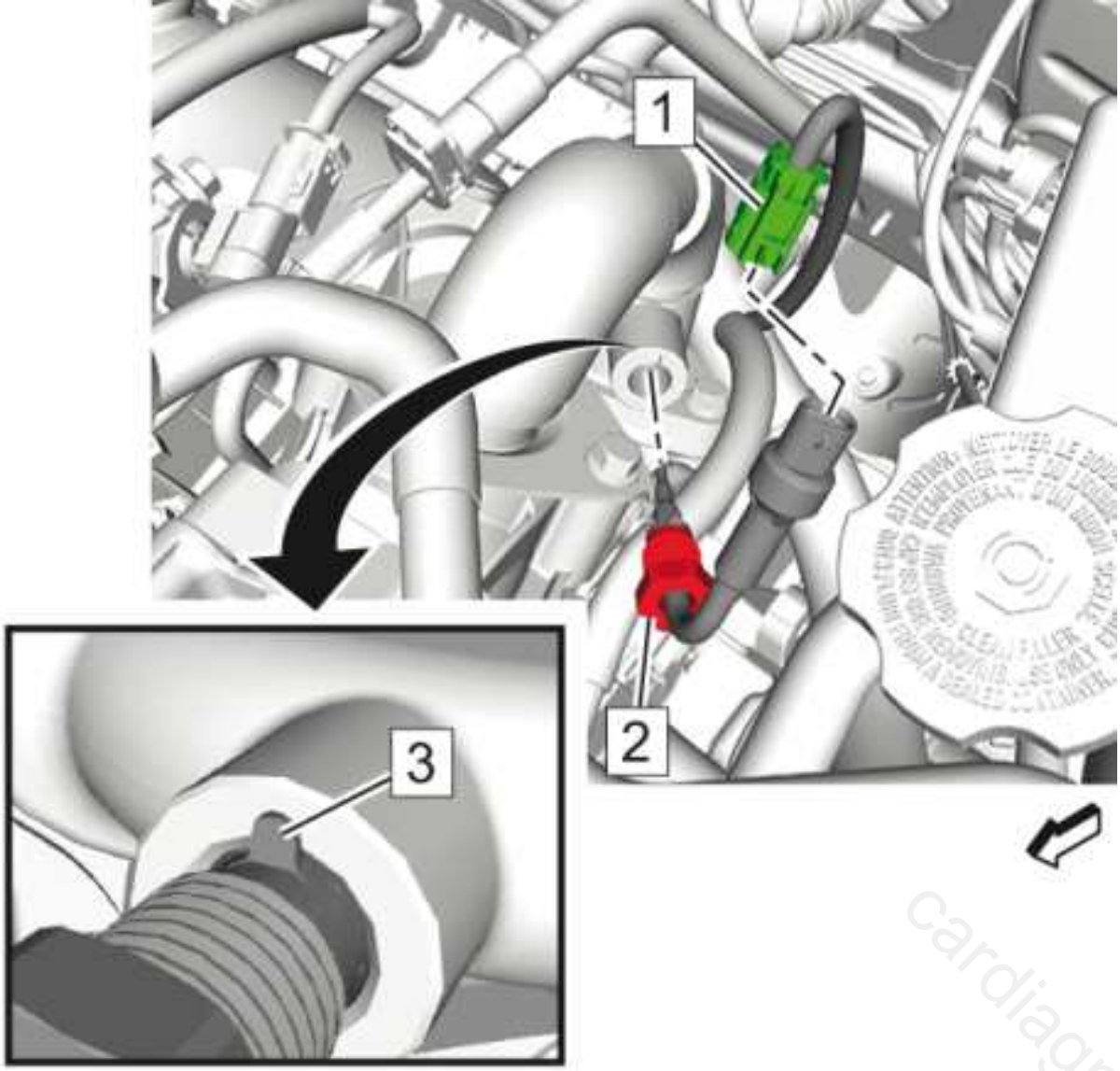

Fig. 350: Exhaust Gas Recirculation Cooler Temperature Sensor - Position 2 And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect Exhaust Gas Recirculation Cooler Temperature Sensor Electrical Connector (1)
2. Remove Exhaust Gas Recirculation Cooler Temperature Sensor - Position 2 (2)

Installation Procedure

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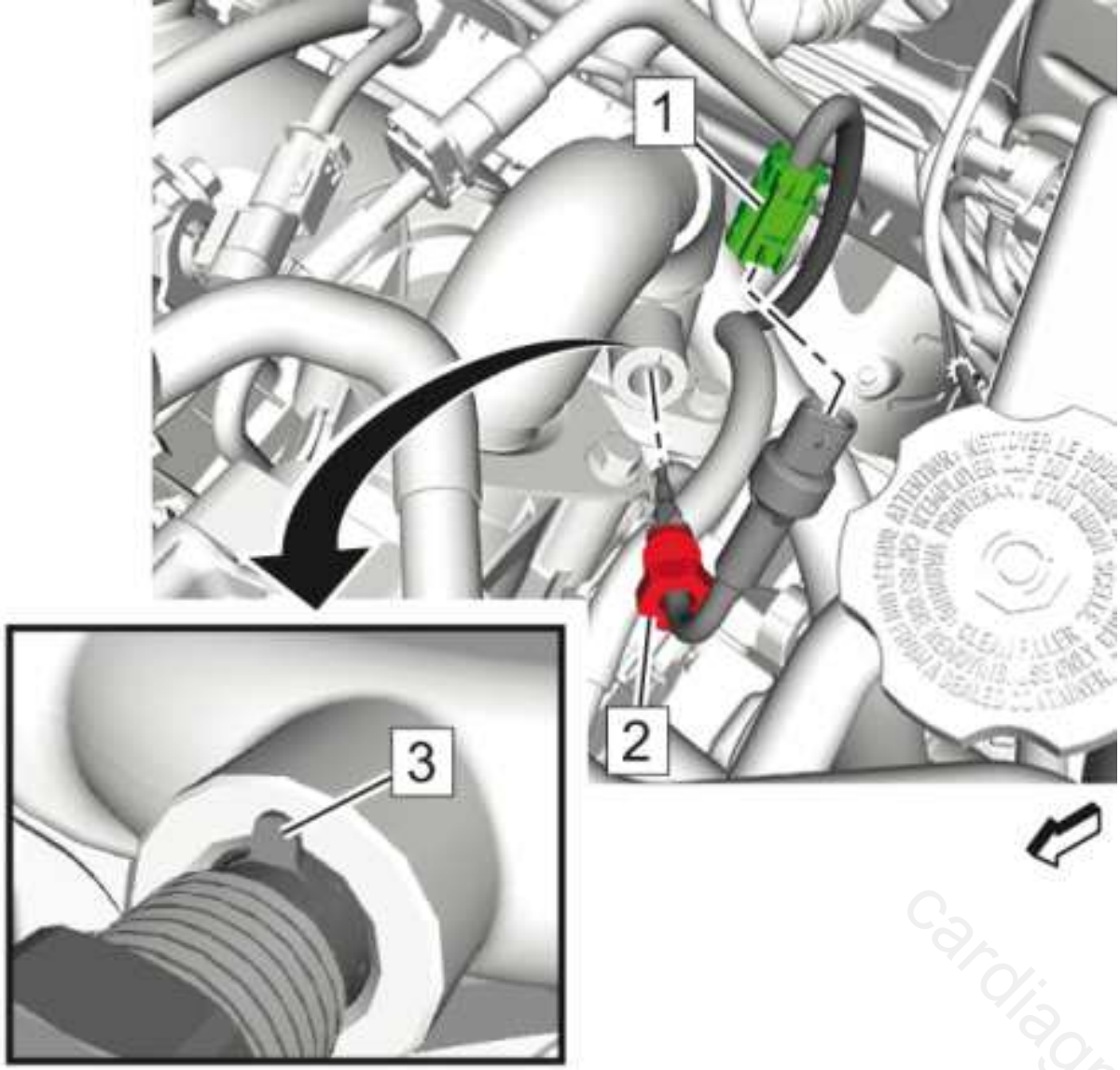

Fig. 351: Exhaust Gas Recirculation Cooler Temperature Sensor - Position 2 And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The guide lug (3) must fit the groove.**

CAUTION: **Refer to Fastener Caution**

1. Install and tighten Exhaust Gas Recirculation Cooler Temperature Sensor - Position 2 (2) to 45 N.m (33 lb ft)
2. Connect Exhaust Gas Recirculation Cooler Temperature Sensor Electrical Connector (1)
3. If replacing, perform the exhaust gas temperature sensor reset. Refer to **Exhaust Gas Temperature Sensor Reset**
4. If replacing, perform the NOx catalyst reductant loading reset. Refer to **NOx Catalyst Reductant Loading Reset**

EXHAUST GAS RECIRCULATION COOLER HOUSING REPLACEMENT

Removal Procedure

1. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**

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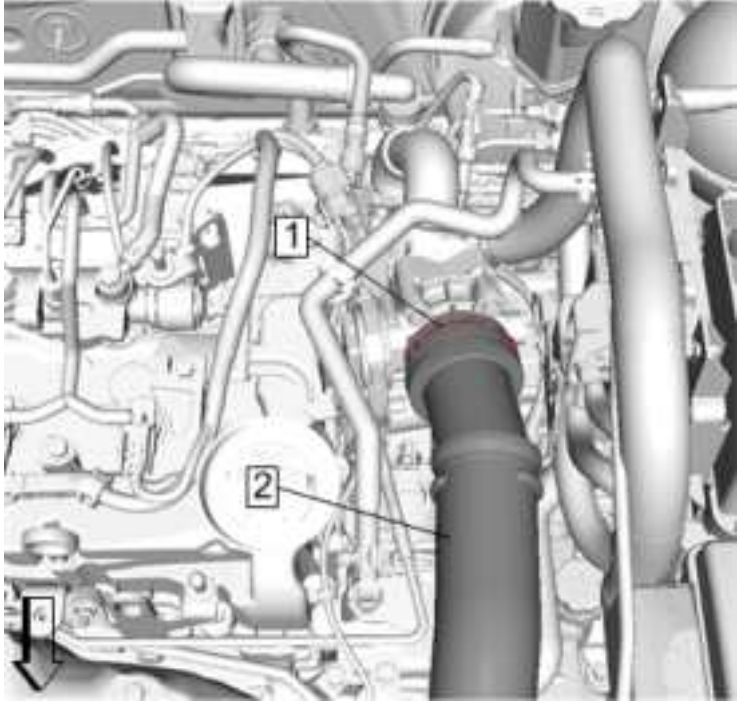

Fig. 352: Charge Air Cooler Outlet Air Tube And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Reposition the charge air cooler outlet air tube as necessary.**

3. Remove Charge Air Cooler Outlet Air Tube (2) @ Throttle Body. Refer to **Charge Air Cooler Outlet Air Tube Replacement**

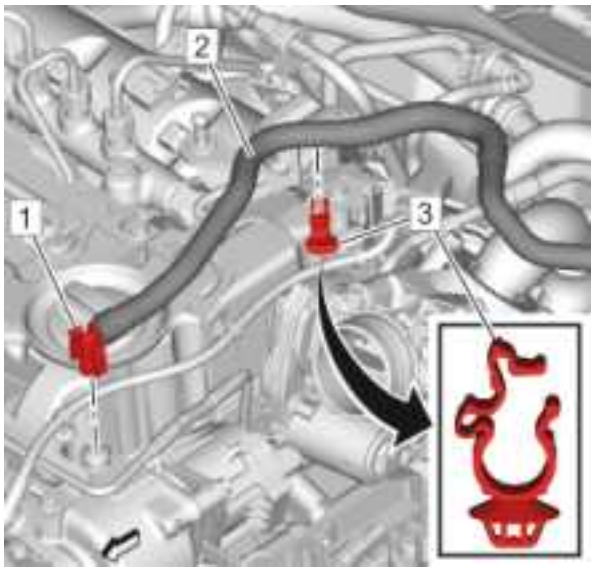

Fig. 353: Engine Coolant Air Bleed Hose, Connector And Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Engine Coolant Air Bleed Hose Connector (1)
5. Remove Engine Coolant Air Bleed Hose (2) @ Retainer Clip (3)
6. Position aside Engine Coolant Air Bleed Hose (2)

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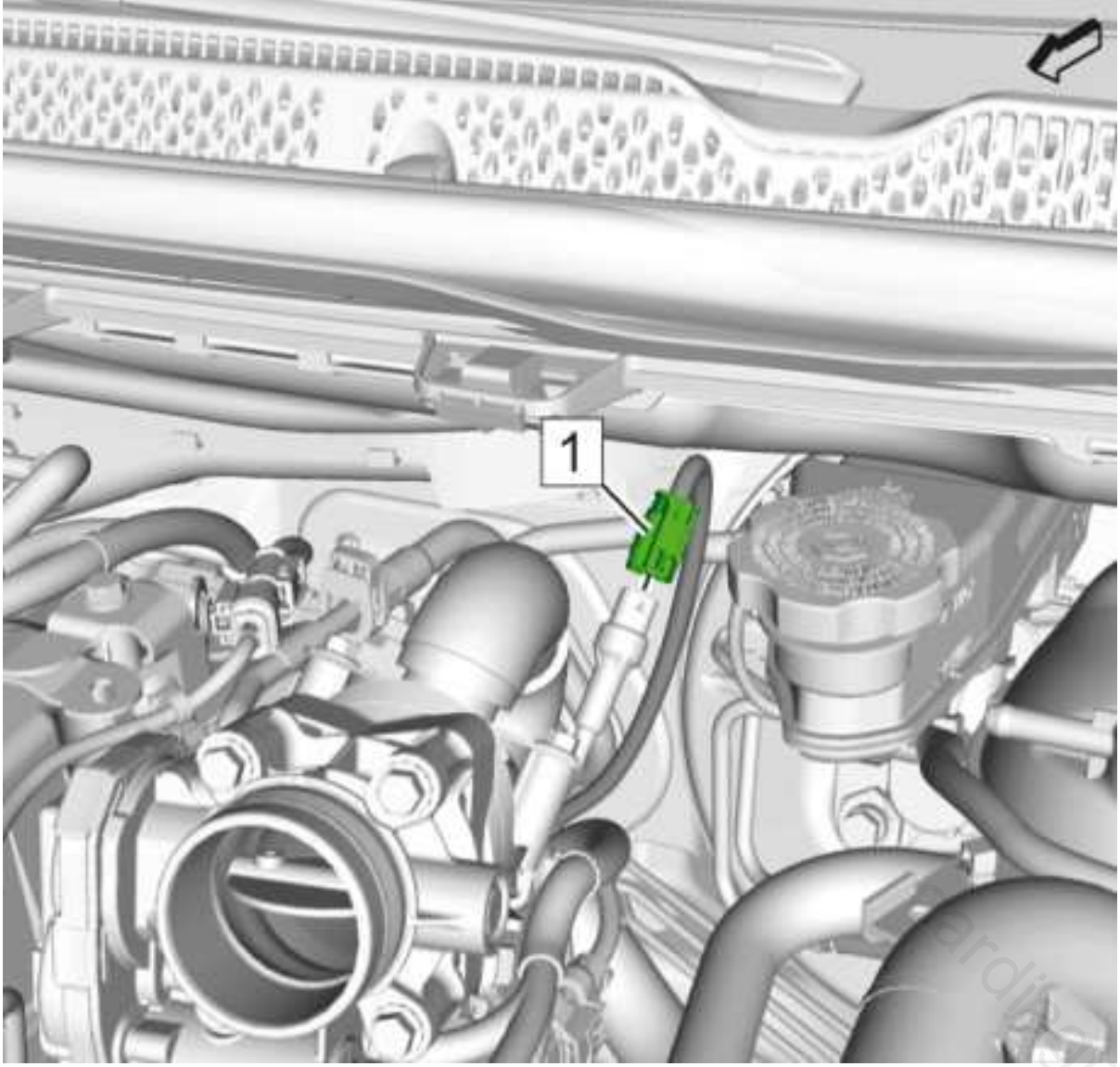

Fig. 354: Exhaust Gas Recirculation Cooler Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Exhaust Gas Recirculation Cooler Temperature Sensor Electrical Connector (1)

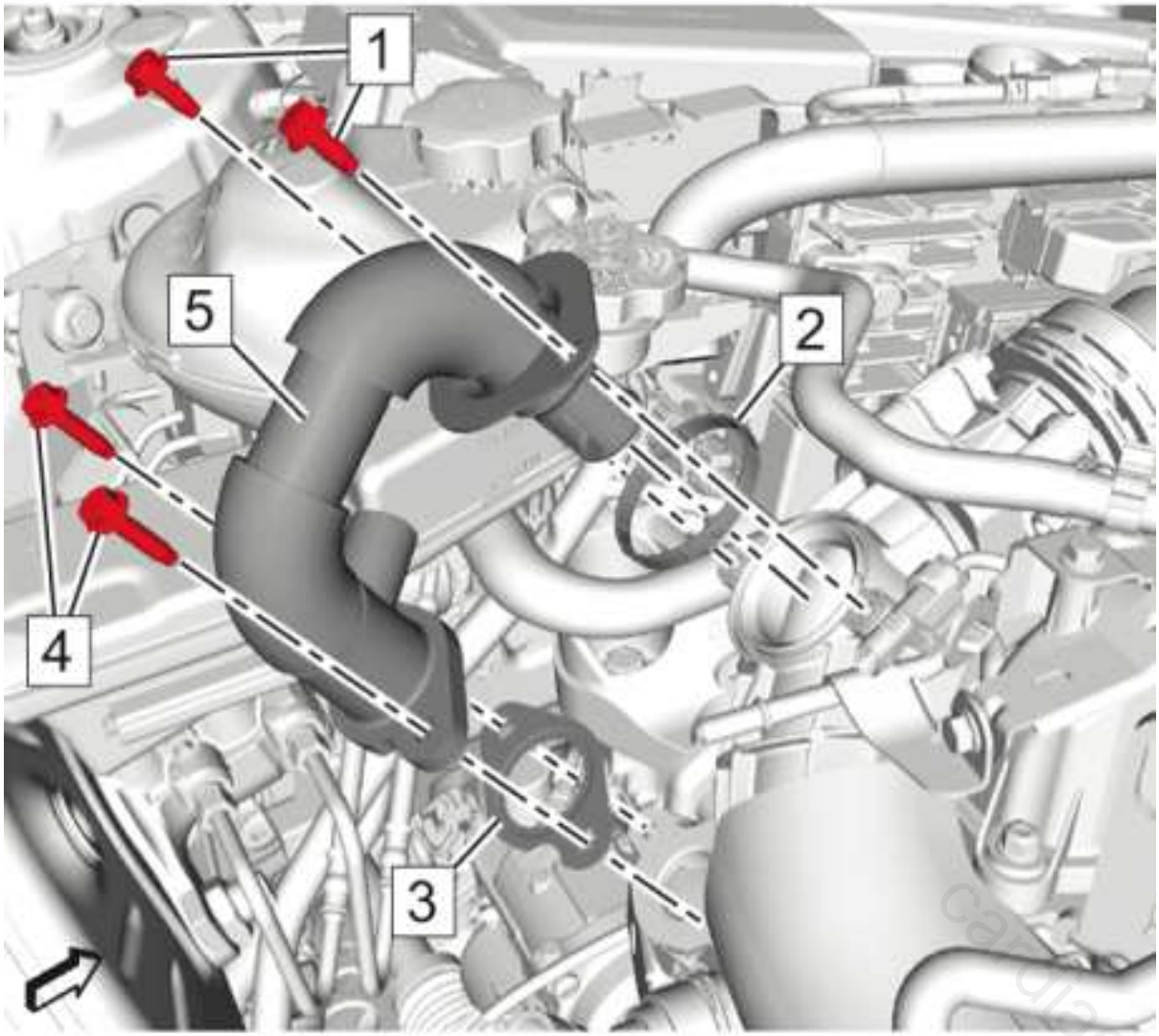

Fig. 355: Exhaust Gas Recirculation Cooler Outlet Pipe, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

8. Remove Exhaust Gas Recirculation Pipe Bolts (1, 4) (Qty: 4)
9. Remove Exhaust Gas Recirculation Pipe (5)
10. Remove and DISCARD Exhaust Gas Recirculation Cooler Pipe Gasket (2)
11. Remove and DISCARD Exhaust Gas Recirculation Cooler Outlet Pipe Gasket (3)

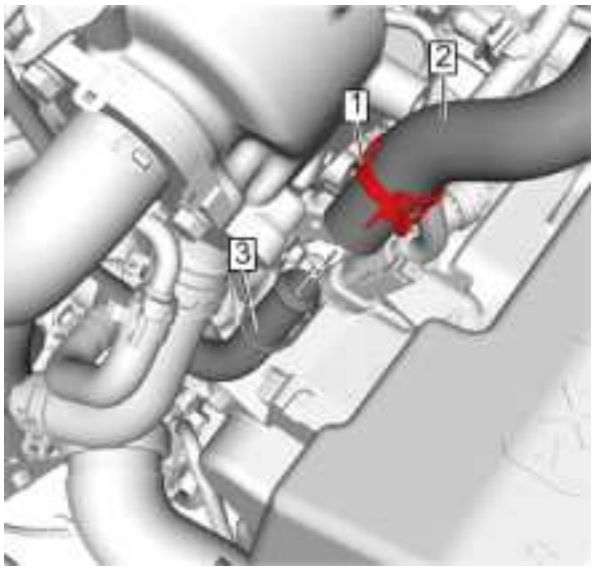

Fig. 356: Radiator Surge Tank Overflow Hose, Thermostat Bypass Pipe And Clamp
Courtesy of GENERAL MOTORS COMPANY

12. Disengage Radiator Surge Tank Overflow Hose Clamp (1)

13. Disconnect Radiator Surge Tank Overflow Hose (2) @ Thermostat Bypass Pipe (3)
14. Position aside Radiator Surge Tank Overflow Hose (2)

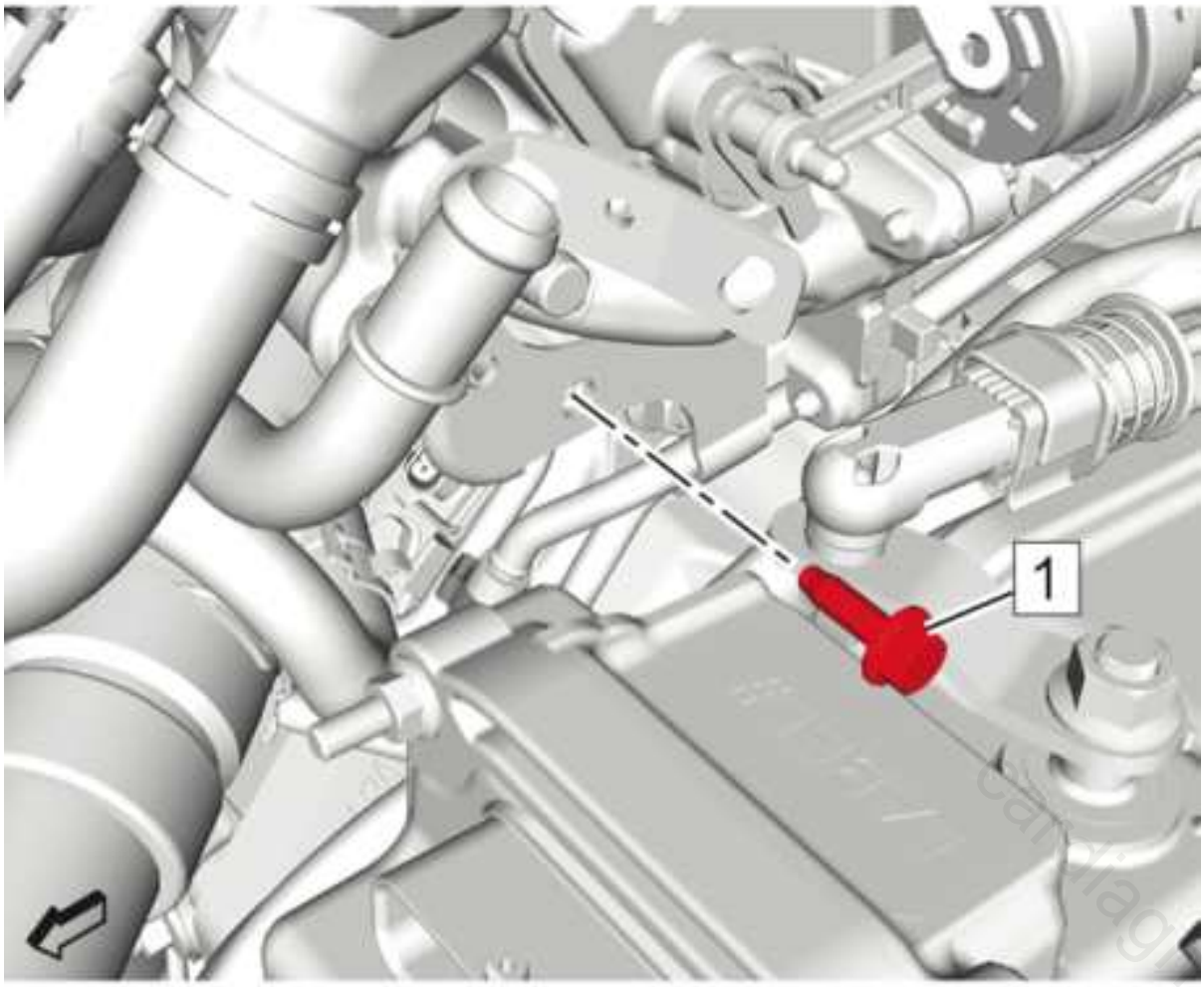

Fig. 357: Exhaust Pressure Sensor Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

15. Remove Exhaust Pressure Differential Sensor Bracket Bolt (1)

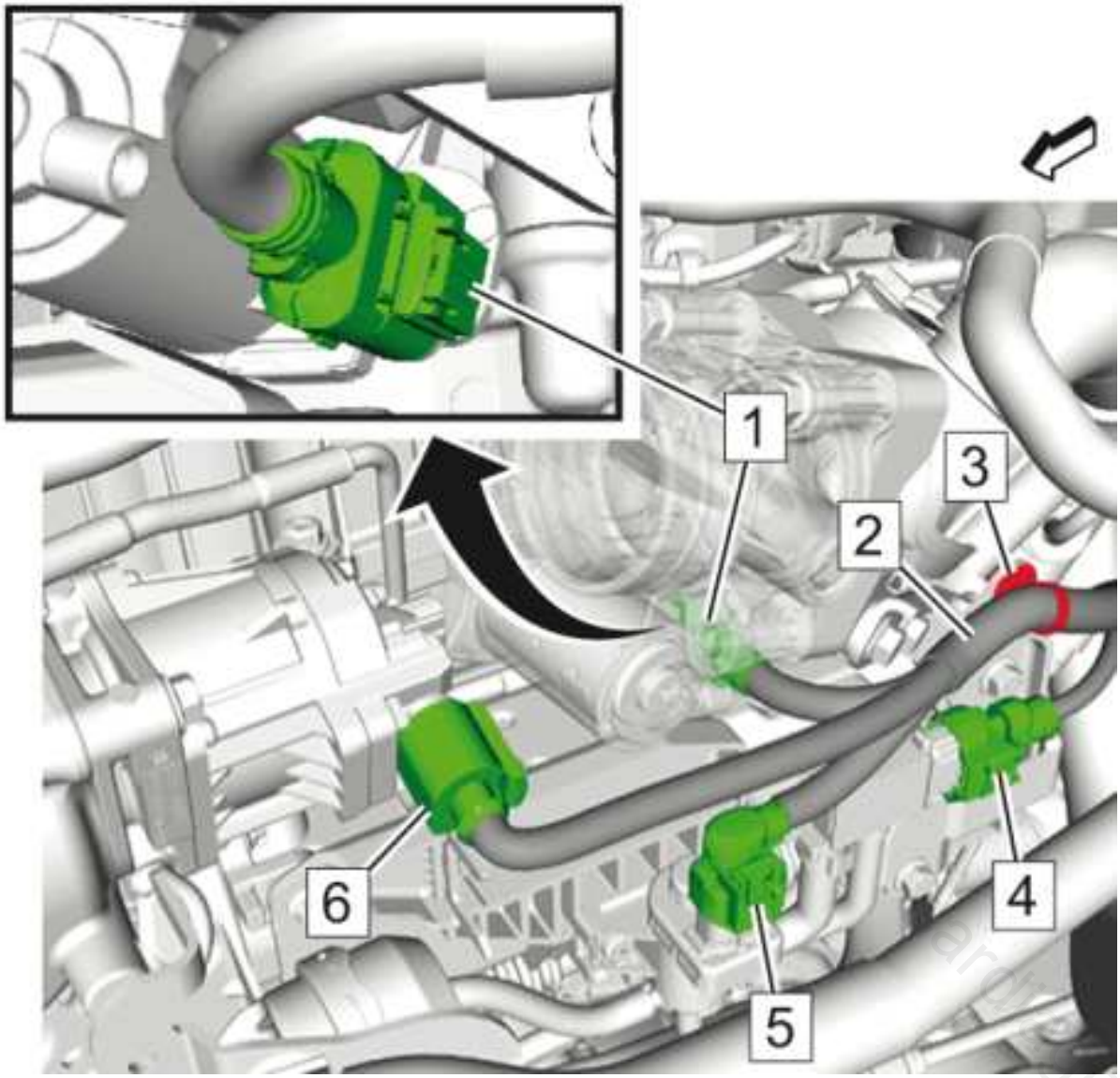

Fig. 358: Electrical Connectors, Engine Wiring Harness And Clip
Courtesy of GENERAL MOTORS COMPANY

16. Disconnect the electrical connectors:
    1. Exhaust Gas Recirculation Valve (6)
    2. Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve (5)
    3. Exhaust Pressure Differential Sensor (4)
    4. Throttle Body (1)
17. Unclip Engine Wiring Harness Clip (3)
18. Position aside Engine Wiring Harness (2)

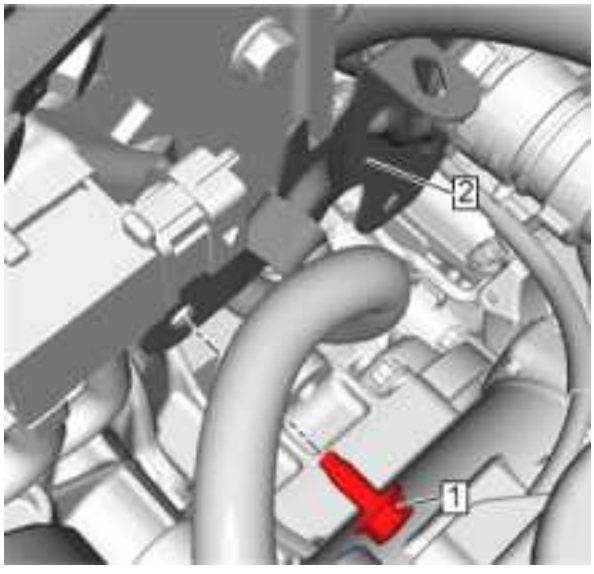

Fig. 359: Heater Inlet/Outlet Pipe Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

19. Remove Heater Inlet Pipe Bracket Bolt (1)
20. Reposition Heater Inlet and Outlet Pipe Bracket (2)

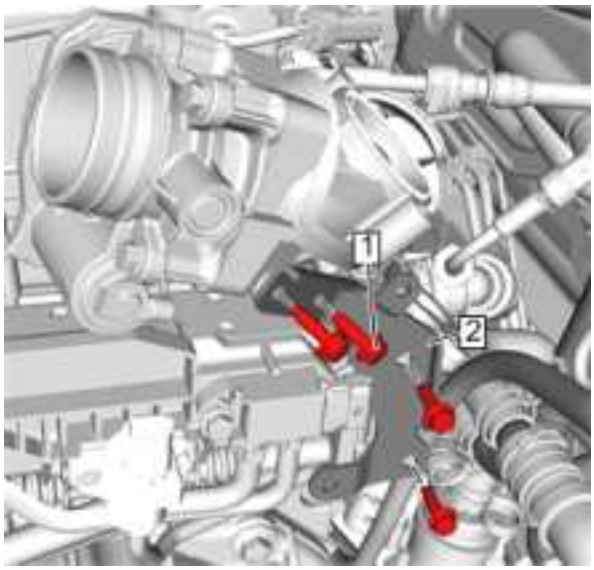

Fig. 360: Intake Manifold Brace And Bolts
Courtesy of GENERAL MOTORS COMPANY

21. Remove Intake Manifold Brace Bolts (1) (Qty: 4)
22. Position aside Intake Manifold Brace (2)

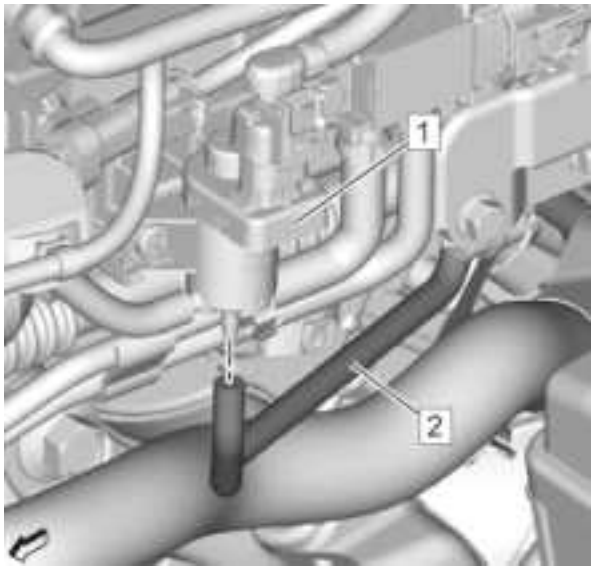

Fig. 361: Charge Air Bypass Regulator Solenoid Valve Inlet Tube And Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

23. Disconnect Charge Air Bypass Regulator Solenoid Valve Inlet Tube (2) @ Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve (1)

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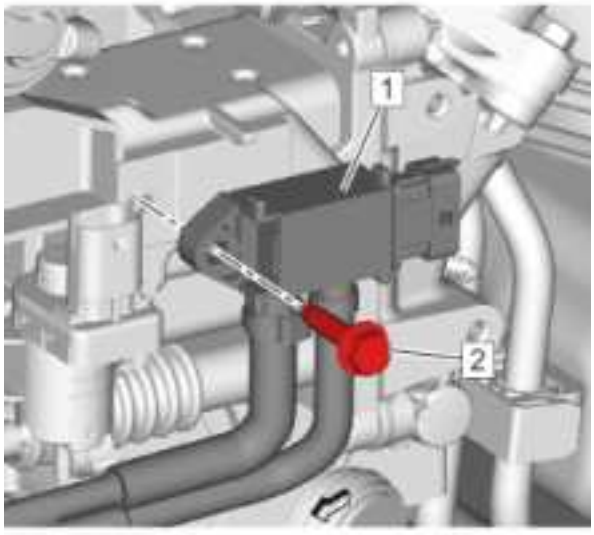

Fig. 362: Exhaust Pressure Differential Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

24. Remove Exhaust Pressure Differential Sensor Bolt (2)
25. Position aside Exhaust Pressure Differential Sensor (1)

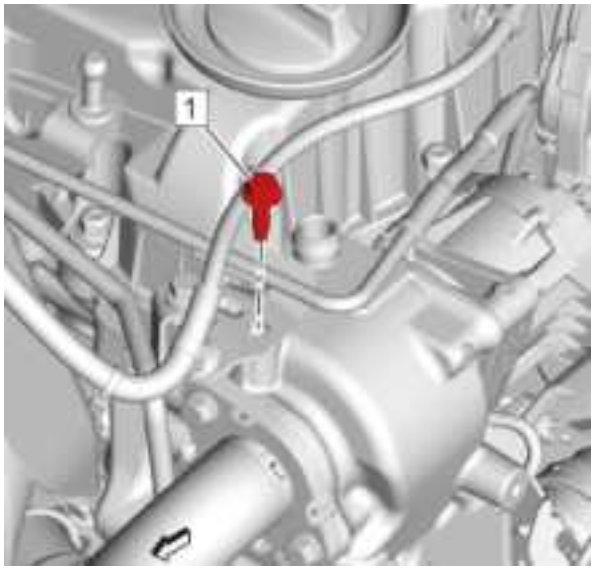

Fig. 363: Turbocharger Actuator Pipe Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

26. Remove the turbocharger actuator pipe bracket bolt (1).

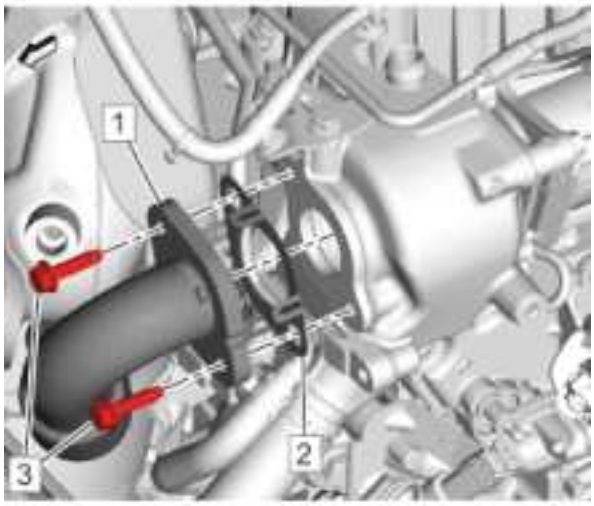

Fig. 364: Exhaust Manifold Pipe, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

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27. Remove the 2 exhaust manifold pipe bolts (3).
28. Remove the exhaust manifold pipe (1) from the EGR cooler housing.
29. Remove and DISCARD the gasket. (2)

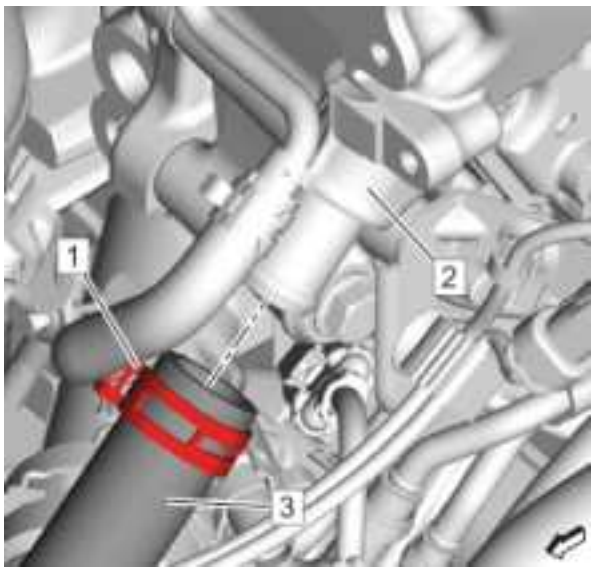

Fig. 365: Exhaust Gas Recirculation Cooler Housing, Thermostat Bypass Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

30. Loosen Thermostat Bypass Hose Clamp (1)
31. Remove Thermostat Bypass Hose (3) @ Exhaust Gas Recirculation Cooler Housing (2)

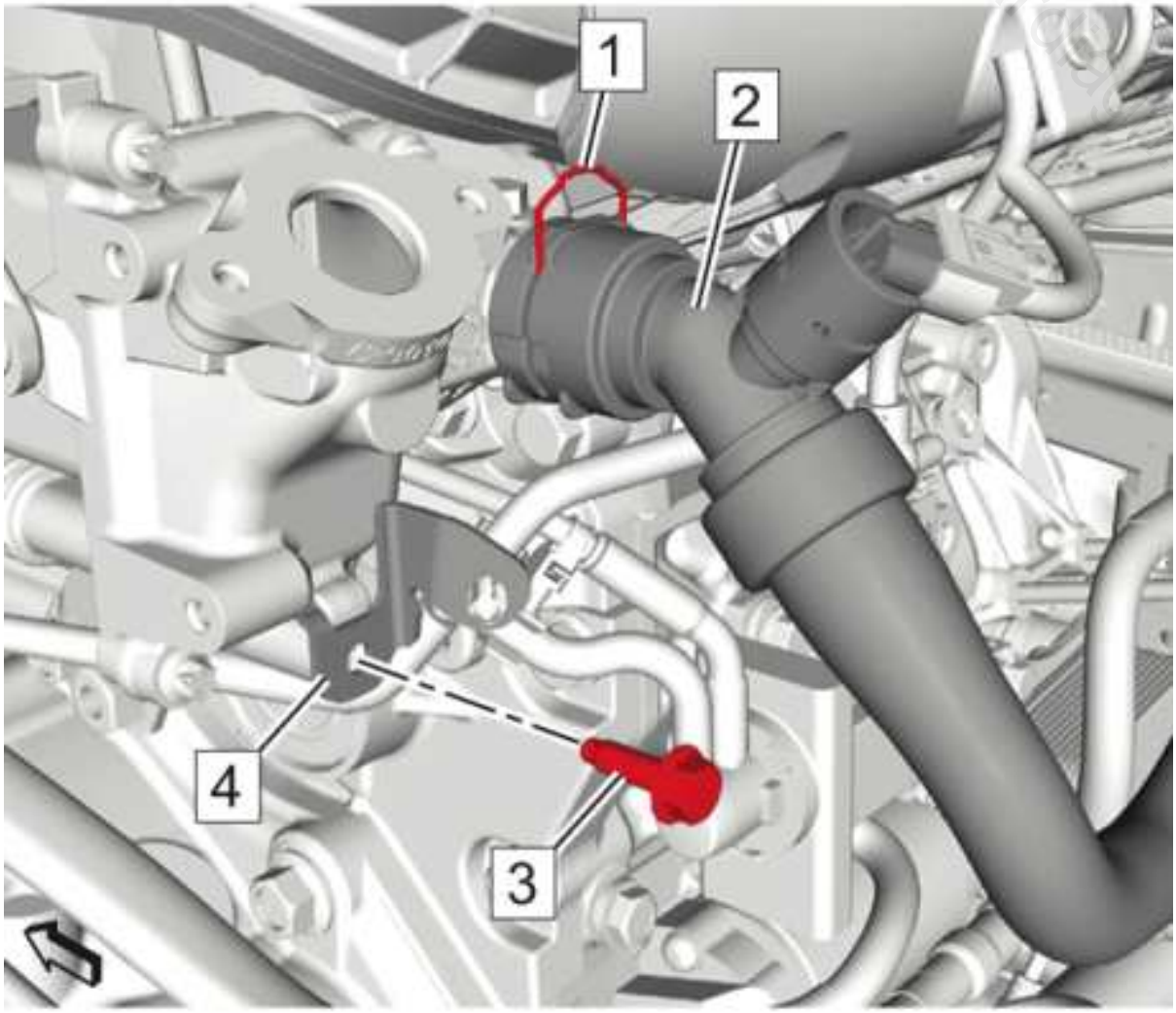

Fig. 366: Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve Bracket, Heater Outlet Hose, Bolt And Clamp

Courtesy of GENERAL MOTORS COMPANY

32. Loosen Quick Connector Clamp (1)
33. Remove Heater Outlet Hose (2)
34. Remove the turbocharger wastegate actuator vacuum control solenoid valve bracket bolt (3).
35. Position aside Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve Bracket (4)

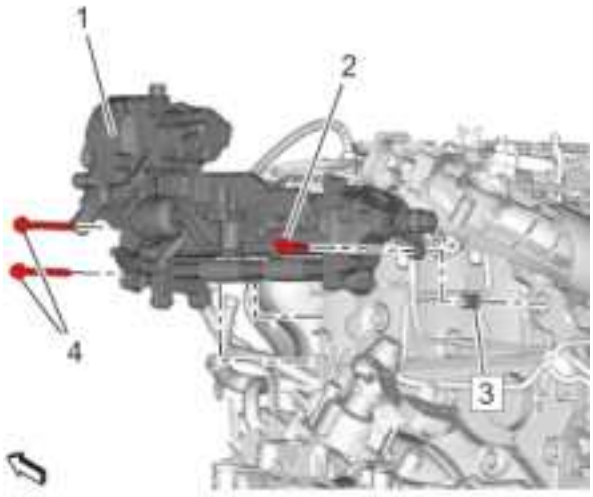

Fig. 367: Exhaust Gas Recirculation Cooler Housing, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

36. Remove the 3 EGR cooler housing bolts (2, 4).
37. Remove Exhaust Gas Recirculation Cooler Housing (1)
38. Remove and DISCARD the gasket. (3)

Disassemble Procedure

Remove Exhaust Gas Recirculation Valve. Refer to **Exhaust Gas Recirculation Valve Replacement**

Assemble Procedure

Install Exhaust Gas Recirculation Valve. Refer to **Exhaust Gas Recirculation Valve Replacement**

Installation Procedure

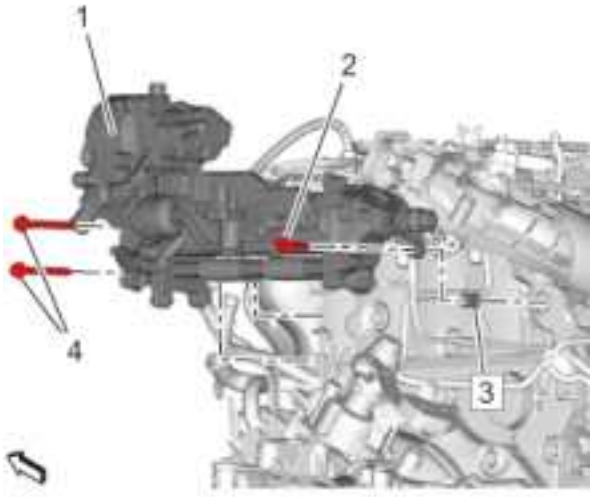

Fig. 368: Exhaust Gas Recirculation Cooler Housing, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW gasket. (3)
2. Install Exhaust Gas Recirculation Cooler Housing (1)

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CAUTION: **Refer to Fastener Caution**

3. Install the 3 EGR cooler housing bolts (2, 4) and tighten to 25 N.m (18 lb ft).

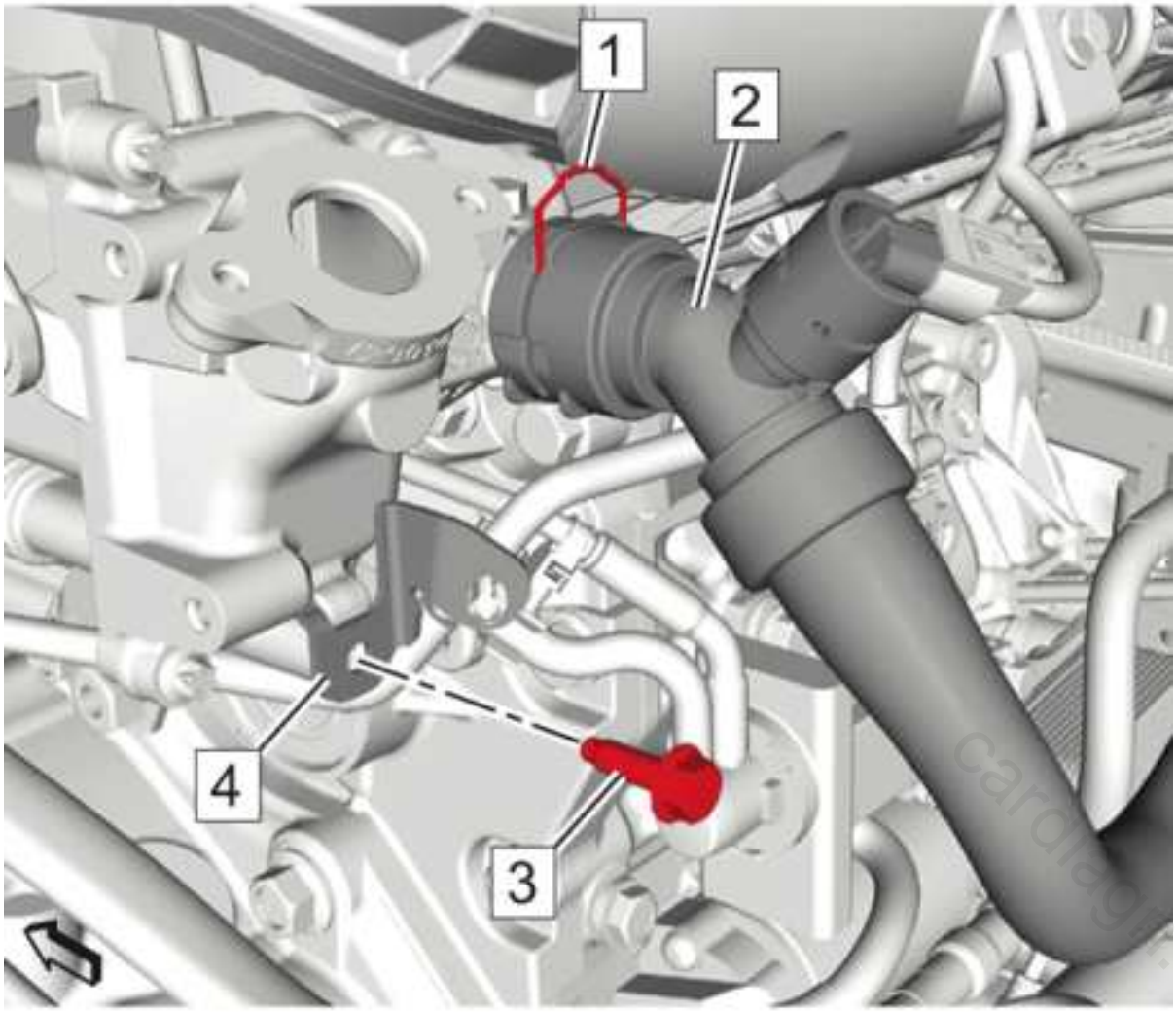

Fig. 369: Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve Bracket, Heater Outlet Hose, Bolt And Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Reposition Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve Bracket (4)
5. Install the turbocharger wastegate actuator vacuum control solenoid valve bracket bolt (3) and tighten to 10 N.m (89 lb in).
6. Install Heater Outlet Hose (2)
7. Install Quick Connector Clamp (1)

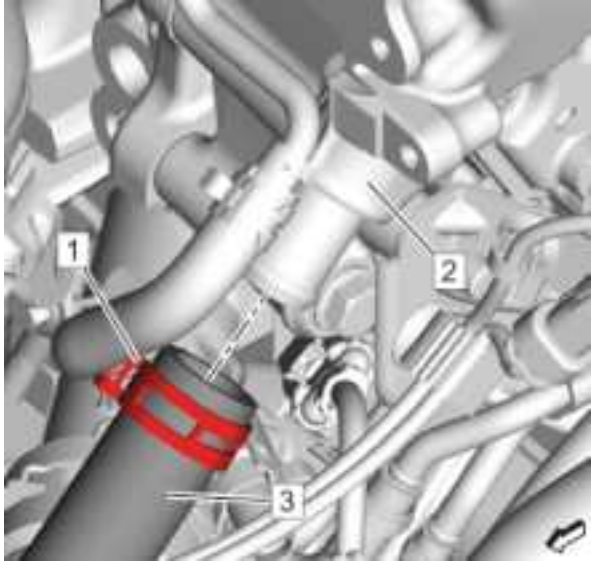

Fig. 370: Exhaust Gas Recirculation Cooler Housing, Thermostat Bypass Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

8. Install Thermostat Bypass Hose (3) @ Exhaust Gas Recirculation Cooler Housing (2)
9. Install Thermostat Bypass Hose Clamp (1)

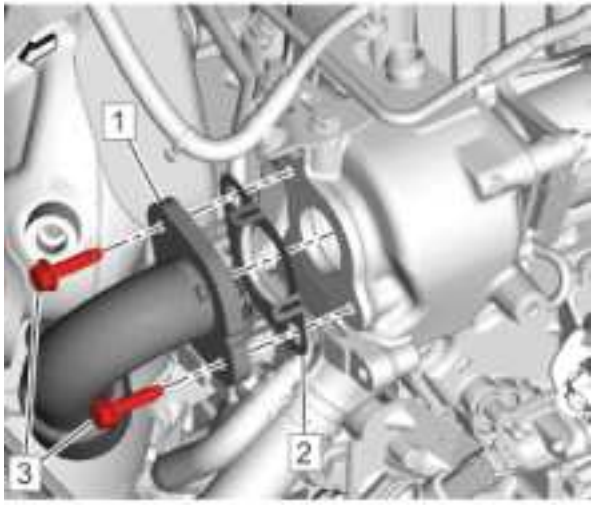

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Fig. 371: Exhaust Manifold Pipe, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

10. Install a NEW gasket. (2)
11. Install the exhaust manifold pipe (1) to the EGR cooler housing.
12. Install the 2 exhaust manifold pipe bolts (3) and tighten to 10 N.m (89 lb in).

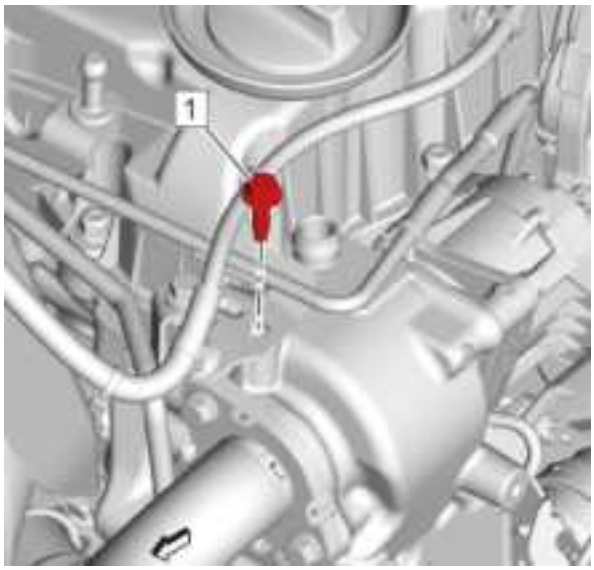

Fig. 372: Turbocharger Actuator Pipe Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Install the turbocharger actuator pipe bracket bolt (1) and tighten to 10 N.m (89 lb in).

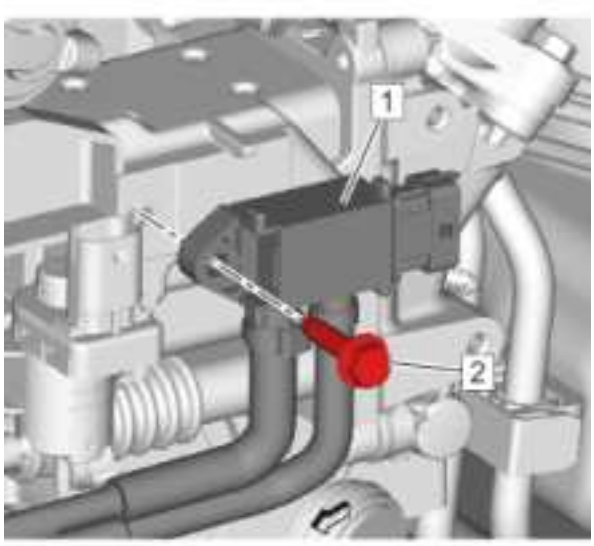

Fig. 373: Exhaust Pressure Differential Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

14. Reposition Exhaust Pressure Differential Sensor (1)
15. Install and tighten Exhaust Pressure Differential Sensor Bolt (2) to 9 N.m (80 lb in)

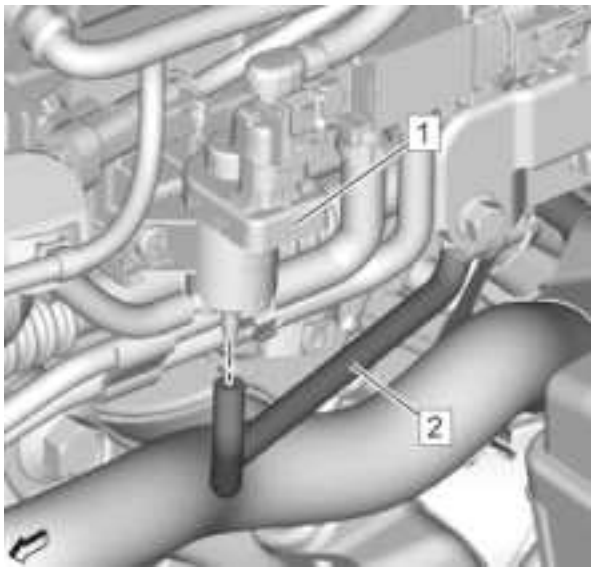

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Fig. 374: Charge Air Bypass Regulator Solenoid Valve Inlet Tube And Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

16. Connect Charge Air Bypass Regulator Solenoid Valve Inlet Tube (2) @ Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve (1)

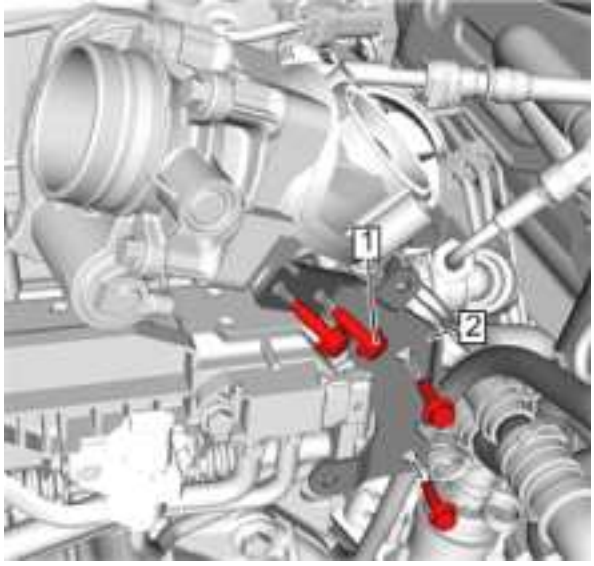

Fig. 375: Intake Manifold Brace And Bolts
Courtesy of GENERAL MOTORS COMPANY

17. Reposition Intake Manifold Brace (2)
18. Install and tighten Intake Manifold Brace Bolts (1) (Qty: 4) to 10 N.m (89 lb in)

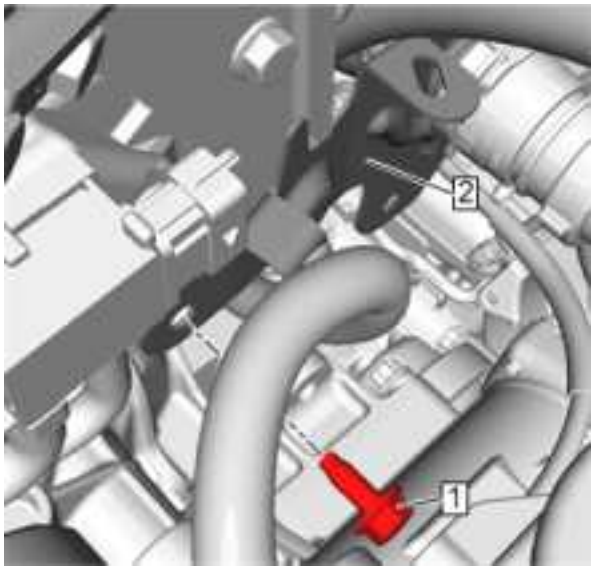

Fig. 376: Heater Inlet/Outlet Pipe Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

19. Install Heater Inlet and Outlet Pipe Bracket (2)
20. Install and tighten Heater Inlet Pipe Bracket Bolt (1) to 9 N.m (80 lb in)

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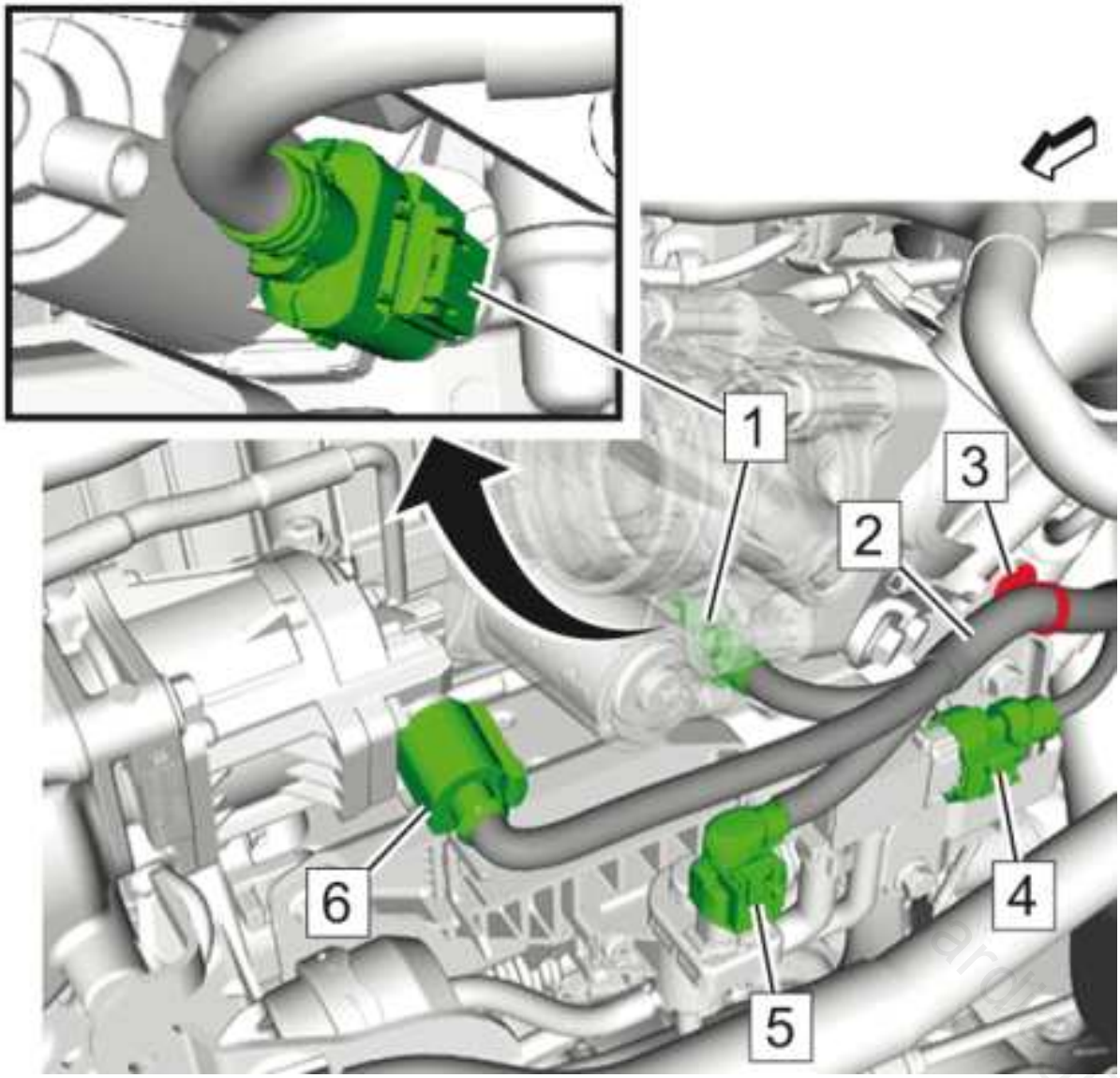

Fig. 377: Electrical Connectors, Engine Wiring Harness And Clip
Courtesy of GENERAL MOTORS COMPANY

21. Connect the electrical connectors:
    1. Exhaust Gas Recirculation Valve (6)
    2. Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve (5)
    3. Exhaust Pressure Differential Sensor (4)
    4. Throttle Body (1)
22. Reposition Engine Wiring Harness (2)
23. Install Engine Wiring Harness Clip (3)

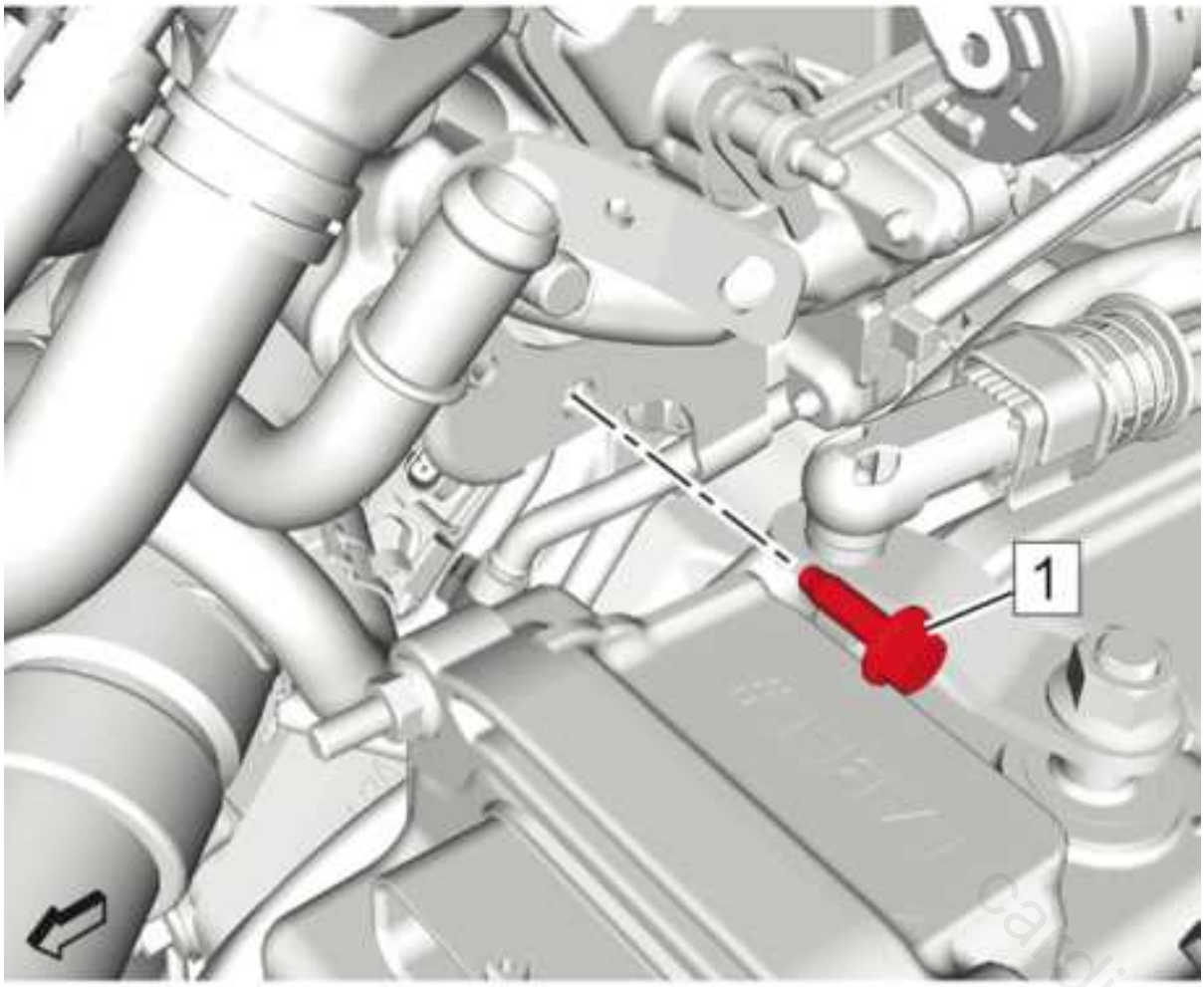

Fig. 378: Exhaust Pressure Sensor Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

24. Install and tighten Exhaust Pressure Differential Sensor Bracket Bolt (1) to 9 N.m (80 lb in)

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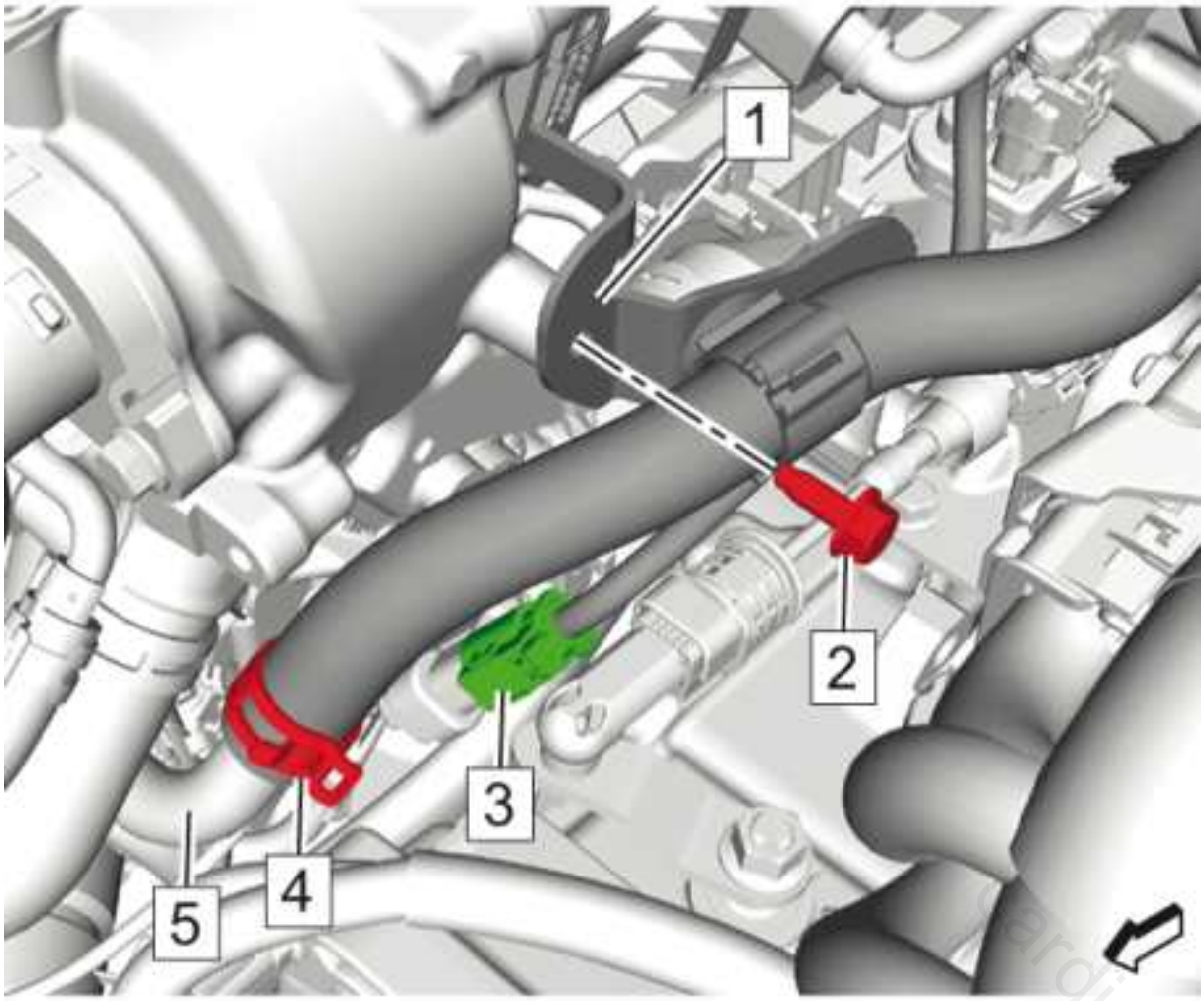

Fig. 379: Exhaust Temperature Sensor Electrical Connector and Radiator Surge Tank Components
Courtesy of GENERAL MOTORS COMPANY

25. Reposition the radiator surge tank engine hose bracket (1) along with the radiator surge tank hose (4).
26. Connect Radiator Surge Tank Overflow Hose (4) @ Thermostat Bypass Pipe (6)
27. Install Radiator Surge Tank Overflow Hose Clamp (5)
28. Connect Exhaust Temperature Sensor Electrical Connector (3)
29. Install the radiator surge tank outlet hose bracket bolt (2) and tighten to 10 N.m (89 lb in).

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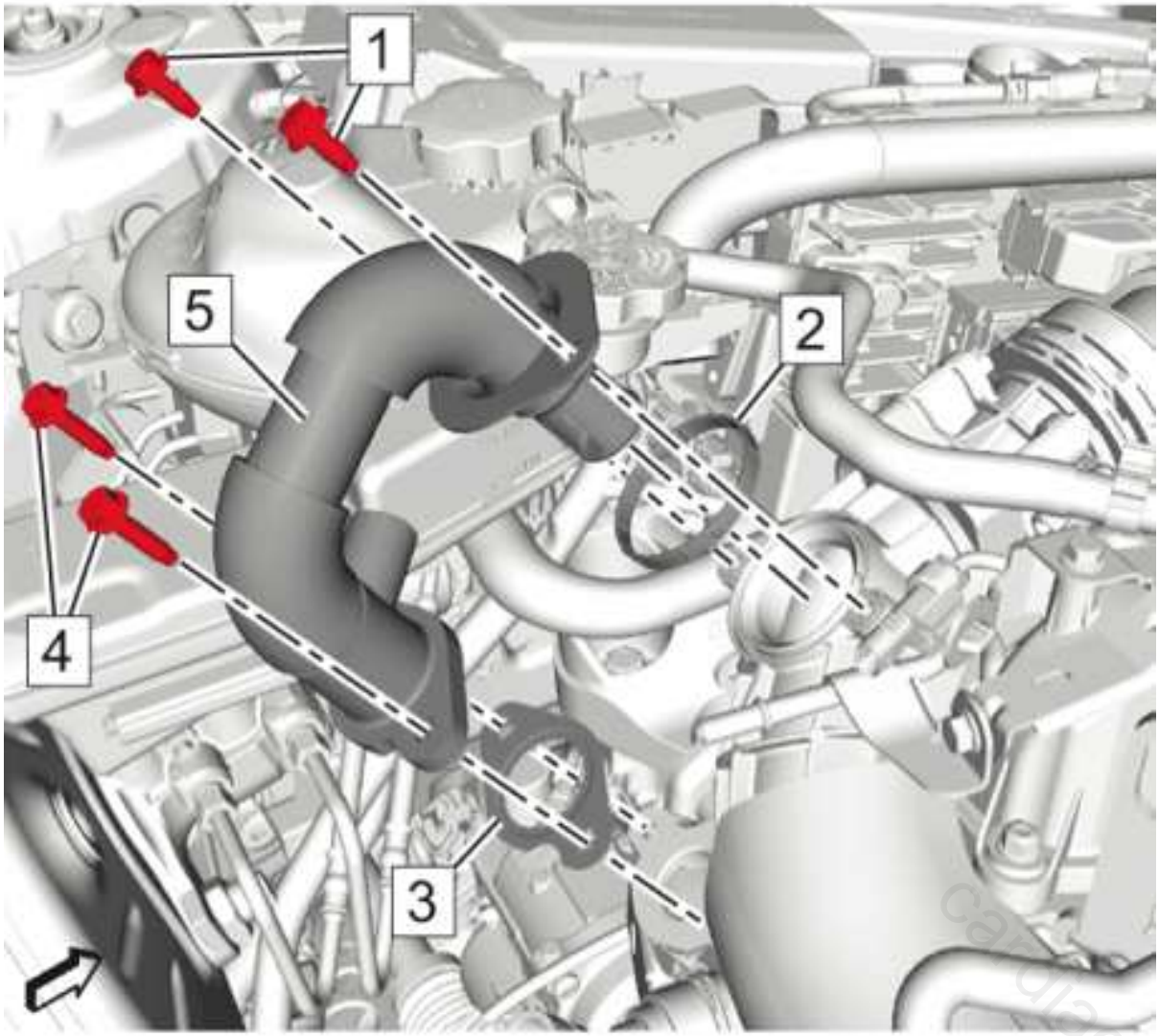

Fig. 380: Exhaust Gas Recirculation Cooler Outlet Pipe, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

30. Install NEW Exhaust Gas Recirculation Cooler Outlet Pipe Gasket (3)
31. Install NEW Exhaust Gas Recirculation Cooler Pipe Gasket (2)
32. Install Exhaust Gas Recirculation Pipe (5)
33. Install and tighten Exhaust Gas Recirculation Pipe Bolts (1, 4) (Qty: 4) to 10 N.m (89 lb in)

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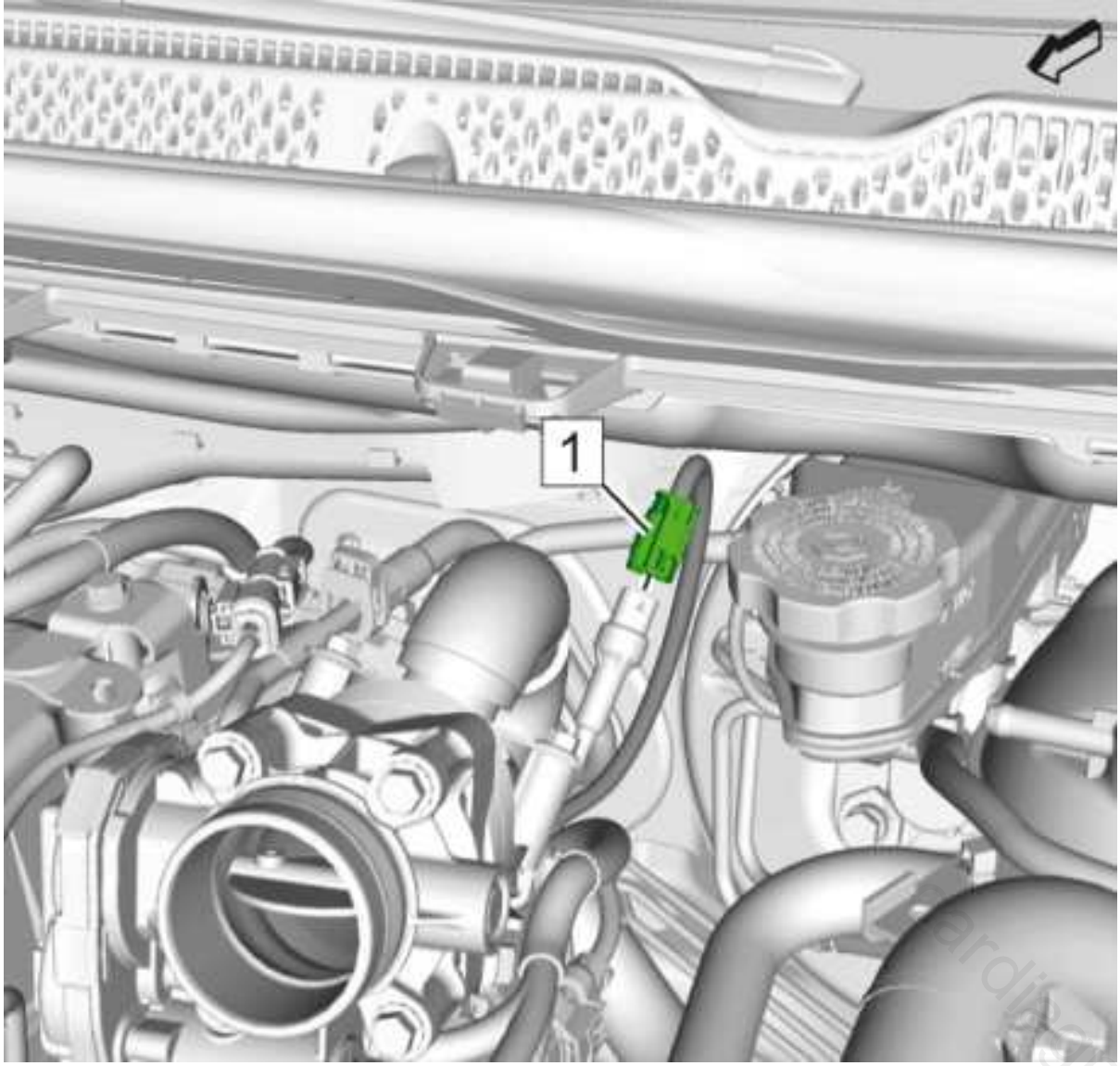

Fig. 381: Exhaust Gas Recirculation Cooler Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

34. Connect Exhaust Gas Recirculation Cooler Temperature Sensor Electrical Connector (1)

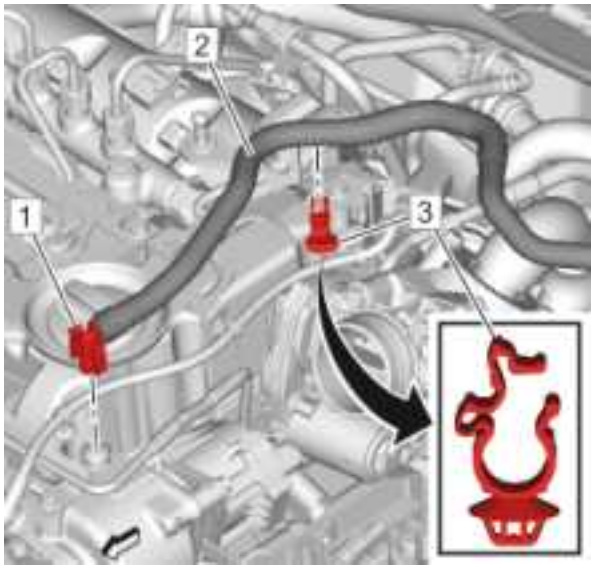

Fig. 382: Engine Coolant Air Bleed Hose, Connector And Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

35. Reposition Engine Coolant Air Bleed Hose (2)
36. Install Engine Coolant Air Bleed Hose (2) @ Retainer Clip (3)
37. Connect Engine Coolant Air Bleed Hose Connector (1)

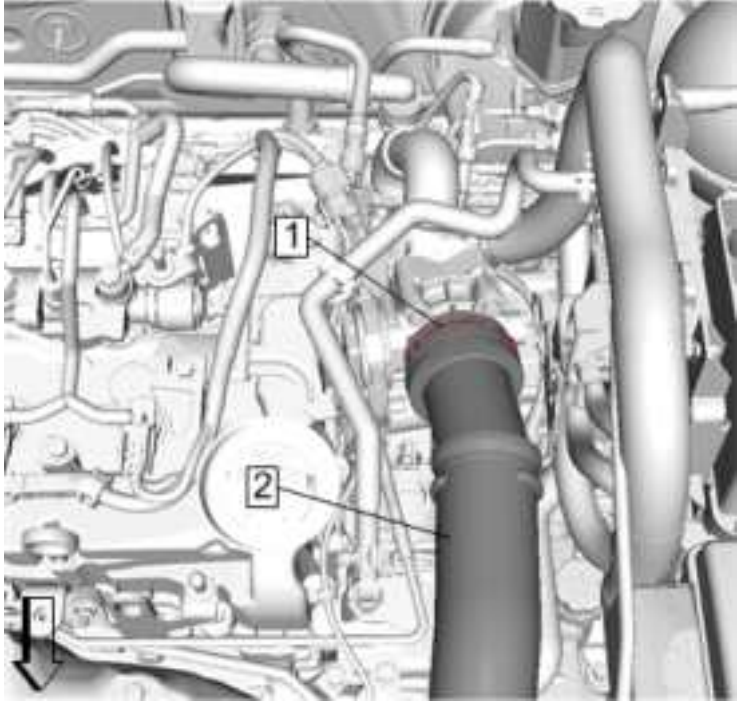

Fig. 383: Charge Air Cooler Outlet Air Tube And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

38. Install Charge Air Cooler Outlet Air Tube (2) @ Throttle Body. Refer to **Charge Air Cooler Outlet Air Tube Replacement**
39. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**
40. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

EXHAUST GAS RECIRCULATION VACUUM REGULATOR SOLENOID VALVE REPLACEMENT

Removal Procedure

1. Disconnect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Charge Air Cooler Outlet Air Tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement**

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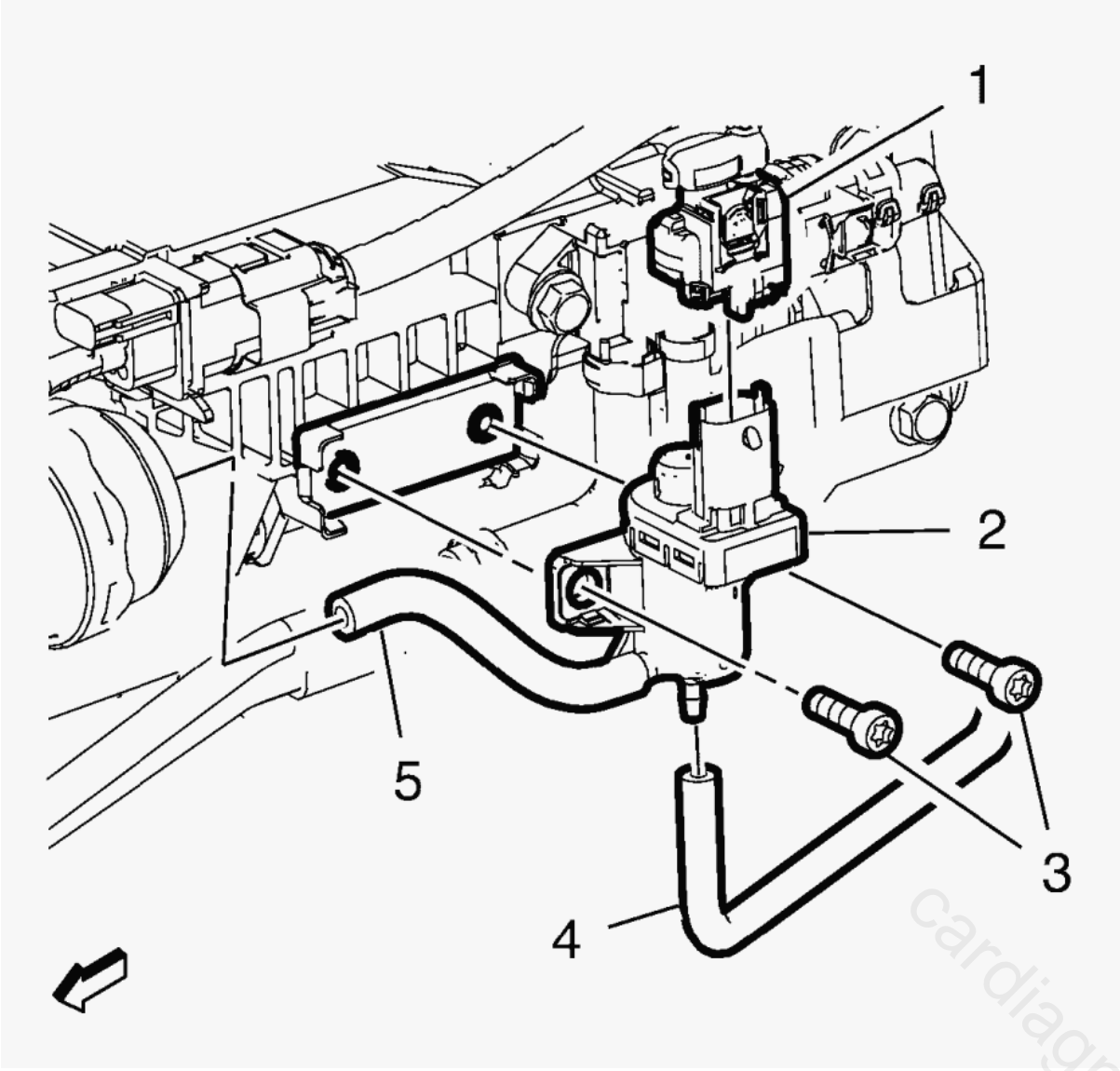

Fig. 384: Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve And Components
Courtesy of GENERAL MOTORS COMPANY

3. Remove the electrical connector (1) from the exhaust gas recirculation vacuum regulator solenoid valve (2).
4. Remove the charge air bypass regulator solenoid valve inlet tube (4) from the exhaust gas recirculation vacuum regulator solenoid valve (2).
5. Remove the exhaust gas recirculation vacuum regulator valve hose (5).
6. Remove the 2 exhaust gas recirculation vacuum regulator solenoid valve bolts (3).
7. Remove the exhaust gas recirculation vacuum regulator solenoid valve (2).

Installation Procedure

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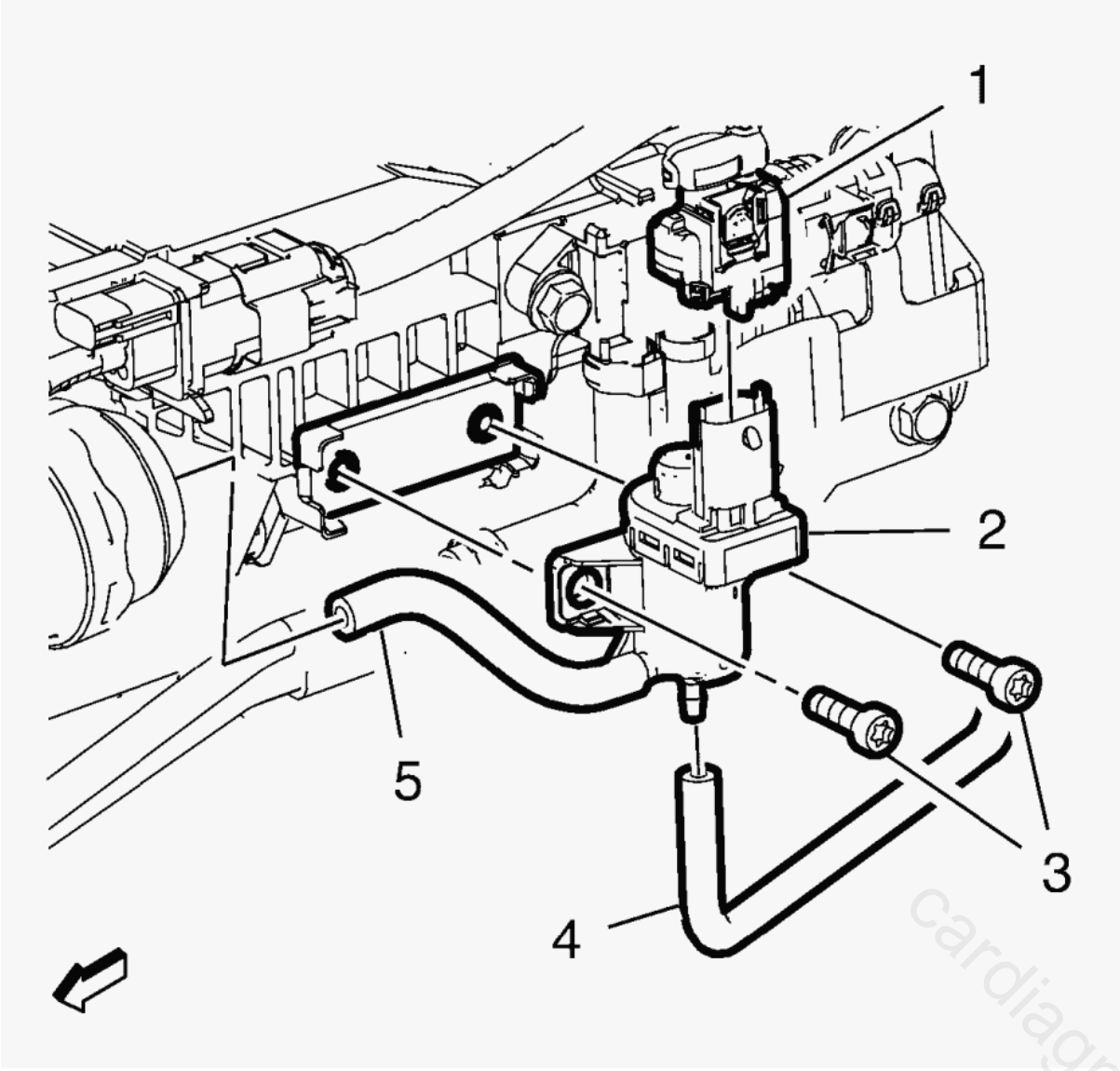

Fig. 385: Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve And Components
Courtesy of GENERAL MOTORS COMPANY

1. Install exhaust gas recirculation vacuum regulator solenoid valve (2).

CAUTION: **Refer to Fastener Caution**

2. Install the 2 exhaust gas recirculation vacuum regulator solenoid valve bolts (3) and tighten to 7 N.m (62 lb in).
3. Install the exhaust gas recirculation vacuum regulator valve hose (5).
4. Install the charge air bypass regulator solenoid valve inlet tube (4) to the exhaust gas recirculation vacuum regulator solenoid valve (2).
5. Install the electrical connector (1) to the exhaust gas recirculation vacuum regulator solenoid valve (2).
6. Install Charge Air Cooler Outlet Air Tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement**
7. Connect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

EXHAUST GAS RECIRCULATION COOLER OUTLET PIPE REPLACEMENT

Removal Procedure

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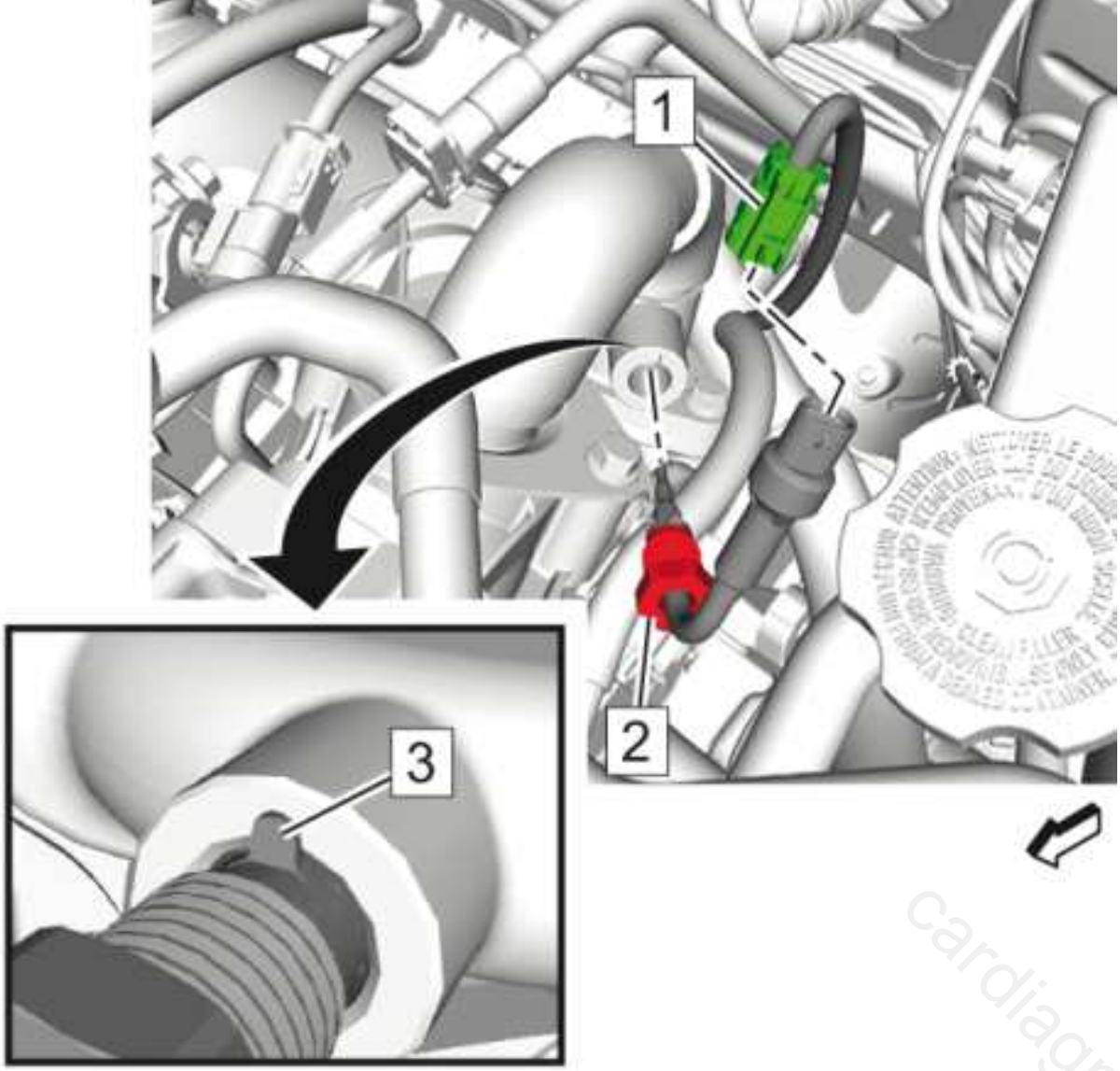

Fig. 386: Exhaust Gas Recirculation Cooler Temperature Sensor - Position 2 And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the electrical connector. (1)
2. Remove Exhaust Gas Recirculation Cooler Temperature Sensor (2)

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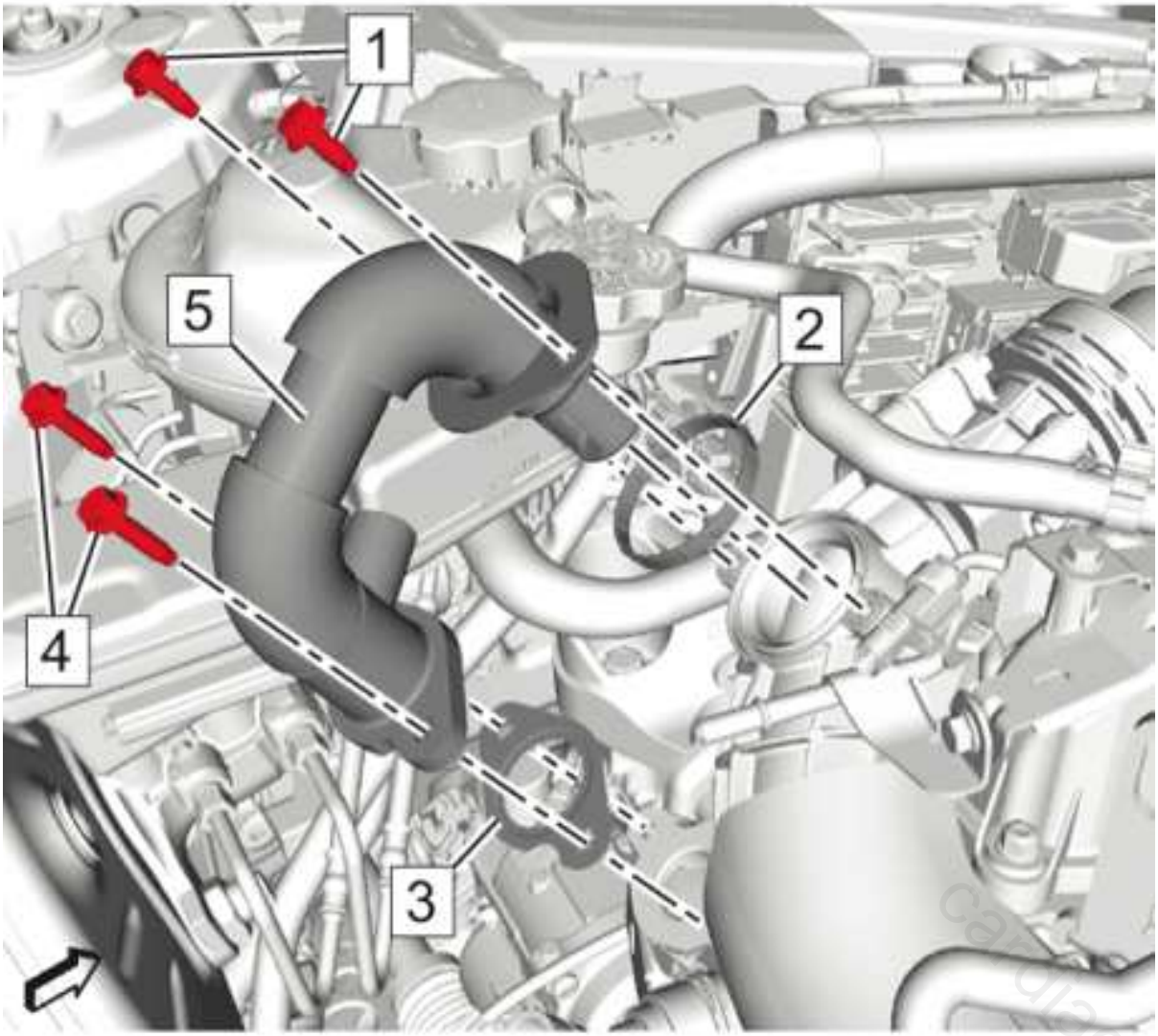

Fig. 387: Exhaust Gas Recirculation Cooler Outlet Pipe, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

3. Remove Exhaust Gas Recirculation Cooler Outlet Pipe Bolts (1) (Qty: 2) @ Intake Manifold
4. Remove Exhaust Gas Recirculation Cooler Outlet Pipe Bolts (4) (Qty: 2) @ Exhaust Gas Recirculation Cooler
5. Remove Exhaust Gas Recirculation Cooler Outlet Pipe (5)
6. Remove and DISCARD Exhaust Gas Recirculation Cooler Outlet Pipe Gasket (3)
7. Remove and DISCARD Exhaust Gas Recirculation Cooler Outlet Pipe Seal (2)

Installation Procedure

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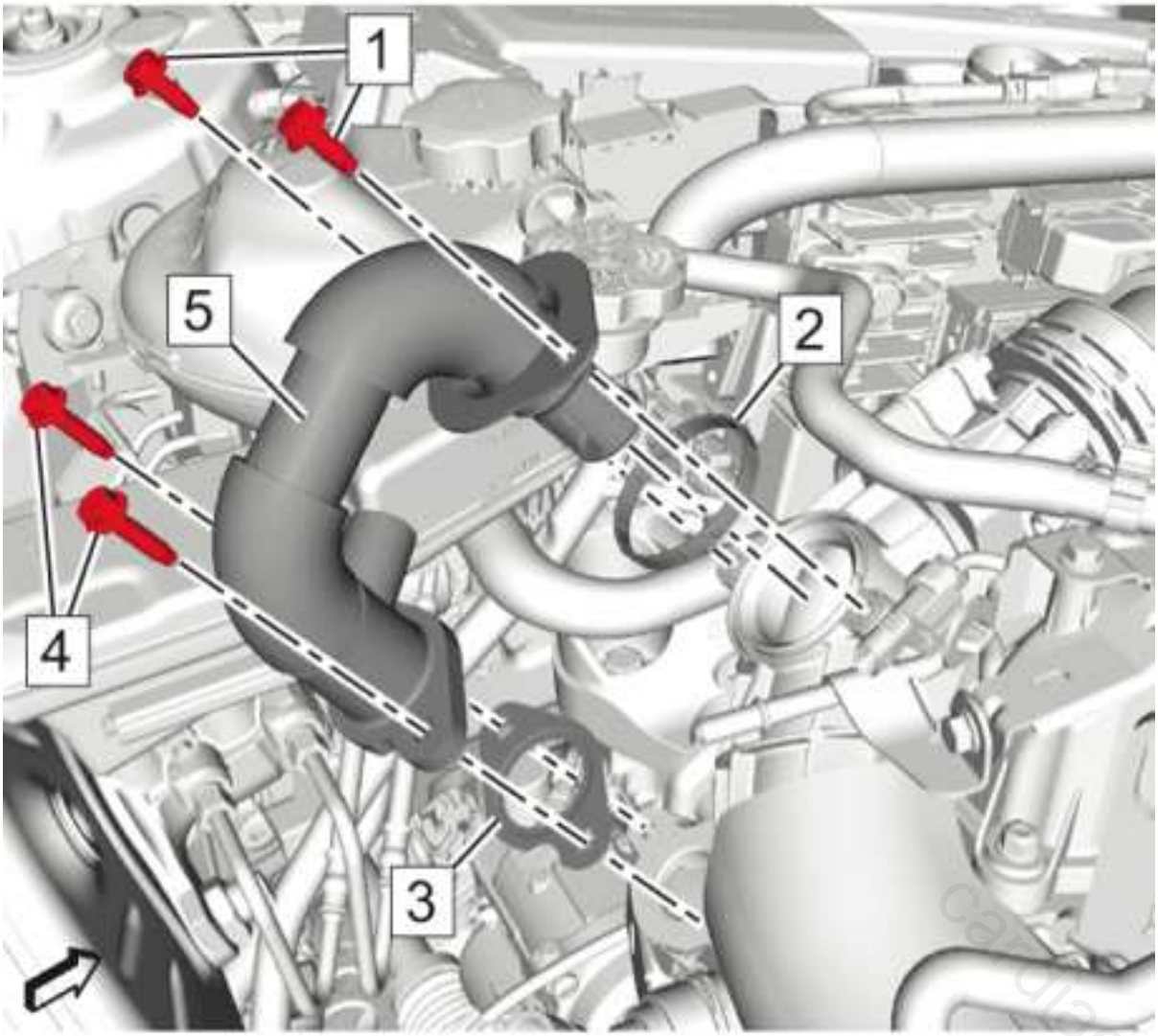

Fig. 388: Exhaust Gas Recirculation Cooler Outlet Pipe, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW Exhaust Gas Recirculation Cooler Outlet Pipe Seal (2)
2. Install NEW Exhaust Gas Recirculation Cooler Outlet Pipe Gasket (3)
3. Install Exhaust Gas Recirculation Cooler Outlet Pipe (5)

CAUTION: **Refer to Fastener Caution**

4. Install and tighten Exhaust Gas Recirculation Cooler Outlet Pipe Bolts (4) (Qty: 2) @ Exhaust Gas Recirculation Cooler to 10 N.m (89 lb in)
5. Install and tighten Exhaust Gas Recirculation Cooler Outlet Pipe Bolts (1) (Qty: 2) @ Intake Manifold to 10 N.m (89 lb in)

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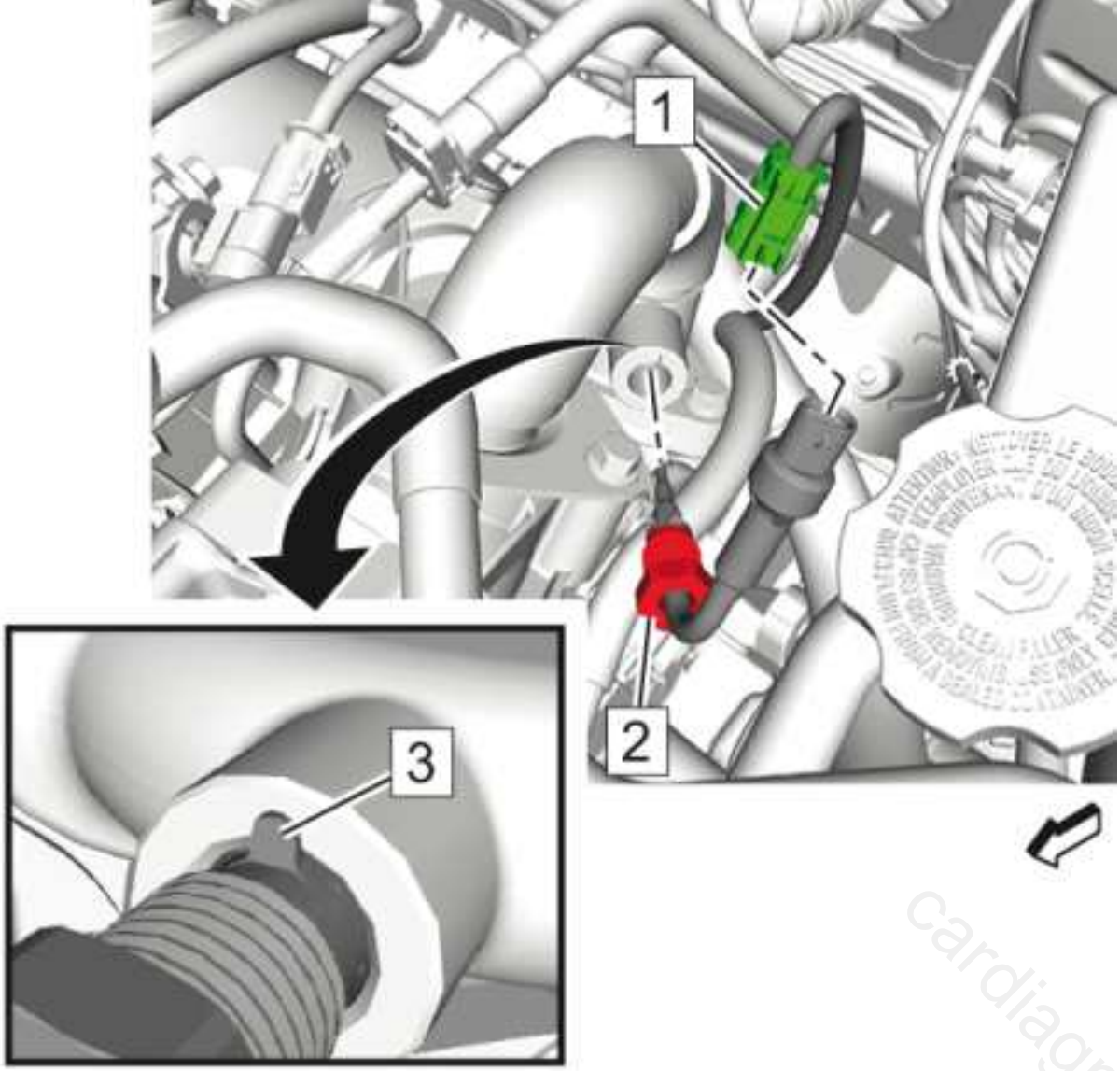

Fig. 389: Exhaust Gas Recirculation Cooler Temperature Sensor - Position 2 And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The guide lug (1) must fit the groove.**

6. Install and tighten Exhaust Gas Recirculation Cooler Temperature Sensor (2) to 45 N.m (33 lb ft)
7. Connect the electrical connector. (1)

PISTON OIL NOZZLE OIL CONTROL SOLENOID VALVE REPLACEMENT (AWD)

Removal Procedure

1. Disconnect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
3. Remove Power Transfer Unit Case. Refer to **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**

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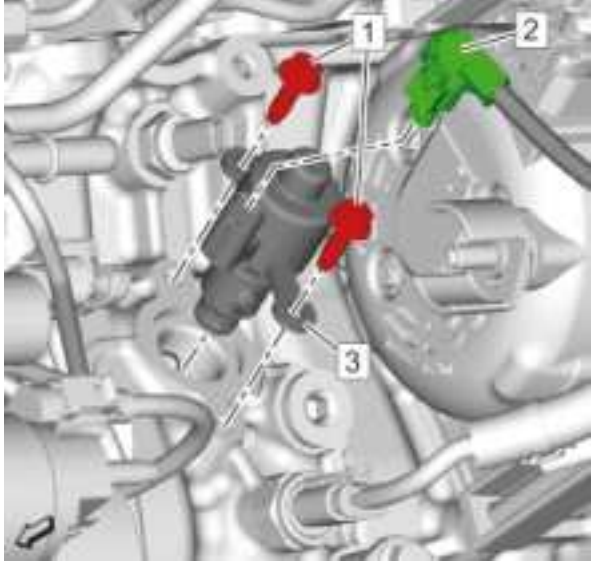

Fig. 390: Piston Oil Nozzle Oil Control Solenoid Valve, Bolts And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Electrical Connector (2)
5. Remove Piston Oil Nozzle Oil Control Solenoid Valve Bolts (1) (Qty: 2)

NOTE: **Inspect the piston oil nozzle oil control solenoid valve o-rings and replace as necessary.**

6. Remove Piston Oil Nozzle Oil Control Solenoid Valve (3)

Installation Procedure

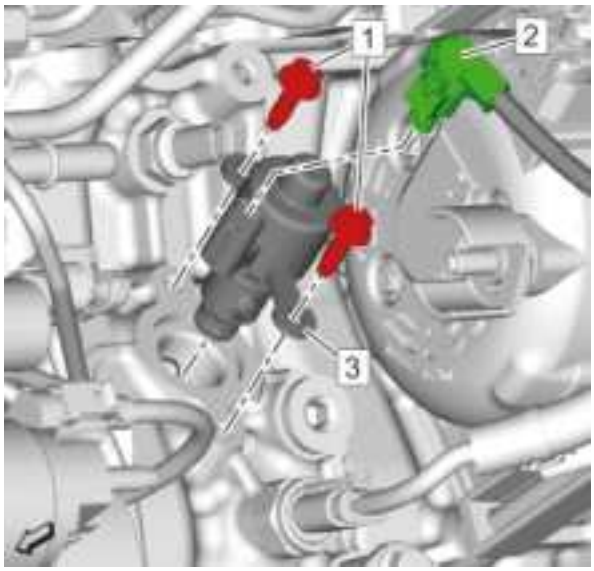

Fig. 391: Piston Oil Nozzle Oil Control Solenoid Valve, Bolts And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Install Piston Oil Nozzle Oil Control Solenoid Valve (3)

CAUTION: **Refer to Fastener Caution**

2. Install and tighten Piston Oil Nozzle Oil Control Solenoid Valve Bolts (1) (Qty: 2) to 10 N.m (89 lb in)
3. Connect Electrical Connector (2)
4. Install Power Transfer Unit Case. Refer to **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**
5. Remove the supports and lower the vehicle. Refer to **Lifting and Jacking the Vehicle**
6. Connect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

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PISTON OIL NOZZLE OIL CONTROL SOLENOID VALVE REPLACEMENT (FWD)

Removal Procedure

1. Disconnect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
3. Remove Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**

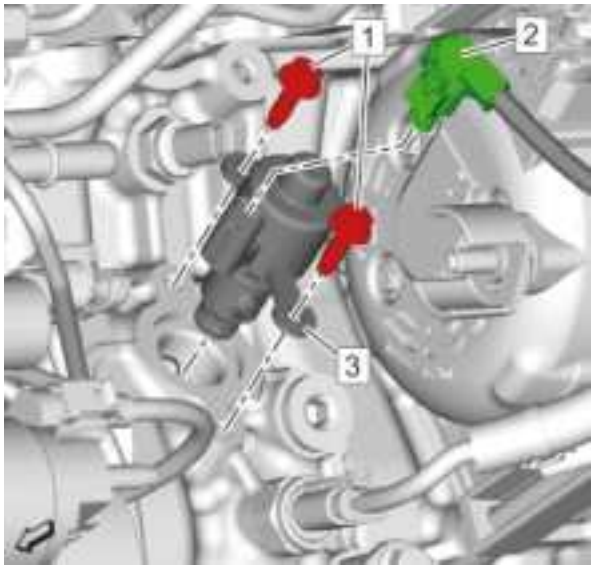

Fig. 392: Piston Oil Nozzle Oil Control Solenoid Valve, Bolts And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Electrical Connector (2)
5. Remove Piston Oil Nozzle Oil Control Solenoid Valve Bolts (1) (Qty: 2)

NOTE: **Inspect the piston oil nozzle oil control solenoid valve o-rings and replace as necessary.**

6. Remove Piston Oil Nozzle Oil Control Solenoid Valve (3)

Installation Procedure

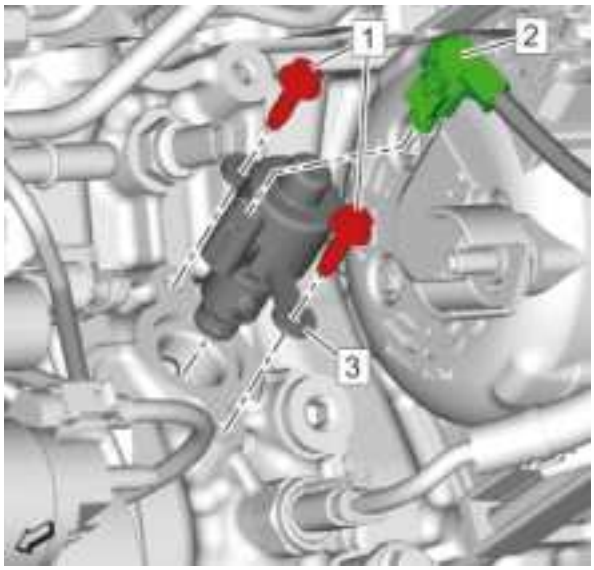

Fig. 393: Piston Oil Nozzle Oil Control Solenoid Valve, Bolts And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Install Piston Oil Nozzle Oil Control Solenoid Valve (3)

CAUTION: **Refer to Fastener Caution**

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2. Install and tighten Piston Oil Nozzle Oil Control Solenoid Valve Bolts (1) (Qty: 2) to 10 N.m (89 lb in)
3. Connect Electrical Connector (2)
4. Install Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**
5. Remove the supports and lower the vehicle. Refer to **Lifting and Jacking the Vehicle**
6. Connect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

OIL PUMP FLOW CONTROL SOLENOID VALVE REPLACEMENT (AWD)

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
3. Remove Power Transfer Unit Case. Refer to **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**

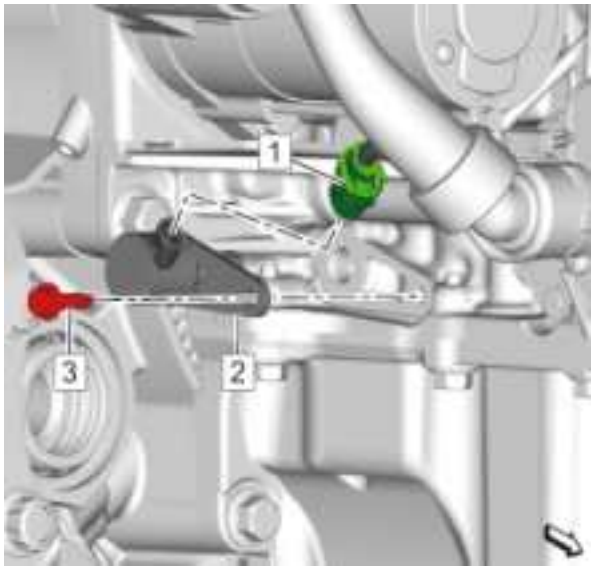

Fig. 394: Oil Pump Flow Control Solenoid Valve, Bolt And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connector. (1)
5. Remove Oil Pump Flow Control Solenoid Valve Bolt (3)
6. Remove Oil Pump Flow Control Solenoid Valve (2)

Installation Procedure

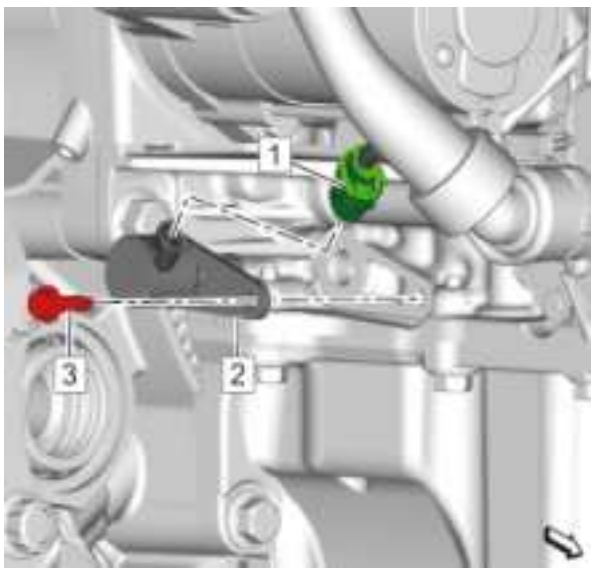

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Fig. 395: Oil Pump Flow Control Solenoid Valve, Bolt And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Install Oil Pump Flow Control Solenoid Valve (2)

CAUTION: **Refer to Fastener Caution**

2. Install and tighten Oil Pump Flow Control Solenoid Valve Bolt (3) to 10 N.m (89 lb in)
3. Connect the electrical connector. (1)
4. Remove the supports and lower the vehicle. Refer to **Lifting and Jacking the Vehicle**
5. Install Power Transfer Unit Case. Refer to **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**
6. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

OIL PUMP FLOW CONTROL SOLENOID VALVE REPLACEMENT (FWD)

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
3. Remove Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**

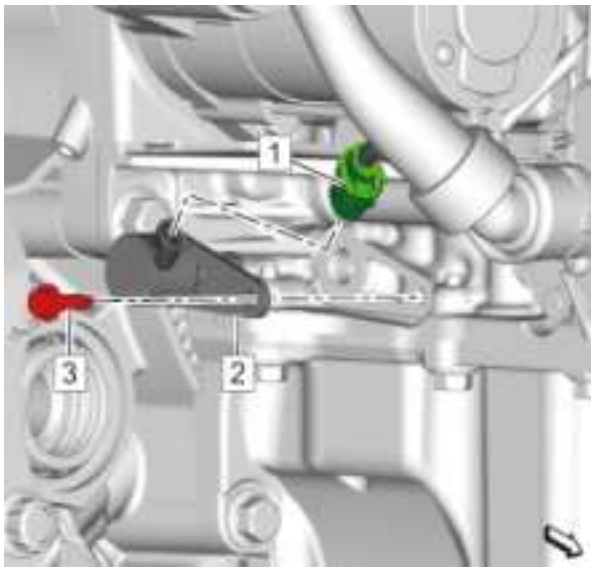

Fig. 396: Oil Pump Flow Control Solenoid Valve, Bolt And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connector. (1)
5. Remove Oil Pump Flow Control Solenoid Valve Bolt (3)
6. Remove Oil Pump Flow Control Solenoid Valve (2)

Installation Procedure

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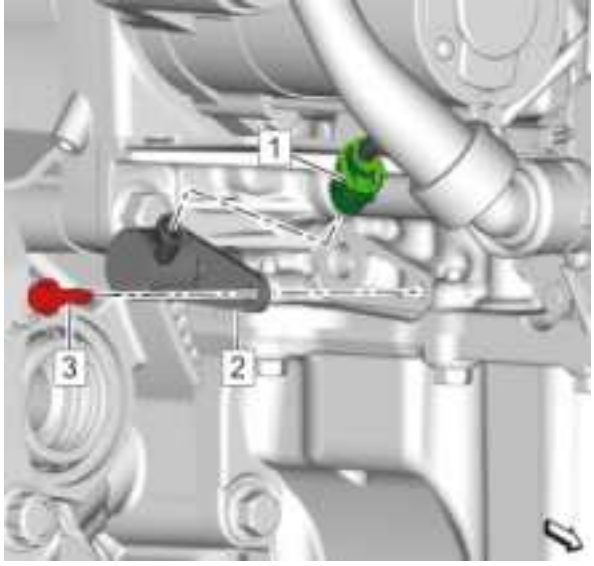

Fig. 397: Oil Pump Flow Control Solenoid Valve, Bolt And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Install Oil Pump Flow Control Solenoid Valve (2)

CAUTION: **Refer to Fastener Caution**

2. Install and tighten Oil Pump Flow Control Solenoid Valve Bolt (3) to 10 N.m (89 lb in)
3. Connect the electrical connector. (1)
4. Remove the supports and lower the vehicle. Refer to **Lifting and Jacking the Vehicle**
5. Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**
6. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

TURBOCHARGER WASTEGATE ACTUATOR VACUUM CONTROL SOLENOID VALVE REPLACEMENT

Removal Procedure

1. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

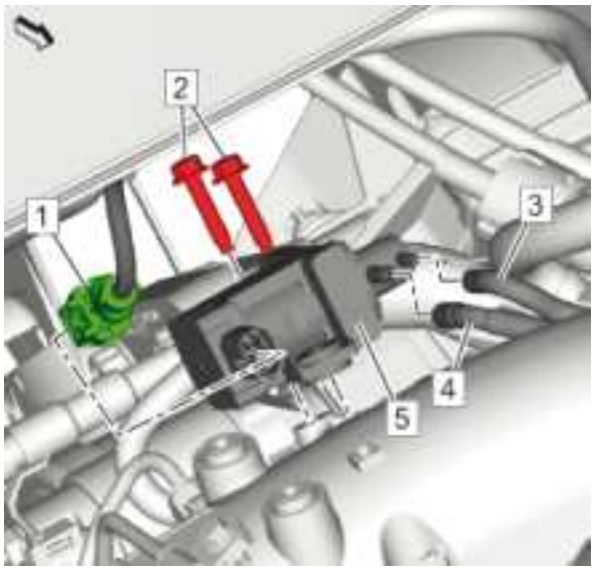

Fig. 398: Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve And Components
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Electrical Connector (1)
3. Disconnect Turbocharger Wastegate Actuator Pipe (3)
4. Disconnect Power Brake Booster Vacuum Pipe (4)

5. Remove Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve Bolts (2) (Qty: 2)
6. Remove Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve (5)

Installation Procedure

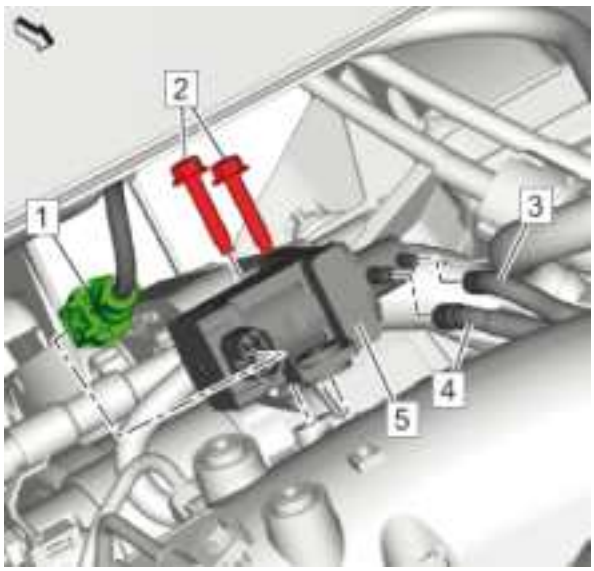

Fig. 399: Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve And Components
Courtesy of GENERAL MOTORS COMPANY

1. Install Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve (5)

CAUTION: **Refer to Fastener Caution**

2. Install and tighten Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve Bolts (2) (Qty: 2) to 10 N.m (89 lb in)
3. Connect Power Brake Booster Vacuum Pipe (4)
4. Connect Turbocharger Wastegate Actuator Pipe (3)
5. Connect Electrical Connector (1)
6. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

TURBOCHARGER WASTEGATE ACTUATOR PIPE REPLACEMENT (TO WASTEGATE ACTUATOR VACUUM CONTROL SOLENOID VALVE AND EGR VACUUM REGULATOR SOLENOID VALVE - FWD)

Removal Procedure

WARNING: **Refer to Safety Goggles and Fuel Warning**

WARNING: **Refer to Diesel/Gasoline Vapors Warning**

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
3. Position aside Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**

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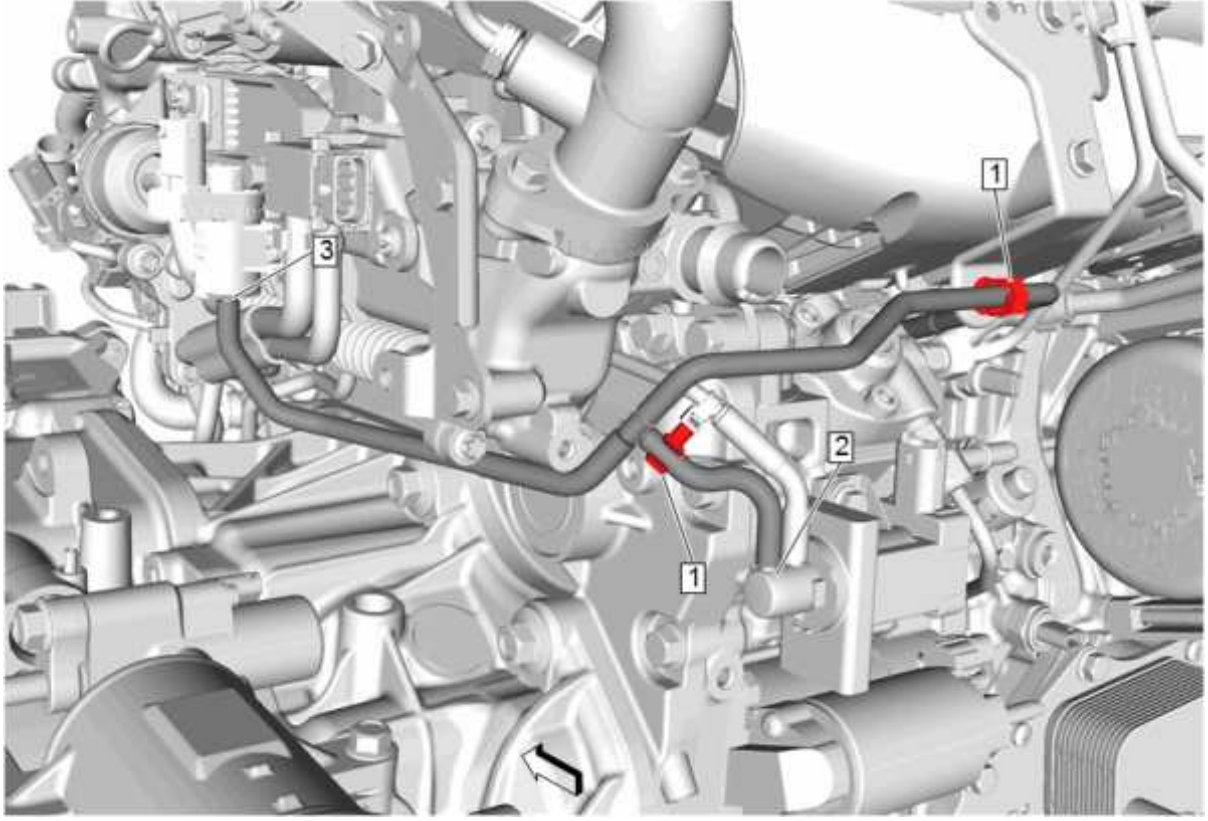

Fig. 400: Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve, Vacuum Regulator Solenoid Valve And Retainer Clips
Courtesy of GENERAL MOTORS COMPANY

4. Remove the turbocharger wastegate actuator pipe from the 2 retainer clips (1).
5. Remove the turbocharger wastegate actuator pipe from the turbocharger wastegate actuator vacuum control solenoid valve (2).
6. Remove the turbocharger wastegate actuator pipe from the exhaust gas recirculation vacuum regulator solenoid valve (3).

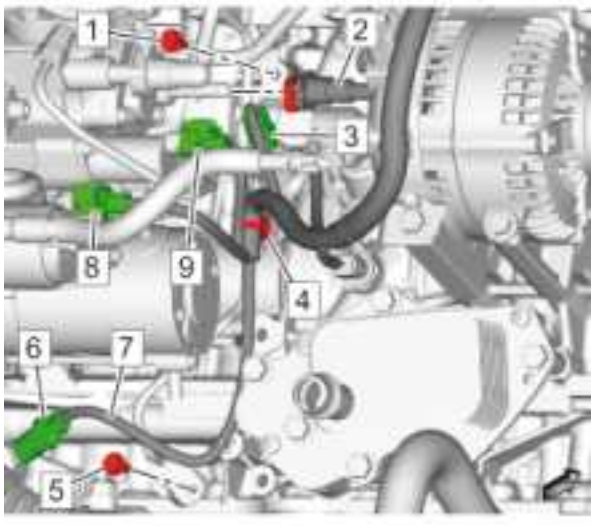

Fig. 401: Fuel Return Front Pipe, Wiring Harness, Connectors, Bolts And Clip
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Fuel Return Front Pipe (2) @ Fuel Injection Pump. Refer to **Plastic Collar Quick Connect Fitting Service**
8. Close all connections with suitable closure plugs.
9. Disconnect the electrical connectors:
    1. Engine Oil Pressure Switch (3)
    2. Fuel Injection Pump (9)
    3. Starter (8)

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4. Oil Pump Flow Control Solenoid Valve (6)

10. Remove Wiring Harness Clip (4)
11. Hang the wiring harness (7) aside.
12. Remove the 2 turbocharger wastegate actuator pipe bracket bolts (1, 5)

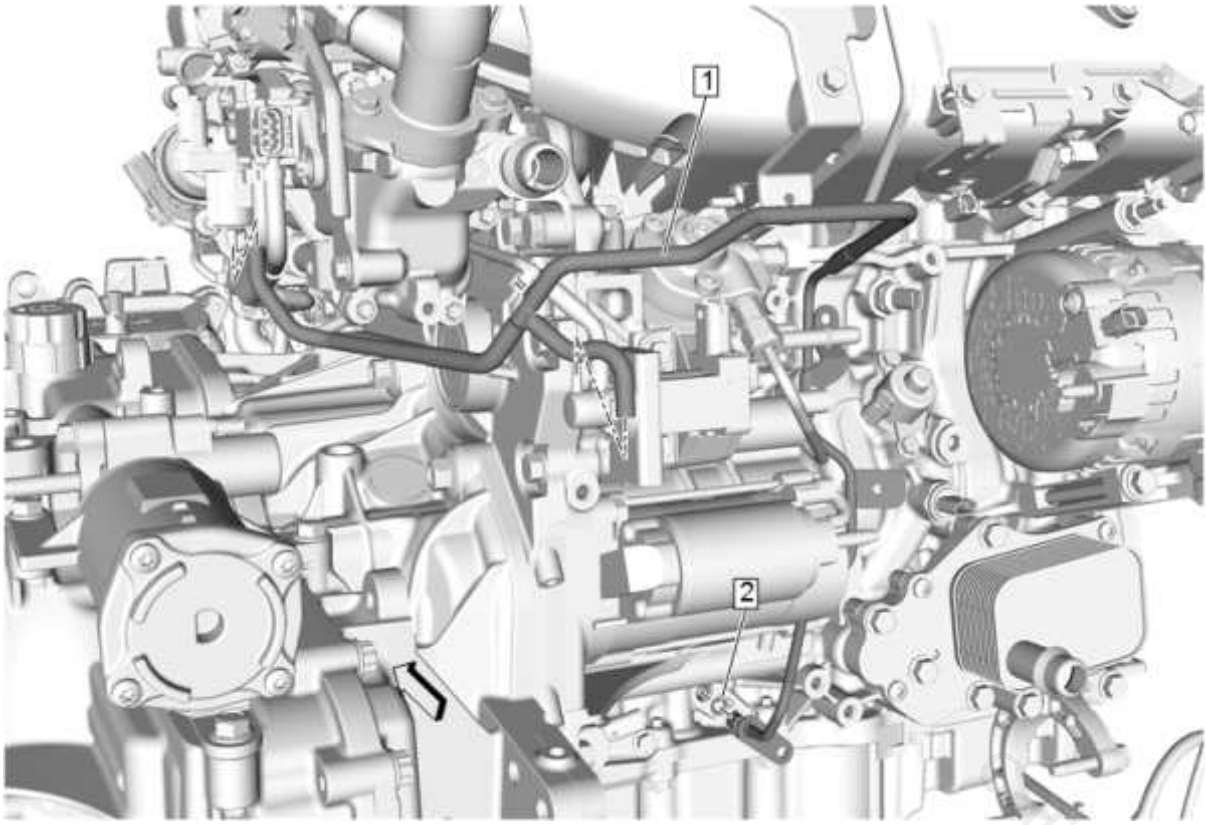

Fig. 402: Turbocharger Wastegate Actuator Pipe And Seal
Courtesy of GENERAL MOTORS COMPANY

13. Remove the turbocharger wastegate actuator pipe (1).
14. Remove and DISCARD the turbocharger wastegate actuator pipe seal (2).

Installation Procedure

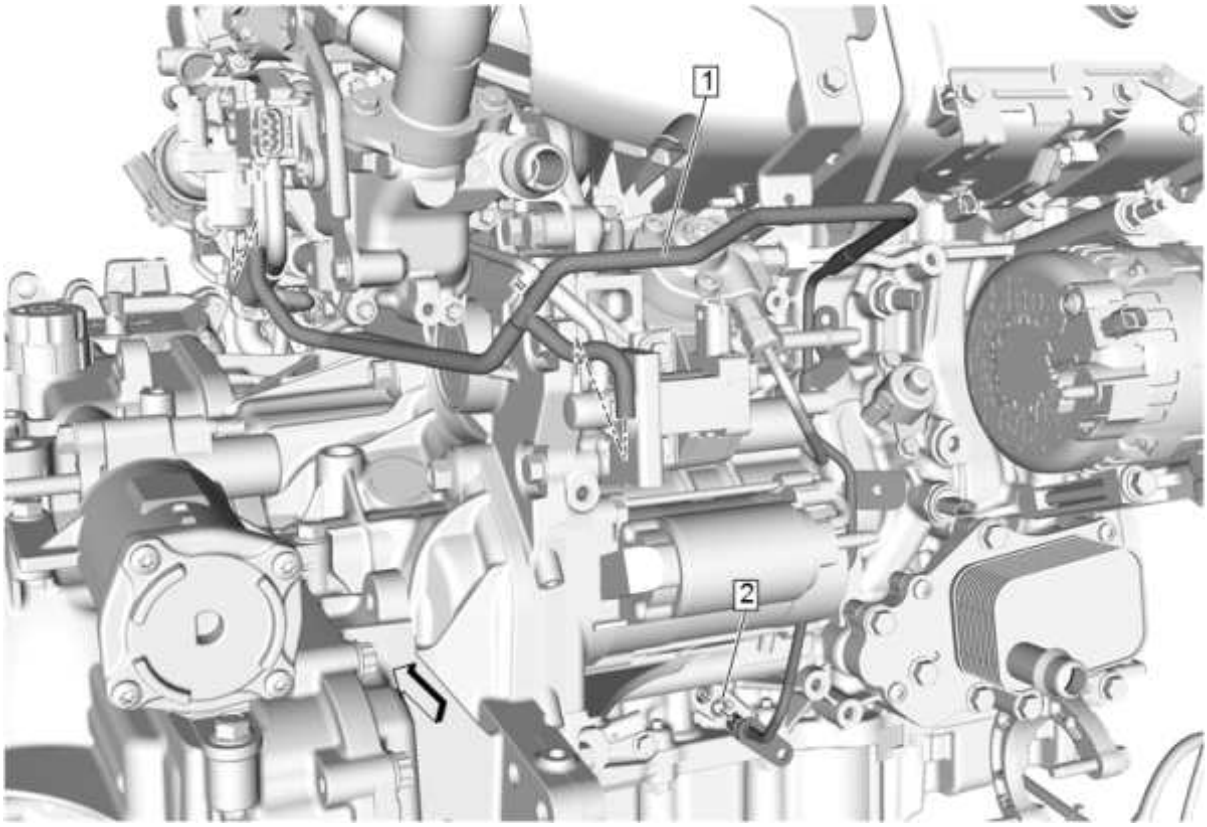

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Fig. 403: Turbocharger Wastegate Actuator Pipe And Seal
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW turbocharger wastegate actuator pipe seal (2).
2. Install the turbocharger wastegate actuator pipe (1).

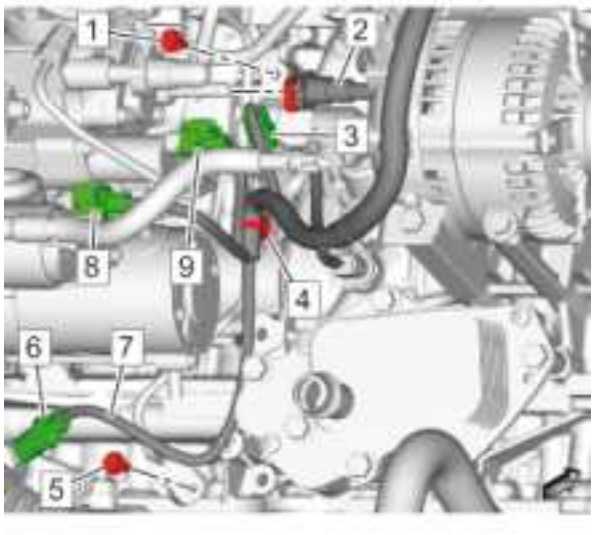

Fig. 404: Fuel Return Front Pipe, Wiring Harness, Connectors, Bolts And Clip
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

3. Install the 2 turbocharger wastegate actuator pipe bracket bolts (1, 5) and tighten to 10 N.m (89 lb in)
4. Position the wiring harness. (7)
5. Install Wiring Harness Clip (4)
6. Connect the electrical connector:
    1. Engine Oil Pressure Switch (3)
    2. Fuel Injection Pump (9)
    3. Starter (8)
    4. Oil Pump Flow Control Solenoid Valve (6)
7. Remove the closure plugs from all connections.
8. Connect Fuel Return Front Pipe (2) @ Fuel Injection Pump. Refer to **Plastic Collar Quick Connect Fitting Service**

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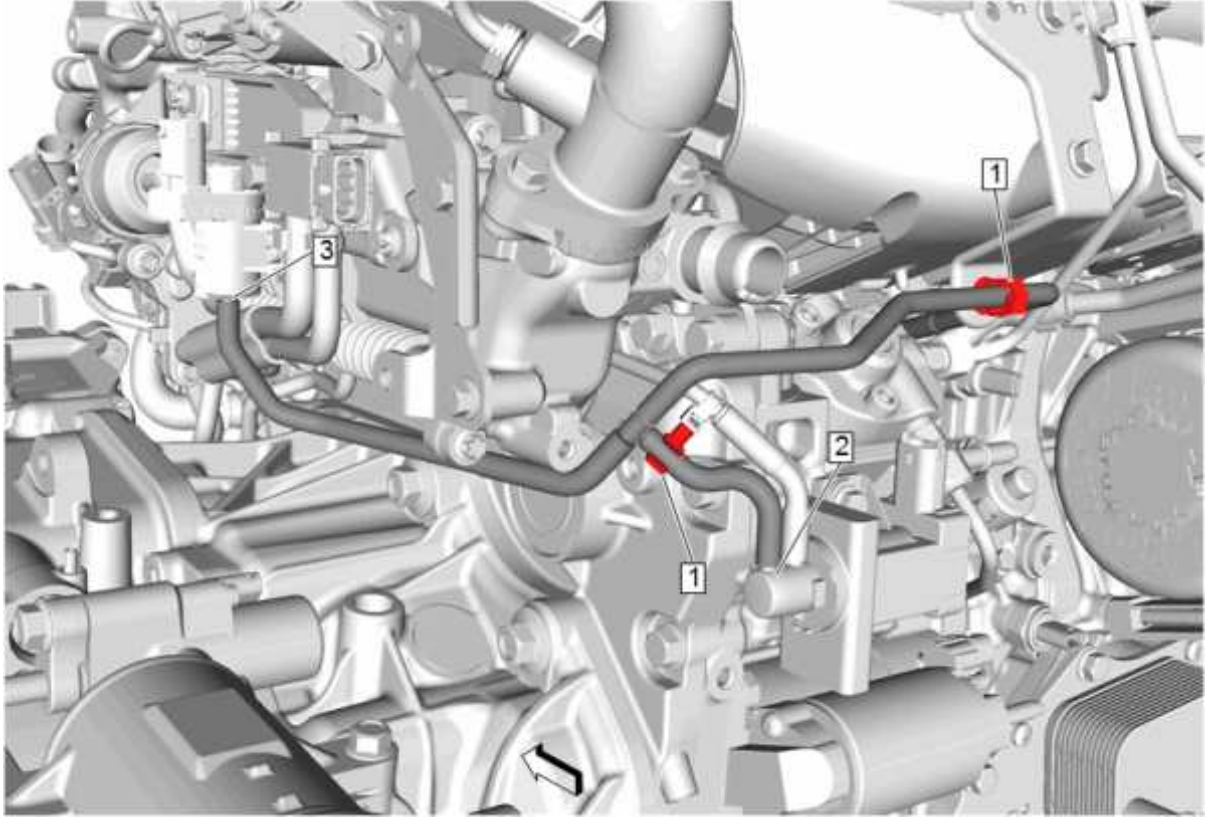

Fig. 405: Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve, Vacuum Regulator Solenoid Valve And Retainer Clips
Courtesy of GENERAL MOTORS COMPANY

9. Install the turbocharger wastegate actuator pipe to the exhaust gas recirculation vacuum regulator solenoid valve (3).
10. Install the turbocharger wastegate actuator pipe to the turbocharger wastegate actuator vacuum control solenoid valve (2).
11. Install the turbocharger wastegate actuator pipe to the 2 retainer clips (1).
12. Install Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**
13. Lower the vehicle.
14. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

TURBOCHARGER WASTEGATE ACTUATOR PIPE REPLACEMENT (TO WASTEGATE ACTUATOR VACUUM CONTROL SOLENOID VALVE AND EGR VACUUM REGULATOR SOLENOID VALVE - AWD)

Removal Procedure

WARNING: Refer to **Safety Goggles and Fuel Warning**

WARNING: Refer to **Diesel/Gasoline Vapors Warning**

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
3. Remove Power Transfer Unit Case. Refer to **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**

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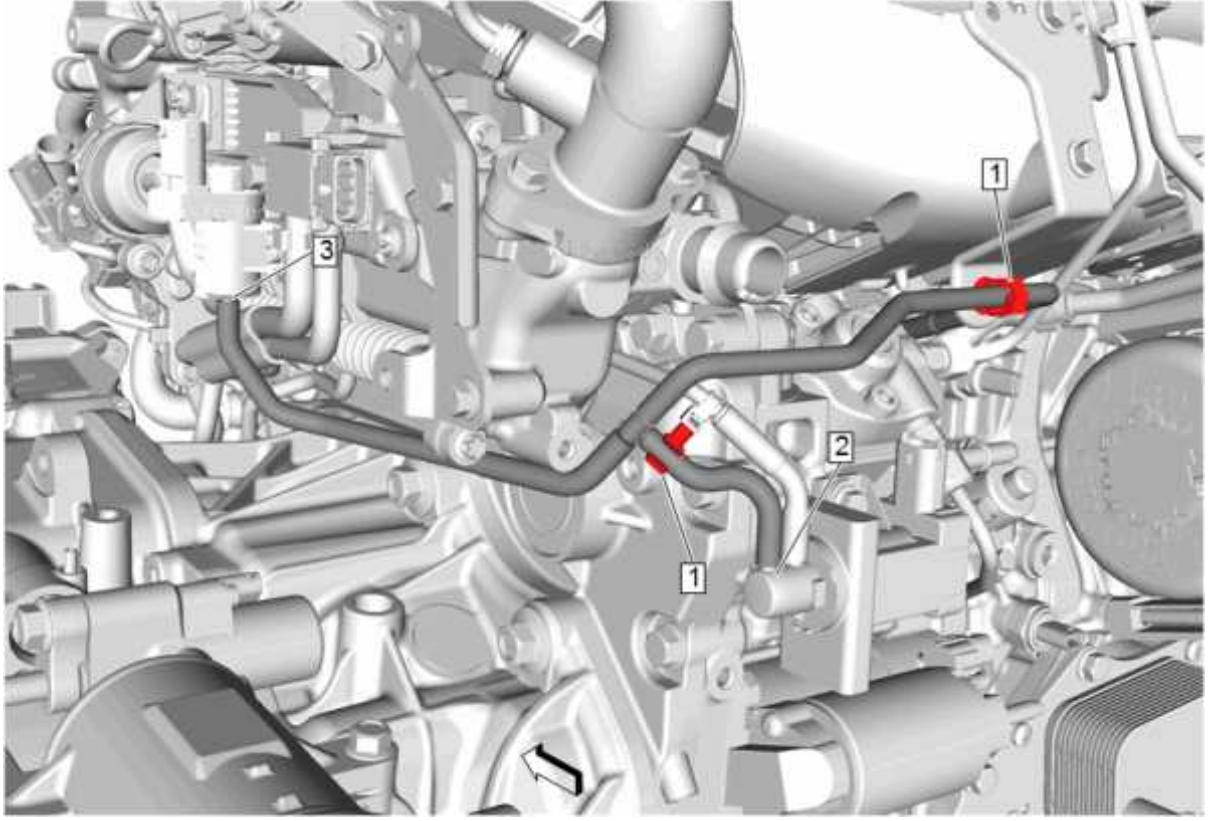

Fig. 406: Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve, Vacuum Regulator Solenoid Valve And Retainer Clips
Courtesy of GENERAL MOTORS COMPANY

4. Remove the turbocharger wastegate actuator pipe from the 2 retainer clips (1).
5. Remove the turbocharger wastegate actuator pipe from the turbocharger wastegate actuator vacuum control solenoid valve (2).
6. Remove the turbocharger wastegate actuator pipe from the exhaust gas recirculation vacuum regulator solenoid valve (3).

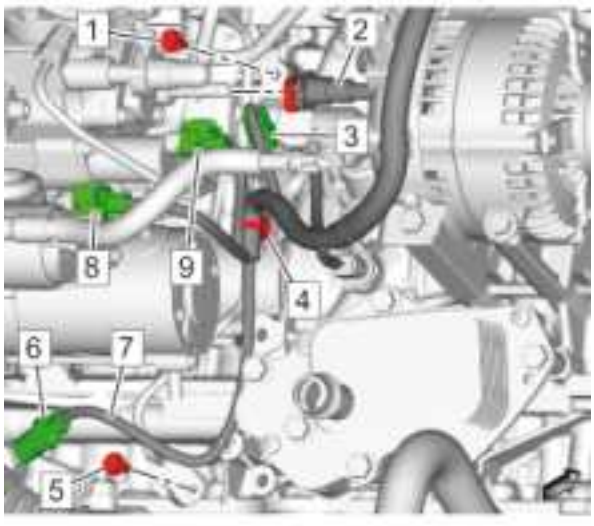

Fig. 407: Fuel Return Front Pipe, Wiring Harness, Connectors, Bolts And Clip
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Fuel Return Front Pipe (2) @ Fuel Injection Pump. Refer to **Plastic Collar Quick Connect Fitting Service**
8. Close all connections with suitable closure plugs.
9. Disconnect the electrical connectors:
    1. Engine Oil Pressure Switch (3)
    2. Fuel Injection Pump (9)
    3. Starter (8)

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4. Oil Pump Flow Control Solenoid Valve (6)

10. Remove Wiring Harness Clip (4)
11. Hang the wiring harness (7) aside.
12. Remove the 2 turbocharger wastegate actuator pipe bracket bolts (1, 5)

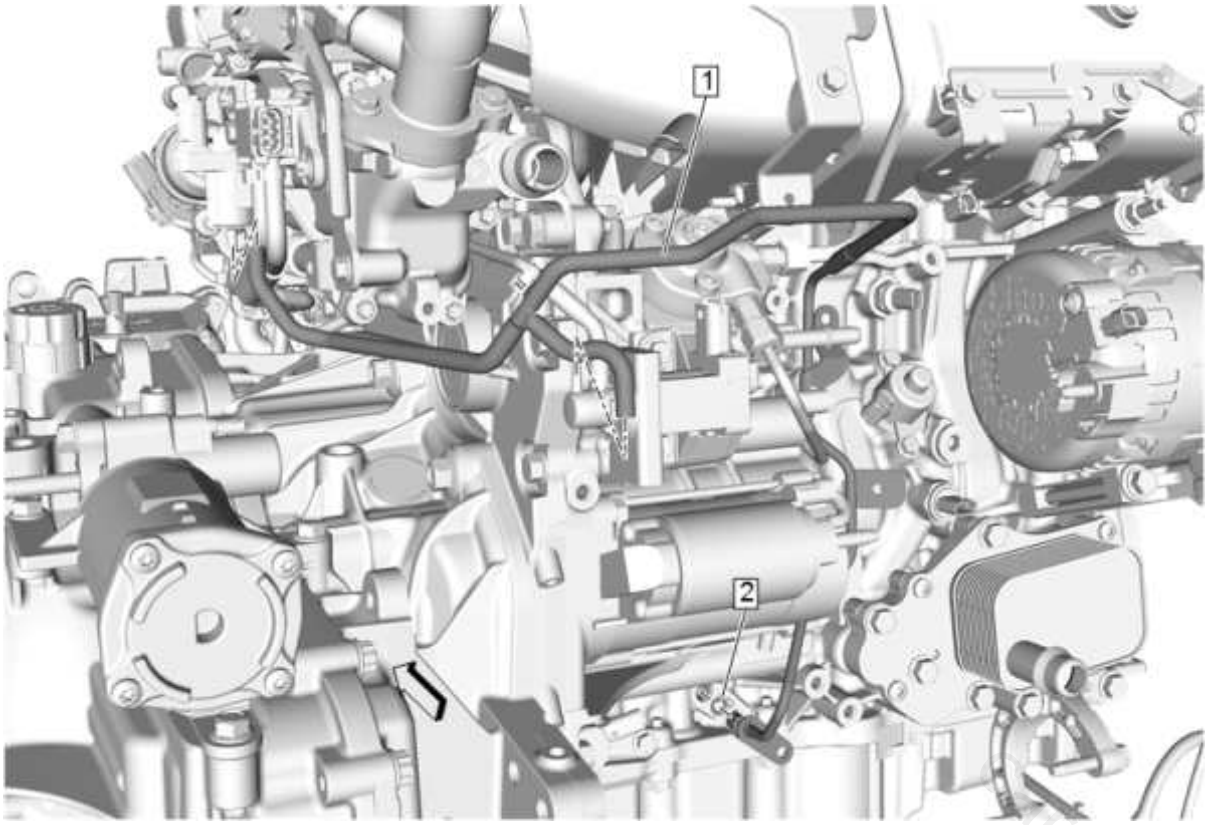

Fig. 408: Turbocharger Wastegate Actuator Pipe And Seal
Courtesy of GENERAL MOTORS COMPANY

13. Remove the turbocharger wastegate actuator pipe (1).
14. Remove and DISCARD the turbocharger wastegate actuator pipe seal (2).

Installation Procedure

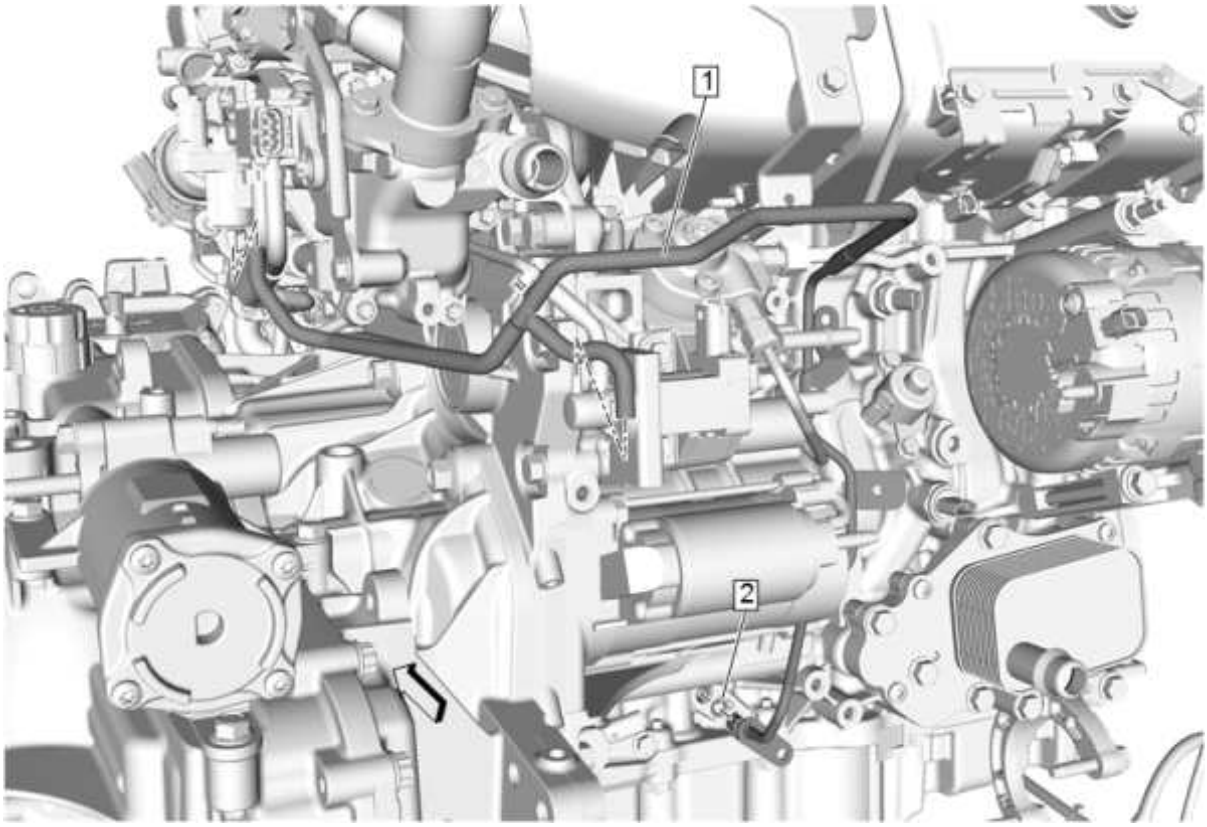

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Fig. 409: Turbocharger Wastegate Actuator Pipe And Seal
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW turbocharger wastegate actuator pipe seal (2).
2. Install the turbocharger wastegate actuator pipe (1

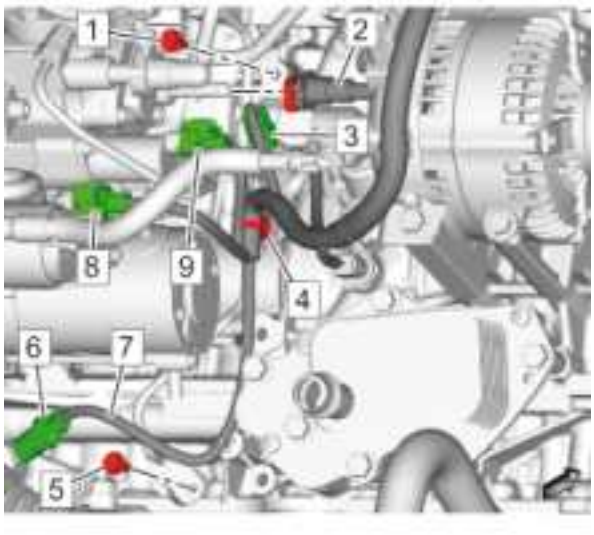

Fig. 410: Fuel Return Front Pipe, Wiring Harness, Connectors, Bolts And Clip
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

3. Install the 2 turbocharger wastegate actuator pipe bracket bolts (1, 5) and tighten to 10 N.m (89 lb in)
4. Position the wiring harness. (7)
5. Install Wiring Harness Clip (4)
6. Connect the electrical connectors:
    1. Engine Oil Pressure Switch (3)
    2. Fuel Injection Pump (9)
    3. Starter (8)
    4. Oil Pump Flow Control Solenoid Valve (6)
7. Remove the closure plugs from all connections.
8. Connect Fuel Return Front Pipe (2) @ Fuel Injection Pump. Refer to **Plastic Collar Quick Connect Fitting Service**

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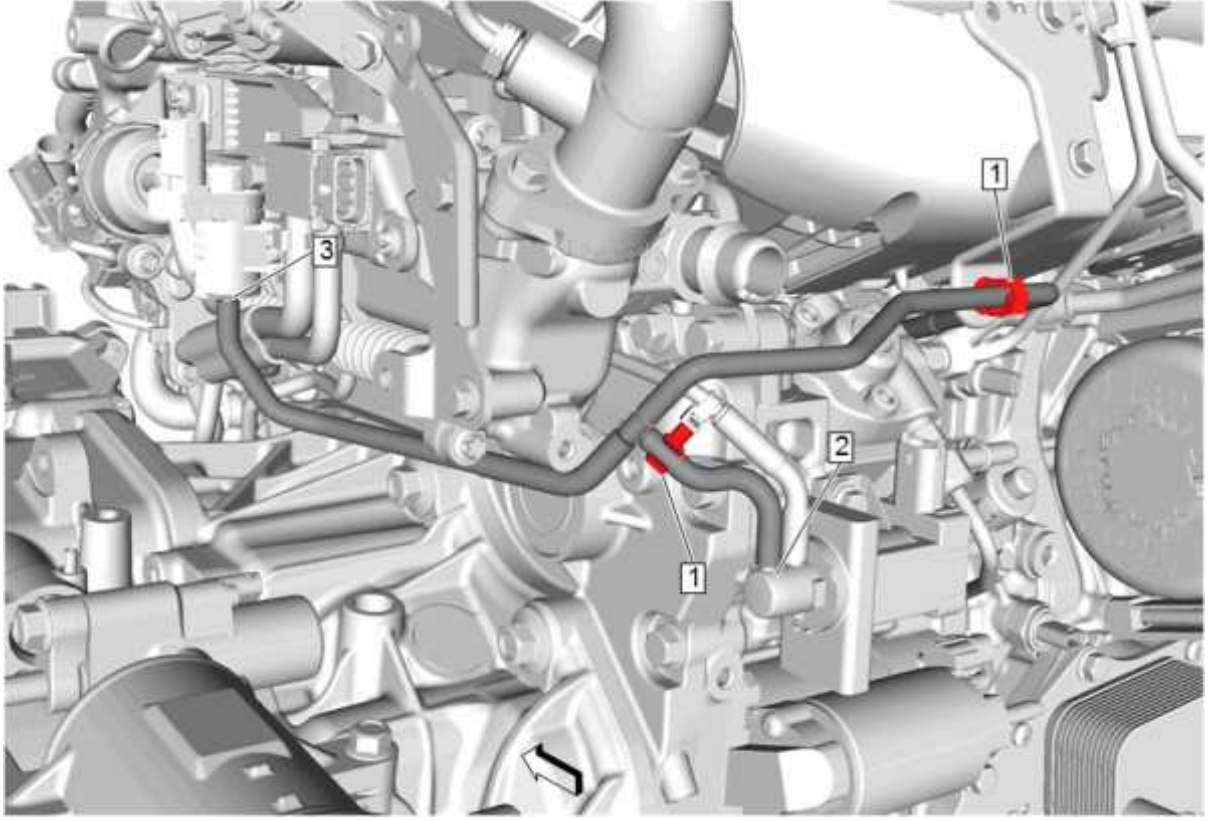

Fig. 411: Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve, Vacuum Regulator Solenoid Valve And Retainer Clips
Courtesy of GENERAL MOTORS COMPANY

9. Install the turbocharger wastegate actuator pipe to the exhaust gas recirculation vacuum regulator solenoid valve (3).
10. Install the turbocharger wastegate actuator pipe to the turbocharger wastegate actuator vacuum control solenoid valve (2).
11. Install the turbocharger wastegate actuator pipe to the 2 retainer clips (1).
12. Install Power Transfer Unit Case. Refer to **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**
13. Lower the vehicle.
14. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

TURBOCHARGER WASTEGATE ACTUATOR PIPE REPLACEMENT

Removal Procedure

1. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**

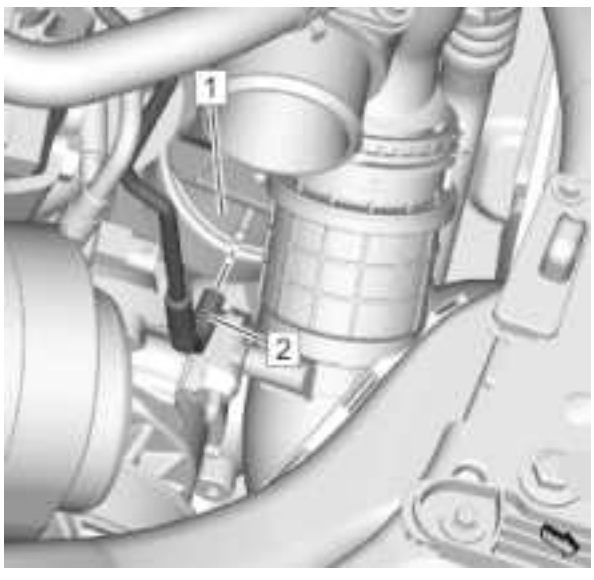

Fig. 412: Turbocharger Wastegate Actuator Pipe And Turbocharger
Courtesy of GENERAL MOTORS COMPANY

3. Remove Turbocharger Wastegate Actuator Pipe (2) @ Turbocharger (1)

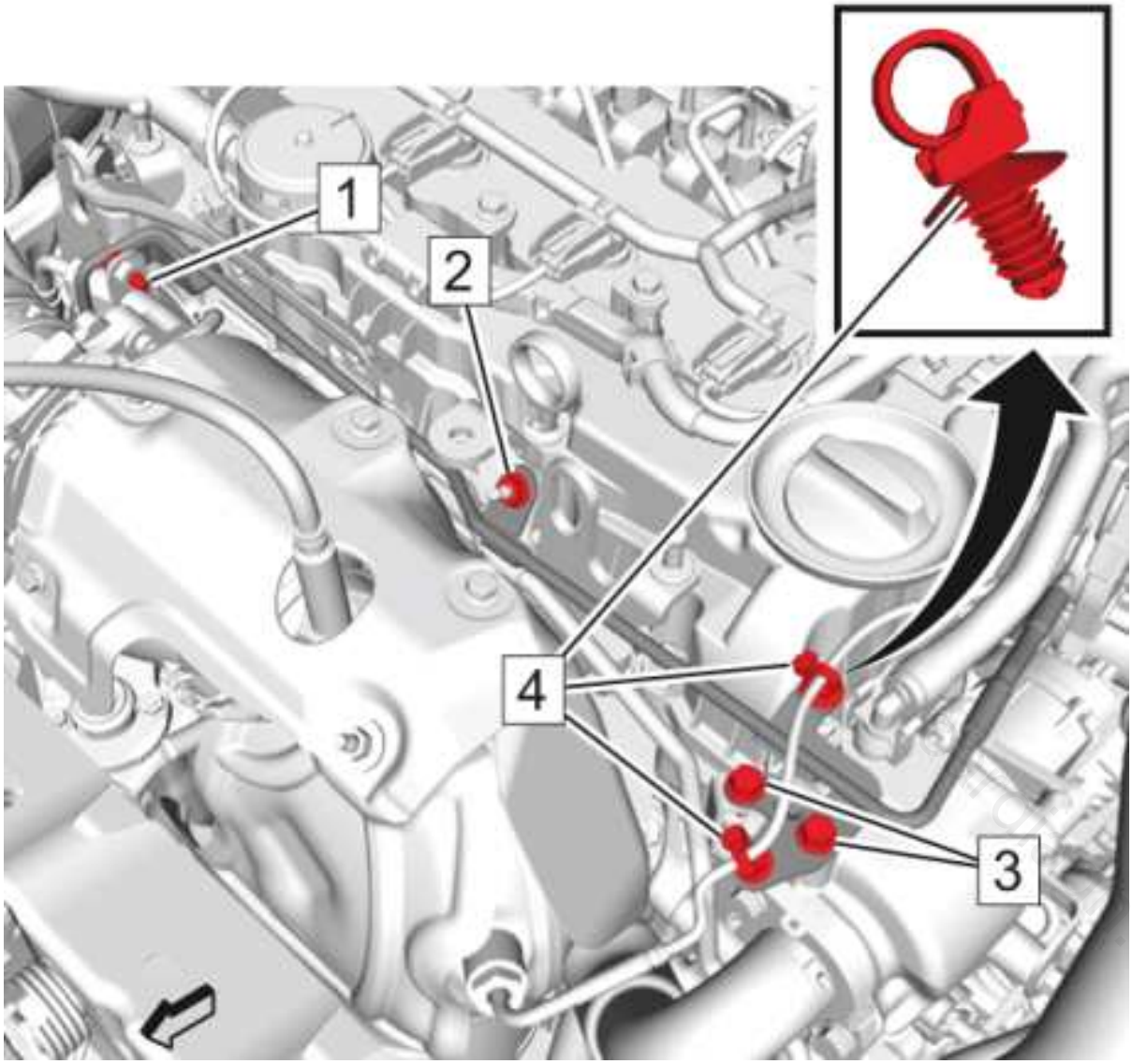

Fig. 413: Turbocharger Wastegate Actuator Pipe Bolts, Nut And Clips
Courtesy of GENERAL MOTORS COMPANY

4. Unclip Wiring Harness Clips (4) (Qty: 2)
5. Remove Turbocharger Wastegate Actuator Pipe Bolts (1, 3) (Qty: 3)
6. Remove the turbocharger wastegate actuator pipe nut (2).

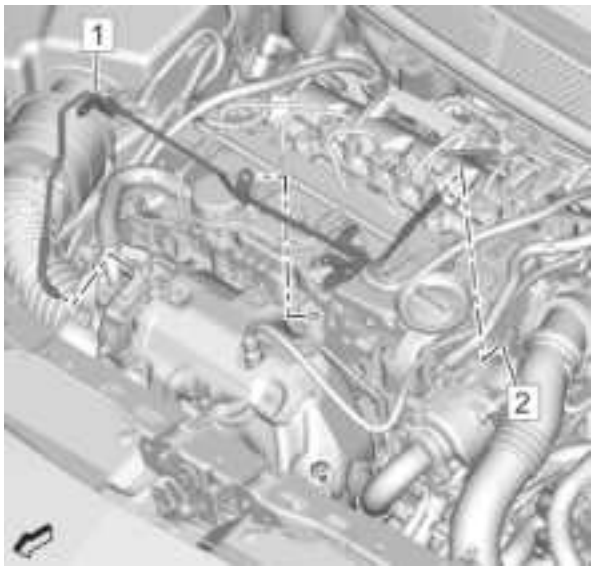

Fig. 414: Turbocharger Wastegate Actuator Pipe And Power Brake Booster Inlet Hose Connector Fitting
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Turbocharger Wastegate Actuator Pipe (1) @ Power Brake Booster Inlet Hose Connector Fitting (2)
8. Remove Turbocharger Wastegate Actuator Pipe (1) @ Vehicle

Installation Procedure

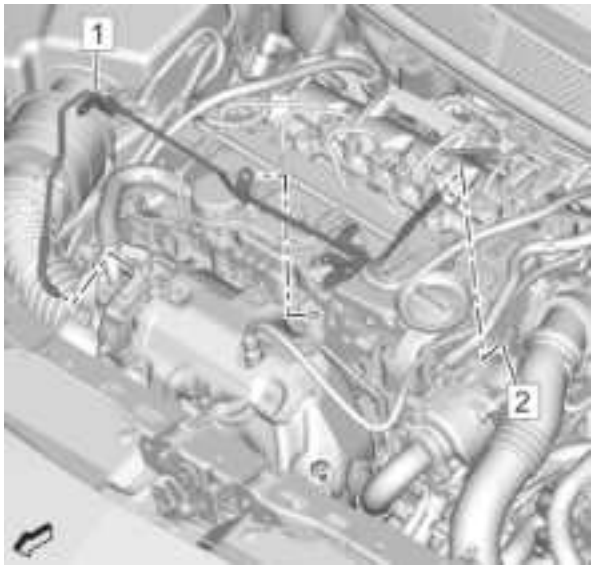

Fig. 415: Turbocharger Wastegate Actuator Pipe And Power Brake Booster Inlet Hose Connector Fitting
Courtesy of GENERAL MOTORS COMPANY

1. Install Turbocharger Wastegate Actuator Pipe (1) @ Vehicle
2. Connect Turbocharger Wastegate Actuator Pipe (1) @ Power Brake Booster Inlet Hose Connector Fitting (2)

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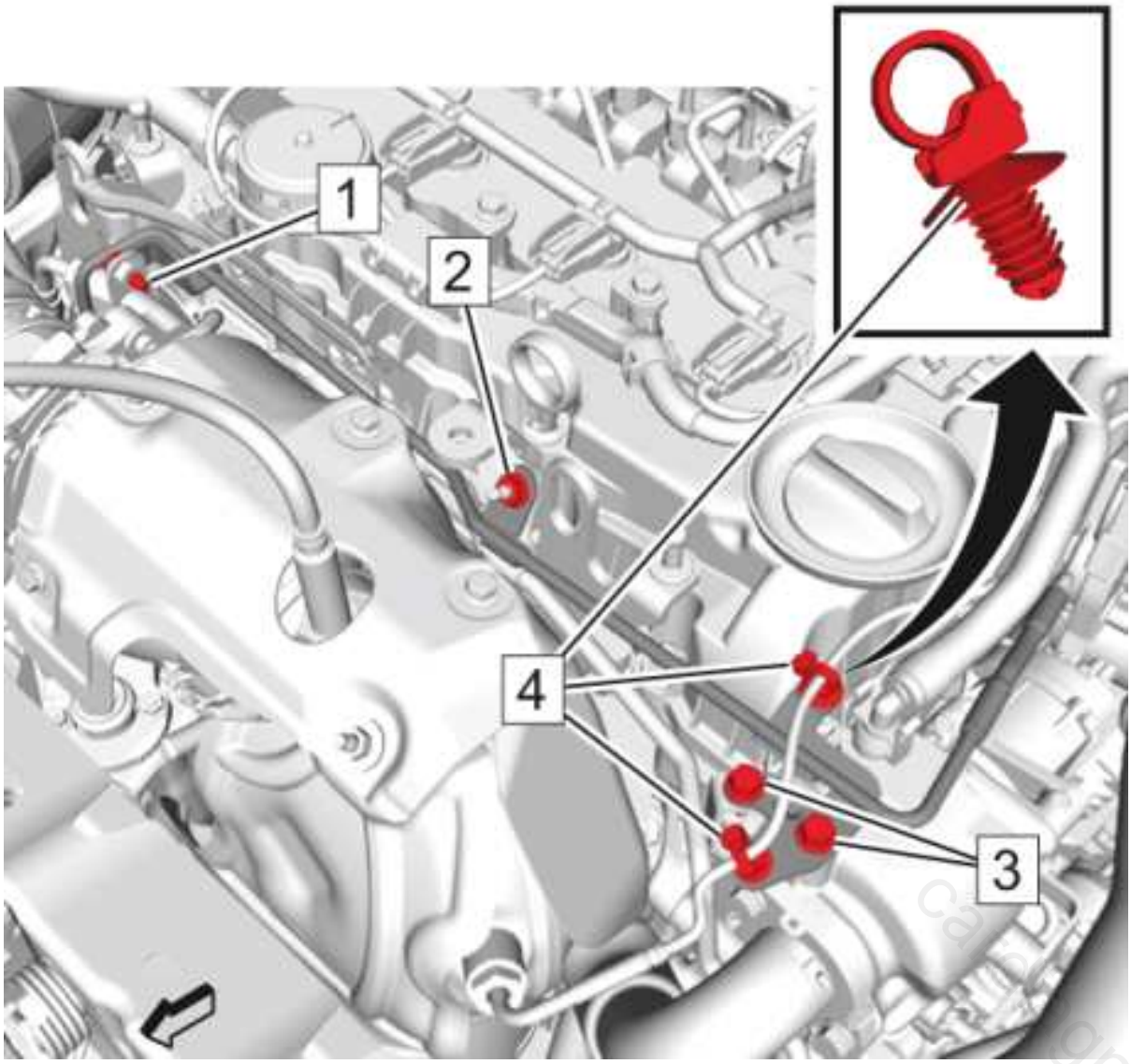

Fig. 416: Turbocharger Wastegate Actuator Pipe Bolts, Nut And Clips
Courtesy of GENERAL MOTORS COMPANY

3. Install the turbocharger wastegate actuator pipe nut (2).

CAUTION: **Refer to Fastener Caution**

4. Install and tighten Turbocharger Wastegate Actuator Pipe Bolts (1, 3) (Qty: 3) to 10 N.m (89 lb in)
5. Tighten the turbocharger wastegate actuator pipe nut (2) to 10 N.m (89 lb in).
6. Install Wiring Harness Clips (4) (Qty: 2)

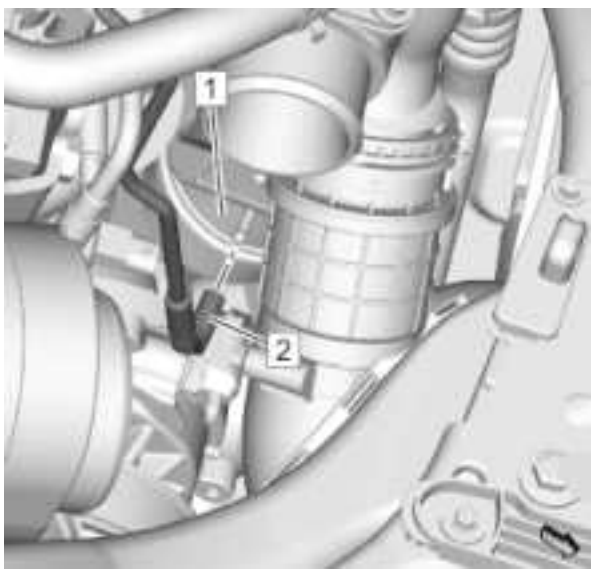

Fig. 417: Turbocharger Wastegate Actuator Pipe And Turbocharger
Courtesy of GENERAL MOTORS COMPANY

7. Install Turbocharger Wastegate Actuator Pipe (2) @ Turbocharger (1)
8. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**
9. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

POWER BRAKE BOOSTER INLET HOSE CONNECTOR FITTING REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
3. Remove the throttle body assembly. Refer to **Throttle Body Assembly Replacement**
4. Remove the exhaust gas recirculation cooler housing. Refer to **Exhaust Gas Recirculation Cooler Housing Replacement**
5. Remove Oxidation Catalytic Converter. Refer to **Oxidation Catalytic Converter Replacement (LH7)**

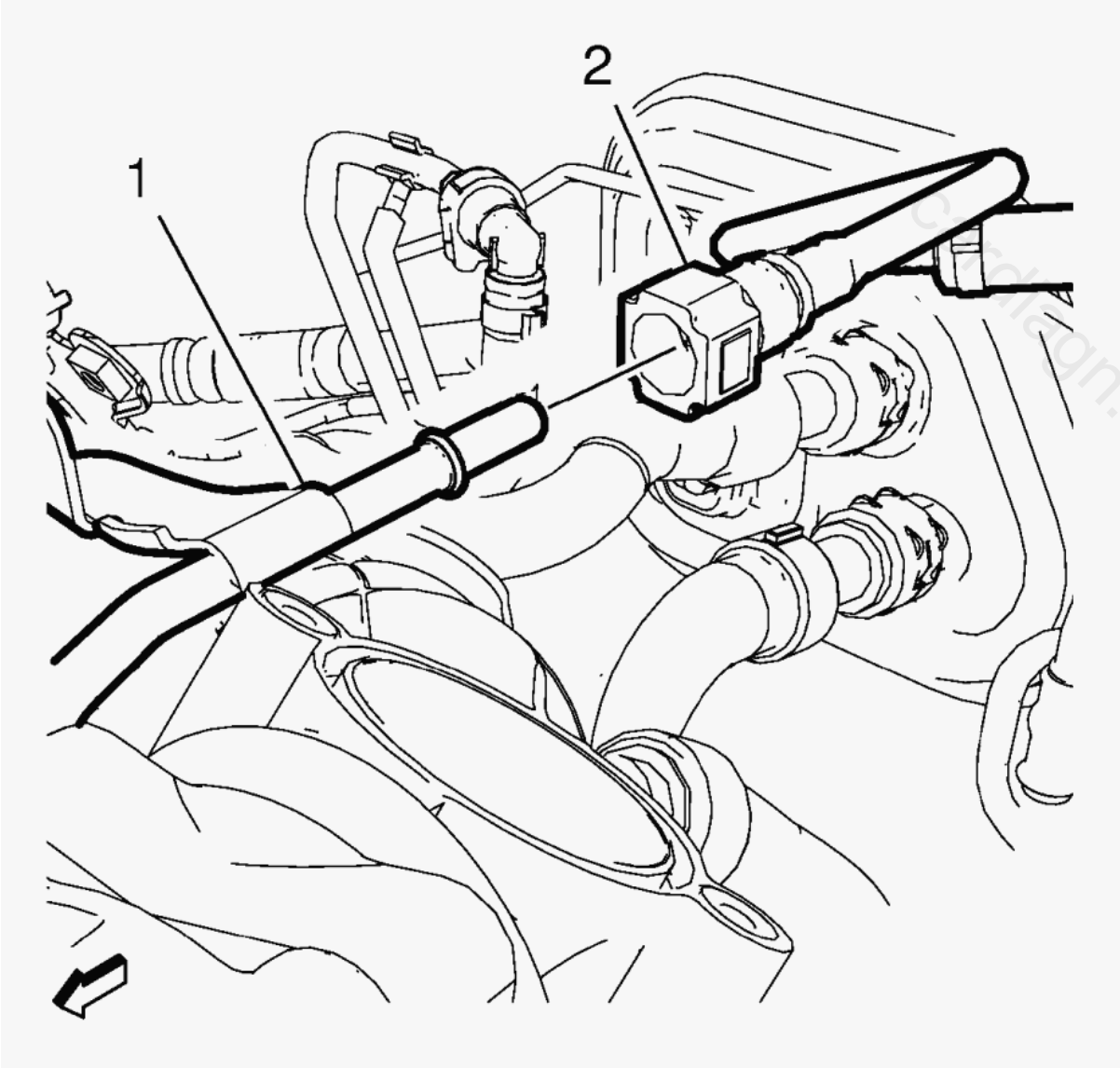

Fig. 418: Power Brake Booster Vacuum Pipe And Power Brake Booster Inlet Hose Fitting
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the power brake booster vacuum pipe (2) from the power brake booster inlet hose fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**

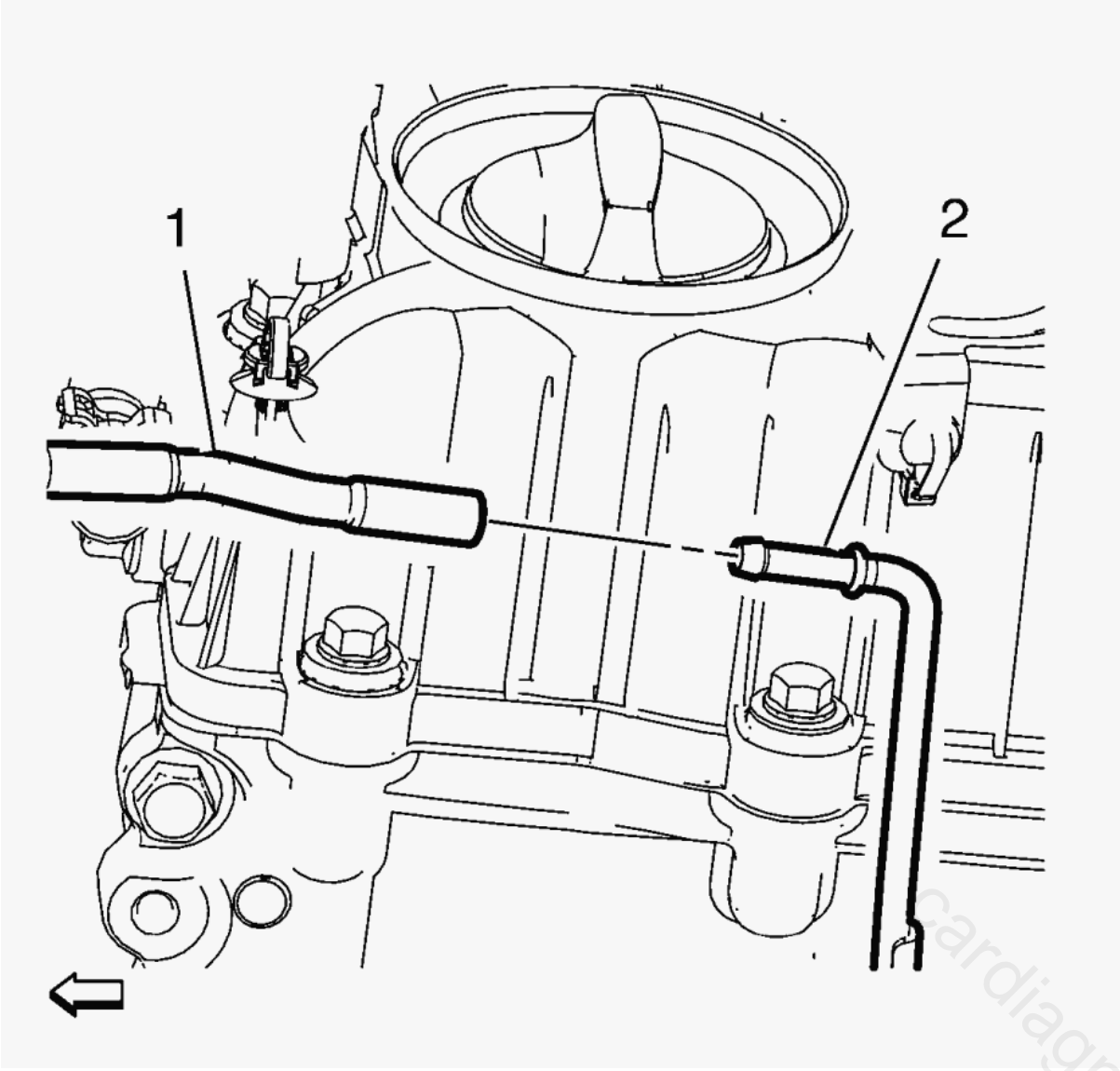

Fig. 419: Power Brake Booster Inlet Hose Connector Fitting And Turbocharger Wastegate Actuator Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Remove the power brake booster inlet hose connector fitting (2) from the turbocharger wastegate actuator pipe (1).

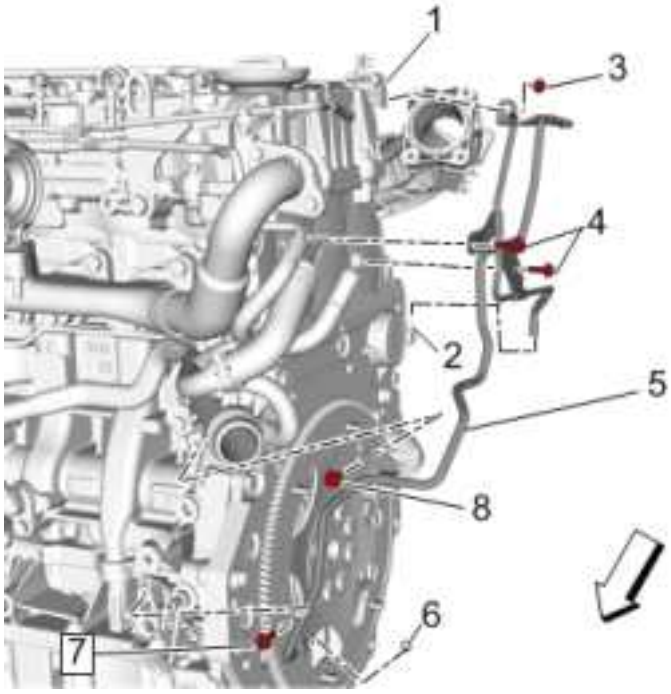

Fig. 420: Power Brake Booster Inlet Hose Connector Fitting And Components
Courtesy of GENERAL MOTORS COMPANY

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8. Remove the power brake booster inlet hose connector fitting bracket bolt (3) from the exhaust temperature sensor wiring harness bracket (1).
9. Remove the 2 power brake booster inlet hose connector fitting bolts (4)
10. Remove the power brake booster inlet hose connector fitting bracket bolt (8) from the engine coolant outlet pipe bracket.
11. Remove the power brake booster inlet hose from the turbocharger wastegate actuator vacuum control solenoid valve (2).
12. Remove Thermostat Bypass Pipe. Refer to **Thermostat Bypass Pipe Replacement (LH7)**
13. Remove Engine Coolant Outlet Pipe. Refer to **Engine Coolant Outlet Pipe Removal**
14. Remove the power brake booster inlet hose connector fitting bolt (7) from the lower crankcase.
15. Remove the power brake booster inlet hose connector fitting (5).
16. Remove the power brake booster inlet hose connector fitting seal (6).

Installation Procedure

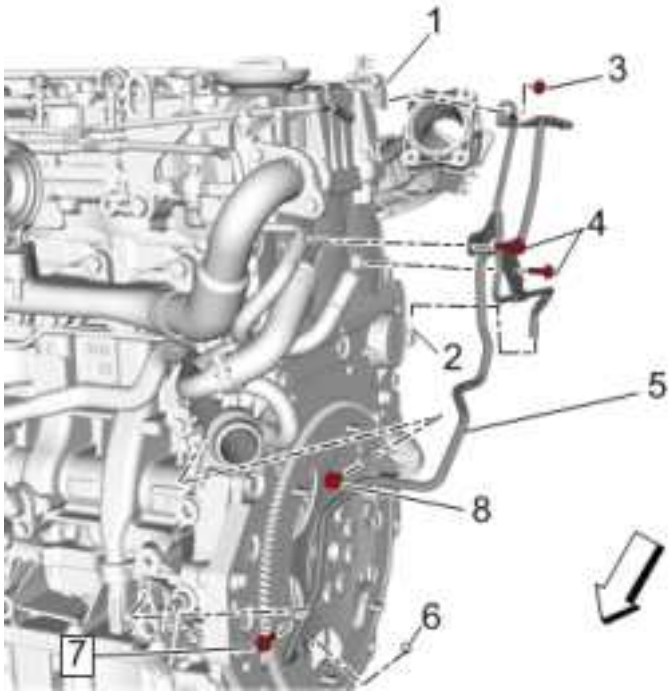

Fig. 421: Power Brake Booster Inlet Hose Connector Fitting And Components
Courtesy of GENERAL MOTORS COMPANY

1. Install the power brake booster inlet hose connector fitting seal (6).
2. Install the power brake booster inlet hose connector fitting (5).

CAUTION: **Refer to Fastener Caution .**

3. Install the power brake booster inlet hose connector fitting bolt (7) to lower crankcase and tighten to 10 N.m (89 lb in).
4. Install the power brake booster inlet hose connector fitting bracket bolt (8) to the engine coolant outlet pipe bracket and tighten to 10 N.m (89 lb in).
5. Install the 2 power brake booster inlet hose connector fitting bolts (4) and tighten to 10 N.m (89 lb in).
6. Install the power brake booster inlet hose to the turbocharger wastegate actuator vacuum control solenoid valve (2).
7. Install Thermostat Bypass Pipe. Refer to **Thermostat Bypass Pipe Replacement (LH7)**
8. Install Engine Coolant Outlet Pipe. Refer to **Engine Coolant Outlet Pipe Removal**
9. Install the power brake booster inlet hose connector fitting bracket bolt (3) to the exhaust temperature sensor wiring harness bracket (1) and tighten to 10 N.m (89 lb in).

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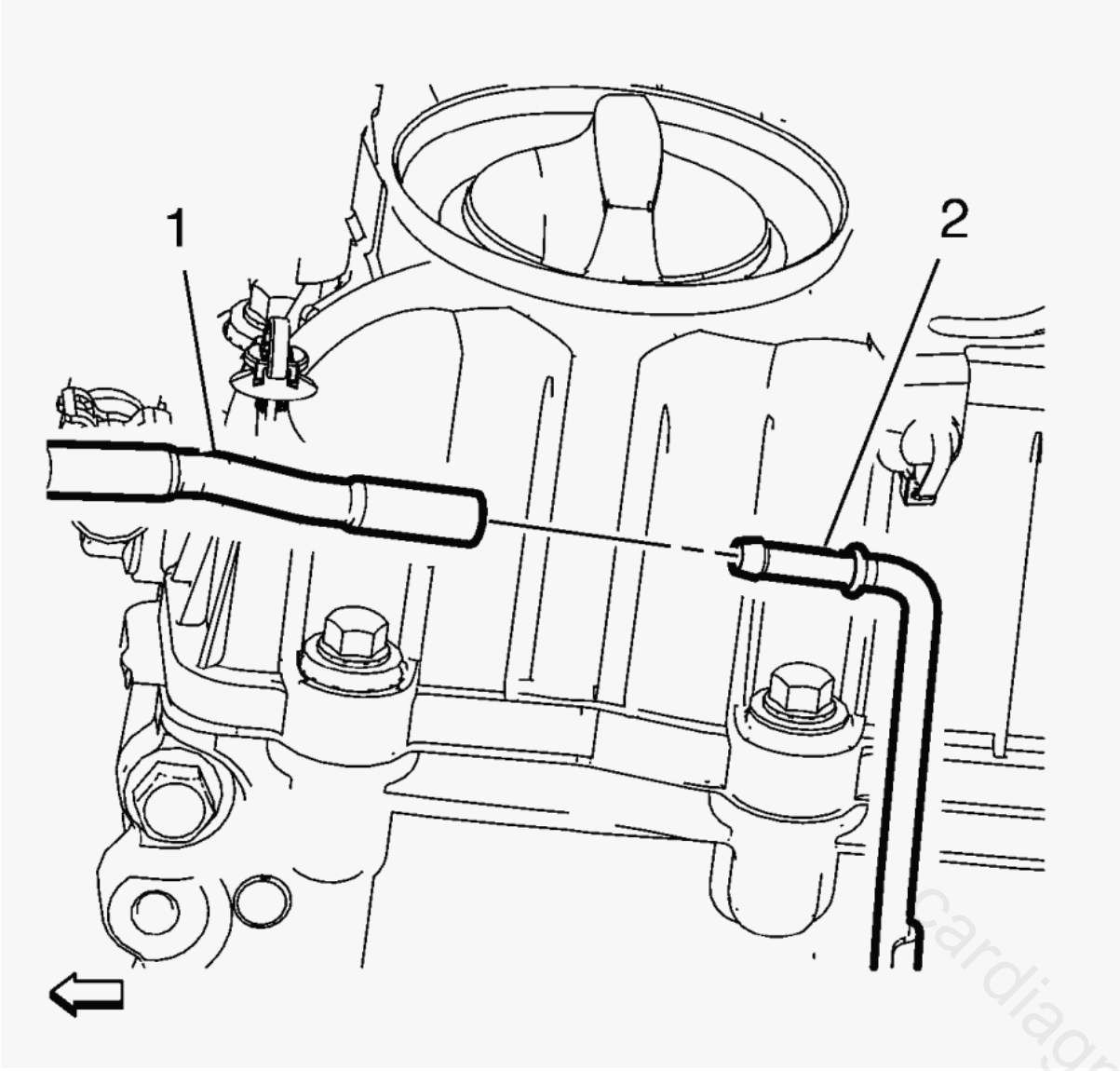

Fig. 422: Power Brake Booster Inlet Hose Connector Fitting And Turbocharger Wastegate Actuator Pipe
Courtesy of GENERAL MOTORS COMPANY

10. Install the power brake booster inlet hose connector fitting (2) to the turbocharger wastegate actuator pipe (1).

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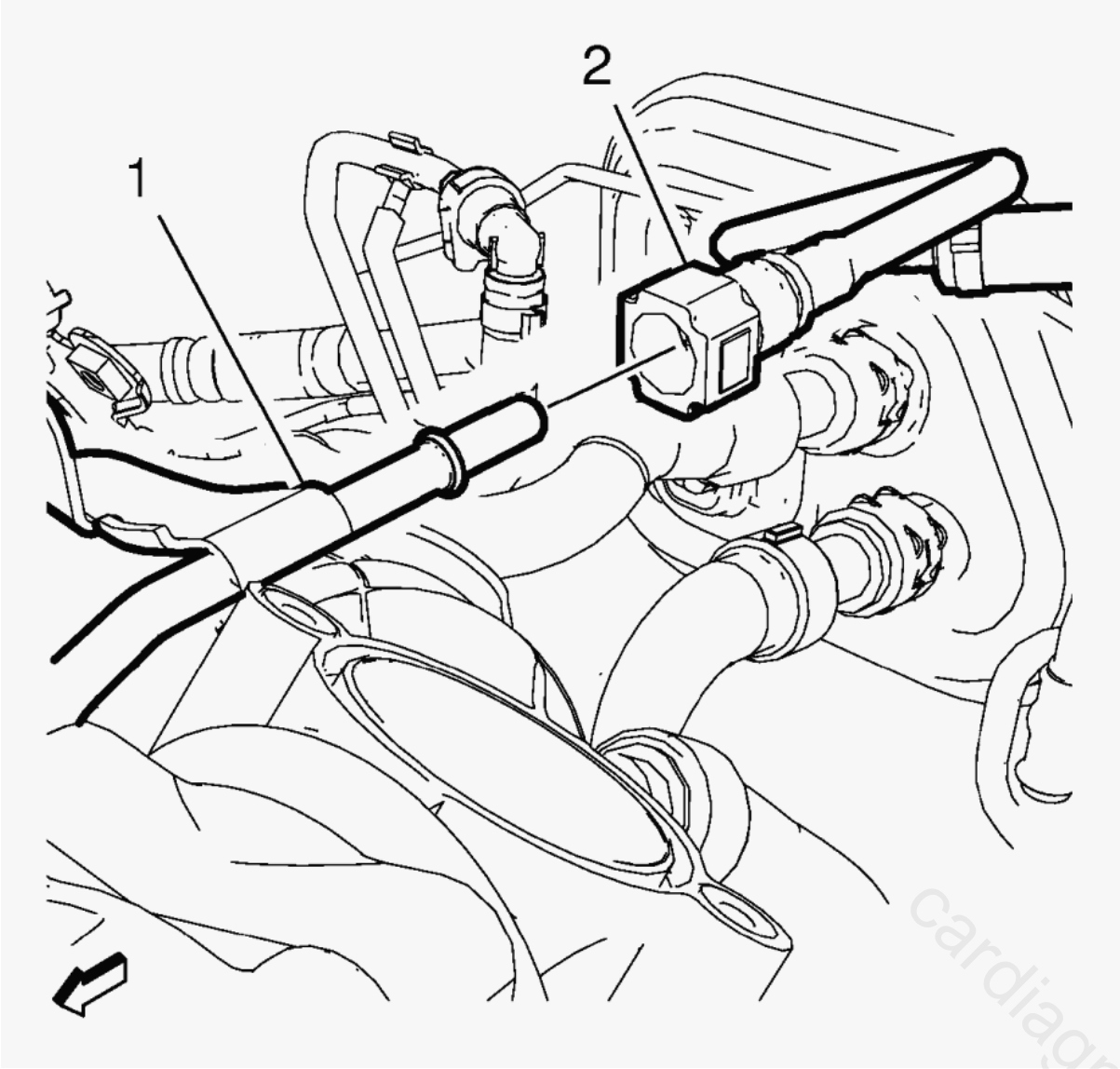

Fig. 423: Power Brake Booster Vacuum Pipe And Power Brake Booster Inlet Hose Fitting
Courtesy of GENERAL MOTORS COMPANY

11. Connect the power brake booster vacuum pipe (2) to the power brake booster inlet hose fitting (1). Refer to **Plastic Collar Quick Connect Fitting Service**
12. Install Oxidation Catalytic Converter. Refer to **Oxidation Catalytic Converter Replacement (LH7)**
13. Install the exhaust gas recirculation cooler housing. Refer to **Exhaust Gas Recirculation Cooler Housing Replacement**
14. Install the throttle body assembly. Refer to **Throttle Body Assembly Replacement**
15. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
16. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

CHARGE AIR BYPASS VALVE VACUUM HOSE REPLACEMENT

Removal Procedure

1. Disconnect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

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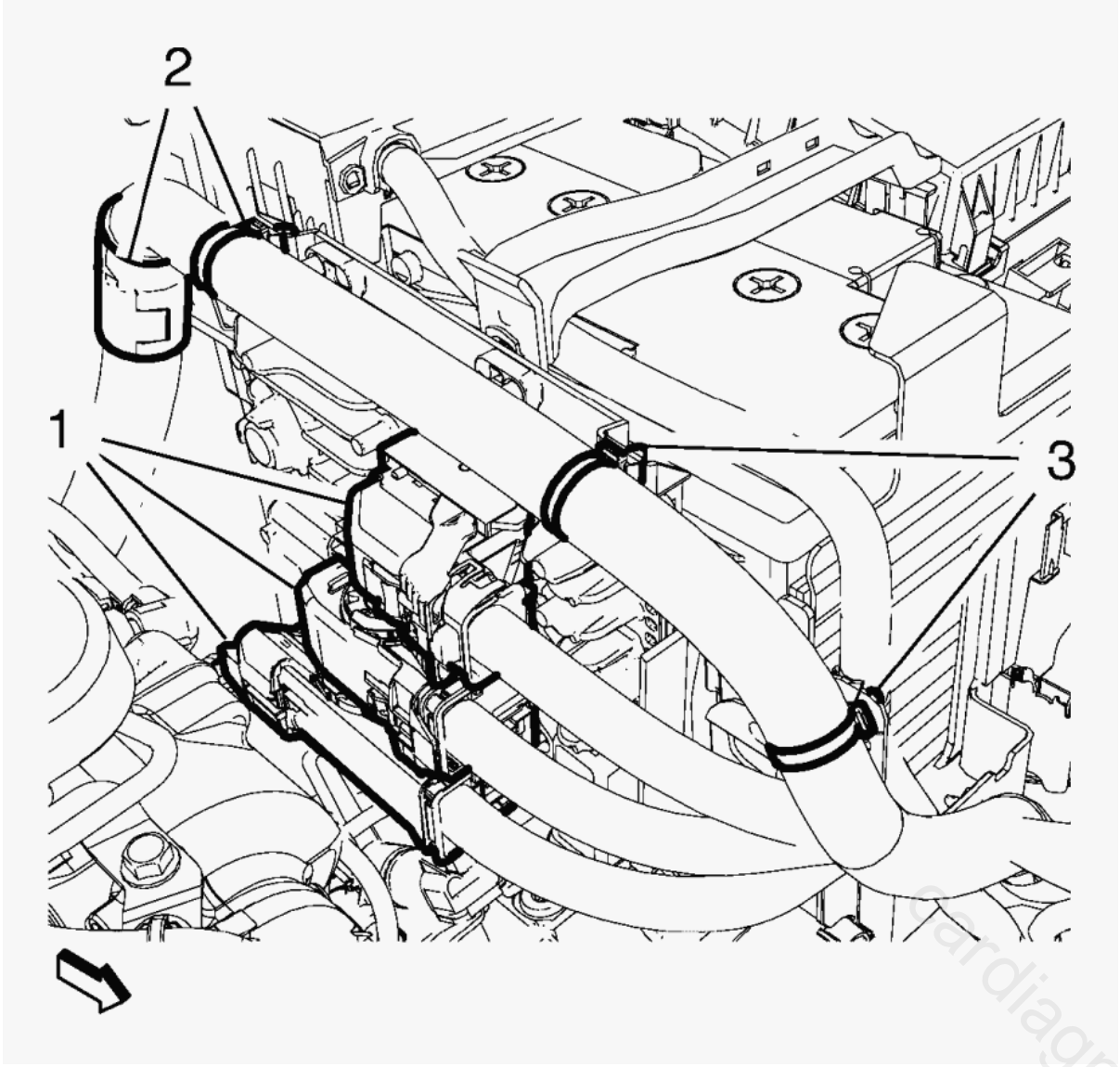

Fig. 424: Engine Control Module Electrical Connectors And Harness Clips
Courtesy of GENERAL MOTORS COMPANY

3. Unclip the 4 wiring harness clips (2, 3) from the bracket.
4. Remove the engine control module bracket along with the engine control module in top direction from the battery tray.
5. Disconnect the 3 engine control module electrical connectors (1) from the engine control module and hang it aside.

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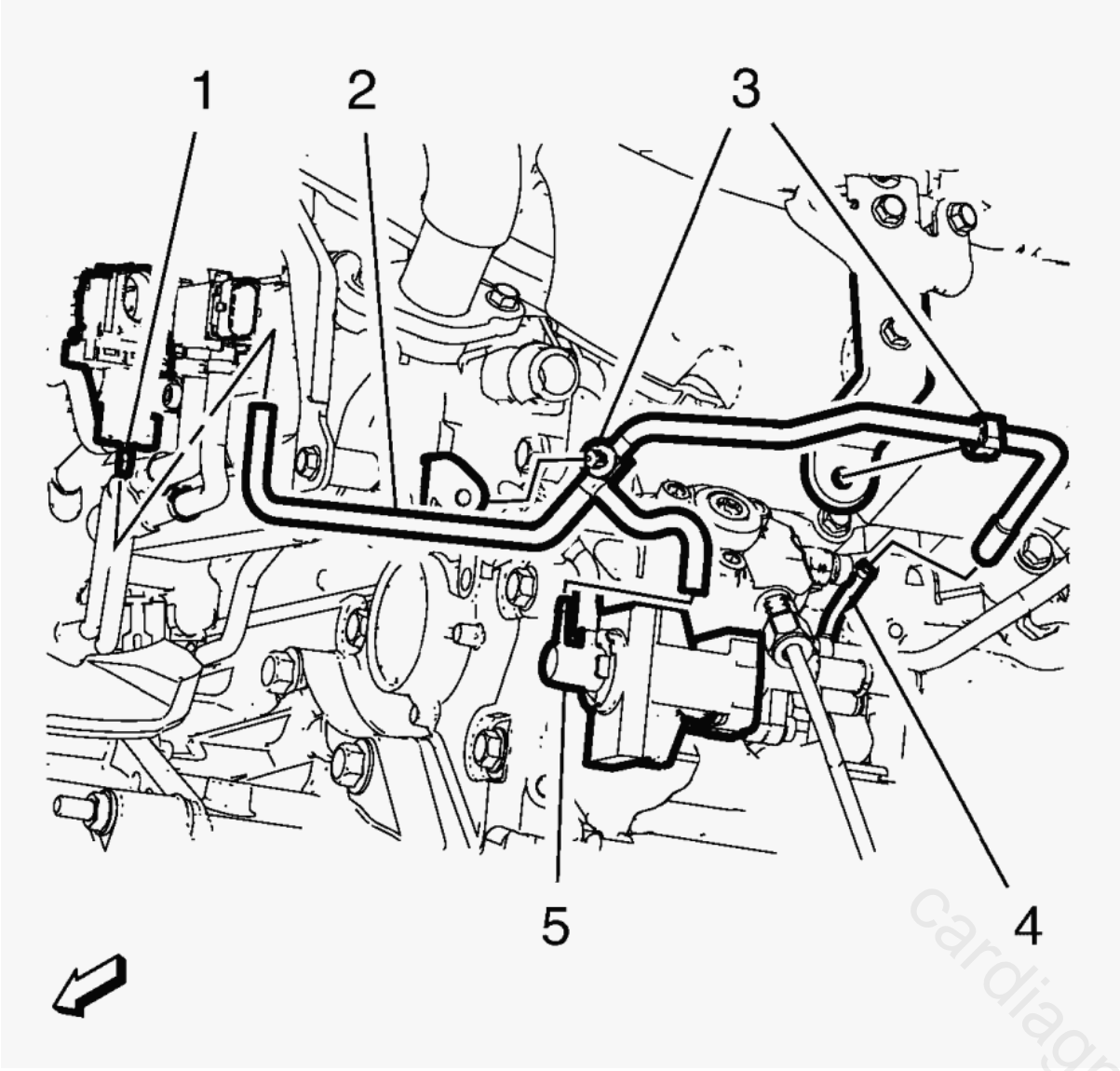

Fig. 425: Charge Air Bypass Valve Vacuum Hose And Components
Courtesy of GENERAL MOTORS COMPANY

6. Remove the charge air bypass valve vacuum hose (2) from the exhaust gas recirculation vacuum regulator solenoid valve (1).
7. Remove the charge air bypass valve vacuum hose (2) from the turbocharger wastegate actuator vacuum control solenoid valve (5).
8. Remove the charge air bypass valve vacuum hose (2) from the charge air bypass regulator solenoid valve vacuum tube (4).
9. Unclip the charge air bypass valve vacuum hose (2) clips from the brackets (3).
10. Remove the charge air bypass valve vacuum hose (2).

Installation Procedure

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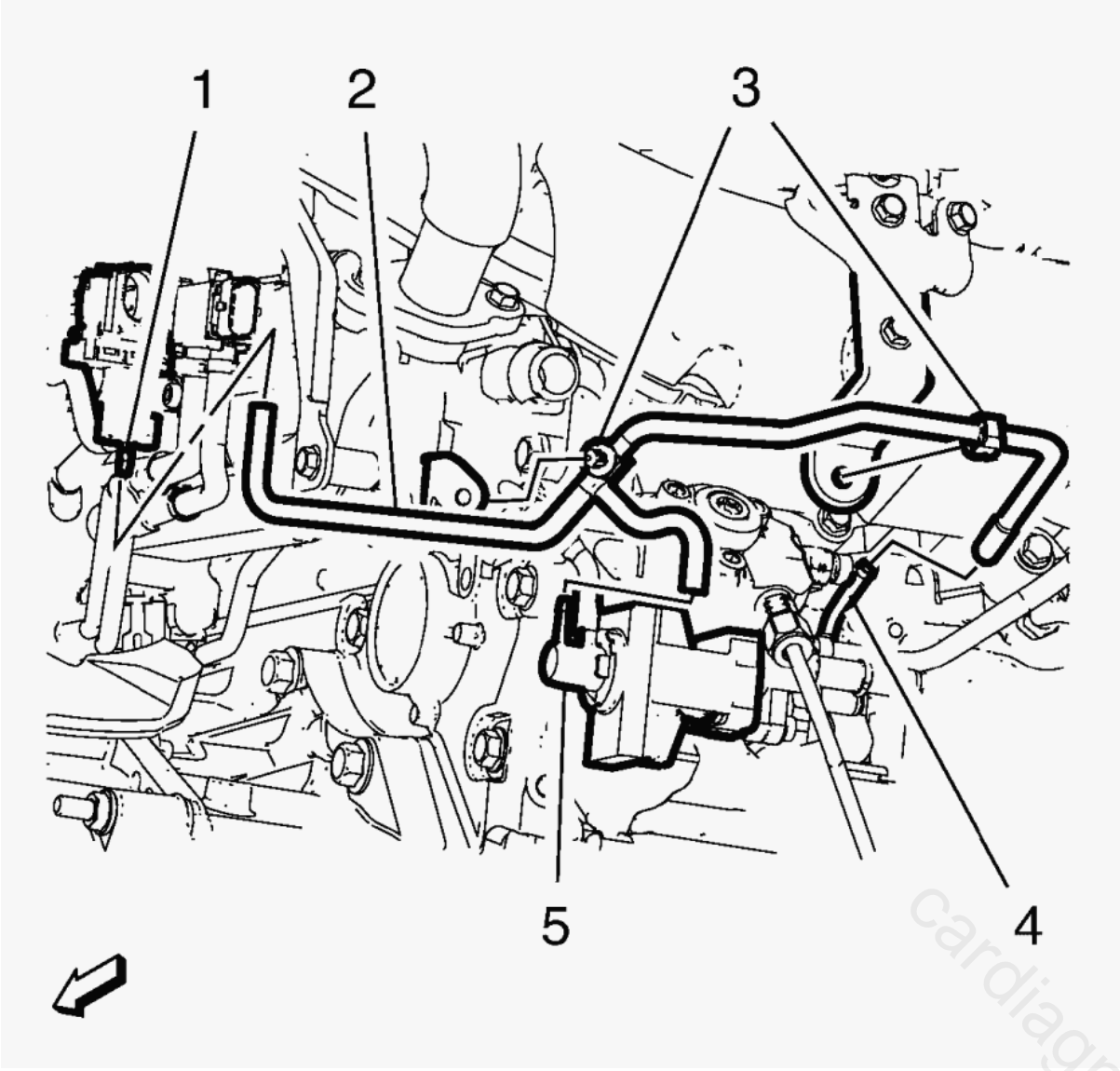

Fig. 426: Charge Air Bypass Valve Vacuum Hose And Components
Courtesy of GENERAL MOTORS COMPANY

1. Install the charge air bypass valve vacuum hose (2).
2. Clip in the charge air bypass valve vacuum hose (2) clips to the brackets (3).
3. Install the charge air bypass valve vacuum hose (2) to the charge air bypass regulator solenoid valve vacuum tube (4).
4. Install the charge air bypass valve vacuum hose (2) to the turbocharger wastegate actuator vacuum control solenoid valve (5).
5. Install the charge air bypass valve vacuum hose (2) to the exhaust gas recirculation vacuum regulator solenoid valve (1).

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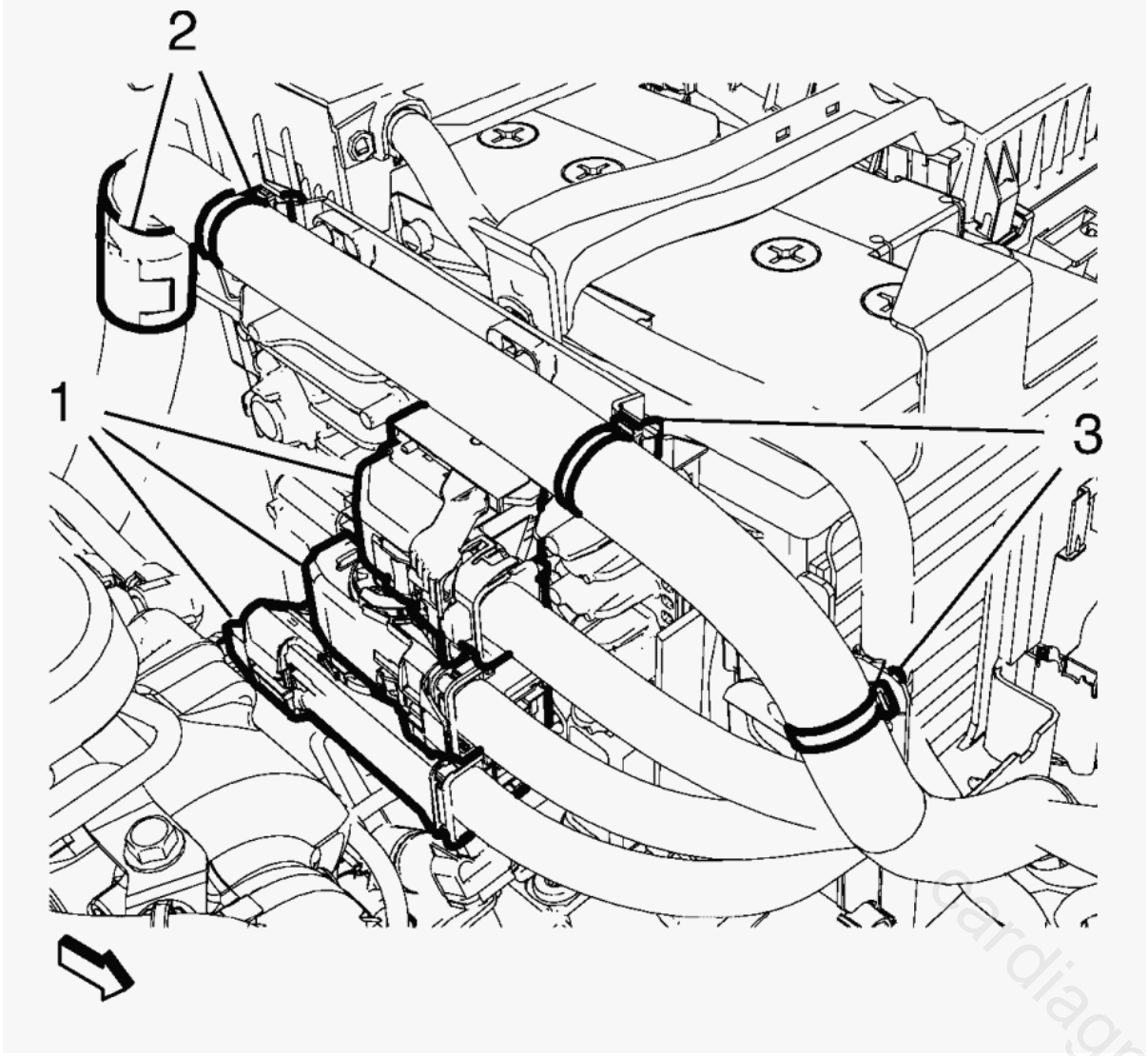

Fig. 427: Engine Control Module Electrical Connectors And Harness Clips
Courtesy of GENERAL MOTORS COMPANY

6. Connect the 3 engine control module electrical connectors (1) from the engine control module.
7. Install the engine control module bracket along with the engine control module in down direction to the battery tray.
8. Clip in the 4 wiring harness clips (2, 3) to the bracket.
9. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
10. Connect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

EXHAUST PRESSURE DIFFERENTIAL SENSOR PIPE REPLACEMENT

Removal Procedure

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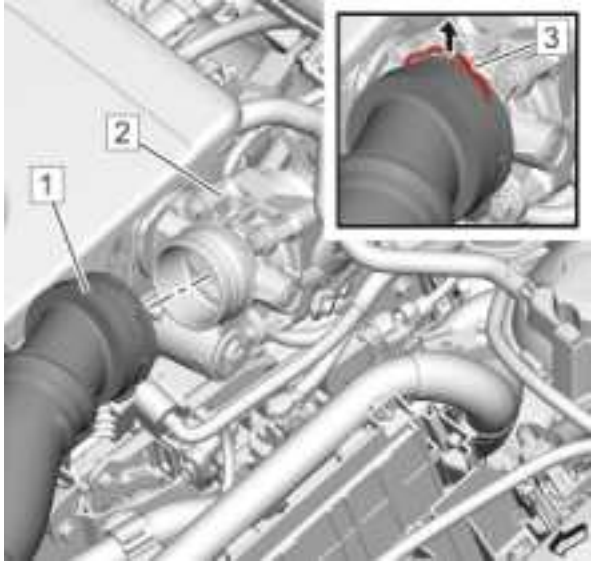

Fig. 428: Charge Air Cooler Outlet Air Hose, Throttle Body And Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Loosen Quick Connector Clamp (3)
2. Remove Charge Air Cooler Outlet Air Hose (1) @ Throttle Body (2)

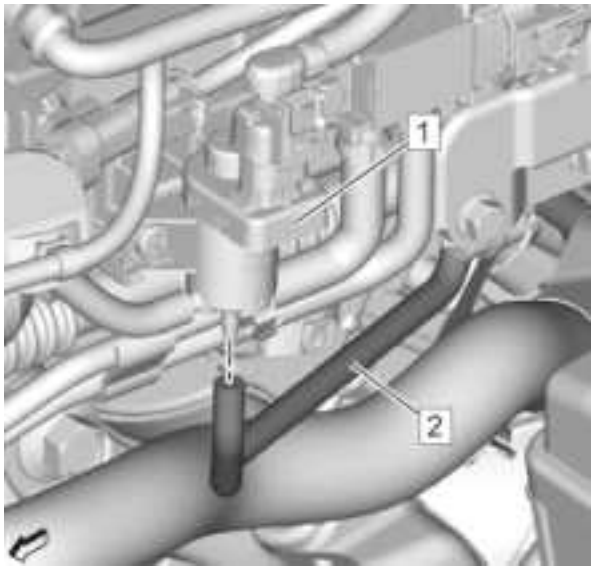

Fig. 429: Charge Air Bypass Regulator Solenoid Valve Inlet Tube And Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

3. Remove the charge air bypass regulator solenoid valve vacuum tube (2) from the exhaust gas recirculation (EGR) valve regulator solenoid valve (1).

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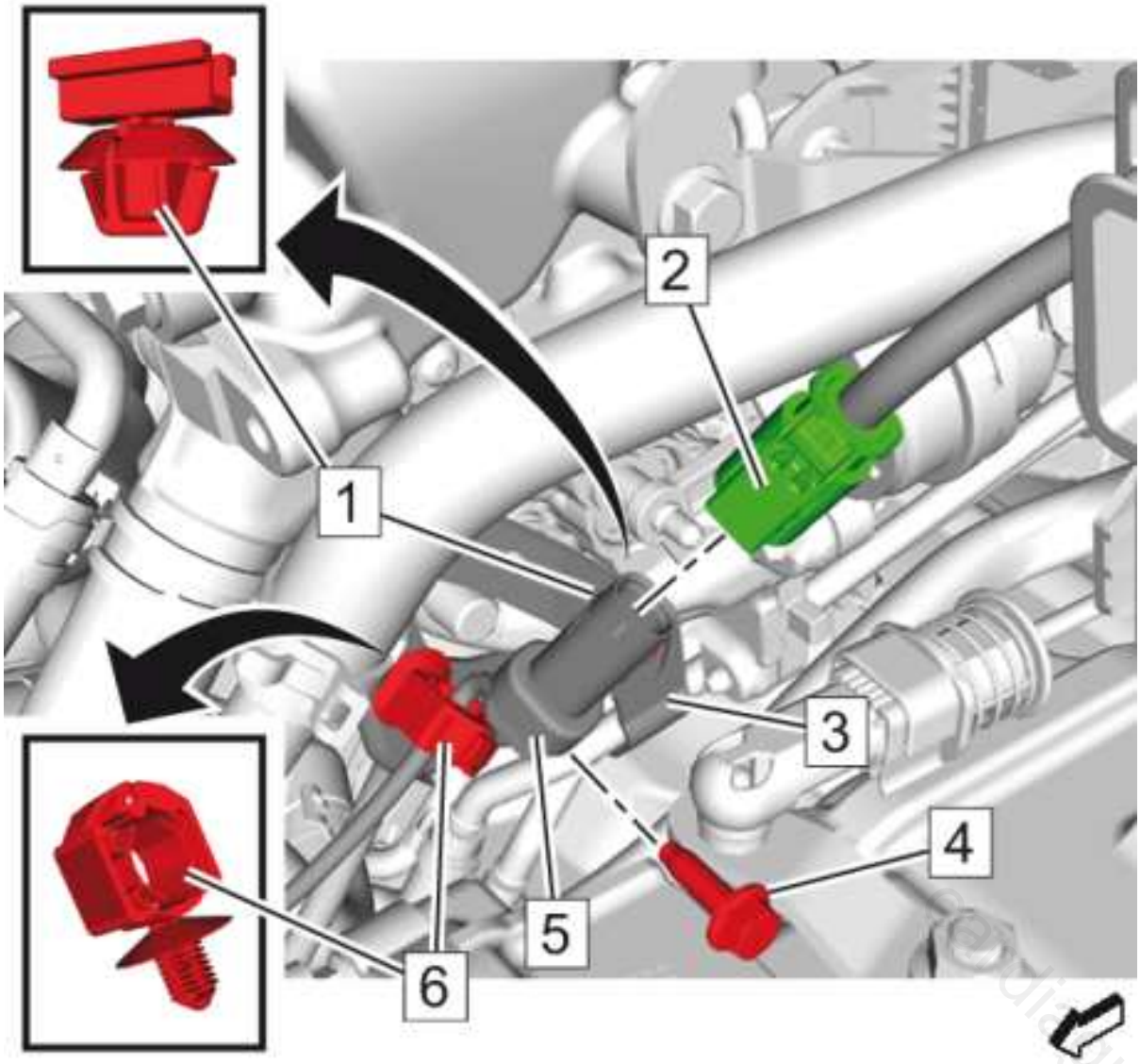

Fig. 430: Exhaust Temperature Sensor, Electrical Connector, Bracket, Bolts And Clips
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Exhaust Temperature Sensor Electrical Connector (2)
5. Remove Wiring Harness Clips (1, 6) (Qty: 3) @ Bracket (3)
6. Position aside Exhaust Temperature Sensor - Position 2 (5)
7. Remove Exhaust Pressure Differential Sensor Bracket Bolt (4)

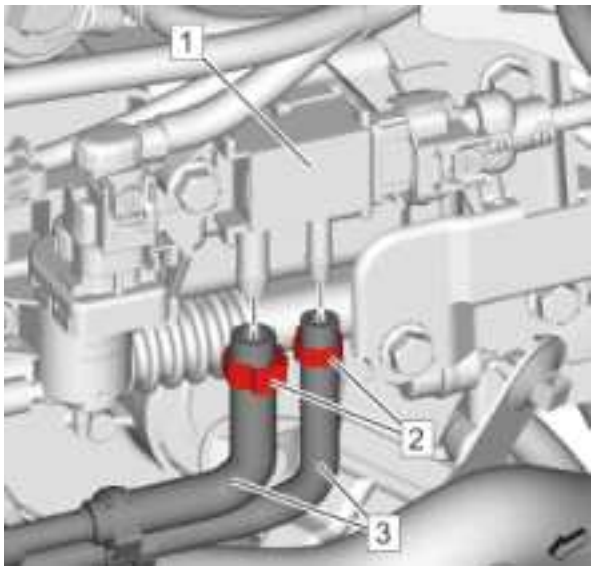

Fig. 431: Exhaust Pressure Differential Sensor, Hoses And Clamps
Courtesy of GENERAL MOTORS COMPANY

8. Remove and DISCARD Clamps (2) (Qty: 2)

NOTE: **Mind the different hose diameters.**

9. Remove the 2 exhaust pressure differential sensor hoses (3) from the exhaust pressure differential sensor (1).
10. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
11. Remove Underbody Front Air Deflector. Refer to **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**

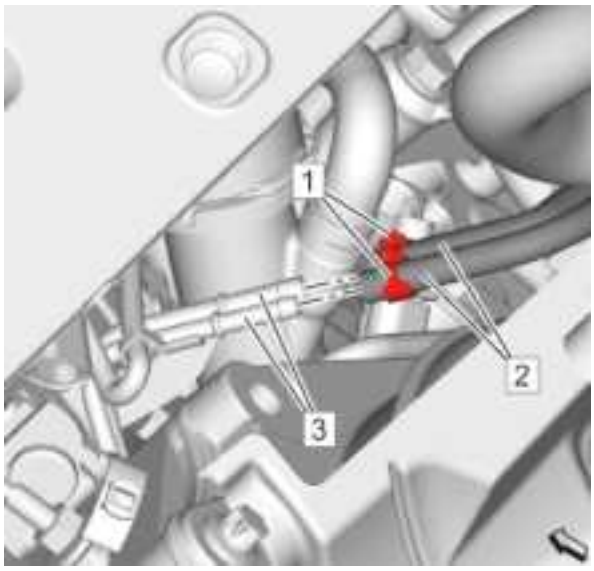

Fig. 432: Exhaust Pressure Differential Sensor Hoses And Pipes
Courtesy of GENERAL MOTORS COMPANY

12. Disengage Clamps (1) (Qty: 2). Refer to **Hose Clamp Replacement Guidelines - Spring Type**

NOTE: **Mind the different hose diameters.**

13. Remove the 2 exhaust pressure differential sensor hoses (2) from the exhaust pressure differential sensor pipes (3).
14. Remove Exhaust Pressure Differential Sensor Pipe
15. Transfer components as necessary.

Installation Procedure

1. Install Exhaust Pressure Differential Sensor Pipe.

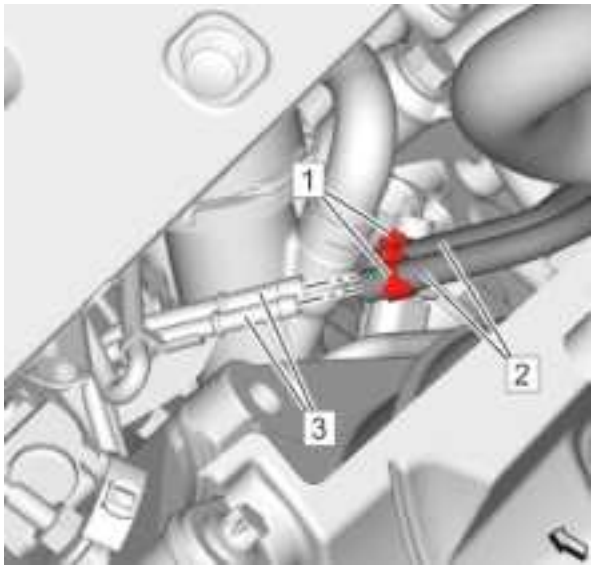

Fig. 433: Exhaust Pressure Differential Sensor Hoses And Pipes
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Mind the different hose diameters.**

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2. Install the 2 exhaust pressure differential sensor hoses (2) to the exhaust pressure differential sensor pipes (3).
3. Engage Clamps (1) (Qty: 2). Refer to **Hose Clamp Replacement Guidelines - Spring Type**
4. Install Underbody Front Air Deflector. Refer to **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**
5. Lower the vehicle.

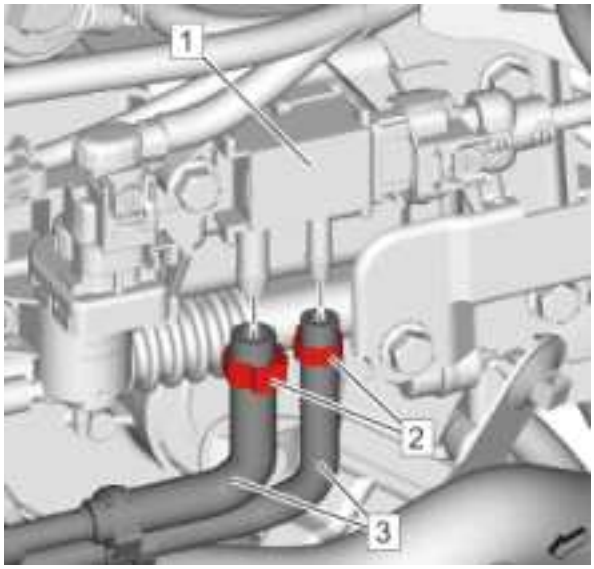

Fig. 434: Exhaust Pressure Differential Sensor, Hoses And Clamps
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Mind the different hose diameters.**

6. Install the 2 exhaust pressure differential sensor hoses (3) to the exhaust pressure differential sensor (1).
7. Install NEW Clamps (2) (Qty: 2)

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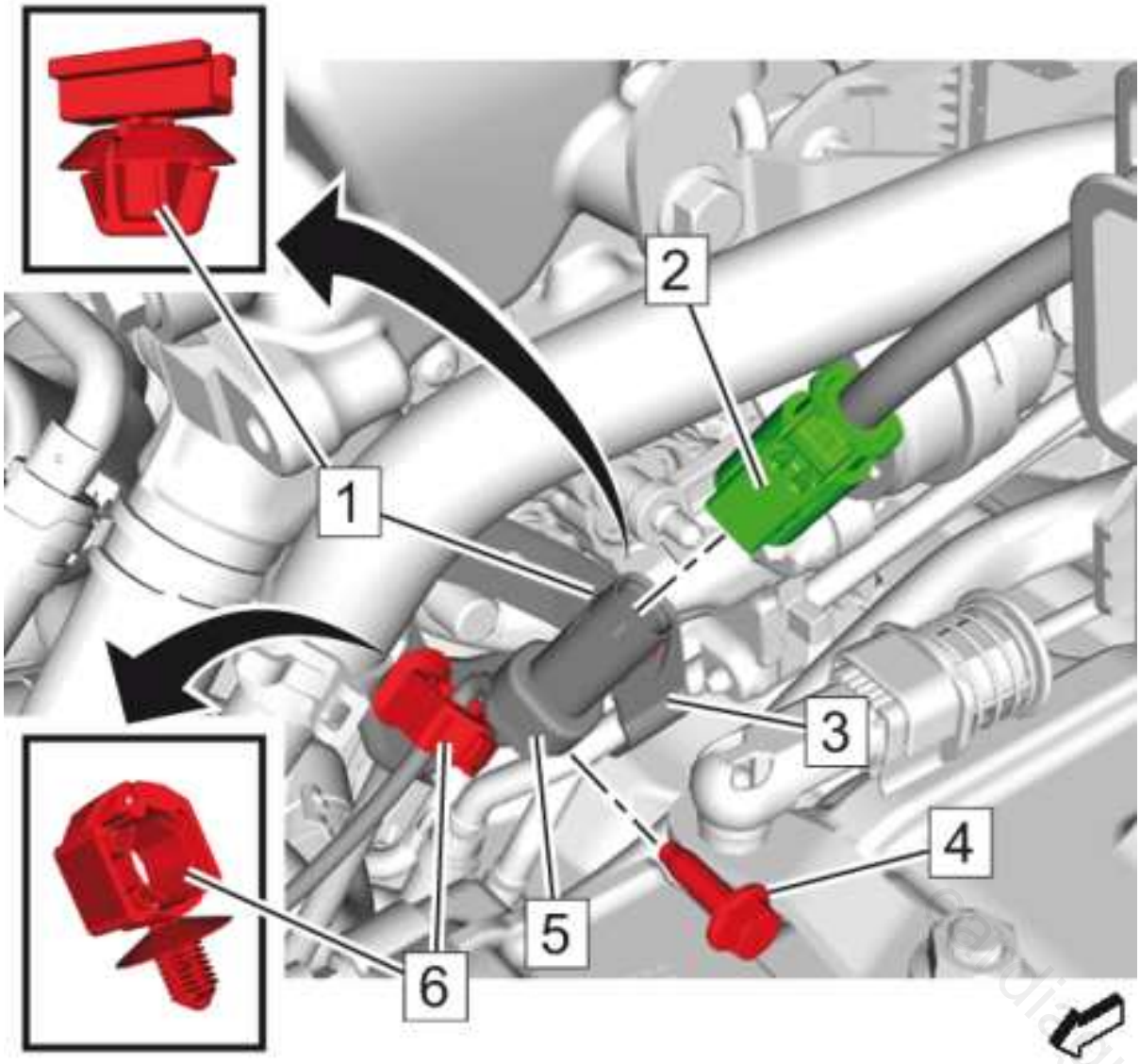

Fig. 435: Exhaust Temperature Sensor, Electrical Connector, Bracket, Bolts And Clips
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

8. Install and tighten Exhaust Pressure Differential Sensor Bracket Bolt (4) to 9 N.m (80 lb in)
9. Reposition Exhaust Temperature Sensor - Position 2 (5)
10. Install Wiring Harness Clips (1, 6) (Qty: 2) @ Bracket (3)
11. Connect Exhaust Temperature Sensor Electrical Connector (2)

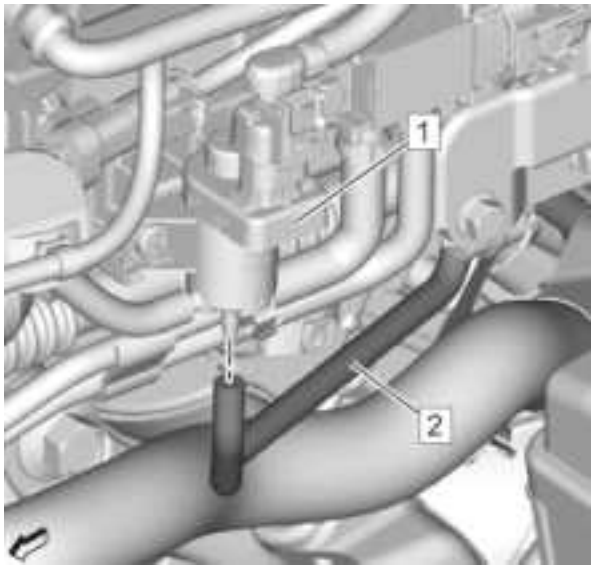

Fig. 436: Charge Air Bypass Regulator Solenoid Valve Inlet Tube And Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve

Courtesy of GENERAL MOTORS COMPANY

12. Install the charge air bypass regulator solenoid valve vacuum tube (2) to the exhaust gas recirculation (EGR) valve regulator solenoid valve (1).

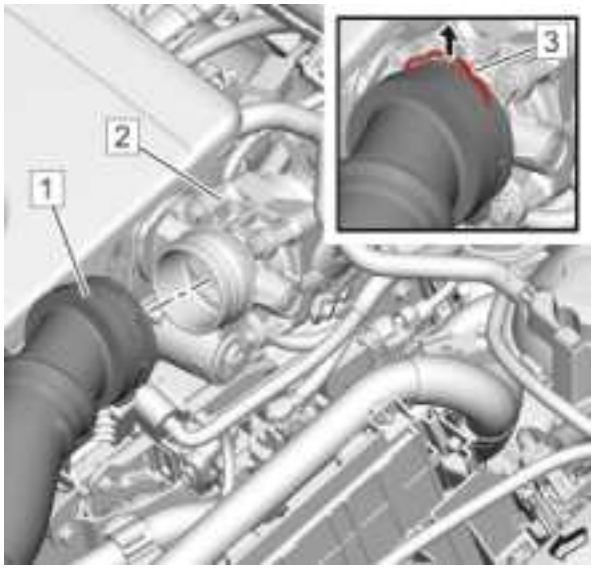

Fig. 437: Charge Air Cooler Outlet Air Hose, Throttle Body And Clamp
Courtesy of GENERAL MOTORS COMPANY

13. Install Charge Air Cooler Outlet Air Hose (1) @ Throttle Body (2)
14. Install Quick Connector Clamp (3)

ENGINE OIL PRESSURE SENSOR REPLACEMENT (FWD)

Removal Procedure

1. Disconnect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
3. Remove Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**

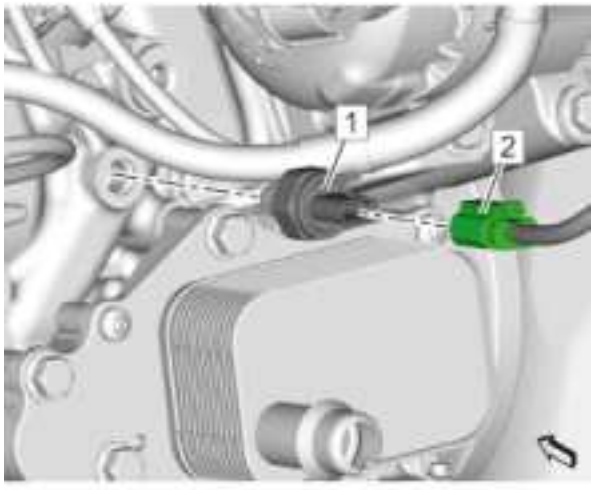

Fig. 438: Engine Oil Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connector. (2)
5. Remove Engine Oil Pressure Sensor (1)

Installation Procedure

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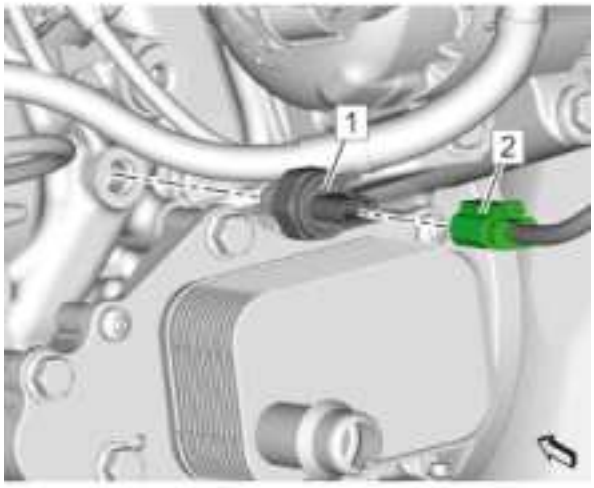

Fig. 439: Engine Oil Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

1. Install and tighten Engine Oil Pressure Sensor (1) to 35 N.m (26 lb ft)
2. Connect the electrical connector. (2)
3. Install Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**
4. Lower the vehicle.
5. Connect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

ENGINE OIL PRESSURE SENSOR REPLACEMENT (AWD)

Removal Procedure

1. Disconnect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
3. Remove Power Transfer Unit Case. Refer to **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**

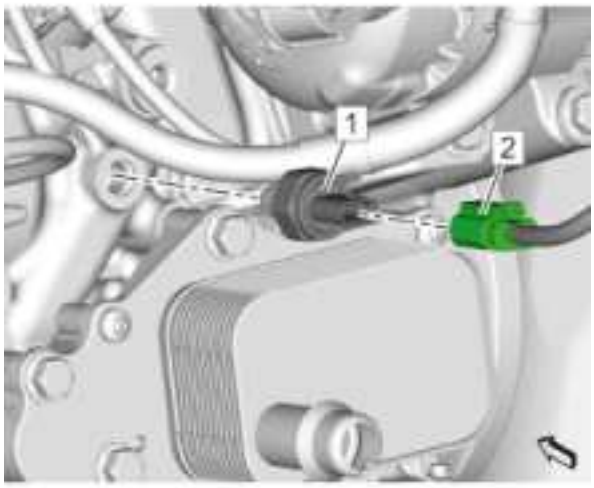

Fig. 440: Engine Oil Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connector. (2)
5. Remove Engine Oil Pressure Sensor (1)

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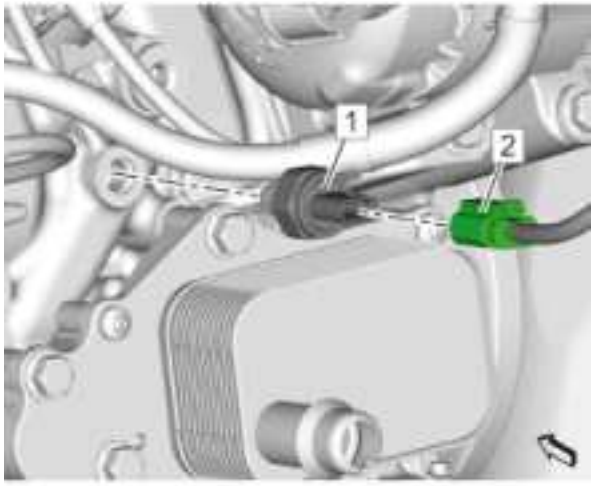

Fig. 441: Engine Oil Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution

1. Install and tighten Engine Oil Pressure Sensor (1) to 35 N.m (26 lb ft)
2. Connect the electrical connector. (2)
3. Install Power Transfer Unit Case. Refer to Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)
4. Lower the vehicle.
5. Connect Battery Negative Cable. Refer to Battery Negative Cable Disconnection and Connection (KL9)

EMISSION REDUCTION FLUID CONTROLLER REPLACEMENT

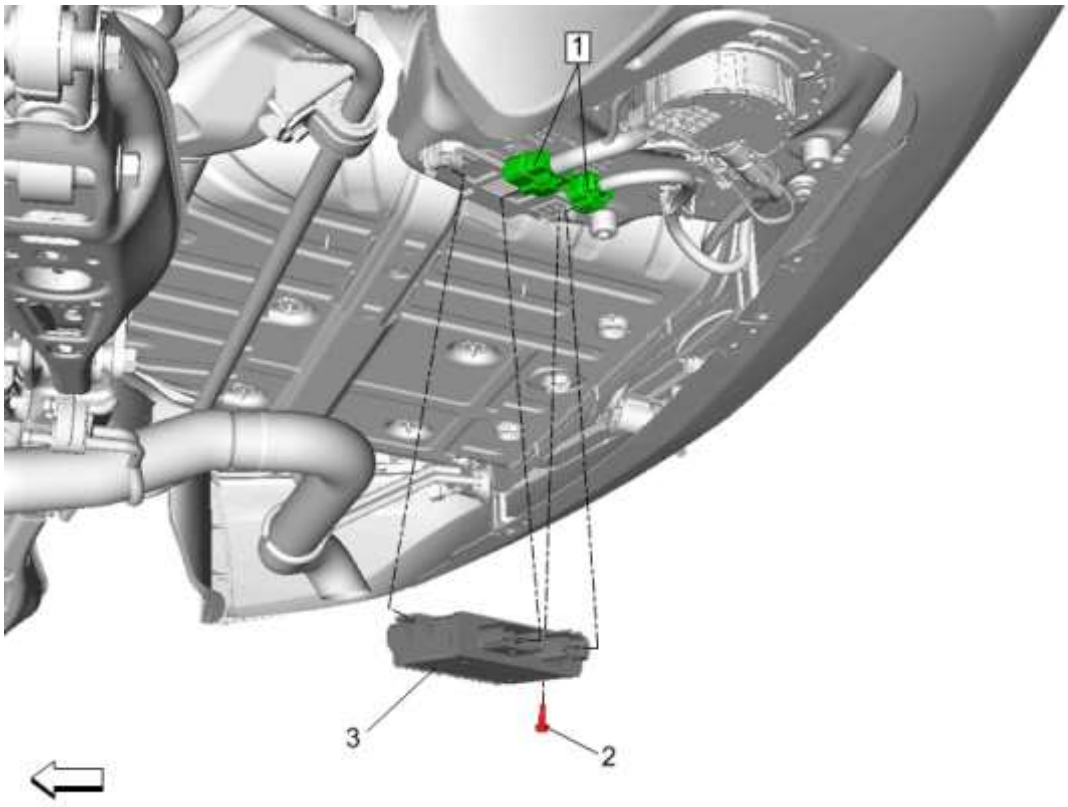

Fig. 442: Emission Reduction Fluid Controller
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

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Callout	Component Name
Preliminary Procedure Remove Emission Reduction Fluid Tank Protector. Refer to **Emission Reduction Fluid Tank Protector Replacement**	
1	Emission Reduction Fluid Pump Module Wiring Harness (Qty: 2)
2	Emission Reduction Fluid Controller Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
3	Emission Reduction Fluid Controller

EMISSION REDUCTION FLUID EXHAUST FRONT PIPE INJECTOR SUPPLY PIPE REPLACEMENT (FWD)

Removal Procedure

1. {If equipped} Remove Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (Front Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**
2. Remove Fuel Tank. Refer to **Fuel Tank Replacement (FWD)**
3. Remove Emission Reduction Fluid Tank. Refer to **Emission Reduction Fluid Tank Replacement**

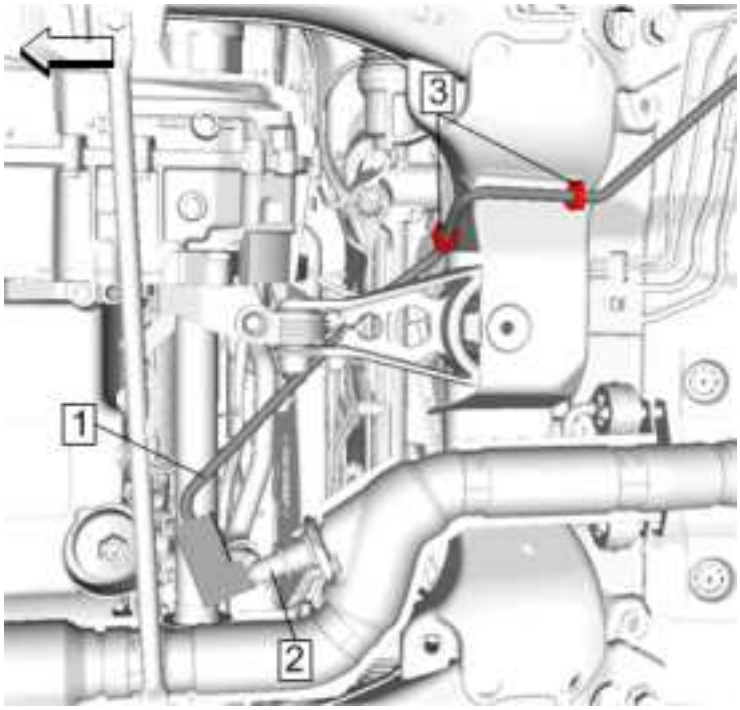

Fig. 443: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe, Emission Reduction Fluid Injector And Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Emission Reduction Fluid Injector (2). Refer to **Plastic Collar Quick Connect Fitting Service**
5. Remove Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (3) (Qty: 2)

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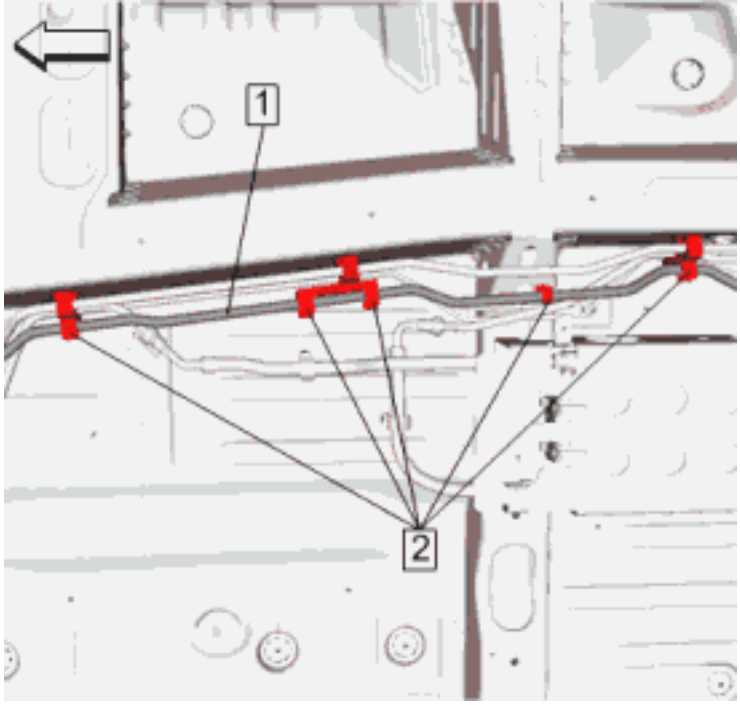

Fig. 444: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

6. Remove Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (2) (Qty: 5)

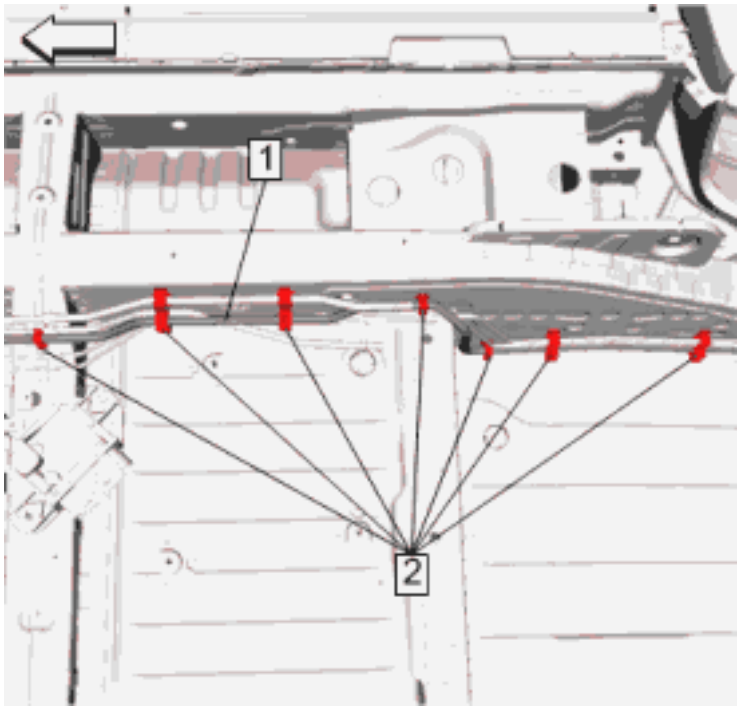

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Fig. 445: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

7. Remove Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (2) (Qty: 7)

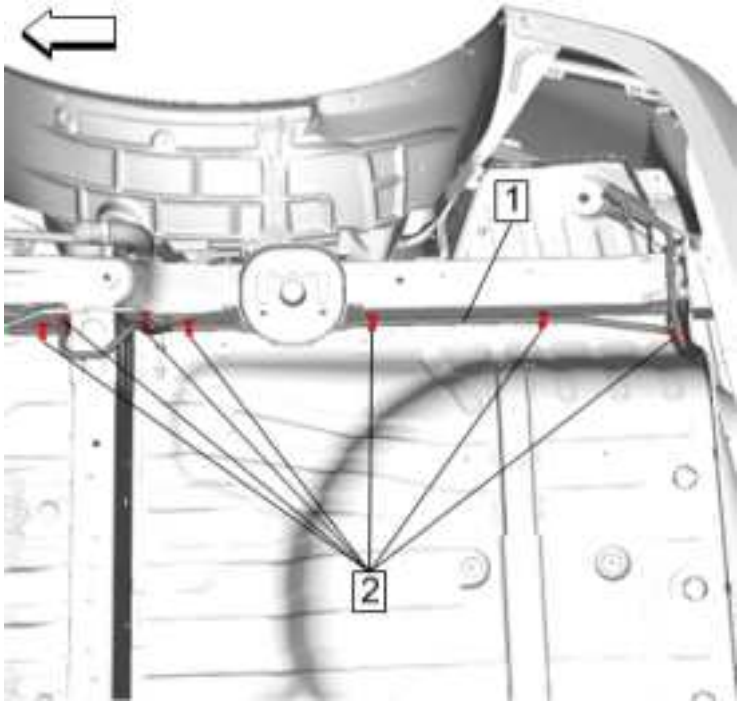

Fig. 446: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

8. Remove Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (2) (Qty: 7)

Installation Procedure

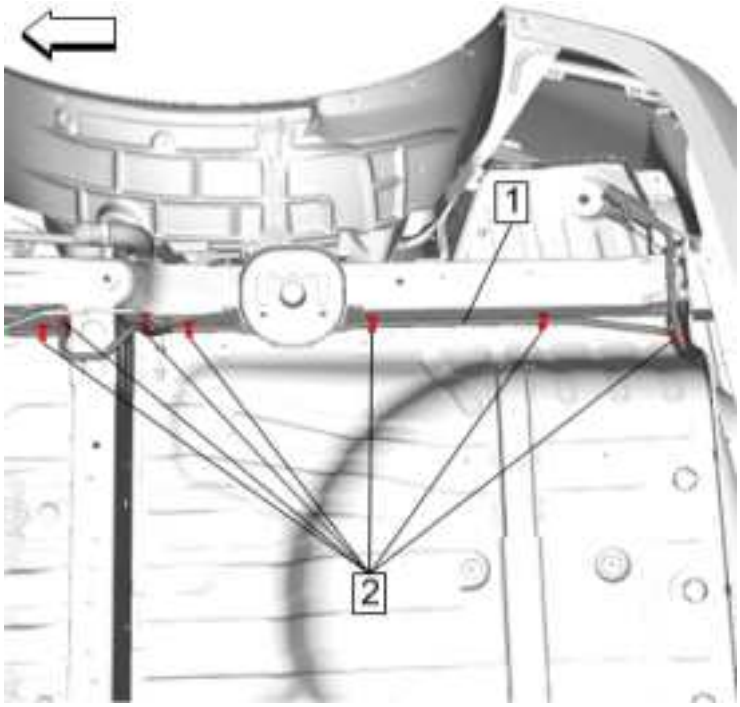

Fig. 447: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (2) (Qty: 7)

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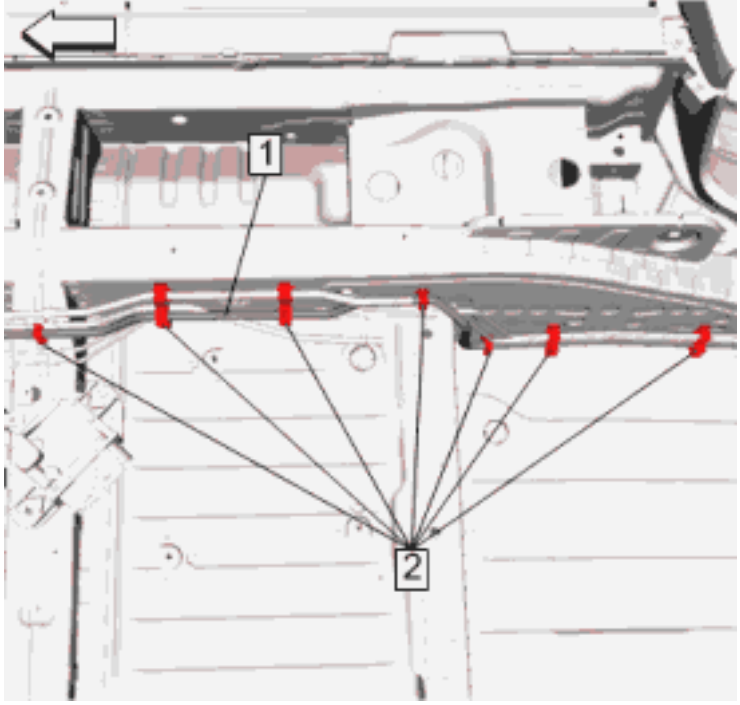

Fig. 448: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Install Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (2) (Qty: 7)

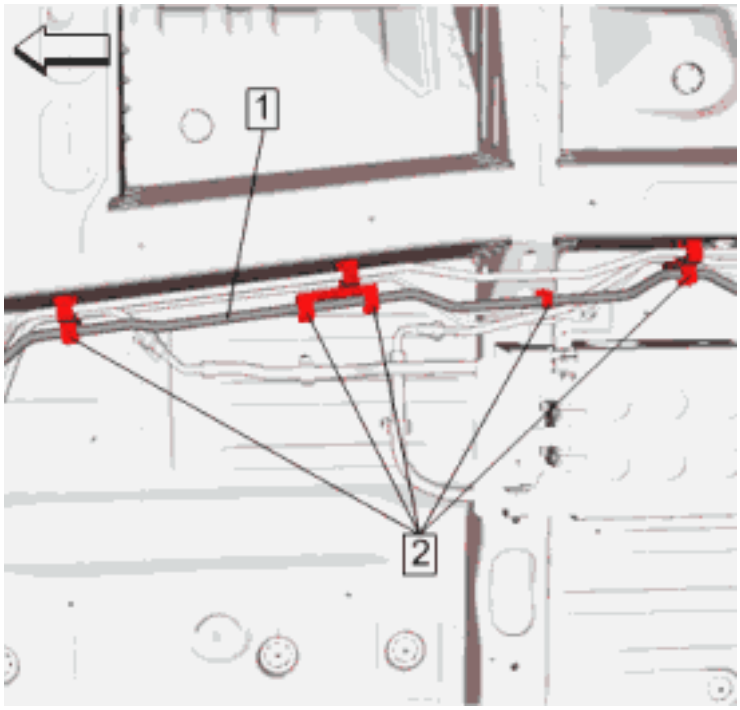

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Fig. 449: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Install Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (2) (Qty: 5)

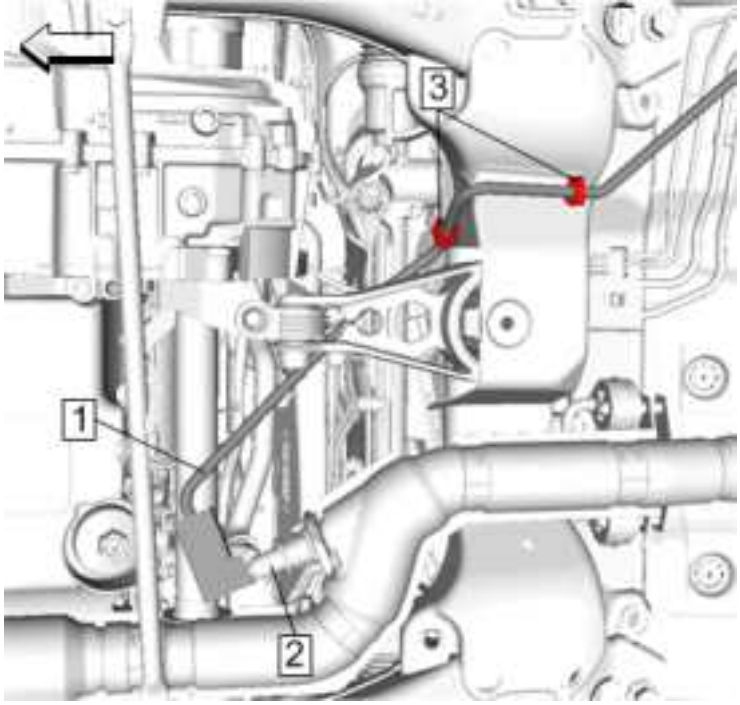

Fig. 450: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe, Emission Reduction Fluid Injector And Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Install Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (3) (Qty: 2)
5. Connect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Emission Reduction Fluid Injector (2). Refer to **Plastic Collar Quick Connect Fitting Service**
6. Install Emission Reduction Fluid Tank. Refer to **Emission Reduction Fluid Tank Replacement**
7. Install Fuel Tank. Refer to **Fuel Tank Replacement (FWD)**
8. {If equipped} Install Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (Front Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

EMISSION REDUCTION FLUID EXHAUST FRONT PIPE INJECTOR SUPPLY PIPE REPLACEMENT (FRONT AWD)

Removal Procedure

1. Remove Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (All Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

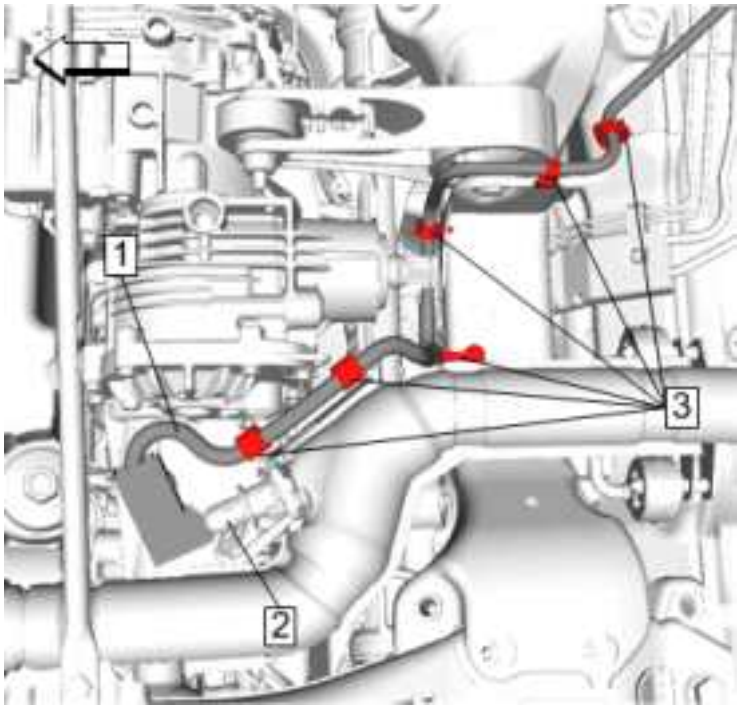

Fig. 451: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe, Emission Reduction Fluid Injector And Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Emission Reduction Fluid Injector (2). Refer to **Plastic Collar Quick Connect Fitting Service**
3. Remove Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1)@ Retainers (3) (Qty: 6)

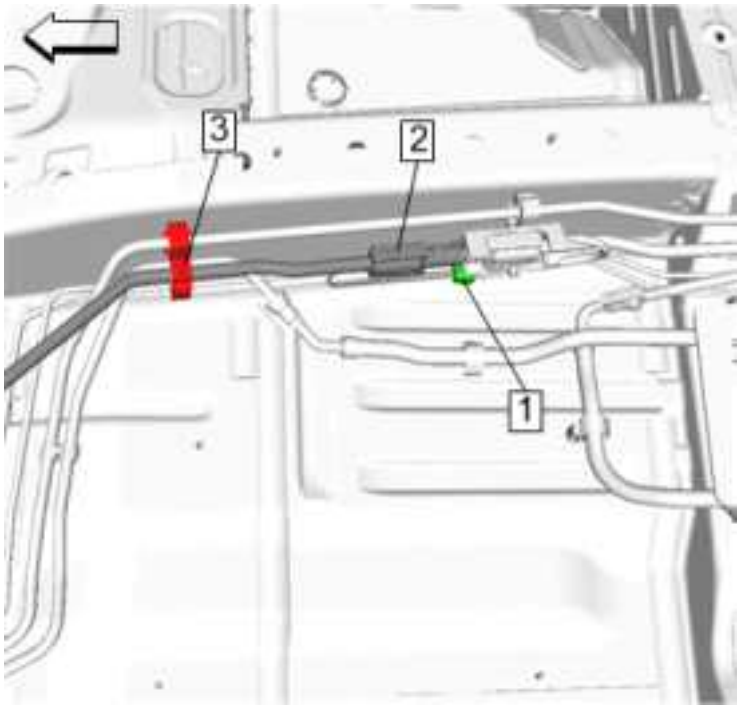

Fig. 452: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe, Electrical Connector And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Electrical Connector (1)
5. Disconnect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (2). Refer to **Plastic Collar Quick Connect Fitting Service**
6. Remove Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (2) @ Retainer (3)

Installation Procedure

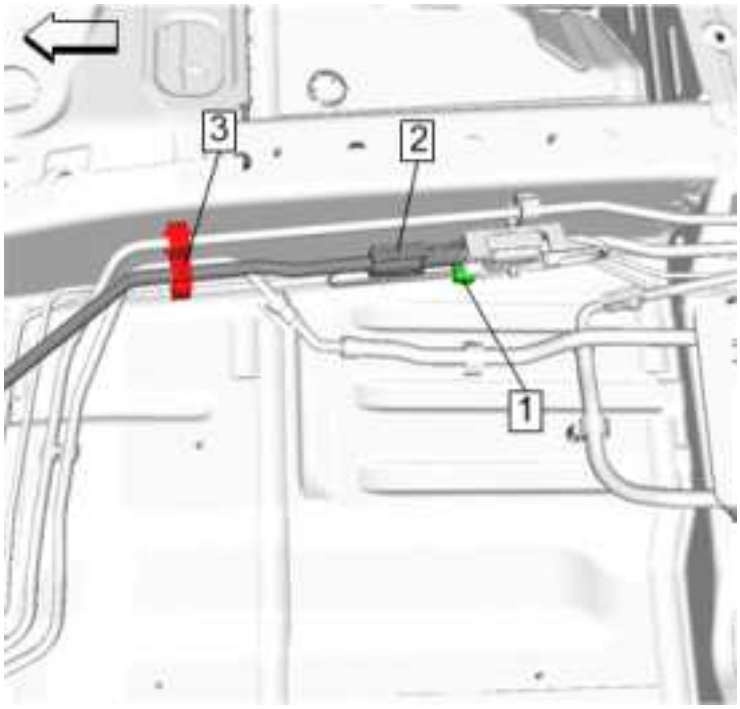

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Fig. 453: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe, Electrical Connector And Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Install Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (2) @ Retainer (3)
2. Connect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (2). Refer to Plastic Collar Quick Connect Fitting Service
3. Connect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Electrical Connector (1)

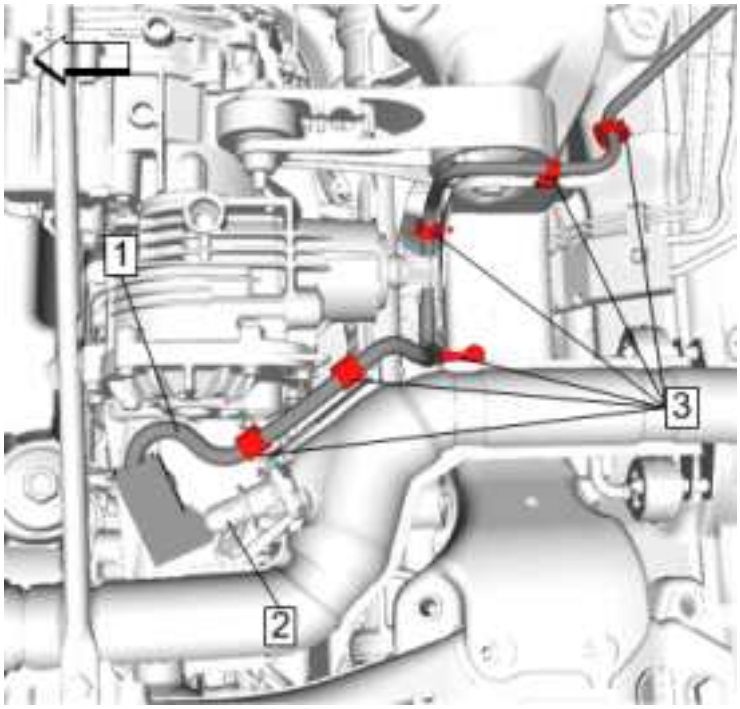

Fig. 454: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe, Emission Reduction Fluid Injector And Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Install Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (3) (Qty: 6)
5. Connect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Emission Reduction Fluid Injector (2). Refer to Plastic Collar Quick Connect Fitting Service
6. Install Underbody Rear Air Deflector. Refer to Underbody Rear Air Deflector Replacement (All Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel)

EMISSION REDUCTION FLUID EXHAUST FRONT PIPE INJECTOR SUPPLY PIPE REPLACEMENT (REAR AWD)

Removal Procedure

1. {If equipped} Remove Underbody Rear Air Deflector. Refer to Underbody Rear Air Deflector Replacement (All Wheel Drive) Underbody Rear Air Deflector Replacement (Diesel)
2. Remove Fuel Tank. Refer to Fuel Tank Replacement (AWD)
3. Remove Emission Reduction Fluid Tank. Refer to Emission Reduction Fluid Tank Replacement

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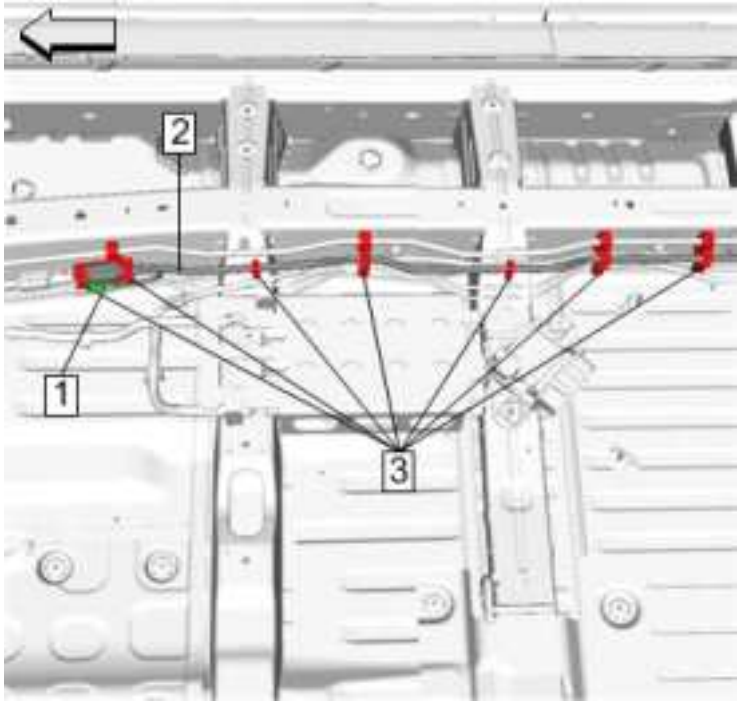

Fig. 455: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe, Electrical Connector And Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Electrical Connector (1)
5. Disconnect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (2). Refer to **Plastic Collar Quick Connect Fitting Service**
6. Remove Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (2) @ Retainers (3) (Qty: 7)

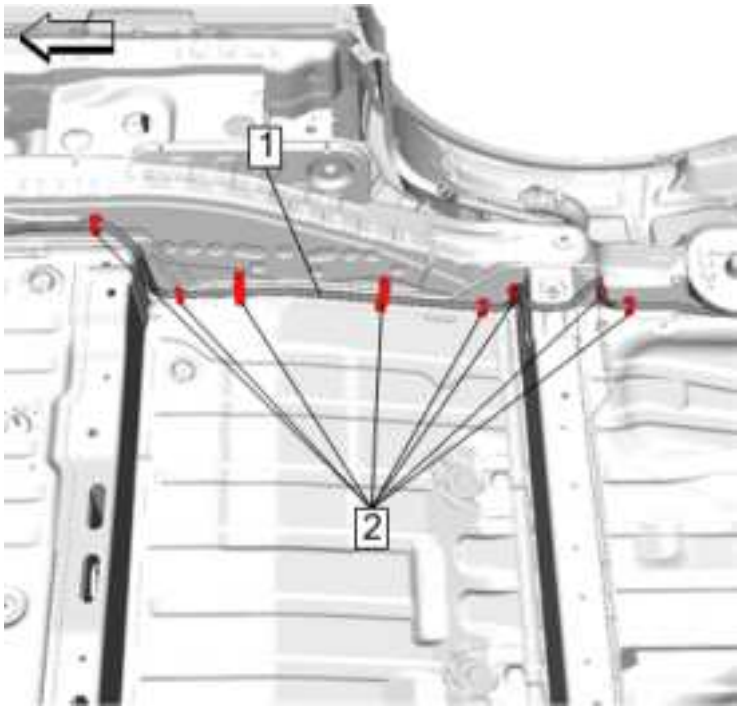

Fig. 456: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

7. Remove Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (2) (Qty: 8)

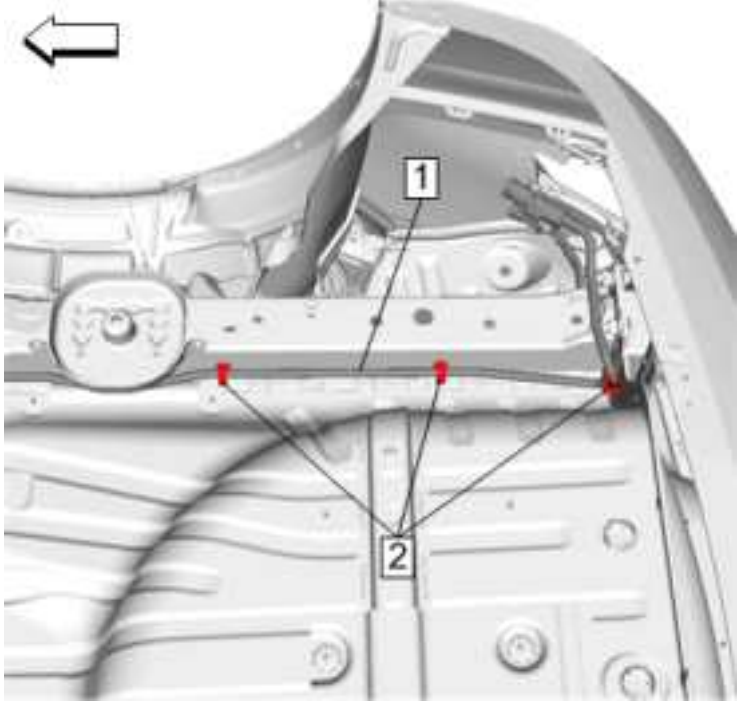

Fig. 457: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

8. Remove Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (2) (Qty: 3)

Installation Procedure

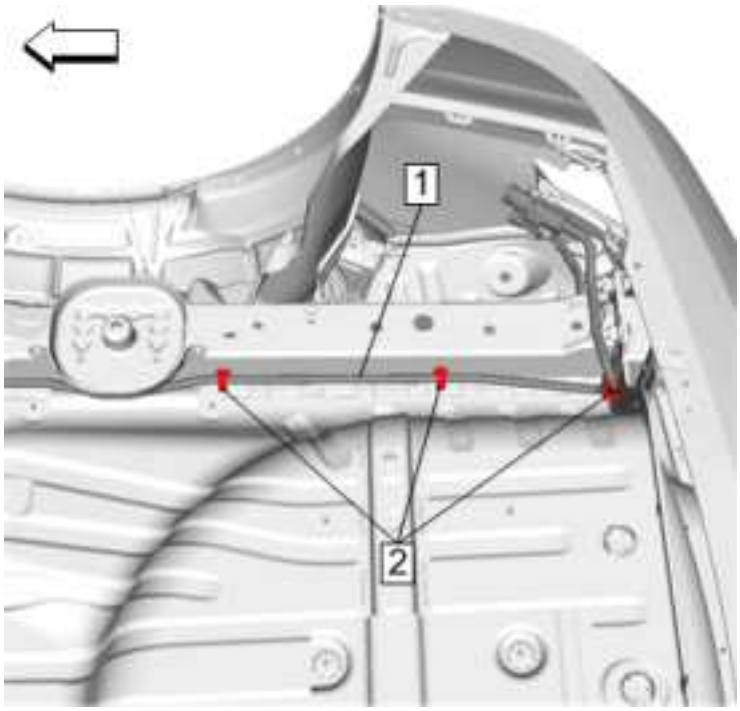

Fig. 458: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (2) (Qty: 3)

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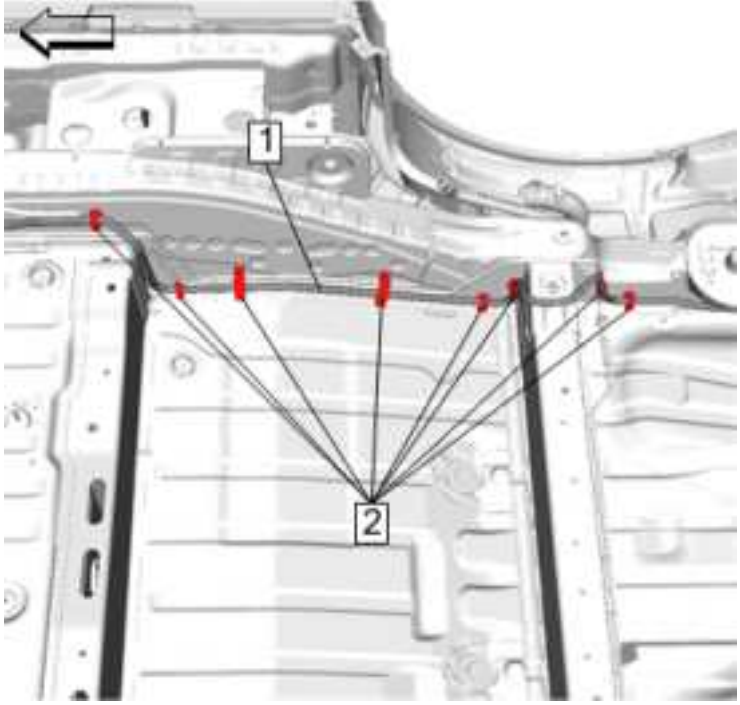

Fig. 459: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Install Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (2) (Qty: 8)

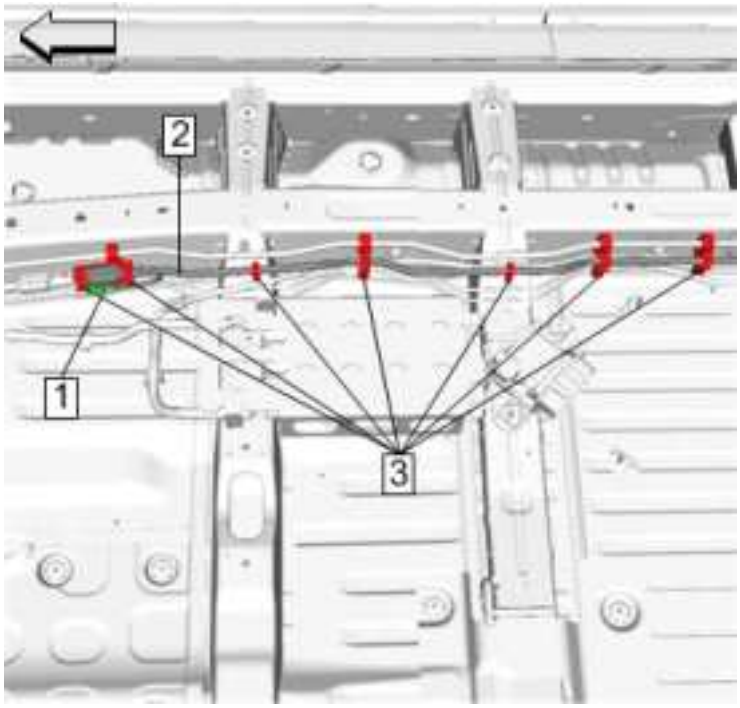

Fig. 460: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe, Electrical Connector And Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Install Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (2) @ Retainers (3) (Qty: 7)
4. Connect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (2). Refer to **Plastic Collar Quick Connect Fitting Service**
5. Connect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Electrical Connector (1)
6. Install Emission Reduction Fluid Tank. Refer to **Emission Reduction Fluid Tank Replacement**
7. Install Fuel Tank. Refer to **Fuel Tank Replacement (AWD)**
8. {If equipped} Install Underbody Rear Air Deflector. Refer to **Underbody Rear Air Deflector Replacement (All Wheel Drive)** **Underbody Rear Air Deflector Replacement (Diesel)**

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EMISSION REDUCTION FLUID SUPPLY PUMP MODULE REPLACEMENT

Special Tools

CH 45722 Fuel Sender Lock Ring Wrench

Equivalent regional tools: **Special Tools (Diagnostic Tools)** **Special Tools (Mechanical Tools)**

Removal Procedure

1. Remove Emission Reduction Fluid Tank. Refer to **Emission Reduction Fluid Tank Replacement**

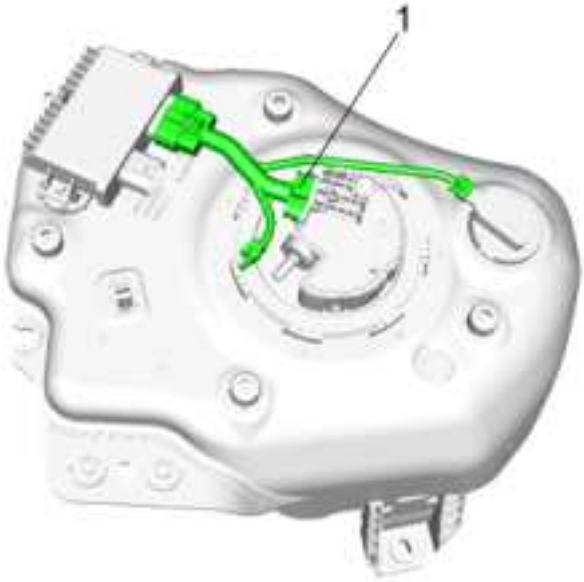

Fig. 461: Emission Reduction Fluid Pump Module Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Emission Reduction Fluid Pump Module Wiring Harness (1)

Fig. 462: Lock Ring
Courtesy of GENERAL MOTORS COMPANY

3. Remove Lock Ring (1) - **CH 45722** Fuel Sender Lock Ring Wrench

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Fig. 463: Emission Reduction Fluid Supply Pump Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

4. Remove Emission Reduction Fluid Supply Pump Module (1)
5. Remove and DISCARD O-Ring (2)

Installation Procedure

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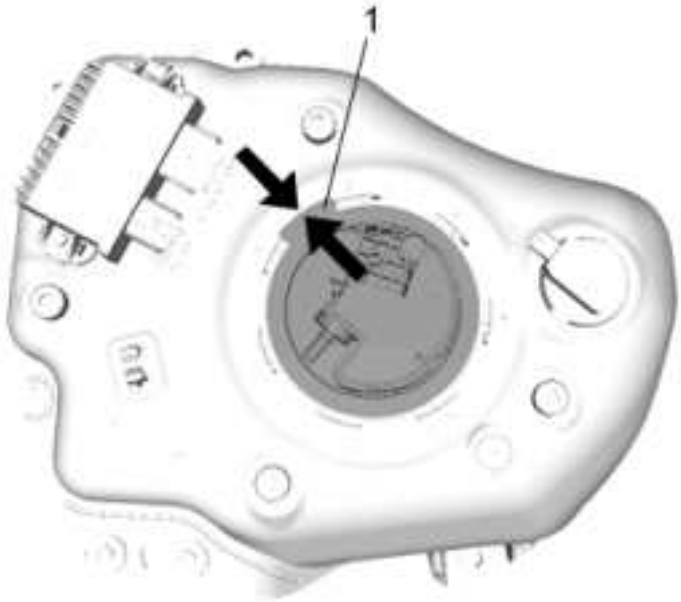

Fig. 464: Lining Up Emission Reduction Fluid Supply Pump Module At Arrows
Courtesy of GENERAL MOTORS COMPANY

1. Line up the emission reduction fluid supply pump module (1) at the arrows.

Fig. 465: Emission Reduction Fluid Supply Pump Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

2. Install NEW O-Ring (2)
3. Install Emission Reduction Fluid Supply Pump Module (1)

Fig. 466: Lock Ring
Courtesy of GENERAL MOTORS COMPANY

4. Install Lock Ring (1) - **CH 45722** Fuel Sender Lock Ring Wrench

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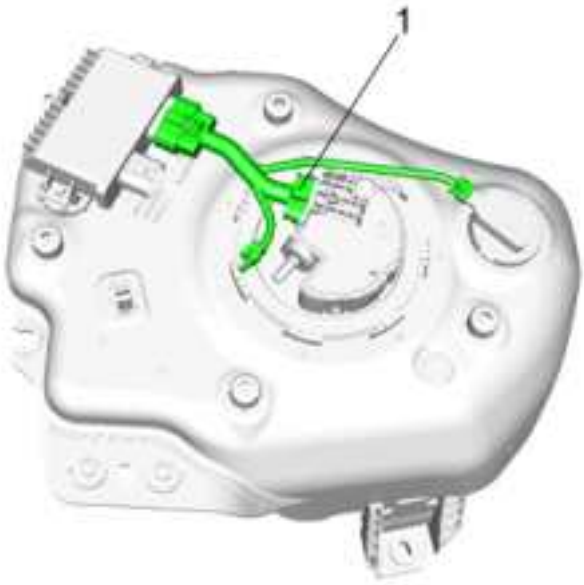

Fig. 467: Emission Reduction Fluid Pump Module Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

5. Connect Emission Reduction Fluid Pump Module Wiring Harness (1)
6. Install Emission Reduction Fluid Tank. Refer to **Emission Reduction Fluid Tank Replacement**
7. Lower the vehicle.
8. Refill the emission reduction fluid tank, add a minimum of 9.5 liters (2.5 gallons).
9. Bleed the emission reduction fluid system:
    1. Connect the scan tool to the vehicle.
    2. Start the emission reduction system leak test using the scan tool.
    3. Wait until the emission reduction fluid pump has reached the delivery pressure of 5 bar (72.5 psi).
    4. Stop the emission reduction system leak test using the scan tool.
    5. Remove the scan tool.
    6. If pump fails to prime disconnect the emission reduction fluid exhaust front pipe injector supply pipe. Refer to **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (FWD)Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Front AWD)Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Rear AWD)**
    7. Start the emission reduction system leak test using the scan tool.
    8. Once fluid is present at front pipe, stop the emission reduction system leak test using the scan tool.
    9. Reconnect the emission reduction fluid exhaust front pipe injector supply pipe. Refer to **Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (FWD)Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Front AWD)Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Replacement (Rear AWD)**
    10. Start the emission reduction system leak test using the scan tool.
    11. Wait until the emission reduction fluid pump has reached the delivery pressure of 5 bar (72.5 psi).
    12. Stop the emission reduction system leak test using the scan tool.
    13. Remove the scan tool.
10. Perform the reductant fluid tank level reset. Refer to **Reductant Fluid Tank Level Reset**

EMISSION REDUCTION FLUID INJECTOR REPLACEMENT (AWD)

Removal Procedure

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1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

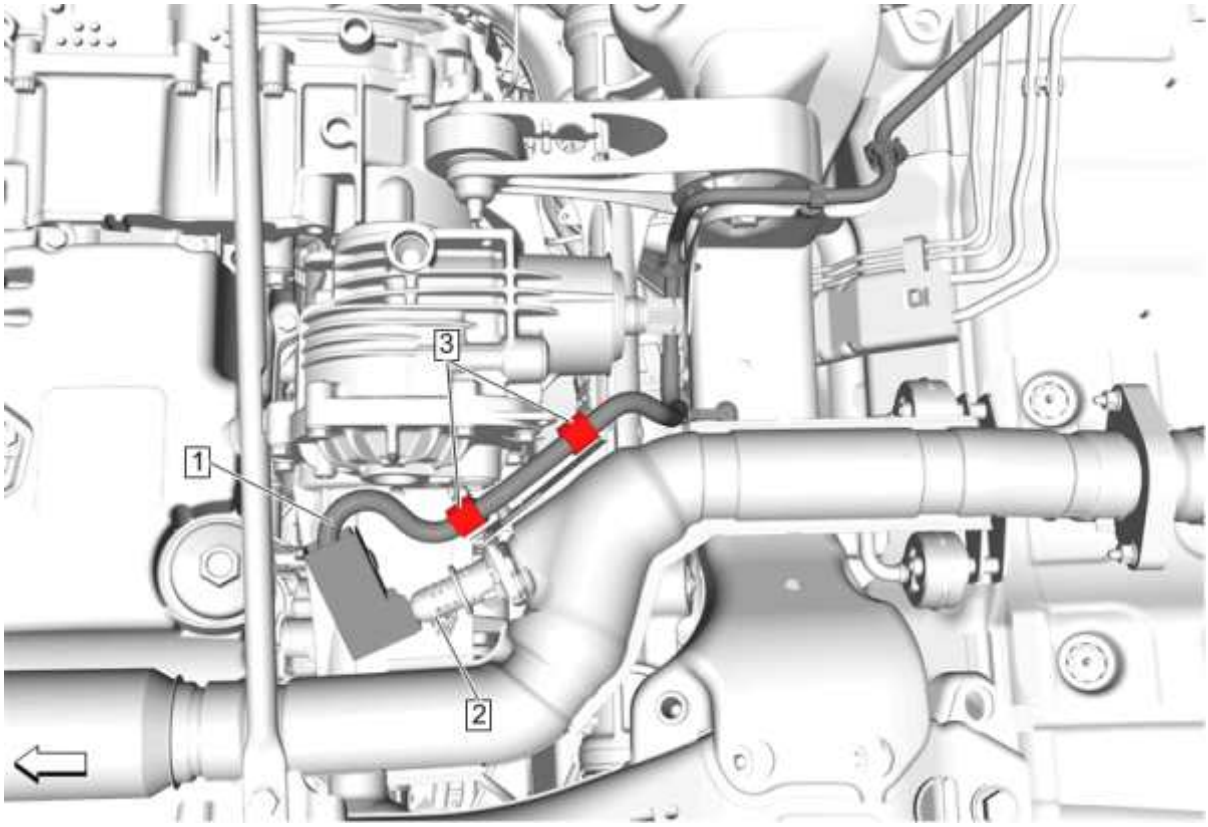

Fig. 468: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe, Emission Reduction Fluid Injector And Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Emission Reduction Fluid Injector (2). Refer to **Plastic Collar Quick Connect Fitting Service**
3. Remove Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (3) (Qty: 2)
4. Disconnect the electrical connector.

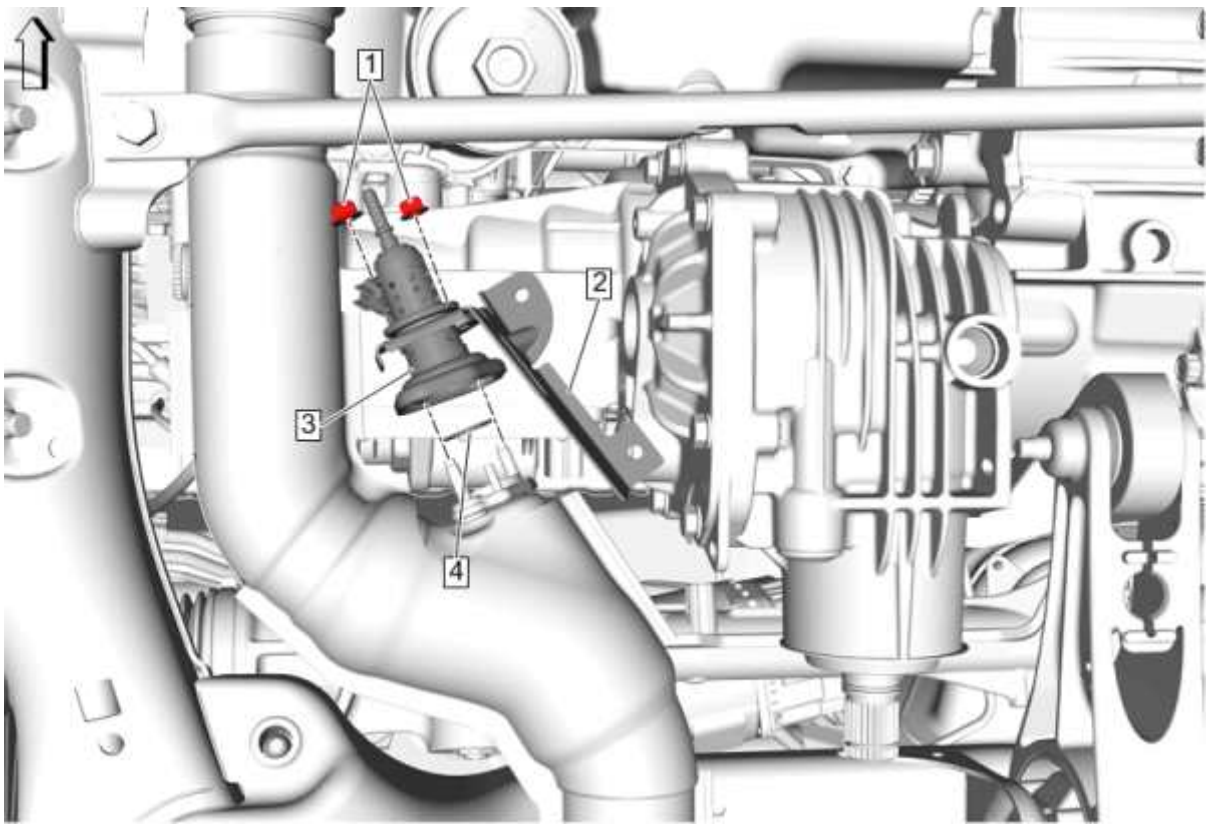

Fig. 469: Emission Reduction Fluid Injector, Nuts, Pipe Bracket And Gasket
Courtesy of GENERAL MOTORS COMPANY

5. Remove Emission Reduction Fluid Injector Nuts (1) (Qty: 2)
6. Remove Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Bracket (2)

NOTE: **Do not use a prying tool to remove the injector.**

7. Remove Emission Reduction Fluid Injector (3)
8. Remove and DISCARD Gasket (4)
9. Clean the exhaust mounting flange and injector mounting surfaces to remove any soot or emission reduction fluid deposits.

Installation Procedure

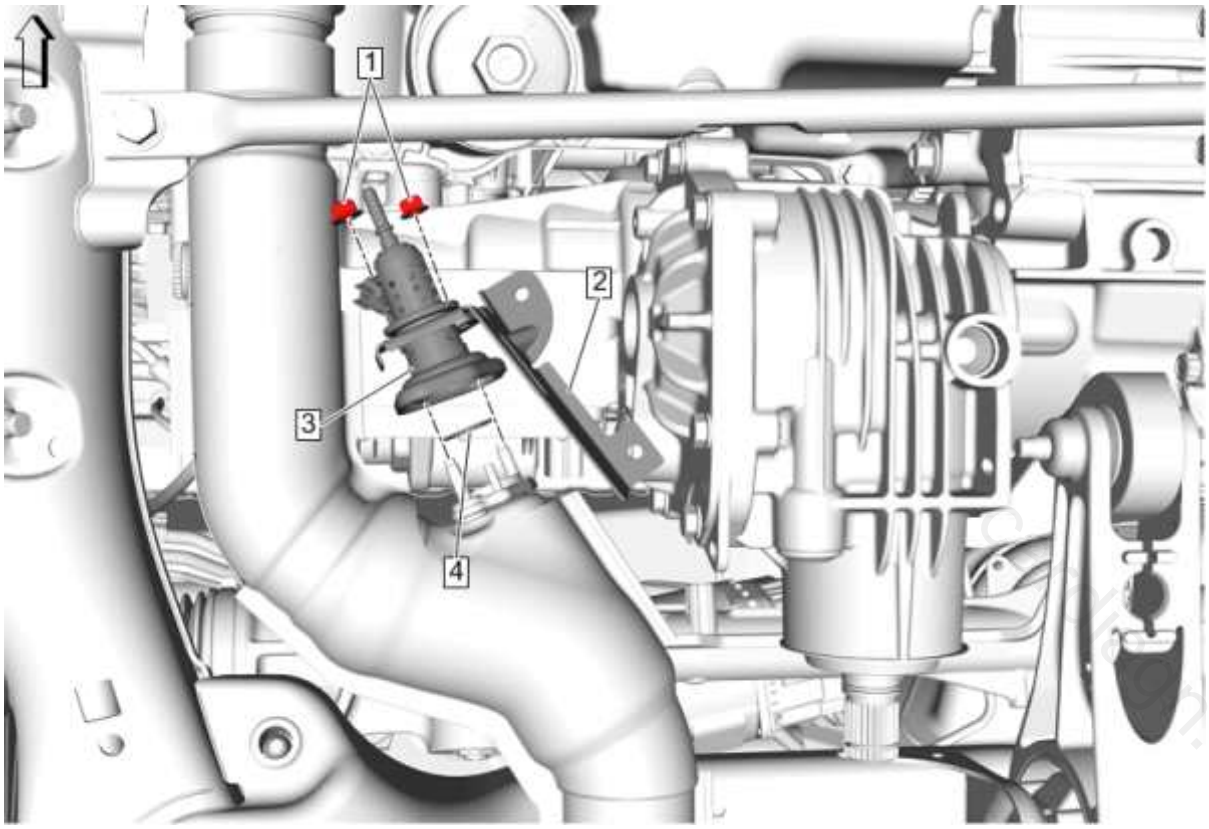

Fig. 470: Emission Reduction Fluid Injector, Nuts, Pipe Bracket And Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **A NEW emission reduction fluid injector will have a new gasket as part of assembly (POA).**

1. Install NEW Gasket (4)
2. Install Emission Reduction Fluid Injector (3)
3. Install Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Bracket (2)

CAUTION: **Refer to Fastener Caution .**

4. Install and tighten Emission Reduction Fluid Injector Nuts (1) (Qty: 2) to 9 N.m (80 lb in)
5. Connect the electrical connector.

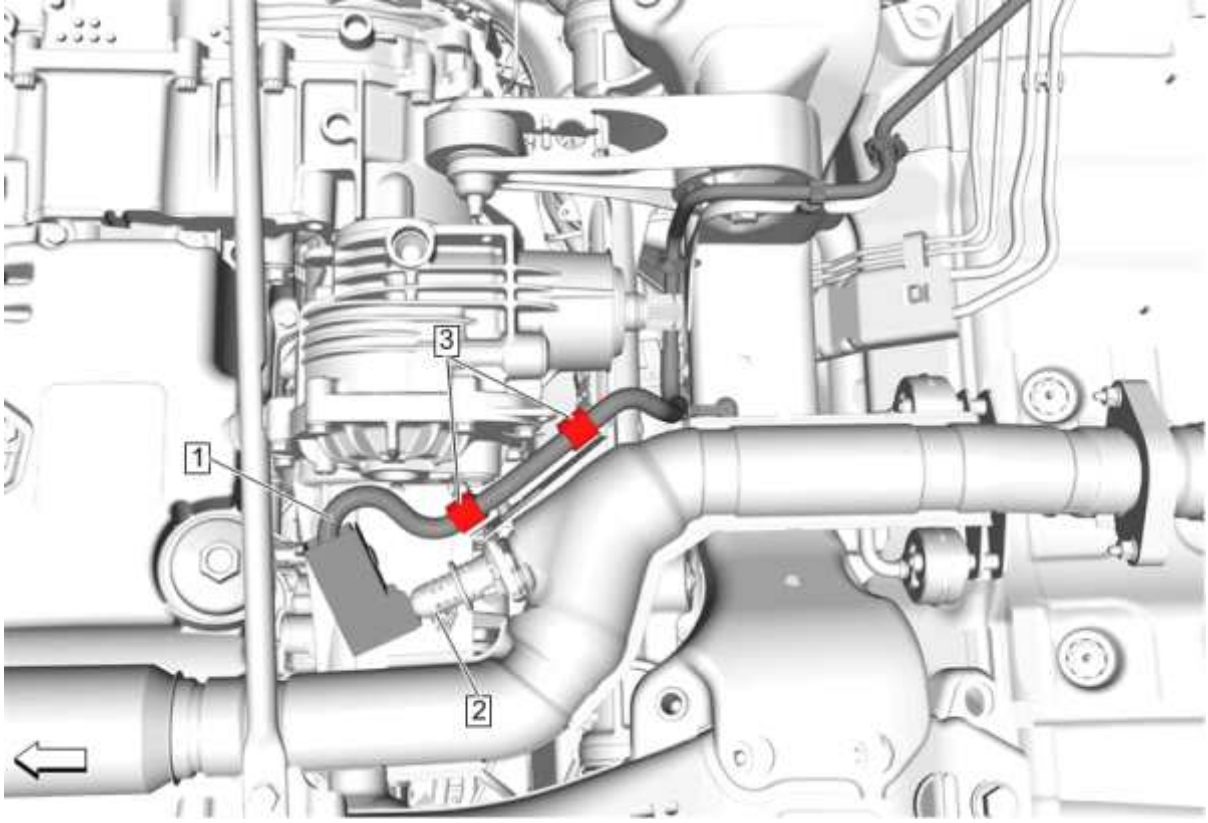

Fig. 471: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe, Emission Reduction Fluid Injector And Retainers
Courtesy of GENERAL MOTORS COMPANY

6. Install Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Retainers (3) (Qty: 2)
7. Connect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Emission Reduction Fluid Injector (2). Refer to **Plastic Collar Quick Connect Fitting Service**
8. Check for leaks and ensure the emission reduction fluid injector joint is properly sealed.
9. If replacing with NEW injector, perform the NOx Catalyst Reductant Loading Reset. Refer to **NOx Catalyst Reductant Loading Reset**
10. Lower the vehicle.

EMISSION REDUCTION FLUID INJECTOR REPLACEMENT (FWD)

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

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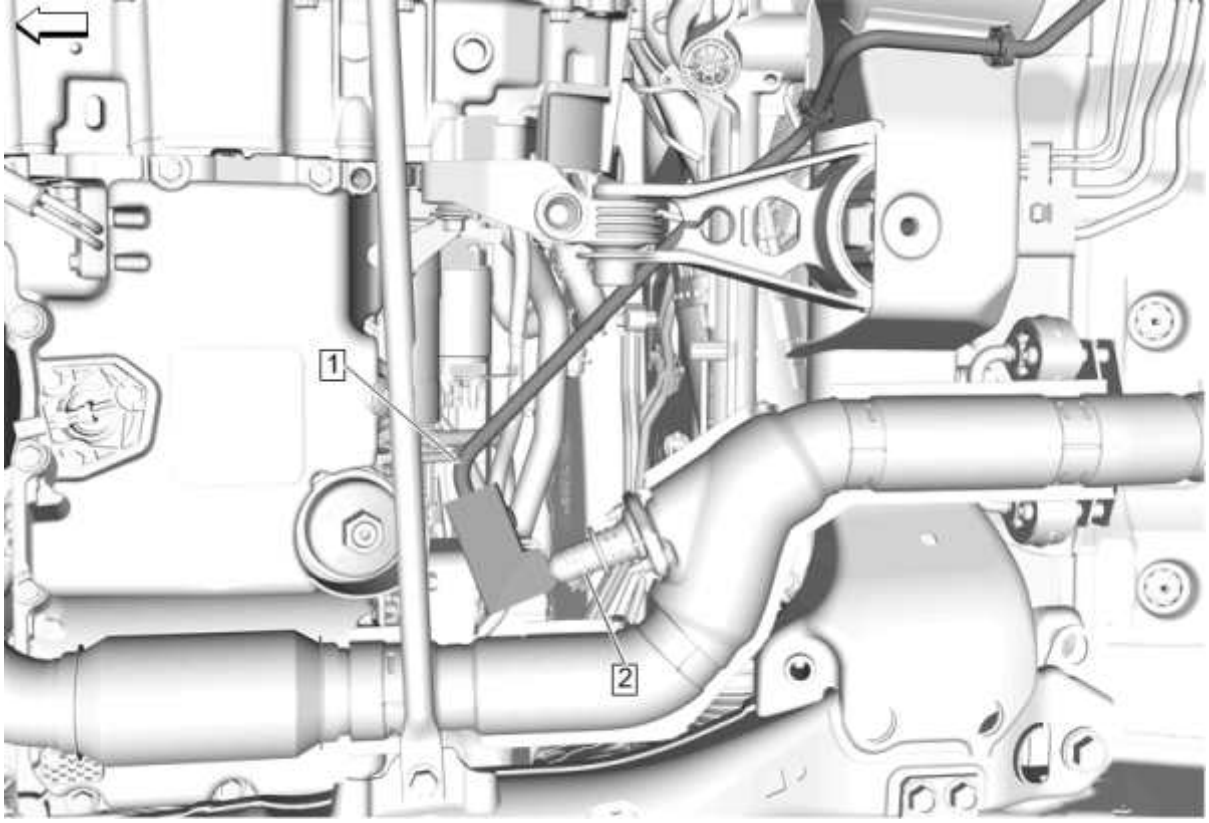

Fig. 472: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe And Emission Reduction Fluid Injector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Emission Reduction Fluid Injector (2). Refer to **Plastic Collar Quick Connect Fitting Service**
3. Disconnect the electrical connector.

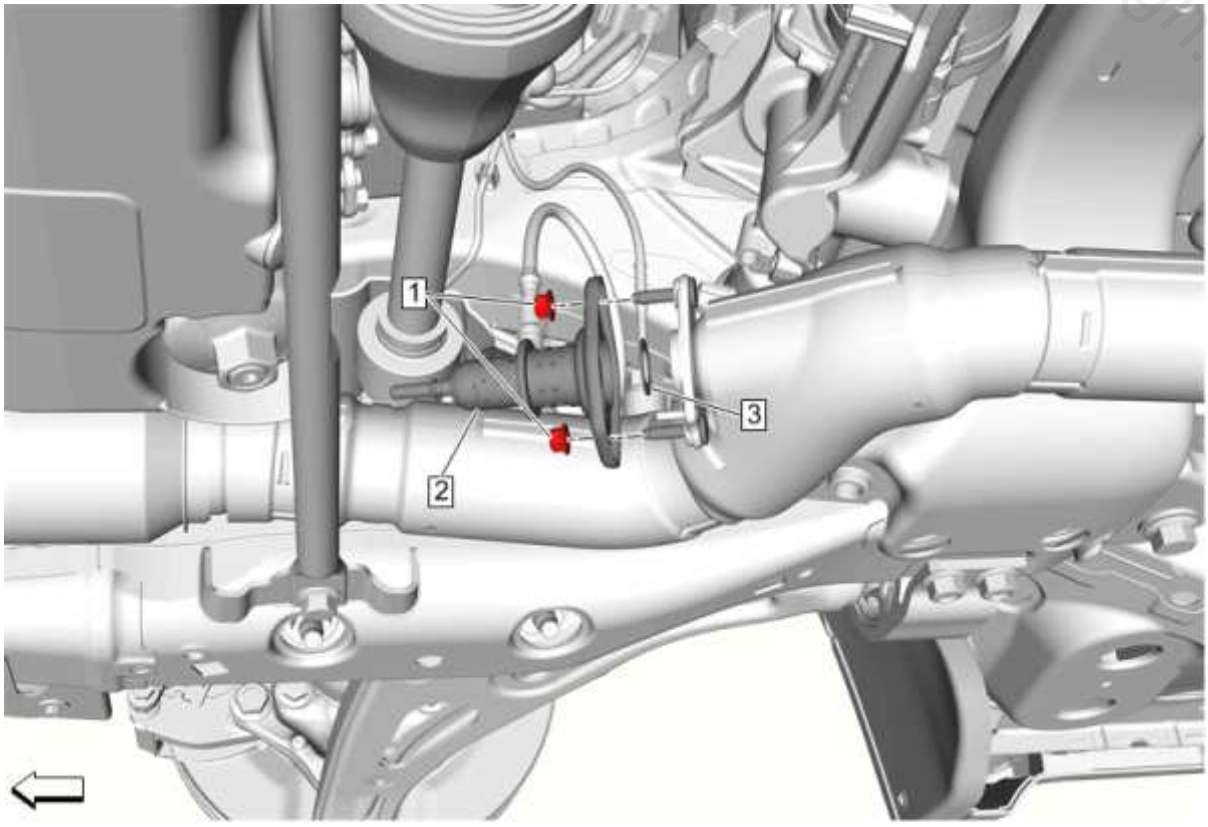

Fig. 473: Emission Reduction Fluid Injector, Nuts And Gasket
Courtesy of GENERAL MOTORS COMPANY

4. Remove Emission Reduction Fluid Injector Nuts (1) (Qty: 2)

NOTE: **Do not use a prying tool to remove the injector.**

5. Remove Emission Reduction Fluid Injector (2)
6. Remove and DISCARD Gasket (3)
7. Clean the exhaust mounting flange and injector mounting surfaces to remove any soot or emission reduction fluid deposits.

Installation Procedure

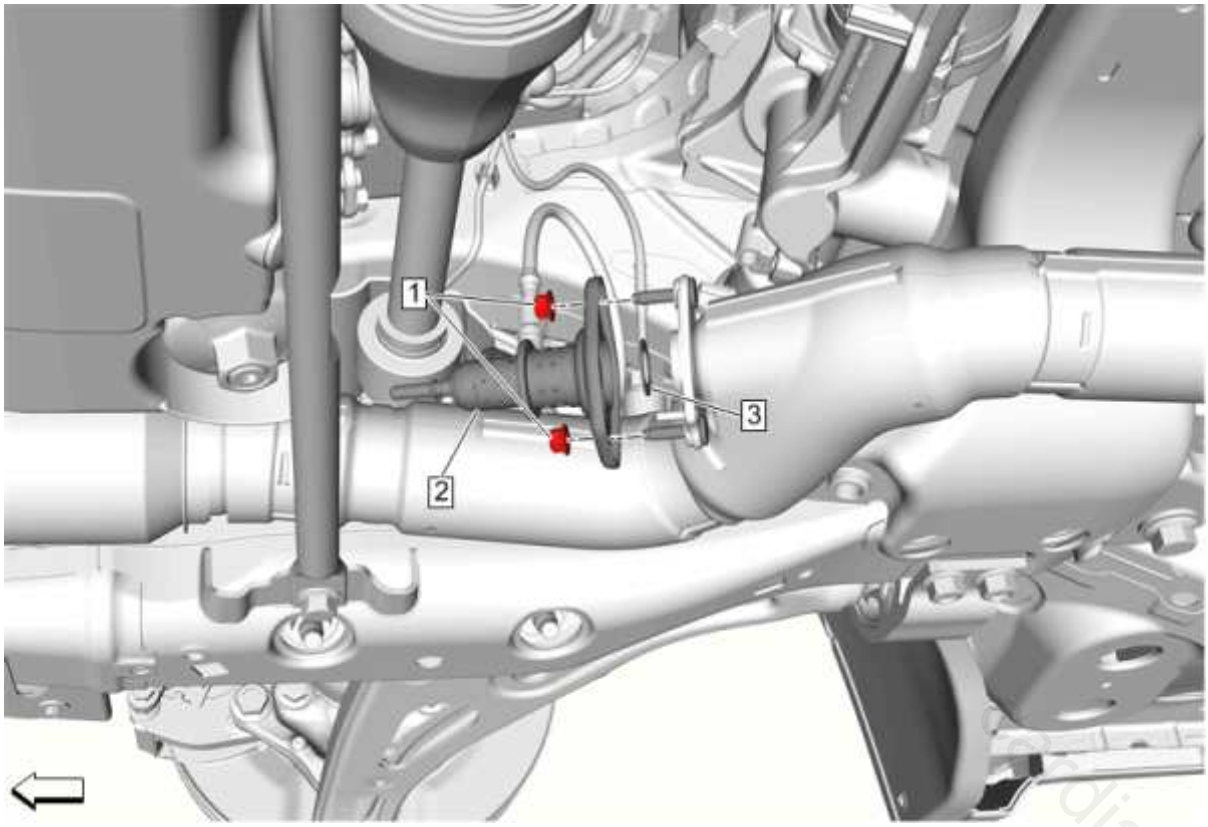

Fig. 474: Emission Reduction Fluid Injector, Nuts And Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **A NEW emission reduction fluid injector will have a new gasket as part of assembly (POA).**

1. Install NEW Gasket (3)
2. Install Emission Reduction Fluid Injector (2)

CAUTION: **Refer to Fastener Caution .**

3. Install and tighten Emission Reduction Fluid Injector Nuts (1) (Qty: 2) to 9 N.m (80 lb in)
4. Connect the electrical connector.

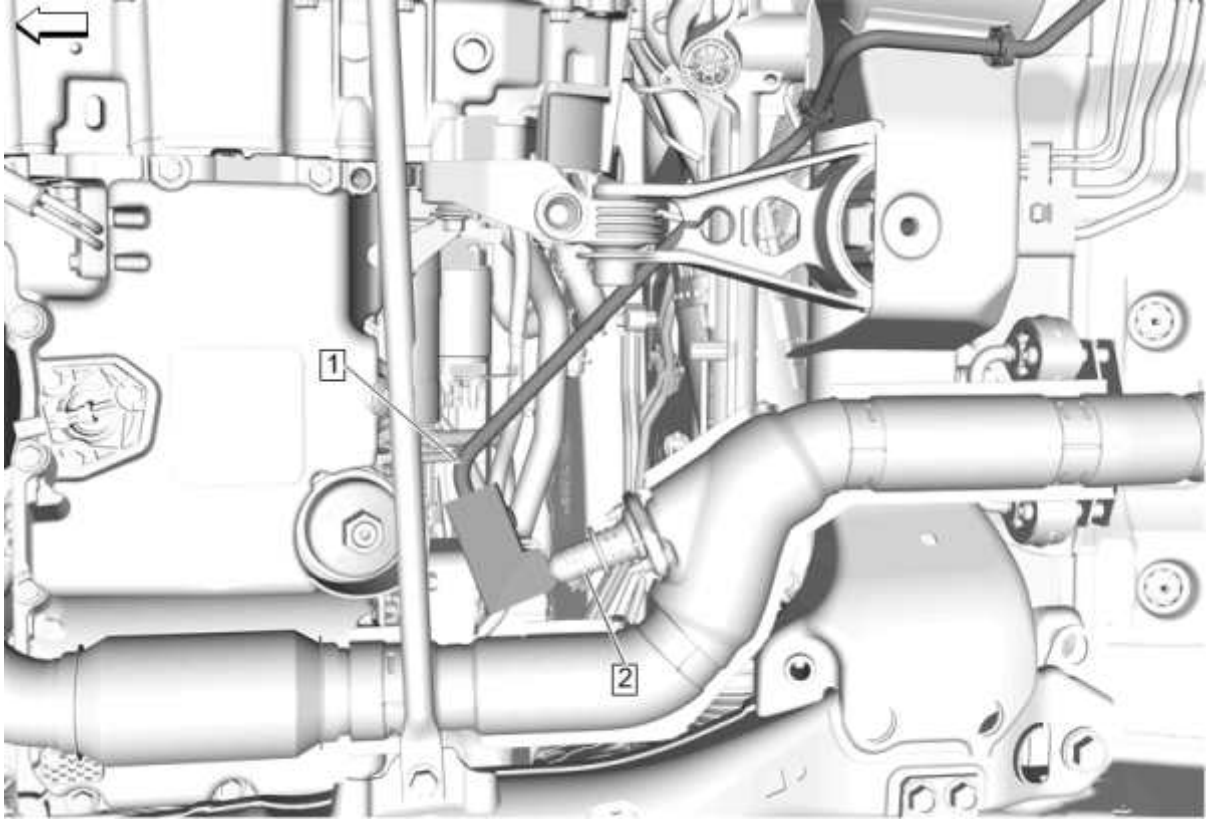

Fig. 475: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe And Emission Reduction Fluid Injector
Courtesy of GENERAL MOTORS COMPANY

5. Connect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (1) @ Emission Reduction Fluid Injector (2). Refer to **Plastic Collar Quick Connect Fitting Service**
6. Check for leaks and ensure the emission reduction fluid injector joint is properly sealed.
7. If replacing with NEW injector, perform the NOx Catalyst Reductant Loading Reset. Refer to **NOx Catalyst Reductant Loading Reset**
8. Lower the vehicle.

EMISSION REDUCTION FLUID TANK OPENING FILLER REPLACEMENT

Removal Procedure

1. Remove Fuel Tank Filler Pipe Housing. Refer to **Fuel Tank Filler Pipe Housing Replacement (Equinox)** **Fuel Tank Filler Pipe Housing Replacement (Terrain)**
2. Remove Rear Wheelhouse Liner-Left Side. Refer to **Rear Wheelhouse Liner Replacement- Left Side (Equinox)** **Rear Wheelhouse Liner Replacement- Left Side (Terrain)**

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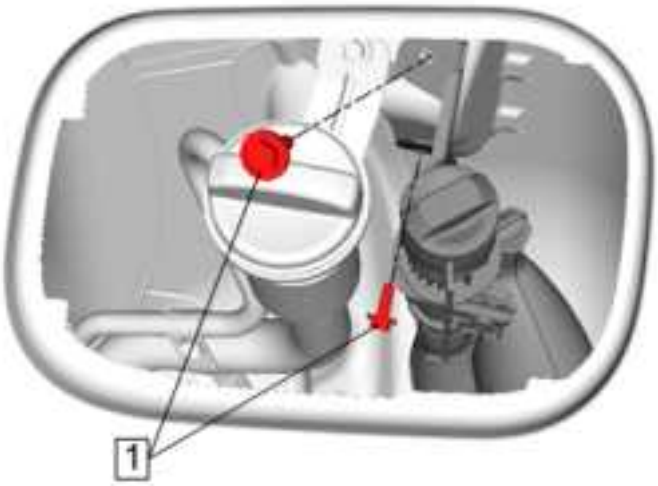

Fig. 476: Fuel Tank Filler Pipe Ground Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove Fuel Tank Filler Pipe Ground Bolts (1) (Qty: 2)
4. Using only a low-pressure clean water hose, spray the upper surface of the emission reduction fluid tank, emission reduction filler pipe and connections to remove dirt and debris.
5. Using only a low pressure air wand or air gun, dry the emission reduction tank, emission reduction filler pipe and connections.

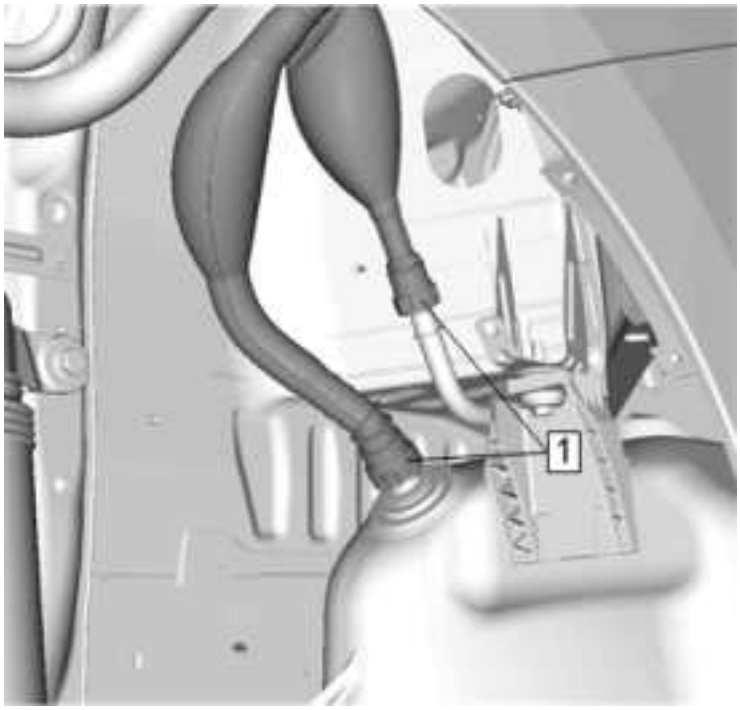

Fig. 477: Emission Reduction Fluid Tank Opening Filler Hoses
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect Emission Reduction Fluid Tank Opening Filler (1) (Qty: 2). Refer to **Plastic Collar Quick Connect Fitting Service**

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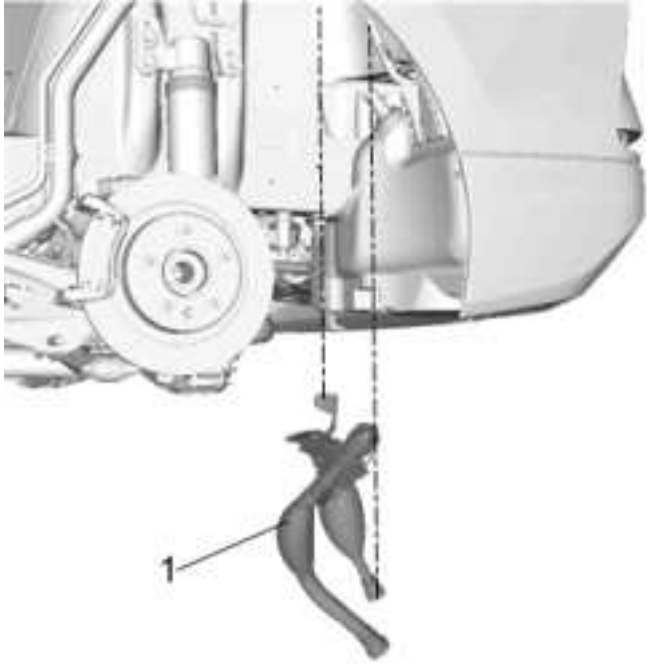

Fig. 478: Emission Reduction Fluid Tank Opening Filler
Courtesy of GENERAL MOTORS COMPANY

7. Remove Emission Reduction Fluid Tank Opening Filler (1)

Installation Procedure

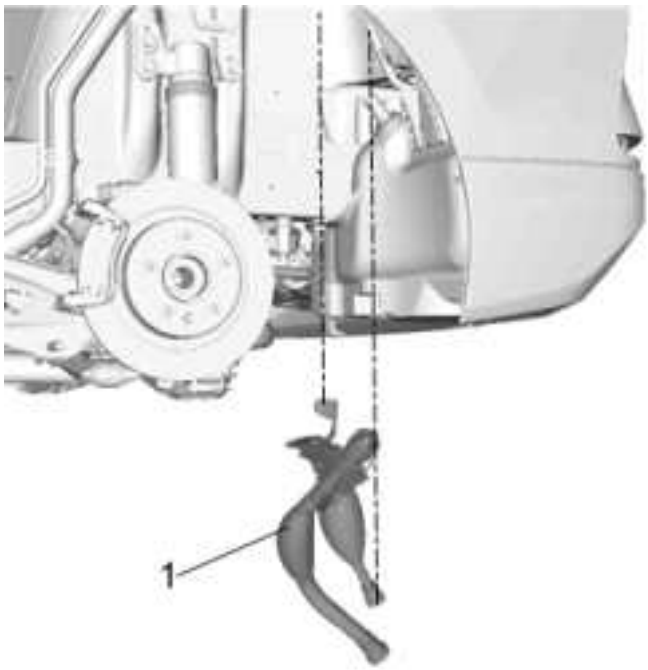

Fig. 479: Emission Reduction Fluid Tank Opening Filler
Courtesy of GENERAL MOTORS COMPANY

1. Install Emission Reduction Fluid Tank Opening Filler (1)

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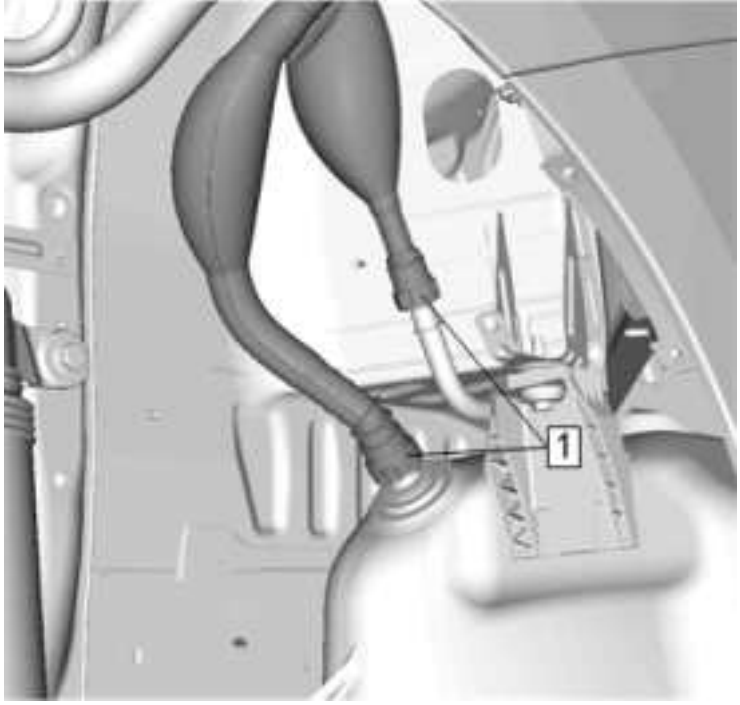

Fig. 480: Emission Reduction Fluid Tank Opening Filler Hoses
Courtesy of GENERAL MOTORS COMPANY

2. Connect Emission Reduction Fluid Tank Opening Filler (1) (Qty: 2). Refer to **Plastic Collar Quick Connect Fitting Service**

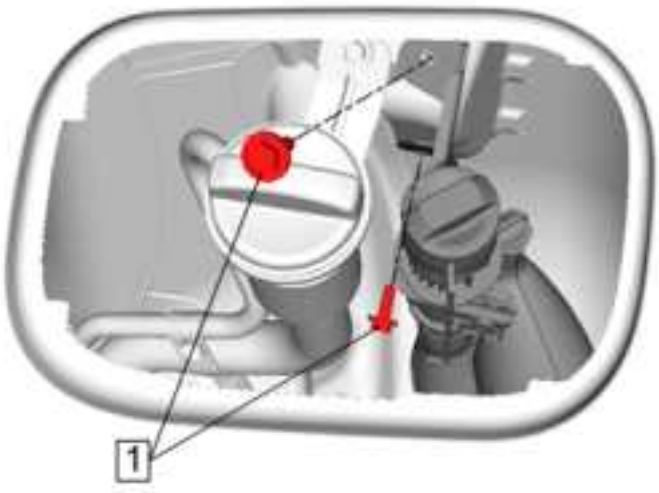

Fig. 481: Fuel Tank Filler Pipe Ground Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install and tighten Fuel Tank Filler Pipe Ground Bolts (1) (Qty: 2) to 9 N.m (80 lb in)
4. Install Rear Wheelhouse Liner-Left Side. Refer to **Rear Wheelhouse Liner Replacement- Left Side (Equinox)** **Rear Wheelhouse Liner Replacement- Left Side (Terrain)**
5. Install Fuel Tank Filler Pipe Housing. Refer to **Fuel Tank Filler Pipe Housing Replacement (Equinox)** **Fuel Tank Filler Pipe Housing Replacement (Terrain)**

EMISSION REDUCTION FLUID TANK PROTECTOR REPLACEMENT

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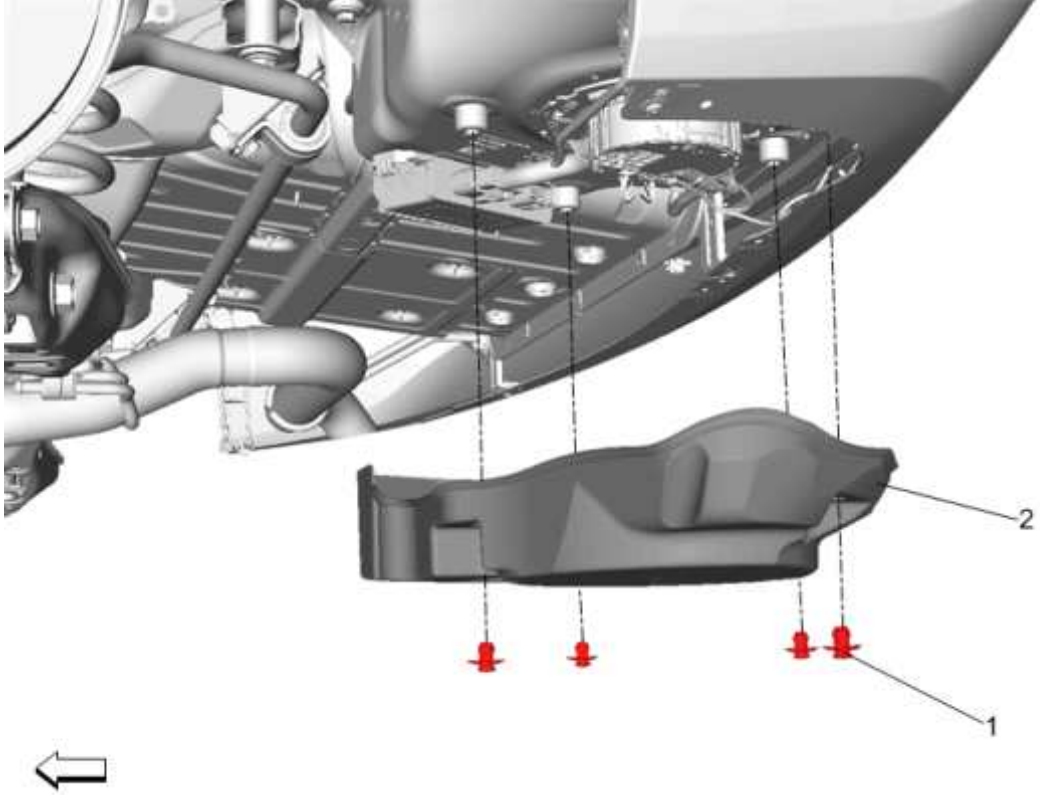

Fig. 482: Emission Reduction Fluid Tank Protector
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Retainer (Qty: 4)
2	Emission Reduction Fluid Tank Protector

EMISSION REDUCTION FLUID TANK REPLACEMENT

Removal Procedure

1. Remove Rear Bumper Fascia. Refer to **Rear Bumper Fascia Replacement (Equinox)** **Rear Bumper Fascia Replacement (Terrain)**
2. Drain the emission reduction fluid tank. Refer to **Emission Reduction Fluid Tank Draining**
3. Remove Emission Reduction Fluid Tank Protector. Refer to **Emission Reduction Fluid Tank Protector Replacement**
4. Using only a low-pressure clean water hose, spray the upper and lower surface of the emission reduction fluid tank, emission reduction filler pipe and connections to remove dirt and debris.
5. Using only a low pressure air wand or air gun, dry the emission reduction tank, emission reduction filler pipe and connections.

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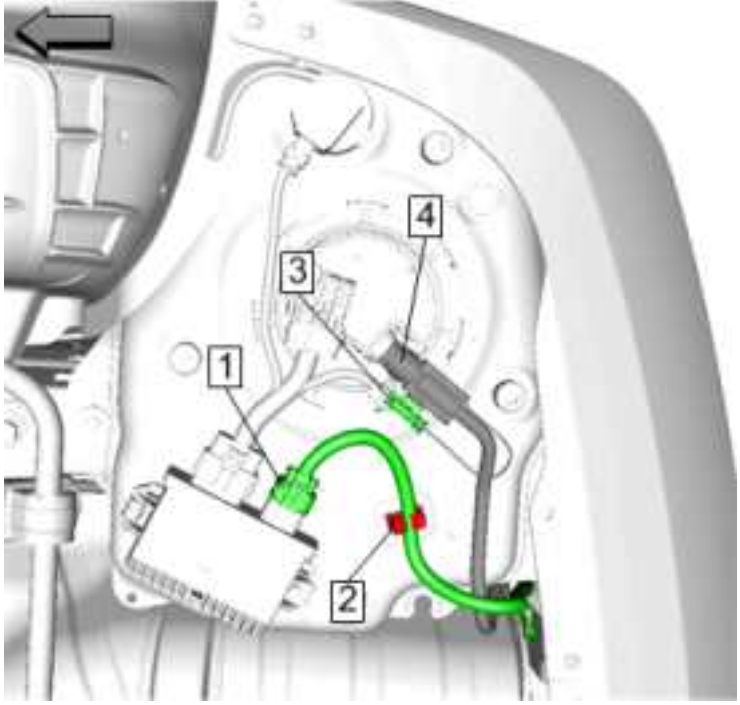

Fig. 483: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe, Electrical Connectors And Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect Electrical Connector (1)
7. Remove Electrical Connector (1) @ Retainer (2)
8. Disconnect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Electrical Connector (3)
9. Disconnect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (4). Refer to **Plastic Collar Quick Connect Fitting Service**

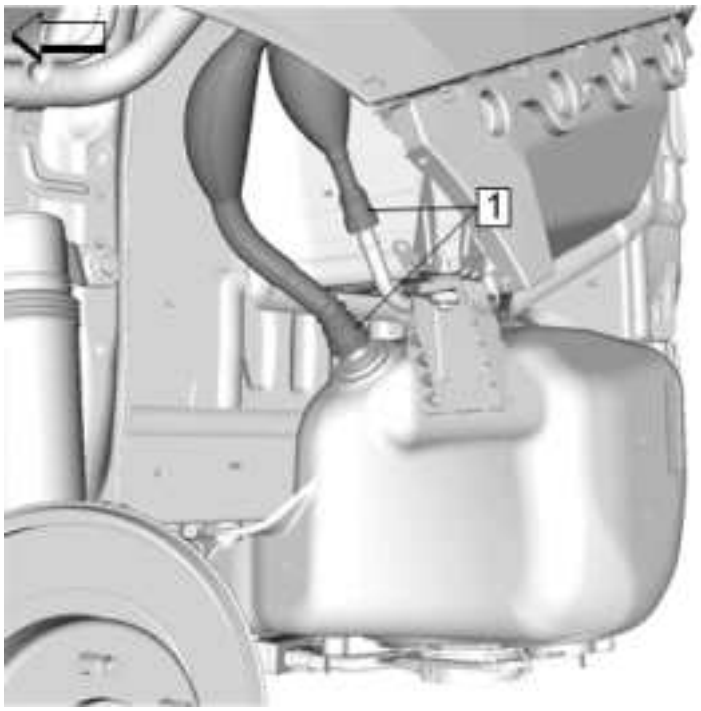

Fig. 484: Emission Reduction Fluid Tank Opening Filler Hoses
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect Emission Reduction Fluid Tank Opening Filler (1) (Qty: 2). Refer to **Plastic Collar Quick Connect Fitting Service**

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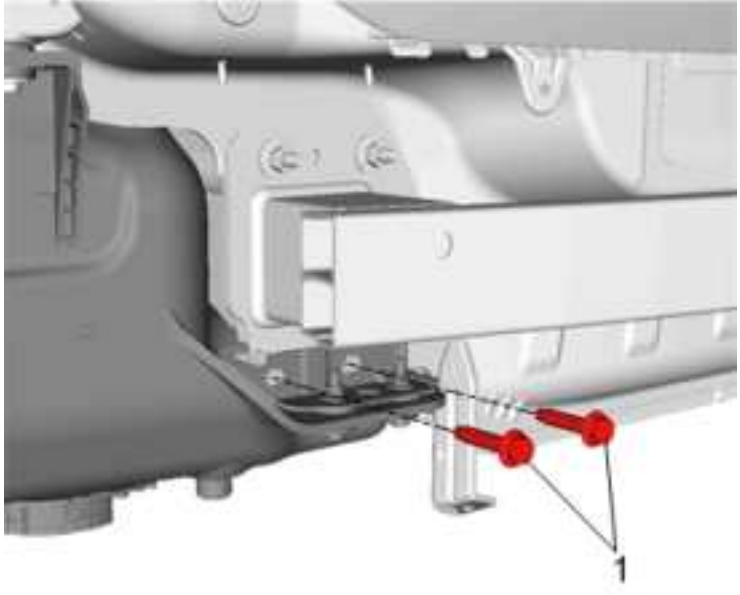

Fig. 485: Emission Reduction Fluid Tank Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove Emission Reduction Fluid Tank Bolts (1) (Qty: 2)

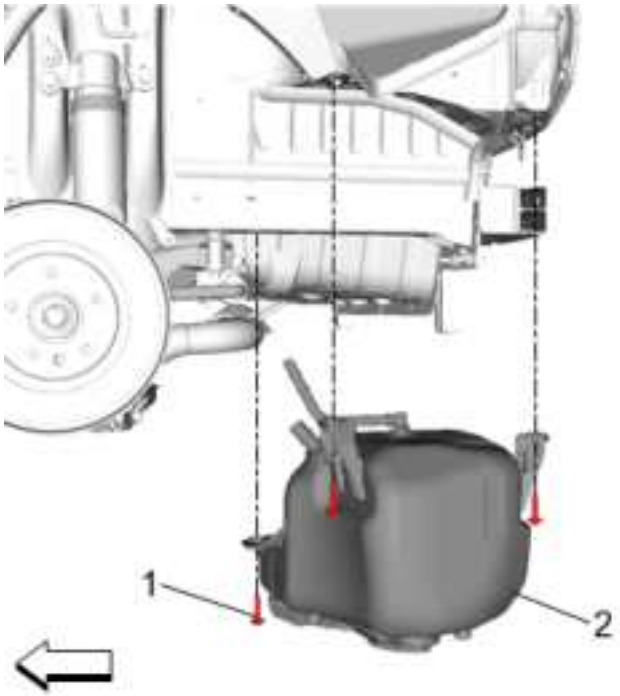

Fig. 486: Emission Reduction Fluid Tank And Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Remove Emission Reduction Fluid Tank Bolts (1) (Qty: 3)
13. Remove Emission Reduction Fluid Tank (2)

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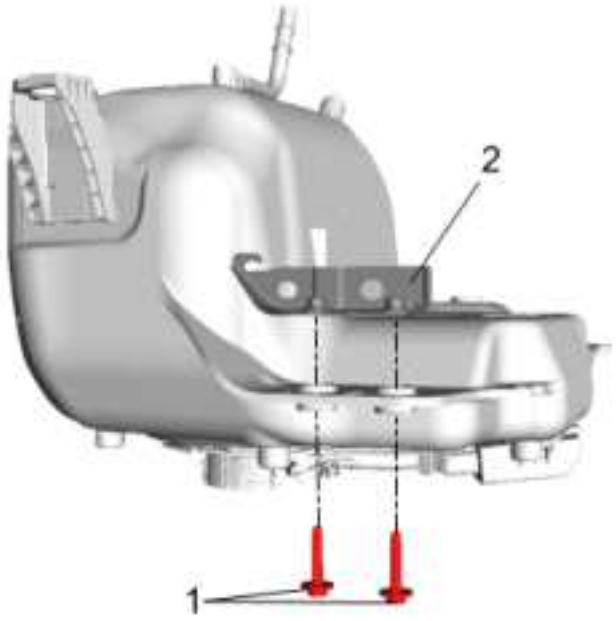

Fig. 487: Emission Reduction Fluid Tank Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If replacing the emission reduction fluid tank remove the metal mounting bracket.**

14. Remove Emission Reduction Fluid Tank Bracket Bolts (1) (Qty: 2)
15. Remove Emission Reduction Fluid Tank Bracket (2)
16. Transfer components as necessary.

Installation Procedure

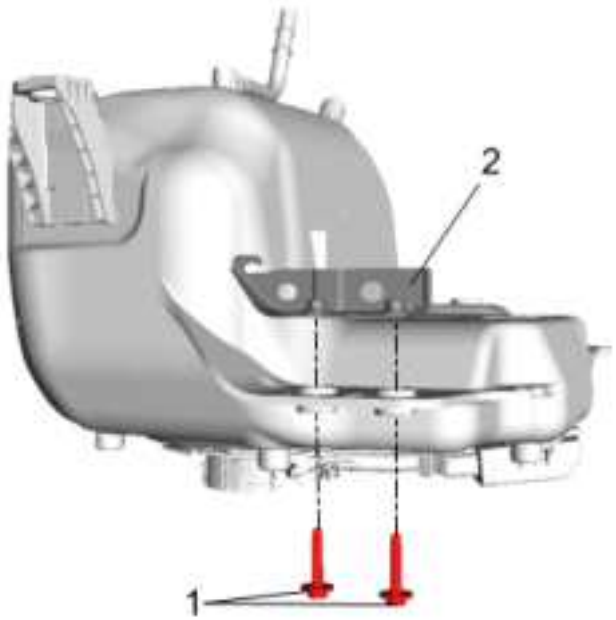

Fig. 488: Emission Reduction Fluid Tank Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If tank was replaced with a new assembly, install the metal mounting bracket. Center bracket over hole in tank.**

1. Install Emission Reduction Fluid Tank Bracket (2)

CAUTION: **Refer to Fastener Caution .**

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2. Install and tighten Emission Reduction Fluid Tank Bracket Bolts (1) (Qty: 2) to 20 N.m (15 lb ft)

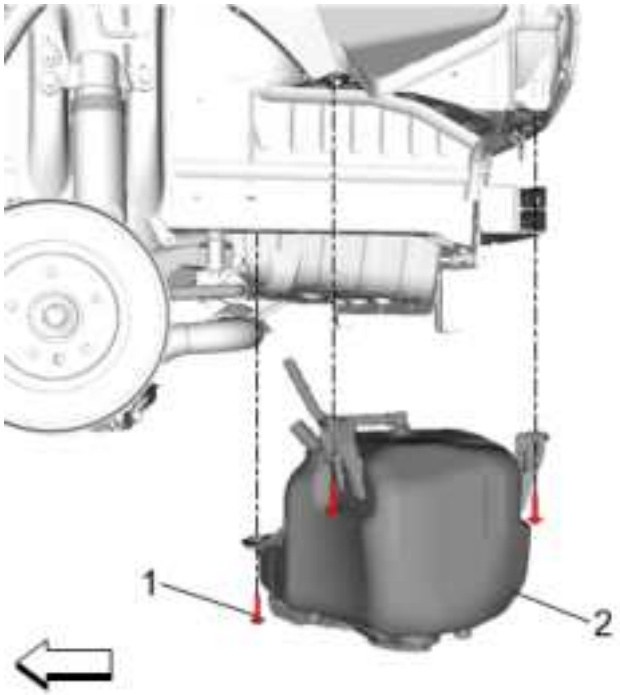

Fig. 489: Emission Reduction Fluid Tank And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install Emission Reduction Fluid Tank (2)
4. Install and tighten Emission Reduction Fluid Tank Bolts (1) (Qty: 3) to 22 N.m (16 lb ft)

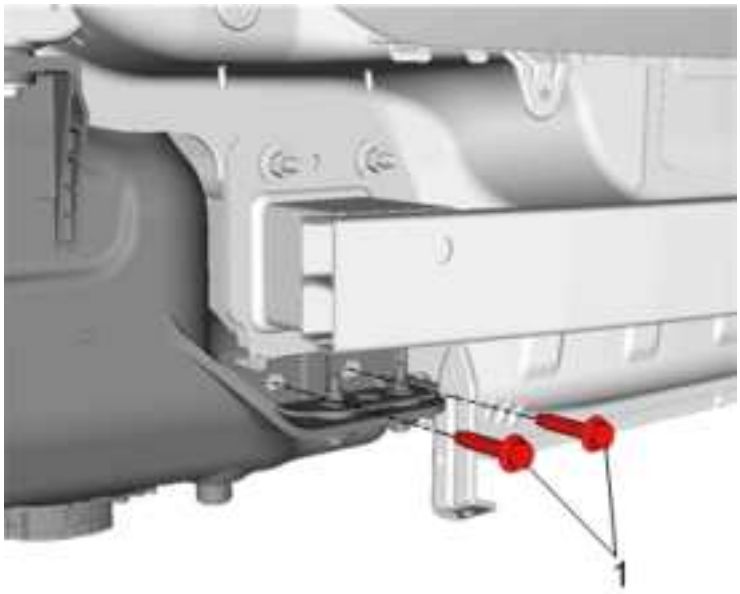

Fig. 490: Emission Reduction Fluid Tank Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install and tighten Emission Reduction Fluid Tank Bolts (1) (Qty: 2) to 58 N.m (43 lb ft)

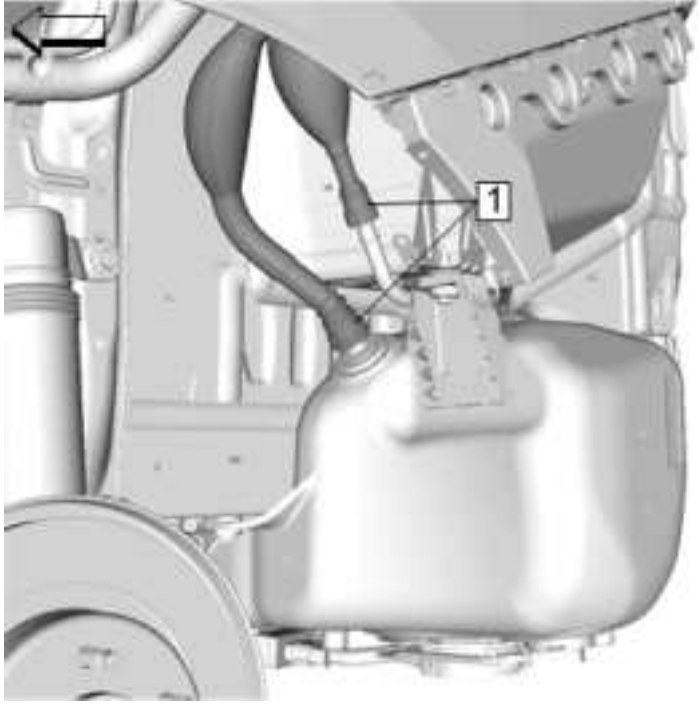

Fig. 491: Emission Reduction Fluid Tank Opening Filler Hoses
Courtesy of GENERAL MOTORS COMPANY

6. Connect Emission Reduction Fluid Tank Opening Filler (1) (Qty: 2). Refer to **Plastic Collar Quick Connect Fitting Service**

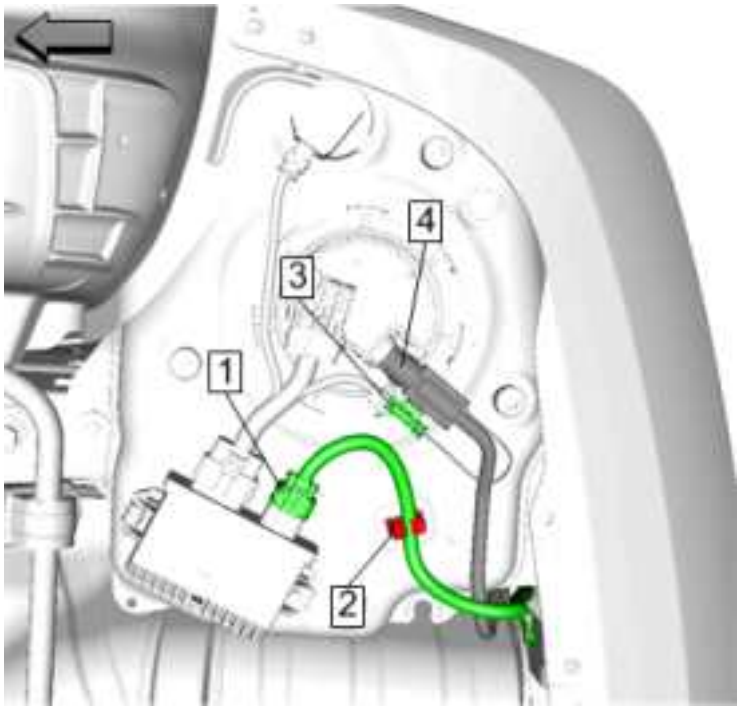

Fig. 492: Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe, Electrical Connectors And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Connect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe (4). Refer to **Plastic Collar Quick Connect Fitting Service**
8. Connect Emission Reduction Fluid Exhaust Front Pipe Injector Supply Pipe Electrical Connector (3)
9. Install Electrical Connector (1) @ Retainer (2)
10. Connect Electrical Connector (1)
11. Install Emission Reduction Fluid Tank Protector. Refer to **Emission Reduction Fluid Tank Protector Replacement**
12. Install Rear Bumper Fascia. Refer to **Rear Bumper Fascia Replacement (Equinox)** **Rear Bumper Fascia Replacement (Terrain)**

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13. Refill the emission reduction fluid tank, add a minimum of 9.5 liters (2.5 gallons).
14. Perform the reductant fluid tank level reset. Refer to **Reductant Fluid Tank Level Reset**

EMISSION REDUCTION FLUID TANK RESERVOIR WIRE HARNESS REPLACEMENT

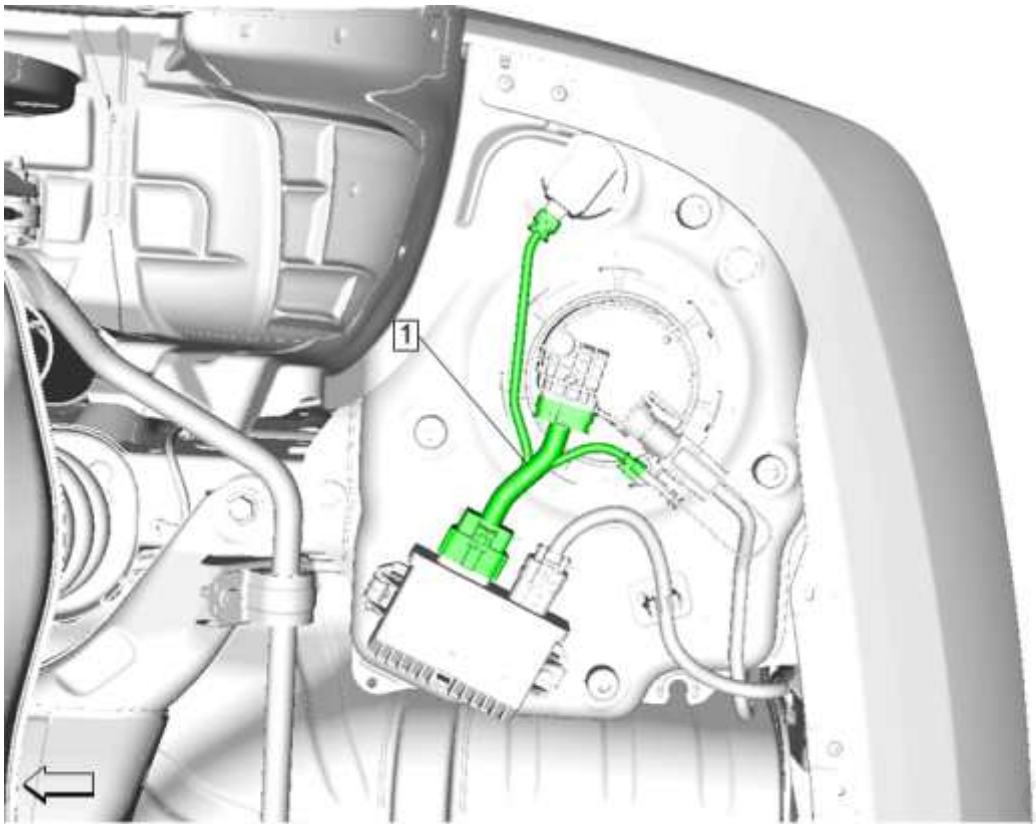

Fig. 493: Emission Reduction Fluid Tank Reservoir Wire Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Emission Reduction Fluid Tank Protector. Refer to **Emission Reduction Fluid Tank Protector Replacement**	
1	Emission Reduction Fluid Tank Reservoir Wire Harness **Procedure** Disconnect the emission reduction fluid tank wire harness connectors.

EMISSION REDUCTION FLUID TANK DRAINING

CAUTION: **The diesel exhaust fluid (DEF) system is part of the emission system for this vehicle, and must be serviced while observing extreme care to prevent foreign contamination of any kind from entering this system. If extreme care is NOT taken to prevent contamination from dirt, debris, fluids other than DEF, etc., reduced performance and/or damage to the DEF system may result.**

- **Cleanliness of the diesel exhaust fluid (DEF) system is crucial to ensure proper operation. Before opening any part of the DEF system, ensure connections and joints are thoroughly clean and dry of any dirt, debris, or other contaminants. Use only low pressure water and low pressure air, as directed.**
- **Diesel exhaust fluid (DEF) will have a tendency over time to develop areas of dried crystallization residue. Crystallization residue is a normal process for this fluid. Dried DEF crystallization residue can be wiped away, or flushed away with clean water, depending on location of the crystallization.**

1. Ensure the ignition is OFF.

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2. Using only a low pressure clean water hose, spray the filler hose cap and filler pocket to remove all dirt and debris.
3. Using only a low pressure air wand or air gun, direct air along the same surfaces to both dry and remove any further contaminants.
4. Remove the emission reduction fluid tank filler cap.

CAUTION: **The diesel exhaust fluid (DEF) must be drained by a clean dedicated siphoning pump and hose. It must NOT have any traces of gasoline, diesel fuel, or any oil based substances. If extreme care is NOT taken to prevent contamination from fluids other than DEF, reduced performance and/or damage to the DEF system may result.**

5. Insert the hose from the pump devise into the emission reduction fluid tank.
6. Using a hand or air operated pump device, drain as much emission reduction fluid from the tank as possible into an approved container and dispose of properly.

Refilling Emission Reduction Fluid Tank

1. Refill the emission reduction fluid tank, add a minimum of 9.5 liters (2.5 gallons).
2. Perform the reductant fluid tank level reset. Refer to **Reductant Fluid Tank Level Reset**

NITROGEN OXIDES SENSOR REPLACEMENT - POSITION 1

Special Tools

- **EN-6179** Oxygen Sensor Wrench

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Front Wheelhouse Liner-Right Side. Refer to **Front Wheelhouse Liner Replacement - Right Side (Equinox)** **Front Wheelhouse Liner Replacement - Right Side (Terrain)**
3. Remove Underbody Front Air Deflector. Refer to **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**

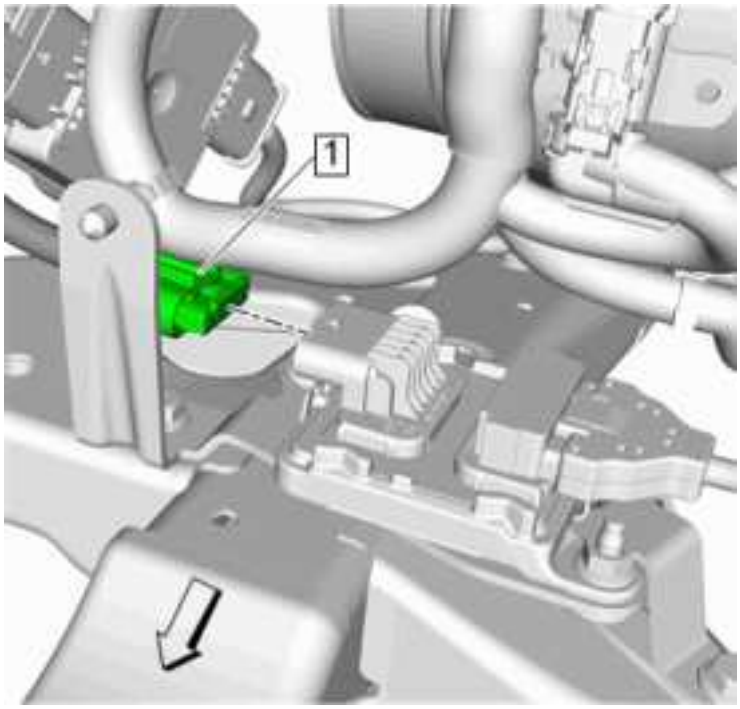

Fig. 494: Nitrogen Oxides Sensor - Position 1 Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

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CAUTION: **Do not disconnect the nitrogen oxide sensor from the nitrogen oxide sensor control module. A separation of the two components may cause a defect on the nitrogen oxide sensor control module. Always replace the nitrogen oxide sensor along with the nitrogen oxide sensor control module as an assembly.**

4. Disconnect the electrical connector. (1)

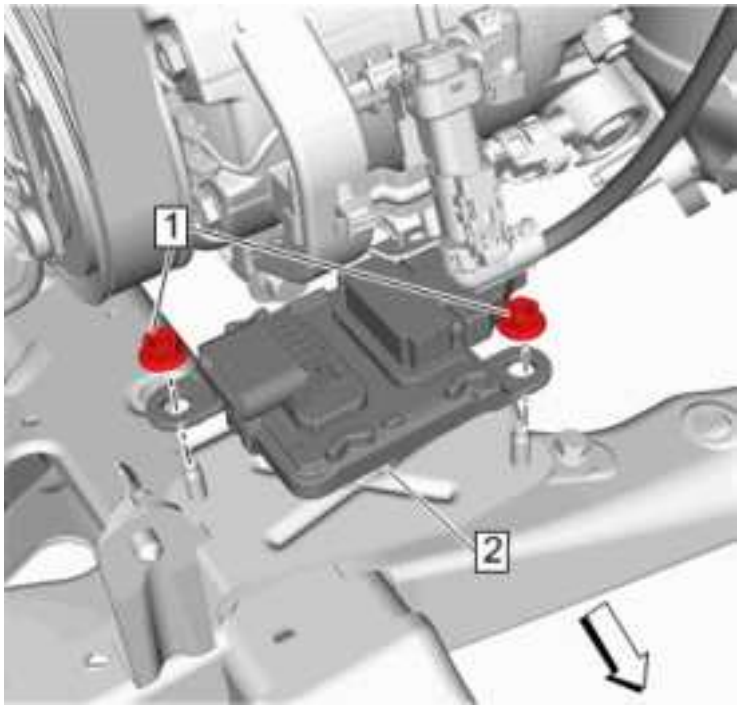

Fig. 495: Nitrogen Oxides Sensor - Position 1 Control Module And Nuts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 2 nitrogen oxides sensor control module nuts (1).

NOTE: **Do not bend the cable sharply at the base of either the sensing unit or sensor ECU in the final mounting position**

6. Remove the nitrogen oxides sensor control module (2).
7. Lower the vehicle.

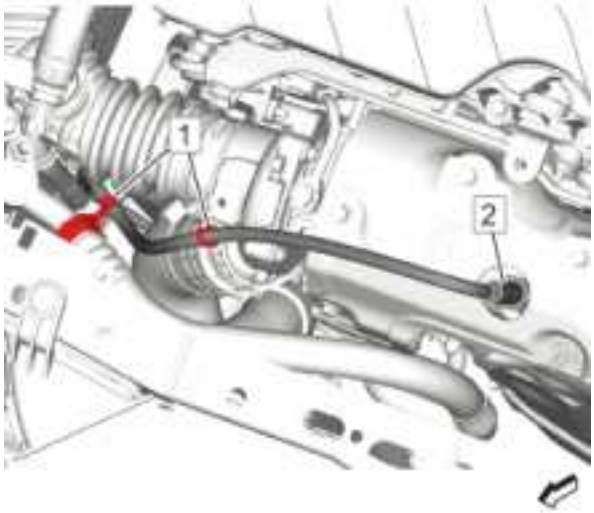

Fig. 496: Nitrogen Oxides Sensor - Position 1 And Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not bend the cable sharply at the base of either the sensing unit or sensor ECU in the final mounting position**

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8. Unclip Wiring Harness Retainers (1) (Qty: 2)
9. Remove Turbocharger Heat Shield. Refer to **Turbocharger Heat Shield Replacement (LH7)**

NOTE: **Use the special tool: *EN-6179* Oxygen Sensor Wrench**

10. Remove Nitrogen Oxides Sensor (2)
11. Remove the nitrogen oxides sensor assembly from the vehicle.

Installation Procedure

1. Install the nitrogen oxides sensor assembly to the vehicle.

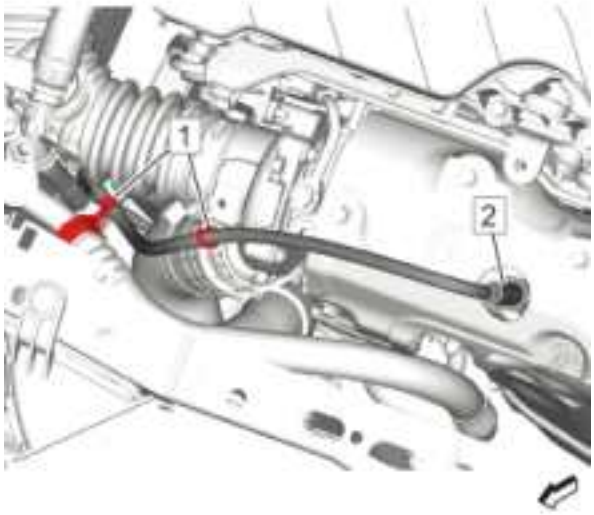

Fig. 497: Nitrogen Oxides Sensor - Position 1 And Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener Tightening Caution**

NOTE: **Do not bend the cable sharply at the base of either the sensing unit or sensor ECU in the final mounting position**

NOTE: **Use the special tool: *EN-6179* Oxygen Sensor Wrench**

2. Install and tighten Nitrogen Oxides Sensor (2) to 50 N.m (37 lb ft)
3. Install Turbocharger Heat Shield. Refer to **Turbocharger Heat Shield Replacement (LH7)**
4. Install Wiring Harness Retainers (1) (Qty: 2)
5. Raise the vehicle.

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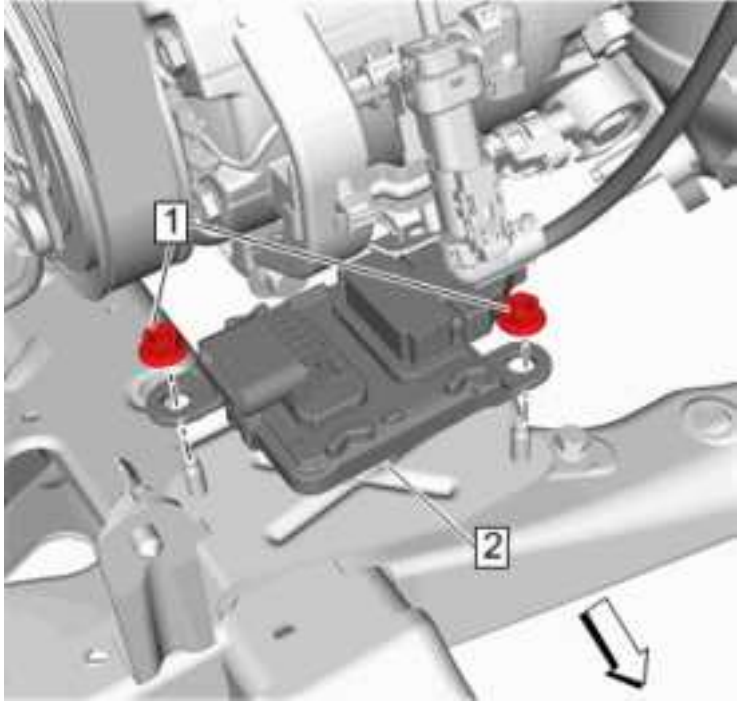

Fig. 498: Nitrogen Oxides Sensor - Position 1 Control Module And Nuts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not bend the cable sharply at the base of either the sensing unit or sensor ECU in the final mounting position**

6. Install the nitrogen oxides sensor control module (2).

CAUTION: **Refer to Fastener Caution**

7. Install the 2 nitrogen oxides sensor control module nuts (1) and tighten to 9 N.m (80 lb in).

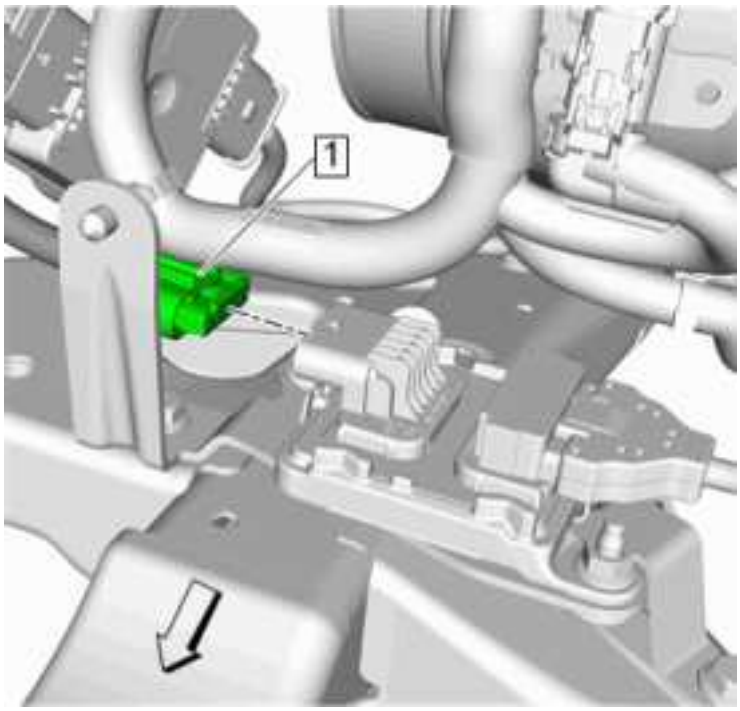

Fig. 499: Nitrogen Oxides Sensor - Position 1 Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

8. Connect the electrical connector. (1)
9. Install Underbody Front Air Deflector. Refer to Underbody Front Air Deflector Replacement (Equinox) Underbody Front Air Deflector Replacement (Terrain)
10. Install Front Wheelhouse Liner-Right Side. Refer to Front Wheelhouse Liner Replacement - Right Side (Equinox) Front Wheelhouse Liner Replacement - Right Side (Terrain)

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11. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
12. If replacing, perform the NOx sensor 1 reset. Refer to **NOx Sensor 1 Reset**
13. If replacing, perform the NOx catalyst reductant loading reset. Refer to **NOx Catalyst Reductant Loading Reset**

NITROGEN OXIDES SENSOR REPLACEMENT - POSITION 2

Removal Procedure

WARNING: **Refer to Exhaust Service Warning**

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

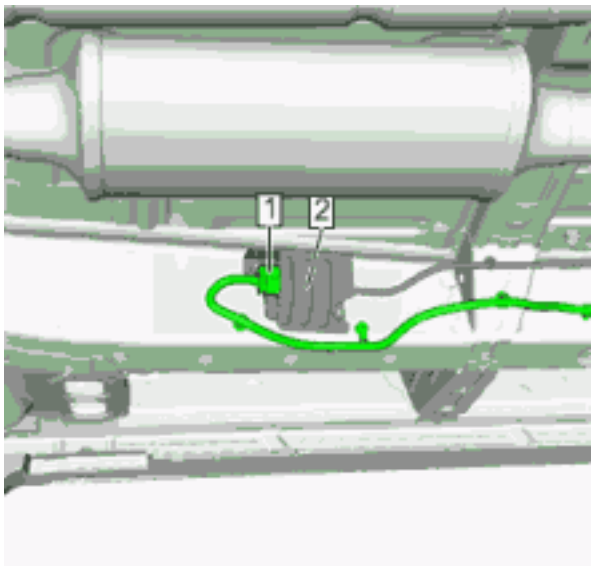

Fig. 500: Nitrogen Oxides Sensor - Position 2 Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Do not disconnect the nitrogen oxide sensor from the nitrogen oxide sensor control module. A separation of the two components may cause a defect on the nitrogen oxide sensor control module. Always replace the nitrogen oxide sensor along with the nitrogen oxide sensor control module as an assembly.**

3. Remove Electrical Connector (1)

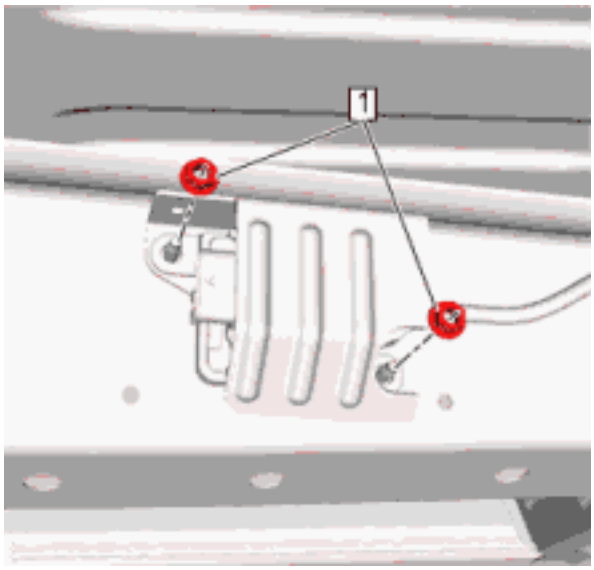

Fig. 501: Nitrogen Oxides Sensor - Position 2 Nuts
Courtesy of GENERAL MOTORS COMPANY

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4. Remove Nitrogen Oxides Sensor Nuts (1) (Qty: 2)

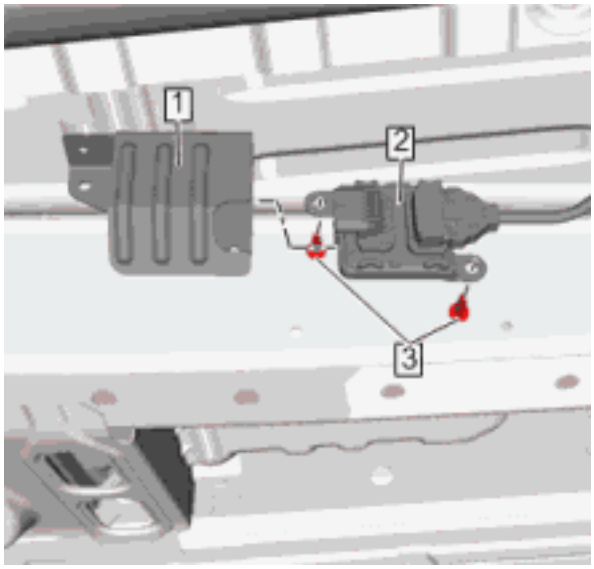

Fig. 502: Nitrogen Oxides Sensor - Position 2 Control Module, Bracket And Side Rail Studs
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Secure the nitrogen oxides sensor control module in a location that prevents unnecessary binding or strain on the cable.**

5. Remove both the nitrogen oxides sensor control module bracket (1) and the nitrogen oxides sensor control module (2) from the front compartment side rail studs (3).

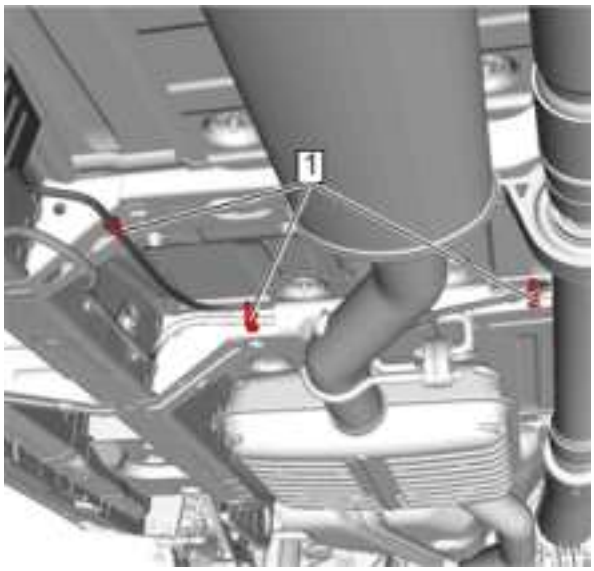

Fig. 503: Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

6. Unclip Wiring Harness Retainers (1) (Qty: 3)

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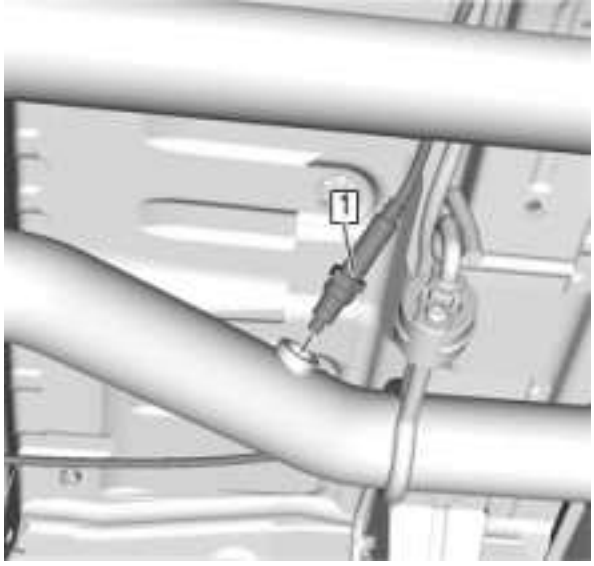

Fig. 504: Nitrogen Oxides Sensor - Position 2
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not bend the cable sharply at the base of either the sensing unit or sensor ECU in the final mounting position**

7. Remove the nitrogen oxides sensor (1) from the exhaust pipe.

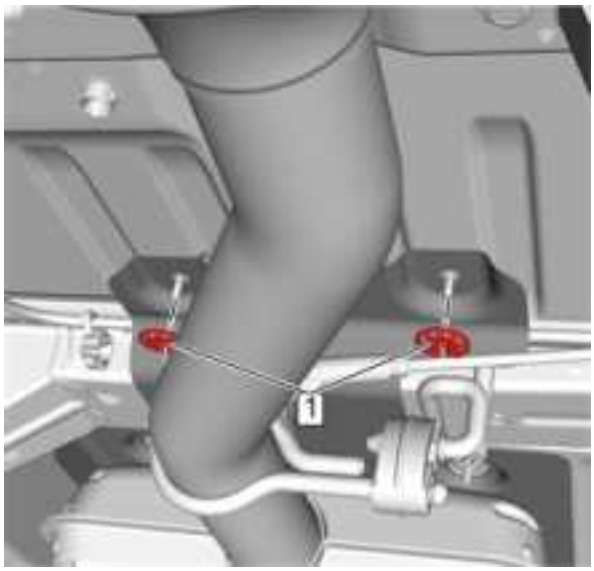

Fig. 505: Exhaust Heat Shield Retainers
Courtesy of GENERAL MOTORS COMPANY

8. Remove Exhaust Heat Shield Retainers (1) (Qty: 2)
9. Remove the nitrogen oxides sensor assembly from the vehicle.

Installation Procedure

CAUTION: **Do not disconnect the nitrogen oxide sensor from the nitrogen oxide sensor control module. A separation of the two components may cause a defect on the nitrogen oxide sensor control module. Always replace the nitrogen oxide sensor along with the nitrogen oxide sensor control module as an assembly.**

1. Install the nitrogen oxides sensor assembly to the vehicle.

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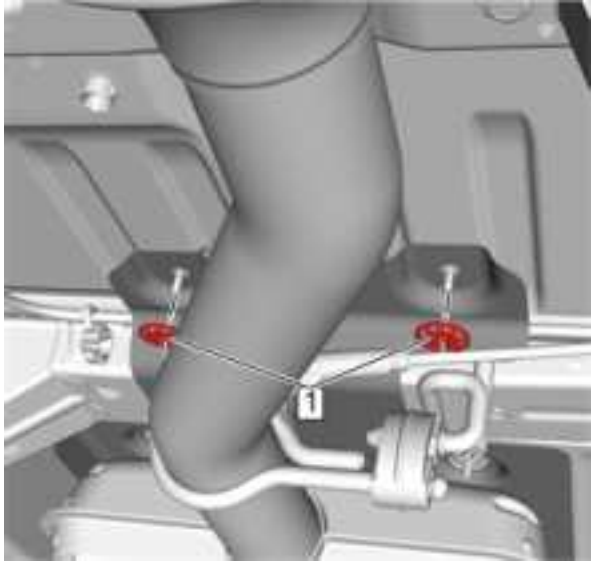

Fig. 506: Exhaust Heat Shield Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Install Exhaust Heat Shield Retainers (1) (Qty: 2)

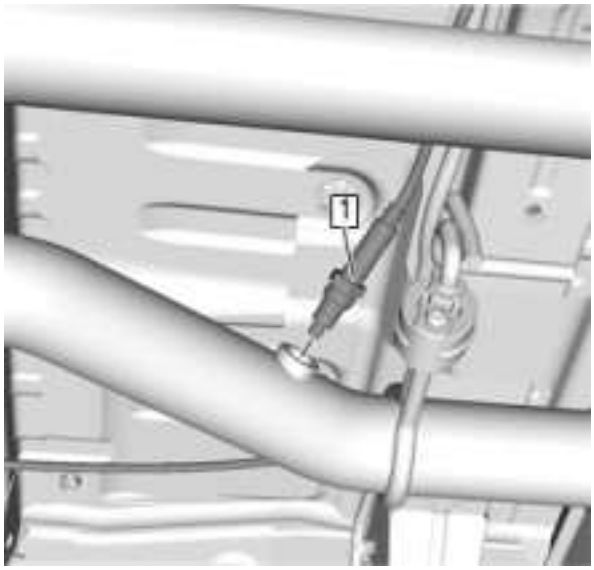

Fig. 507: Nitrogen Oxides Sensor - Position 2
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener Tightening Caution .**

NOTE: **Do not bend the cable sharply at the base of either the sensing unit or sensor ECU in the final mounting position**

3. Install the nitrogen oxides sensor (1) to the exhaust pipe and tighten to 50 N.m (37 lb ft).

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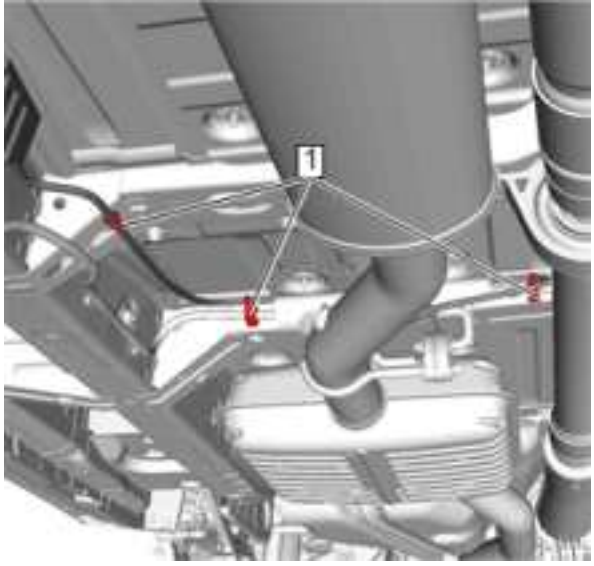

Fig. 508: Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Install Wiring Harness Retainers (1) (Qty: 3)

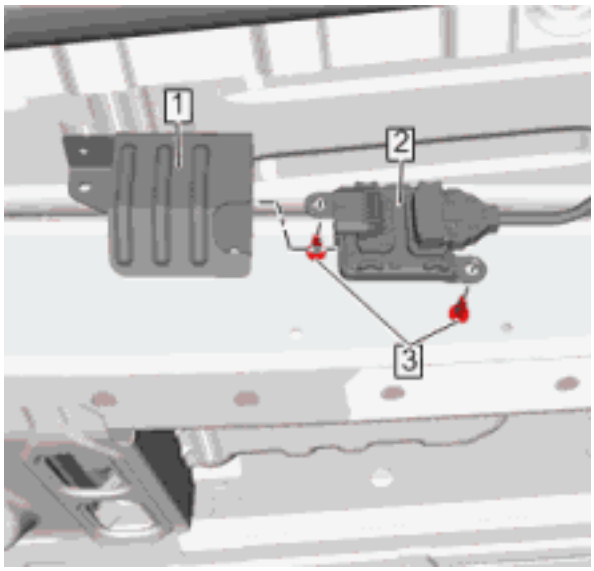

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Fig. 509: Nitrogen Oxides Sensor - Position 2 Control Module, Bracket And Side Rail Studs
Courtesy of GENERAL MOTORS COMPANY

5. Install both the nitrogen oxides sensor control module bracket (1) and the nitrogen oxides sensor control module (2) to the front compartment side rail studs (3).

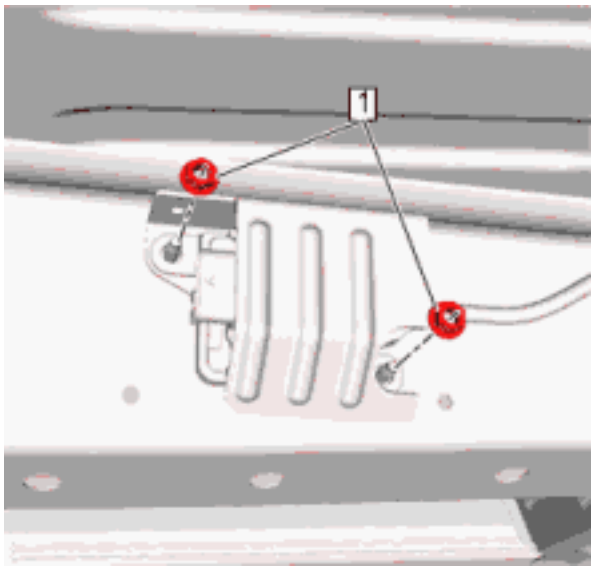

Fig. 510: Nitrogen Oxides Sensor - Position 2 Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

6. Install and tighten Nitrogen Oxides Sensor Nuts (1) (Qty: 2) to 9 N.m (80 lb in)

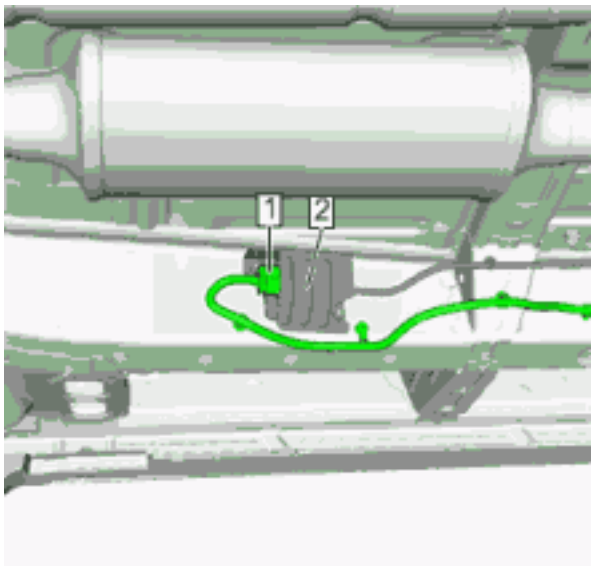

Fig. 511: Nitrogen Oxides Sensor - Position 2 Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

7. Connect Electrical Connector (1)
8. Remove the supports and lower the vehicle.
9. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
10. If replacing, perform the NOx sensor 2 reset. Refer to **NOx Sensor 2 Reset**
11. If replacing, perform the NOx catalyst reductant loading reset. Refer to **NOx Catalyst Reductant Loading Reset**

CHARGE AIR COOLER INLET AIR TUBE REPLACEMENT

Removal Procedure

1. Remove Air Cleaner Outlet Duct. Refer to **Air Cleaner Outlet Duct Replacement**

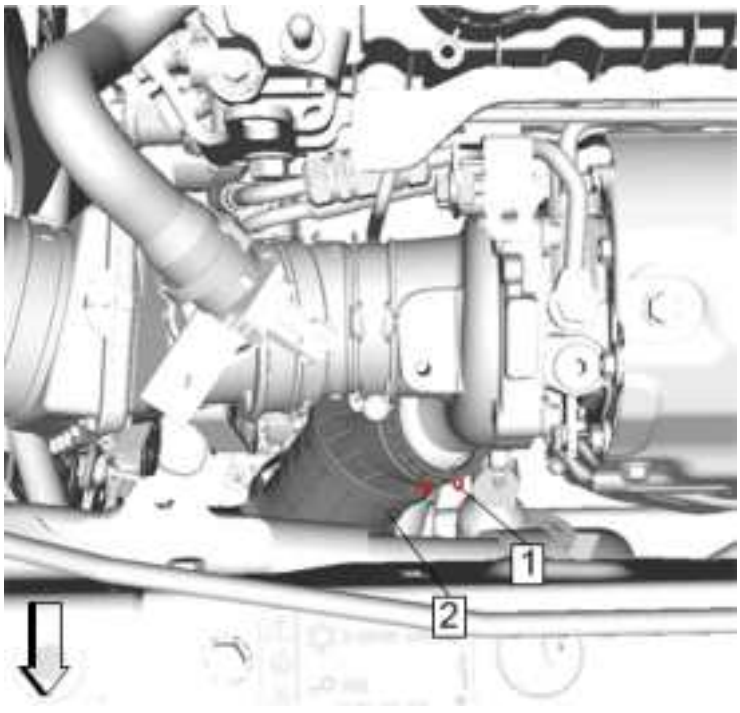

Fig. 512: Charge Air Cooler Inlet Air Tube And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

2. Release Retainer Spring (1)

3. Remove Charge Air Cooler Inlet Air Tube (2)
4. Remove Underbody Front Air Deflector. Refer to **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**

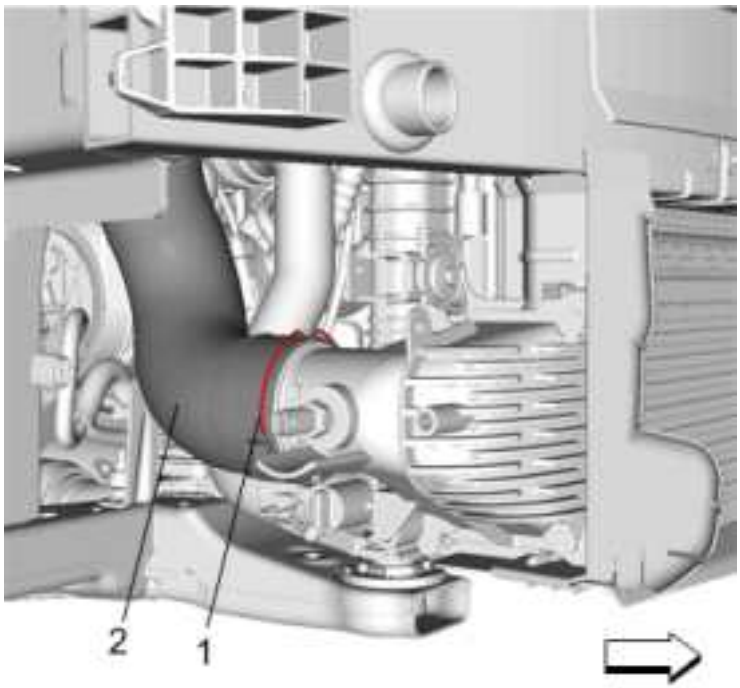

Fig. 513: Charge Air Cooler Inlet Air Tube And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

5. Release Retainer Spring (1)
6. Remove Charge Air Cooler Inlet Air Tube (2)

Installation Procedure

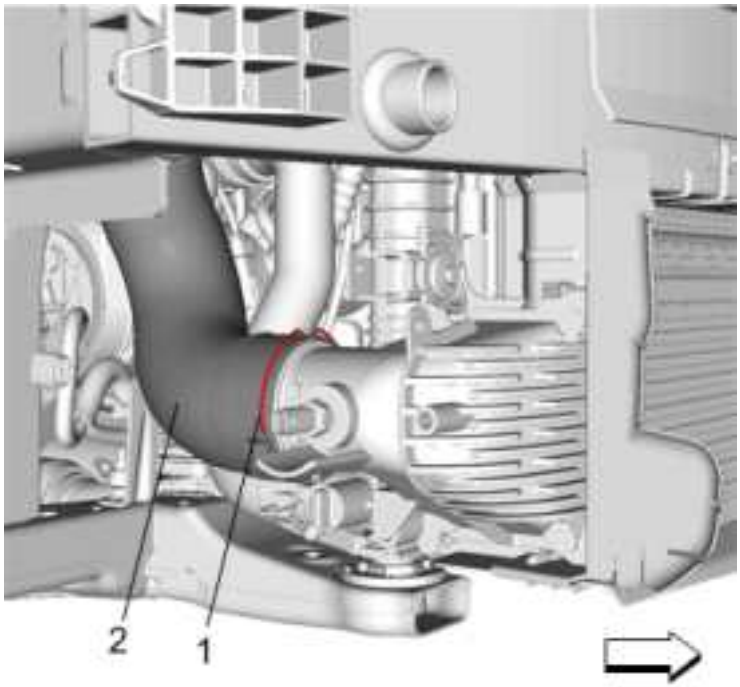

Fig. 514: Charge Air Cooler Inlet Air Tube And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

1. Install Charge Air Cooler Inlet Air Tube (2)
2. Engage Retainer Spring (1)
3. Install Underbody Front Air Deflector. Refer to **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**

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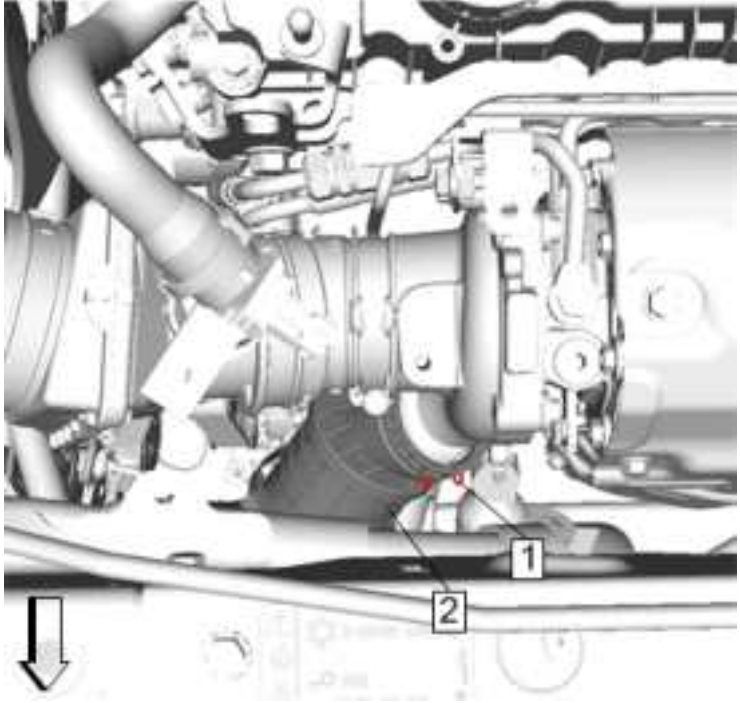

Fig. 515: Charge Air Cooler Inlet Air Tube And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

4. Install Charge Air Cooler Inlet Air Tube (2)
5. Engage Retainer Spring (1)
6. Install Air Cleaner Outlet Duct. Refer to **Air Cleaner Outlet Duct Replacement**

CHARGE AIR COOLER OUTLET AIR TUBE REPLACEMENT

Removal Procedure

1. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

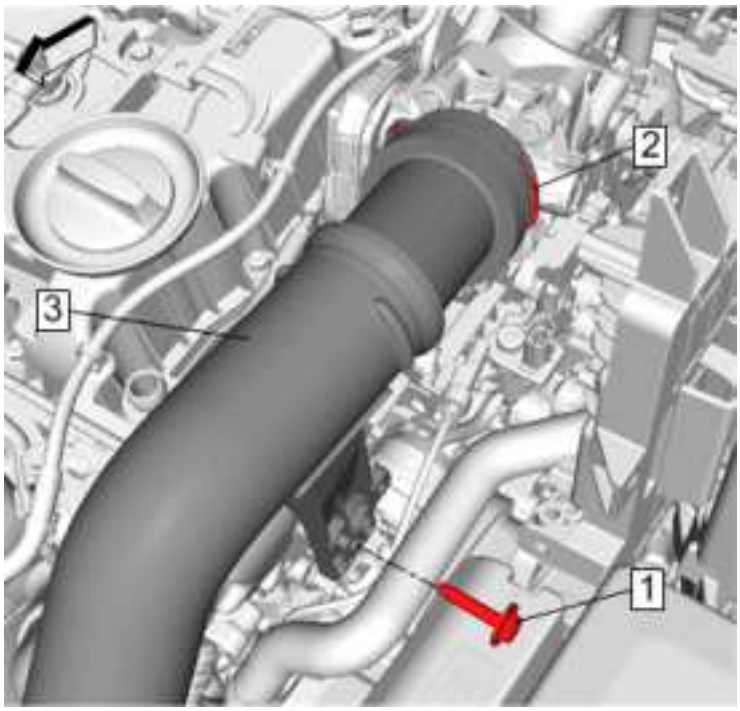

Fig. 516: Charge Air Cooler Outlet Air Tube, Bolt And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

2. Remove Charge Air Cooler Outlet Air Tube Bolt (1)
3. Release Retainer Spring (2)
4. Remove Charge Air Cooler Outlet Air Tube (3)
5. Disconnect harness retainer.

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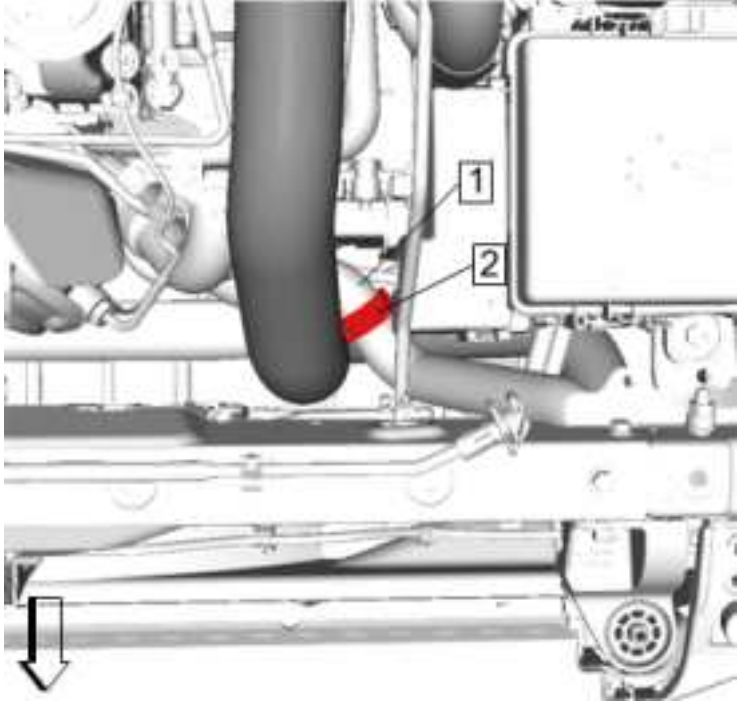

Fig. 517: Radiator Inlet Hose And Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Remove Radiator Inlet Hose (1) @ Retainer (2)
7. Remove Underbody Front Air Deflector. Refer to **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**
8. Disconnect the cooling fan 2 wire connector and disconnect from the shroud.

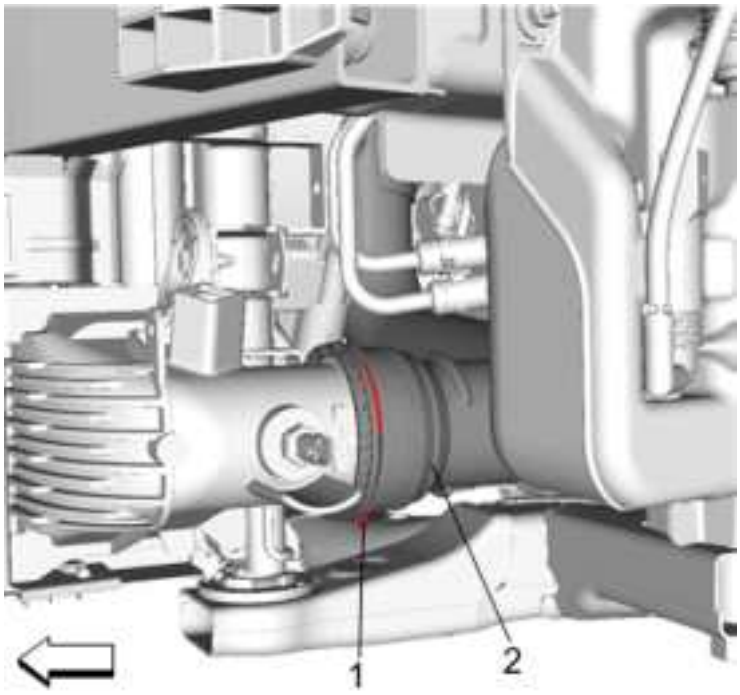

Fig. 518: Charge Air Cooler Outlet Air Tube And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

9. Release Retainer Spring (1)

NOTE: **Remove the tube from the vehicle from the top.**

10. Remove Charge Air Cooler Outlet Air Tube (2)

Installation Procedure

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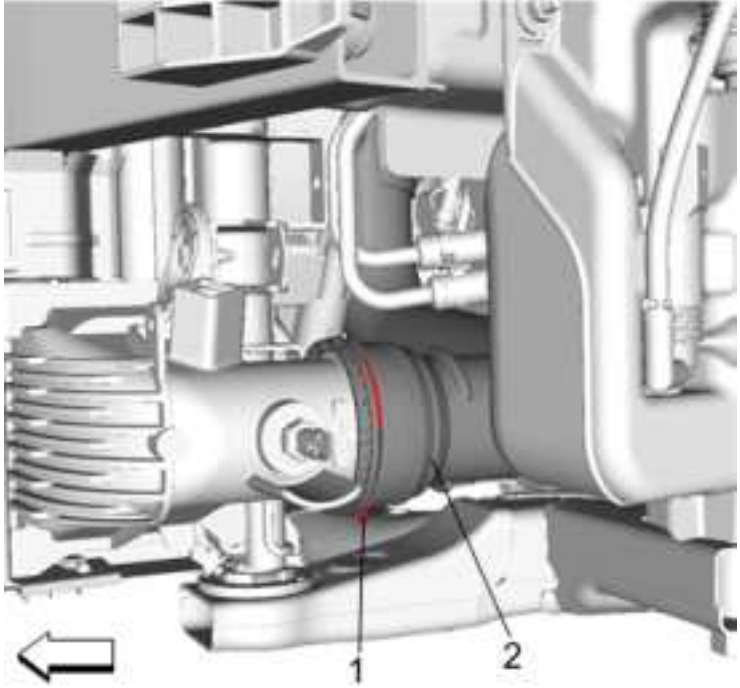

Fig. 519: Charge Air Cooler Outlet Air Tube And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the tube to the vehicle from the top.**

1. Install Charge Air Cooler Outlet Air Tube (2)
2. Engage Retainer Spring (1)
3. Reconnect the 2 wire cooling fan connector and retainer to the shroud.
4. Install Underbody Front Air Deflector. Refer to **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**

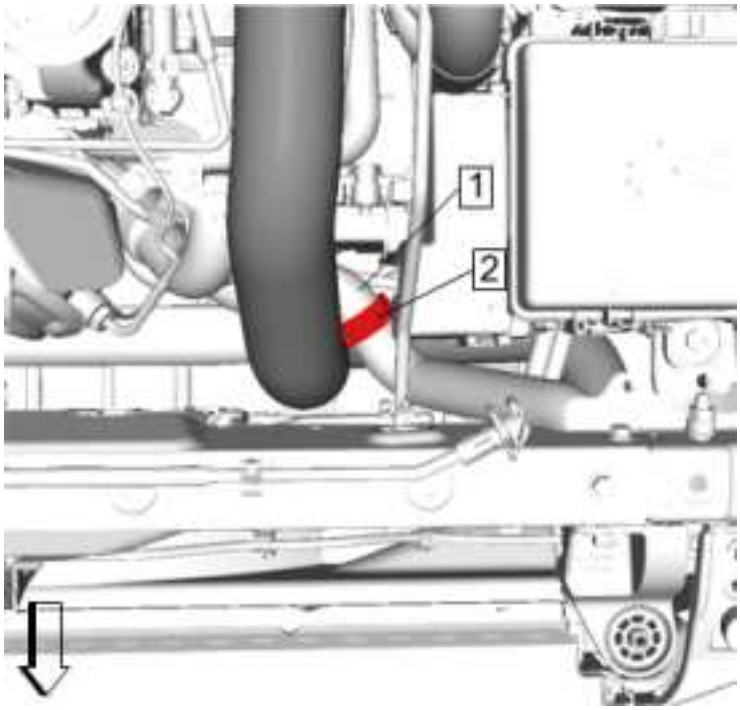

Fig. 520: Radiator Inlet Hose And Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Install Radiator Inlet Hose (1) @ Retainer (2)

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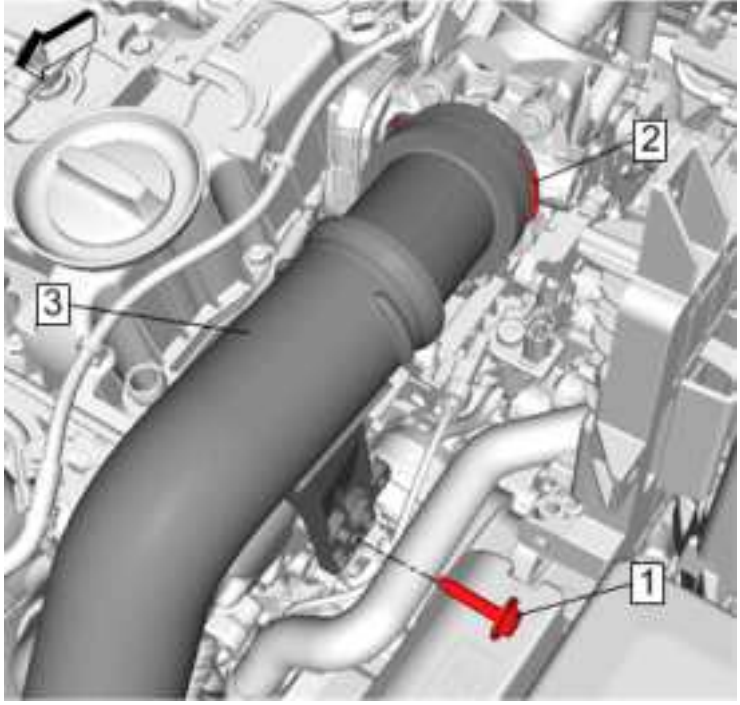

Fig. 521: Charge Air Cooler Outlet Air Tube, Bolt And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

6. Install Charge Air Cooler Outlet Air Tube (3)
7. Engage Retainer Spring (2)

CAUTION: **Refer to Fastener Caution .**

8. Install and tighten Charge Air Cooler Outlet Air Tube Bolt (1) to 9 N.m (80 lb in)
9. Install the wire harness retainer.
10. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

CHARGE AIR TEMPERATURE SENSOR REPLACEMENT (INLET)

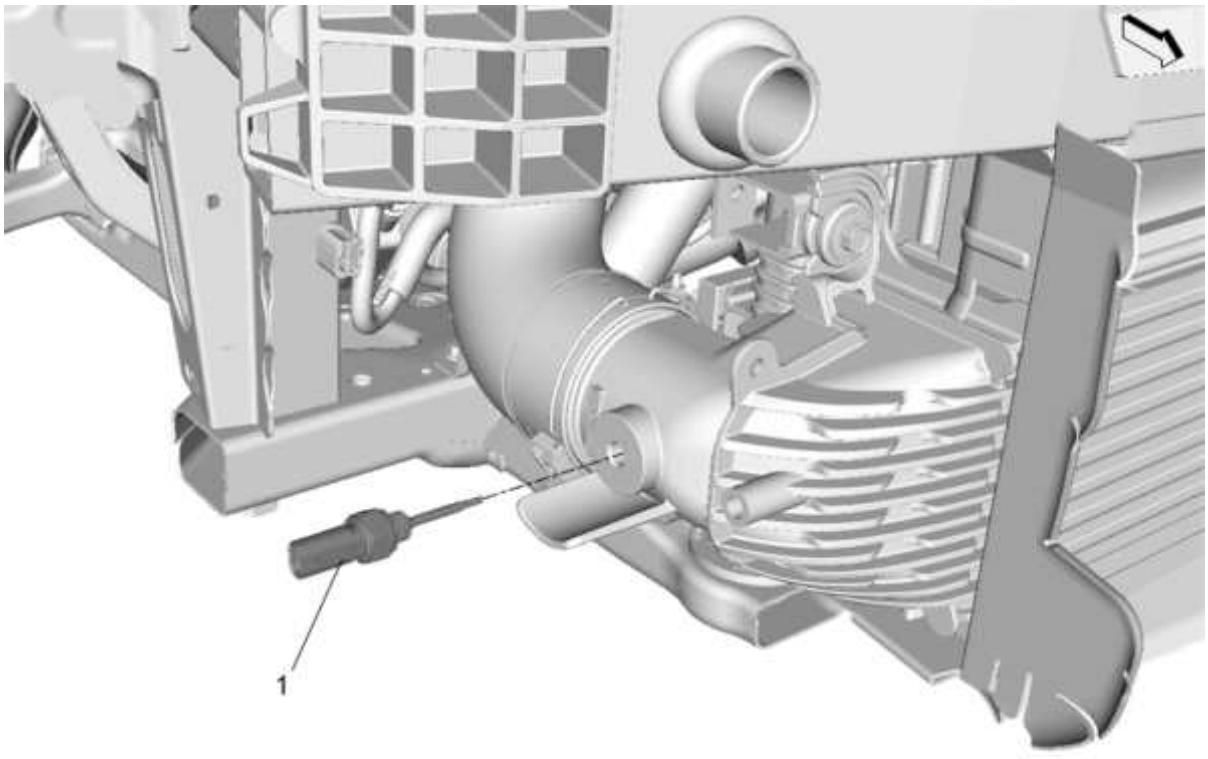

Fig. 522: Charge Air Temperature Sensor (Inlet)
Courtesy of GENERAL MOTORS COMPANY

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Callout	Component Name
Preliminary Procedure Remove Underbody Front Air Deflector. Refer to Underbody Front Air Deflector Replacement (Equinox) Underbody Front Air Deflector Replacement (Terrain)	
1	Charge Air Temperature Sensor **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** Disconnect the electrical connector. **Tighten** 19 N.m (14 lb ft)

CHARGE AIR TEMPERATURE SENSOR REPLACEMENT (OUTLET)

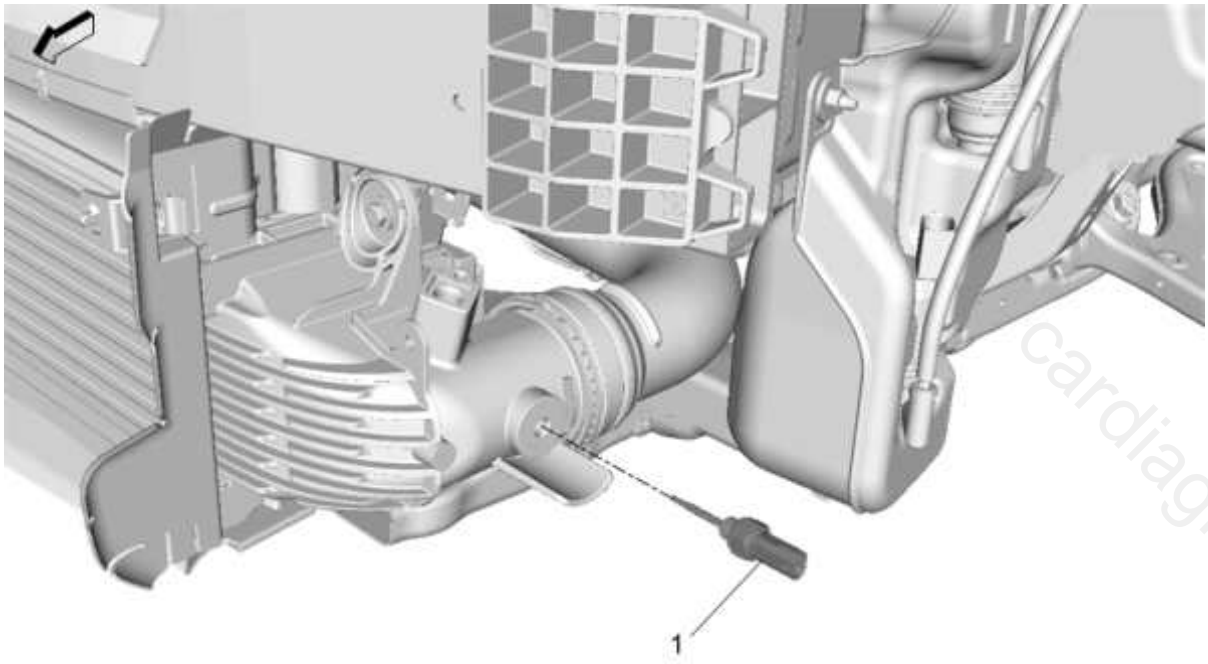

Fig. 523: Charge Air Temperature Sensor (Outlet)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Underbody Front Air Deflector. Refer to Underbody Front Air Deflector Replacement (Equinox) Underbody Front Air Deflector Replacement (Terrain)	
1	Charge Air Temperature Sensor **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** Disconnect the electrical connector. **Tighten** 19 N.m (14 lb ft)

CHARGE AIR COOLER REPLACEMENT

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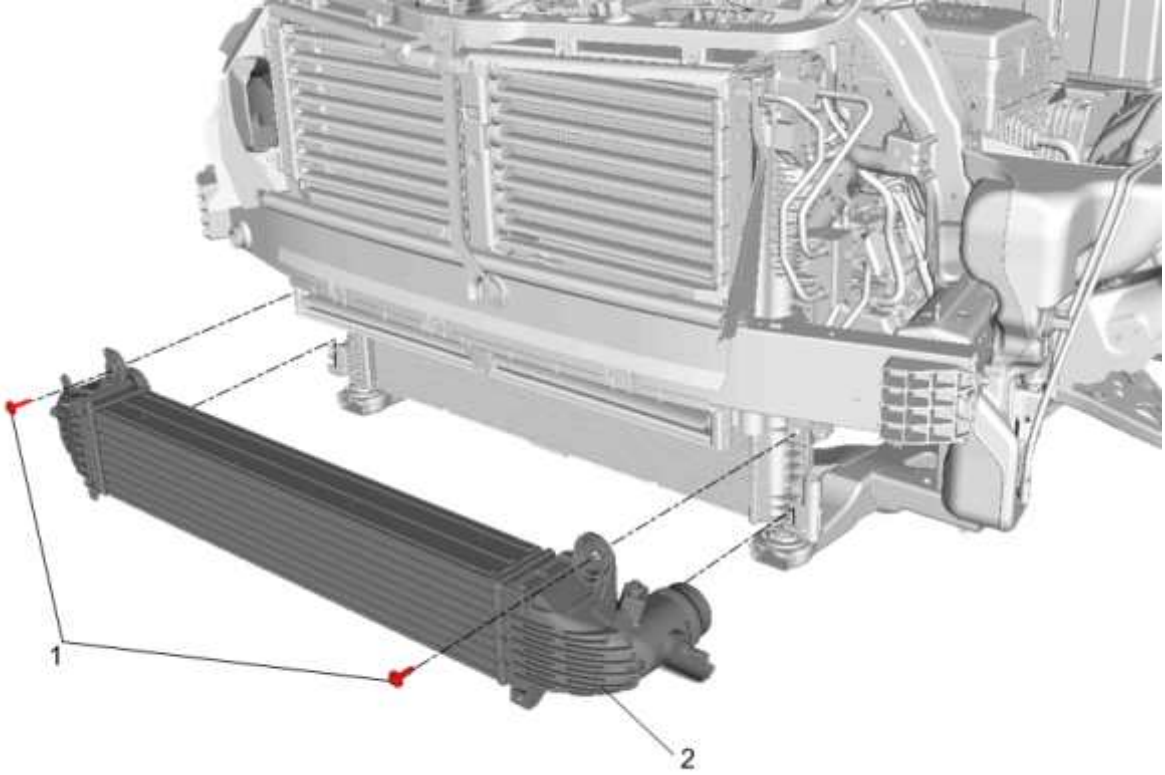

Fig. 524: Charge Air Cooler
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove Radiator Air Lower Baffle. Refer to **Radiator Air Lower Baffle Replacement (LH7 LTG LYX)** 2. Disconnect Charge Air Cooler Outlet Air Tube @ Charge Air Cooler. Refer to **Charge Air Cooler Outlet Air Tube Replacement** 3. Disconnect Charge Air Cooler Inlet Air Tube @ Charge Air Cooler. Refer to **Charge Air Cooler Inlet Air Tube Replacement** 4. Disconnect the electrical connector.	
1	Charge Air Cooler Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Charge Air Cooler **Procedure** Transfer parts as necessary.

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Back To Article

Engine Controls And Fuel - 1.6L (LH7) Diesel - Schematic And Routing Diagrams - Engine Controls Schematics - Equinox & Terrain

SCHEMATIC WIRING DIAGRAMS

ENGINE CONTROLS WIRING SCHEMATICS 1.6L (LH7)

Power, Ground, Serial Data, and MIL

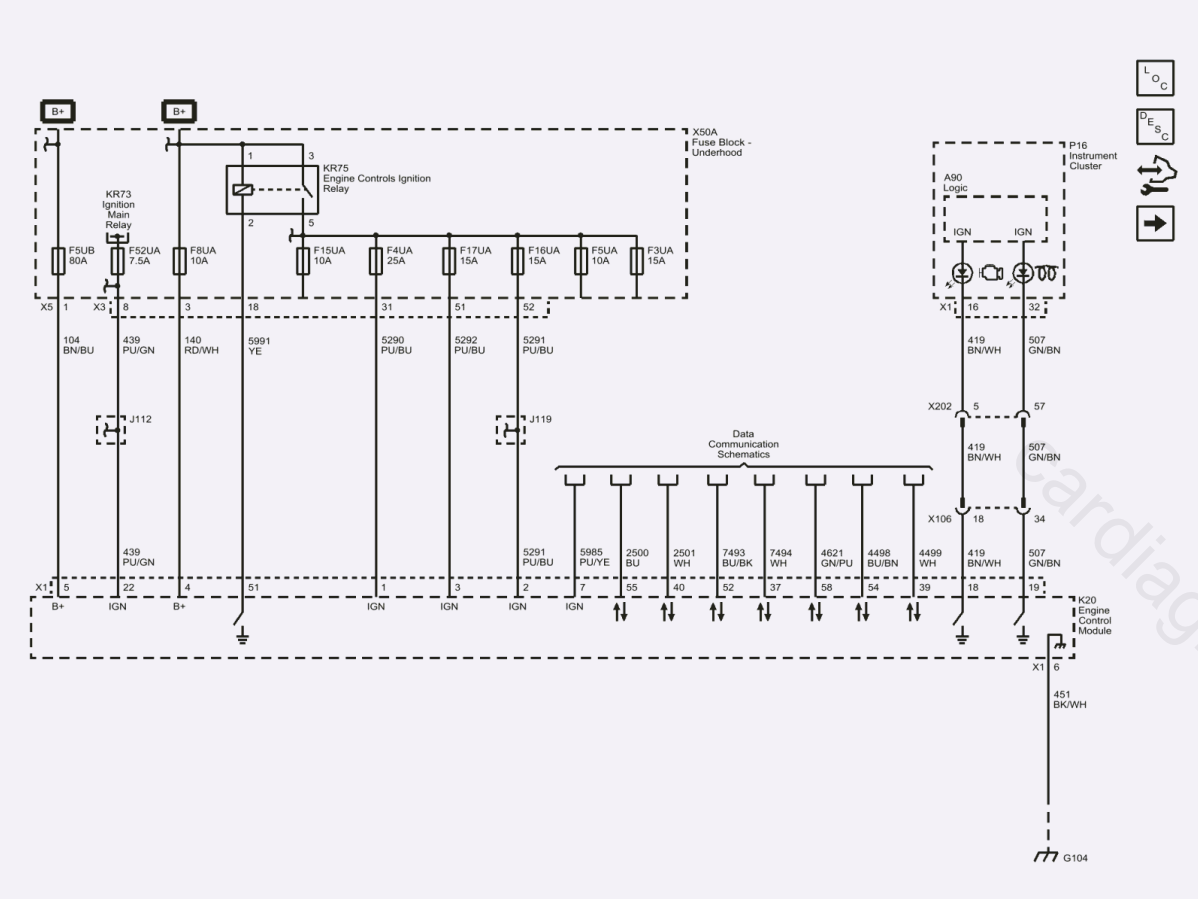

Fig. 1: Power, Ground, Serial Data, and MIL
Courtesy of GENERAL MOTORS COMPANY

5V1, and Low Reference Bus (1 of 3)

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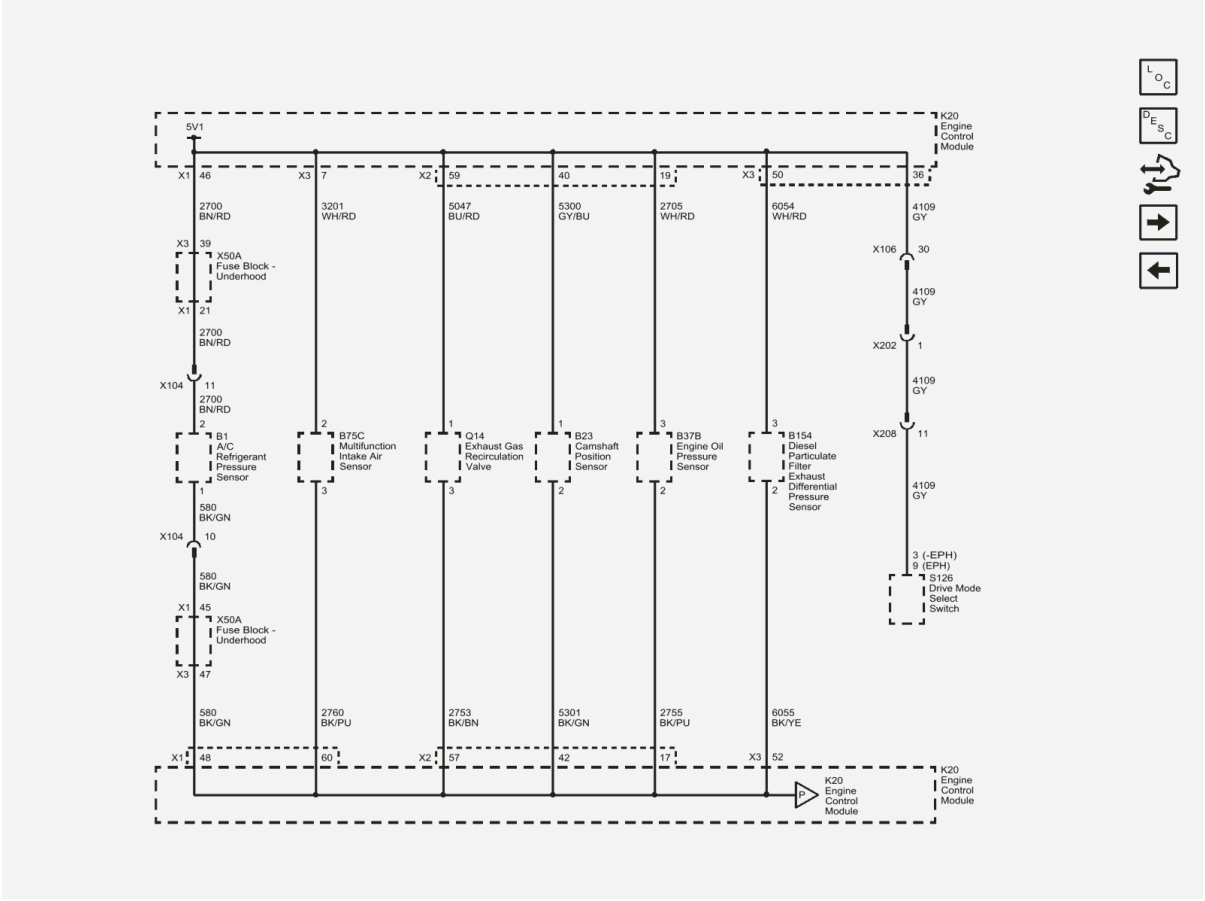

Fig. 2: 5V1, and Low Reference Bus (1 of 3)
Courtesy of GENERAL MOTORS COMPANY

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5V2, 5V3, 5V4, and Low Reference Bus (2 of 3)

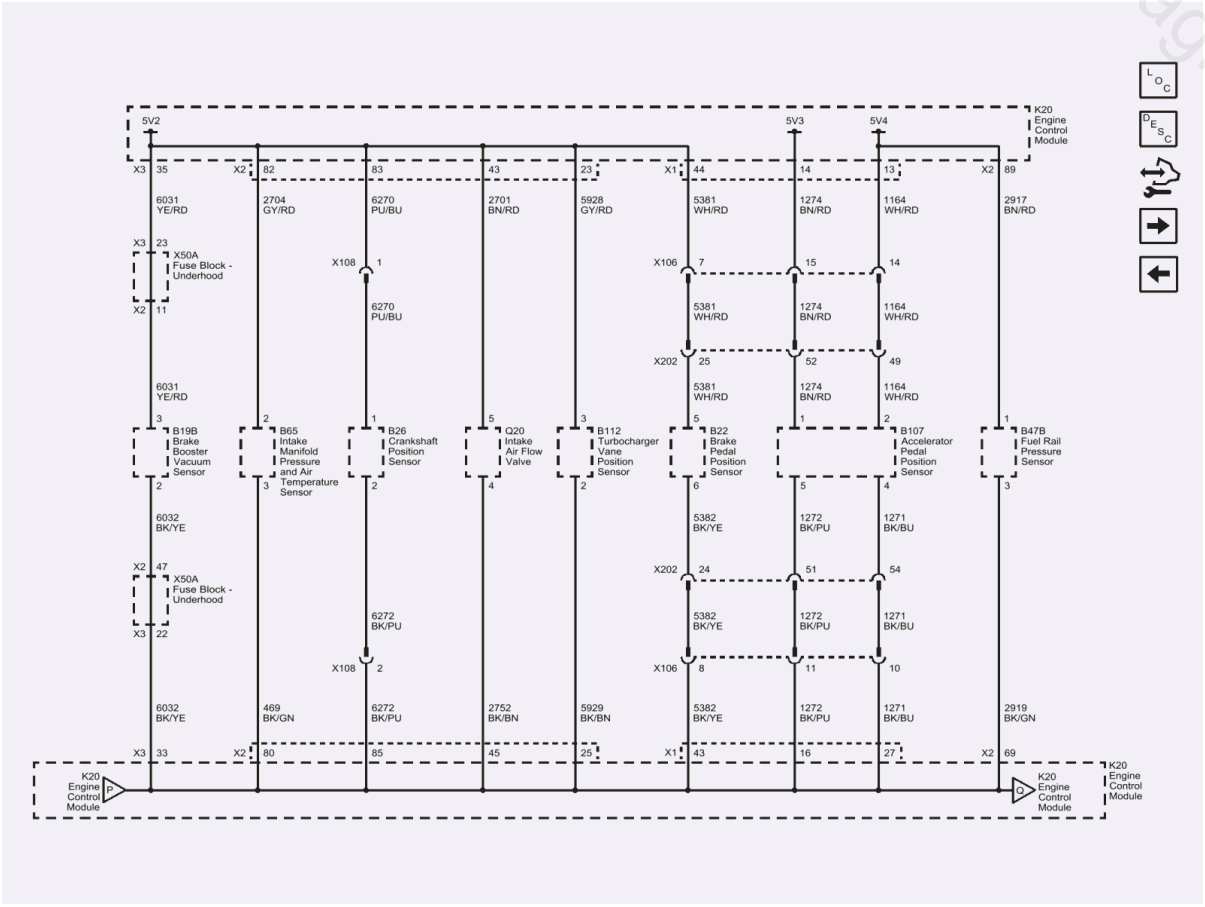

Fig. 3: 5V2, 5V3, 5V4, and Low Reference Bus (2 of 3)
Courtesy of GENERAL MOTORS COMPANY

Low Reference Bus (3 of 3)

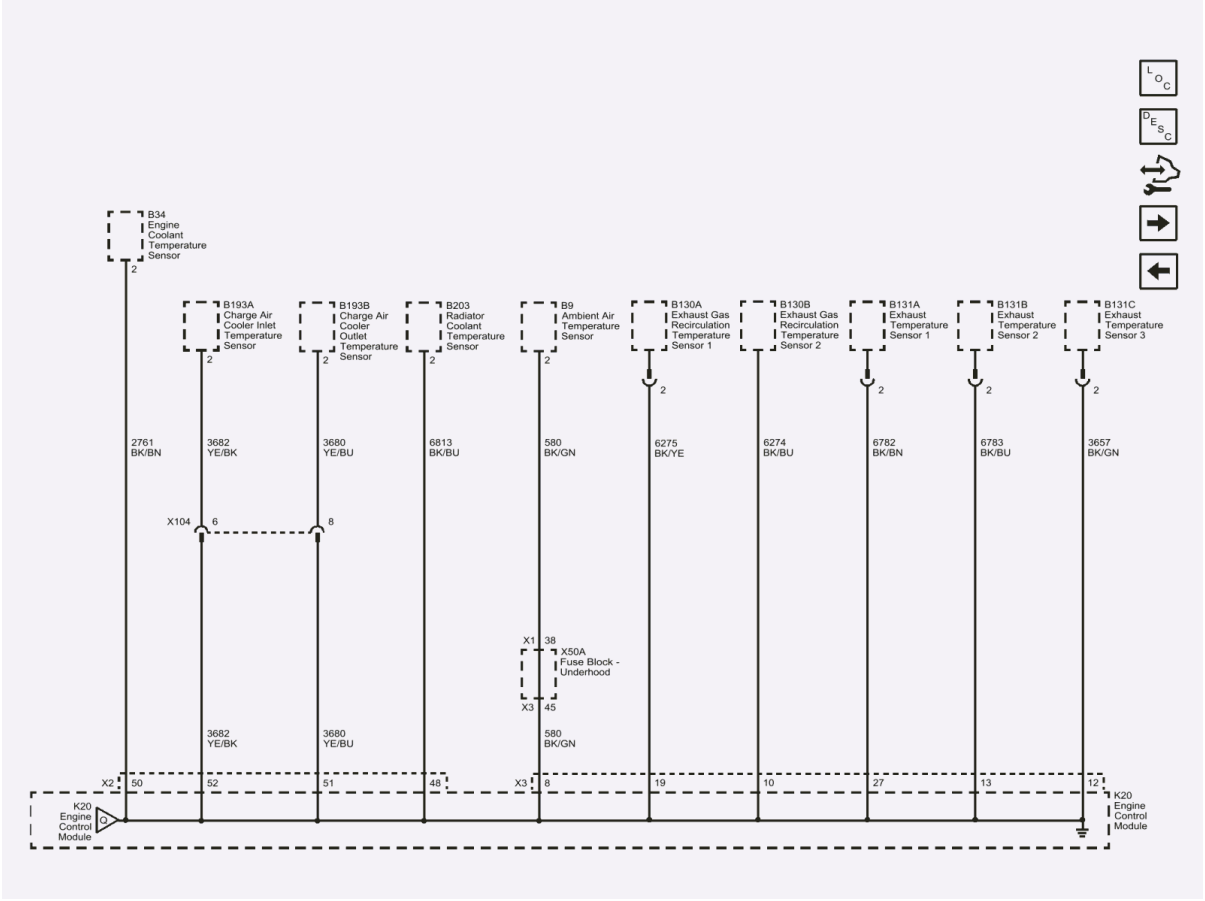

Fig. 4: Low Reference Bus (3 of 3)
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Temperature, and Diesel Particulate Filter Exhaust Differential Pressure Sensor

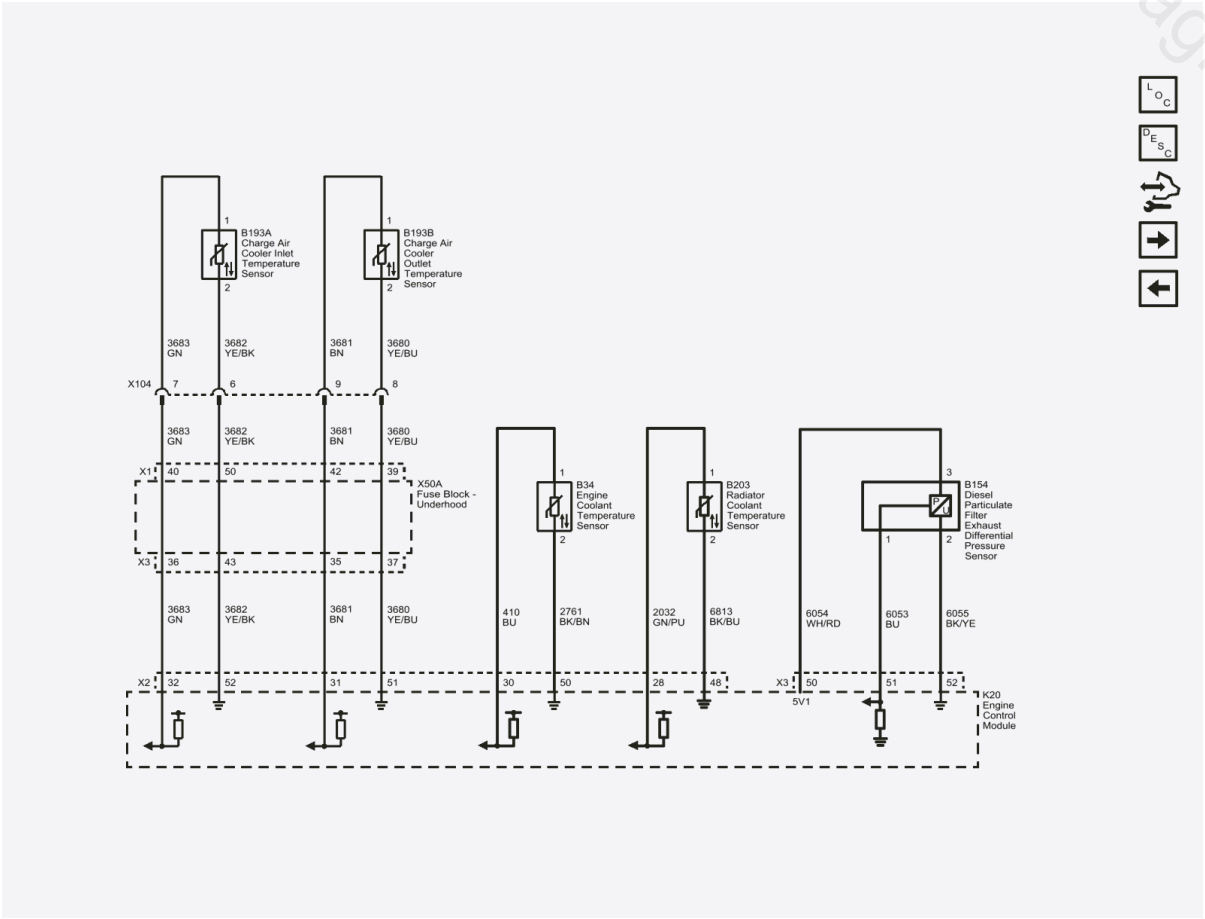

Fig. 5: Engine Data Sensors - Temperature, and Diesel Particulate Filter Exhaust Differential Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Throttle and Brake Sensor Controls

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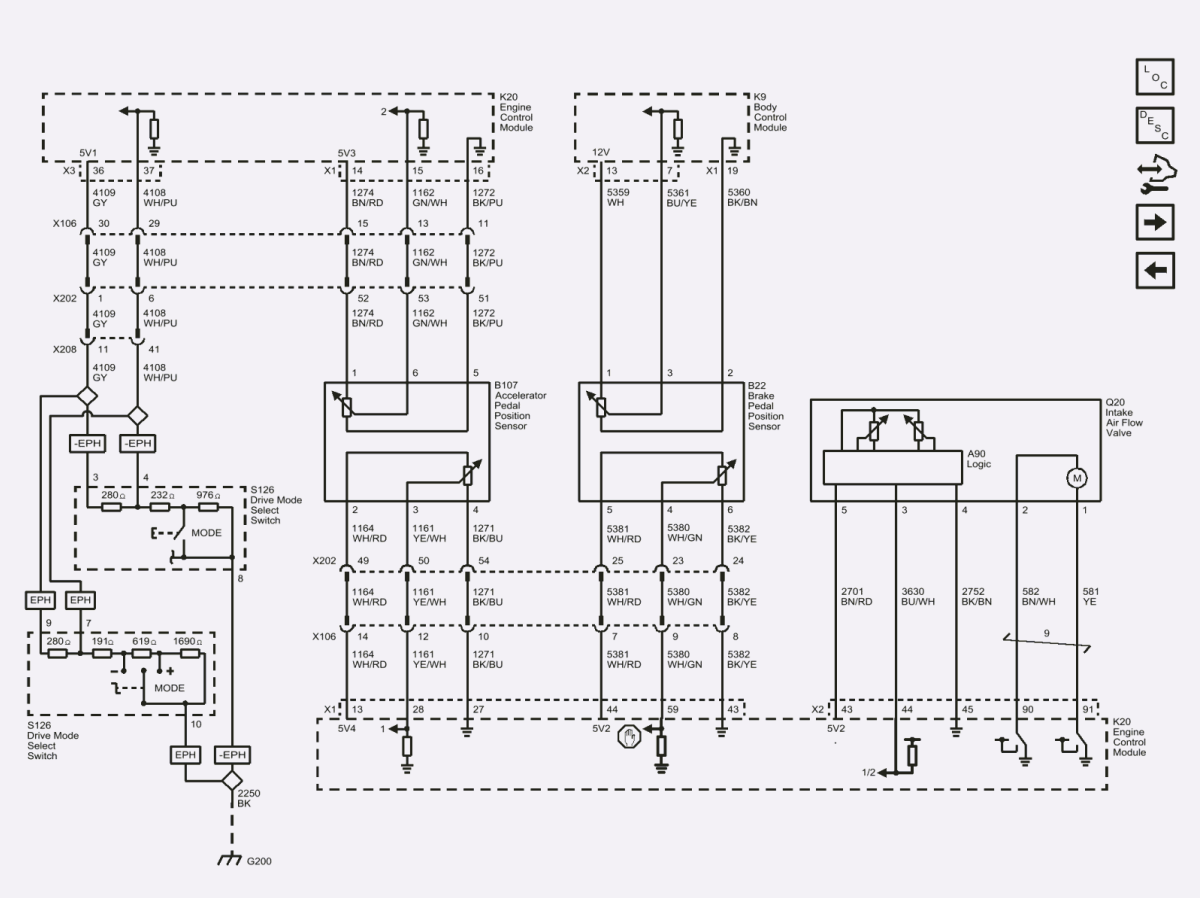

Fig. 6: Engine Data Sensors - Throttle and Brake Sensor Controls
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Exhaust Temperature Sensors

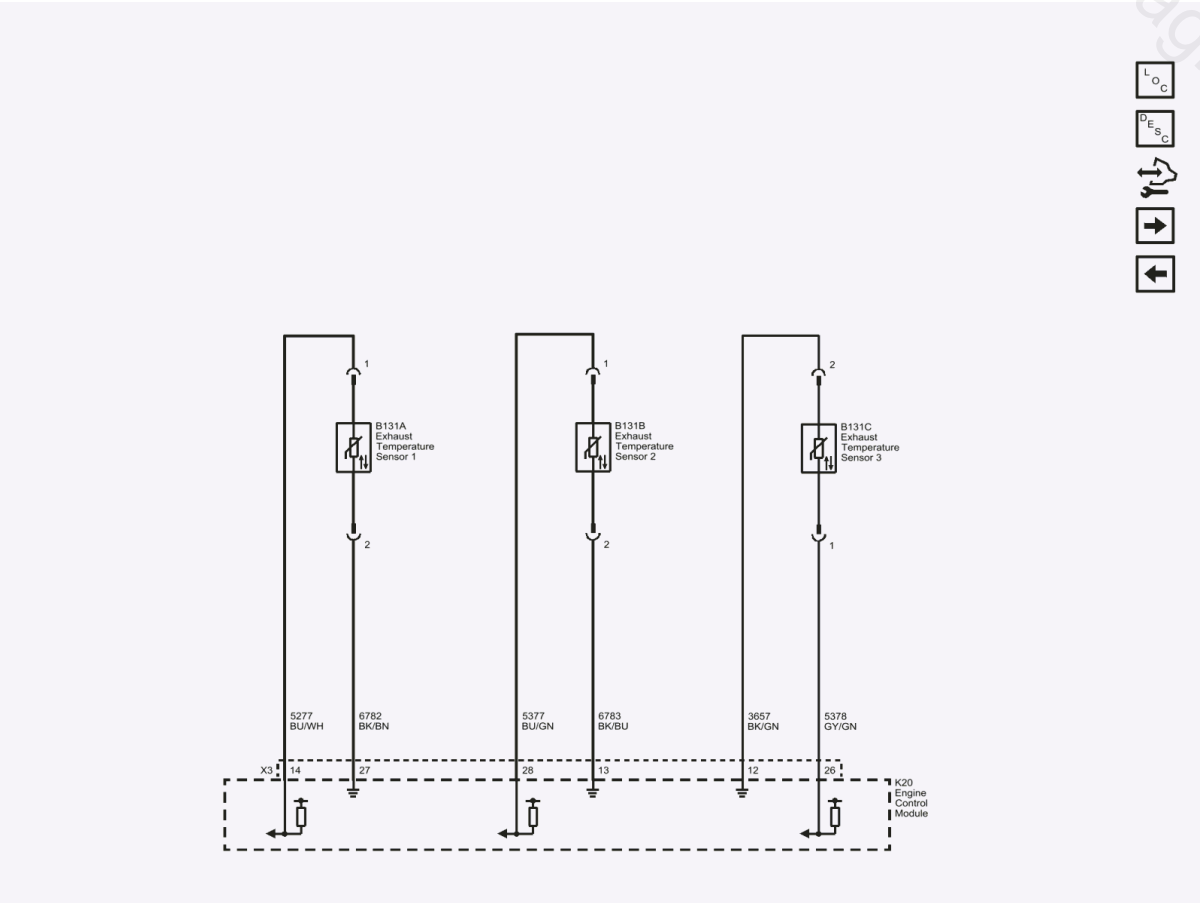

Fig. 7: Engine Data Sensors - Exhaust Temperature Sensors
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - EGR and Turbocharger Controls

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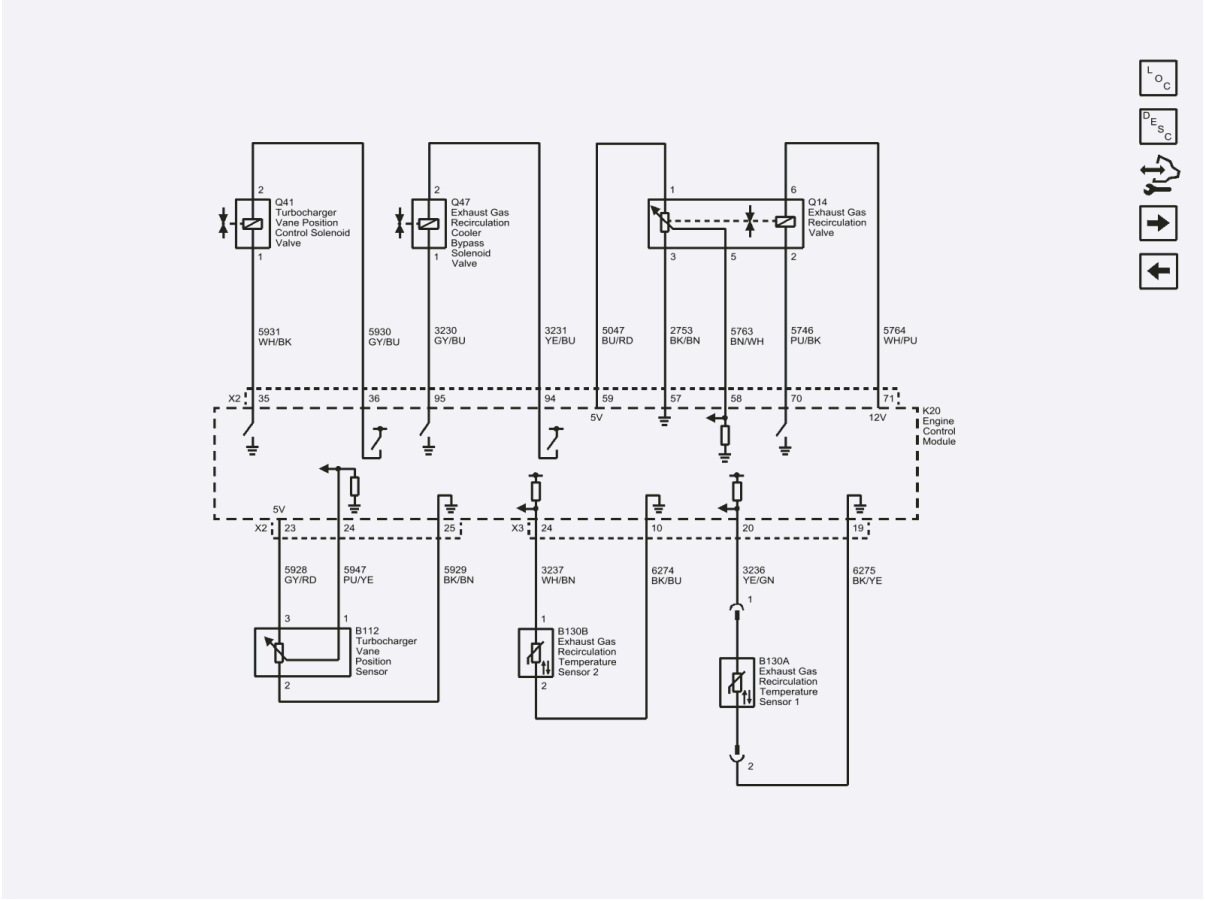

Fig. 8: Engine Data Sensors - EGR and Turbocharger Controls
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Camshaft, Crankshaft, and Intake Runner Actuator

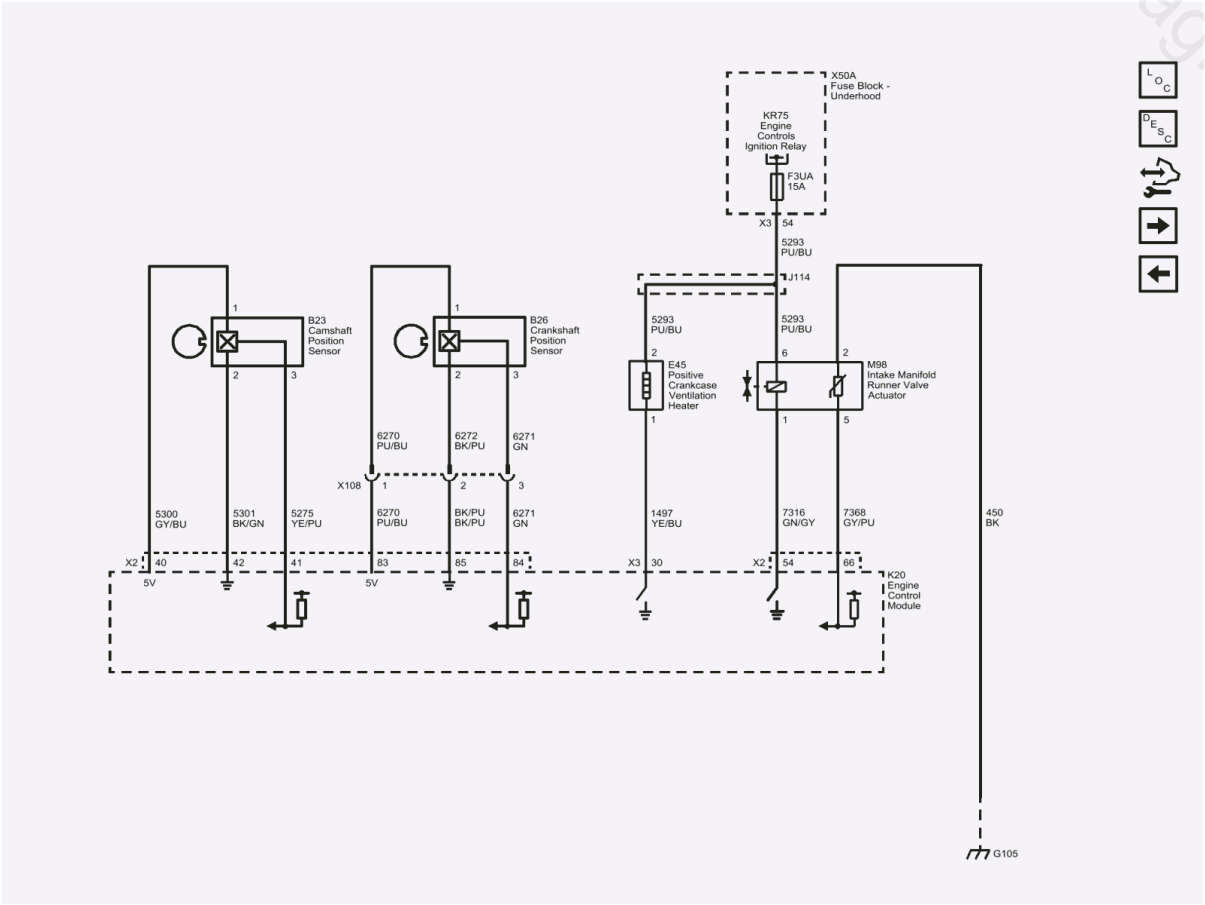

Fig. 9: Engine Data Sensors - Camshaft, Crankshaft, and Intake Runner Actuator
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Rail Sensor, Fuel Pressure Regulator, and Fuel Injectors

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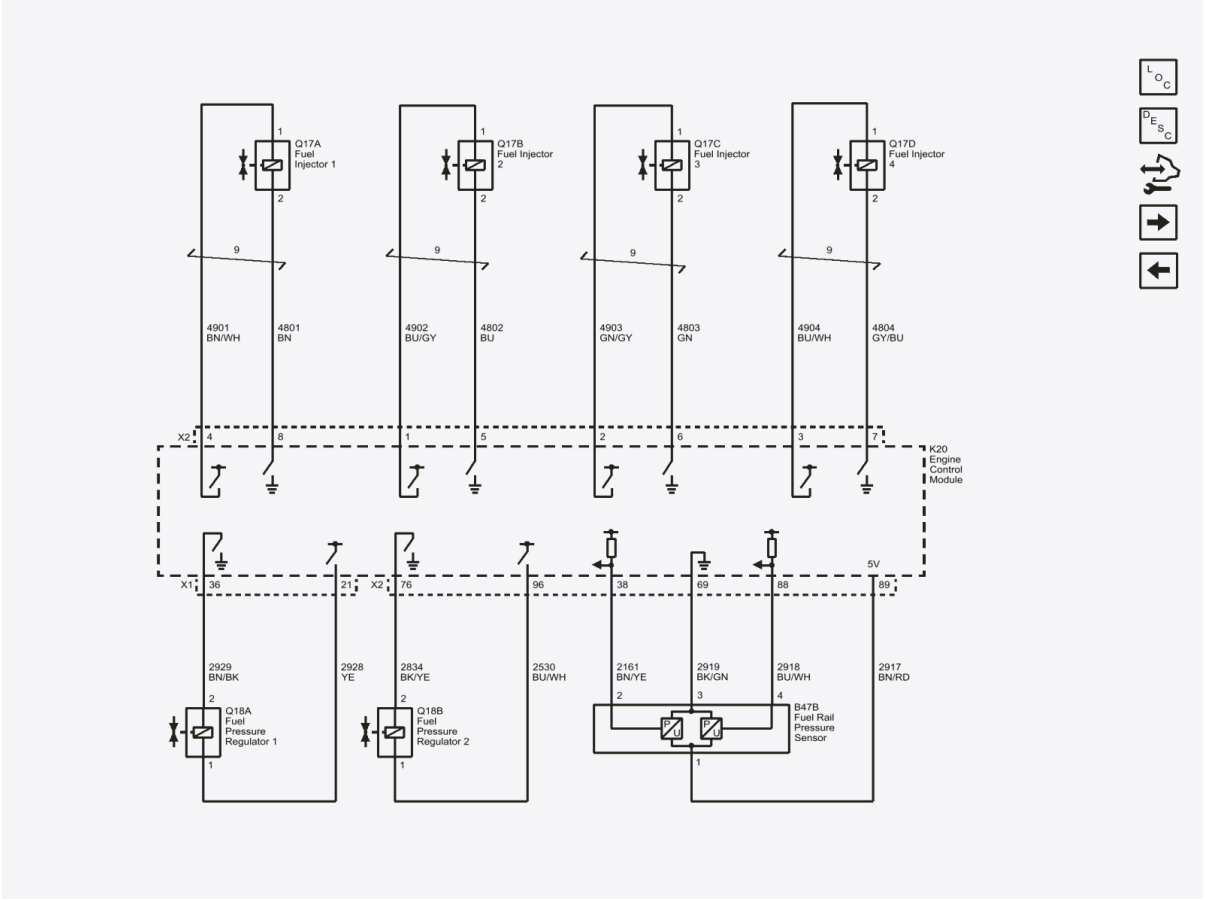

Fig. 10: Fuel Controls - Fuel Rail Sensor, Fuel Pressure Regulator, and Fuel Injectors
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Pump Controls

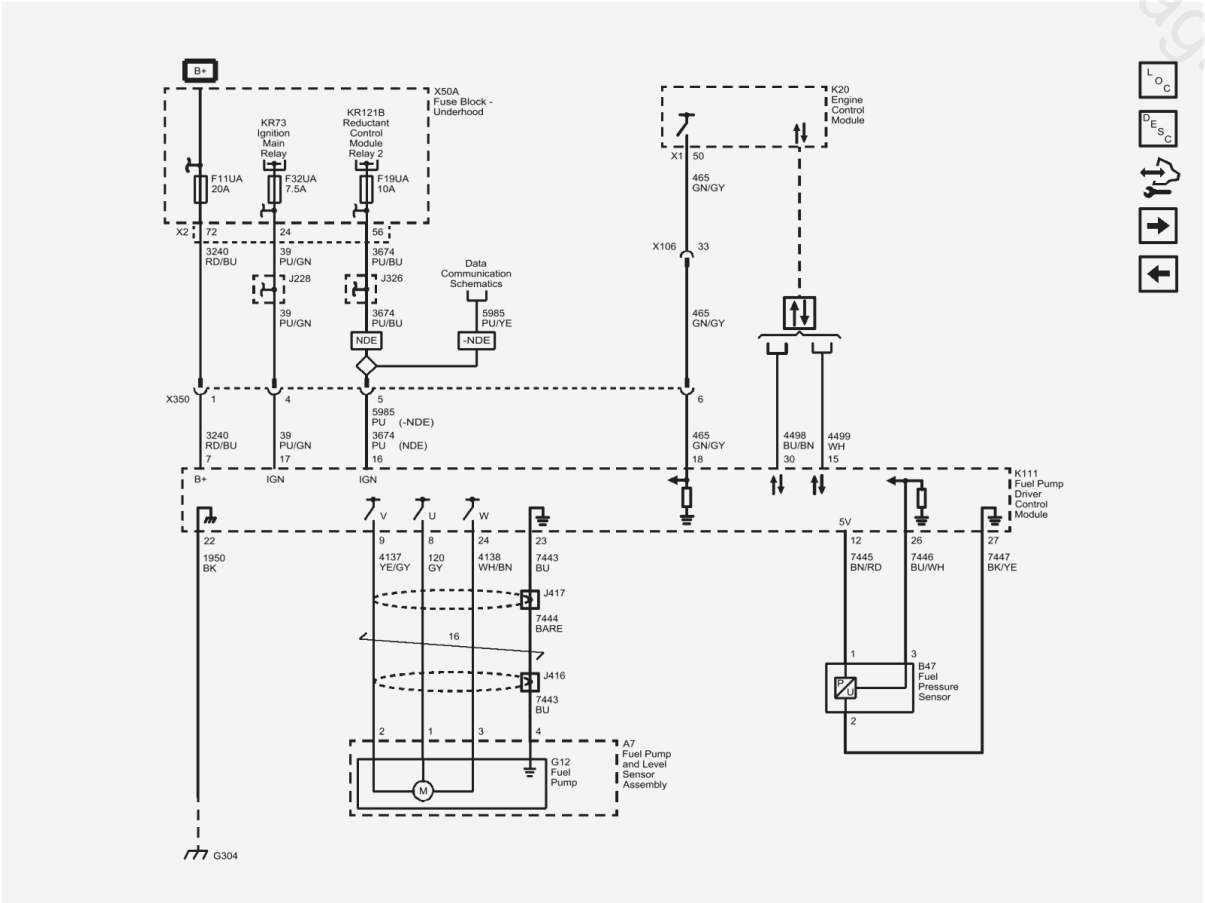

Fig. 11: Fuel Controls - Fuel Pump Controls
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Heater and Water in Fuel Sensor

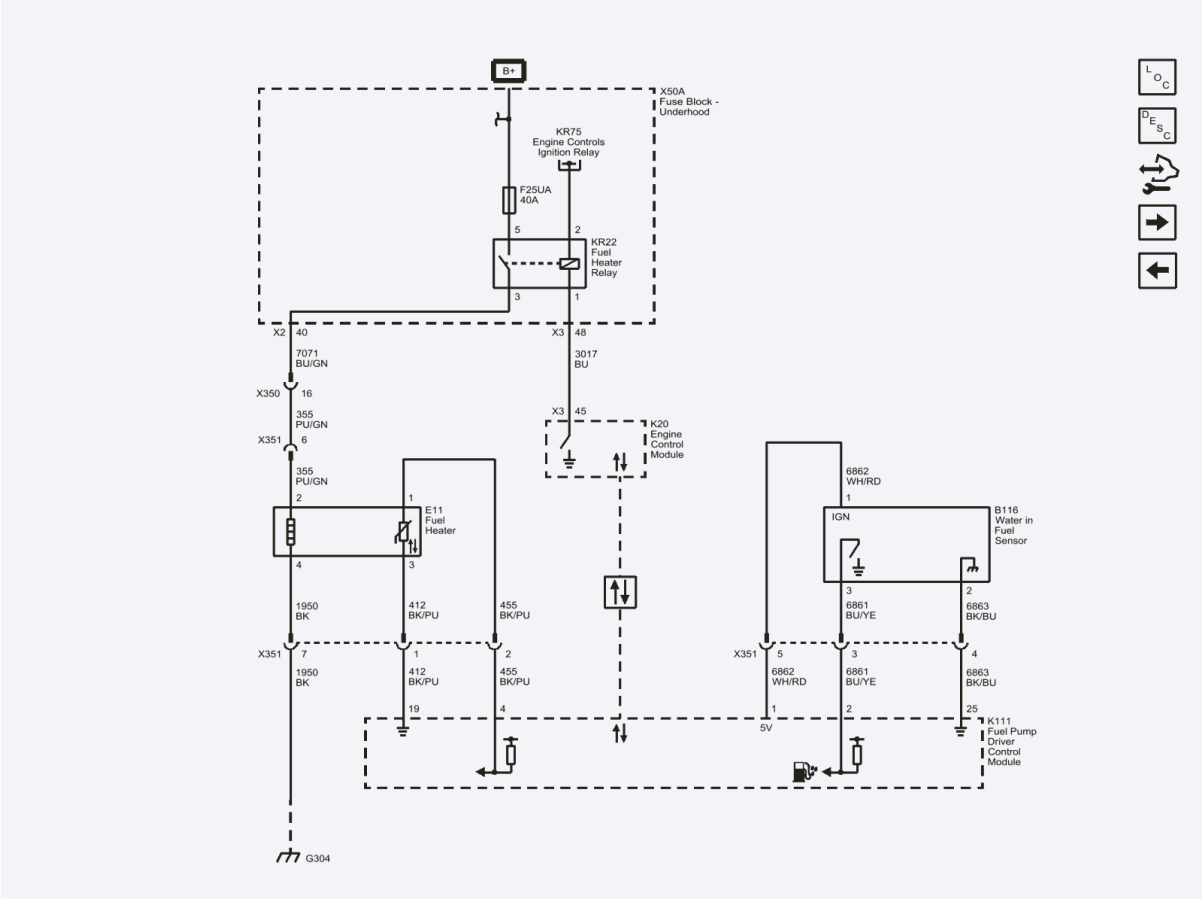

Fig. 12: Fuel Controls - Fuel Heater and Water in Fuel Sensor
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Intake Manifold Pressure, and Mass Air Flow Sensor

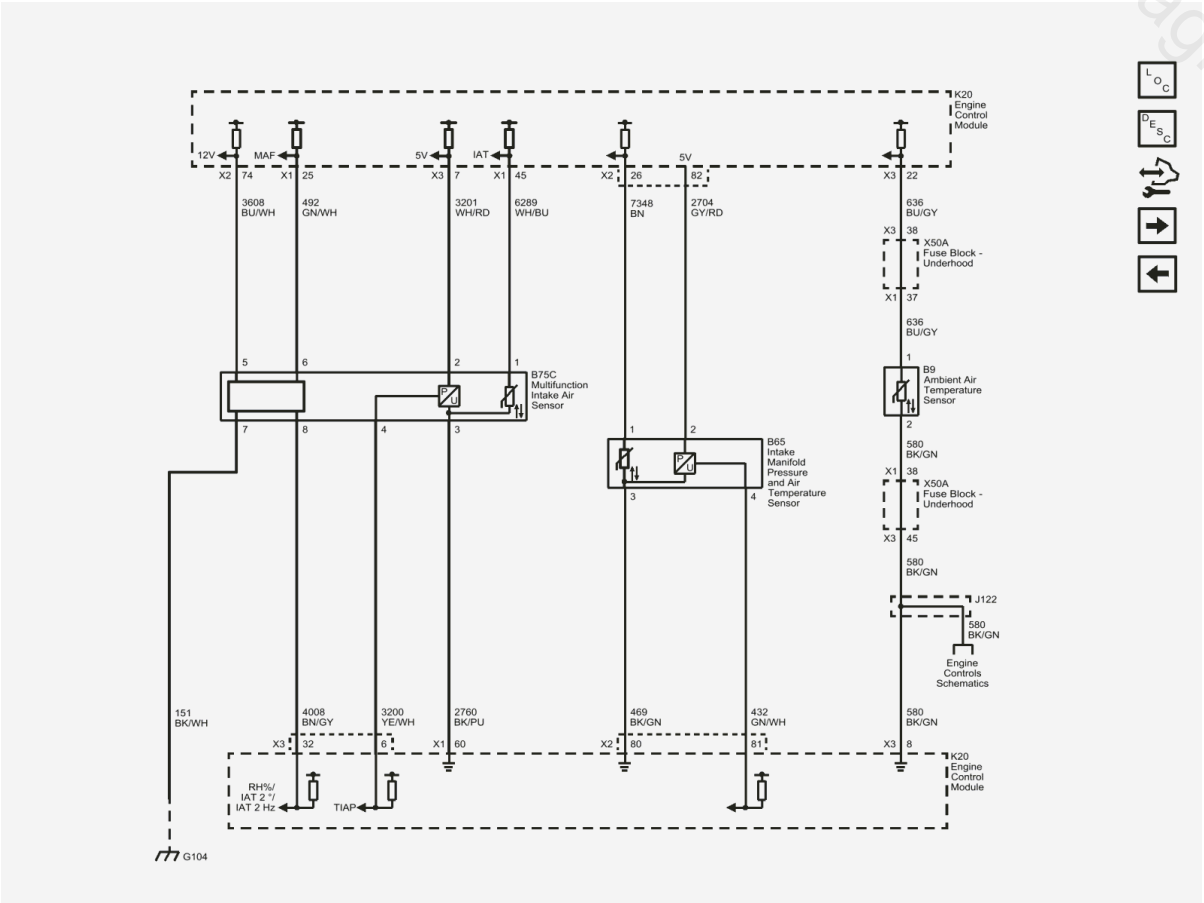

Fig. 13: Fuel Controls - Intake Manifold Pressure, and Mass Air Flow Sensor
Courtesy of GENERAL MOTORS COMPANY

Glow Plug Controls

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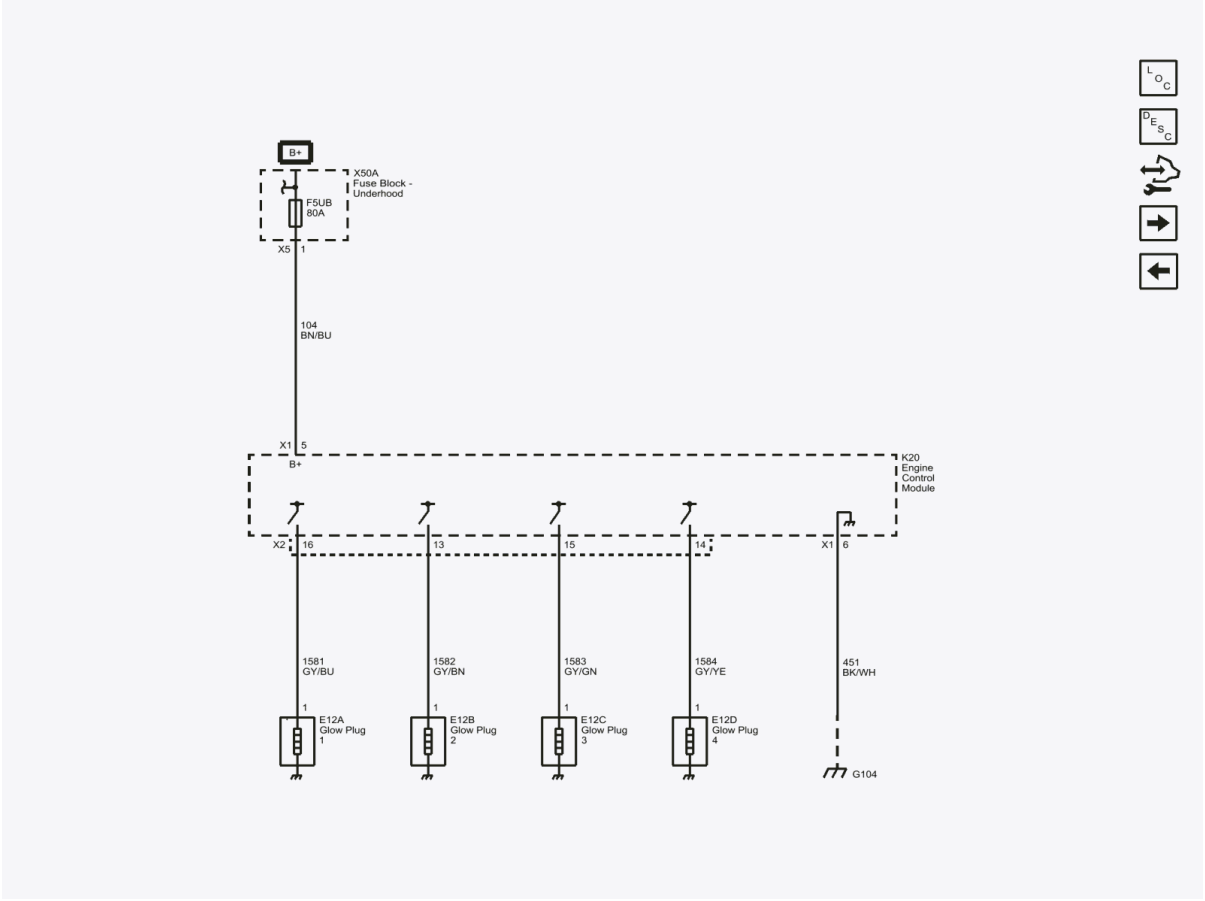

Fig. 14: Glow Plug Controls
Courtesy of GENERAL MOTORS COMPANY

Emission Controls - Reductant System

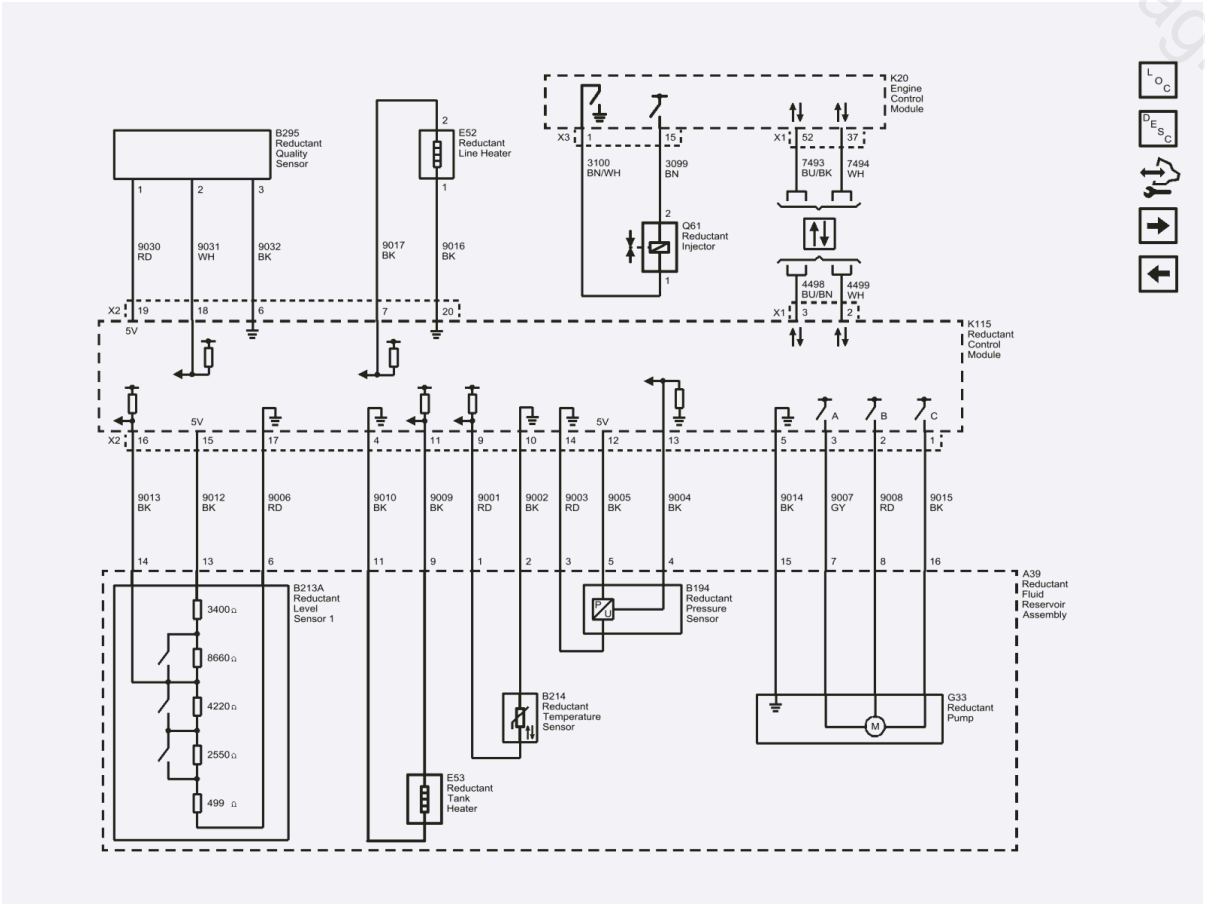

Fig. 15: Emission Controls - Reductant System
Courtesy of GENERAL MOTORS COMPANY

Emission Controls - Nitrogen Oxides, Exhaust Particulate Matter Sensor, and Reductant Sensor Module

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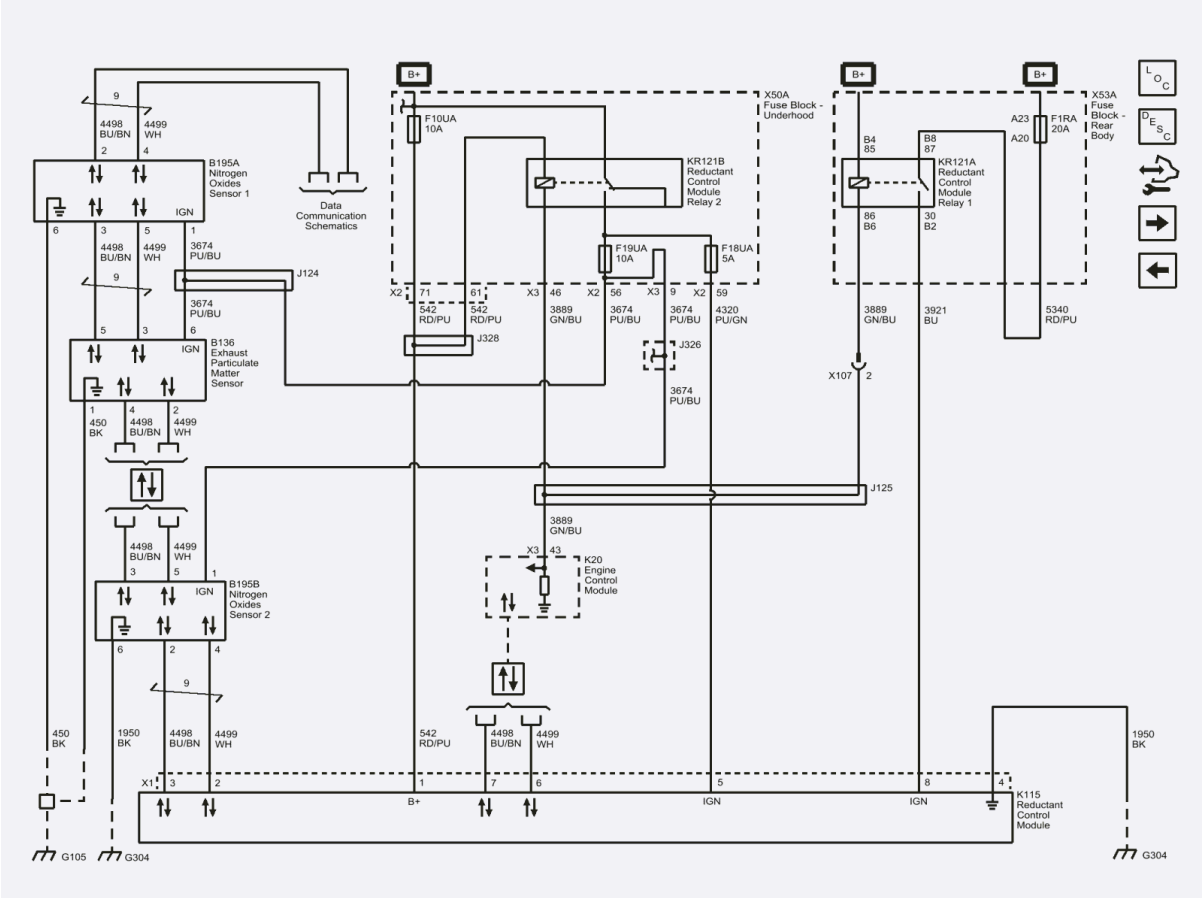

Fig. 16: Emission Controls - Nitrogen Oxides, Exhaust Particulate Matter Sensor, and Reductant Sensor Module
Courtesy of GENERAL MOTORS COMPANY

Blunt Cuts - Cavity Plugs

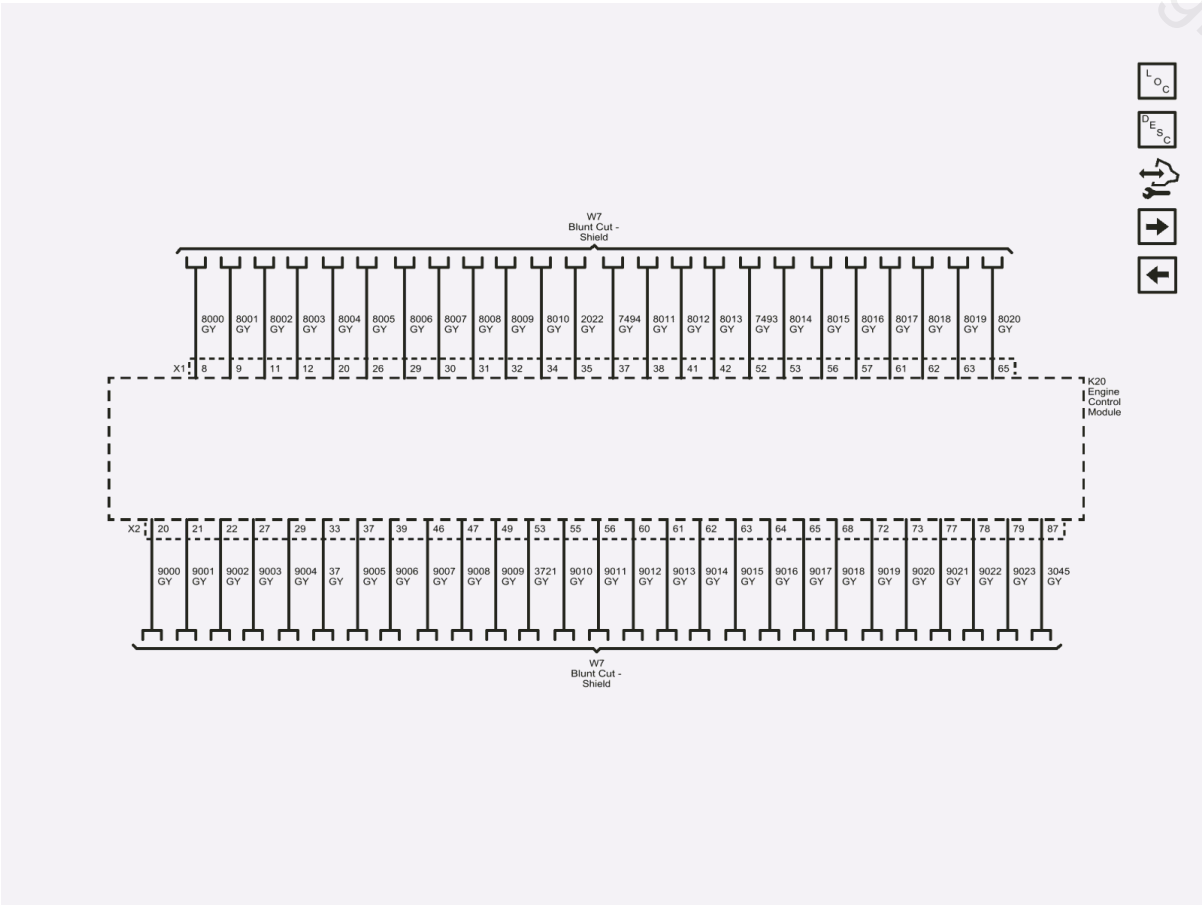

Fig. 17: Blunt Cuts - Cavity Plugs
Courtesy of GENERAL MOTORS COMPANY

Controlled/Monitored Subsystem References

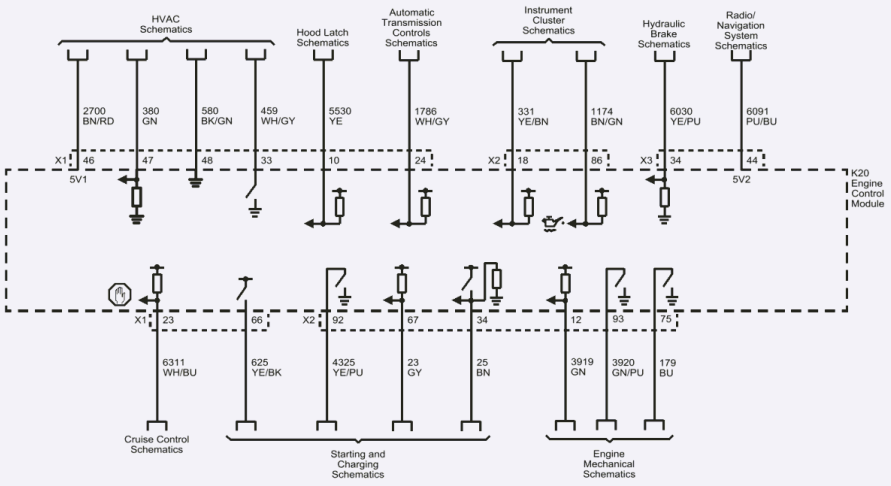

Fig. 18: Controlled/Monitored Subsystem References
Courtesy of GENERAL MOTORS COMPANY

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SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS (DIAGNOSTIC TOOLS)

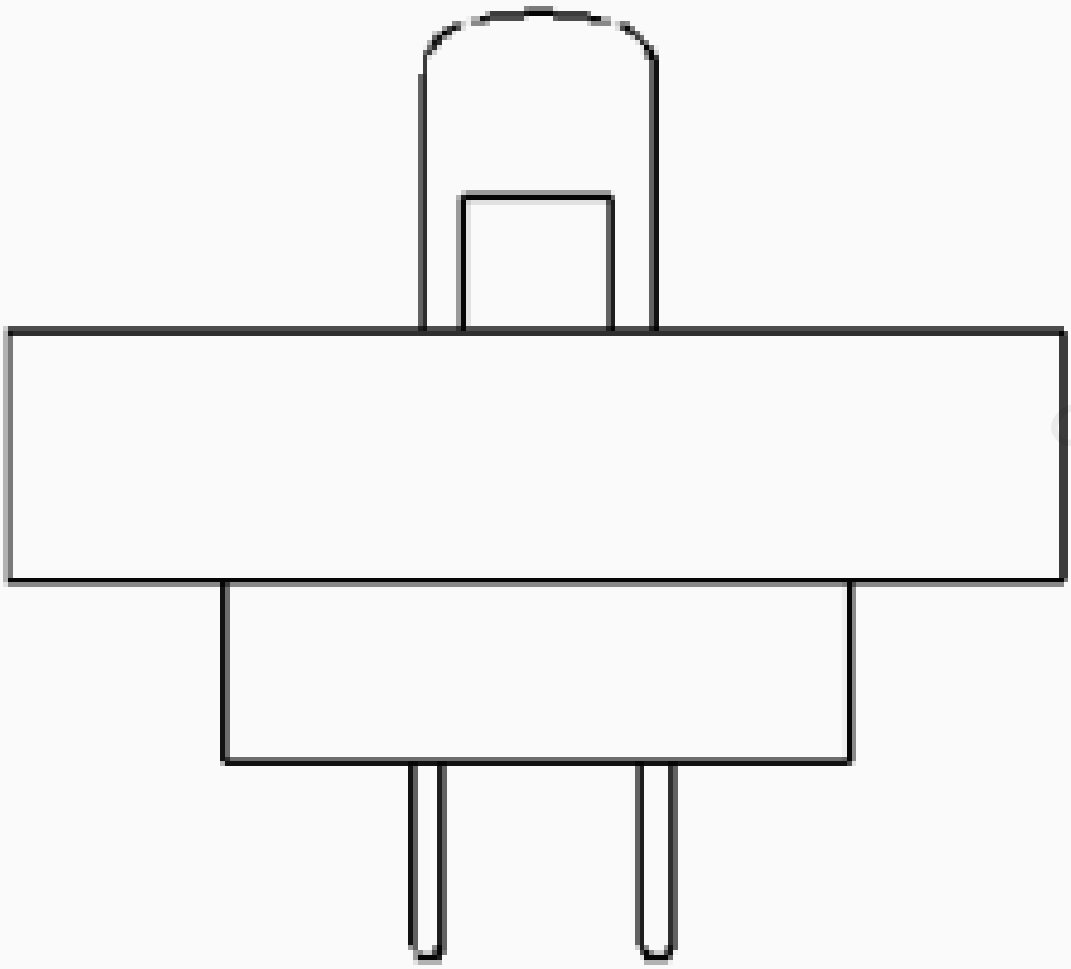
Illustration	Tool Number/Description
	CH-34730-2C J-34730-2C Injector Test Lamp

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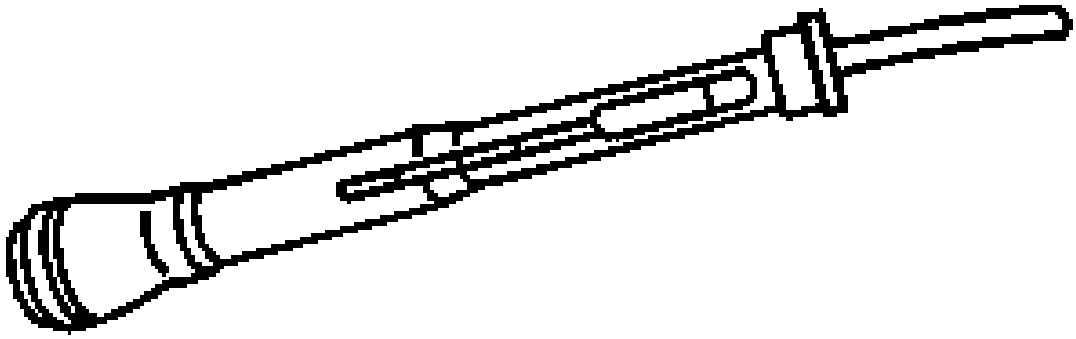
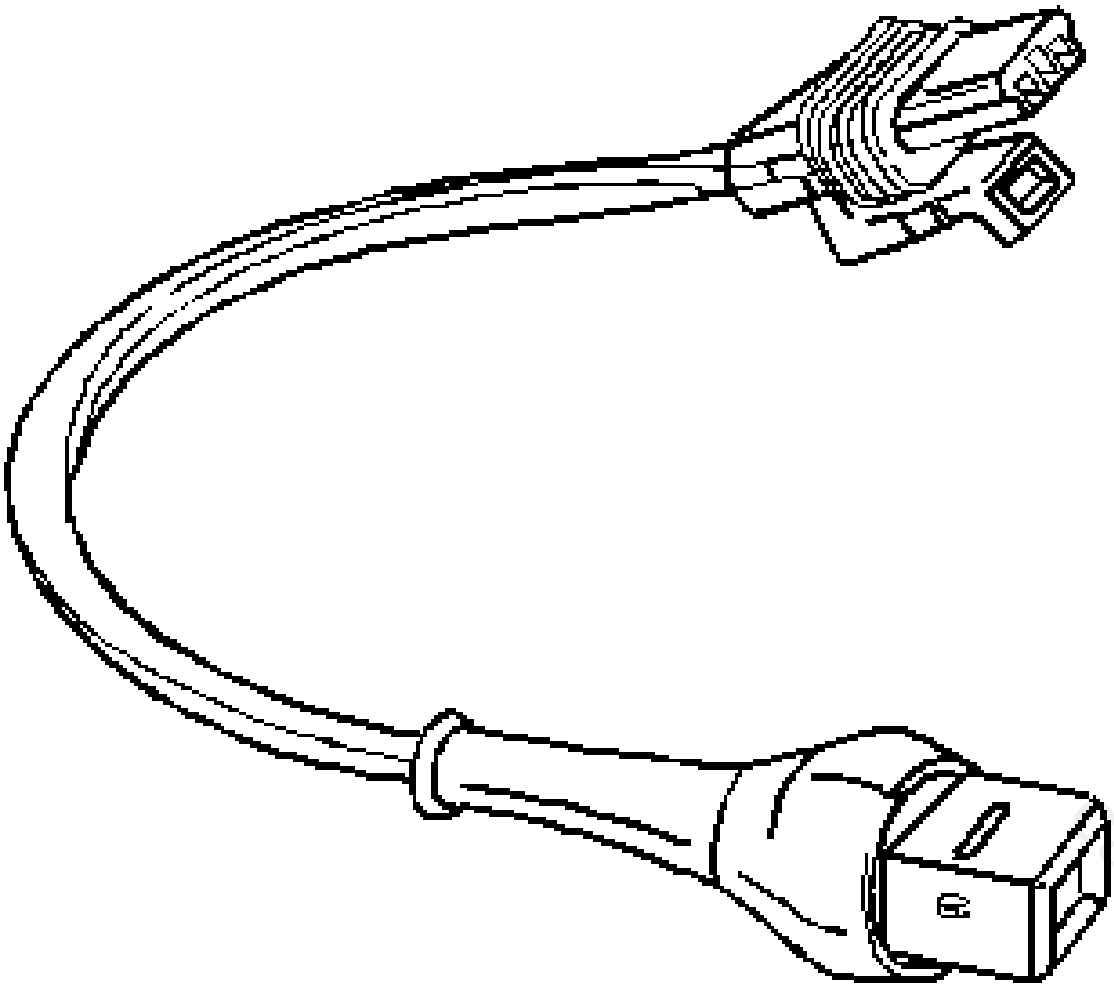
Illustration	Tool Number/Description
	CH-37287-1A Fuel Pressure Gauge Adapter 3/8"
	CH-38641-B J-38641-B Diesel Fuel Quality Tester

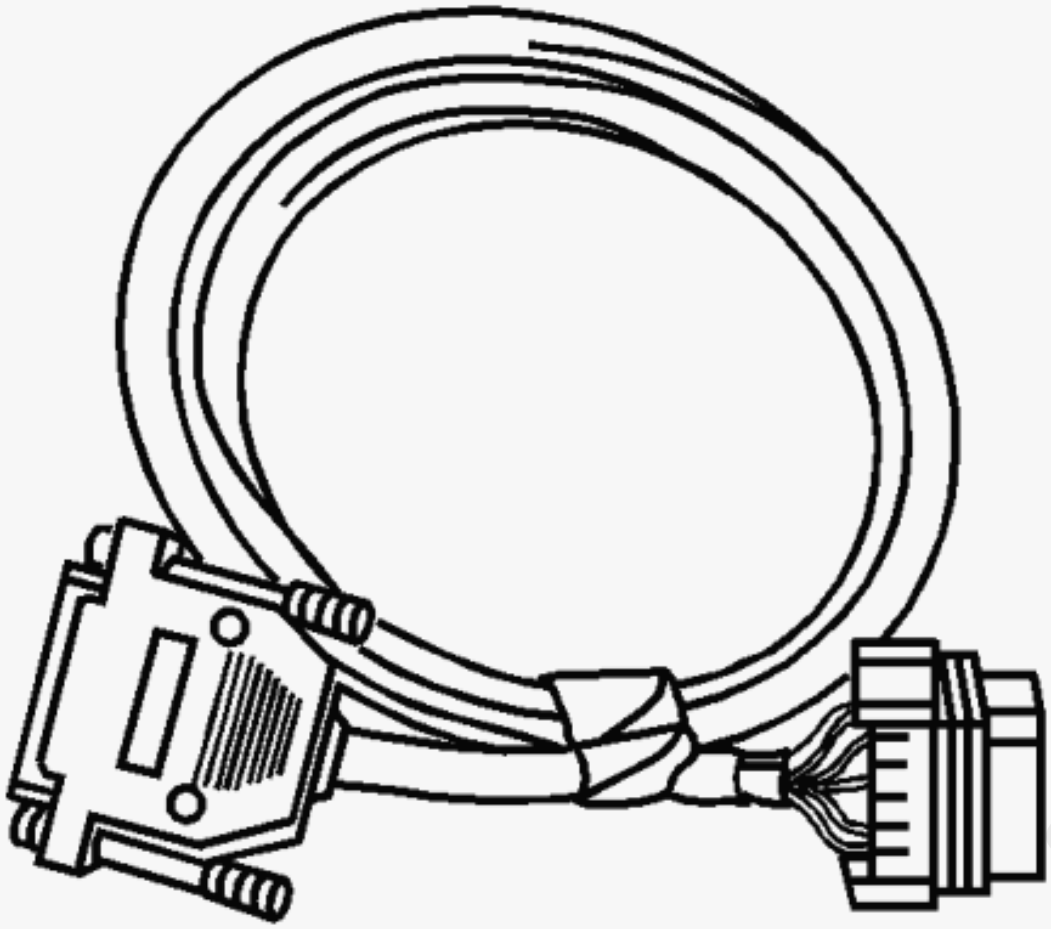
cardiagn.com

Illustration	Tool Number/Description
	

cardiagn.com

Illustration	Tool Number/Description
	CH-39021-301 J-39021-301 Fuel Injector Harness Adapter

mydiagn.com

Illustration	Tool Number/Description
	CH-39021-460 J-39021-460 Fuel Injector Test Adapter

cardiagn.com

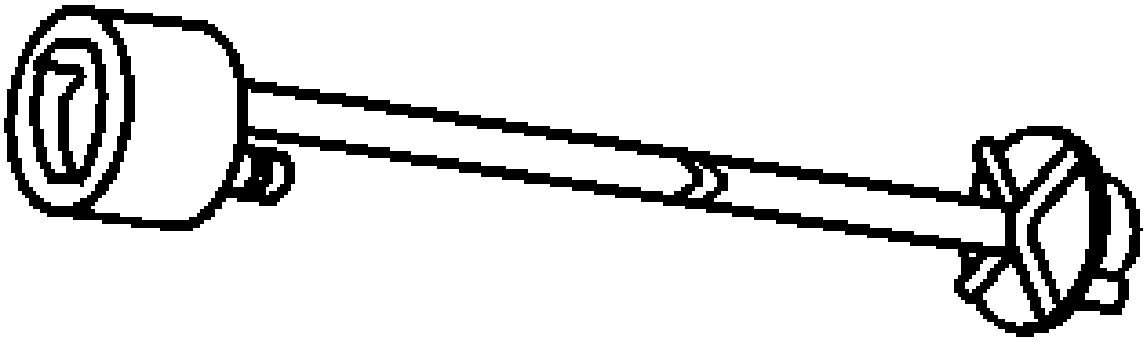
Illustration	Tool Number/Description
	CH-41415-30 GE-41415-30 J-41415-30 Fuel Tank Cap Adapter

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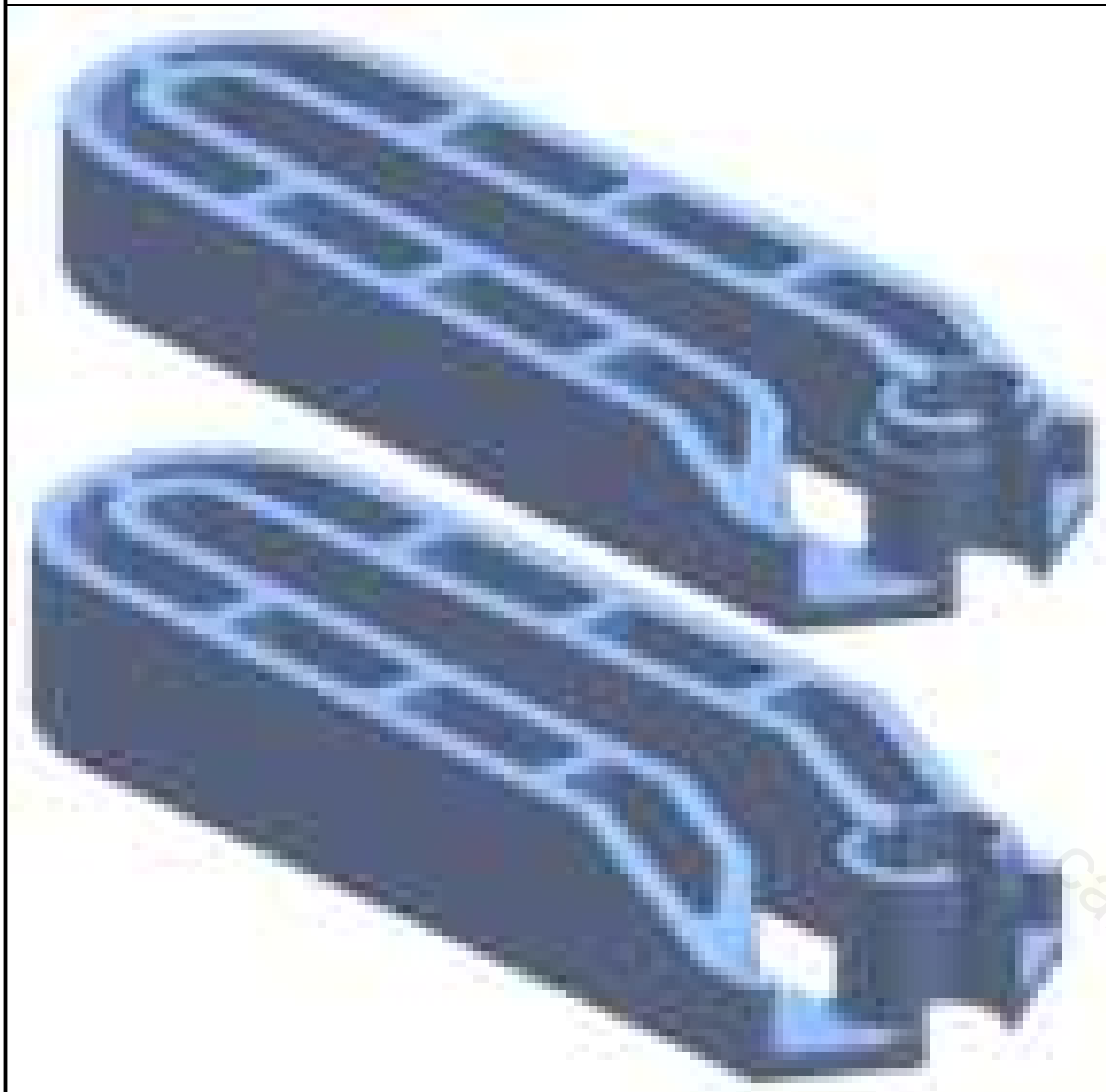
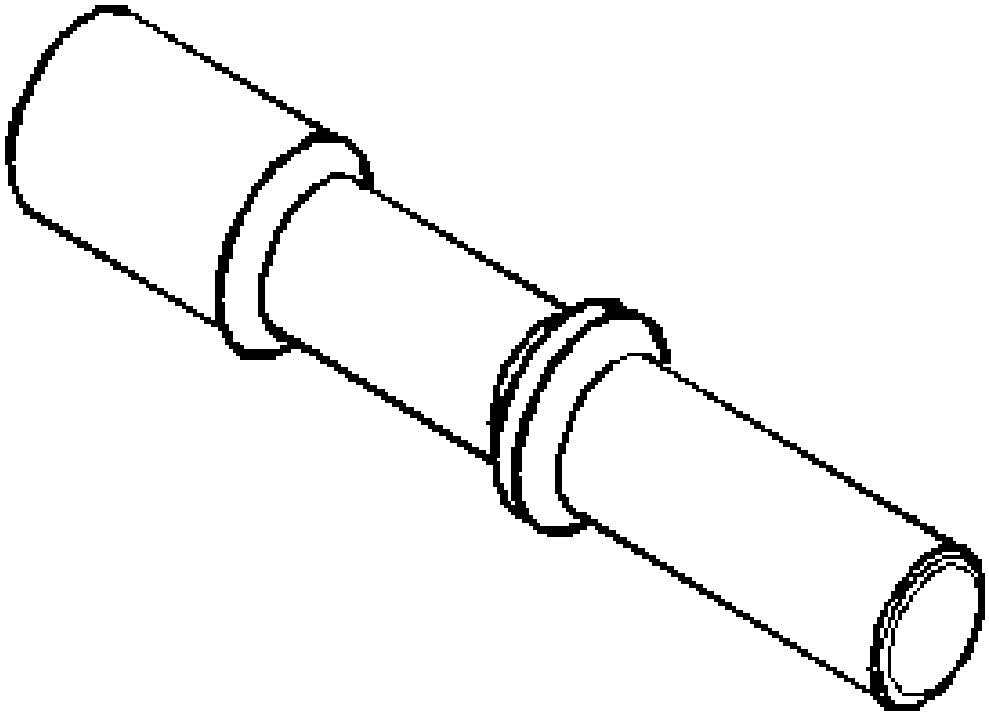
Illustration	Tool Number/Description
	CH-41769 J-41769 Fuel Line Quick Disconnect Tool
	CH-44284-2 J-44284-2 Fuel Flapper Door Holder

cardiagn.com

Illustration	Tool Number/Description
	

cardiagn.com

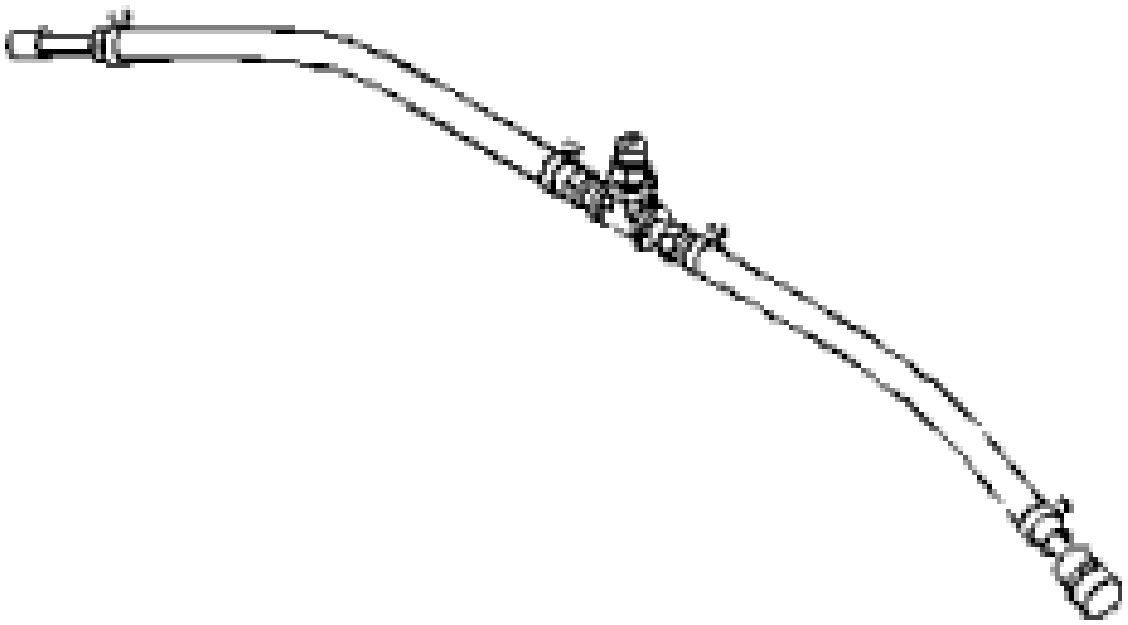
Illustration	Tool Number/Description
	CH-42982 J-42982 Fuel Pressure Gauge Adapter

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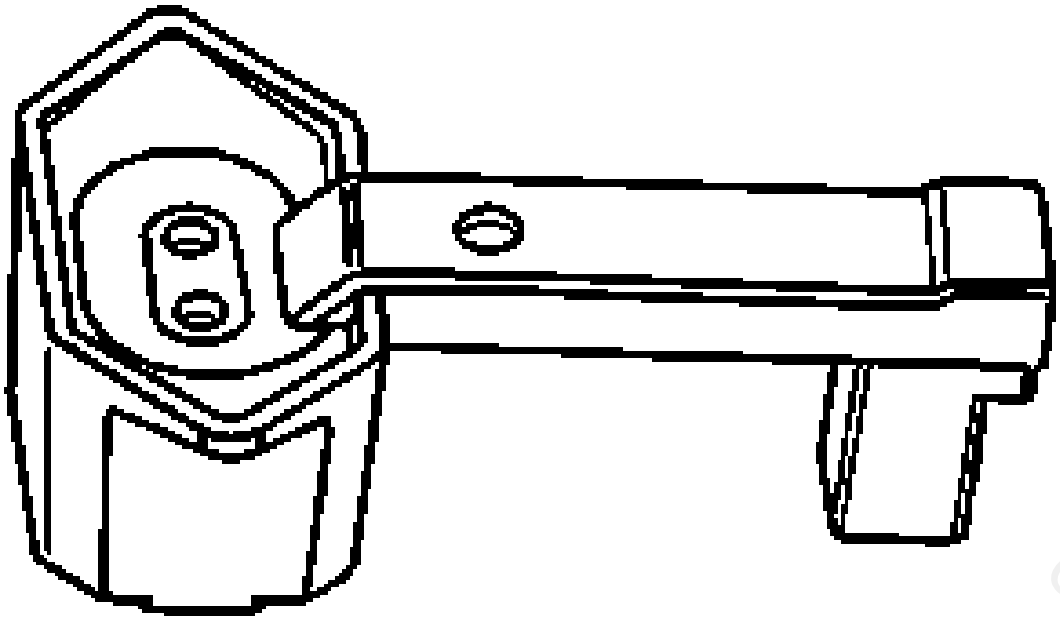
Illustration	Tool Number/Description
	CH-44175-A J-44175-A Fuel Composition Tester

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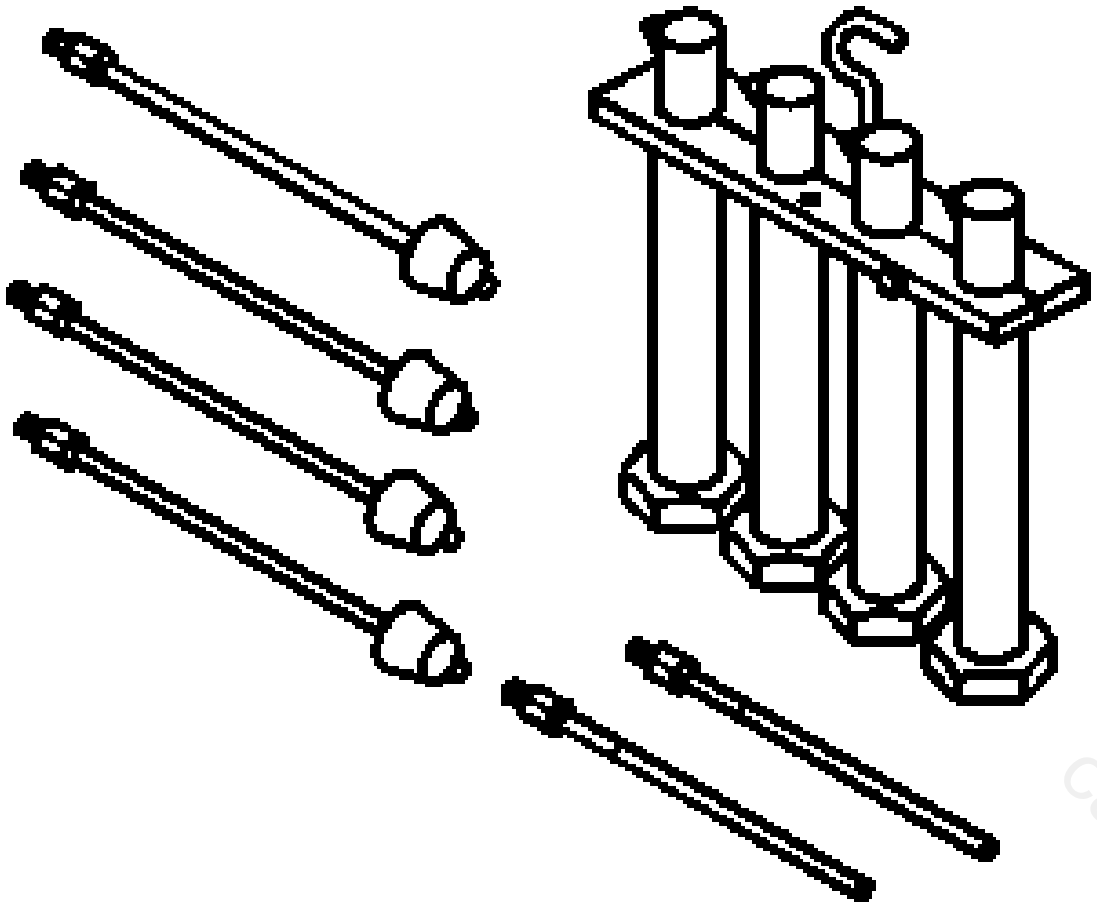
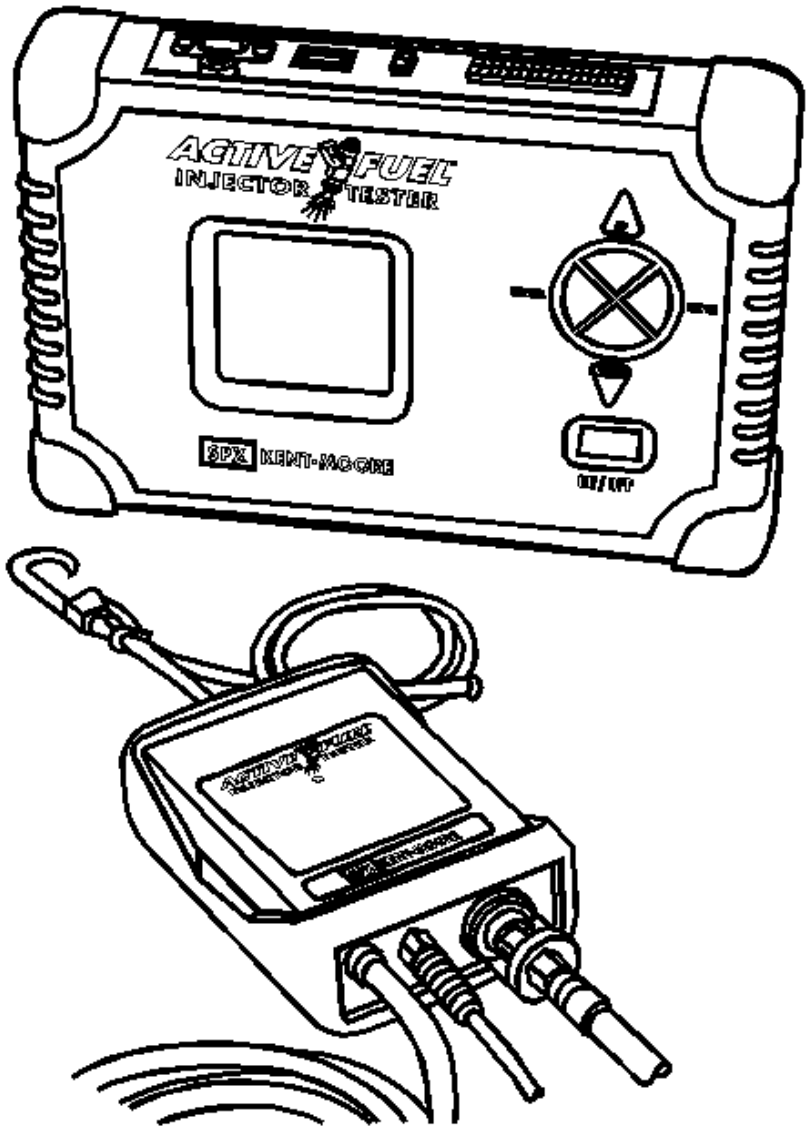
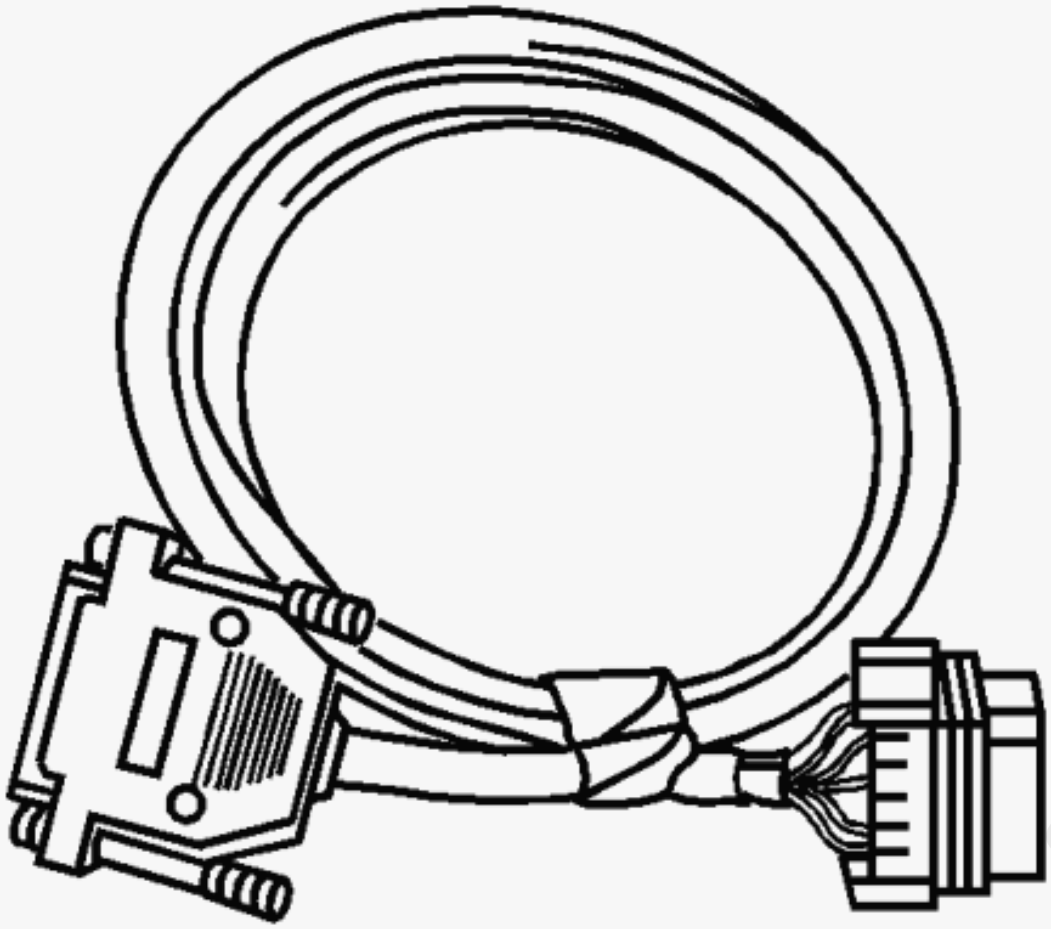
Illustration	Tool Number/Description
	CH-45873 J-45873 Fuel Return Volume Test Kit

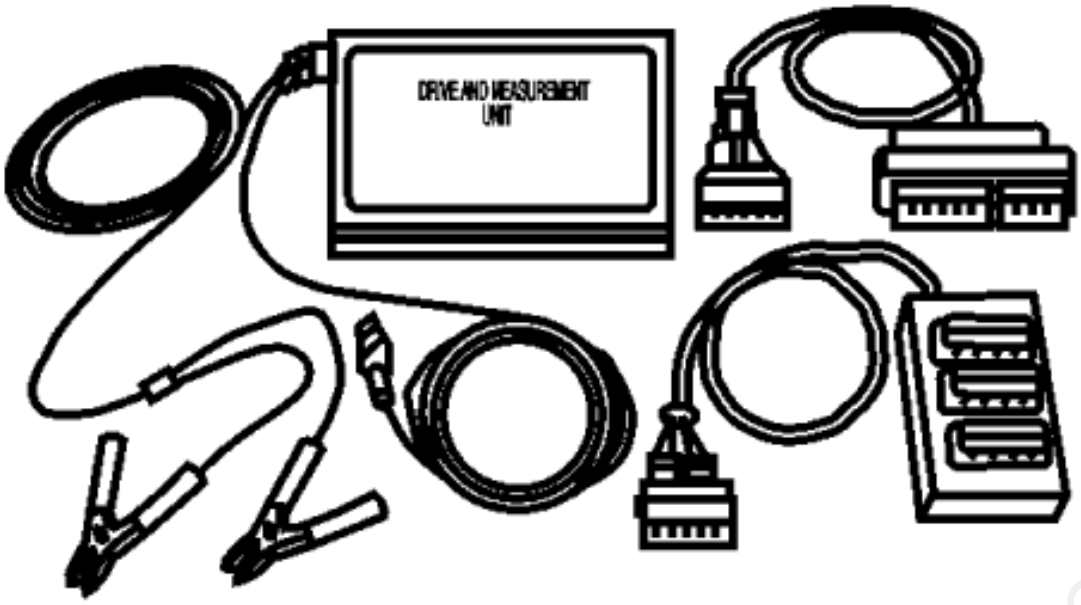
cardiagn.com

Illustration	Tool Number/Description
	CH-47976 Active Fuel Injector Tester (AFIT)

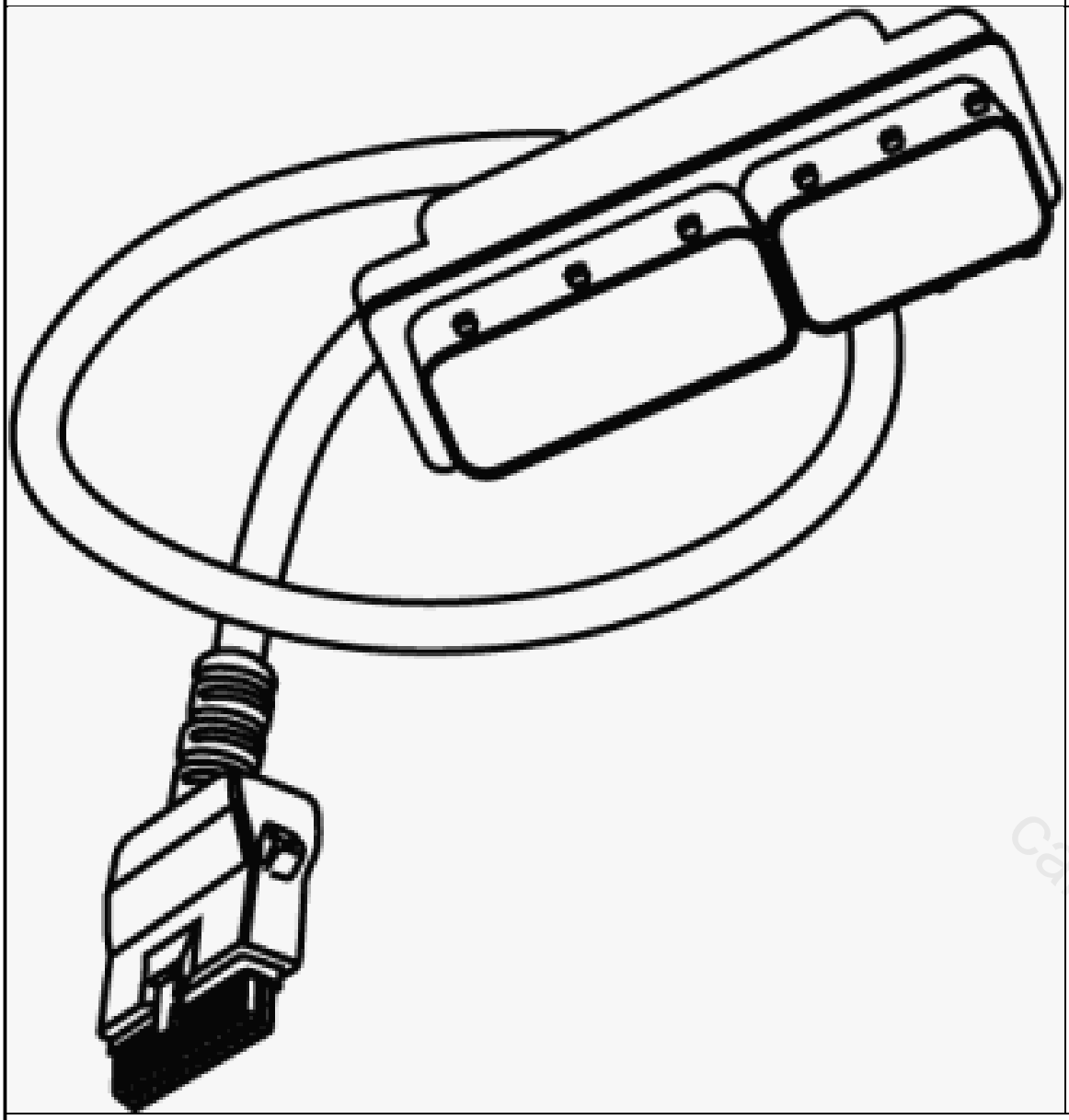
cardiagn.com

Illustration	Tool Number/Description
	CH-47976-75 Fuel Injector Harness Adapter

cardiagn.com

Illustration	Tool Number/Description
	CH-47976-500A Active Fuel Injection Tester (AFIT) SIDI Adapter Kit
	CH-47976-501 AFIT SIDI G1 Adapter Cable

cardiagn.com

Illustration	Tool Number/Description
	

cardiagn.com

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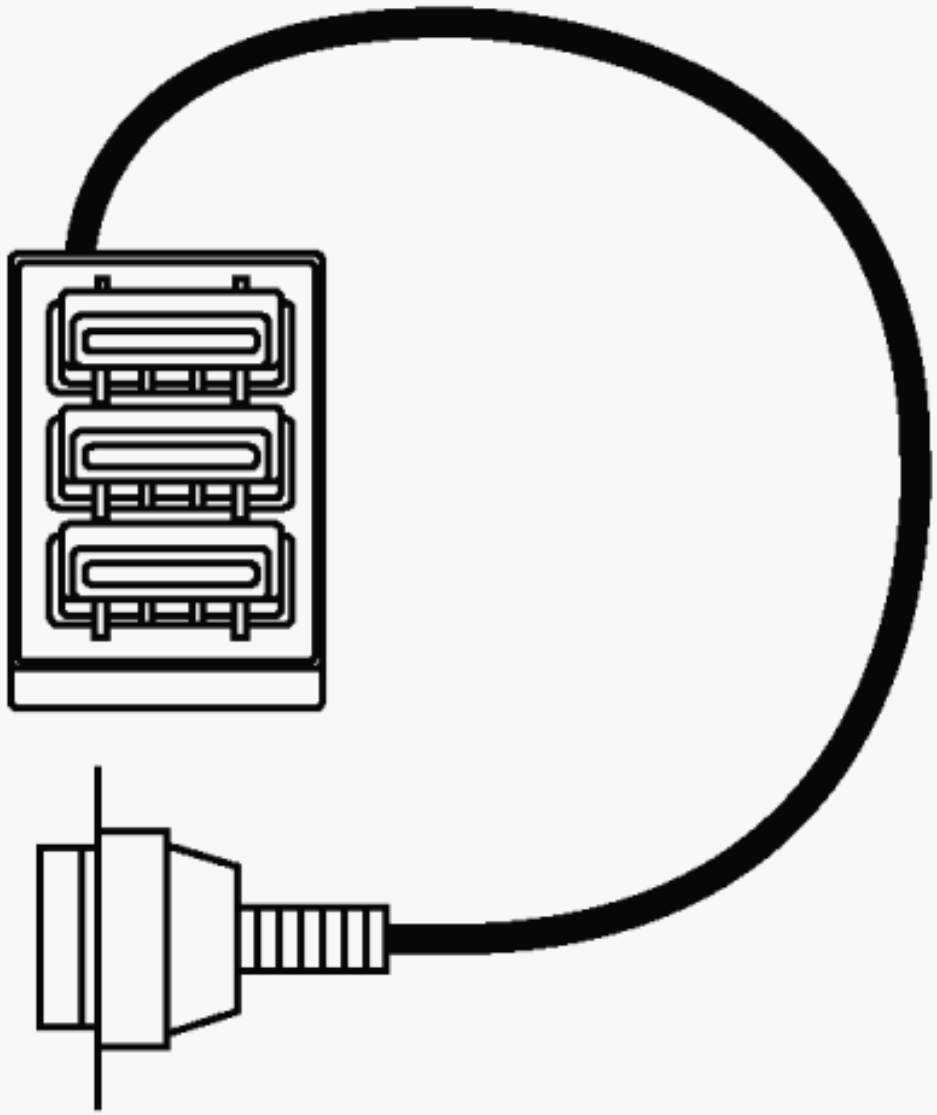
	CH-47976-502A AFIT SIDI E92 G2A Adapter Cable

cardiagn.com

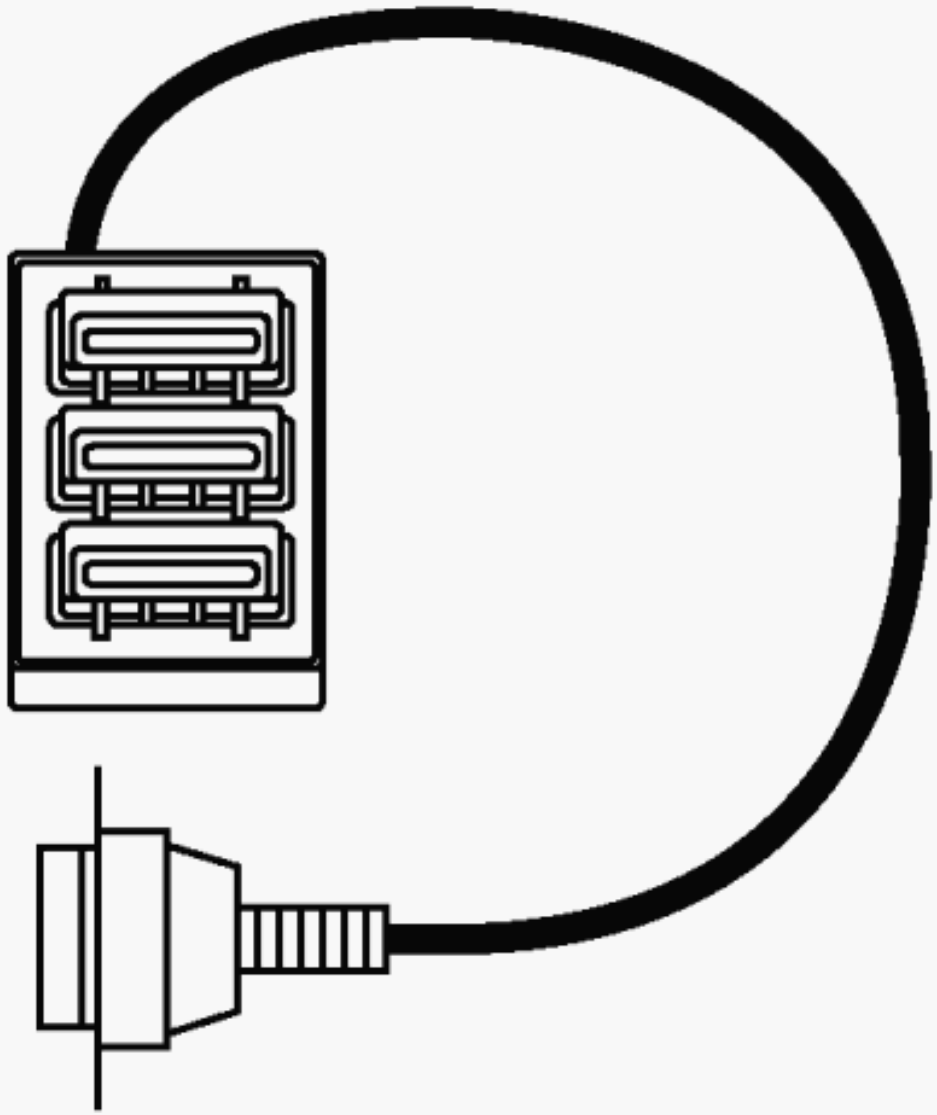
Illustration	Tool Number/Description
	CH-47976-503 AFIT SIDI E80 G3 Adapter Cable

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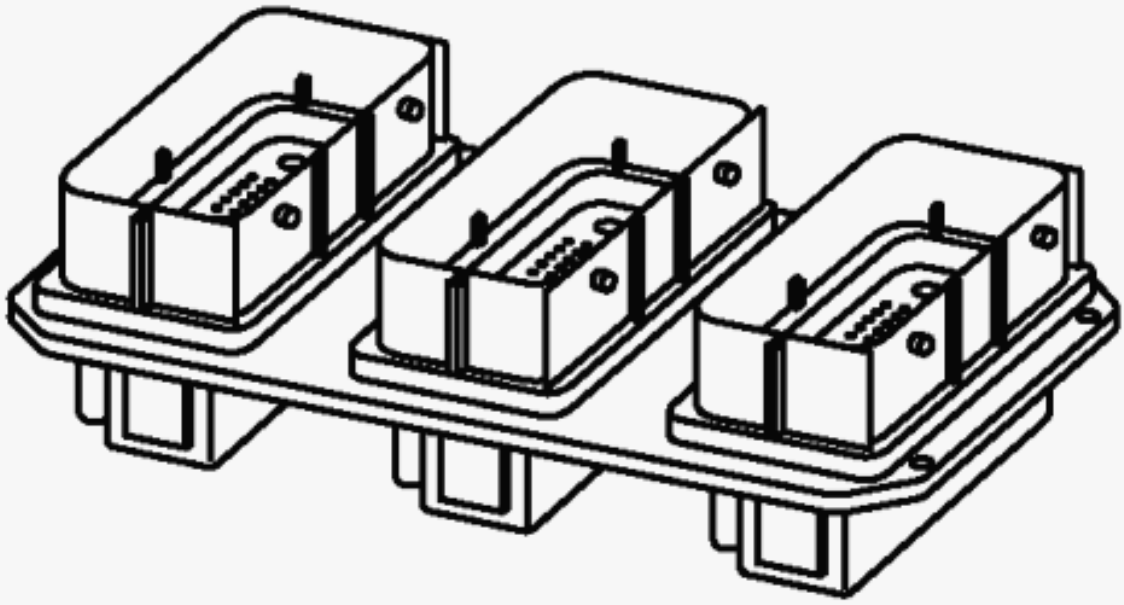
Illustration	Tool Number/Description
	CH-47976-504 E92/E39A G2B Start/Stop Adapter

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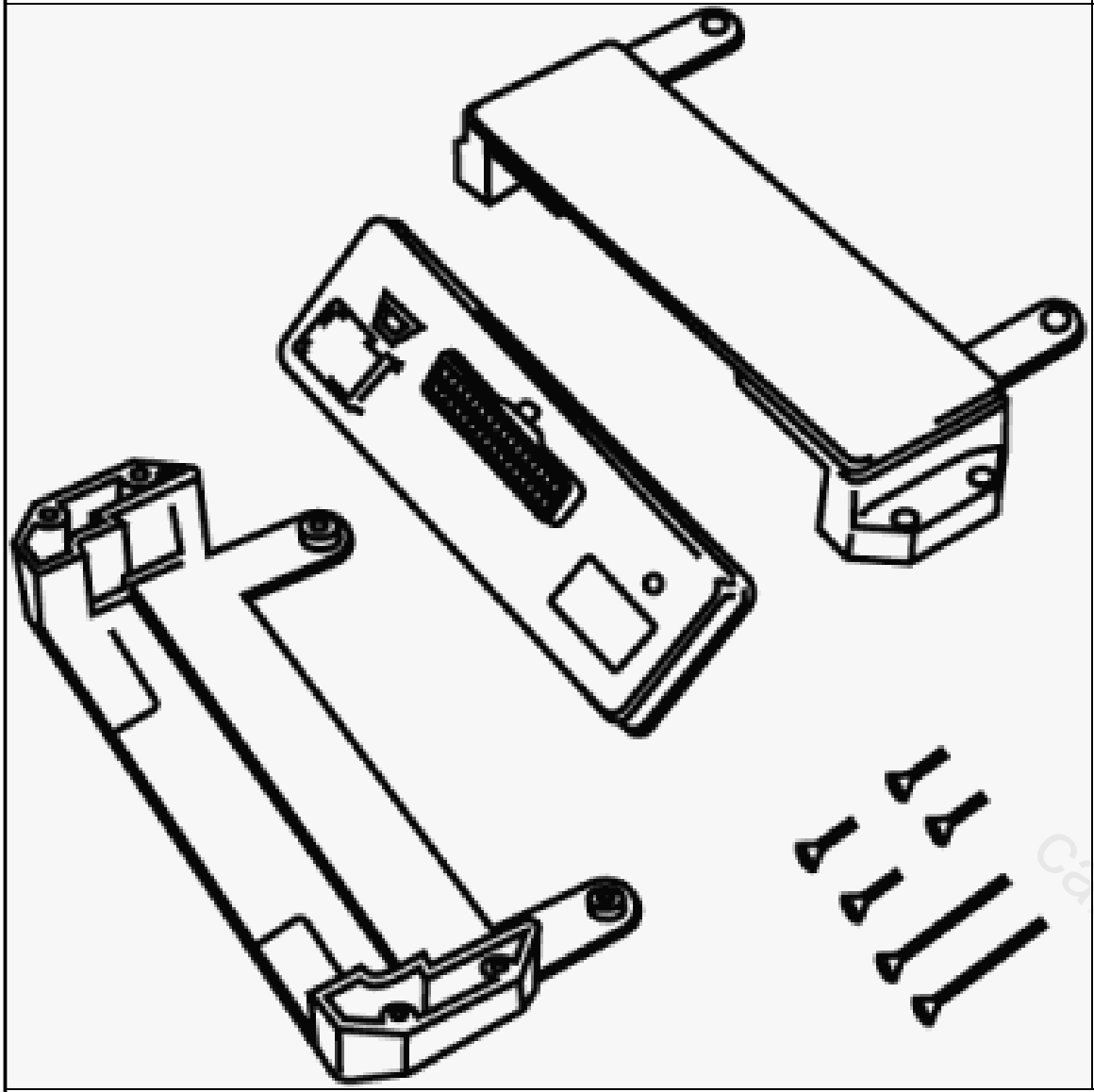
Illustration	Tool Number/Description
	CH-47976-507 AFIT Sent Adapter

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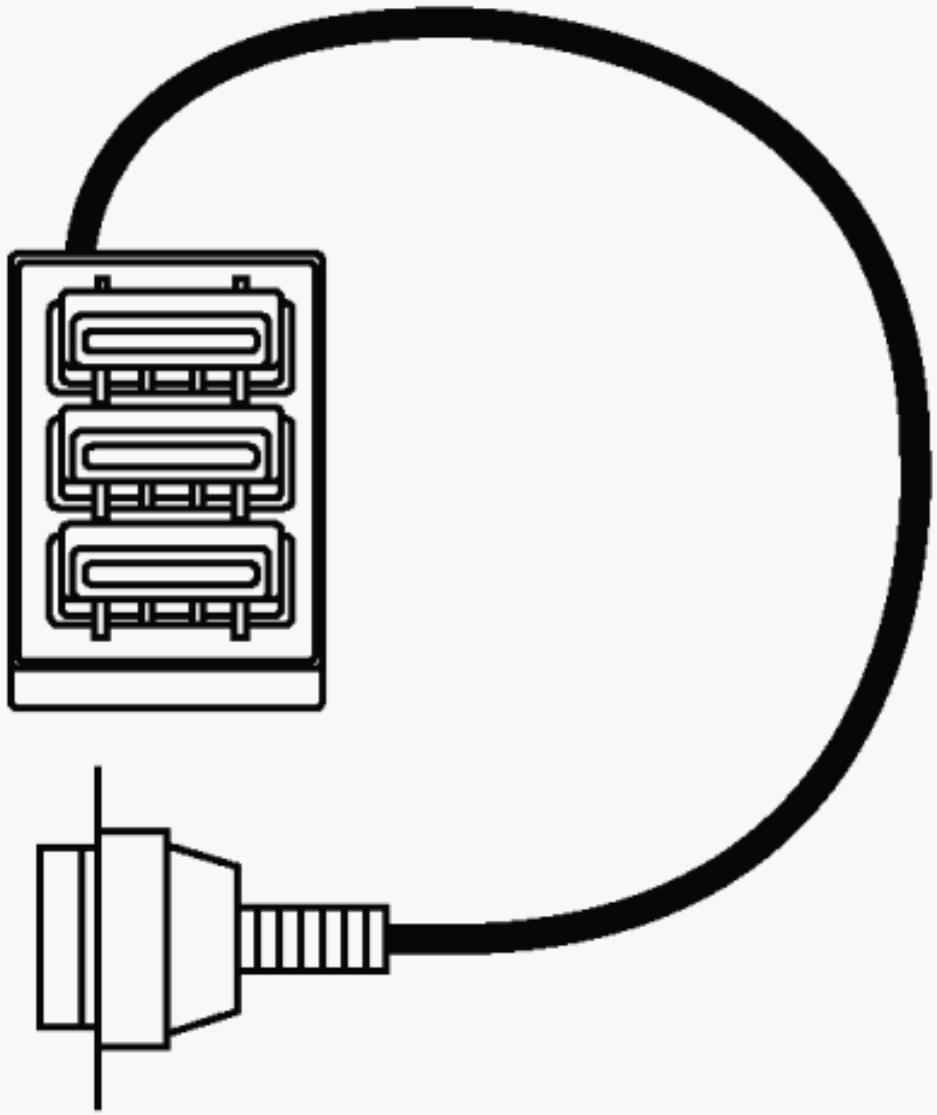
Illustration	Tool Number/Description
	CH-47976-509 AFIT SIDI E81 G4 Adapter Cable

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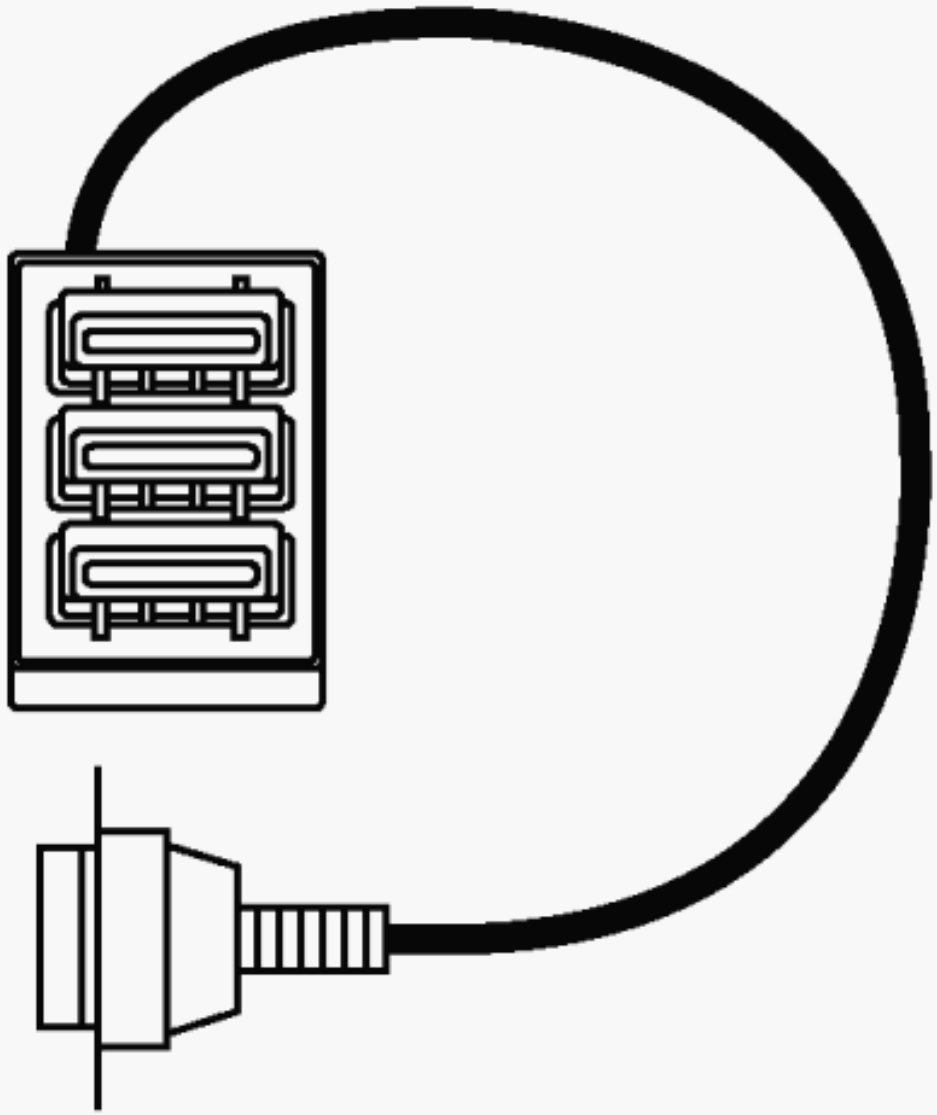
Illustration	Tool Number/Description
	CH-47976-511 AFIT SIDI E82 G5 Adapter Cable

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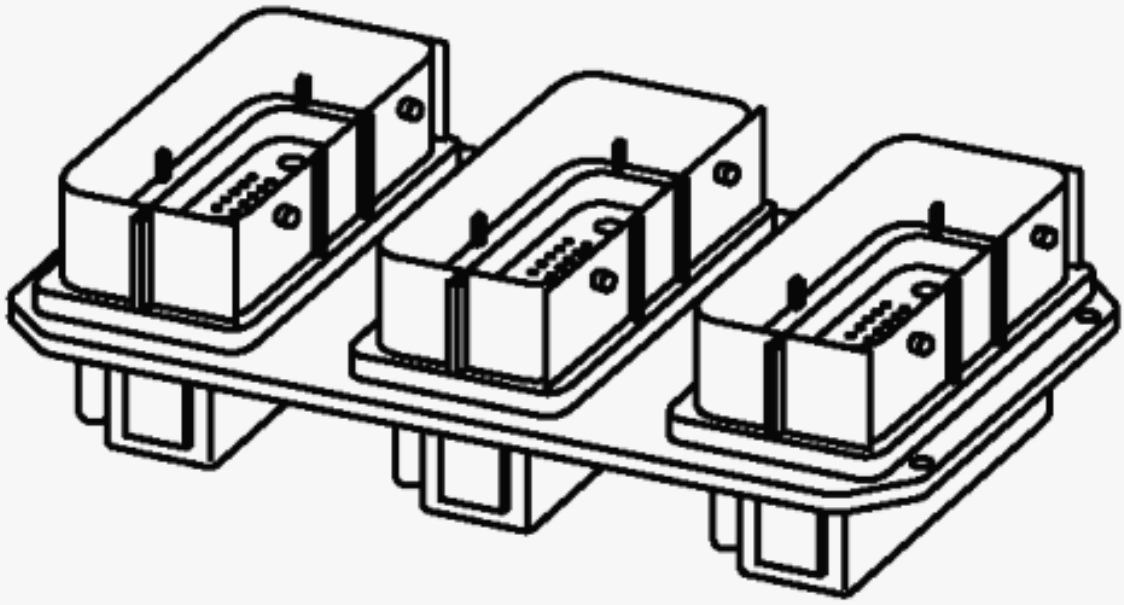
Illustration	Tool Number/Description
	CH-47976-512 E80 G3B Stop/Start Adapter

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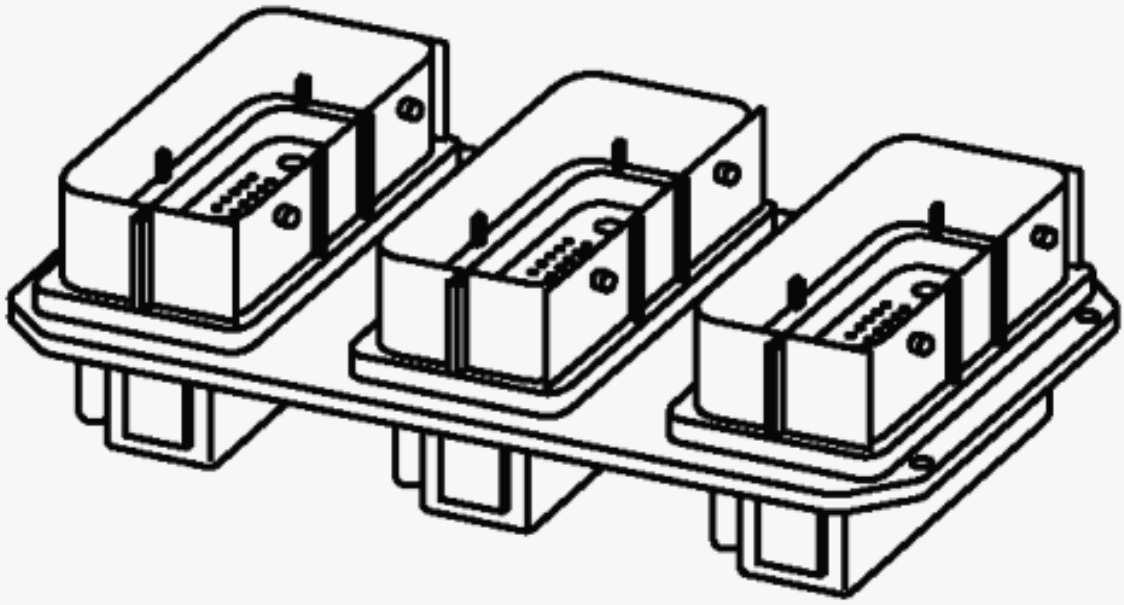
Illustration	Tool Number/Description
	CH-47976-513 E92 G2C Stop/Start and SENT Adapter

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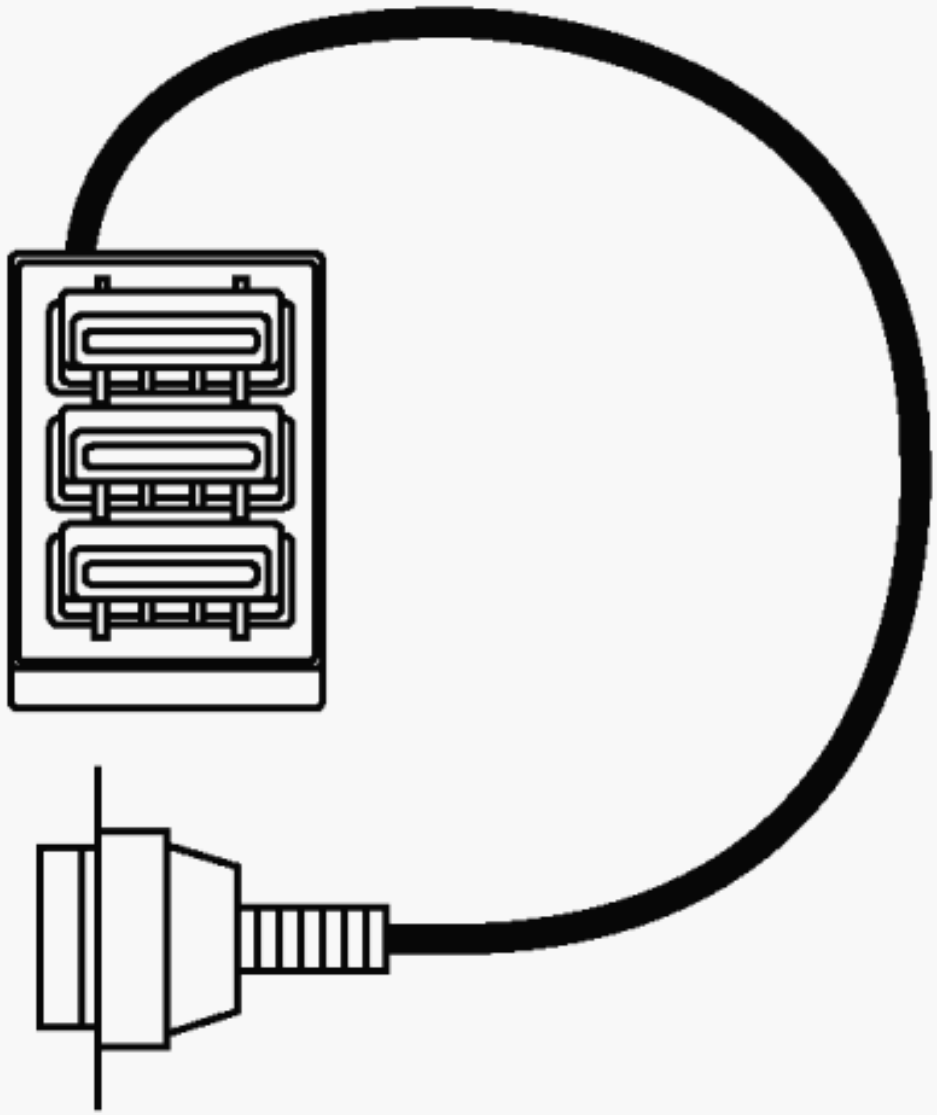
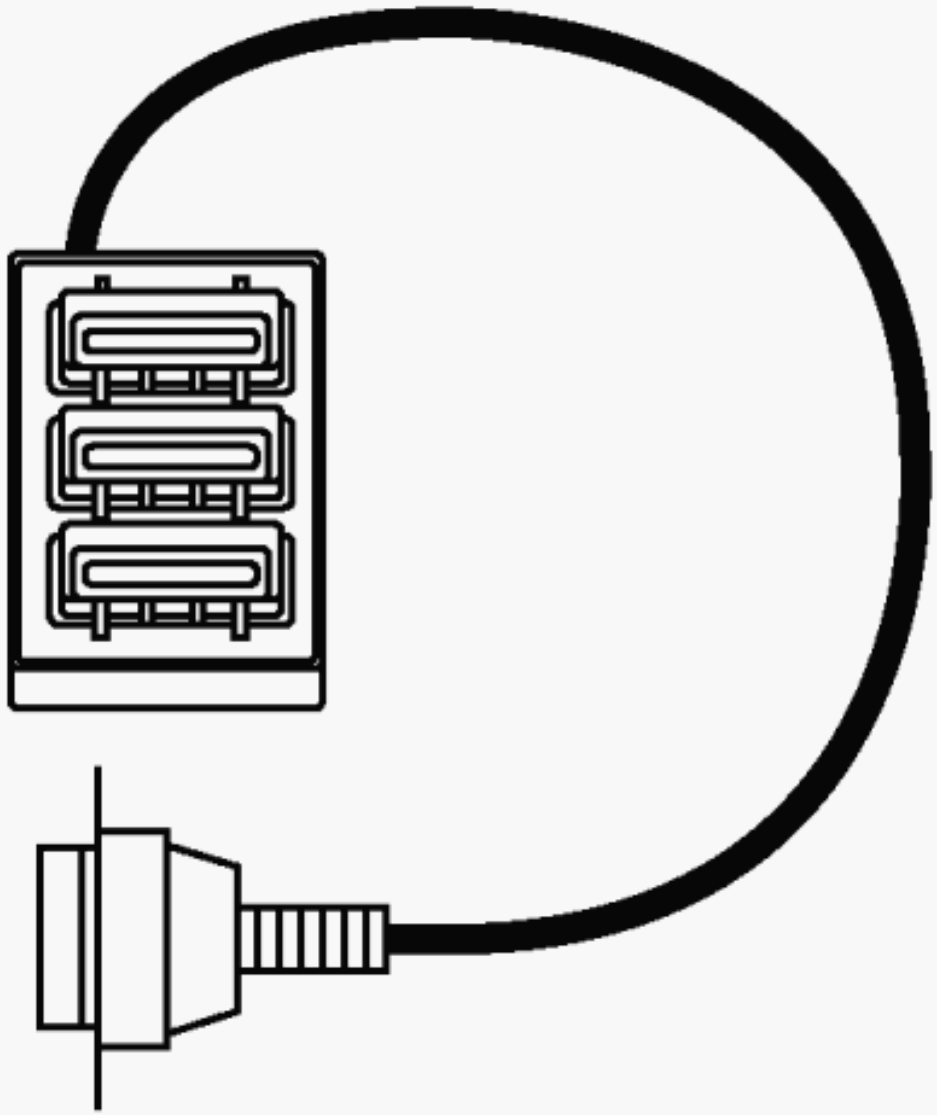
Illustration	Tool Number/Description
	CH-47976-514 AFIT SIDI E88 G6 Adapter Cable

cardiagn.com

Illustration	Tool Number/Description
	CH-47976-515 AFIT Universal Cable

cardiagn.com

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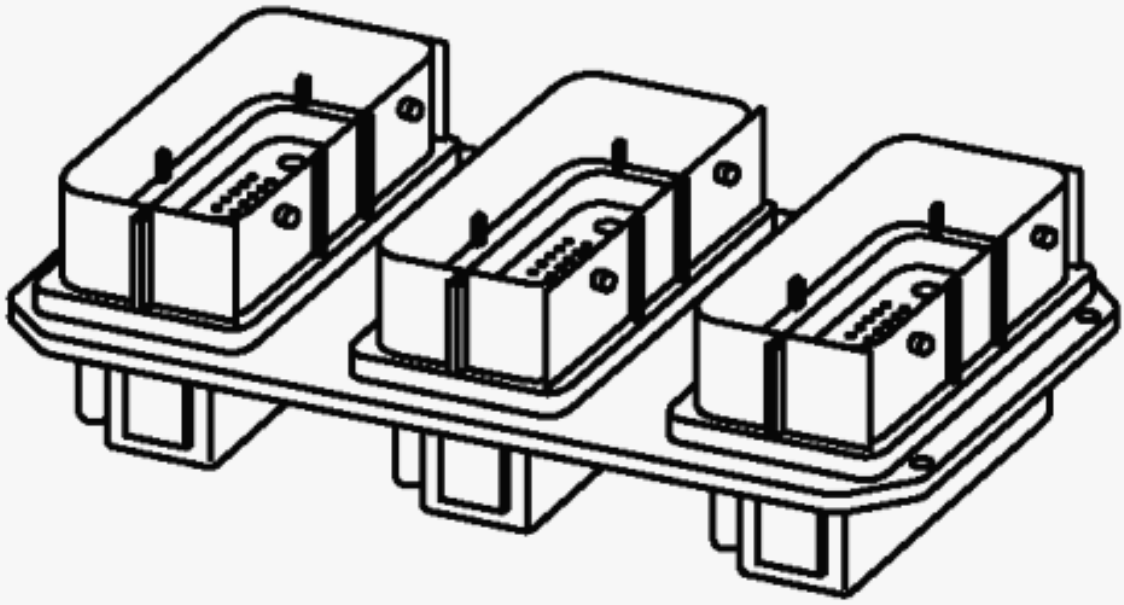	CH-47976-516 AFIT E01 G7 Adapter Cable

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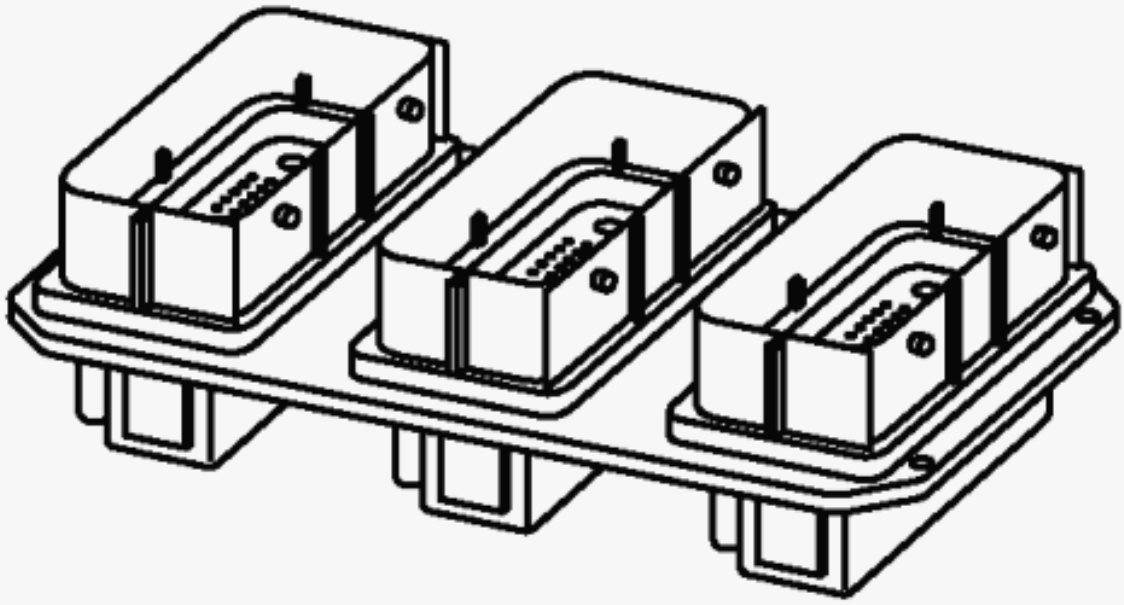
Illustration	Tool Number/Description
	CH-47976-517 AFIT E90 & E93 G8 Adapter Cable

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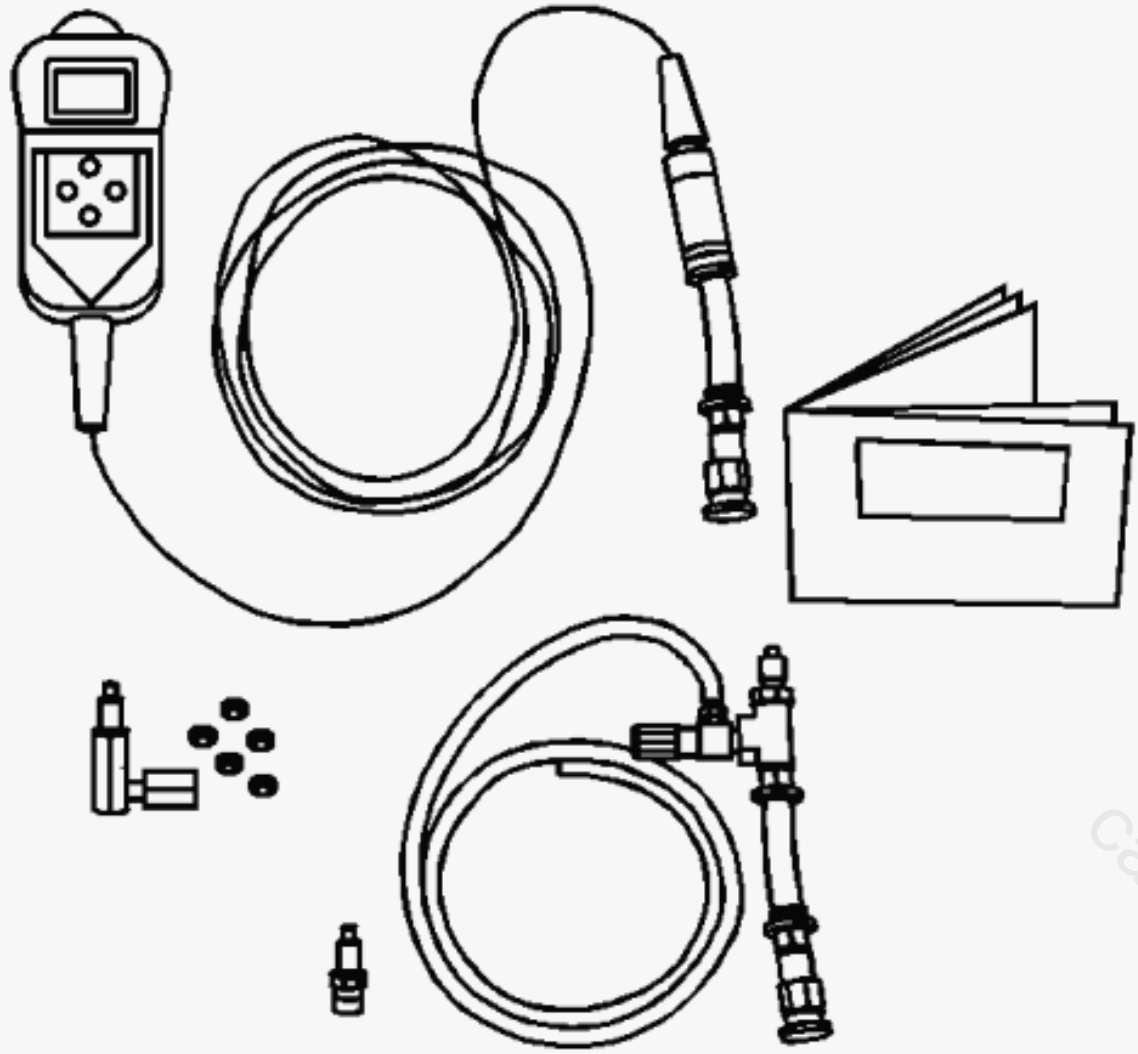
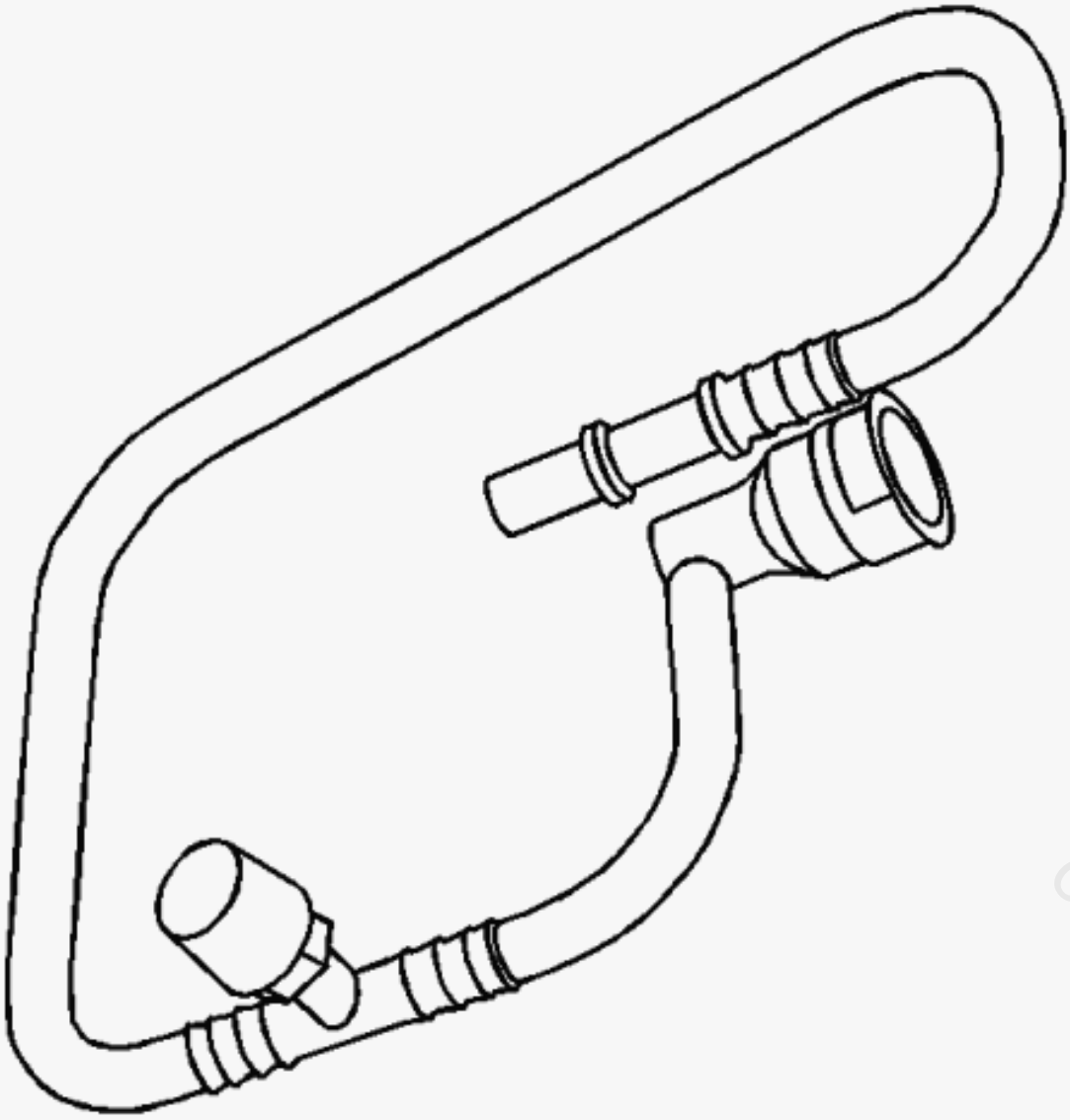
Illustration	Tool Number/Description
	CH-48027 Fuel Pressure Gauge

cardiagn.com

Illustration	Tool Number/Description
	CH-48096 EVAP Service Access Port Tool

cardiagn.com

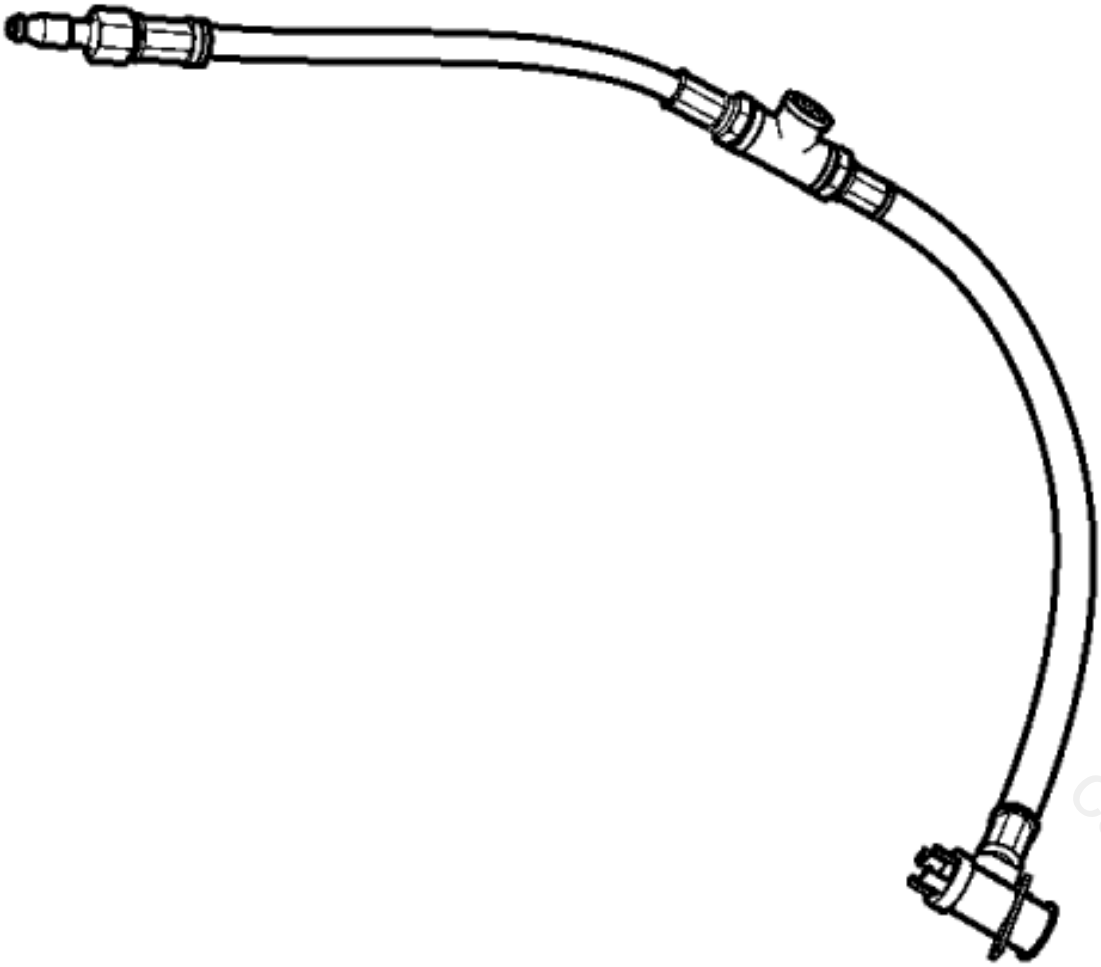
Illustration	Tool Number/Description
	CH-50375 Diesel Injector Return Line Pressure Adapter

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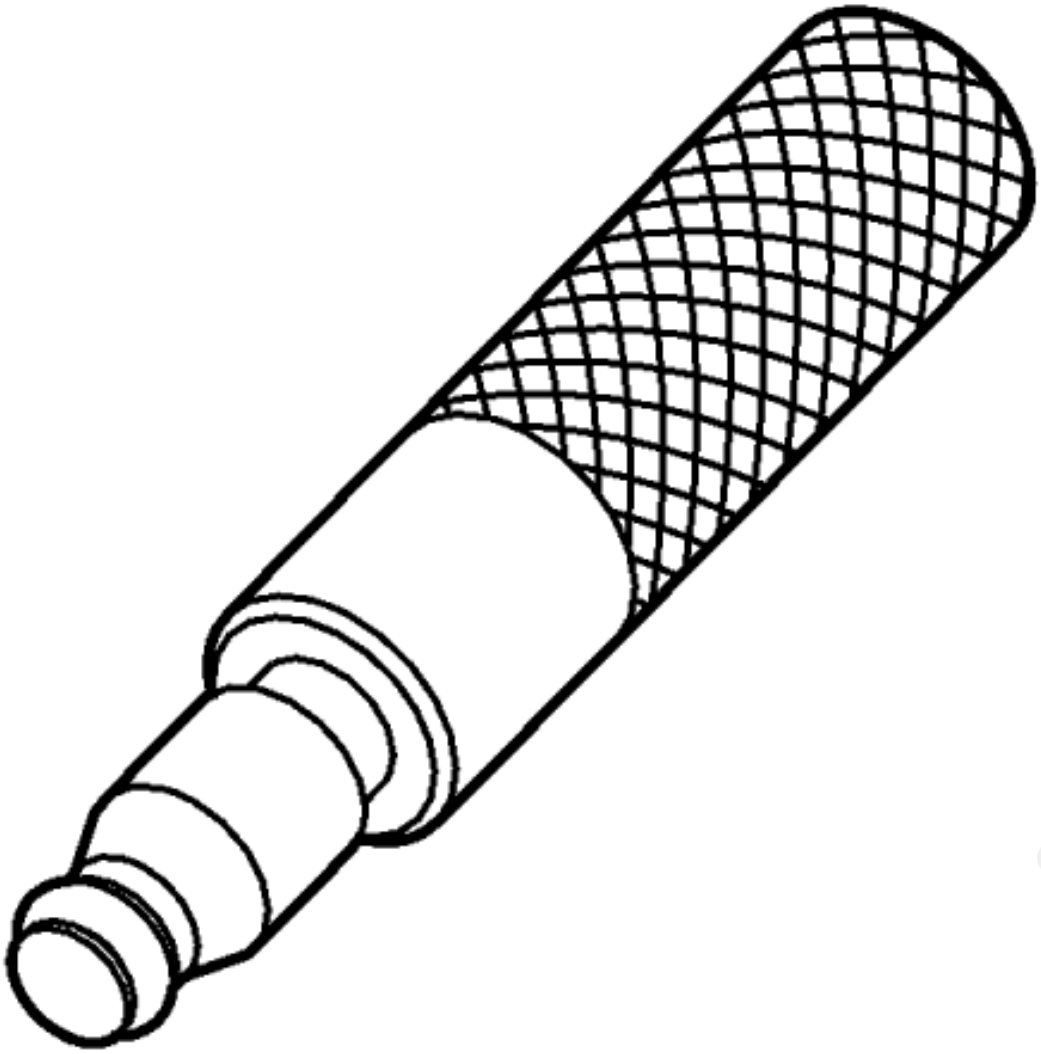
Illustration	Tool Number/Description
	CH-50377-A Injector Return Line Cap

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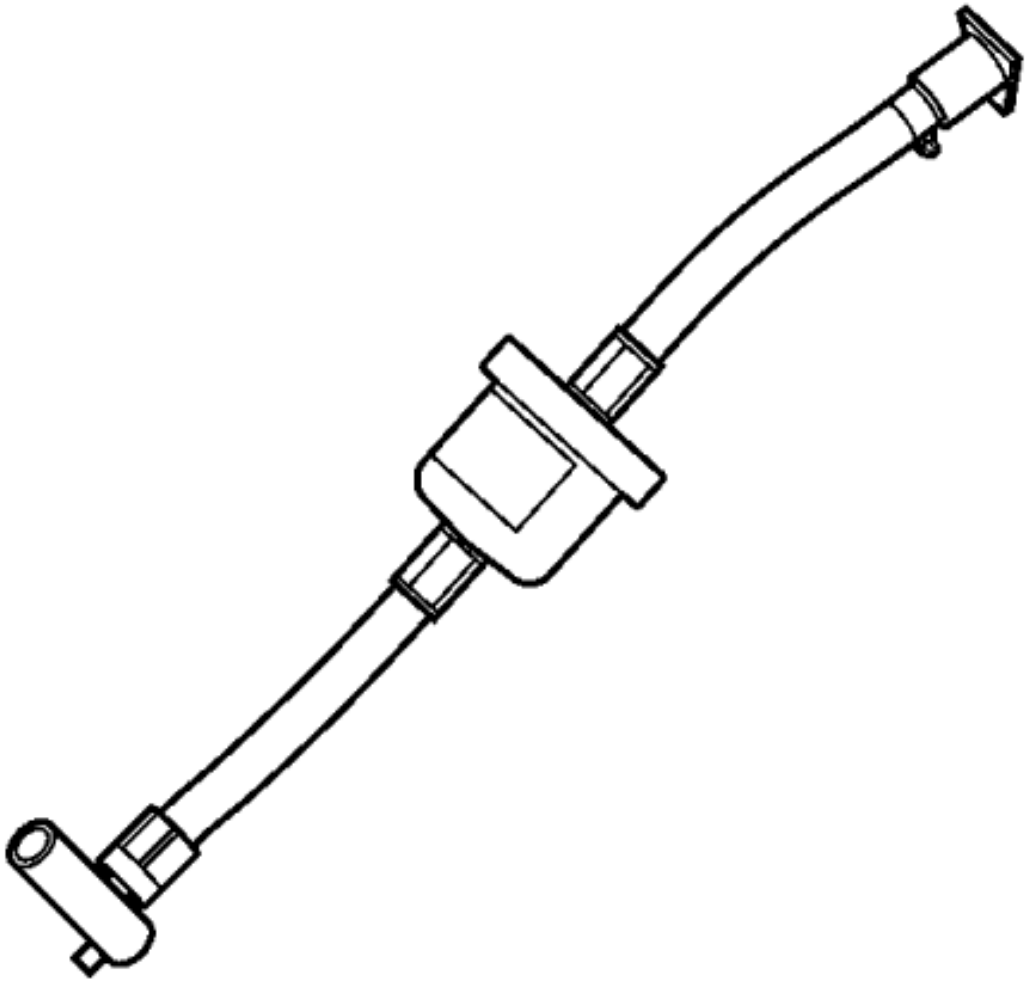
Illustration	Tool Number/Description
	CH-50378 Injector Return Leakage Test Adapter

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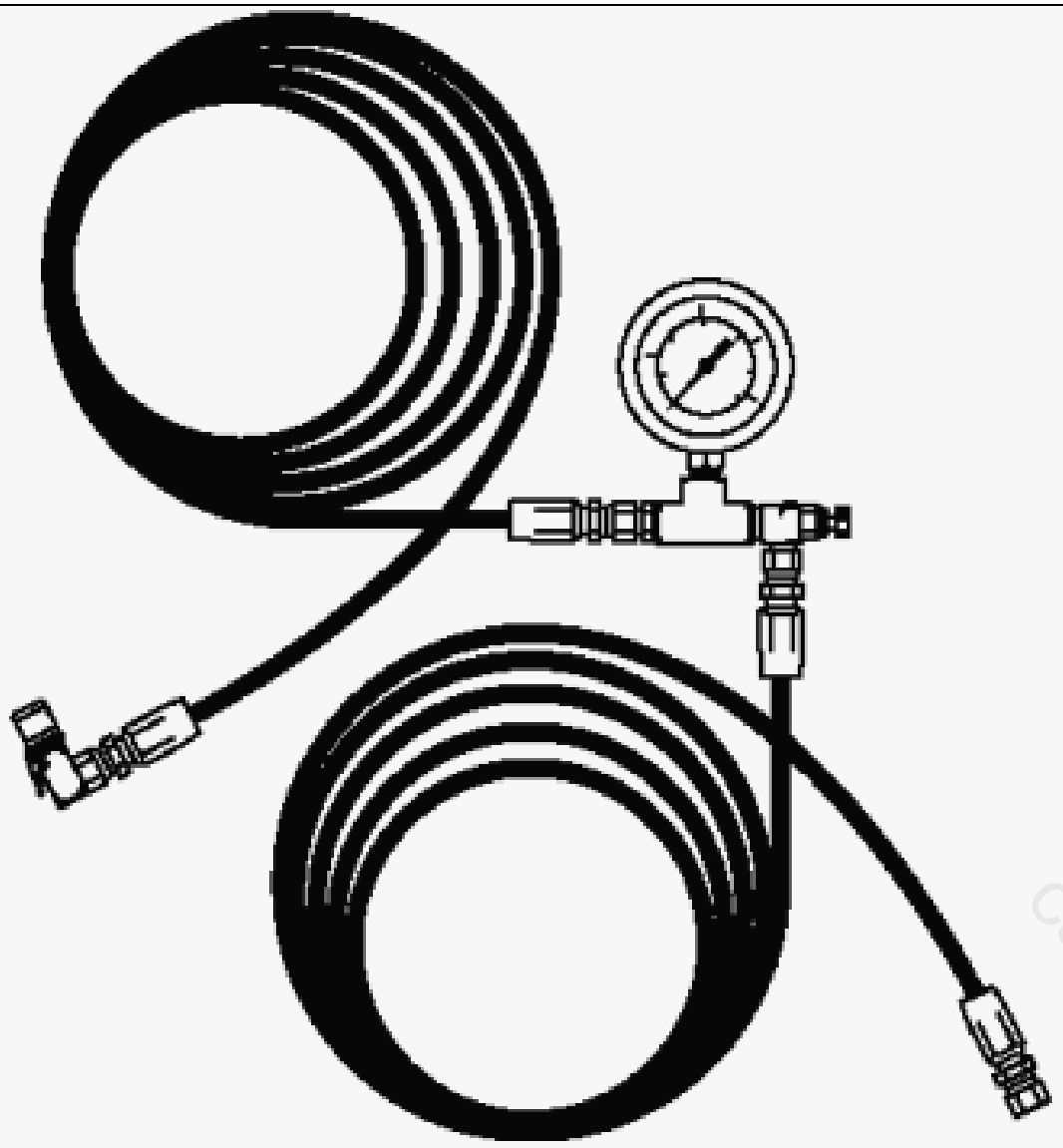
Illustration	Tool Number/Description
	CH-50933 Gauge Assembly, Liquid Propane Gas (LPG)

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Illustration	Tool Number/Description
	CH-52519 EVAP Service Access Port Tool
	EL-26792 J-26792 HEI Spark Tester

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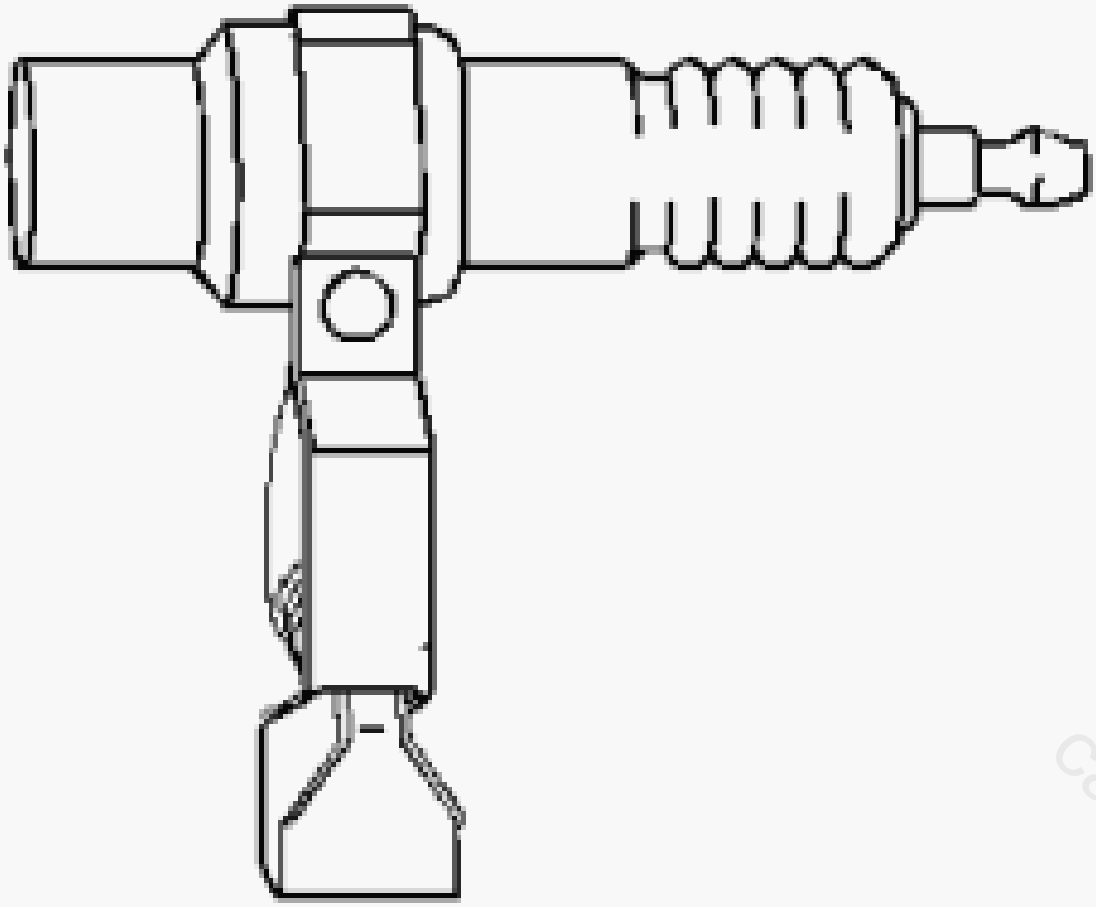
Illustration	Tool Number/Description
	EL-34730-405 J-34730-405 Injector Test Lamp

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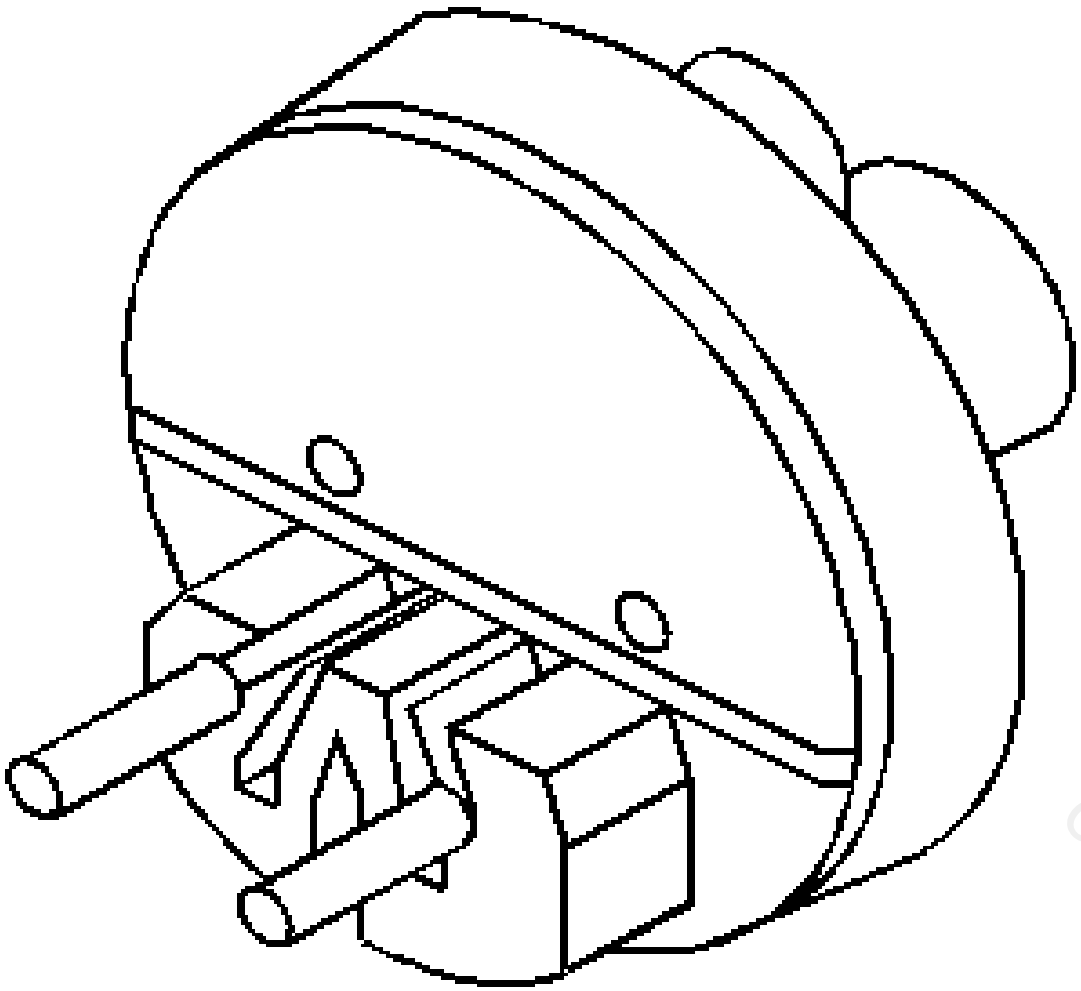
Illustration	Tool Number/Description
	

cardiagn.com

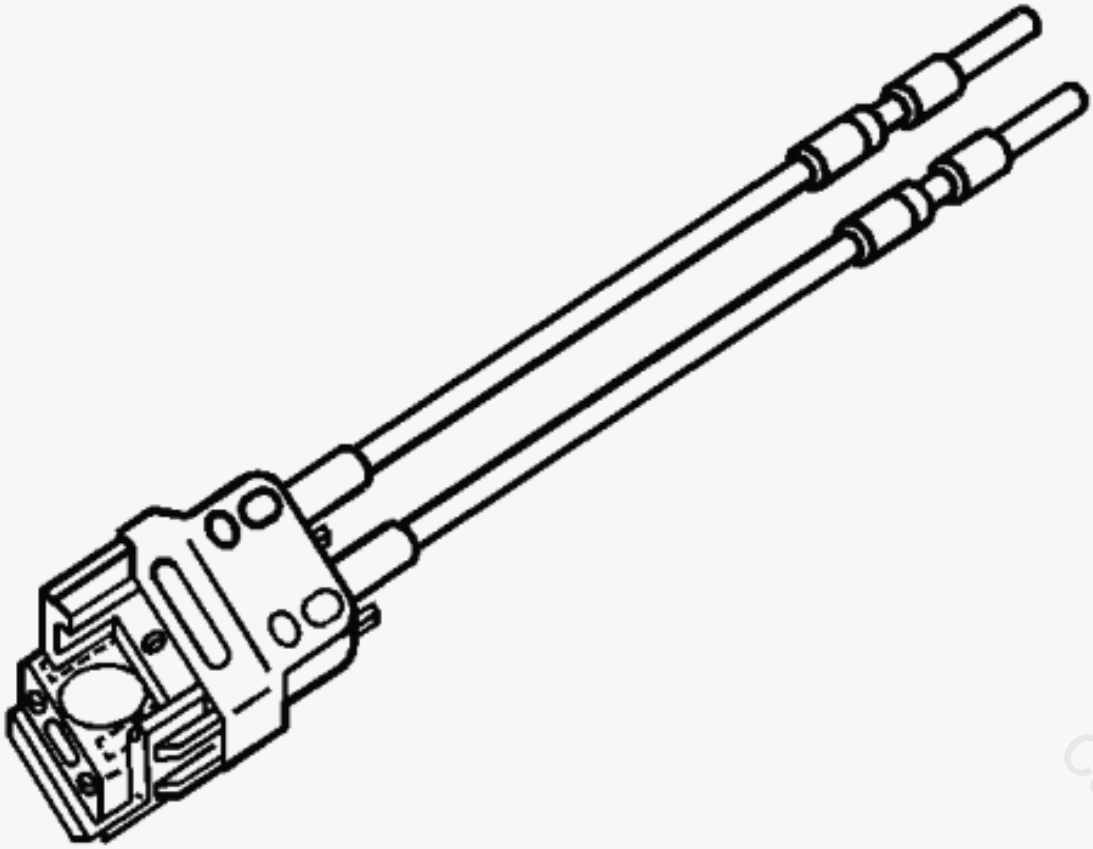
Illustration	Tool Number/Description
	EL-36169-HD Heavy Duty Fused Jumper
	EL-38522-A J-38522-A Variable Signal Generator

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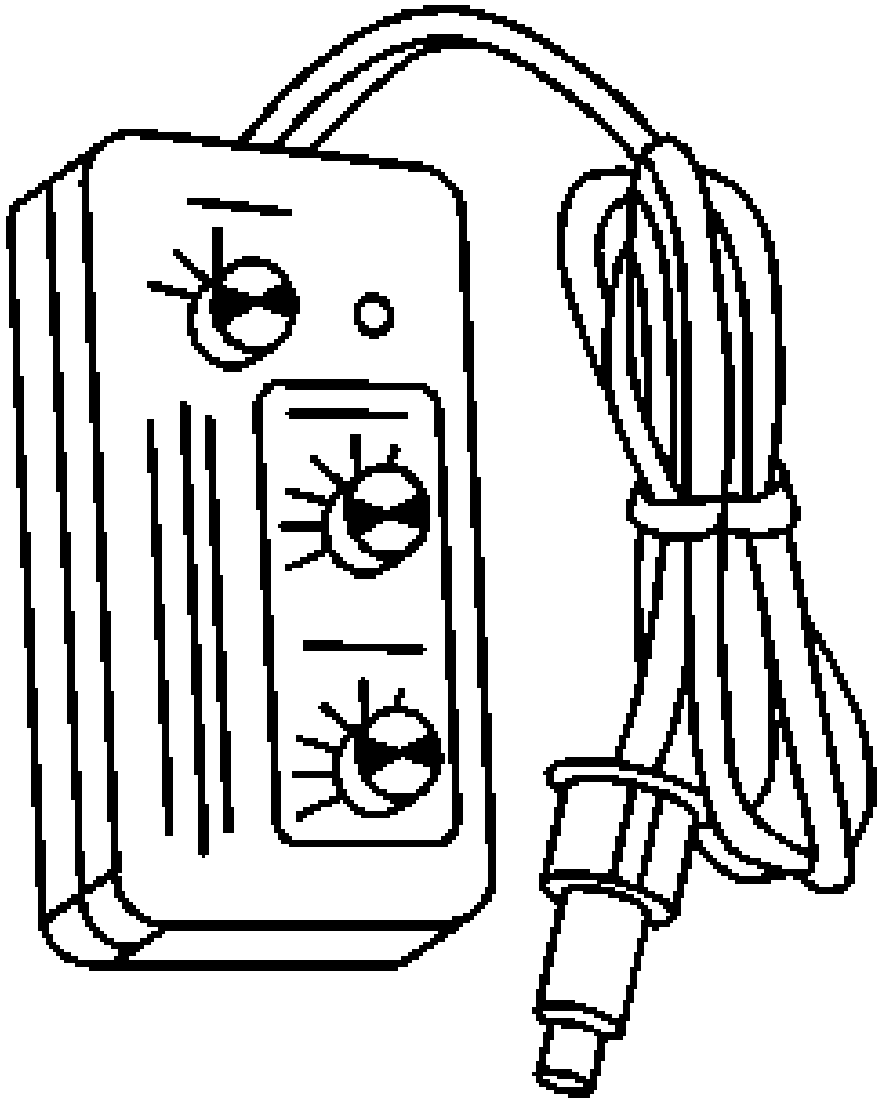
Illustration	Tool Number/Description
	

cardiagn.com

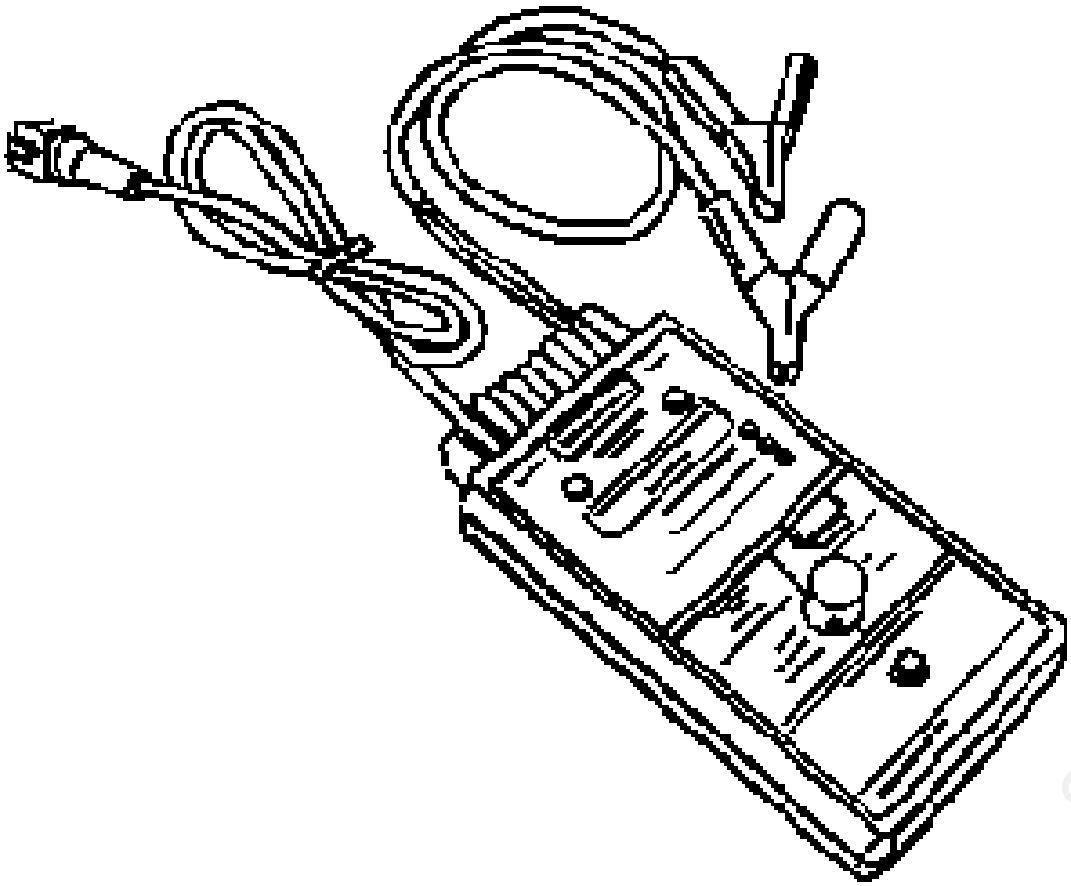
Illustration	Tool Number/Description
	EL-39021 J-39021 Fuel Injector Coil Balance Tester

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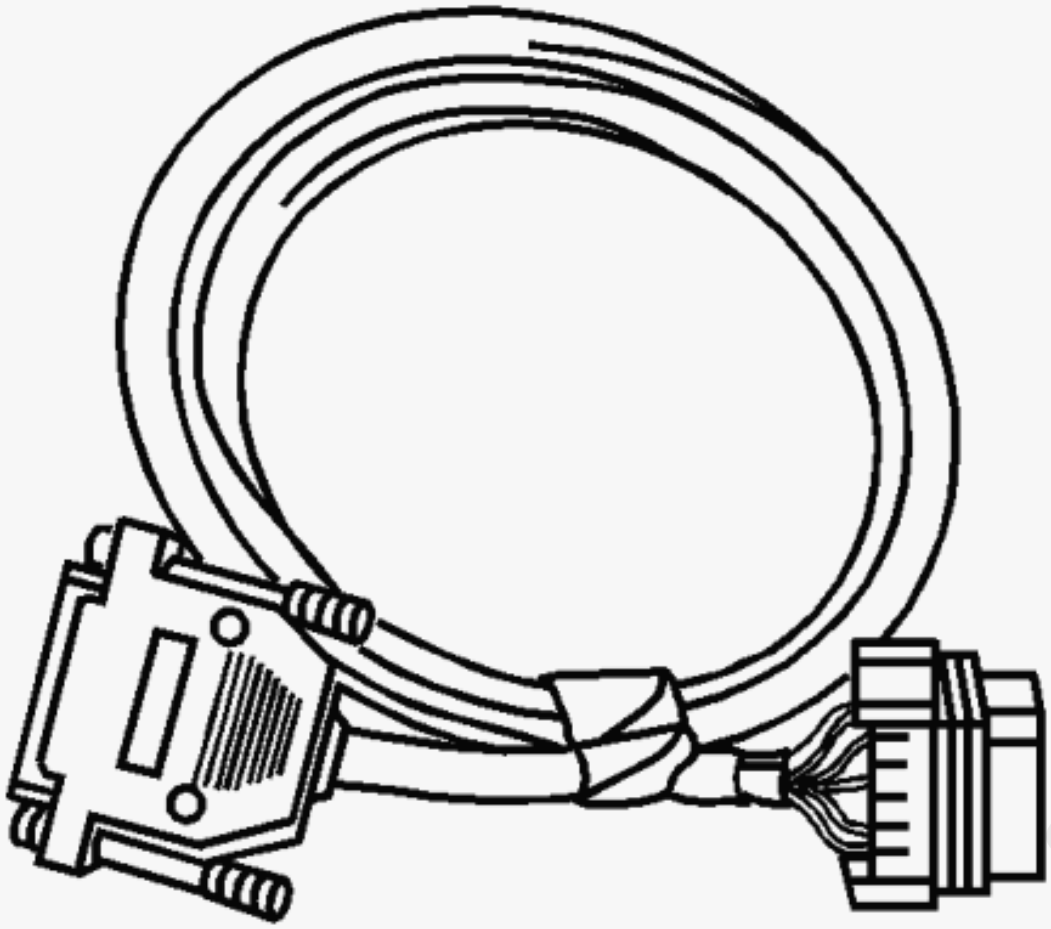
Illustration	Tool Number/Description
	EL-39021-460 J-39021-460 Fuel Injector Test Adapter

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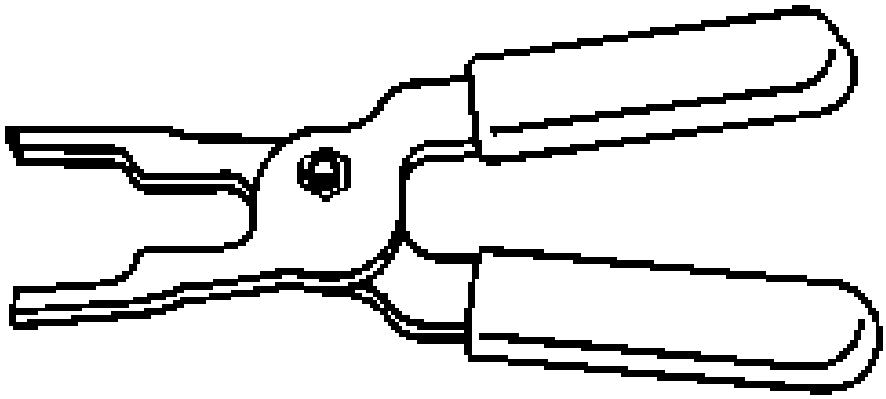
Illustration	Tool Number/Description
	EL-43244 J-43244 Relay Puller Pliers

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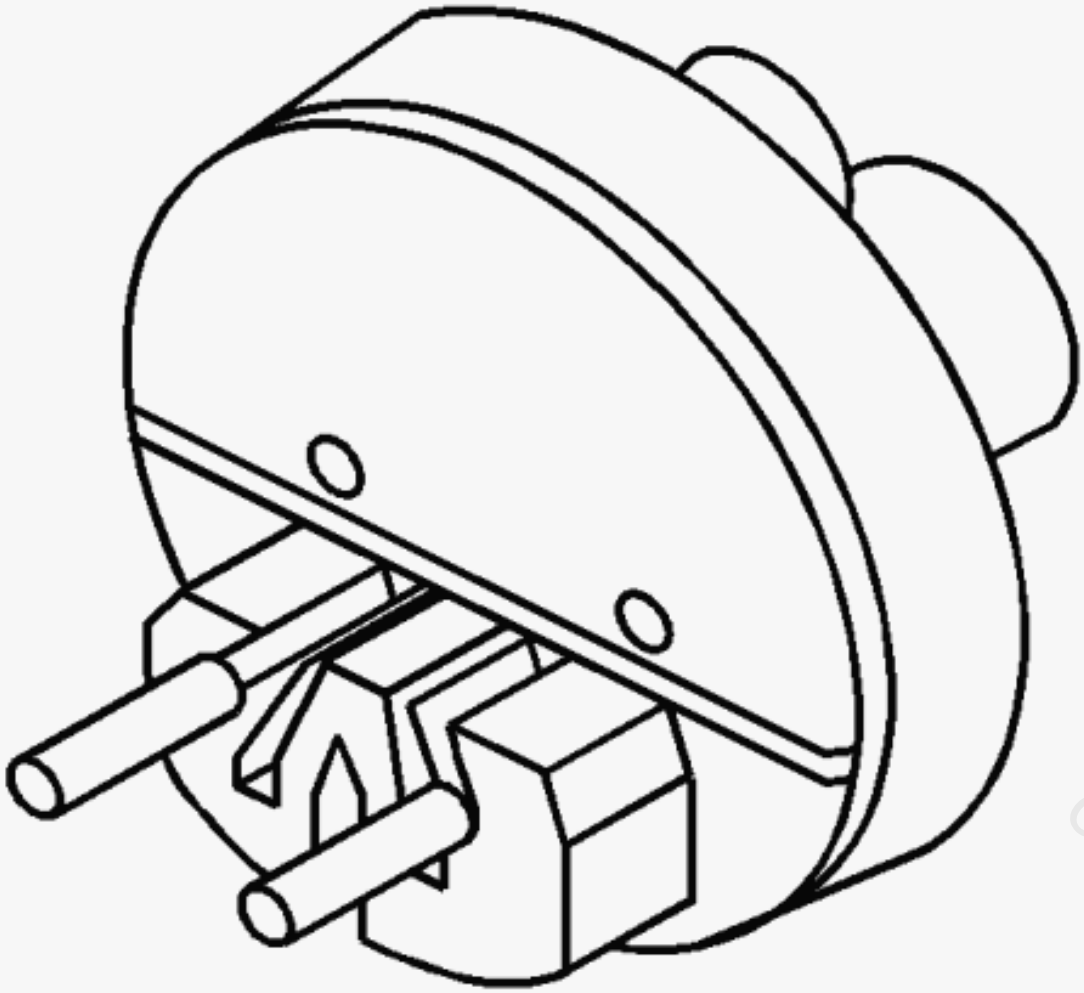
Illustration	Tool Number/Description
	EL-44603 J-44603 Injector Test Lamp

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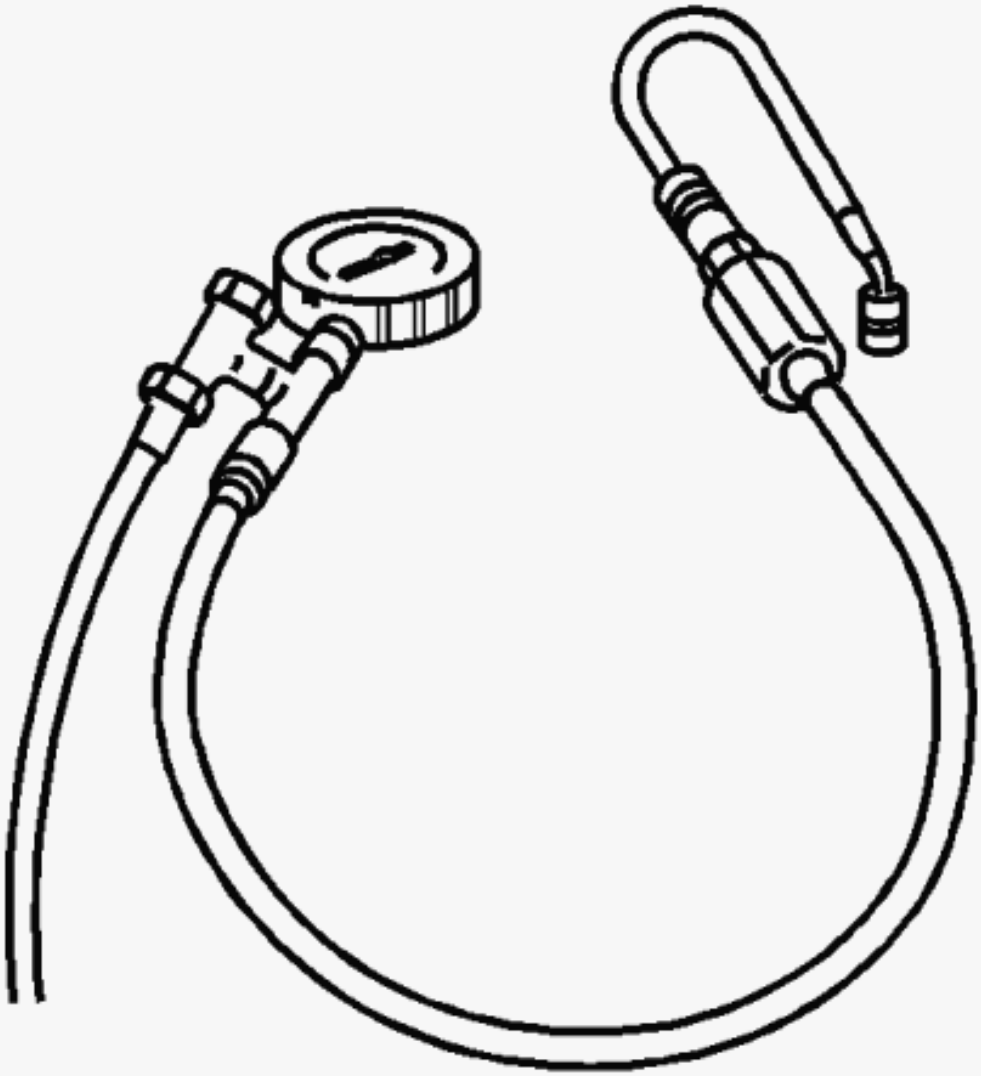
Illustration	Tool Number/Description
	EN-34730-91 J-34730-91 KM-J-34730-91 Pressure Tester
	EN-36012-A J-36012-A Ignition System Diagnosis Harness

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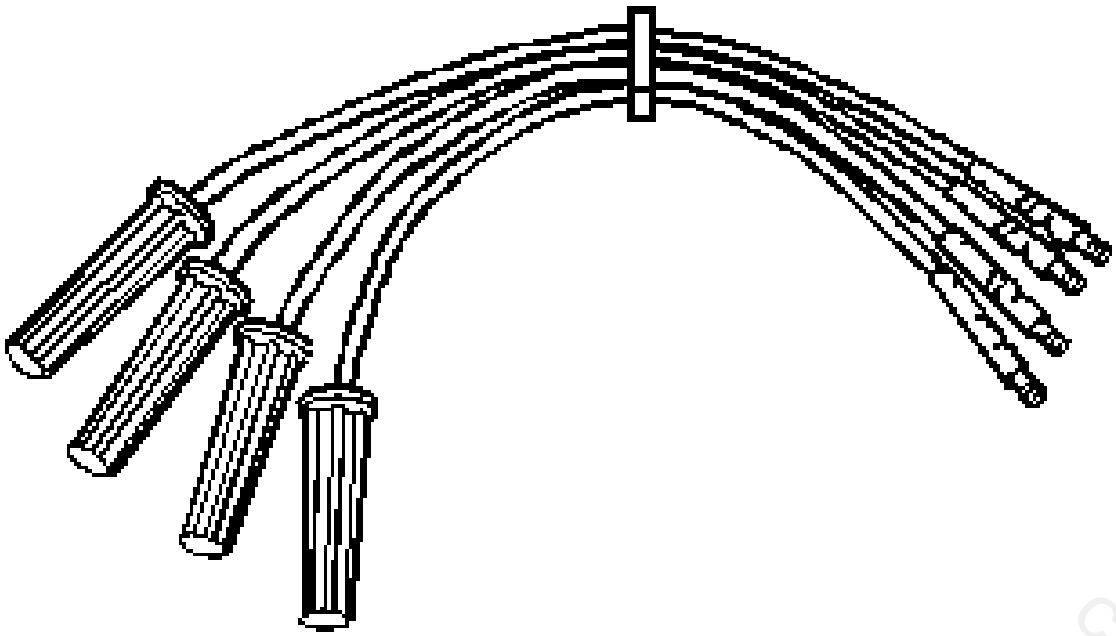
Illustration	Tool Number/Description
	EN-37287 J-37287 Fuel Line Shut-off Adapters

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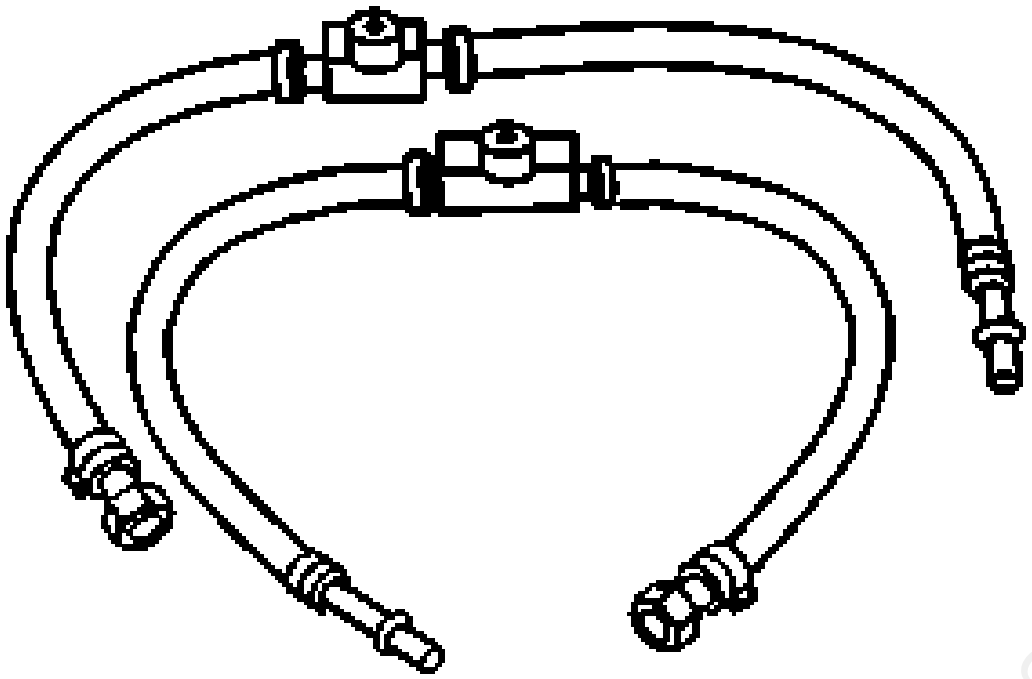
Illustration	Tool Number/Description
	

cardiagn.com

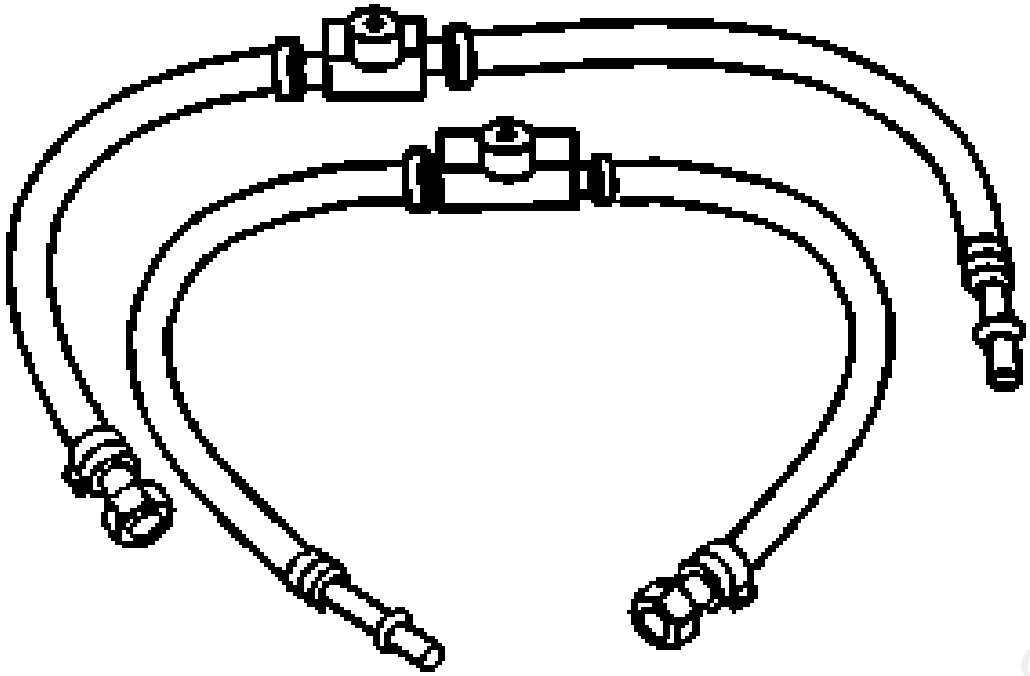
Illustration	Tool Number/Description
	EN-37287 - FF Fuel Line Shut-off Adapters

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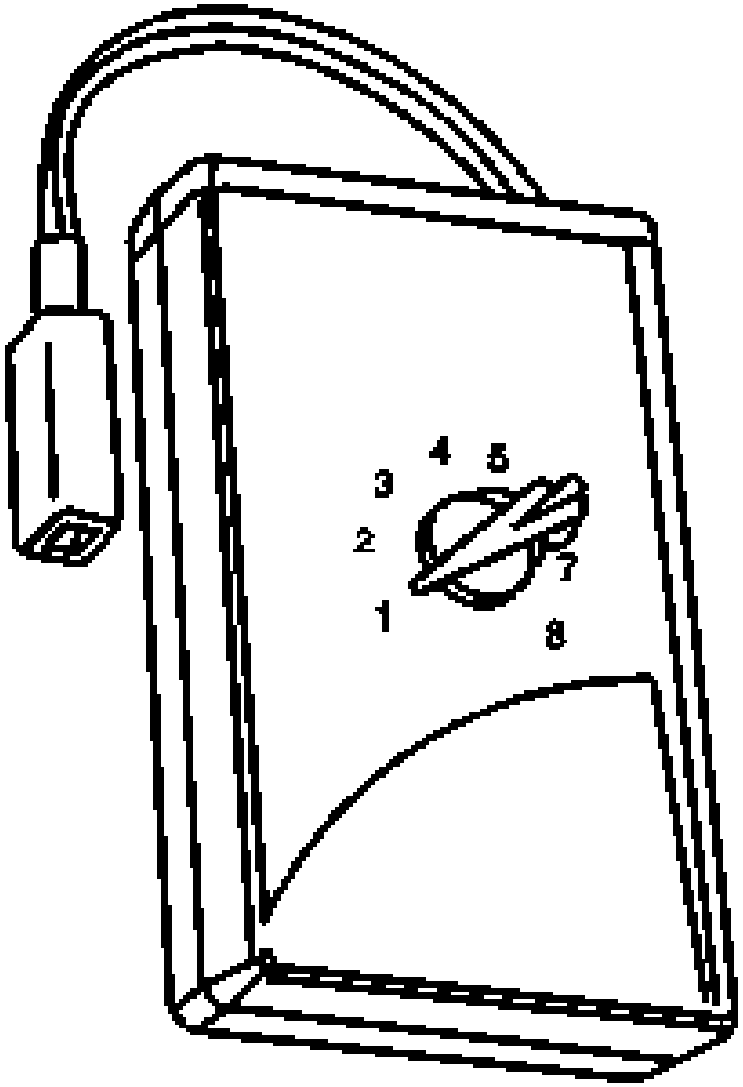
Illustration	Tool Number/Description
	EN-39021-210 J-39021-210 Injector Tester Adapter Box

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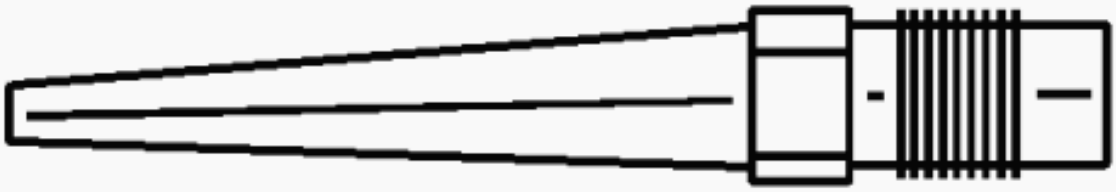
Illustration	Tool Number/Description
	EN-41413-311 J-41413-311 EVAP Plug

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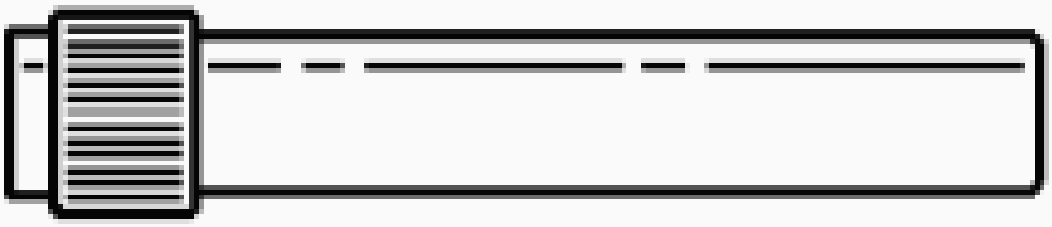
Illustration	Tool Number/Description
	EN-41413-VLV J-41413-VLV EVAP Service Port Vent Fitting
	EN-44602 J-44602 Injector Test Adapter

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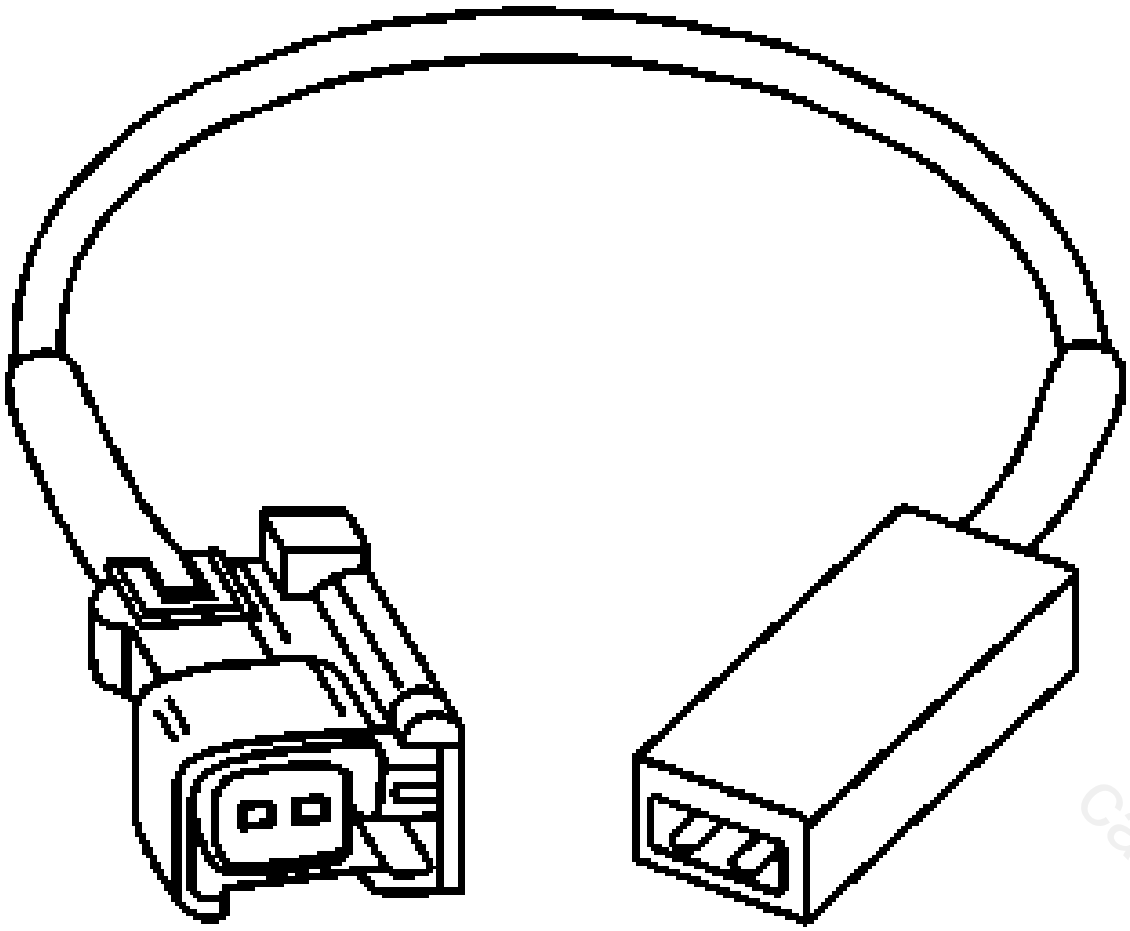
Illustration	Tool Number/Description
	

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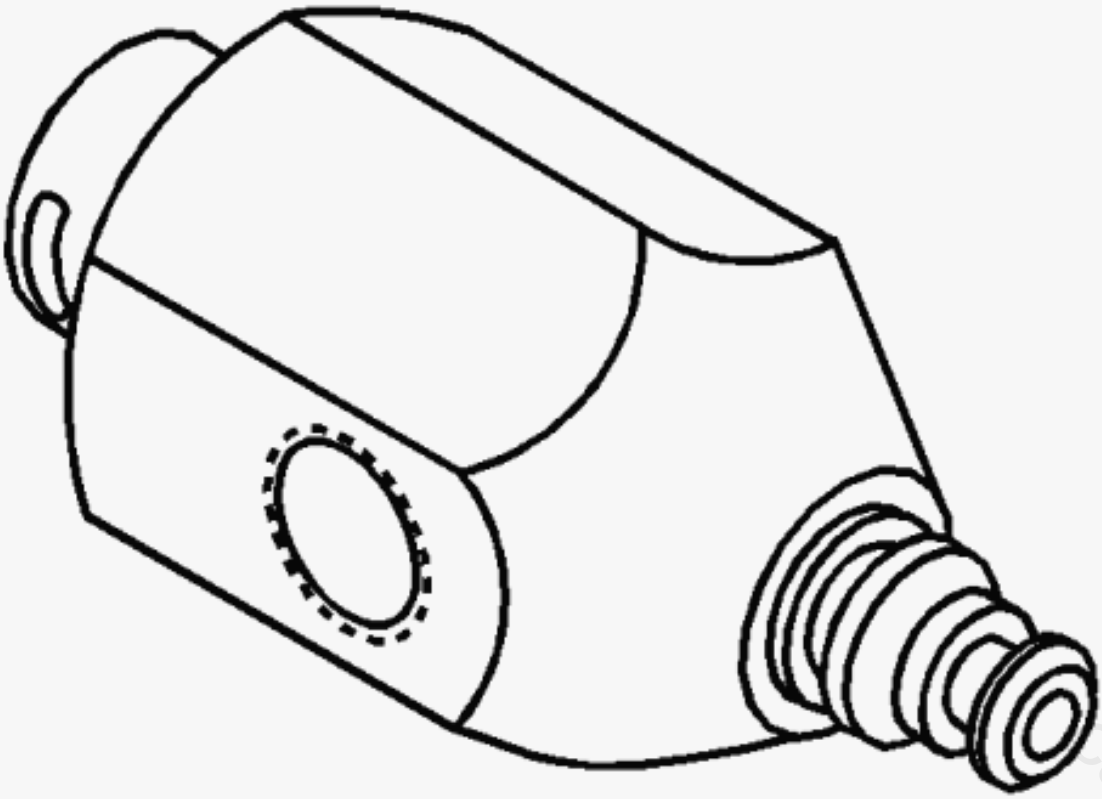
Illustration	Tool Number/Description
	EN-45873-30 J-45873-30 Injector Flow Test Adapter

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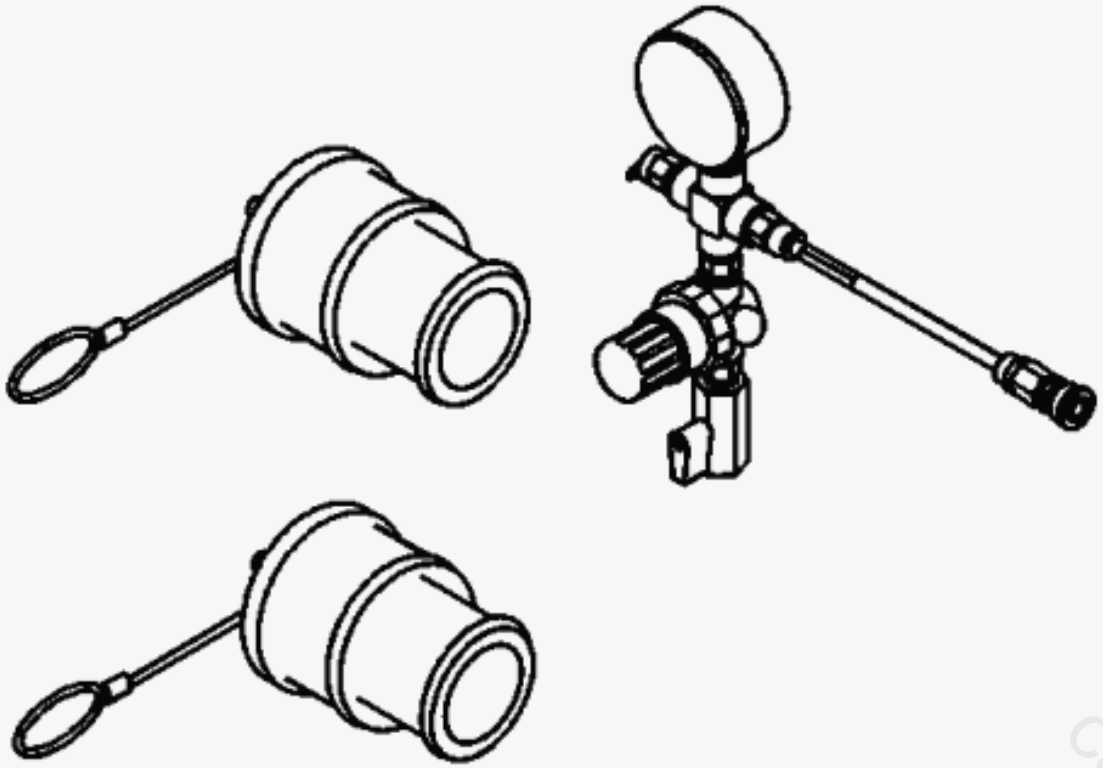
Illustration	Tool Number/Description
	EN-46091 J-46091 Charge Air Cooler Tester

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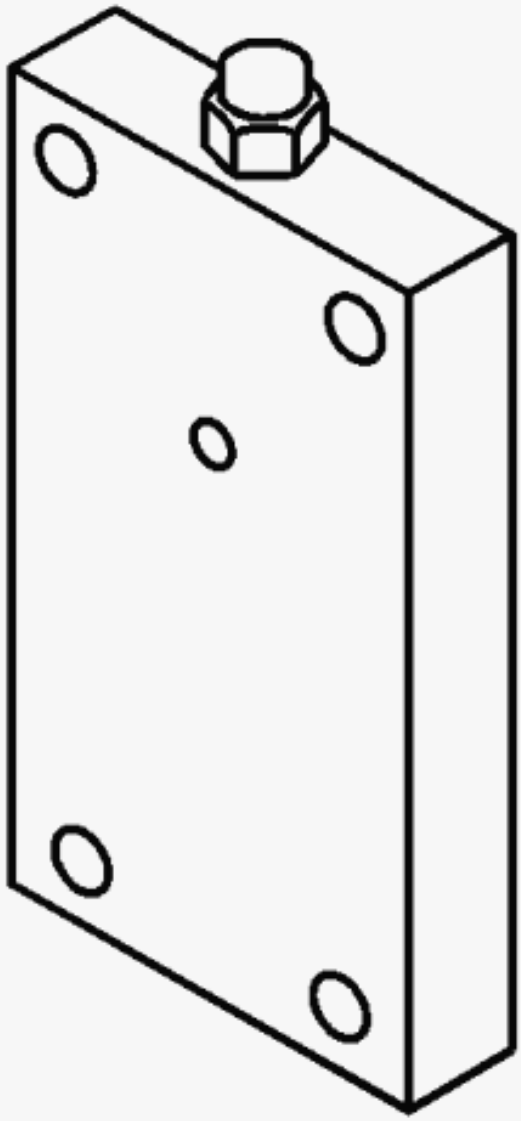
Illustration	Tool Number/Description
	EN-46091-5 J-46091-5 Charge Air Cooler Tester Adapter

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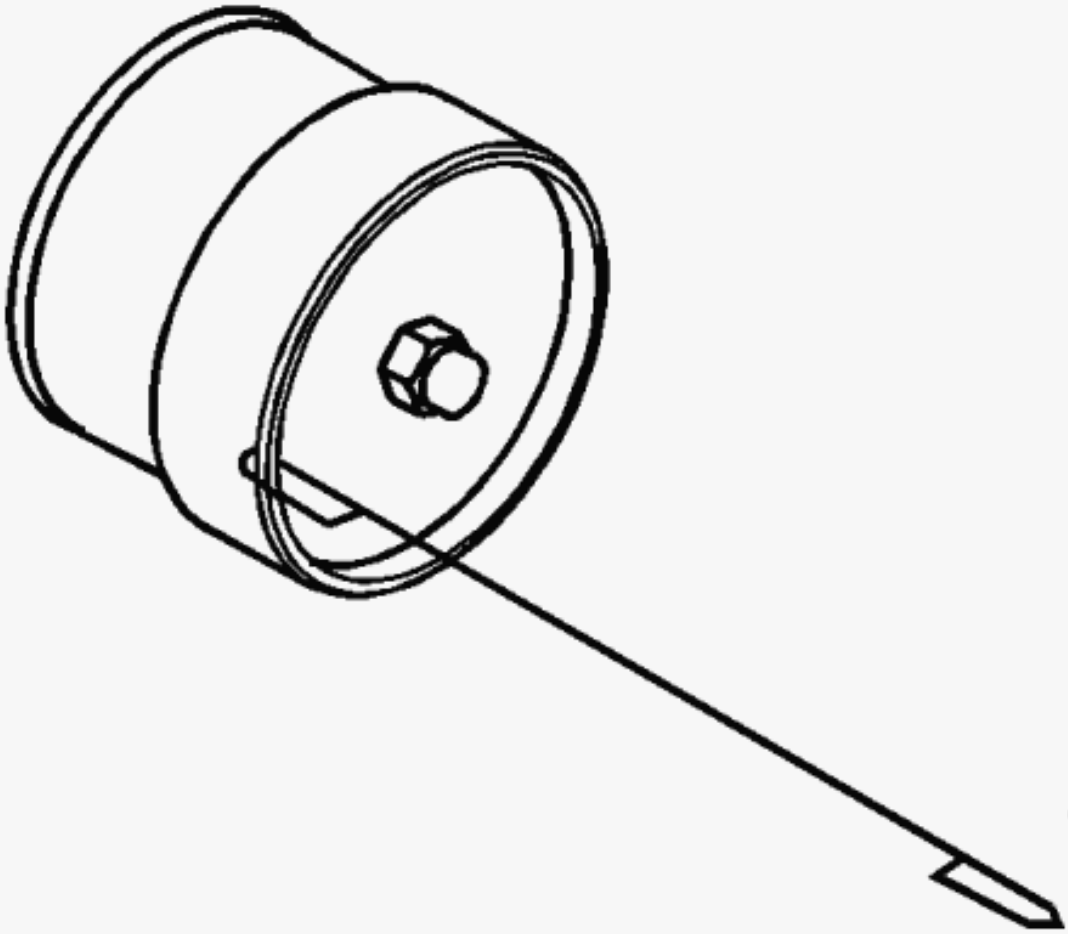
Illustration	Tool Number/Description
	EN-46091-10A Diesel Engine Pressure Test Adapter

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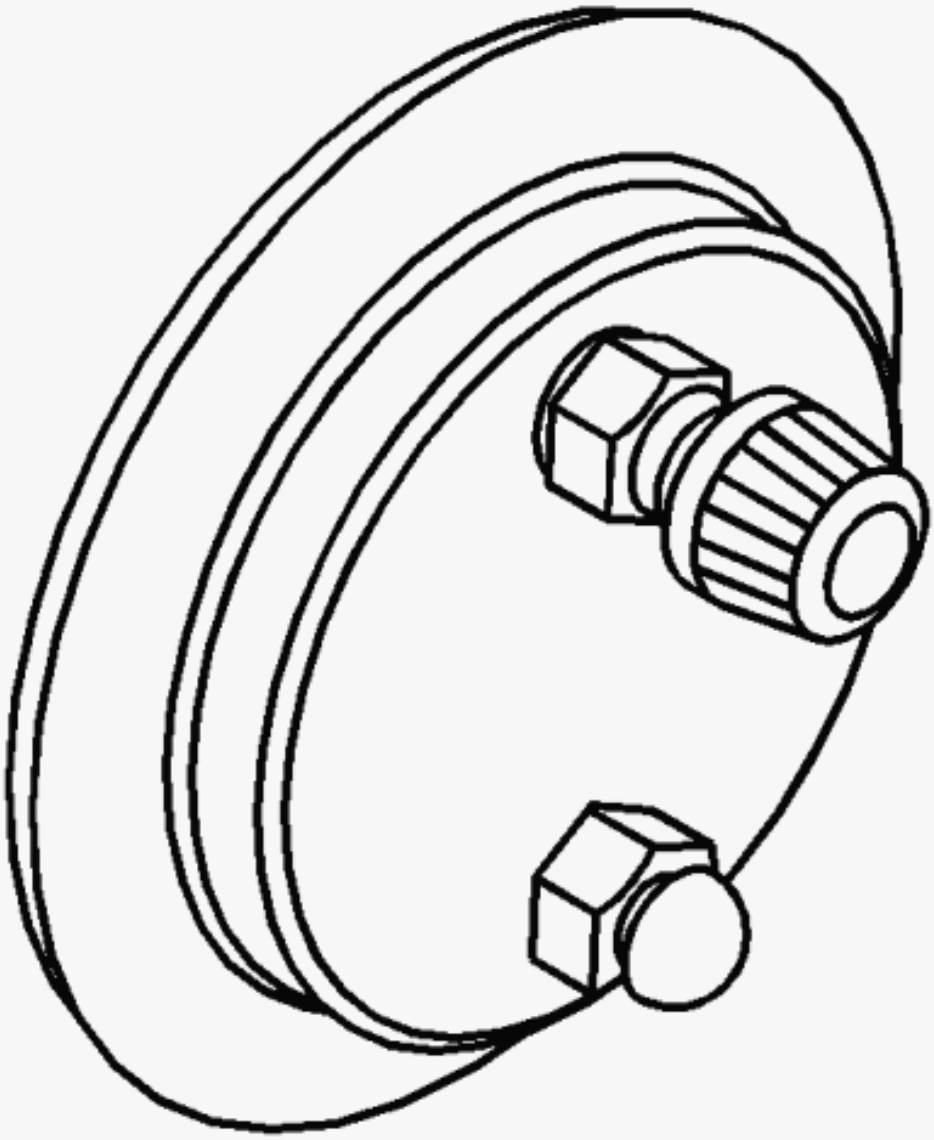
Illustration	Tool Number/Description
	EN-46091-15 J-46091-15 Engine Pressure Test Adapter

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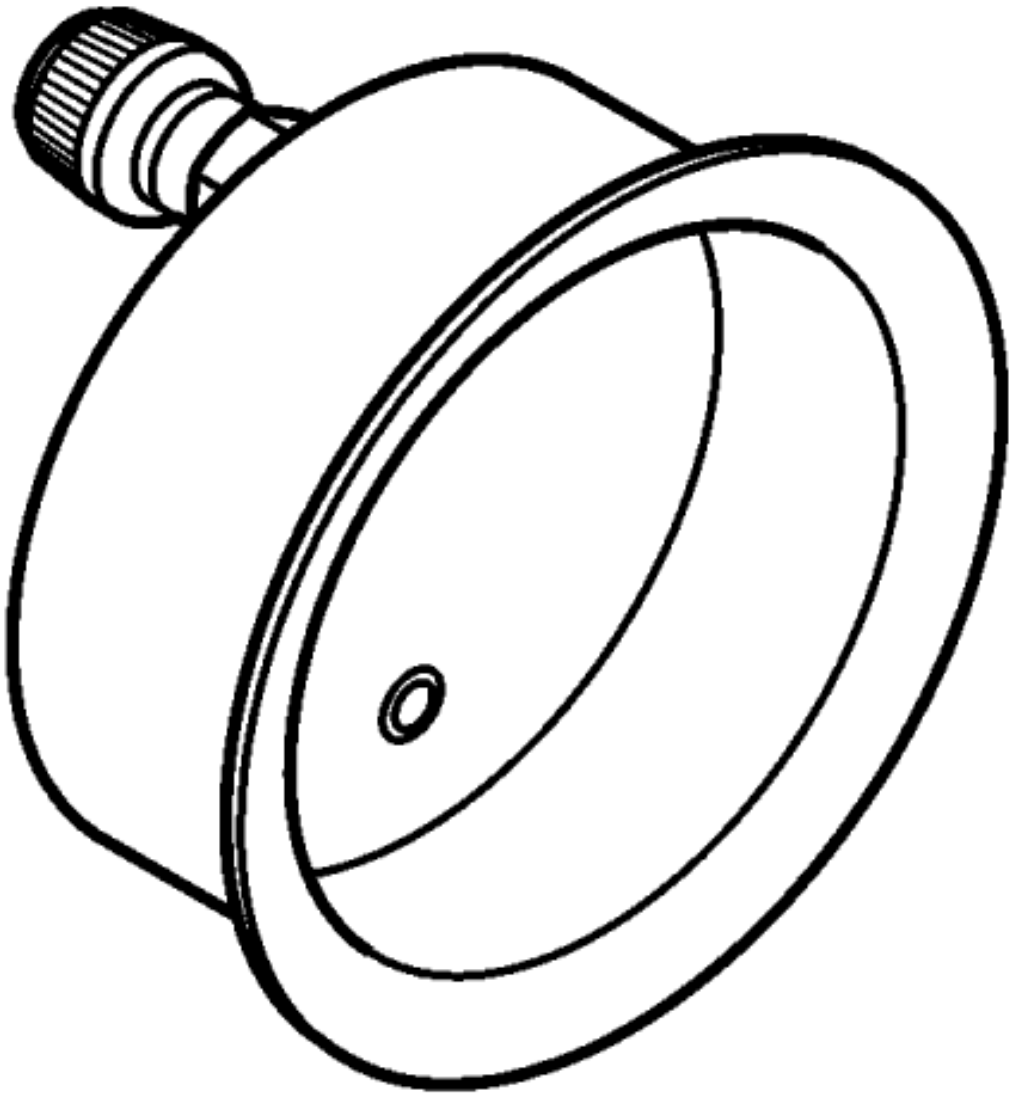
Illustration	Tool Number/Description
	EN-46091-15A J-46091-15A Diesel Engine Pressure Test Adapter

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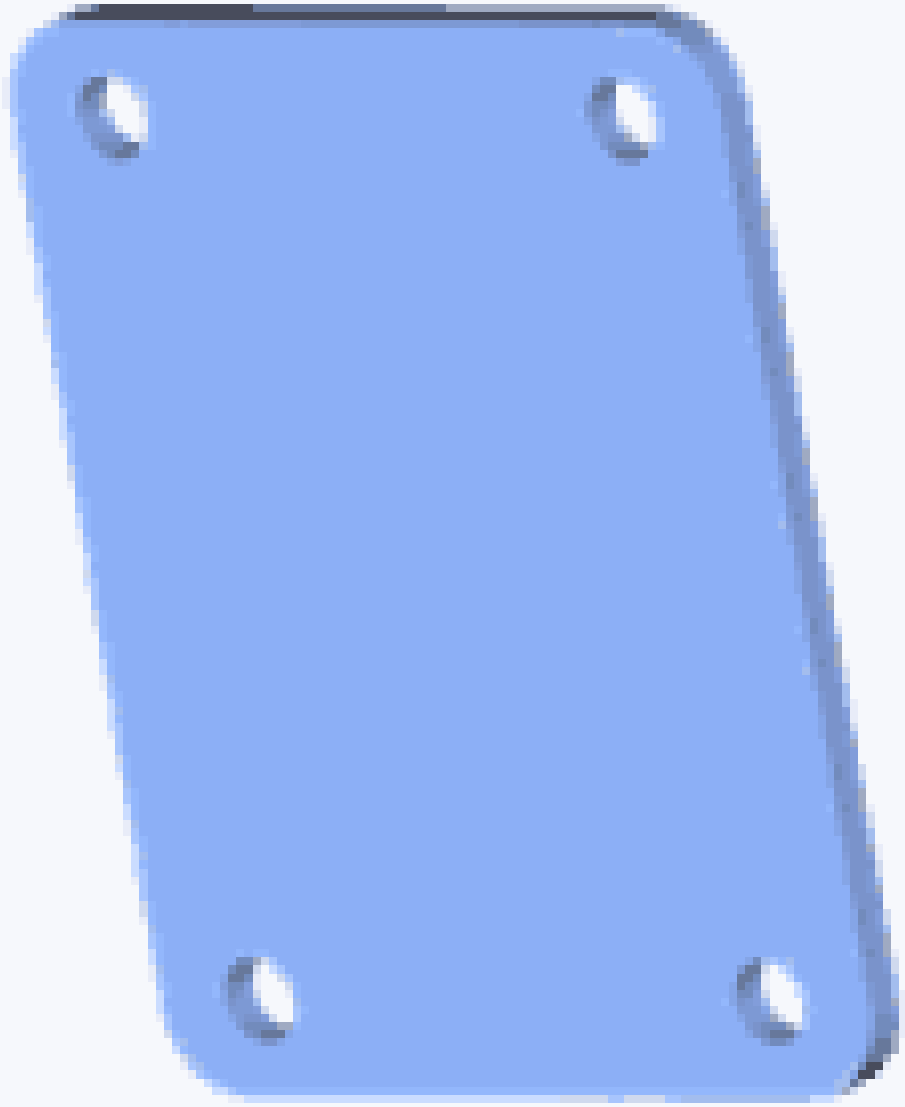
Illustration	Tool Number/Description
	EN-46091-25 J-46091-25 Diesel Engine Pressure Test Adapter

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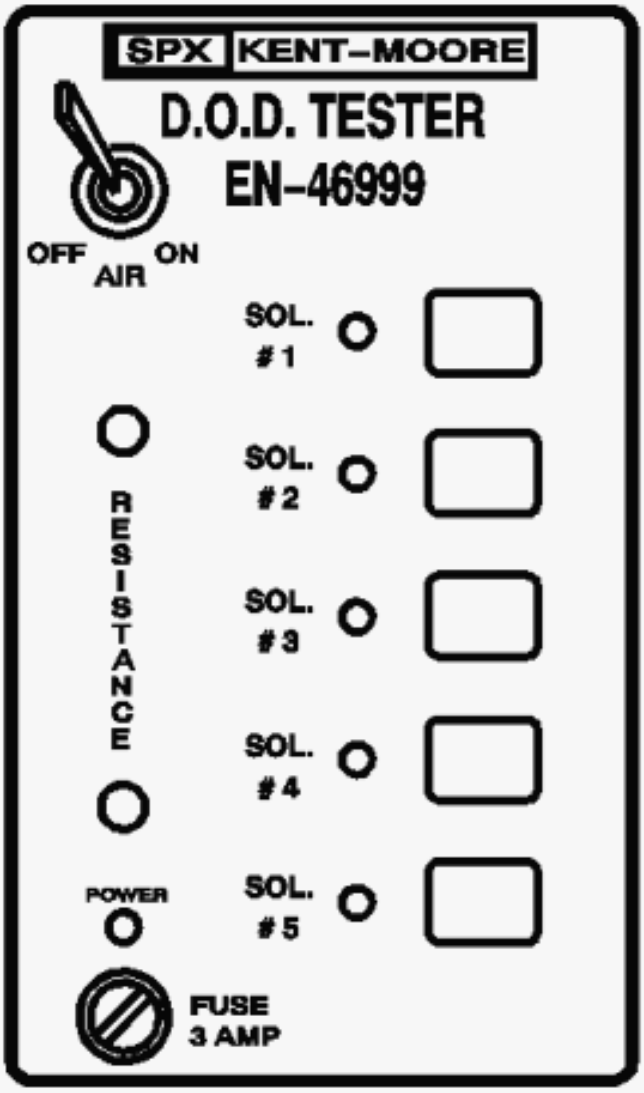
Illustration	Tool Number/Description
	EN-46999 Displacement On Demand Tester

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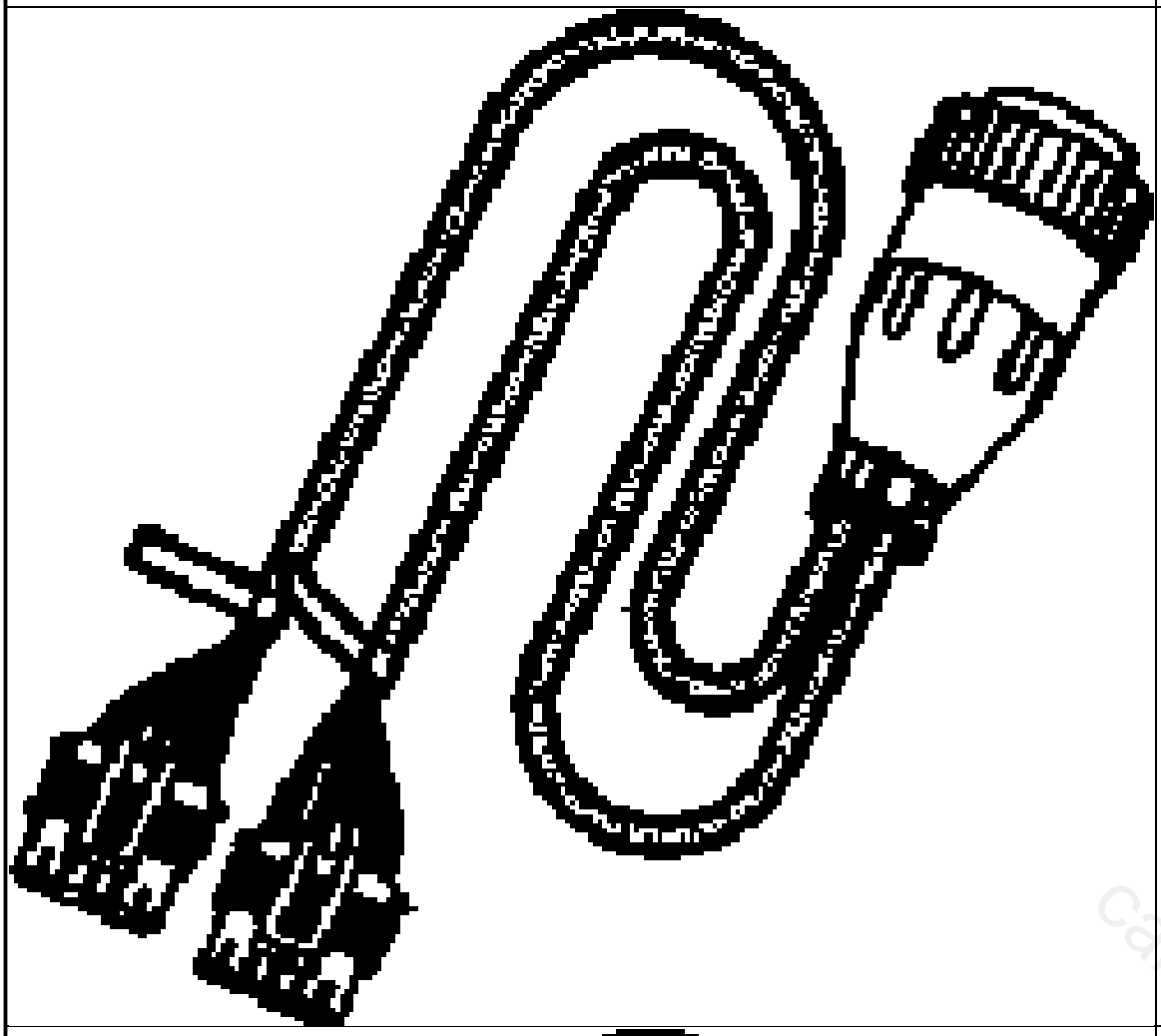
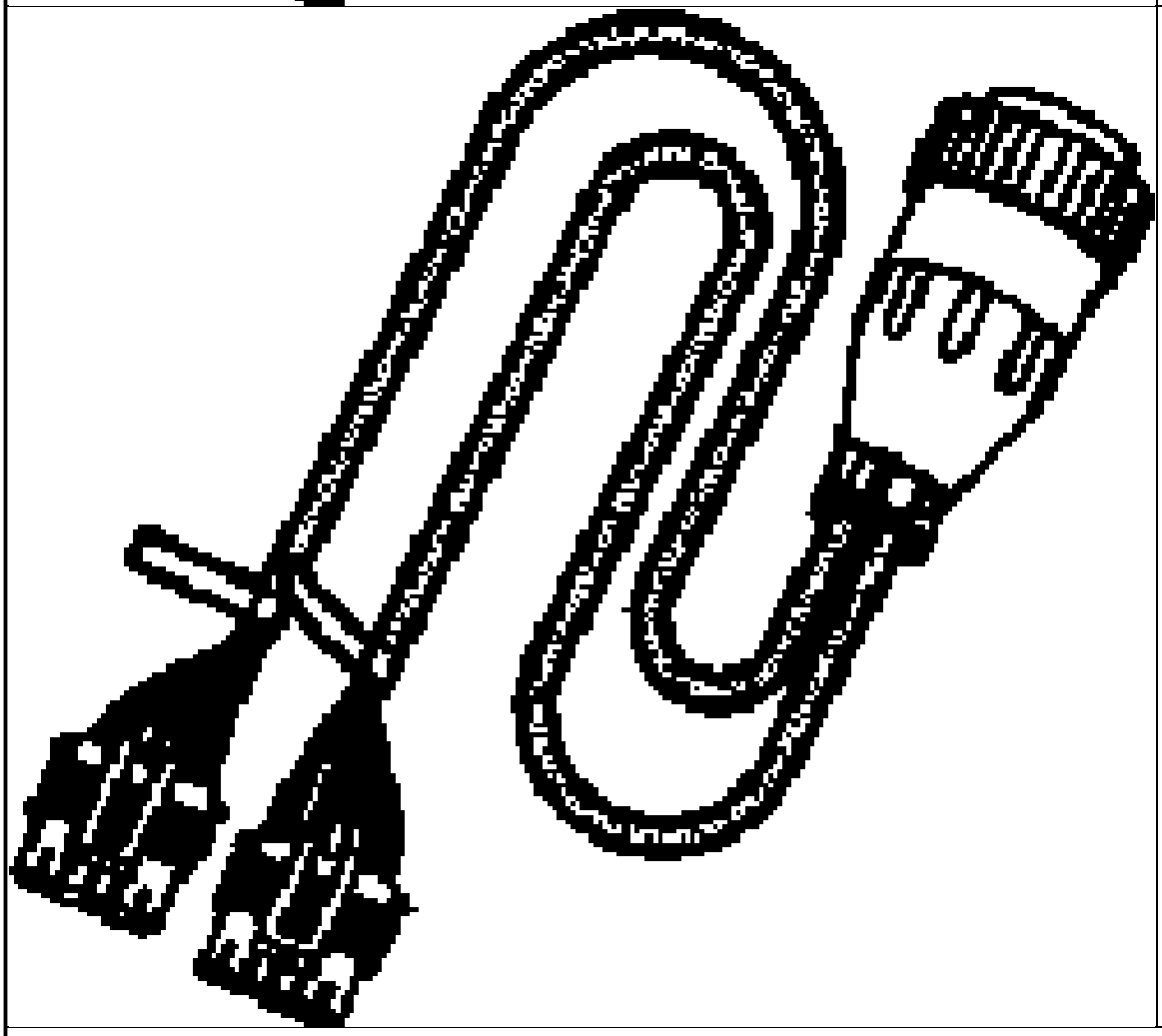
Illustration	Tool Number/Description
	EN-46999-15 Active Fuel Management Tester Harness - V6
	EN-46999-20 Active Fuel Management Tester Harness - Small Block V8

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Illustration	Tool Number/Description
	EN-47603 Compression Gauge Adapter

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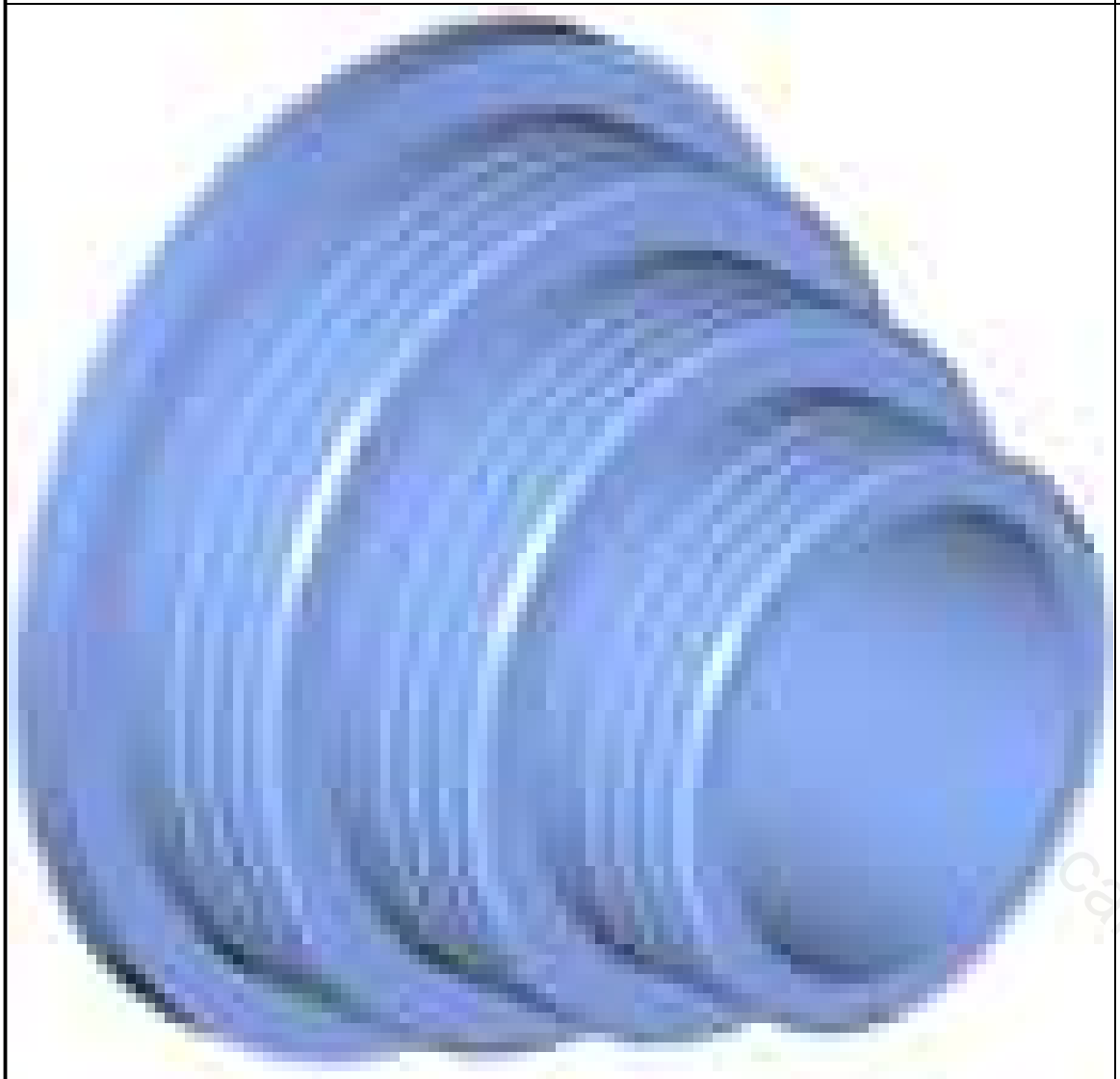
Illustration	Tool Number/Description
	EN-47656-NA Pressure Test Plugs
	GE-23738-A J-23738-A Vacuum Pump

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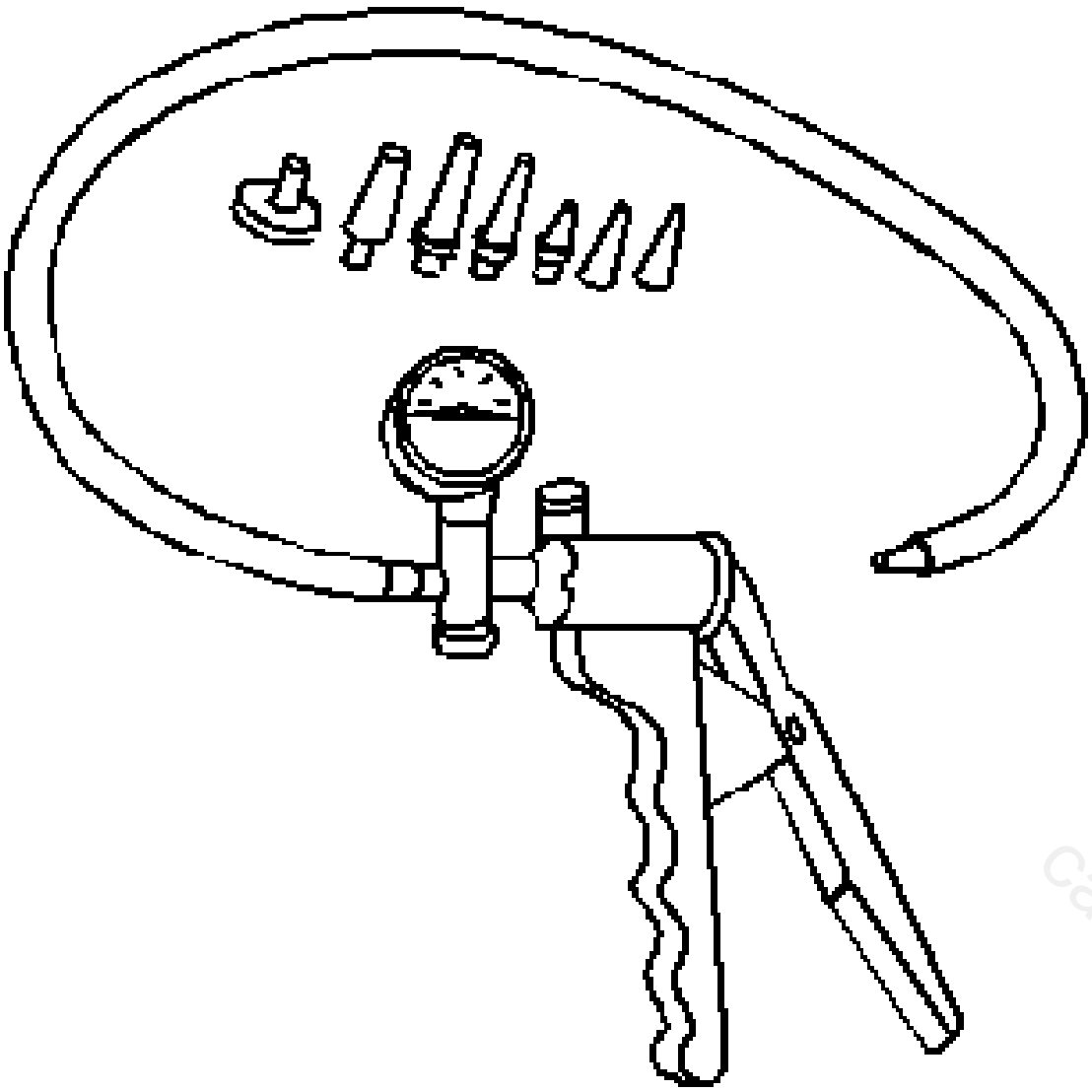
Illustration	Tool Number/Description
	

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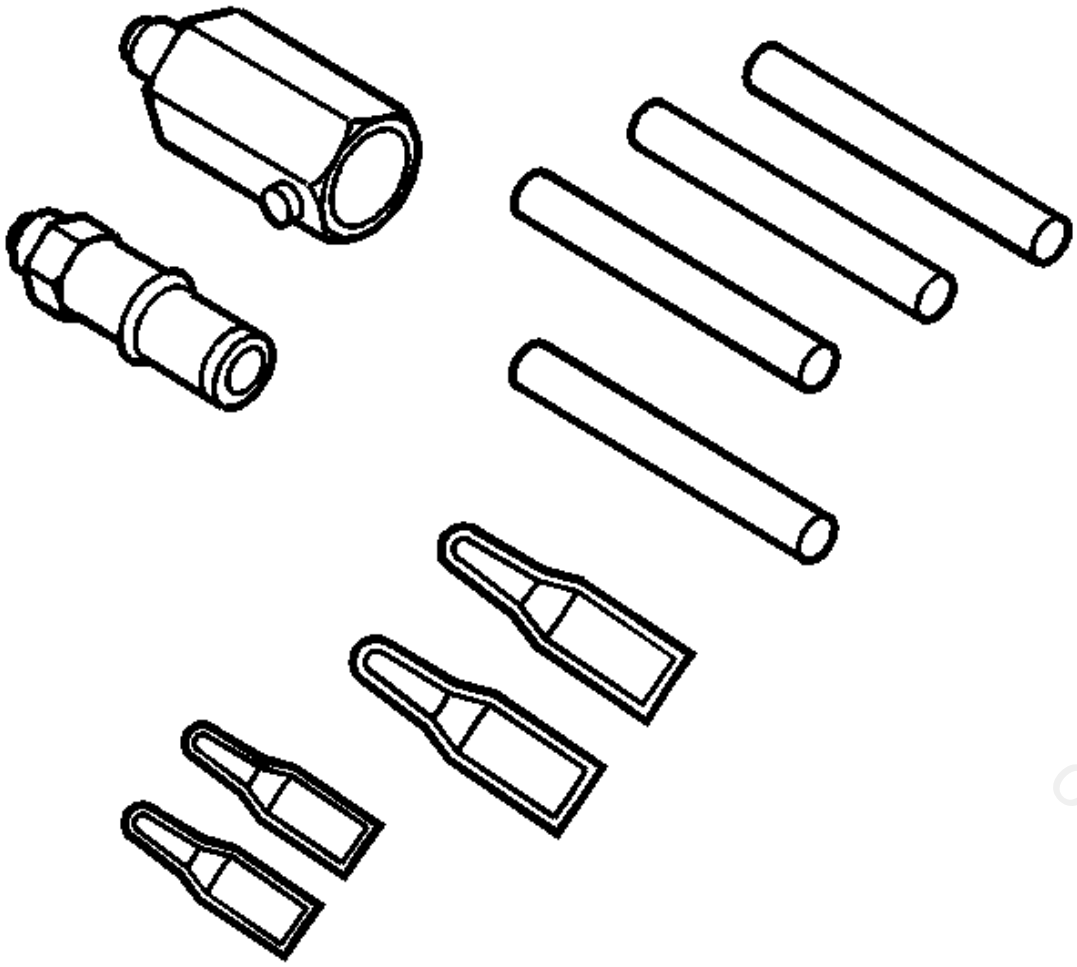
Illustration	Tool Number/Description
	GE-41413-300 EN-41413-300 J-41413-300 EVAP Cap and Plug Kit

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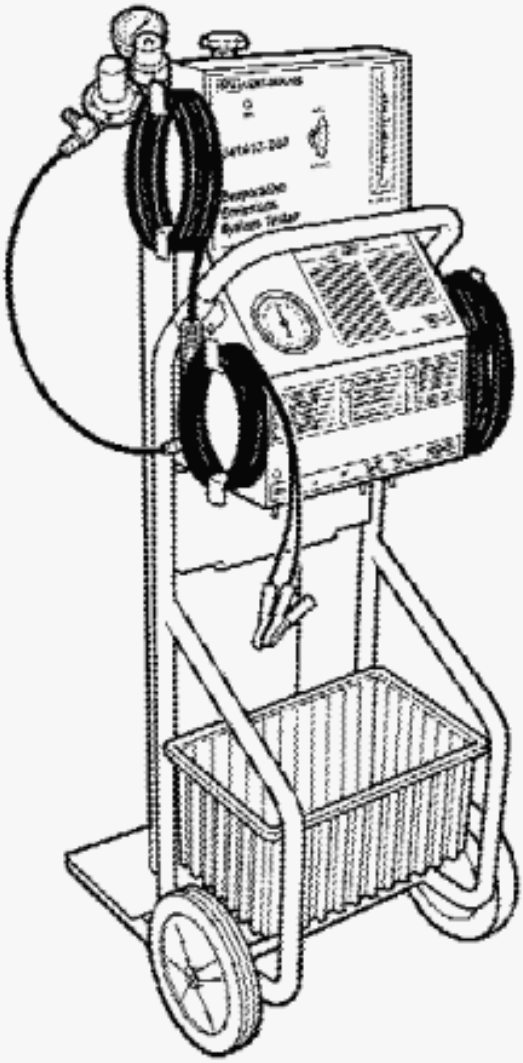
Illustration	Tool Number/Description
	GE-41413-A EN-41413-A J-41413-A Evaporative Emissions System Tester (EEST)
	GE-41413-B Evaporative Emissions System Tester (EEST)

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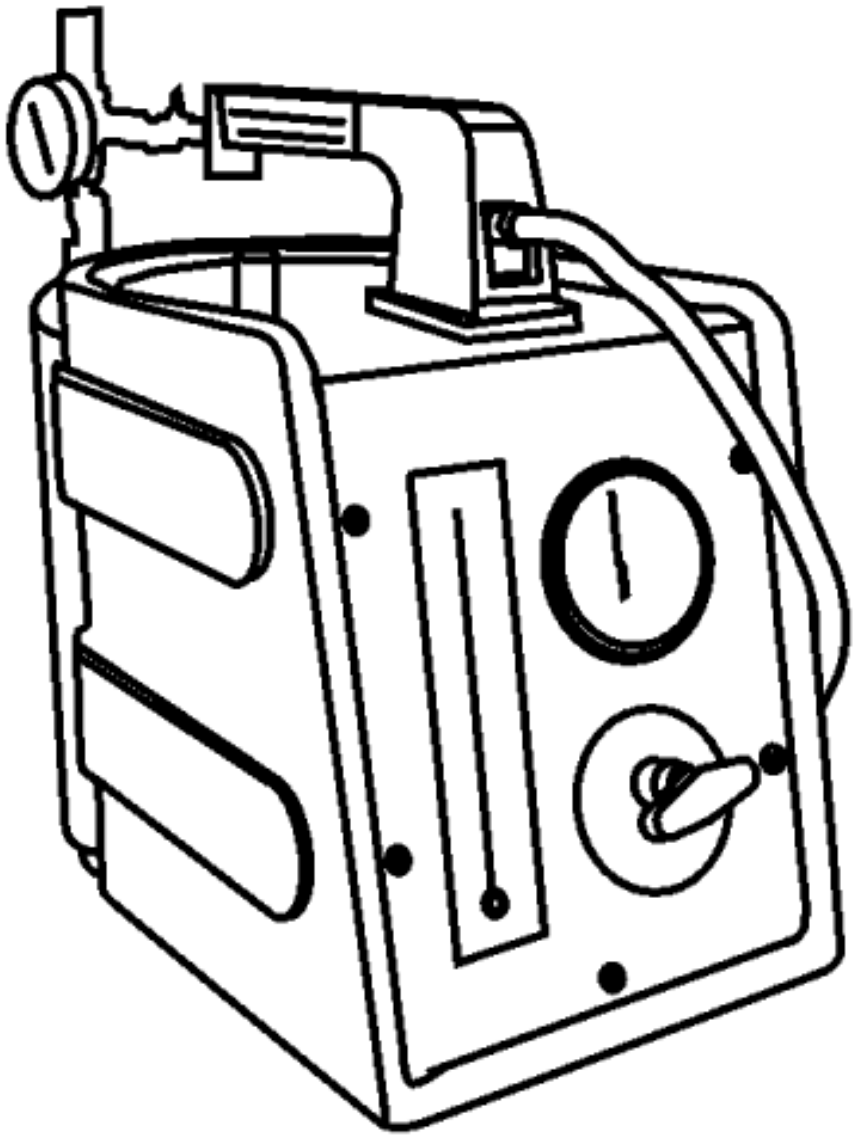
Illustration	Tool Number/Description
	

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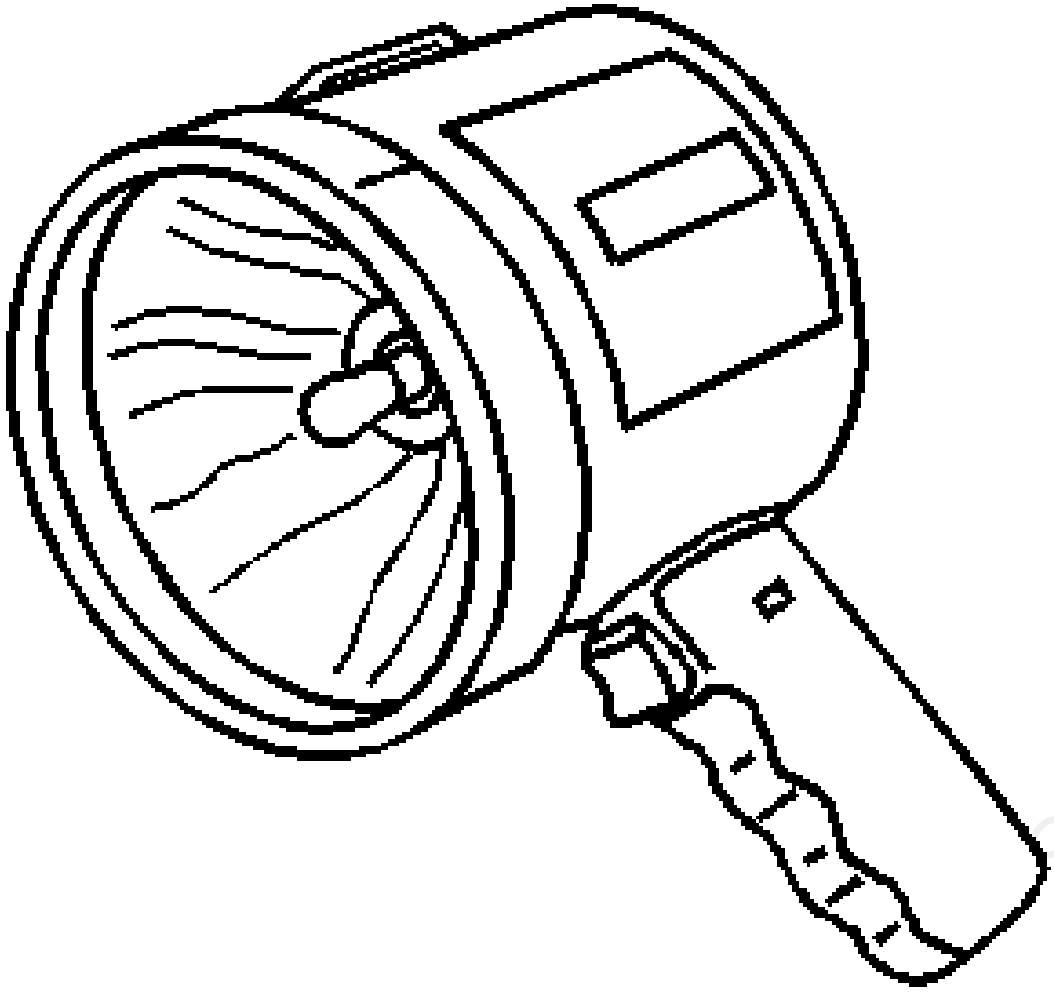
Illustration	Tool Number/Description
	GE-41413-SPT J-41413-SPT High Intensity White Light

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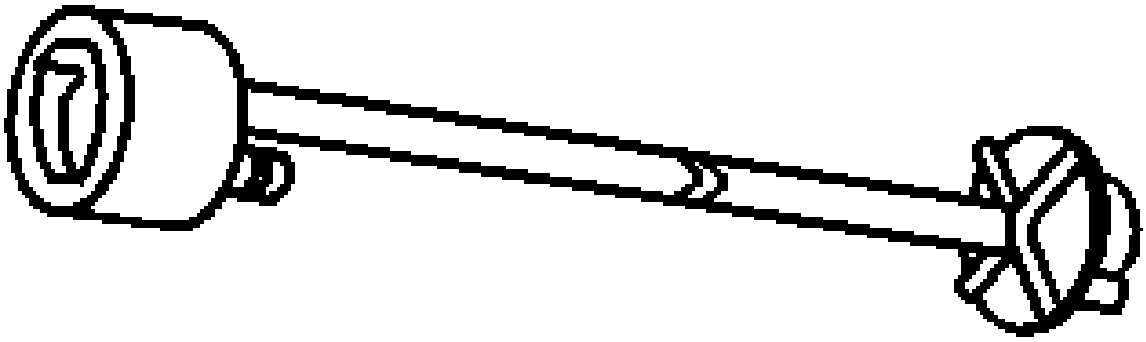
Illustration	Tool Number/Description
	GE-41415-50 J-41415-50 Fuel Tank Cap Adapter

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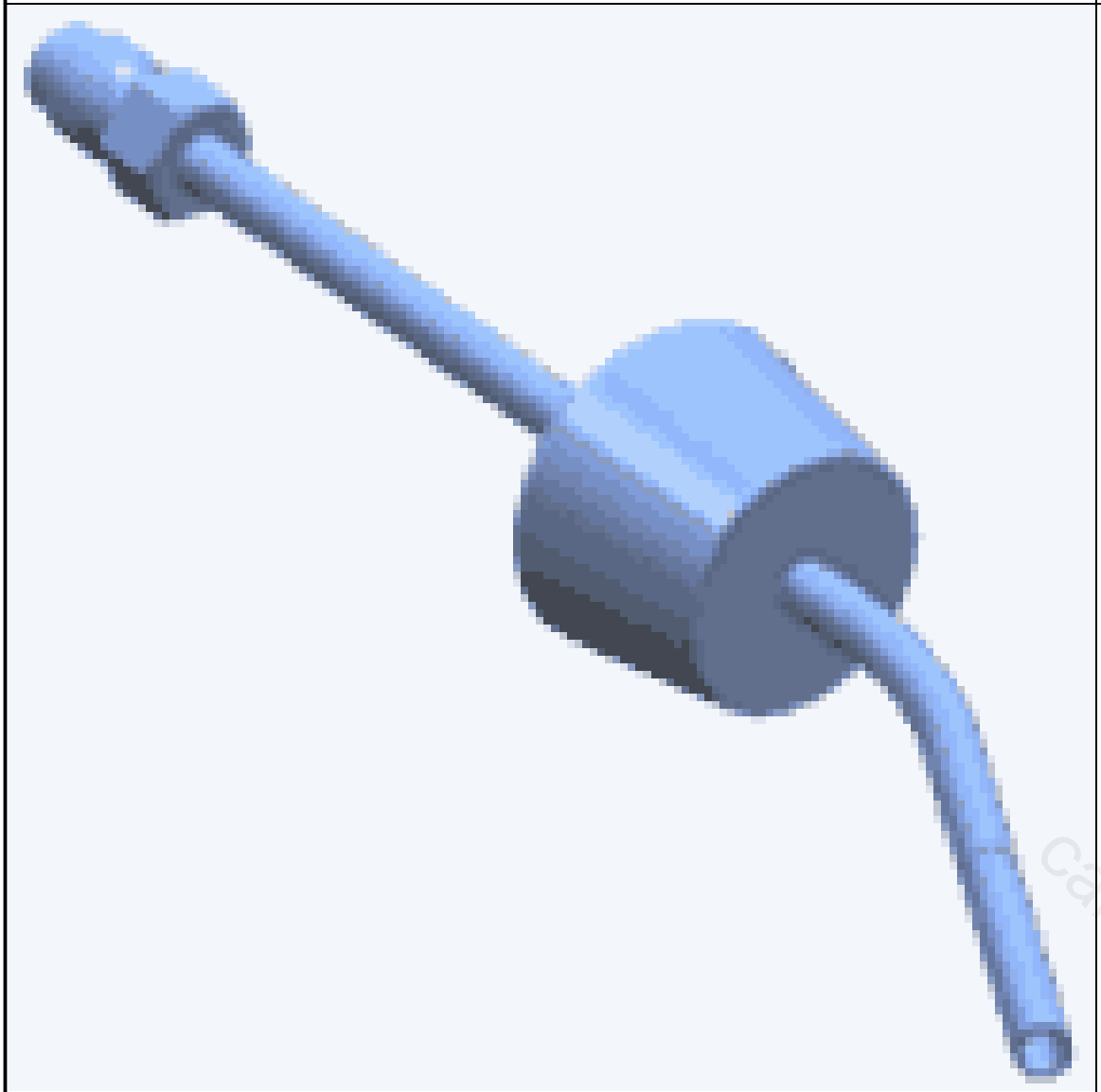
Illustration	Tool Number/Description
	GE-41415-60 Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter
	J-25070 Heat Gun 260 - 399Â°C (500 - 750Â°F)

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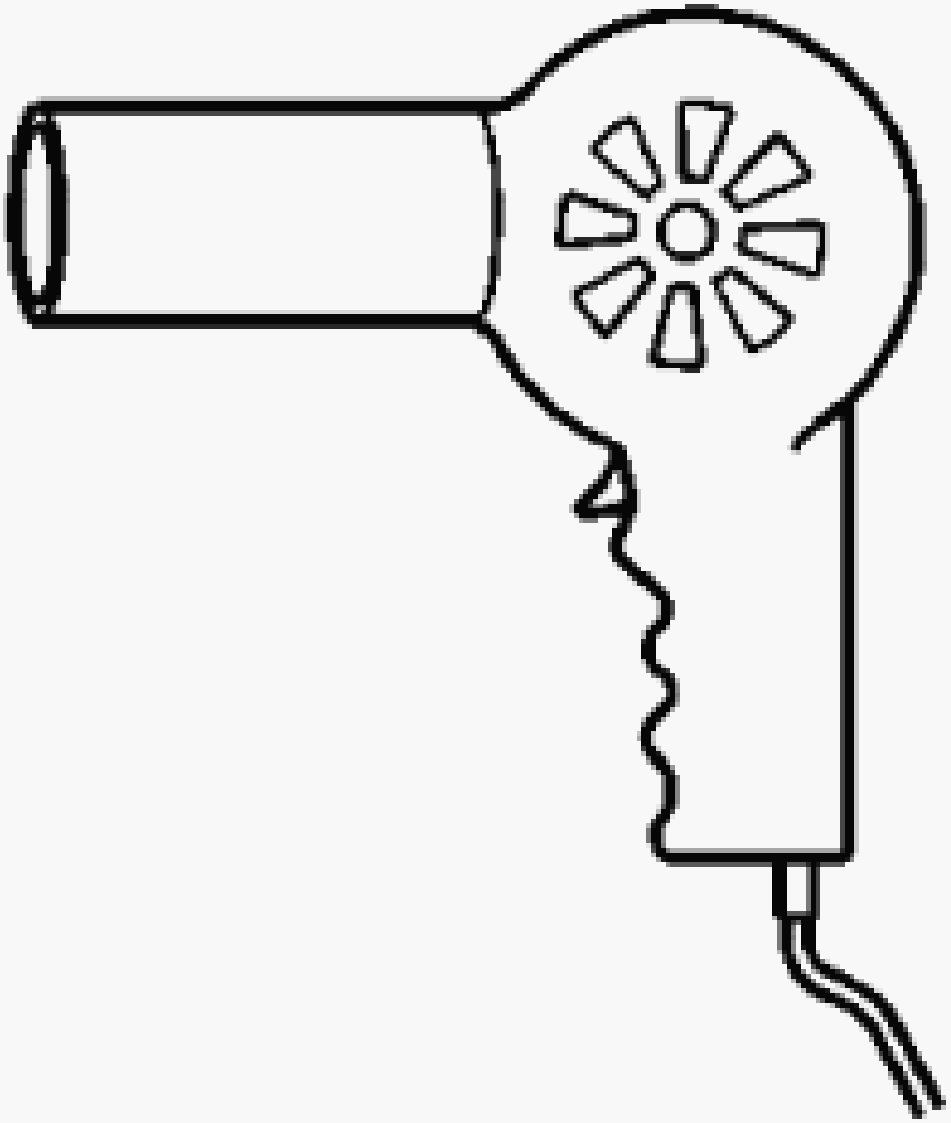
Illustration	Tool Number/Description
	J-34730-375 Injector Test Lamp

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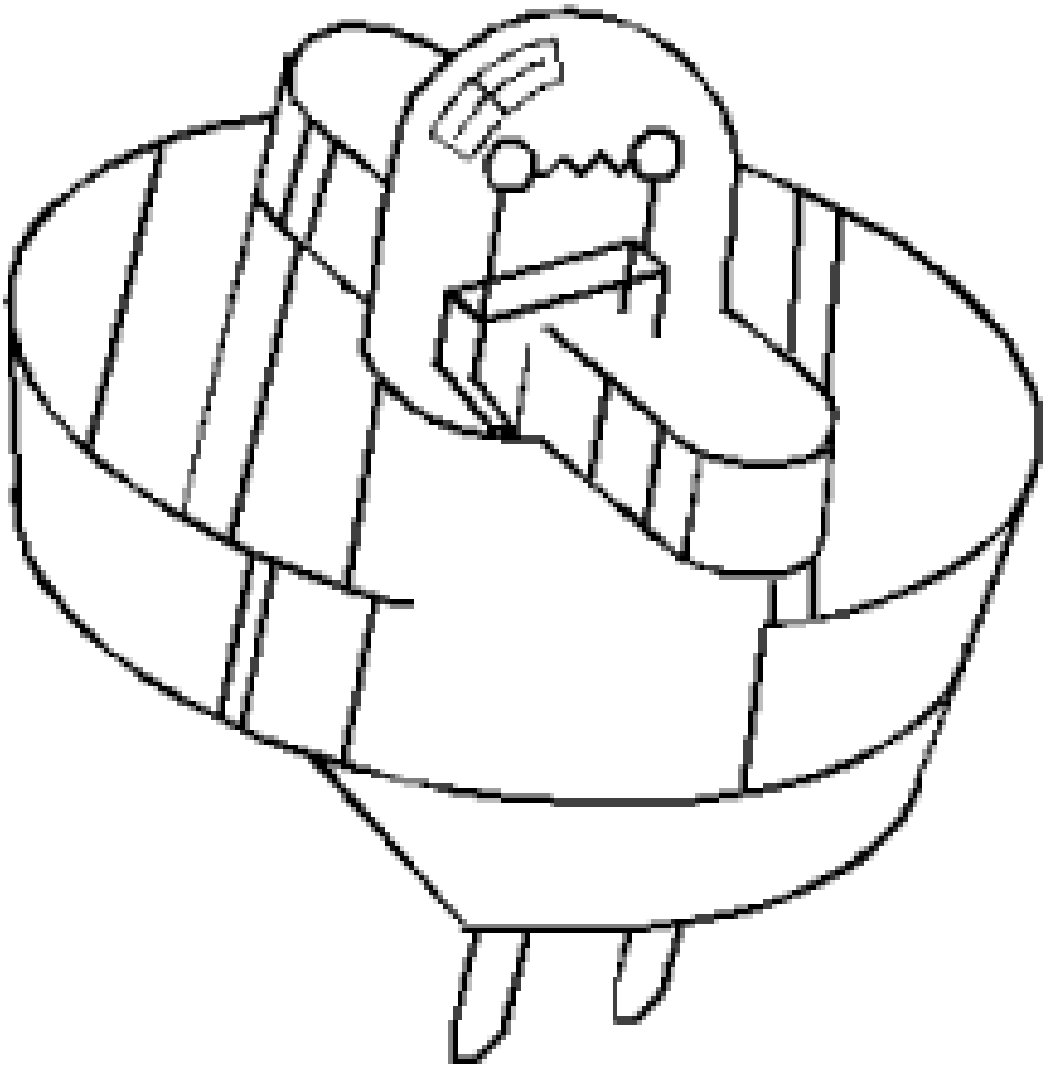
Illustration	Tool Number/Description
	

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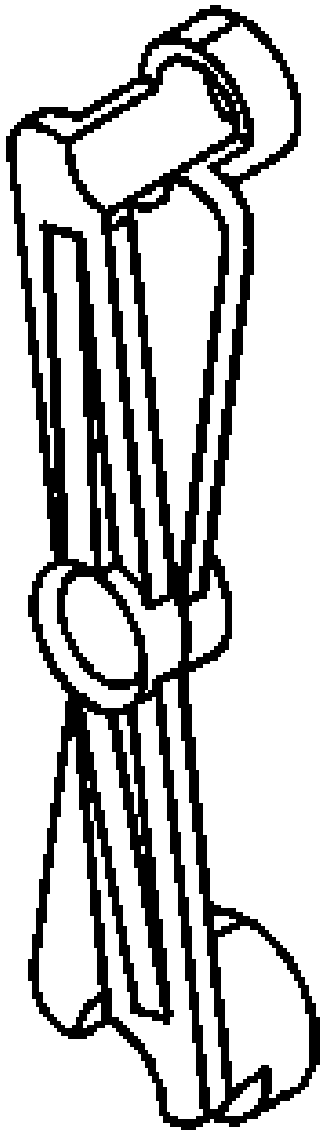
Illustration	Tool Number/Description
	J-44581 Fuel Line Disconnect Tool

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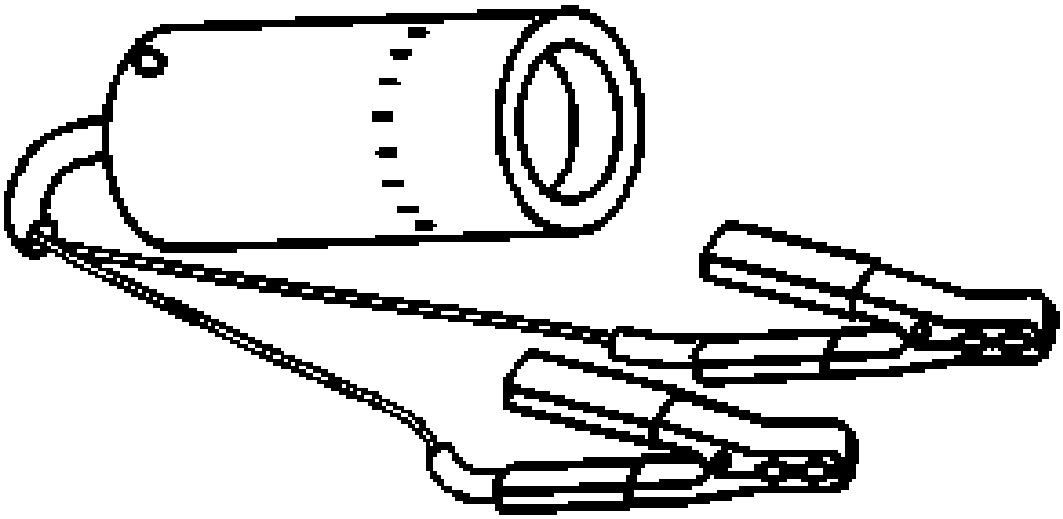
Illustration	Tool Number/Description
	J-28428-E J 42220 CH 42220 Universal 12-Volt Leak Detection Lamp

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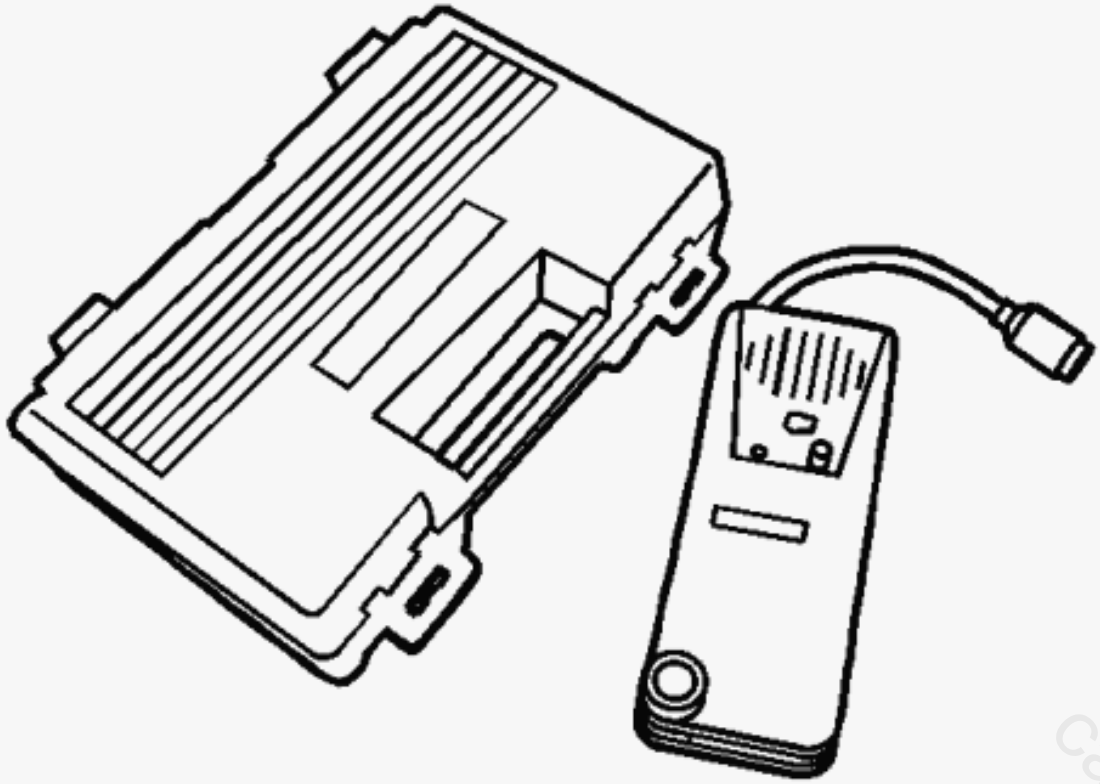
Illustration	Tool Number/Description
	J-45878 Combustible Gas Detector

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SPECIAL TOOLS (MECHANICAL TOOLS)

Illustration	Tool Number/Description

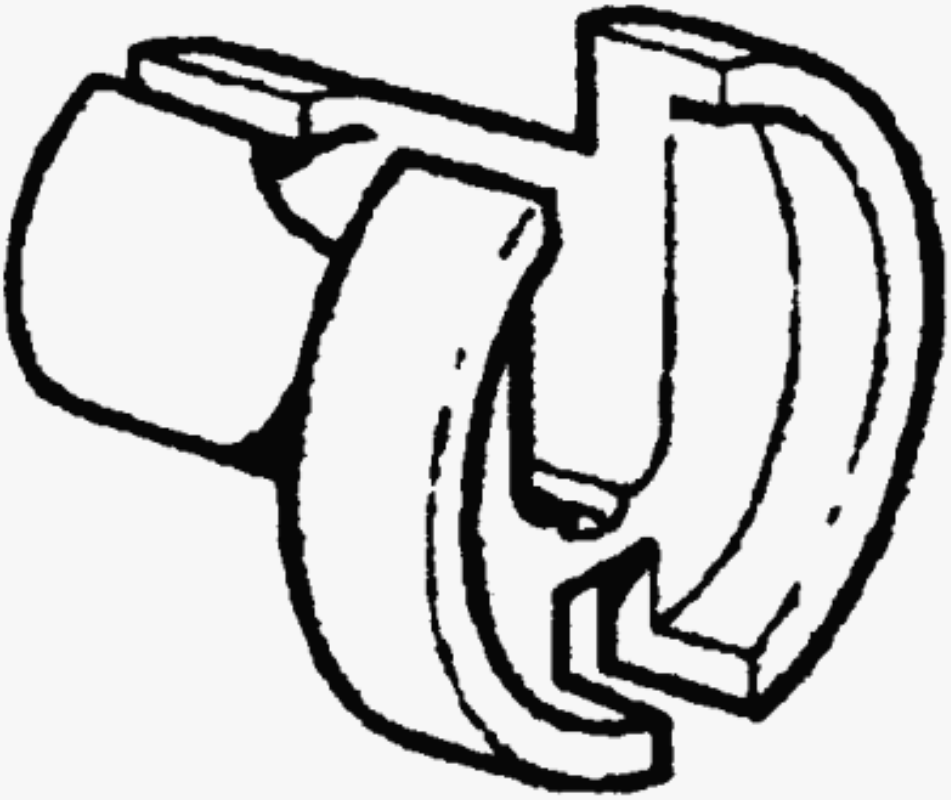
Illustration	Tool Number/Description
	CH-41769-1 J-41769-1 Fuel Line Quick Connect Separator 3/8
	J-42572 CV Boot Clamp Pliers

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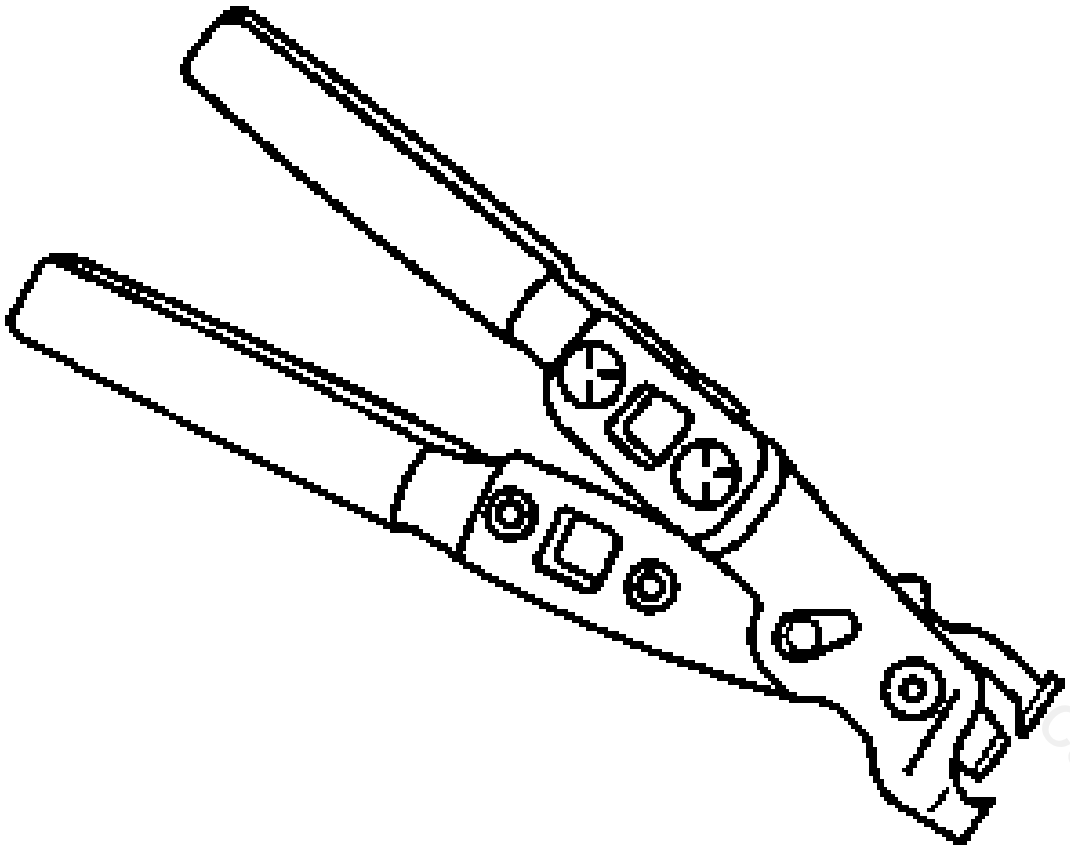
Illustration	Tool Number/Description
	

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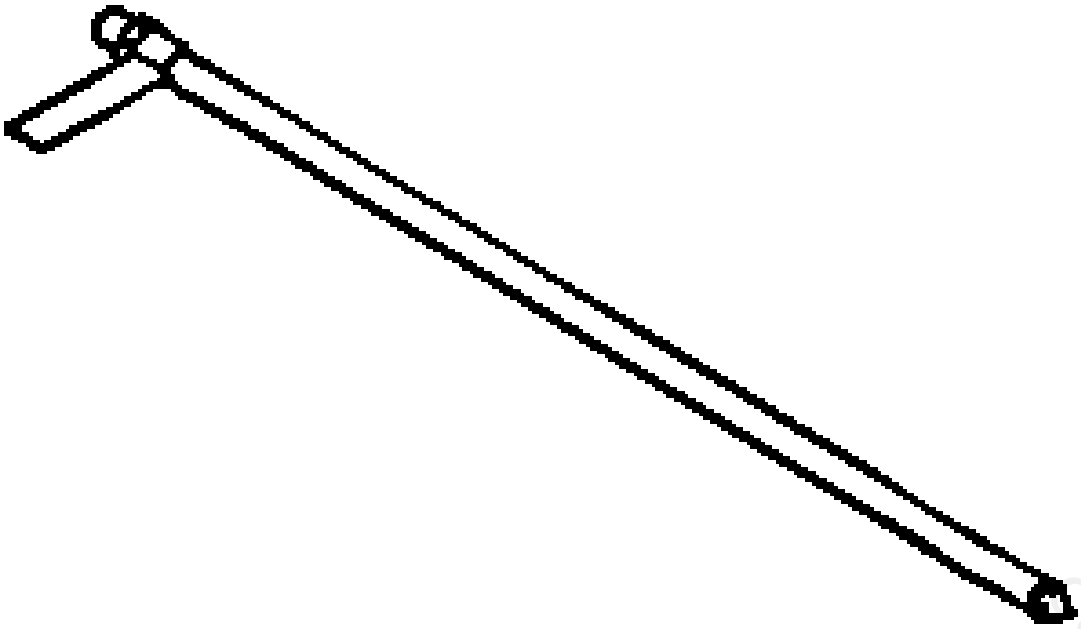
Illustration	Tool Number/Description
	CH-45004 J-45004 Fuel Tank Drain Hose

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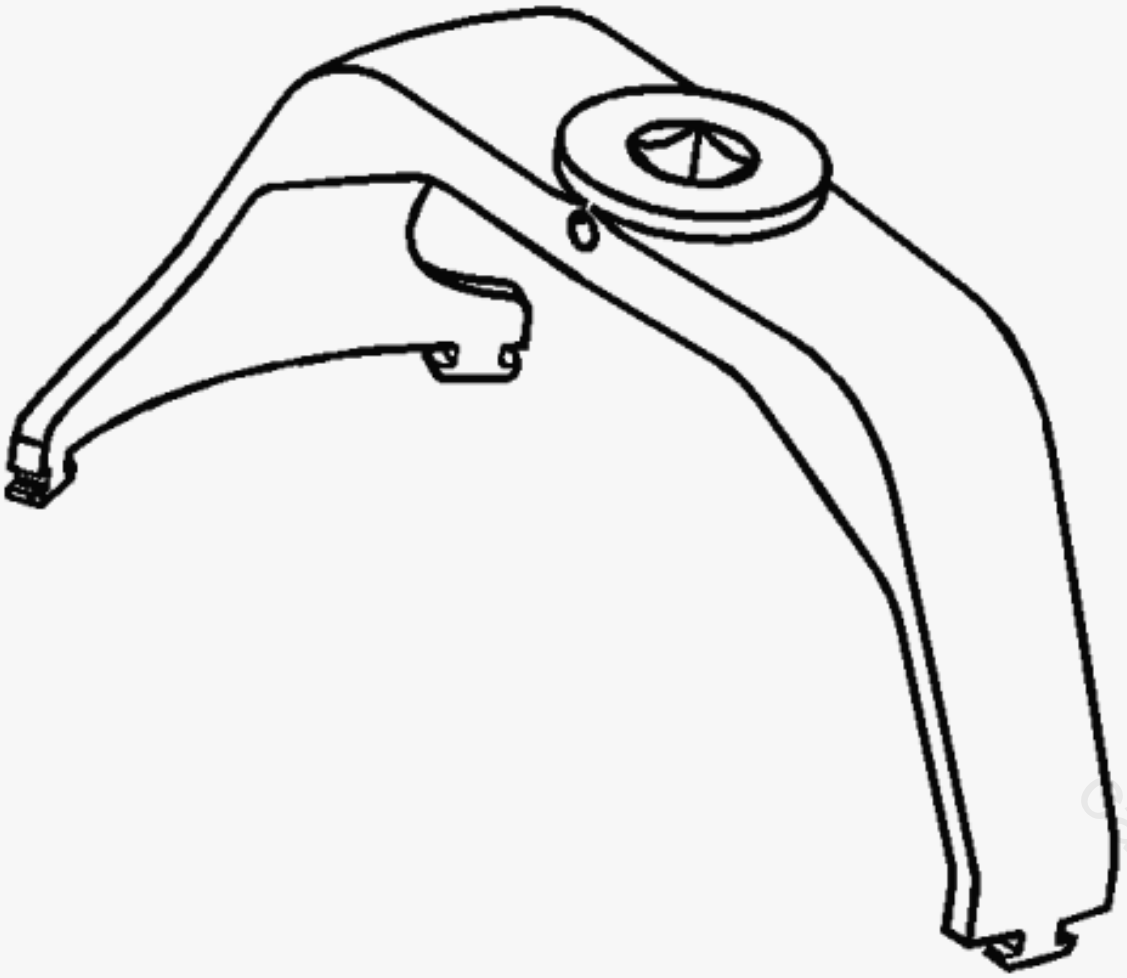
Illustration	Tool Number/Description
	CH-45722 J-45722 Fuel Sender Lock Ring Wrench

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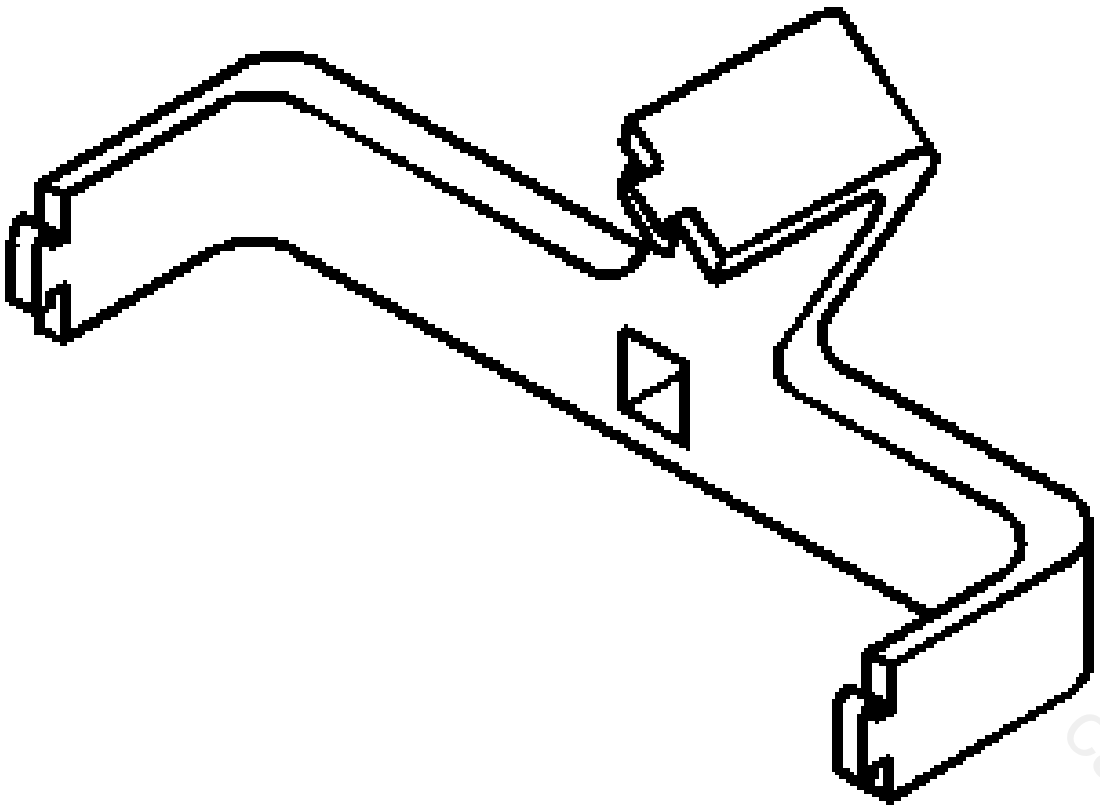
Illustration	Tool Number/Description
	CH-52075 J-45747 Fuel Sender Lock Ring Wrench

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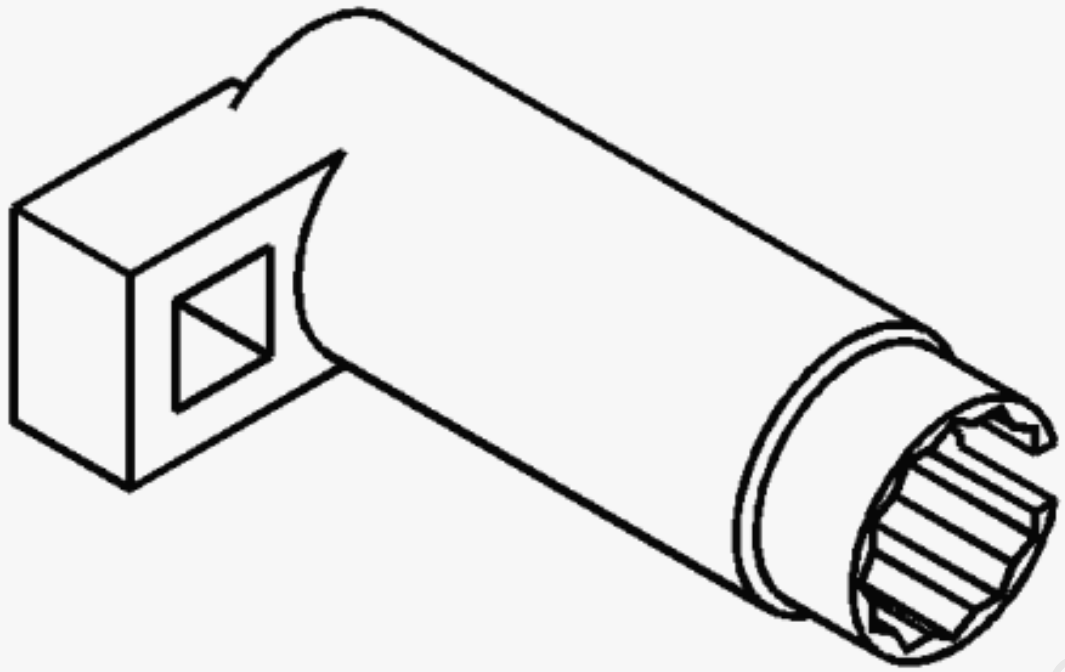
Illustration	Tool Number/Description
	CH-6179 EN-6179 KM-6179 Oxygen Sensor Wrench

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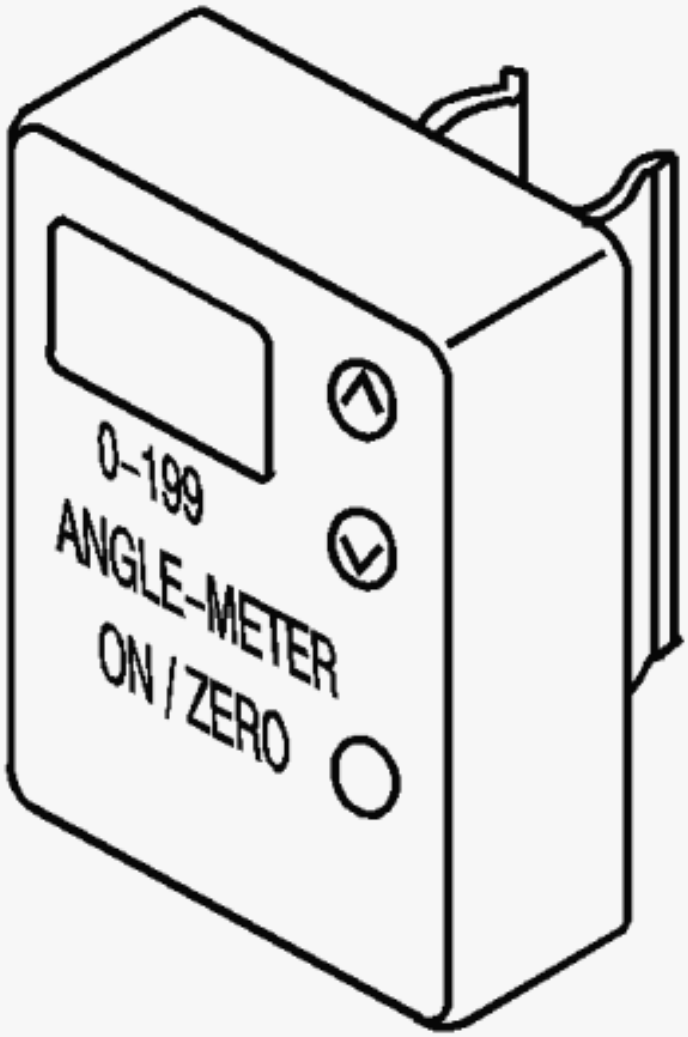
Illustration	Tool Number/Description
	EN-40459 Angle Meter

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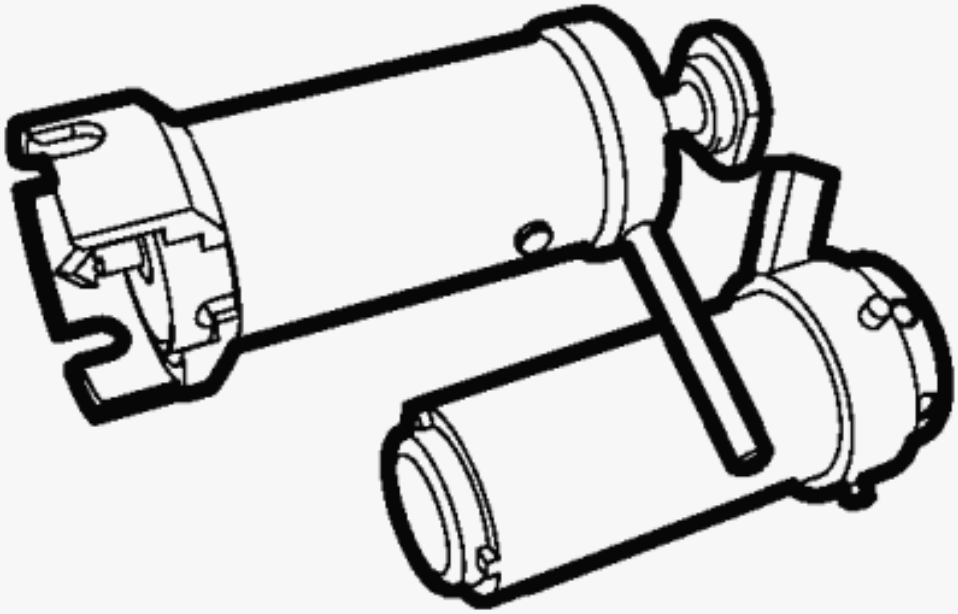
Illustration	Tool Number/Description
	EN-50885-1 EN-50885-2 Fuel Injection Pump Remover/Installer/Fixing Tool

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Illustration	Tool Number/Description
	EN-51146-1-3 Sliding Hammer

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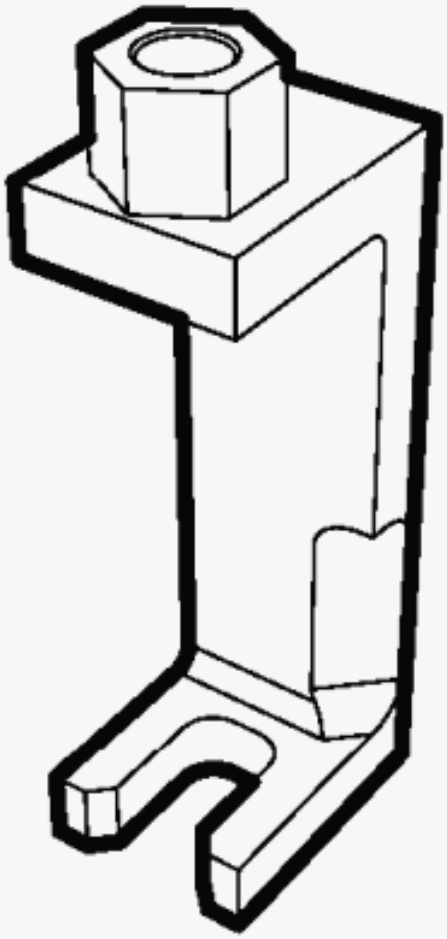
Illustration	Tool Number/Description
	EN-51187 Injector Remover

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2018 ENGINE PERFORMANCE

Engine Controls And Fuel - 1.6L (LH7) Diesel - Specifications - Equinox & Terrain

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

Temperature CÂ°/FÂ°	Resistance Minimum Ohms	Resistance Maximum Ohms
Bosch Intake Air Temperature (IAT) Sensor		
-40/-40	36, 595	42, 717
-20/-4	12, 947	14, 744
-10/14	8, 082	9, 105
0/32	5, 191	5, 789
20/68	2, 309	2, 530
25/77	1, 913	2, 088
40/104	1, 122	1, 210
60/140	587	625
80/176	328	345

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Temperature CÂ°/FÂ°	Resistance Minimum Ohms	Resistance Maximum Ohms
Bosch Intake Air Temperature (IAT) Sensor		
100/212	193	201
120/248	119	125
140/284	76	81

ALTITUDE VERSUS BAROMETRIC PRESSURE

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)	Barometric Pressure Measured in Pounds Per Square Inch (PSI)
Determine your altitude by contacting a local weather station or by using another reference source.			
4, 267	14, 000	56 - 64	8.1 - 9.3
3, 962	13, 000	58 - 66	8.4 - 9.6
3, 658	12, 000	61 - 69	8.8 - 10.0
3, 353	11, 000	64 - 72	9.3 - 10.4
3, 048	10, 000	66 - 74	9.6 - 10.7
2, 743	9, 000	69 - 77	10.0 - 11.2
2, 438	8, 000	71 - 79	10.3 - 11.5
2, 134	7, 000	74 - 82	10.7 - 11.9
1, 829	6, 000	77 - 85	11.2 - 12.3
1, 524	5, 000	80 - 88	11.6 - 12.8
1, 219	4, 000	83 - 91	12.0 - 13.2
914	3, 000	87 - 95	12.6 - 13.8
610	2, 000	90 - 98	13.1 - 14.2
305	1, 000	94 - 102	13.6 - 14.8
0	0 Sea Level	96 - 104	13.9 - 15.1
-305	-1, 000	101 - 105	14.6 - 15.2

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
Charge Air Bypass Regulator Solenoid Valve Vacuum Tube Seal
Emission Reduction Fluid Supply Pump Module O-Ring
Exhaust Gas Recirculation Cooler housing Gasket
Exhaust Gas Recirculation Cooler Outlet Pipe Gasket
Exhaust Gas Recirculation Cooler Outlet Pipe Seal
Exhaust Gas Recirculation Cooler Pipe Gasket
Exhaust Gas Recirculation Valve Gasket
Exhaust Gas Recirculation Valve Seat Gasket
Exhaust Manifold Pipe Gasket
Exhaust Pressure Differential Sensor Hose Clamp
Fuel Filter Seal
Fuel Injection Pump Metering Valve O-Ring
Fuel Injection Pump Seal Ring
Fuel Injection Pump Sprocket Access Hole Plug
Fuel Injector Fuel Return Hose Seal Ring
Fuel Injector Washer

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NOTE:

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application
Fuel Return Hose Clamp
Fuel Tank Fuel Pump Module O-Ring
Throttle Body 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 Injection Fuel Feed Pipe	28 N.m (21 lb ft)
Fuel Injector Bracket Bolt	
• First Pass:	10 N.m (89 lb in)
• Final Pass:	60 Degrees
Fuel Pressure Sensor	35 N.m (26 lb ft)

Reusable Threaded Fastener Tightening Specifications

NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Accelerator Pedal Position Sensor Bolt	9 N.m (80 lb in)
Air Cleaner Bolt	9 N.m (80 lb in)
Air Cleaner Outlet Duct Clamp	3.5 N.m (31 lb in)
Air Cleaner Upper Housing Bolt	4 N.m (35 lb in)
Camshaft Position Sensor Bolt	10 N.m (89 lb in)
Charge Air Bypass Regulator Solenoid Valve Vacuum Tube Bracket Bolt	10 N.m (89 lb in)
Charge Air Cooler Bolt	9 N.m (80 lb in)
Charge Air Temperature Sensor	19 N.m (14 lb ft)
Crankshaft Position Sensor Bolt	10 N.m (89 lb in)
Diesel Fuel Separator Bolt	10 N.m (89 lb in)
Emission Reduction Fluid Controller Bolt	2 N.m (18 lb in)
Emission Reduction Fluid Injector Nut	9 N.m (80 lb in)
Emission Reduction Fluid Tank Bolt - M8	22 N.m (16 lb ft)
Emission Reduction Fluid Tank Bolt - M10	58 N.m (43 lb ft)
Engine Coolant Temperature Sensor	45 N.m (33 lb ft)
Engine Oil Pressure Sensor	35 N.m (26 lb ft)
Engine Wiring Harness Conduit Bolt	9 N.m (80 lb in)
Exhaust Gas Recirculation Cooler Housing Bolt	25 N.m (18 lb ft)
Exhaust Gas Recirculation Cooler Outlet Pipe Bolt	10 N.m (89 lb in)
Exhaust Gas Recirculation Cooler Temperature Sensor	45 N.m (33 lb ft)
Exhaust Gas Recirculation Pipe Bolt	10 N.m (89 lb in)

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NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve Bolt	7 N.m (62 lb in)
Exhaust Gas Recirculation Valve Bolt	10 N.m (89 lb in)
Exhaust Manifold Pipe Bolt	10 N.m (89 lb in)
Exhaust Particulate Sensor	45 N.m (33 lb ft)
Exhaust Particulate Sensor Control Module Bracket Nut	9 N.m (80 lb in)
Exhaust Pressure Differential Sensor Bolt	9 N.m (80 lb in)
Exhaust Pressure Differential Sensor Bracket Bolt	9 N.m (80 lb in)
Exhaust Temperature Sensor	45 N.m (33 lb ft)
Front Intake Air Duct Nut	9 N.m (80 lb in)
Fuel Filter Drain Plug	1.6 N.m (14 lb in)
Fuel Cooler Bolt	9 N.m (80 lb in)
Fuel Injection Fuel Feed Pipe Bracket Bolt	9 N.m (80 lb in)
Fuel Injection Fuel Rail Bolt	25 N.m (18 lb ft)
Fuel Injection Pump Driven Sprocket Nut	64 N.m (47 lb ft)
Fuel Injection Pump Metering Valve Fastener	9 N.m (80 lb in)
Fuel Injection Pump Bolt	25 N.m (18 lb ft)
Fuel Injection Pump Drive Pulley Nut	64 N.m (47 lb ft)
Fuel Pump Power Control Module Bolt	9 N.m (80 lb in)
Fuel Pump Power Control Module Bracket Bolt	9 N.m (80 lb in)
Fuel Pump Power Control Module Nut	9 N.m (80 lb in)
Fuel Tank Filler Hose Clamp	4 N.m (35 lb in)
Fuel Tank Filler Pipe Ground Bolt	9 N.m (80 lb in)
Fuel Tank Strap Bolt	22 N.m (16 lb ft)
Fuel/Water Separator Reservoir	25 N.m (18 lb ft)
Glow Plug	16.5 N.m (12 lb ft)
Heater Inlet Pipe Bracket Bolt	9 N.m (80 lb in)
Intake Air Pressure and Temperature Sensor Bolt	1.6 N.m (14 lb in)
Intake Manifold Brace Bolt	10 N.m (89 lb in)
Mass Airflow Sensor Bolt	4 N.m (35 lb in)
Nitrogen Oxides Sensor	50 N.m (37 lb ft)
Nitrogen Oxides Sensor Control Module Nut	9 N.m (80 lb in)
Nitrogen Oxides Sensor Nut	9 N.m (80 lb in)
Oil Pump Flow Control Solenoid Valve Bolt	10 N.m (89 lb in)
Piston Oil Nozzle Oil Control Solenoid Valve Bolt	10 N.m (89 lb in)
Power Brake Booster Inlet Hose Connector Fitting Bolt	10 N.m (89 lb in)
Power Brake Booster Inlet Hose Connector Fitting Bracket Bolt	10 N.m (89 lb in)
Radiator Surge Tank Outlet Hose Bracket Bolt	10 N.m (89 lb in)
Throttle Body Bolt	10 N.m (89 lb in)
Transmission Bolt	58 N.m (43 lb ft)
Turbocharger Actuator Pipe Bracket Bolt	10 N.m (89 lb in)
Turbocharger Wastegate Actuator Pipe Bolt	10 N.m (89 lb in)
Turbocharger Wastegate Actuator Pipe Nut	10 N.m (89 lb in)
Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve Bolt	10 N.m (89 lb in)
Turbocharger Wastegate Actuator Vacuum Control Solenoid Valve Bracket Bolt	10 N.m (89 lb in)

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APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	English
Fuel Tank Capacity - AWD	59.0 liters	15.6 gallons
Fuel Tank Capacity - FWD	56.0 liters	14.8 gallons
Emission Reduction Fluid Tank Capacity	19.8 liters	5.2 gallons

FUEL SYSTEM SPECIFICATIONS

What Fuel to Use in the United States

CAUTION: **Use of diesel fuel other than Ultra Low Sulfur Diesel (15 ppm sulfur maximum) or engine oil other than low ash CJ-4 oil will cause permanent damage to the DPF and related components.**

In the United States, for best results use Number 2-D diesel fuel year-round, above and below freezing conditions, as oil companies blend Number 2-D fuel to address climate differences. Number 1-D diesel fuel may be used in very cold temperatures when the temperature stays below -18Â°C (0Â°F). However, the fuel will produce a power and fuel economy loss. The use of Number 1-D diesel fuel in warm or hot climates may result in stalling, poor starting when the engine is hot and may damage the fuel injection system.

It is acceptable to use diesel fuel containing up to 20 percent biodiesel (B20), but the final blended fuel must meet the same specification, ASTM D 975 (Grades No. 2-D or No. 1-D S15 commonly known as Ultra Low Sulfur diesel), as the other fuels used in your vehicle, and the biodiesel used for making this fuel must meet the latest version of ASTM specification D 6751. Biodiesel is produced from vegetable oils or animal fat that have been chemically modified to reduce the possibility of damage to the fuel system and engine. Higher concentration (i.e. greater than B20) biodiesel-containing fuels or the use of unmodified bio-oils blended into diesel fuel at any concentration is not recommended and could damage the fuel system and engine. Such damage would not be covered by your warranty. If there are questions about the biodiesel-containing fuels you are using, contact your fuel supplier.

Because of the cleansing properties of biodiesel, switching from straight diesel to a biodiesel blend can prematurely restrict the fuel filter with normal deposits in the fuel system. A fuel filter replacement might be required sooner than the recommended interval.

Diesel fuel may foam when filling the tank. This can cause the automatic pump nozzle to shut OFF, even though the tank is not full. If this happens, just wait for the foaming to stop and then continue to fill the tank.

What Fuel to Use in Canada

Canadian fuels are blended for seasonal changes. Diesel Type A fuel is blended for better cold weather starting, when it stays below -18Â°C (0Â°F). However, the fuel will produce a power and fuel economy loss. The use of Type A diesel fuel in warmer climates may result in stalling, poor starting. Diesel Type B fuel is blended for temperatures above -18Â°C (0Â°F). The emission control system requires the use of diesel fuel with ultra low sulfur, 15 ppm (maximum), content. Both low and higher sulfur fuels will be available in Canada. Only ultra low sulfur diesel fuels are available in the United States. Diesel-powered trucks must be refueled with ultra low sulfur fuel only. Use of fuels with higher-sulfur content will affect the function of the emission components and may cause reduced performance, excessive smoke and unpleasant odor.

It is acceptable to use diesel fuel containing up to 20 percent biodiesel (B20), but the final blended fuel must meet the same specification, CAN/CGSB-3.517 (ULS) in Canada, as other fuels used in your vehicle, and the biodiesel used for making this fuel must meet the latest version of ASTM specification D 6751. Biodiesel is produced from vegetable oils or animal fat that have been chemically modified to reduce the possibility of damage to the fuel system and engine. Higher concentration (i.e. greater than B20) biodiesel-containing fuels or the use of unmodified bio-oils blended into diesel fuel at any concentration is not recommended and could damage the fuel system and engine. Such damage would

not be covered by your warranty. If there are questions about the biodiesel-containing fuels you are using, contact your fuel supplier.

Very Cold Weather Operation

If the vehicle is driven in very cold temperatures and cannot get a winterized Number 2-D that has been adapted to cold weather or a Number 1-D, use one gallon of kerosene for every 2 gallons of diesel fuel. Once you add kerosene, run the engine for several minutes to mix the fuels. Only add kerosene when the temperature falls below -18Â°C (0Â°F), because the fuel economy and lubricating qualities of kerosene is not as good as that of diesel fuel.

In cold weather, the fuel filter may become clogged (waxed). To unclog the filter, move the vehicle to a warm garage area and warm the filter to a temperature between 0 - 10Â°C (32 - 50Â°F). Replacing the filter is not necessary.

Fuel Specific Gravity Testing

Use a **J 38641-B** Diesel Fuel Quality Tester to measure the fuel specific gravity (API Rating). Follow the instructions on the tool to obtain the proper temperature-adjusted value. This information must be accurate for the proper diagnosis of the fuel system.

Water in Fuel

Sometimes, water can be found in the fuel tank along with diesel fuel. This can happen if the service station does not regularly inspect and clean their fuel storage tanks, or the fuel is contaminated as received from the service stations suppliers.

If water is detected by the Water in Fuel Sensor, a Water-In-Fuel light will illuminate. If the Water-In-Fuel light illuminates, the water must be drained from the fuel system on the vehicle.

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)

Application	Type of Material	GM Part Number
High Pressure Fuel Pump Bolt	Threadlocker	GM P/N 12345382 (Canadian P/N 10953489)
Silicon Free Engine Oil	5W-30	GM P/N 19293000 (Canadian P/N 19386321)
Top Engine Cleaner	Cleaner	GM P/N 1052626 (Canadian P/N 993026)

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