

## Engine Control Module Description

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

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

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

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

### ECM Function

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

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

### EEPROM

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

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

### Data Link Connector (DLC)

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

### Malfunction Indicator Lamp (MIL)

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

### ECM Service Precautions

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

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### Emissions Diagnosis For State I/M Programs

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

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

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

### Aftermarket (Add-On) Electrical And Vacuum Equipment

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

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

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

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

### Electrostatic Discharge (ESD) Damage

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

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

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

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

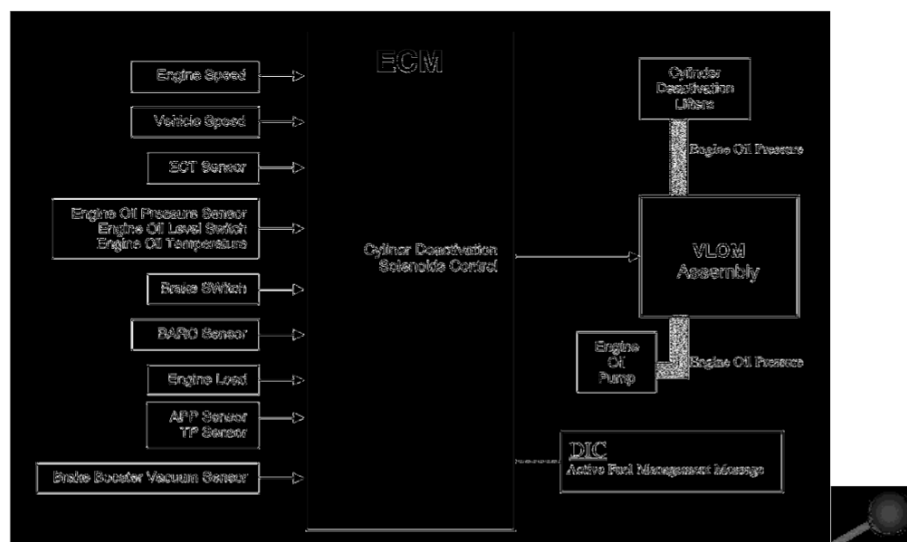
### Emissions Control Information Label

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

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



## Cylinder Deactivation (Active Fuel Management) System Description



To provide maximum fuel economy under light load driving conditions, the engine control module (ECM) will command the cylinder deactivation system ON to deactivate engine cylinders 1, 7, 6, and 4, switching to a V4 mode. The engine will operate on 8 cylinders, or V8 mode, during engine starting, engine idling, and medium to heavy throttle applications.

Manifold absolute pressure (MAP) and the conditions listed below determine when cylinder deactivation is enabled.

- Engine has been running for greater than 30 s
- Engine speed is between 700 and 2,800rpm
- Engine oil pressure is between 187–455 kPa (27–66 psi)
- Engine coolant temperature is between 40–129°C (100–264°F)
- Engine oil temperature is between 16–128°C (61–263°F)
- Throttle angle is 6% or less
- Ignition voltage is greater than 11 V
- Transmission is not in first, second, or reverse gear
- Vehicle speed is greater than 25 kph (15.5 mph)
- Brake booster pressure is greater than 42.0 kPa (6 psi)
- Vehicle is not in fuel shut off mode
- Vehicle is not in heater performance mode
- Vehicle is not in tip in bump acceleration mode
- Vehicle is not in oil aeration mode

When cylinder deactivation is commanded, the ECM will determine what cylinder is firing and begin deactivation on the next closest deactivated cylinder in firing order sequence. For example, if cylinder number 1 is on its combustion event when cylinder deactivation is commanded ON, the next cylinder in the firing order sequence that can be deactivated is cylinder number 7. If cylinder number 5 is on its combustion event when cylinder deactivation is commanded ON, then the next cylinder in the firing order sequence that can be deactivated is cylinder number 4.

Cylinder deactivation is accomplished by not allowing the intake and exhaust valves to open on the selected cylinders by using special valve lifters. The deactivation lifters contain spring loaded locking pins that connect the internal pin housing of the lifter to the outer housing.

The pin housing contains the lifter plunger and pushrod seat which interfaces with the pushrod. The outer housing contacts the camshaft lobe through a roller. During V8 mode, when all cylinders are active, the locking pins are pushed outward by spring force, locking the pin housing and outer housing together causing the lifter to function as a normal lifter. When cylinder deactivation is commanded ON, the locking pins are pushed inward with engine oil pressure directed from the valve lifter oil manifold assembly solenoids. When the lifter pin housing is unlocked from the outer housing, the pin housing will remain stationary, while the outer housing will move with the profile of the camshaft lobe, which results in the valve remaining closed. One valve lifter oil manifold assembly solenoid controls both the intake and exhaust valves for each deactivating cylinder. There are 2 distinct oil passages going to each cylinder deactivation lifter bore, one for the hydraulic lash-adjusting feature of the lifter, and one for controlling the locking pins used for cylinder deactivation.

Although both intake and exhaust valve lifters are controlled by the same solenoid in the valve lifter oil manifold assembly, the intake and exhaust valves do not become deactivated at the same time. Cylinder deactivation is timed so that the cylinder is on an intake event. During an intake event, the intake cam lobe is pushing the valve lifter upwards to open the intake valve against the force of the valve spring. The force exerted by the valve spring is acting on the side of the lifter locking pins, preventing them from moving until the intake valve has closed. When the intake valve lifter reaches the base circle of the camshaft lobe, the valve spring force is reduced, allowing the locking pins to move, deactivating the intake valve. However, when cylinder deactivation is commanded ON, the exhaust valve for the deactivated cylinder is in the closed position, allowing the locking pins on the valve lifter to move immediately, and deactivate the exhaust valve.

By deactivating the exhaust valve first, this allows the capture of a burnt air/fuel charge, or exhaust gas charge, in the combustion chamber. The capture of exhaust gases in the combustion chamber will contribute to a reduction in oil consumption, noise and vibration levels, and exhaust emissions when operating in V4 mode cylinder deactivation mode.

During the transition from V8 to V4 mode, the fuel injectors will be turned OFF on the deactivated cylinders. To help prevent spark plug fouling, the ignition system secondary voltage or spark is still present across the spark plug electrodes on the deactivated cylinders. If all enabling conditions are met and maintained for cylinder deactivation operation, the ECM calibrations will limit cylinder deactivation to a cycle time of 10 minutes in V4 mode, then return to V8 mode for 1 minute.

Switching between V8 and V4 modes is accomplished in less than 250 milliseconds, making the transitions seamless and transparent to the vehicle operator. The 250 milliseconds includes the time for the ECM to sequence the transitions, the response time for the valve lifter oil manifold assembly solenoids to energize, and the time for the valve lifters to deactivate, all within 2 revolutions of the engine crankshaft.

#### **Valve Lifter Oil Manifold Assembly**

The cylinder deactivation system uses an electro-hydraulic actuator device called the valve lifter oil manifold assembly. The valve lifter oil manifold assembly is bolted to the top of the engine valley, below the intake manifold assembly. The valve lifter oil manifold assembly consists of 4 electrically operated normally closed solenoids. Each solenoid controls the application of engine oil pressure to the intake and exhaust valve lifters on the cylinders selected to deactivate. Engine oil pressure is routed to the valve lifter oil manifold assembly from an internal oil passage on the rear of the cylinder block.

All 4 valve lifter oil manifold assembly solenoids are connected in parallel to a fused ignition 1 voltage circuit, supplied by the powertrain relay. The ground or control circuit for each solenoid is connected to a low side driver internal to the engine control module (ECM).

When all enabling conditions are met for cylinder deactivation, the ECM will ground each solenoid control circuit in firing order sequence, allowing current to flow through the solenoid windings. With the coil windings energized, the solenoid valve opens, redirecting engine oil pressure through the valve lifter oil manifold assembly into 8 separate vertical passages in the engine lifter valley. The 8 vertical passages, 2 per cylinder, are connected to the valve lifter bores of the cylinders to be deactivated. When vehicle-operating conditions require a return to V8 mode, the ECM will turn OFF the control circuit for the solenoids, allowing the solenoid valves to close. With the solenoid valves closed, engine oil pressure in the control ports is exhausted through the body of the solenoids into the engine block lifter valley. The housing of the valve lifter oil manifold assembly incorporates several bleeds in the oil passages to purge any air trapped in the valve lifter oil manifold assembly or engine block.

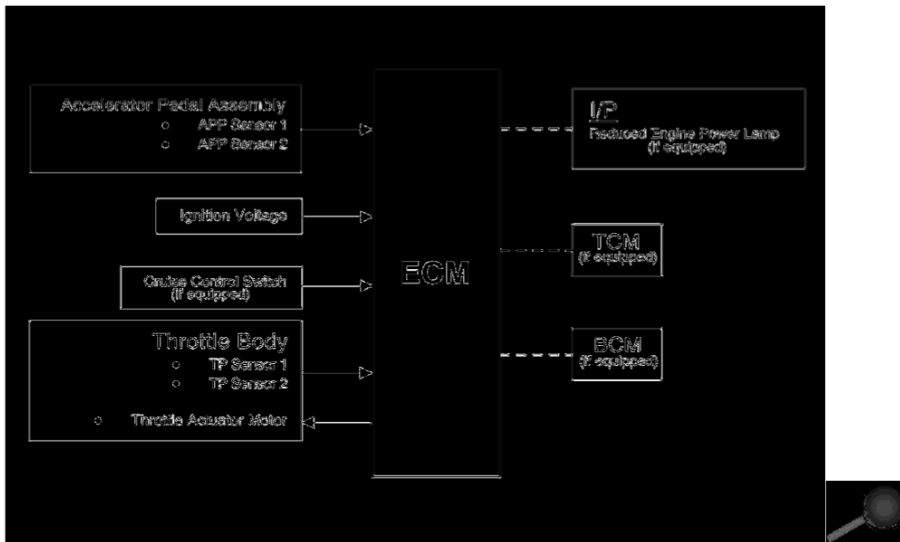
To help control contamination to the hydraulic circuits, a small replaceable oil screen is located in the valve lifter oil manifold assembly oil inlet passage, below the oil pressure sensor. The oil pressure sensor is a 3-wire sensor which provides oil pressure information to the ECM.

During service, use extreme care in keeping the valve lifter oil manifold assembly free of any contamination or foreign material.

Cylinder deactivation may be inhibited for many reasons including the following:

- Engine coolant temperature out of range for cylinder activation
- Engine vacuum out of range
- Brake booster vacuum out of range
- Transmission gear incorrect or shift in progress
- Accelerator pedal out of range or rate of pedal application too fast
- Engine oil pressure and temperature out of range
- Engine speed out of range
- Vehicle speed out of range
- Minimum time in V8 mode not met
- Maximum V4 mode time exceeded
- Decel fuel cutoff is active
- Reduced engine power is active
- Torque management is active
- Catalytic converter over temperature protection is active
- Piston protection is active, knock detected
- Cylinder deactivation solenoid driver circuit faults

## Throttle Actuator Control (TAC) System Description



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

### Modes Of Operation

#### Normal Mode

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

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

#### Reduced Engine Power Mode

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

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



## Fuel System Description

### Fuel System Overview

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

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

The primary fuel pump module also contains a primary jet pump and a secondary jet pump. Fuel pump flow loss, caused by vapor expulsion in the pump inlet chamber, is diverted to the primary jet pump and the secondary jet pump through a restrictive orifice located on the pump cover. The primary jet pump fills the reservoir of the primary fuel pump module. The secondary jet pump creates a venturi action which causes the fuel to be drawn from the secondary side of the fuel tank, through the fuel transfer pipe, to the primary side of the fuel tank.

### Electronic Returnless Fuel System

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

### Chassis Control Module

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

### Fuel Pressure Sensor

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

### Flex Fuel Sensor

The flex fuel sensor measures the ethanol-gasoline ratio of the fuel being used in a flexible fuel vehicle. Flexible fuel vehicles can be operated with a blend of ethanol and gasoline, up to 85 percent ethanol. In order to adjust the ignition timing and the fuel quantity to be injected, the engine management system requires information about the percentage of ethanol in the fuel.

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

The flex fuel sensor has a three-wire electrical harness connector. The three wires provide a ground circuit, a power source, and a signal output to the ECM. The power source is battery positive voltage and the ground circuit connects to an engine ground. The signal circuit carries the ethanol percentage via a frequency signal.

### **Fuel Tank**

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

The fuel tank is a saddle configuration in order to provide space for a driveshaft through the center area of the fuel tank. Because of the saddle shape of the tank, two fuel pump modules are required.

### **Fuel Fill Pipe**

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

### **Fuel Filler Cap**

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

### **Primary Fuel Pump Module**

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

- The fuel level sensor
- The fuel pump and reservoir assembly
- The fuel filter
- The pressure relief regulator valve
- The fuel strainer
- The primary jet pump
- The secondary jet pump

### **Secondary Fuel Pump Module**

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

- The fuel level sensor
- The fuel pick-up

### **Fuel Level Sensor**

The fuel level sensor consists of a float, a wire float arm, and a ceramic resistor card. The position of the float arm indicates the fuel level. The fuel level sensor contains a variable resistor which changes resistance in correspondence with the position of the float arm. The engine control module (ECM) sends the fuel level information via the High Speed CAN-Bus to the body control module (BCM). The BCM then sends the fuel level percentage via the Low Speed CAN-Bus to the instrument cluster in order to control the fuel gauge. The control module monitors the signal circuits of the primary fuel level sensor and the secondary fuel level sensor in order to determine the fuel level.

### **Fuel Pump**

The fuel pump is mounted in the primary fuel pump module reservoir. The fuel pump is an electric pump. Fuel is pumped to the fuel injection system at a pressure that is based on feedback from the fuel pressure sensor. The fuel pump delivers a constant flow of fuel even

during low fuel conditions and aggressive vehicle maneuvers. The fuel pump flex pipe acts to dampen the fuel pulses and noise generated by the fuel pump.

### **Fuel Filter**

The fuel filter is located in the primary fuel pump module. The paper filter element traps particles in the fuel that may damage the fuel injection system. The filter housing is made to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature.

### **Pressure Relief Regulator Valve**

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

### **Fuel Strainer**

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

### **Primary and Secondary Jet Pumps**

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

The secondary jet pump creates a venturi action which causes the fuel to be drawn from the secondary side of the fuel tank, through the transfer pipe, to the primary side of the fuel tank.

### **Nylon Fuel Pipes**

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

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

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

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

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

### **Quick-Connect Fittings**

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

### **Fuel Rail Assembly**

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

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

### **Fuel Injectors**

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

### **Engine Fueling**

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

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

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

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

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

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

### **Sequential Fuel Injection**

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

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

### **Starting Mode**

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

### **Clear Flood Mode**

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

### **Run Mode**

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

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

### **Acceleration Mode**

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

### **Deceleration Mode**

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

### **Battery Voltage Correction Mode**

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

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

### **Fuel Shut-Off Mode**

The ECM has the ability to completely turn OFF all of the injectors or selectively turn OFF some of the injectors when certain conditions are met. These fuel shut-off modes allow the ECM to protect the engine from damage and also to improve the vehicles driveability.

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

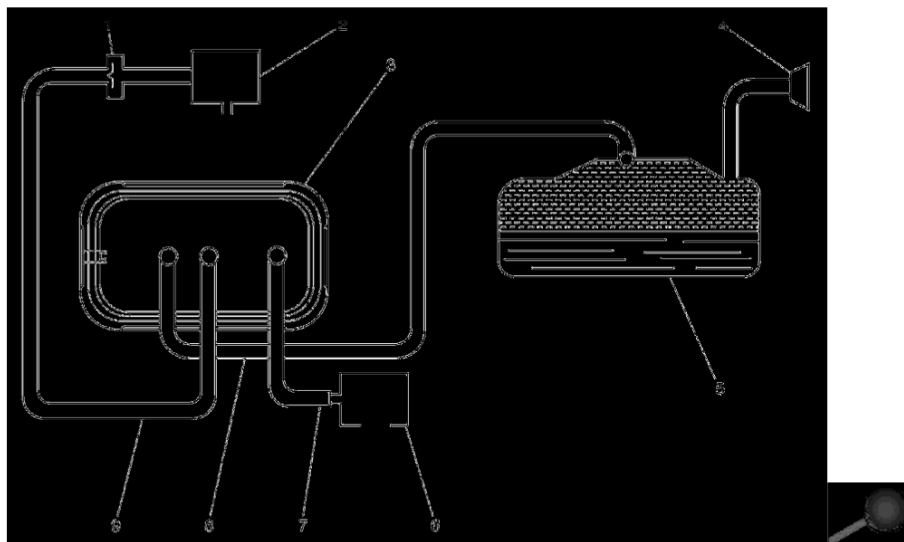
- Ignition OFF—Prevents engine run-on
- Ignition ON but no crankshaft position signal—Prevents flooding or backfiring
- A high engine speed—Above the red line
- A high vehicle speed—Above the rated tire speed
- Closed throttle coast down—Reduces the emissions and increases engine braking.

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

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

## Evaporative Emission Control System Description

### EVAP System Operation



- (1) Purge Tube Check Valve, Turbo-Charged Applications Only
- (2) EVAP Canister Purge Solenoid Valve
- (3) EVAP Canister
- (4) Fuel Fill Cap/Fill Neck
- (5) Fuel Tank
- (6) EVAP Air Inlet
- (7) EVAP Vent Pipe
- (8) EVAP Vapor Pipe
- (9) EVAP Purge Pipe

The evaporative emission (EVAP) control system limits fuel vapors from escaping into the atmosphere. Fuel tank vapors are allowed to move from the fuel tank, due to pressure in the tank, through the vapor pipe, into the EVAP canister. Carbon in the canister absorbs and stores the fuel vapors. Excess pressure is vented through the vent pipe and EVAP air inlet to atmosphere. The EVAP canisters store the fuel vapors until the engine is able to use them. At an appropriate time, the control module will command the EVAP purge solenoid valve open, allowing engine vacuum to be applied to the EVAP canister. Fresh air will be drawn through the EVAP air inlet and vent pipe to the EVAP canisters. Fresh air is drawn through the EVAP canister, pulling fuel vapors from the carbon. The air/fuel vapor mixture continues through the EVAP purge pipe and EVAP purge solenoid valve into the intake manifold to be consumed during normal combustion.

### EVAP System Components

The EVAP system is made up of the following components:

- The purge tube check valve, turbo-charged applications only

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- The EVAP canister purge solenoid valve
- The EVAP canister
- The fuel fill cap/fill neck
- The fuel tank
- The EVAP air inlet
- The EVAP vent pipe
- The EVAP vapor pipe
- The EVAP purge pipe

#### **EVAP Canister**

The EVAP canister is a sealed unit with 3 ports.

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

#### **EVAP Purge Solenoid Valve**

The EVAP purge solenoid valve controls the flow of vapors from the EVAP system to the intake manifold. This normally closed valve is pulse width modulated (PWM) by the control module to precisely control the flow of fuel vapor to the engine.

#### **EVAP Air Inlet**

The EVAP air inlet filters air entering the EVAP canister.

#### **Purge Tube Check Valve**

Turbocharged vehicles have a check valve in the purge tube, between the EVAP purge solenoid valve and the EVAP canister, to prevent pressurization of the EVAP system under boost conditions.

## Electronic Ignition System Description

### Electronic Ignition System Operation

The electronic ignition system produces and controls the high energy secondary spark. This spark ignites the compressed air/fuel mixture at precisely the correct time, providing optimal performance, fuel economy, and control of exhaust emissions. The engine control module (ECM) primarily collects information from the crankshaft position and camshaft position sensors to control the sequence, dwell, and timing of the spark.

### Crankshaft Position Sensor

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

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

### Camshaft Position Sensor

The camshaft position sensor detects magnetic flux changes between the four narrow and wide tooth slots on the reluctor wheel. The camshaft position sensor provides a digital ON/OFF DC voltage of varying frequency per each camshaft revolution. The ECM will recognize the narrow and wide tooth patterns to identify camshaft position, or which cylinder is in compression and which is in exhaust. The information is then used to determine the correct time and sequence for fuel injection and ignition spark events.

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

### Knock Sensor

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

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

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

### **Ignition Coils**

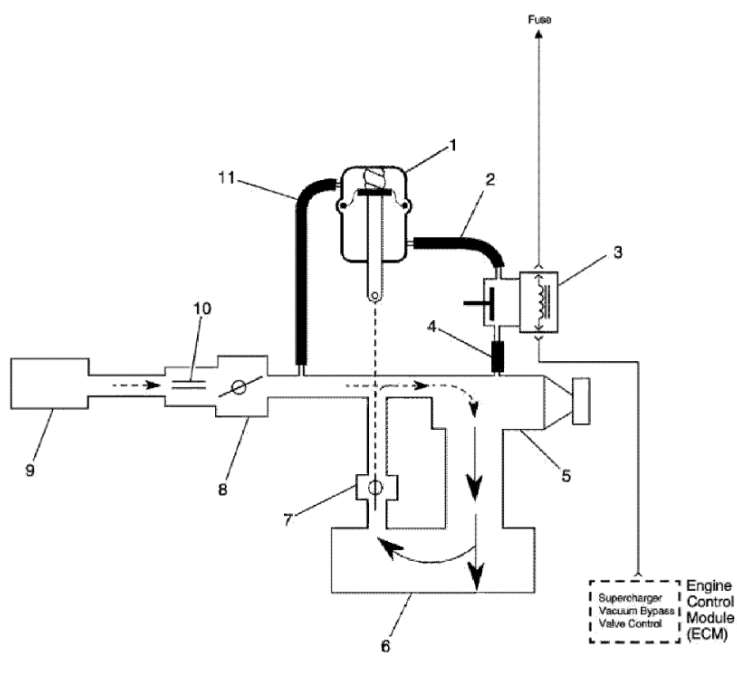
Each ignition coil has an ignition 1 voltage feed and a ground circuit. The engine control module (ECM) supplies a low reference and an ignition control circuit. Each ignition coil contains a solid state driver module. The ECM will command the ignition control circuit ON, which allows the current to flow through the primary coil windings. When the ECM commands the ignition control circuit OFF, this will interrupt current flow through the primary coil windings. The magnetic field created by the primary coil windings will collapse across the secondary coil windings, which induces a high voltage across the spark plug electrodes.

### **Engine Misfire Detection**

The crankshaft position sensor is used to determine when an engine misfire is occurring. The camshaft position sensor is used to determine which cylinder is misfiring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM is able to detect individual misfire events. For accurate detection of engine misfire, the ECM must distinguish between crankshaft deceleration caused by actual misfire and deceleration caused by rough road conditions. The antilock brake system (ABS) can detect if the vehicle is on a rough road based on wheel acceleration/deceleration data supplied by the wheel speed sensors. If the ABS detects rough road above a predetermined threshold, this information is sent to the ECM. The ECM uses the rough road information when calculating engine misfire. Under certain driving conditions, a misfire rate can be high enough to cause the 3-way catalytic converter to overheat damaging the converter. The malfunction indicator lamp (MIL) will flash ON and OFF when converter overheating, damaging conditions are present.

## Boost Control System Description

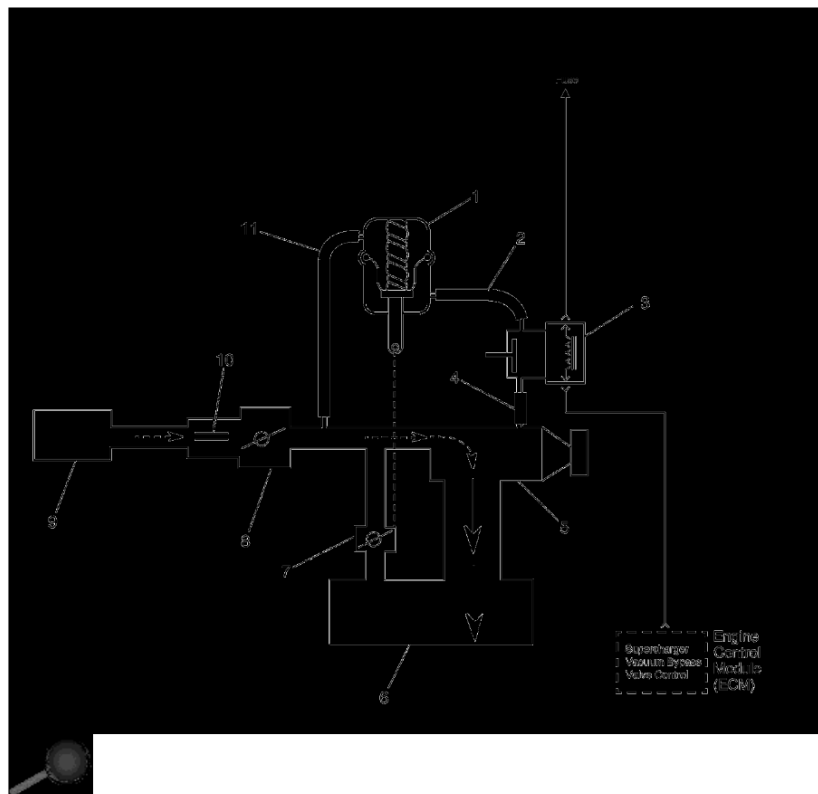
### Bypass Valve Open



- (1) By-pass Valve Actuator
- (2) Boost Signal
- (3) Boost Control Solenoid
- (4) Boost Vacuum Source
- (5) Supercharger
- (6) Intake Plenum
- (7) By-pass Valve (normally closed)
- (8) Throttle Body
- (9) Air Cleaner
- (10) MAF Sensor
- (11) Inlet Vacuum Signal

### Boost Control System Operation

#### Bypass Valve Closed



- (1) By-pass Valve Actuator
- (2) Boost Signal
- (3) Boost Control Solenoid
- (4) Boost Vacuum Source
- (5) Supercharger
- (6) Intake Plenum
- (7) By-pass Valve (normally closed)
- (8) Throttle Body
- (9) Air Cleaner
- (10) MAF Sensor
- (11) Inlet Vacuum Signal

### Operation

Supercharger boost pressure is regulated to prevent engine and drive train damage. When the engine is operating under high boost conditions, the engine control module (ECM) limits boost pressure to 83 kPa (12 psi). The ECM disables boost under the following conditions:

- Reverse gear is selected.
- Drivetrain abuse is detected.
- An electronic throttle control fault is detected.
- Engine coolant temperature (ECT) is greater than 125°C (257°F).
- An intercooler pump failure is detected.

- Intake air temperature (IAT) sensor 2 is equal to or greater than 120.5°C (248°F), boost pressure is limited to 145 kPa (7 psi). The ECM commands the boost control solenoid to default to 62 % duty cycle.
- Vehicle speeds exceed 256 km/h (159 mph) in second, third or fourth gear for greater than 150 s.

The ECM controls boost pressure by using the boost control solenoid. The boost control solenoid is normally an open valve. Under most conditions, the ECM commands the boost control solenoid to operate at a 99–100 % duty cycle. This keeps the solenoid valve closed and allows only inlet vacuum to control the position of the bypass valve. At idle, engine vacuum is applied to the upper side of the bypass valve actuator, counteracting spring tension to hold the bypass valve open. As engine load is increased, engine vacuum is decreased, causing the spring in the bypass valve actuator to overcome the applied vacuum, closing the bypass valve and allowing the boost pressure to increase. The bypass valve starts to close when the vacuum measures 10 in Hg and is fully closed at 3.5 in Hg. When reduced boost pressure is desired, the ECM commands the boost control solenoid to operate at a 0 % duty cycle, but may command a partial duty cycle, approximately 62 %, depending on the operating condition. This opens the solenoid valve and allows boost pressure to enter the bypass valve actuator at the lower side to counteract the spring tension, opening the bypass valve and re-circulating excess boost pressure back into the supercharger inlet.

### **Results of Incorrect Operation**

The following conditions will result in reduced engine power, especially during a wide open throttle (WOT) operation:

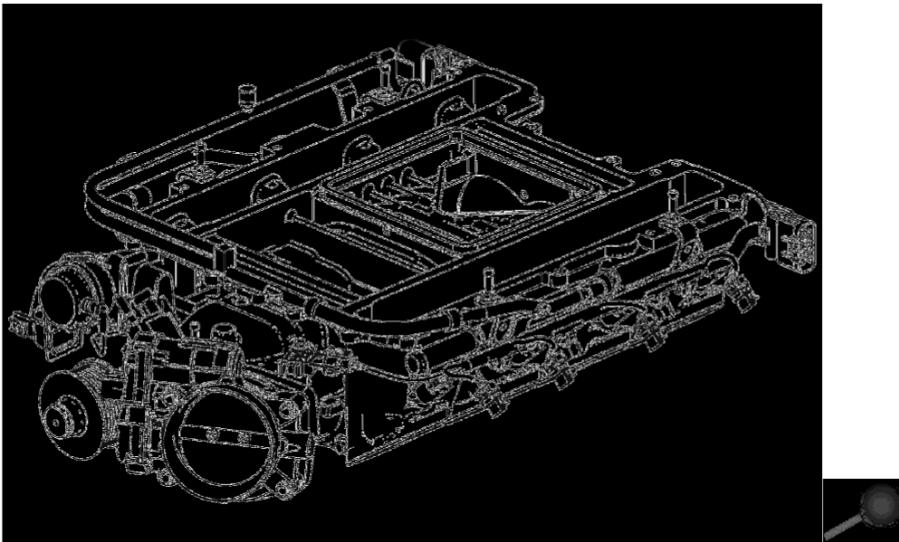
- An open boost control solenoid control circuit.
- An open control solenoid ignition 1 voltage circuit.
- An open control solenoid control circuit.
- A boost control solenoid valve that is stuck open.

The following conditions will result in full boost to be commanded at all times. These conditions can also result in overboost conditions during high engine load situations.

- A boost control solenoid control circuit shorted to ground.
- A boost control solenoid valve is stuck closed.
- A restriction in the boost source or signal vacuum hoses.
- A restriction in the exhaust system may cause an overboost condition and reduced fuel economy.

A restriction in the vacuum signal hose to the bypass valve actuator or stuck closed bypass valve will cause a noisy idle and reduced fuel economy.

## Supercharger Description and Operation



### Intake Manifold/Supercharger Assembly

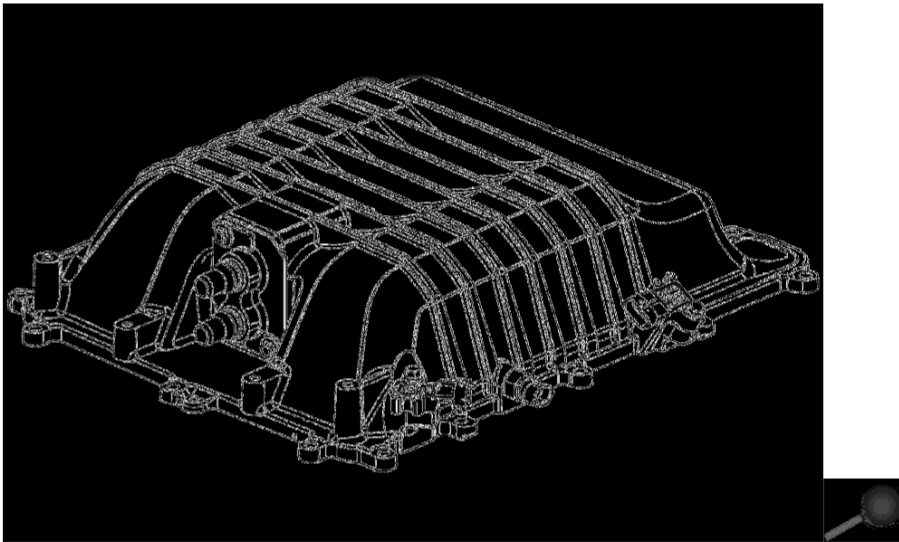
The LSA Roots type supercharger is a positive displacement pump that consists of 2 counter-rotating rotors installed into the lower intake manifold housing. The rotors are designed with 4 lobes and a helical twist. The rotors of the supercharger are designed to run at a minimal clearance, not in contact with each other or the housing, and are timed to each other by a pair of precision spur gears which are pressed onto the rotor shafts. The rotors are supported at each end by self-lubricating, non-serviceable bearings. The drive belt pulley is pressed onto the input shaft and is also not serviceable.

The lower supercharger assembly consists of the following components:

- Lower intake manifold housing, to include rotors, gears, bearings, and drive belt pulley
- Bypass valve
- Bypass actuator
- Charged air bypass valve
- Fuel rail with injectors
- Throttle body assembly
- Evaporative emission canister purge valve
- Inlet pressure sensor

### Cover/Intercooler





The cover assembly is provided with an integrated intercooler. Cooling the air enhances the effectiveness of the supercharger. The intercooler uses conventional coolant in a system that is separate from the engine cooling system. The intercooler assembly includes the cover, a charge air cooler/heat exchanger, a water manifold assembly and a variety of sensors to monitor air temperature and pressure. The water manifold, located at the front of cover transfers coolant to the cover via two internal transfer tubes. The transfer tubes and water manifold are sealed with o-rings and press-in-place seals. Coolant enters the inlet port of the water manifold assembly, is directed into and through the charge air cooler/heat exchanger, and exits back into the water manifold. Coolant then exits the water manifold outlet port returning to the separate cooling system.

The cover/intercooler consists of the following components:

- Water manifold assembly
- Charge air cooler cover
- Charge air coolers/heat exchanger
- Intake air temperature (IAT) sensor
- Barometric pressure sensor
- Air outlet pressure sensor

### Operation

The supercharger is designed to increase the air pressure and density in the intake manifold. When this air is mixed with the correct amount of fuel the result is more power from the engine. This excess air creates a boost pressure in the intake manifold with a maximum engine boost of 62 kPa (9 psi). Because the supercharger is a positive displacement pump and is directly driven from the engine drive belt system, boost pressure is available at all driving conditions. When boost is not required in situations such as idle or light throttle cruising, the excess air is routed through an internal bypass passage located between the intake manifold and the supercharger inlet. The bypass circuit is regulated by a bypass valve which is similar to a throttle plate. Spring force holds the bypass valve in a normally closed position to create boost. The bypass actuator is a vacuum operated valve that is connected to the vacuum signal between the throttle and the supercharger inlet. Vacuum to the actuator pulls the bypass valve open during idle and light load conditions to decrease boost. The charge air bypass valve is a vacuum/electrically operated solenoid valve that is attached to the supercharger housing. The three-way valve is controlled by the engine control module (ECM), which determines when

pressure from the manifold is routed to the bypass actuator. The charge air bypass valve allows pressure from the manifold to open the bypass valve and lower boost pressure during specific driving conditions. The open bypass valve reduces the pumping effort of the supercharger, thereby increasing the fuel efficiency in light load operations.

## DTC P0016

### Diagnostic Instructions

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

### DTC Descriptor

#### **DTC P0016**

Crankshaft Position – Camshaft Position Not Plausible

### Circuit/System Description

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

### Conditions for Running the DTC

- DTC P0335, P0336, P0340, P0341, P0641, or P0651 is not set.
- The engine is running.
- The engine speed is less than 1200 RPM.

The DTC runs continuously when the above conditions are met.

### Conditions for Setting the DTC

The ECM detects that the crankshaft position sensor pulses occur more than 11 crank degrees before or 11 crank degrees after the normal position for 24 out of 30 engine cycles.

### Action Taken When the DTC Sets

DTC P0016 is a Type B DTC.

### Conditions for Clearing the DTC

DTC P0016 is a Type B DTC.

### Reference Information

#### **Description and Operation**

[Electronic Ignition System Description](#)

#### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

#### **Scan Tool Reference**

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

### Circuit/System Verification

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

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

↓ **If none of the DTCs are set**

3. Engine Running at normal operating temperature.
4. Verify DTC P0016 is not set.

⇒ **If the DTC is set**

Inspect for the following and repair as necessary:

- The correct installation of the B23 Camshaft Position Sensor.
- The correct installation of the B26 Crankshaft Position Sensor.
- A timing chain tensioner condition.
- An incorrectly installed timing chain.
- Excessive play in the timing chain or sprockets.
- A timing chain that jumped teeth.

↓ **If the DTC is not set**

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

⇒ **If the DTC sets**

A mechanical condition listed above still exists.

↓ **If the DTC does not set**

7. All OK.

### **Repair Instructions**

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

- [Camshaft Position Sensor Replacement](#)
- [Camshaft Timing Chain and Sprocket Replacement](#)
- [Crankshaft Position Sensor Replacement](#)

## **DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161**

### **Diagnostic Instructions**

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

### **DTC Descriptors**

#### **DTC P0030**

HO2S Heater Control Circuit Bank 1 Sensor 1

#### **DTC P0036**

HO2S Heater Control Circuit Bank 1 Sensor 2

#### **DTC P0050**

HO2S Heater Control Circuit Bank 2 Sensor 1

#### **DTC P0053**

HO2S Heater Resistance Bank 1 Sensor 1

#### **DTC P0054**

HO2S Heater Resistance Bank 1 Sensor 2

#### **DTC P0056**

HO2S Heater Control Circuit Bank 2 Sensor 2

#### **DTC P0059**

HO2S Heater Resistance Bank 2 Sensor 1

#### **DTC P0060**

HO2S Heater Resistance Bank 2 Sensor 2

#### **DTC P0135**

HO2S Heater Performance Bank 1 Sensor 1

#### **DTC P0141**

HO2S Heater Performance Bank 1 Sensor 2

#### **DTC P0155**

HO2S Heater Performance Bank 2 Sensor 1

#### **DTC P0161**

HO2S Heater Performance Bank 2 Sensor 2

### **Diagnostic Fault Information**

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| Circuit                    | Short to Ground                                                                       | High Resistance                                                                    | Open                                                                                                           | Short to Voltage                                                            | Signal Performance         |
|----------------------------|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|----------------------------|
| HO2S Heater Voltage Supply | P0030, P0036, P0050, P0056, P0135, P0138, P0141, P0155, P0158, P0161, *<br>Opens fuse | P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161 | P0030, P0036, P0050, P0056, P0135, P0141, P0155, P0158, P0160, P0161, P0300, P0443, P3401, P3425, P3441, P3449 | P0690                                                                       | P0135, P0141, P0155, P0161 |
| HO2S Heater Control        | P0030, P0036, P0050, P0056                                                            | P0053, P0054, P0059, P0060, P0138, P0140, P0158, P0160                             | P0030, P0036, P0050, P0056, P0135, P0141, P0152, P0154, P0155, P0158, P0160, P0161                             | P0030, P0036, P0050, P0056, P0135, P0141, P0151, P0155, P0158, P0160, P0161 | P0135, P0141, P0155, P0161 |
| *Opens fuse                |                                                                                       |                                                                                    |                                                                                                                |                                                                             |                            |

#### Typical Scan Tool Data

##### HO2S Bank 1 or 2 Sensor 1 or 2 Heater

| Circuit                                  | Short to Ground | Open | Short to Voltage |
|------------------------------------------|-----------------|------|------------------|
| <b>Parameter Normal Range: 0.3–1.5 A</b> |                 |      |                  |
| Ignition Voltage                         | 0 A             | 0 A  | 0.3–1.5 A        |
| HO2S Heater Low Control                  | 0 A             | 0 A  | 0 A              |

#### Circuit/System Description

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. A heating element inside the HO2S minimizes the time required for the sensors to reach operating temperature. Voltage is provided to the heater by an ignition voltage circuit through a fuse. With the engine running, ground is provided to the heater by the HO2S heater low control circuit through a low side driver within the engine control module (ECM). The ECM uses pulse width modulation (PWM) to control the HO2S heater operation to maintain a specific HO2S operating temperature range.

### Conditions for Running the DTC

#### **P0030, P0036, P0050, or P0056**

- The ignition 1 voltage is between 11–32 volts.
- The engine speed is greater than 400 RPM.
- The DTCs run continuously when the above conditions are met for 1 second.

#### **P0053, P0054, P0059, or P0060**

- DTCs P0112, P0113, P0117, P0118, or P2610 are not set.
- The engine run time is less than 3 seconds.
- The ignition voltage is less than 32 volts.
- The ignition is OFF for greater than 8 hours.
- The engine coolant temperature (ECT) is between –30 to +45°C (–22 to +113°F) at engine start-up.
- The ECT and the intake air temperature (IAT) are within 8°C (14°F) at engine start-up.
- The DTCs run once per drive cycle when the above conditions are met.

#### **P0135, P0141, P0155, or P0161**

- DTCs P0116, P0117, P0118, P0125, or P0128 are not set.
- The ignition 1 voltage is between 10–32 volts.
- The HO2S is at operating temperature.
- The HO2S is commanded OFF.
- Device controls not active.
- The DTCs run once per drive cycle when the above conditions are met for 120 seconds.

### Conditions for Setting the DTC

#### **P0030, P0036, P0050, or P0056**

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 7 seconds.

#### **P0053, P0054, P0059, or P0060**

The ECM detects the HO2S heater is not within a specified resistance range at engine start-up for greater than 3 second.

#### **P0135 or P0155**

The ECM detects that the HO2S 1 heater current is greater than 3.1 amps, or less than 0.3 amps for greater than 10 seconds.

#### **P0141 or P0161**

The ECM detects that the HO2S 2 heater current is greater than 2.9 amps, or less than 0.3 amps for greater than 10 seconds.

### Action Taken When the DTC Sets

DTCs P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, and P0161 are Type B DTCs.

### Conditions for Clearing the MIL/DTC

DTCs P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, and P0161 are Type B DTCs.

### Reference Information



**Schematic Reference**[Engine Controls Schematics](#)**Connector End View Reference**[Component Connector End 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. Engine idling.
  2. Verify the parameters listed below do not display Malfunction when commanding the HO2S Heater Bank 1 or 2 Sensor 1 or 2 ON and OFF with a scan tool:
    - HO2S Heater Control Circuit Low Voltage Test Status Bank 1 or 2 Sensor 1 or 2
    - HO2S Heater Control Circuit Open Test Status Bank 1 or 2 Sensor 1 or 2
    - HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2
- ⇒ **If Malfunction is displayed**  
Refer to Circuit/System Testing
- ⇓ **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
  4. Verify the DTC does not set.
    - ⇒ **If the DTC sets**  
Refer to Circuit/System Testing
    - ⇓ **If the DTC does not set**
  5. All OK.

**[Circuit/System Testing](#)**

1. Ignition OFF, disconnect the harness connector at the appropriate B52 Heated Oxygen Sensor. Ignition ON.
2. Verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.
  - ⇒ **If the test lamp does not illuminate and the circuit fuse is good**
    - 2.1. Ignition OFF, remove the test lamp.
    - 2.2. Test for less than 2  $\Omega$  in the ignition circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , verify the fuse is OK and there is voltage at the fuse.
  - ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
    - 2.1. Ignition OFF.

- 2.2. Test for infinite resistance between the ignition circuit and ground.
- ⇒ If less than infinite resistance, repair the short to ground on the circuit.
- ⇒ If infinite resistance, test all components connected to the fuse and replace as necessary.
- ↓ **If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal D and the control circuit terminal C.
- ⇒ **If the test lamp illuminates**
- 3.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
- 3.2. Test for infinite resistance between the control circuit and ground.
- ⇒ If less than infinite resistance, repair the short to ground on the circuit.
- ⇒ If infinite resistance, replace the K20 Engine Control Module.
- ↓ **If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2 parameter is OK when commanding the HO2S Heater ON with a scan tool.
- ⇒ **If the parameter is not OK**
- 5.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module. Ignition ON.
- 5.2. Test for less than 1 V between the control circuit and ground.
- ⇒ If 1 V or greater, repair the short to voltage on the circuit.
- ⇒ If less than 1 V, replace the K20 Engine Control Module.
- ↓ **If the parameter is OK**
- Note:**
- Less than 10  $\Omega$  of additional resistance on the ignition voltage circuit, or control circuit may set a DTC. If there is resistance on a circuit, the driver will remain ON and the scan tool HO2S High Voltage Test Status parameter will display OK.
  - Performance this test may set additional DTCs.
6. Install a 10  $\Omega$  fused jumper wire between the control circuit terminal C and the ignition voltage circuit terminal D.
- Note:** This test may only be performed once per key cycle. If test is repeated, ignition OFF, allow the engine control module to shut down completely, then ignition ON.
7. Verify the scan tool HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2 parameter is Malfunction when commanding the HO2S Heater ON with a scan tool.
- ⇒ **If the Parameter is not Malfunction**
- 7.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
- 7.2. Test for less than 2  $\Omega$  in the control circuit end to end.
- ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
- ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
- ↓ **If the Parameter is Malfunction**
8. Test or replace the B52 Heated Oxygen Sensor.

## Repair Instructions

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

- [Heated Oxygen Sensor Replacement - Bank 1 Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Bank 1 Sensor 2](#)
- [Heated Oxygen Sensor Replacement - Bank 2 Sensor 1](#)
- [Heated Oxygen Sensor Replacement - Bank 2 Sensor 2](#)

- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing a HO2S.
- [Control Module References](#) for ECM replacement, setup, and programming

## DTC P0033

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P0033

Supercharger Bypass Valve Solenoid Control Circuit

### Diagnostic Fault Information

#### Supercharger Bypass Valve Control Solenoid

| Circuit                           | Short to Ground | High Resistance | Open  | Short to Voltage | Signal Performance |
|-----------------------------------|-----------------|-----------------|-------|------------------|--------------------|
| Supercharger Bypass Valve Control | P0033           | P0033           | P0033 | P0033            | —                  |
| Ignition 1 Voltage                | P0033           | P0033           | P0033 | —                | —                  |

### Circuit Description

Supercharger boost pressure is regulated to prevent engine and drive train damage. When the engine is operating under high boost conditions, the engine control module (ECM) limits boost pressure to 82.7 kPa (12 psi) or less. The ECM limits or disables boost under the following conditions:

- Reverse gear is selected
- Electronic throttle control fault is detected.
- An intercooler pump failure is detected
- Engine Coolant Temperature (ECT), is equal to or greater than 125°C (257°F).
- Drivetrain abuse is detected
- When intake air temperature (IAT) sensor2 is equal to or greater than 120.5°C (248°F), the ECM commands the boost control solenoid to 62 % duty cycle and boost pressure is limited to 145 kPa (7 psi).
- When vehicle speed exceeds 256 km/h (159 mph) in third or fourth gear, boost is limited to a predetermined threshold after 150 s.

The ECM controls boost pressure by pulse width modulation of the supercharger bypass solenoid valve, which is normally open. Under most conditions, the ECM commands the bypass valve solenoid to operate at a 99–100 % duty cycle. This keeps the bypass valve closed and allows only inlet vacuum from the supercharger plenum to the bypass valve actuator to control the position of the valve. At idle, engine vacuum is applied to the upper side of the bypass valve actuator, counteracting spring tension to hold the bypass valve open. When the engine load is increased, the engine vacuum is decreased, causing the spring in the bypass valve actuator to overcome the diminishing applied vacuum, closing the bypass valve and allowing the boost pressure to increase. When reduced boost pressure is desired, the ECM commands the boost control solenoid to operate between 0 to approximately 62 % duty cycle. This opens

the solenoid valve and allows boost pressure to enter the bypass valve actuator at the lower side to counteract the spring tension, opening the bypass valve and recirculating excess boost pressure back into the supercharger inlet.

The ECM monitors the voltage level on the boost control solenoid control circuit.

#### **Conditions for Running the DTC**

- Engine is running.
- Ignition voltage is between 11–32 V.
- This DTC runs continuously within the enabling conditions.

#### **Conditions for Setting the DTC**

The ECM detects that the commanded and actual states of output driver do not match for greater than 5 s.

#### **Action Taken When the DTC Sets**

DTC P0033 is a Type B DTC.

#### **Conditions for Clearing the MIL/DTC**

DTC P0033 is a Type B DTC.

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End Views](#)

##### **Description and Operation**

- [Supercharger Description and Operation](#)
- [Boost Control System Diagnosis](#)
- [Boost Control System Description](#)

##### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)
- [Measuring Frequency](#)

##### **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 a click is heard or felt from the Q36 Supercharger Bypass Solenoid Valve when commanding the Supercharger Bypass Solenoid Valve between 0–10 % with a scan tool.  
⇒ **If a click is not heard or felt**

Refer to Circuit/System Testing

↓ **If a click is heard or felt**

3. Verify the parameters listed below do not display Malfunction when commanding the Supercharger Bypass Solenoid Valve between 0–10 % with a scan tool:
  - Supercharger Bypass Solenoid Valve Control Circuit High Voltage Test Status
  - Supercharger Bypass Solenoid Valve Control Circuit Open Test Status
  - Supercharger Bypass Solenoid Valve Control Circuit Low Voltage Test Status

⇒ **If Malfunction is displayed**

Refer to Circuit/System Testing.

↓ **If Malfunction is not displayed**

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

### Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the Q36 Supercharger Bypass Solenoid Valve. Ignition On.
2. Verify a test lamp illuminates between the ignition supply circuit terminal 1 and ground.
- ⇒ **If the test lamp does not illuminate and the circuit fuse is good**
  - 2.1. Ignition Off, remove the test lamp.
  - 2.2. Test for less than 2  $\Omega$  in the ignition circuit end to end.
    - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
    - ⇒ If less than 2  $\Omega$ , verify the fuse is not open and there is voltage at the fuse.
- ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
  - 2.1. Ignition Off, remove the test lamp.
 

**Note:** An internal short in any component supplied by the fuse may cause the fuse to open and set a DTC when the component is activated.
  - 2.2. Test for infinite resistance between the ignition circuit and ground.
    - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
    - ⇒ If infinite resistance, test all components connected to the ignition voltage circuit for a short and replace as necessary.
- ↓ **If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the control circuit terminal 2 and the ignition circuit terminal 1.
- ⇒ **If the test lamp illuminates**
  - 3.1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module. Remove the test lamp.
  - 3.2. Test for infinite resistance between the control circuit and ground.
    - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
    - ⇒ If infinite resistance, replace the K20 Engine Control Module.
- ↓ **If the test lamp does not illuminate**
4. Remove the test lamp.

5. Verify the corresponding scan tool Supercharger Bypass Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the Supercharger Bypass Solenoid Valve to 10% with a scan tool.

⇒ **If OK is not displayed**

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

⇓ **If OK is displayed**

6. Install a 3 A fused jumper wire between the control circuit terminal 2 and the ignition circuit terminal 1.
7. Verify the corresponding scan tool Supercharger Bypass Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the Supercharger Bypass Solenoid Valve to 10% with a scan tool.

⇒ **If Malfunction is not displayed**

- 7.1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
- 7.2. Test for less than 2  $\Omega$  in the control circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

⇓ **If Malfunction is displayed**

8. Test or replace the Q36 Supercharger Bypass Solenoid Valve.

## **Component Testing**

### **Static Test**

1. Ignition Off, disconnect the harness connector at the Q36 Supercharger Bypass Solenoid Valve.
2. Test for 30–55  $\Omega$  between the control terminal 1 and the ignition terminal 2 of the valve.
  - ⇒ **If not within 30–55  $\Omega$**   
Replace the Q36 Supercharger Bypass Solenoid Valve.
  - ⇓ **If within 30–55  $\Omega$**
3. All OK.

### **Dynamic Test**

1. Install a 10 A fused jumper wire between the ignition terminal 1 and 12 V. Install a jumper wire between the control terminal 2 and ground.
2. Verify the Q36 Supercharger Bypass Solenoid Valve clicks.
  - ⇒ **If the valve does not click**  
Replace the Q36 Supercharger Bypass Solenoid Valve.
  - ⇓ **If the valve clicks**
3. All OK

## **Repair Instructions**

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

- [Charge Air Bypass Regulator Solenoid Valve Replacement](#) for supercharger bypass solenoid valve replacement.
- [Control Module References](#) for ECM replacement, programming, and setup

## DTC P0068 or P1101 (With Supercharger)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0068

Throttle Body Air Flow Performance

#### DTC P1101

Intake Air Flow System Performance

### Circuit Description

**Note:** The following applies to the intake air flow system performance diagnostic that is used in this supercharged engine:

- When referring to the supercharger intake manifold models, the plenum volume between the throttle body and the supercharger is considered to be the intake manifold.
- When referring to engine pumping, the supercharger and the intercooler plenum are considered to be part of the engine.
- The manifold absolute pressure (MAP) estimates are used in the engine air flow estimates. Air flow into the intake system must be the same as the air flow out of the intake system, the Intake Air Flow Rationality Diagnostics (IFRD) calculates air flowing out of the engine based on MAP estimates, volumetric efficiency, and RPM.

The engine control module (ECM) uses the following information to calculate an expected airflow rate:

- The throttle position (TP)
- The barometric pressure (BARO)
- The manifold absolute pressure (MAP)
- The intake air temperature (IAT)
- The supercharger inlet absolute pressure (SCIAP)
- The intake air temperature (IAT) sensor 2
- The engine RPM

The intake airflow system performance diagnostic provides the within-range rationality check for the mass air flow (MAF), supercharger inlet absolute pressure (SCIAP), MAP, by-pass valve stuck, and the throttle position (TP) sensors. This is an explicit model-based diagnostic containing 4 separate models for the intake system.

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

### Conditions for Running the DTCs

#### P0068

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- The engine speed is above 800 RPM.
- The ignition voltage is at least 6 V.
- This DTC runs continuously when the above enabling conditions are met.

**P1101**

- DTCs P0096, P0097, P0098, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P012C, P012D, P0335, P0336, P0401, P0405, P1404, P2226, P2227, P2228 are not set.
- The engine speed is between 450–6,500 RPM.
- The intake air temperature is between –20 and +125°C (–4 and +257°F).
- The engine coolant temperature is between –20 and +125°C (–4 and +257°F).
- This DTC runs continuously when the above enabling conditions are met.

**Conditions for Setting the DTCs****P0068**

The ECM detects that the throttle position and the indicated engine load do not correspond with the expected load and throttle position for less than 1 second.

**P1101**

The engine control module (ECM) detects that the actual measured airflow from the MAF, MAP, SC Inlet Pressure, and the TP sensors are not within a range of the calculated airflow that are derived from the system of models by greater than a calibrated threshold for greater than 10 s.

**Action Taken When the DTCs Set****P0068**

- DTC P0068 is a Type A DTC.
- The control module commands the throttle actuator control (TAC) system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions the control module commands the engine OFF.

**P1101**

DTC P1101 is a Type B DTC.

**Conditions for Clearing the MIL/DTCs**

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

**Diagnostic Aids**

Inspect for the following conditions that may set this DTC:

- Any condition that can cause the MAF, MAP, SC IAP, and TP sensors to be shifted in value.
- A steady or intermittent high resistance of 15  $\Omega$  or greater on the ignition voltage circuit will cause the MAF sensor signal to be increased by as much as 60 g/s. To pinpoint this condition perform a voltage drop test on the circuit.
- Any type of contamination on the MAF sensor heating elements will degrade the proper operation of the sensor. Certain types of contaminants act as a heat insulator, which will impair the response of the sensor to airflow changes. Water or snow can create the opposite effect, and cause the signal to increase rapidly.

- Depending on the current ambient temperature, and the vehicle operating conditions, a MAF sensor signal circuit that is shorted to the IAT signal circuit will increase or decrease the MAF sensor signal that is interpreted by the ECM. Additionally it may cause a rapid fluctuation in the IAT Sensor parameter.
- A skewed or stuck engine coolant temperature (ECT) or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to [Temperature Versus Resistance](#).
- Certain aftermarket air filters may cause this DTC to set.
- Certain aftermarket air induction systems may cause this DTC to set.
- Modifications to the air induction system may cause this DTC to set.

## [Reference Information](#)

### Schematic Reference

[Engine Controls Schematics](#)

### Connector End View Reference

[Component Connector End Views](#)

### 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](#)

## [Circuit/System Verification](#)

1. Ignition ON.
2. Verify the scan tool TB Idle Air Flow Compensation parameter is less than 90 %.  
⇒ **90 % or greater**  
Refer to [Throttle Body Cleaning](#).  
↓ **If less than 90 %**
3. Verify the scan tool TP Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.  
⇒ **If Disagree**  
Refer to [DTC P0120-P0123, P0220, P0222, P0223, or P2135](#) for further diagnosis.  
↓ **If Agree**
4. Determine the current vehicle testing altitude.
5. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.  
⇒ **The MAP Sensor pressure is not in range**  
Refer to [DTC P0106](#) for further diagnosis.  
↓ **The MAP Sensor pressure is within range**

6. Verify the scan tool SC Inlet Pressure Sensor pressure parameter is within range specified in the [Altitude Versus Barometric Pressure](#) table.
  - ⇒ **The SC Inlet Pressure Sensor pressure is not in range**  
Refer to [DTC P012B](#) for further diagnosis.
  - ↓ **The SC Inlet Pressure Sensor pressure is within range**
7. Verify the SC Inlet Pressure Sensor pressure parameter decreases after starting the engine.
  - ⇒ **The SC Inlet Pressure Sensor pressure did not decrease**  
Refer to [DTC P012B](#) for further diagnosis.
  - ↓ **The SC Inlet Pressure Sensor pressure decrease**
8. Verify the scan tool MAP Sensor pressure parameter is between 26–52 kPa (3.8–7.5 PSI) and changes with accelerator pedal input.
  - ⇒ **If not between 26–52 kPa (3.8–7.5 PSI) or does not change**  
Refer to [DTC P0106](#) for further diagnosis.
  - ↓ **If between 26–52 kPa (3.8–7.5 PSI) and changes**
9. 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.
  - 9.1. Engine idling
  - 9.2. Perform the scan tool snapshot function.
  - 9.3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
  - 9.4. Exit from the scan tool snapshot and review the data.
  - 9.5. Observe the MAF Sensor parameter frame by frame with a scan tool.
  - ⇒ **The MAF Sensor parameter does not change smoothly and gradually**  
Refer to [DTC P0101](#) for further diagnosis.
  - ↓ **The MAF Sensor parameter changes smoothly and gradually**
10. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
11. Verify the DTC does not set.
  - ⇒ **If the DTC sets**  
Refer to Circuit/System Testing.
  - ↓ **If the DTC does not set**
12. All OK

#### Circuit/System Testing

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

1. Verify the integrity of the entire air induction system by verifying that none of the following conditions exist:
  - Any damaged, improperly installed, collapsed, or restricted components
  - Improper operation of turbocharger wastegate actuator or bypass valve; where equipped
  - Loose clamps, cracks, or other damage
  - An air flow restriction
  - Restricted air filter
  - Splits, kinks, leaks, or improper connections at the vacuum hoses
  - Vacuum leaks at the intake manifold, MAP sensor, and throttle body
  - Water intrusion

- Any snow or ice buildup, in cold climates
- Contamination of the MAF sensor element
- Missing, restricted, or leaking exhaust components—Refer to [Symptoms - Engine Exhaust](#) for diagnosis.

⇒ **If a condition is found**

Repair or replace component as appropriate.

↓ **If no condition is found**

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

⇒ **If a condition is found**

Repair or replace component as appropriate.

↓ **If no condition is found**

3. All OK

### **[Repair Instructions](#)**

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

## DTC P0068 or P1101 (Without Supercharger)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0068

Throttle Body Air Flow Performance

#### DTC P1101

Intake Air Flow System Performance

### Circuit/System Description

The engine control module (ECM) uses the following information to calculate an expected airflow rate:

- The throttle position (TP)
- The barometric pressure (BARO)
- The manifold absolute pressure (MAP)
- The intake air temperature (IAT)
- The engine RPM

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

- The throttle model describes the flow through the throttle body and is used to estimate the MAF through the throttle body as a function of barometric pressure (BARO), TP, intake air temperature (IAT), and estimated MAP. The information from this model is displayed on the scan tool as the MAF Performance Test parameter.
- The first intake manifold model describes the intake manifold and is used to estimate MAP as a function of the MAF into the manifold from the throttle body and the MAF out of the manifold caused by engine pumping. The flow into the manifold from the throttle uses the MAF estimate calculated from the above throttle model. The information from this model is displayed on the scan tool as the MAP Performance Test 1 parameter.
- The second intake manifold model is identical to the first intake manifold model except that the MAF sensor measurement is used instead of the throttle model estimate for the throttle air input. The information from this model is displayed on the scan tool as the MAP Performance Test 2 parameter.
- The fourth model is created from the combination and additional calculations of the throttle model and the first intake manifold model. The information from this model is displayed on the scan tool as the TP Performance Test parameter.

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

### Conditions for Running the DTCs

#### P0068

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- The engine speed is above 800 RPM.
- The ignition voltage is at least 6 V.
- This DTC runs continuously when the above conditions are met.

**P1101**

- DTCs P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0335, or P0336 are not set.
- The engine speed is between 450–5,750 RPM.
- The intake air temperature is between –20 and +125°C (–4 and +257°F).
- The engine coolant temperature is between –20 and +125°C (–4 and +257°F).
- This DTC runs continuously when the above conditions are met.

**Conditions for Setting the DTC****P0068**

The ECM detects that the throttle position and the indicated engine load do not correspond with the expected load and throttle position for less than 1 second.

**P1101**

The engine control module (ECM) detects that the actual measured airflow from the MAF, MAP, and TP sensors is not within range of the calculated airflow that is derived from the system of models for more than 0.5 s.

**Action Taken When the DTCs Set****P0068**

- DTC P0068 is a Type A DTC.
- The control module commands the throttle actuator control (TAC) system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions the control module commands the engine OFF.

**P1101**

DTC P1101 is a Type B DTC.

**Conditions for Clearing the MIL/DTCs**

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

**Diagnostic Aids**

- A steady or intermittent high resistance of 15  $\Omega$  or greater on the ignition voltage circuit will cause the MAF sensor signal to be increased by as much as 60 g/s. To pinpoint this condition perform a voltage drop test on the circuit.
- Any type of contamination on the MAF sensor heating elements will degrade the proper operation of the sensor. Certain types of contaminants act as a heat insulator, which will impair the response of the sensor to airflow changes. Water or snow can create the opposite effect, and cause the signal to increase rapidly.
- Depending on the current ambient temperature, and the vehicle operating conditions, a MAF sensor signal circuit that is shorted to the IAT signal circuit will increase or decrease the MAF sensor signal that is interpreted by the ECM. Additionally it may cause a rapid fluctuation in the IAT Sensor parameter.
- A skewed or stuck engine coolant temperature (ECT) or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to [Temperature Versus Resistance](#)

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

## **Reference Information**

### **Schematic Reference**

[Engine Controls Schematics](#)

### **Connector End View Reference**

[Component Connector End Views](#)

### **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](#)

## **Circuit/System Verification**

1. Ignition ON.
2. Verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90 %.  
⇒ **90 % or greater**  
Refer to [Throttle Body Cleaning](#).  
↓ **If less than 90 %**
3. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.  
⇒ **If Disagree**  
Refer to [DTC P0120-P0123, P0220, P0222, P0223, or P2135](#) for further diagnosis.  
↓ **If Agree**
4. Determine the current vehicle testing altitude.
5. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.  
⇒ **The MAP Sensor pressure is not in range**  
Refer to [DTC P0106](#) for further diagnosis.  
↓ **The MAP Sensor pressure is within range**
6. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 26–52 kPa (3.8–7.5 PSI) and changes with accelerator pedal input.  
⇒ **If not between 26–52 kPa (3.8–7.5 PSI) or does not change**  
Refer to [DTC P0106](#) for further diagnosis.  
↓ **If between 26–52 kPa (3.8–7.5 PSI) and changes**

7. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
  - 7.1. Engine idling
  - 7.2. Perform the scan tool snapshot function.
  - 7.3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
  - 7.4. Exit from the scan tool snapshot and review the data.
  - 7.5. Observe the MAF Sensor parameter frame by frame with a scan tool.
- ⇒ **The MAF Sensor parameter does not change smoothly and gradually**  
Refer to [DTC P0101](#) for further diagnosis.
- ↓ **The MAF Sensor parameter changes smoothly and gradually**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.
  - ⇒ **If the DTC sets**  
Refer to Circuit/System Testing.
  - ↓ **If the DTC does not set**
10. All OK

### Circuit/System Testing

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

1. Verify the integrity of the entire air induction system by verifying that none of the following conditions exist:
  - Any damaged, improperly installed, collapsed, or restricted components
  - Improper operation of turbocharger wastegate actuator or bypass valve; where equipped
  - Loose clamps, cracks, or other damage
  - An air flow restriction
  - Restricted air filter
  - Splits, kinks, leaks, or improper connections at the vacuum hoses
  - Vacuum leaks at the intake manifold, MAP sensor, and throttle body
  - Water intrusion
  - Any snow or ice buildup, in cold climates
  - Contamination of the MAF sensor element
  - Missing, restricted, or leaking exhaust components—Refer to [Symptoms - Engine Exhaust](#) for diagnosis.
- ⇒ **If a condition is found**  
Repair or replace component as appropriate.
- ↓ **If no condition is found**
2. Test the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#) for diagnosis.
  - ⇒ **If a condition is found**  
Repair or replace component as appropriate.
  - ↓ **If no condition is found**
3. All OK

### Repair Instructions



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

## DTC P006D

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P006D

Barometric Pressure (BARO) – Supercharger Inlet Pressure Correlation

### Circuit/System Description

The barometric pressure (BARO) sensor measures the pressure of the atmosphere. This pressure is affected by altitude and weather conditions. A diaphragm within the BARO sensor is displaced by the pressure changes that occur from varying altitudes and weather conditions. The sensor translates this diaphragm displacement into the voltage signal input that is used by the engine control module (ECM) for diagnostics and emissions control.

The supercharger inlet pressure sensor measures the absolute pressure of the air just after the throttle body, at the inlet of the supercharger. The plenum volume between the throttle body and the supercharger is where this sensor is located, and for the purpose of this diagnostic, this area is considered to be the intake manifold. The diaphragm within the supercharger inlet pressure sensor functions in the same manner as the BARO sensor. The sensors are not interchangeable.

The purpose of this diagnostic is to analyze the correlation between the BARO sensor and the supercharger inlet pressure sensor. This is accomplished by continually comparing the difference between BARO and supercharger inlet pressure at key ON, engine OFF, closed throttle idle conditions and at wide open throttle update events. At key ON, engine OFF, the difference between BARO and the supercharger inlet pressure should be very close to zero, and is represented on the scan tool by the Supercharger Inlet Pressure parameter. A negative Supercharger Inlet Pressure parameter means that the BARO sensor value is less than the supercharger inlet pressure value. A positive Supercharger Inlet Pressure parameter represents a BARO sensor value that is greater than the supercharger inlet pressure value.

At idle the Supercharger Inlet Pressure parameter should be a positive value and represents the calculated difference between BARO and the reduced pressure that is present in the supercharger intake plenum. At wide open throttle the Supercharger Inlet Pressure parameter should be very close to zero and represents the calculated difference between BARO and the increased pressure that is present in the supercharger intake plenum.

If the ECM detects that the BARO sensor signal and the supercharger inlet pressure sensor signal are not within a calibrated range, DTC P006D sets.

### Conditions for Running the DTC

- DTC P0068, P0101, P0102, P0103, P0111, P0112, P0113, P0117, P0118, P0120, P0121, P0122, P0123, P012B, P012C, P012D, P0220, P0222, P0223, P1516, P2101, P2228, or P2229 is not set.
- The engine is running.
- DTC P006D runs continuously when the above conditions are met.

### Conditions for Setting the DTC

The ECM detects that the difference between BARO and Supercharger Inlet Pressure is greater than 15 kPa (2.2 psi) for greater than 5 s.

### **Action Taken When the DTC Sets**

DTC P006D is a Type B DTC.

### **Conditions for Clearing the DTC**

DTC P006D is a Type B DTC.

### **Diagnostic Aids**

- Any condition that can cause the BARO or supercharger inlet pressure sensors to be shifted in value may cause this DTC to set.
- A resistance of 20–50  $\Omega$  on the 5 V reference terminal 1 or the low reference circuit terminal 2 may cause this DTC to set.
- The harness connectors for the BARO sensor and the supercharger inlet pressure sensor are of the same configuration but are not interchangeable. Review the engine controls schematics for the BARO sensor and the supercharger inlet pressure sensor and note the circuit colors. Inspect the wiring harnesses of both sensors for the proper connections.

### **Reference Information**

#### **Schematic Reference**

[Engine Controls Schematics](#)

#### **Connector End View Reference**

[Component Connector End 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

#### **Special Tools**

GE 23738-A Vacuum Pump

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

### **Circuit/System Verification**

1. Verify that DTC P0106, P0107, P0108, P012B, P012C, P012D, P0641, P0651, P2227, P2228, or P2229 is not set.  
⇒ If a DTC is set, refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
2. Ignition ON.
3. Verify the scan tool BARO parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.  
⇒ **The BARO parameter is not in range**  
Refer to [DTC P2227](#).

↓ **The BARO parameter is within range**

4. Verify the scan tool Supercharger Inlet Pressure Sensor pressure parameter is within range specified in the [Altitude Versus Barometric Pressure](#) table.

⇒ **The pressure is not in range**

Refer to [DTC P012B](#).

↓ **The pressure is within range**

5. Verify the Supercharger Inlet Pressure Sensor pressure parameter decreases after starting the engine.

⇒ **The pressure does not decrease**

Refer to Circuit/System Testing.

↓ **The pressure decreases**

6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
7. Verify the DTC does not set.
- ⇒ **If the DTC sets**  
Refer to Circuit/System Testing
- ↓ **If no DTCs set**
8. All OK

### **Circuit/System Testing**

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

1. Verify none of the conditions listed below exist:

- Loose clamps, cracks, or other damage in the air intake duct system
- Collapsed or restricted air intake duct system
- Restricted air filter
- Splits, kinks or improper connections at the vacuum hoses
- Missing, restricted or leaking exhaust components. Refer to [Symptoms - Engine Mechanical](#).
- Vacuum leaks at the intake manifold and throttle body

⇒ **If a condition exists, repair as necessary.**

↓ **If no condition exists.**

2. Verify the integrity of the supercharger system by inspecting for the following conditions:

- A binding or restricted supercharger bypass valve, linkage or actuator. Refer to [Supercharger Cleaning and Inspection](#)
- Any damaged components
- Loose or improper installation of any components
- An air flow restriction
- Any vacuum leaks
- Water intrusion
- Missing or leaking seal on the B105 supercharger inlet pressure sensor or B17 barometric pressure sensor
- Contamination or debris blocking or restricting the B105 supercharger inlet pressure sensor port

⇒ **If a condition exists, repair as necessary.**

↓ **If none of the conditions exist**

3. Test or replace the B105 supercharger inlet pressure sensor.

## Component Test

**Note:** You must perform the Circuit/System Testing before proceeding with the Component Testing.

### Skewed Signal Test

1. Ignition OFF, remove the B105 supercharger inlet pressure sensor.
2. Ignition ON, apply 5 in Hg of vacuum to the sensor, with the *GE 23738-A*. Verify the corresponding scan tool pressure sensor parameter decreases between 13–21 kPa (1.8–3.0 psi).
  - ⇒ **If the pressure does not decrease between 13–21 kPa (1.8–3.0 psi)**  
Replace the B105 supercharger inlet pressure sensor.
  - ⇓ **If the pressure decreases between 13–21 kPa (1.8–3.0 psi)**
3. Apply 10 in Hg of vacuum to the sensor with the *GE 23738-A*. Verify the corresponding scan tool pressure parameter decreases between 30–38 kPa (4.4–5.5 psi).
  - ⇒ **If the pressure does not decrease between 30–38 kPa (4.4–5.5 psi)**  
Replace the B105 supercharger inlet pressure sensor.
  - ⇓ **If the pressure decreases between 30–38 kPa (4.4–5.5 psi)**

### Erratic Signal Test

1. Ignition OFF, remove the B105 supercharger inlet pressure sensor.
2. Install a 3 A fused jumper between the harness connector 5 V reference circuit terminal 1 and terminal 1 or A of the sensor.
3. Install a jumper wire between the low reference circuit terminal 2 or B of the sensor and ground.
4. Ignition ON, Test for 5.2–0 V between the signal terminal 3 and the low reference terminal 2, and verify there are NO spikes or dropouts in the voltage signal while slowly applying vacuum to the sensor with the *GE 23738-A*.
  - ⇒ **If not between 5.2–0 V or has spikes or dropouts**  
Replace the B105 supercharger inlet pressure sensor.
  - ⇓ **If between 5.2–0 V and there are no spikes or dropouts**
5. All OK

## Repair Instructions

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

- [Supercharger Air Inlet Pressure Sensor Replacement](#)
- [Control Module References](#) for ECM replacement, programming, and setup

DTC P0096

Diagnostic Instructions

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

DTC Descriptor

DTC P0096

Intake Air Temperature (IAT) Sensor 2 Performance

Diagnostic Fault Information

IAT Sensor 2

| Circuit                                                                   | Short to Ground | High Resistance | Open  | Short to Voltage | Signal Performance |
|---------------------------------------------------------------------------|-----------------|-----------------|-------|------------------|--------------------|
| Signal                                                                    | P0097           | P0096           | P0098 | P0098*           | P0096              |
| Low Reference                                                             | —               | P0096           | P0098 | —                | P0096              |
| *Internal ECM or sensor damage may occur if the circuit is shorted to B+. |                 |                 |       |                  |                    |

IAT Sensor 1

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

Typical Scan Tool Data

IAT Sensor 2

| Circuit                                                                                                                        | Short to Ground | Open          | Short to Voltage |
|--------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------|------------------|
| <b>Operating Conditions:</b> Key ON, engine OFF<br><b>Parameter Normal Range:</b> Varies between -39 to +120°C (-38 to +248°F) |                 |               |                  |
| Signal                                                                                                                         | 150°C (300°F)   | -40°C (-40°F) | -40°C (-40°F)*   |

| Circuit                                                                  | Short to Ground | Open             | Short to Voltage  |
|--------------------------------------------------------------------------|-----------------|------------------|-------------------|
| Low Reference                                                            | —               | −40°C<br>(−40°F) | −40°C<br>(−40°F)* |
| *Internal ECM or sensor damage may occur if the circuit is shorted to B+ |                 |                  |                   |

**IAT Sensor 1**

| Circuit                                                                                                           | Short to Ground  | Open or High Resistance | Short to Voltage  |
|-------------------------------------------------------------------------------------------------------------------|------------------|-------------------------|-------------------|
| <b>Operating Conditions:</b> Key ON, engine OFF<br><b>Parameter Normal Range:</b> Varies with ambient temperature |                  |                         |                   |
| Signal                                                                                                            | 140°C<br>(284°F) | −40°C<br>(−40°F)        | −40°C<br>(−40°F)* |
| Low Reference                                                                                                     | —                | —                       | —                 |
| *Internal ECM or sensor damage may occur if the circuit is shorted to B+                                          |                  |                         |                   |

**Circuit/System Description**

The intake air temperature (IAT) sensor 2 is a variable resistor. The IAT sensor 2 measures the temperature of the air at the engine intake manifold. The engine control module (ECM) supplies 5 V to the IAT sensor 2 signal circuit, and a ground for the IAT sensor 2 low reference circuit. When the IAT sensor 2 is cold, the sensor resistance is high. When the intake manifold air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the IAT sensor 2 signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the IAT sensor 2 signal circuit. The ECM monitors the IAT sensor 2 and the IAT sensor signal voltages for a voltage that is not within a calibrated range of each other.

**Conditions for Running the DTC**

- DTCs P0097, P0098, P0112, P0113, P0116, P0117, P0118, P0128, P0500, P0502, P0603 are not set.
- DTC P0116 has run and passed.
- The engine has been OFF for greater than 8 hours.
- The IAT sensor is warmer than 10°C (50°F).
- DTC P0096 runs once per key cycle within the enabling conditions.

**Conditions for Setting the DTC**

At start-up, after an 8 hour engine soak time, the IAT sensor 2 temperature is more than 20°C (36°F) warmer or colder than the IAT sensor.

**Action Taken When the DTC Sets**

DTC P0096 is a Type B DTC.

**Conditions for Clearing the MIL/DTC**

DTC P0096 is a Type B DTC.

**Diagnostic Aids**

- An IAT sensor that is skewed lower at various ambient temperatures, due to greater resistance than is normal, can widen the spread between the 2 sensors and cause this DTC to set. Measure and record the resistance of the IAT sensor and IAT sensor 2 at various ambient temperatures, and then compare those measurements to the Temperature vs. Resistance [Temperature Versus Resistance](#) table.
- Inspect both IAT sensors terminals, for corrosion or a poor connection.

## Reference Information

### Schematic Reference

[Engine Controls Schematics](#)

### Connector End View Reference

[Component Connector End Views](#)

### Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

### Powertrain Component Views

[Powertrain Component Views](#)

### DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

### Scan Tool Reference

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

## Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641 or P0651 is not set.  
⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.
- ⇓ **If the 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 15°C (27°F) of each other.
  - Start-Up IAT Sensor 1
  - IAT Sensor 2
  - Start-Up ECT
 ⇒ **If not within 15°C (27°F)**  
Refer to Circuit/System Testing.  
⇓ **If within 15°C (27°F)**
5. Engine idling, verify the following scan tool parameters are between: -38 and +149°C (-36 and +300°F).
  - IAT Sensor 1
  - IAT Sensor 2



- ECT Sensor

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

Refer to Circuit/System Testing.

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

6. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

7. Verify the DTCs do not set.

⇒ **If any DTC sets**

Refer to Circuit/System Testing.

⇓ **If no DTC sets**

8. All OK

### Circuit/System Testing

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

1. Verify none of the following conditions exist:

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

⇒ **If a condition exists**

Repair or replace component as appropriate.

⇓ **If no condition exists**

2. Ignition OFF, and all vehicle systems OFF, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the IAT sensor 2.

3. Test for less than 2 Ω between the low reference circuit terminal B and ground.

⇒ **If 2 Ω or greater**

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

3.2. 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 Engine Control Module.

⇓ **If less than 2 Ω**

4. Ignition ON, test for 4.8–5.2 V between the intake air temperature signal 2 circuit terminal A and ground.

⇒ **If less than 4.8 V**

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

4.2. 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

- 4.3. Test for less than 2  $\Omega$  in the signal circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the 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.

- 4.1. Ignition OFF, disconnect the harness connector at the Engine Control Module.
- 4.2. 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 Engine Control Module.

⇓ **If between 4.8–5.2 V**

5. Ignition ON, verify the scan tool IAT sensor 2 parameter is colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ).

⇒ **If not colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ).**

Replace the Engine Control Module.

⇓ **If colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ).**

6. Ignition OFF. Install a 3 A fused jumper wire between the signal circuit terminal A and the low reference circuit terminal B.

7. Ignition ON. Verify the scan tool IAT sensor 2 parameter is warmer than  $130^{\circ}\text{C}$  ( $266^{\circ}\text{F}$ ).

⇒ **If not warmer than  $130^{\circ}\text{C}$  ( $266^{\circ}\text{F}$ ).**

Replace the Engine Control Module.

⇓ **If warmer than  $130^{\circ}\text{C}$  ( $266^{\circ}\text{F}$ ).**

8. Test or replace IAT sensor 2.

### Component Testing

#### **IAT sensor 2**

1. Test the IAT sensor 2 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance](#) table. The resistance values should be in range of the table values.

⇒ **If not within the table values.**

Replace the IAT sensor 2.

⇓ **If within the table values.**

2. All OK

### Repair Instructions

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

- [Intake Air Temperature Sensor Replacement](#) for IAT sensor 2 replacement.
- [Control Module References](#) for engine control module replacement, setup, and programming

## DTC P0097 or P0098

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0097

Intake Air Temperature (IAT) Sensor 2 Circuit Low Voltage

#### DTC P0098

Intake Air Temperature (IAT) Sensor 2 Circuit High Voltage

### Diagnostic Fault Information

IAT Sensor 2

| Circuit                                                                   | Short to Ground | High Resistance | Open  | Short to Voltage | Signal Performance |
|---------------------------------------------------------------------------|-----------------|-----------------|-------|------------------|--------------------|
| IAT Sensor Signal 2                                                       | P0097           | P0096           | P0098 | P0098*           | P0096              |
| Low Reference                                                             | —               | P0096           | P0098 | —                | P0096              |
| *Internal ECM or sensor damage may occur if the circuit is shorted to B+. |                 |                 |       |                  |                    |

### Typical Scan Tool Data

IAT Sensor 2

| Circuit                                                                                                       | Short to Ground | Open or High Resistance | Short to Voltage |
|---------------------------------------------------------------------------------------------------------------|-----------------|-------------------------|------------------|
| <b>Operating Conditions:</b> Engine running<br><b>Parameter Normal Range:</b> Varies with ambient temperature |                 |                         |                  |
| IAT Sensor 2 Signal                                                                                           | 150°C (300°F)   | -40°C (-40°F)           | -40°C (-40°F)*   |
| Low Reference                                                                                                 | —               | -40°C (-40°F)           | -40°C (-40°F)*   |
| * Internal ECM or sensor damage may occur if the circuit is shorted to B+.                                    |                 |                         |                  |

### Circuit/System Description

The intake air temperature (IAT) sensor 2 is a variable resistor. The IAT sensor 2 has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air at the engine's intake manifold. The engine control module (ECM) supplies 5V to the IAT 2 signal

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circuit, and a ground for the IAT 2 low reference circuit. When the IAT sensor 2 is cold, the sensor resistance is high. When the intake manifold air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the IAT 2 signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the IAT 2 signal circuit. The ECM continuously monitors the IAT signal voltage for an excessively high or low voltage, or a voltage signal that is not in correlation with the mass air flow/ intake (MAF/IAT) sensor.

#### **Conditions for Running**

- The engine run has been in operation for greater than 10 s.
- The engine coolant temperature (ECT) is warmer than  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ).
- The vehicle speed is greater than 1 km/h (1 mph).
- The MAF is less than 512 g/s.
- DTC P0097 and P0098 run continuously within the enabling conditions.

#### **Conditions for Setting the DTC**

##### **P0097**

The IAT sensor 2 is warmer than  $148^{\circ}\text{C}$  ( $298^{\circ}\text{F}$ ) for greater than 5 s. This is equal to or less than 0.24 V on the IAT sensor 2 signal circuit as measured by the ECM for P0097.

##### **P0098**

The IAT sensor 2 is colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ) for greater than 5 s. This is equal to or greater than 4.86 V on the IAT signal circuit as measured by the ECM for P0098.

#### **Action Taken When the DTC Sets**

DTCs P0097 and P0098 are Type B DTCs.

#### **Conditions for Clearing the MIL/DTC**

DTCs P0097 and P0098 are Type B DTCs.

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End Views](#)

##### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

##### **Powertrain Component Views**

[Powertrain Component Views](#)

##### **DTC Type Definitions**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

##### **Scan Tool Reference**

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

### Circuit/System Verification

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

1. Ignition ON.
2. Verify the following scan tool parameters are within 15°C (27°F) of each other.
  - Start-Up IAT Sensor 1
  - IAT Sensor 2
  - Start-Up ECT

⇒ **If not within 15°C (27°F)**  
Refer to Circuit/System Testing.

⇓ **If within 15°C (27°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and +149°C (-36 and +300°F).
  - IAT Sensor 1
  - IAT Sensor 2
  - ECT Sensor

⇒ **If not between: -38 and +149°C (-36 and +300°F)**  
Refer to Circuit/System Testing.

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

⇒ **If any DTC sets**  
Refer to Circuit/System Testing.

⇓ **If no DTC sets**
6. All OK

### Circuit/System Testing

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

1. 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 IAT sensor 2.
2. Test for less than 2 Ω between the low reference circuit terminal B and ground.
 

⇒ **If 2 Ω or greater**

  - 2.1. Ignition OFF, disconnect the harness connector at the Engine Control Module.
  - 2.2. 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 Engine Control Module.

⇓ **If less than 2 Ω**
3. Ignition ON, test for 4.8–5.2 V between the intake air temperature signal 2 circuit terminal A and ground.
 

⇒ **If less than 4.8 V**

  - 3.1. Ignition OFF, disconnect the harness connector at the Engine Control Module.
  - 3.2. 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

3.3. Test for less than  $2\ \Omega$  in the signal circuit end to end.

⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than  $2\ \Omega$ , replace the 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.

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

3.2. 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 Engine Control Module.

↓ **If between 4.8–5.2 V**

4. Ignition ON, verify the scan tool IAT sensor 2 parameter is colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ).

⇒ **If not colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ).**

Replace the Engine Control Module.

↓ **If colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ).**

5. Ignition OFF. Install a 3 A fused jumper wire between the signal circuit terminal A and the low reference circuit terminal B.

6. Ignition ON. Verify the scan tool IAT sensor 2 parameter is warmer than  $130^{\circ}\text{C}$  ( $266^{\circ}\text{F}$ ).

⇒ **If not warmer than  $130^{\circ}\text{C}$  ( $266^{\circ}\text{F}$ ).**

Replace the Engine Control Module.

↓ **If warmer than  $130^{\circ}\text{C}$  ( $266^{\circ}\text{F}$ ).**

7. Test or replace IAT sensor 2.

### Component Testing

#### **IAT sensor 2**

1. Test the IAT sensor 2 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance](#) table. The resistance values should be in range of the table values.

⇒ **If not within the table values.**

Replace the IAT sensor 2.

↓ **If within the table values.**

2. All OK

### Repair Instructions

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

- [Intake Air Temperature Sensor Replacement](#) for IAT sensor 2 replacement.
- [Control Module References](#) for engine control module replacement, programming, and setup

## DTC P0101 (With Supercharger)

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P0101

Mass Air Flow (MAF) Sensor Performance

### Diagnostic Fault Information

| Circuit          | Short to Ground | High Resistance | Open  | Short to Voltage | Signal Performance  |
|------------------|-----------------|-----------------|-------|------------------|---------------------|
| Ignition Voltage | P0102           | P0101, P0102    | P0102 | —                | P0101, P0103        |
| Signal           | P0102           | P0102           | P0102 | P0102            | P0101, P0103, P1101 |
| Ground           | —               | P0102           | P0102 | —                | P0102               |

### Typical Scan Tool Data

#### MAF Sensor

| Circuit                                                                                                                      | Short to Ground | Open | Short to Voltage |
|------------------------------------------------------------------------------------------------------------------------------|-----------------|------|------------------|
| <b>Operating Conditions:</b> Engine running at various operating conditions<br><b>Parameter Normal Range:</b> 2,000–9,500 Hz |                 |      |                  |
| Ignition Voltage                                                                                                             | 0 Hz            | 0 Hz | —                |
| Signal                                                                                                                       | 0 Hz            | 0 Hz | 0 Hz             |
| Ground                                                                                                                       | —               | 0 Hz | —                |

### Circuit Description

**Note:** The following applies to the intake airflow system performance diagnostic that is used in this supercharged engine:

- When referring to the supercharger intake manifold models, the plenum volume between the throttle body and the supercharger is considered to be the intake manifold.
- When referring to engine pumping, the supercharger and the intercooler plenum are considered to be part of the engine.

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- The manifold absolute pressure (MAP) estimates are used in the engine air flow estimates. Air flow into the intake system must be the same as the air flow out of the intake system, the Intake Air Flow Rationality Diagnostics (IFRD) calculates air flowing out of the engine based on MAP estimates, volumetric efficiency, and RPM.

The engine control module (ECM) uses the following information to calculate an expected airflow rate:

- The throttle position (TP)
- The barometric pressure (BARO)
- The manifold absolute pressure (MAP)
- The intake air temperature (IAT)
- The supercharger inlet absolute pressure (SCIAP)
- The intake air temperature (IAT) sensor 2
- The engine RPM

The intake airflow system performance diagnostic provides the within-range rationality check for the mass air flow (MAF), supercharger inlet absolute pressure (SCIAP), MAP, by-pass valve stuck, and the throttle position (TP) sensors. This is an explicit model-based diagnostic containing separate models for the intake system.

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

#### **Conditions for Running the DTC**

- DTCs P0096, P0097, P0098, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P012C, P012D, P0335, P0336, P0401, P0405, P1404, P2226, P2227, P2228 are not set.
- The engine speed is between 450–6,500 RPM.
- The intake air temperature is between  $-20$  and  $+125^{\circ}\text{C}$  ( $-4$  and  $+257^{\circ}\text{F}$ ).
- The engine coolant temperature is between  $-20$  and  $+125^{\circ}\text{C}$  ( $-4$  and  $+257^{\circ}\text{F}$ ).
- This DTC runs continuously when the above enabling conditions are met.

#### **Conditions for Setting the DTC**

The engine control module (ECM) detects that the actual measured airflow from the MAF, MAP, SC Inlet Pressure, and the TP sensors are not within a range of the calculated airflow that are derived from the system of models by greater than a calibrated threshold for greater than 10 s.

#### **Action Taken When the DTC Sets**

DTC P0101 is a Type B DTC.

#### **Conditions for Clearing the MIL/DTC**

DTC P0101 is a Type B DTC.

#### **Diagnostic Aids**

Inspect for the following conditions that may set this DTC:

- Any condition that can cause the MAF, MAP, SCIAP, and TP sensors to be shifted in value.
- A steady or intermittent high resistance of  $15\ \Omega$  or greater on the ignition voltage circuit will cause the MAF sensor signal to be increased by as much as 60 g/s. To pinpoint this condition perform a voltage drop test on the circuit.
- Any type of contamination on the MAF sensor heating elements will degrade the proper operation of the sensor. Certain types of contaminants act as a heat insulator, which will



impair the response of the sensor to airflow changes. Water or snow can create the opposite effect, and cause the signal to increase rapidly.

- Depending on the current ambient temperature, and the vehicle operating conditions, a MAF sensor signal circuit that is shorted to the IAT signal circuit will increase or decrease the MAF sensor signal that is interpreted by the ECM. Additionally it may cause a rapid fluctuation in the IAT Sensor parameter.
- A skewed or stuck engine coolant temperature (ECT) or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to [Temperature Versus Resistance](#).
- Certain aftermarket air filters may cause this DTC to set.
- Certain aftermarket air induction systems may cause this DTC to set.
- Modifications to the air induction system may cause this DTC to set.

## **[Reference Information](#)**

### **Schematic Reference**

[Engine Controls Schematics](#)

### **Connector End View Reference**

[Component Connector End Views](#)

### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

### **Powertrain Component Views**

[Powertrain Component Views](#)

### **Scan Tool Reference**

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

### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

### **Special Tools**

EL-38522-A Variable Signal Generator

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

## **[Circuit/System Verification](#)**

1. Ignition ON, verify that DTC P0641 or P0651 is not set.  
⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.
- ↓ **If the none of the DTCs are set**
2. If you were sent here from DTC P0068, P0106, P0121, P012B, or P1101 refer to Circuit/System Testing.
3. Ignition ON, verify the scan tool TB Idle Air Flow Compensation parameter is less than 90 %..  
⇒ **90 % or greater**  
Refer to [Throttle Body Cleaning](#).

- ↓ **If less than 90 %**
4. Verify the scan tool TP Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
- ⇒ **If Disagree**  
Refer to [DTC P0120-P0123, P0220, P0222, P0223, or P2135](#) for further diagnosis.
- ↓ **If Agree**
5. Determine the current vehicle testing altitude.
  6. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.
- ⇒ **The MAP Sensor pressure is not in range**  
Refer to [DTC P0106](#) for further diagnosis.
- ↓ **The MAP Sensor pressure is within range**
7. Verify the scan tool SC Inlet Pressure Sensor pressure parameter is within range specified in the [Altitude Versus Barometric Pressure](#) table.
- ⇒ **The SC Inlet Pressure Sensor pressure is not in range**  
Refer to [DTC P012B](#) for further diagnosis.
- ↓ **The SC Inlet Pressure Sensor pressure is within range**
8. Verify the SC Inlet Pressure Sensor pressure parameter decreases after starting the engine.
- ⇒ **The SC Inlet Pressure Sensor pressure did not decrease**  
Refer to [DTC P012B](#) for further diagnosis.
- ↓ **The SC Inlet Pressure Sensor pressure decrease**
9. Verify the scan tool MAP Sensor pressure parameter is between 26–52 kPa (3.8–7.5 PSI) and changes with accelerator pedal input.
- ⇒ **If not between 26–52 kPa (3.8–7.5 PSI) or does not change**  
Refer to [DTC P0106](#) for further diagnosis.
- ↓ **If between 26–52 kPa (3.8–7.5 PSI) and changes**
10. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
    - 10.1. Engine idling
    - 10.2. Perform the scan tool snapshot function.
    - 10.3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
    - 10.4. Exit from the scan tool snapshot and review the data.
    - 10.5. Observe the MAF Sensor parameter frame by frame with a scan tool.
- ⇒ **The MAF Sensor parameter does not change smoothly and gradually**  
Refer to Circuit/System Testing.
- ↓ **The MAF Sensor parameter changes smoothly and gradually**
11. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
  12. Verify the DTC does not set.
- ⇒ **If the DTC sets**  
Refer to Circuit/System Testing.
- ↓ **If the DTC does not set**
13. All OK

#### [Circuit/System Testing](#)

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

1. Visually and physically inspect the by-pass valve and linkage for a binding or sticking condition when opening or closing.
  - ⇒ If any of the above conditions are found, refer to [Supercharger Cleaning and Inspection](#).
2. Verify the integrity of the entire supercharger and entire air induction system by inspecting for the following conditions:
  - Loose clamps, cracks, or other damage in the air intake duct system
  - Splits, kinks or improper connections at the vacuum hoses
  - Vacuum leaks at the intake manifold and throttle body
  - A dirty, restricted, or deteriorating air filter element
  - A leaking, loose, disconnected, or cracked positive crankcase ventilation valve, pipe, or seal
  - A collapsed, restricted, or collapsed air intake duct
  - A misaligned or damaged air intake duct
  - Any objects blocking the air inlet probe of the MAF/IAT sensor
  - Any contamination or debris on the sensing elements in the probe of the MAF/IAT sensor
  - A cracked or damaged MAF sensor housing
  - Any water intrusion in the induction system
  - Any snow or ice build-up at the air cleaner, MAF or MAP sensors in cold climates
  - Any intake manifold leak
  - A MAP sensor seal that is leaking, missing, or damaged
  - Improperly installed components
  - A SCRAP sensor vacuum hose that is missing or damaged
  - An Intake Manifold Resonator with a leaking seal, or a cracked or broken housing
  - ⇒ **If a condition exists**  
Repair or replace component as appropriate.
  - ↓ **No condition found**
3. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow /Intake Air Temperature sensor.
4. Test for less than 2  $\Omega$  between the ground circuit terminal B and ground.
  - ⇒ **If 2  $\Omega$  or greater**
    - 4.1. Ignition OFF.
    - 4.2. Test for less than 2  $\Omega$  in the ground circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , repair the open/high resistance in the ground connection.
  - ↓ **If less than 2  $\Omega$**
5. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal C and ground.
  - ⇒ **If the test lamp does not illuminate and the circuit fuse is good**
    - 5.1. Ignition OFF.
    - 5.2. Test for less than 2  $\Omega$  in the ignition voltage circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , verify the fuse is not open and there is voltage at the fuse.
  - ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
    - 5.1. Ignition OFF.
    - 5.2. 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

5.3. Test for greater than  $2\ \Omega$  between the ignition voltage circuit terminal C and ground.

⇒ If less than  $2\ \Omega$ , repair the short to ground on the circuit.

⇒ If greater than  $2\ \Omega$ , test all the components connected to the circuit and repair or replace as necessary.

⇓ **If the test lamp illuminates**

6. Ignition ON, test for 4.8–5.2 volts between the signal circuit terminal A and ground.

⇒ **If less than 4.8 V**

6.1. Ignition OFF, disconnect the harness connector at the engine control module.

6.2. 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

6.3. Test for less than  $2\ \Omega$  in the signal circuit end to end.

⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than  $2\ \Omega$ , replace the engine control module.

⇒ **If greater than 5.2 V**

6.1. Ignition OFF, disconnect the harness connector at the engine control module, ignition ON.

6.2. 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 engine control module.

⇓ **If between 4.8–5.2 V**

7. Determine if *EL-38522-A* Variable Signal Generator or equivalent is available.

⇒ **EL-38522-A, Variable Signal Generator; or equivalent is not available**

7.1. Replace the K20 Engine Control Module.

7.2. 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.

7.3. Verify the DTC does not set.

⇒ **If the DTC sets**

Refer to step 11.

⇓ **If the DTC does not set**

7.4. All OK.

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

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

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

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

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

10. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950–5,050 Hz.

⇒ **If not between 4,950–5,050 Hz.**

Replace the K20 Engine Control Module.

↓ **If between 4,950–5,050 Hz.**

11. Test or replace the B75B Mass Air Flow /Intake Air Temperature sensor.

### **Repair Instructions**

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

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

## DTC P0101 (Without Supercharger)

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P0101

Mass Air Flow (MAF) Sensor Performance

### Diagnostic Fault Information

| Circuit          | Short to Ground | High Resistance | Open  | Short to Voltage | Signal Performance  |
|------------------|-----------------|-----------------|-------|------------------|---------------------|
| Ignition Voltage | P0102           | P0101, P0102    | P0102 | —                | P0101, P0103        |
| Signal           | P0102           | P0102           | P0102 | P0102            | P0101, P0103, P1101 |
| Ground           | —               | P0102           | P0102 | —                | P0102               |

### Typical Scan Tool Data

#### MAF Sensor

| Circuit                                                                                                                      | Short to Ground | Open | Short to Voltage |
|------------------------------------------------------------------------------------------------------------------------------|-----------------|------|------------------|
| <b>Operating Conditions:</b> Engine running at various operating conditions<br><b>Parameter Normal Range:</b> 2,000–9,500 Hz |                 |      |                  |
| Ignition Voltage                                                                                                             | 0 Hz            | 0 Hz | —                |
| Signal                                                                                                                       | 0 Hz            | 0 Hz | 0 Hz             |
| Ground                                                                                                                       | —               | 0 Hz | —                |

### Circuit Description

The engine control module (ECM) uses the following information to calculate an expected airflow rate:

- The throttle position (TP)
- The barometric pressure (BARO)
- The manifold absolute pressure (MAP)
- The intake air temperature (IAT)

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- The engine RPM

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

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

#### **Conditions for Running the DTC**

- DTCs P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0335, P0336 are not set.
- The engine speed is between 450–8,000 RPM.
- The intake air temperature is between  $-20$  and  $+125^{\circ}\text{C}$  ( $-4$  and  $+257^{\circ}\text{F}$ ).
- The engine coolant temperature is between  $-20$  and  $+125^{\circ}\text{C}$  ( $-4$  and  $+257^{\circ}\text{F}$ ).
- This DTC runs continuously when the above conditions are met.

#### **Conditions for Setting the DTC**

The engine control module (ECM) detects that the actual measured airflow from the MAF, MAP, and TP sensors is not within range of the calculated airflow that is derived from the system of models for more than 0.5 s.

#### **Action Taken When the DTC Sets**

DTC P0101 is Type B DTC.

#### **Conditions for Clearing the MIL/DTC**

DTC P0101 is Type B DTC.

#### **Diagnostic Aids**

- A steady or intermittent high resistance of  $15\ \Omega$  or greater on the ignition voltage circuit will cause the MAF sensor signal to be increased by as much as 60 g/s. To pinpoint this condition perform a voltage drop test on the circuit.
- Any type of contamination on the MAF sensor heating elements will degrade the proper operation of the sensor. Certain types of contaminants act as a heat insulator, which will impair the response of the sensor to airflow changes. Water or snow can create the opposite effect, and cause the signal to increase rapidly.
- Depending on the current ambient temperature, and the vehicle operating conditions, a MAF sensor signal circuit that is shorted to the IAT signal circuit will increase or decrease the MAF sensor signal that is interpreted by the ECM. Additionally it may cause a rapid fluctuation in the IAT Sensor parameter.
- A skewed or stuck engine coolant temperature (ECT) or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to [Temperature Versus Resistance](#).
- Certain aftermarket air filters may cause this DTC to set.
- Certain aftermarket air induction systems may cause this DTC to set.
- Modifications to the air induction system may cause this DTC to set.

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End Views](#)

## Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

## Powertrain Component Views

[Powertrain Component Views](#)

## DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

## Scan Tool Reference

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

## Special Tools

EL-38522-A Variable Signal Generator

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

## Circuit/System Verification

1. Ignition ON, verify that DTC P0641 or P0651 is not set.  
⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.  
↓ **If the none of the DTCs are set**
2. If you were sent here from DTC P0068, P0106, P0121, or P1101 refer to Circuit/System Testing.
3. Ignition ON, verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90 %..  
⇒ **90 % or greater**  
Refer to [Throttle Body Cleaning](#).  
↓ **If less than 90 %**
4. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.  
⇒ **If Disagree**  
Refer to [DTC P0120-P0123, P0220, P0222, P0223, or P2135](#) for further diagnosis.  
↓ **If Agree**
5. Determine the current vehicle testing altitude.
6. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.  
⇒ **The MAP Sensor pressure is not in range**  
Refer to [DTC P0106](#) for further diagnosis.  
↓ **The MAP Sensor pressure is within range**
7. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 26–52 kPa (3.8–7.5 PSI) and changes with accelerator pedal input.  
⇒ **If not between 26–52 kPa (3.8–7.5 PSI) or does not change**  
Refer to [DTC P0106](#) for further diagnosis.  
↓ **If between 26–52 kPa (3.8–7.5 PSI) and changes**
8. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.



- 8.1. Engine idling
  - 8.2. Perform the scan tool snapshot function.
  - 8.3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
  - 8.4. Exit from the scan tool snapshot and review the data.
  - 8.5. Observe the MAF Sensor parameter frame by frame with a scan tool.
- ⇒ **The MAF Sensor parameter does not change smoothly and gradually**  
Refer to Circuit/System Testing.
- ↓ **The MAF Sensor parameter changes smoothly and gradually**
9. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
  10. Verify the DTC does not set.
- ⇒ **If the DTC sets**  
Refer to Circuit/System Testing.
- ↓ **If the DTC does not set**
11. All OK

### Circuit/System Testing

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

1. Verify the integrity of the entire air induction system by inspecting for the following conditions:
    - Loose clamps, cracks, or other damage in the air intake duct system
    - Splits, kinks or improper connections at the vacuum hoses
    - Vacuum leaks at the intake manifold and throttle body
    - A dirty, restricted, or deteriorating air filter element
    - A leaking, loose, disconnected, or cracked positive crankcase ventilation valve, pipe, or seal
    - A collapsed, restricted, or collapsed air intake duct
    - A misaligned or damaged air intake duct
    - Any objects blocking the air inlet probe of the MAF/IAT sensor
    - Any contamination or debris on the sensing elements in the probe of the MAF/IAT sensor
    - A cracked or damaged MAF sensor housing
    - Any water intrusion in the induction system
    - Any snow or ice build-up at the air cleaner, MAF or MAP sensors in cold climates
    - Any intake manifold leak
    - A MAP sensor seal that is leaking, missing, or damaged
    - Improperly installed components
    - An Intake Manifold Resonator with a leaking seal, or a cracked or broken housing
- ⇒ **If a condition is found**  
Repair or replace component as appropriate.
- ↓ **No condition found**
2. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow /Intake Air Temperature sensor.
  3. Test for less than 2  $\Omega$  between the ground circuit terminal C and ground.
- ⇒ **If 2  $\Omega$  or greater**

- 3.1. Ignition OFF.
- 3.2. Test for less than  $2\ \Omega$  in the ground circuit end to end.
  - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than  $2\ \Omega$ , repair the open/high resistance in the ground connection.
- ⇓ **If less than  $2\ \Omega$**
- 4. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal B and ground.
  - ⇒ **If the test lamp does not illuminate and the circuit fuse is good**
    - 4.1. Ignition OFF.
    - 4.2. Test for less than  $2\ \Omega$  in the ignition voltage circuit end to end.
      - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than  $2\ \Omega$ , verify the fuse is not open and there is voltage at the fuse.
  - ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
    - 4.1. Ignition OFF.
    - 4.2. 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
    - 4.3. Test for greater than  $2\ \Omega$  between the ignition voltage circuit terminal B and ground.
      - ⇒ If less than  $2\ \Omega$ , repair the short to ground on the circuit.
      - ⇒ If greater than  $2\ \Omega$ , test all the components connected to the circuit and repair or replace as necessary.
- ⇓ **If the test lamp illuminates**
- 5. Ignition ON, test for 4.8–5.2 volts between the signal circuit terminal A and ground.
  - ⇒ **If less than 4.8 V**
    - 5.1. Ignition OFF, disconnect the harness connector at the engine control module.
    - 5.2. 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
    - 5.3. Test for less than  $2\ \Omega$  in the signal circuit end to end.
      - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than  $2\ \Omega$ , replace the engine control module.
  - ⇒ **If greater than 5.2 V**
    - 5.1. Ignition OFF, disconnect the harness connector at the engine control module, ignition ON.
    - 5.2. 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 engine control module.
- ⇓ **If between 4.8–5.2 V**
- 6. Determine if EL-38522-A Variable Signal Generator or equivalent is available.
  - ⇒ **EL-38522-A, Variable Signal Generator; or equivalent is not available**
    - 6.1. Test or replace the B75B Mass Air Flow /Intake Air Temperature sensor.
    - 6.2. 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.
    - 6.3. Verify the DTC does not set.
      - ⇒ **If the DTC sets**

Replace the K20 Engine Control Module.

↓ **If the DTC does not set**

6.4. All OK.

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

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

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

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

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

9. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950–5,050 Hz.

⇒ **If not between 4,950–5,050 Hz.**

Replace the K20 Engine Control Module.

↓ **If between 4,950–5,050 Hz.**

10. Test or replace the B75B Mass Air Flow /Intake Air Temperature sensor.

### **Repair Instructions**

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

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

## DTC P0102 or P0103 (Without Supercharger)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0102

Mass Air Flow (MAF) Sensor Circuit Low Frequency

#### DTC P0103

Mass Air Flow (MAF) Sensor Circuit High Frequency

### Diagnostic Fault Information

| Circuit          | Short to Ground | High Resistance | Open  | Short to Voltage | Signal Performance  |
|------------------|-----------------|-----------------|-------|------------------|---------------------|
| Ignition Voltage | P0102           | P0101, P0102    | P0102 | —                | P0101, P0103        |
| Signal           | P0102           | P0102           | P0102 | P0102            | P0101, P0103, P1101 |
| Ground           | —               | P0102           | P0102 | —                | P0102               |

### Typical Scan Tool Data

#### MAF Sensor

| Circuit                                                                                                                      | Short to Ground | Open | Short to Voltage |
|------------------------------------------------------------------------------------------------------------------------------|-----------------|------|------------------|
| <b>Operating Conditions:</b> Engine running at various operating conditions<br><b>Parameter Normal Range:</b> 2,000–9,500 Hz |                 |      |                  |
| Ignition Voltage                                                                                                             | 0 Hz            | 0 Hz | —                |
| Signal                                                                                                                       | 0 Hz            | 0 Hz | 0 Hz             |
| Ground                                                                                                                       | —               | 0 Hz | —                |

### Circuit/System Description

The mass air flow (MAF) sensor is integrated with the intake air temperature (IAT) sensor. The MAF sensor is an air flow meter that measures the amount of air entering the engine. 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

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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 frequency based on the inlet air flow through the sensor bore. The frequency varies within a range of near 2,000 Hertz at idle to near 9,500 Hertz at maximum engine load.

#### **Conditions for Running the DTC**

- The engine is running for greater than 1 s.
- The engine speed is greater than 300 RPM.
- The ignition 1 signal is greater than 9 V.
- The above conditions are met for greater than 1 s.
- These DTCs run continuously when the above conditions are met.

#### **Conditions for Setting the DTC**

##### **P0102**

The ECM detects that the MAF Sensor parameter is less than 1,500 Hz for greater than 5 s.

##### **P0103**

The ECM detects that the MAF Sensor parameter is greater than 14,500 Hz for greater than 5 s.

#### **Action Taken When the DTC Sets**

DTCs P0102 and P0103 are Type B DTCs.

#### **Conditions for Clearing the MIL/DTC**

DTCs P0102 and P0103 are Type B DTCs.

#### **Diagnostic Aids**

- Verify the integrity of the air induction system by inspecting for the following conditions:
  - Any water intrusion in the induction system
  - Any contamination or debris on the sensing elements of the MAF sensor
  - Damaged components
- Verify that any electrical aftermarket devices are properly connected and grounded. Refer to [Checking Aftermarket Accessories](#).

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End Views](#)

##### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

##### **Powertrain Component Views**

[Powertrain Component Views](#)**DTC Type Reference**[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)**Scan Tool Reference**

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

**Special Tools**

EL-38522-A Variable Signal Generator

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

**[Circuit/System Verification](#)**

1. Ignition ON, verify that DTC P0641 or P0651 is not set.
  - ⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.
  - ↓ **If the none of the DTCs are set**
2. Ignition ON, 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.
  - 2.1. Engine idling
  - 2.2. Perform the scan tool snapshot function.
  - 2.3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
  - 2.4. Exit from the scan tool snapshot and review the data.
  - 2.5. Observe the MAF Sensor parameter frame by frame with a scan tool.
  - ⇒ **The MAF Sensor parameter does not change smoothly and gradually**  
Refer to Circuit/System Testing.
  - ↓ **The MAF Sensor parameter changes smoothly and gradually**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
  - ⇒ **If the DTC sets**  
Refer to Circuit/System Testing.
  - ↓ **If the DTC does not set**
5. All OK

**[Circuit/System Testing](#)**

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

1. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow /Intake Air Temperature sensor.
2. Test for less than 2  $\Omega$  between the ground circuit terminal C and ground.
  - ⇒ **If 2  $\Omega$  or greater**
    - 2.1. Ignition OFF.
    - 2.2. Test for less than 2  $\Omega$  in the ground circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , repair the open/high resistance in the ground connection.

↓ **If less than 2 Ω**

3. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal B and ground.

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

3.1. Ignition OFF.

3.2. 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**

3.1. Ignition OFF.

3.2. 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

3.3. Test for greater than 2 Ω between the ignition voltage circuit terminal B and ground.

⇒ If less than 2 Ω, repair the short to ground on the circuit.

⇒ If greater than 2 Ω, test all the components connected to the circuit and repair or replace as necessary.

↓ **If the test lamp illuminates**

4. Ignition ON, test for 4.8–5.2 volts between the signal circuit terminal A and ground.

⇒ **If less than 4.8 V**

4.1. Ignition OFF, disconnect the harness connector at the engine control module.

4.2. 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

4.3. 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 engine control module.

⇒ **If greater than 5.2 V**

4.1. Ignition OFF, disconnect the harness connector at the engine control module, ignition ON.

4.2. 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 engine control module.

↓ **If between 4.8–5.2 V**

5. Determine if EL-38522-A Variable Signal Generator or equivalent is available.

⇒ **EL-38522-A, Variable Signal Generator; or equivalent is not available**

5.1. Test or replace the B75B Mass Air Flow /Intake Air Temperature sensor.

5.2. 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.

5.3. Verify the DTC does not set.

⇒ **If the DTC sets**

Replace the K20 Engine Control Module.

↓ **If the DTC does not set**

5.4. All OK.

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

6. Ignition OFF, connect the leads of the *EL-38522-A* Variable Signal Generator as follows:
  - Red lead to the signal circuit terminal A at the harness connector
  - Black leads to ground
  - Battery voltage supply lead to B+
7. Set the *EL-38522-A* Variable Signal Generator to the following specifications.
  - Signal switch to 5 V
  - Frequency switch to 5 kHz
  - Duty Cycle switch to 50 % (Normal)
8. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950–5,050 Hz.
  - ⇒ **If not between 4,950–5,050 Hz.**  
Replace the K20 Engine Control Module.
  - ↓ **If between 4,950–5,050 Hz.**
9. Test or replace the B75B Mass Air Flow /Intake Air Temperature sensor.

### **Repair Instructions**

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

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



## DTC P0102 or P0103 (With Supercharger)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0102

Mass Air Flow (MAF) Sensor Circuit Low Frequency

#### DTC P0103

Mass Air Flow (MAF) Sensor Circuit High Frequency

### Diagnostic Fault Information

| Circuit          | Short to Ground | High Resistance | Open  | Short to Voltage | Signal Performance  |
|------------------|-----------------|-----------------|-------|------------------|---------------------|
| Ignition Voltage | P0102           | P0101, P0102    | P0102 | —                | P0101, P0103        |
| Signal           | P0102           | P0102           | P0102 | P0102            | P0101, P0103, P1101 |
| Ground           | —               | P0102           | P0102 | —                | P0102               |

### Typical Scan Tool Data

#### MAF Sensor

| Circuit                                                                                                                      | Short to Ground | Open | Short to Voltage |
|------------------------------------------------------------------------------------------------------------------------------|-----------------|------|------------------|
| <b>Operating Conditions:</b> Engine running at various operating conditions<br><b>Parameter Normal Range:</b> 2,000–9,500 Hz |                 |      |                  |
| Ignition Voltage                                                                                                             | 0 Hz            | 0 Hz | —                |
| Signal                                                                                                                       | 0 Hz            | 0 Hz | 0 Hz             |
| Ground                                                                                                                       | —               | 0 Hz | —                |

### Circuit/System Description

The mass air flow (MAF) sensor is integrated with the intake air temperature (IAT) sensor. The MAF sensor is an air flow meter that measures the amount of air entering the engine. 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

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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 frequency based on the inlet air flow through the sensor bore. The frequency varies within a range of near 2,000 Hertz at idle to near 9,500 Hertz at maximum engine load.

#### **Conditions for Running the DTC**

- The engine is running for greater than 1 s.
- The engine speed is greater than 300 RPM.
- The ignition 1 signal is greater than 9 V.
- The above conditions are met for greater than 1 s.
- These DTCs run continuously when the above conditions are met.

#### **Conditions for Setting the DTC**

##### **P0102**

The ECM detects that the MAF Sensor parameter is less than 1,500 Hz for greater than 5 s.

##### **P0103**

The ECM detects that the MAF Sensor parameter is greater than 14,500 Hz for greater than 5 s.

#### **Action Taken When the DTC Sets**

DTCs P0102 and P0103 are Type B DTCs.

#### **Conditions for Clearing the MIL/DTC**

DTCs P0102 and P0103 are Type B DTCs.

#### **Diagnostic Aids**

- Verify the integrity of the air induction system by inspecting for the following conditions:
  - Any water intrusion in the induction system
  - Any contamination or debris on the sensing elements of the MAF sensor
  - Damaged components
- Verify that any electrical aftermarket devices are properly connected and grounded. Refer to [Checking Aftermarket Accessories](#).

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

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[Component Connector End Views](#)

##### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

##### **Powertrain Component Views**

[Powertrain Component Views](#)**DTC Type Reference**[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)**Scan Tool Reference**

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

**Special Tools**

EL-38522-A Variable Signal Generator

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

**[Circuit/System Verification](#)**

1. Ignition ON, verify that DTC P0641 or P0651 is not set.
  - ⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.
  - ⇓ **If the none of the DTCs are set**
2. Ignition ON, 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.
  - 2.1. Engine idling
  - 2.2. Perform the scan tool snapshot function.
  - 2.3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
  - 2.4. Exit from the scan tool snapshot and review the data.
  - 2.5. Observe the MAF Sensor parameter frame by frame with a scan tool.
  - ⇒ **The MAF Sensor parameter does not change smoothly and gradually**  
Refer to Circuit/System Testing.
  - ⇓ **The MAF Sensor parameter changes smoothly and gradually**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
  - ⇒ **If the DTC sets**  
Refer to Circuit/System Testing.
  - ⇓ **If the DTC does not set**
5. All OK

**[Circuit/System Testing](#)**

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

1. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow /Intake Air Temperature sensor.
2. Test for less than 2  $\Omega$  between the ground circuit terminal B and ground.
  - ⇒ **If 2  $\Omega$  or greater**
    - 2.1. Ignition OFF.
    - 2.2. Test for less than 2  $\Omega$  in the ground circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , repair the open/high resistance in the ground connection.

↓ **If less than 2  $\Omega$**

3. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal C and ground.

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

3.1. Ignition OFF.

3.2. Test for less than 2  $\Omega$  in the ignition voltage circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , verify the fuse is not open and there is voltage at the fuse.

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

3.1. Ignition OFF.

3.2. 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

3.3. Test for greater than 2  $\Omega$  between the ignition voltage circuit terminal C and ground.

⇒ If less than 2  $\Omega$ , repair the short to ground on the circuit.

⇒ If greater than 2  $\Omega$ , test all the components connected to the circuit and repair or replace as necessary.

↓ **If the test lamp illuminates**

4. Ignition ON, test for 4.8–5.2 volts between the signal circuit terminal A and ground.

⇒ **If less than 4.8 V**

4.1. Ignition OFF, disconnect the harness connector at the engine control module.

4.2. 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

4.3. Test for less than 2  $\Omega$  in the signal circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the engine control module.

⇒ **If greater than 5.2 V**

4.1. Ignition OFF, disconnect the harness connector at the engine control module, ignition ON.

4.2. 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 engine control module.

↓ **If between 4.8–5.2 V**

5. Determine if EL-38522-A Variable Signal Generator or equivalent is available.

⇒ **EL-38522-A, Variable Signal Generator; or equivalent is not available**

5.1. Replace the K20 Engine Control Module.

5.2. 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.

5.3. Verify the DTC does not set.

⇒ **If the DTC sets**

Refer to step 9.

↓ **If the DTC does not set**

5.4. All OK.

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

6. Ignition OFF, connect the leads of the *EL-38522-A* Variable Signal Generator as follows:
  - Red lead to the signal circuit terminal A at the harness connector
  - Black leads to ground
  - Battery voltage supply lead to B+
7. Set the *EL-38522-A* Variable Signal Generator to the following specifications.
  - Signal switch to 5 V
  - Frequency switch to 5 kHz
  - Duty Cycle switch to 50 % (Normal)
8. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950–5,050 Hz.
  - ⇒ **If not between 4,950–5,050 Hz.**  
Replace the K20 Engine Control Module.
  - ↓ **If between 4,950–5,050 Hz.**
9. Test or replace the B75B Mass Air Flow /Intake Air Temperature sensor.

### **Repair Instructions**

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

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

## DTC P0106

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P0106

Manifold Absolute Pressure (MAP) Sensor Performance

### Diagnostic Fault Information

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

### Typical Scan Tool Data

#### MAP Sensor

| Circuits                                                                                                                                                       | Short to Ground | Open                       | Short to Voltage    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------|---------------------|
| <b>Operating Conditions:</b> Engine running at various operating conditions<br><b>Parameter Normal Range:</b> 12–103 kPa (1.7–14.9 PSI) (Varies with altitude) |                 |                            |                     |
| 5 V Reference                                                                                                                                                  | 0 kPa (0 PSI)   | 0 kPa (0 PSI)              | 128 kPa (18.6 PSI)  |
| Signal                                                                                                                                                         | 0 kPa (0 PSI)   | 0 kPa (0 PSI)              | 128 kPa (18.6 PSI)* |
| Low Reference                                                                                                                                                  | —               | 80–128 kPa (11.6–18.6 PSI) | —                   |
| * Internal ECM or sensor damage may occur if the circuit is shorted to B+.                                                                                     |                 |                            |                     |

**MAP Sensor, if equipped with Turbocharger**

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

**Circuit/System Description**

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

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

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

**Conditions for Running the DTC**

- DTCs P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0125, P0128, P0335, P0336, P0401, or P042E are not set
- The engine speed is between 450–5400 RPM.
- The engine coolant temperature (ECT) sensor is between  $-7-129^{\circ}\text{C}$  ( $19-264^{\circ}\text{F}$ ).
- The intake air temperature (IAT) sensor is between  $-20-129^{\circ}\text{C}$  ( $-4-264^{\circ}\text{F}$ ).
- This DTC runs continuously when the above conditions are met.

**Conditions for Setting the DTC**

The ECM determines if the MAP Sensor is stuck within the normal operating range. It accomplishes this by running 3 different models within the software to determine the values.

**Action Taken When the DTC Sets**

DTC P0106 is a Type B DTC.

**Conditions for Clearing the DTC**

DTC P0106 is a Type B DTC.

## Reference Information

### Schematic Reference

[Engine Controls Schematics](#)

### Connector End View Reference

[Component Connector End Views](#)

### Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

### DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

### Scan Tool Reference

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

### Special Tools

GE-23738-A Vacuum Pump

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

## Circuit/System Verification

1. Ignition ON, verify that DTC P0641 or P0651 is not set.  
⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.  
↓ **If none of the DTCs are set**
2. If you were sent here from DTC P0068, P0101, P0121, or P1101; refer to Circuit/System Testing.
3. Ignition ON, verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90 %  
⇒ **If 90 % or greater**  
Refer to [Throttle Body Cleaning](#) for this publication.  
↓ **If less than 90 %**
4. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.  
⇒ **If Disagree**  
Refer to [DTC P0120-P0123, P0220, P0222, P0223, or P2135](#) for further diagnosis.  
↓ **If Agree**
5. Determine the current vehicle testing altitude.
6. Verify the scan tool MAP Sensor parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.  
⇒ **If the MAP Sensor parameter is not in range**  
Refer to Circuit/System Testing.  
↓ **If the MAP Sensor parameter is within range**



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

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

Refer to Circuit/System Testing.

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

8. Verify the scan tool MAF Sensor parameter g/s changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
  - 8.1. Engine idling
  - 8.2. Perform the scan tool snapshot function.
  - 8.3. Increase the engine speed slowly to 3000 RPM and then back to idle.
  - 8.4. Exit from the scan tool snapshot and review the data.
  - 8.5. Observe the MAF Sensor parameter frame by frame with a scan tool.
- ⇒ **If the MAF Sensor parameter does not change smoothly and gradually**  
Refer to [DTC P0101](#) or [DTC P0068 or P1101](#) for further diagnosis.
- ⇓ **If the MAF Sensor parameter changes smoothly and gradually**
9. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
10. Verify the DTC does not set.
  - ⇒ **If the DTC sets**  
Refer to Circuit/System Testing.
  - ⇓ **If the DTC does not set**
11. All OK.

### Circuit/System Testing

1. Verify the integrity of the entire air induction system and verify that none of the following conditions exist:
  - Any damaged components
  - Improper operation of turbocharger wastegate actuator or bypass valve, if equipped
  - Loose or improper installation of the turbocharger and the charge air cooler, including the flexible ductwork, if equipped
  - An air flow restriction
  - Any vacuum leak
  - Improperly routed vacuum hoses
  - In cold climates, inspect for any snow or ice buildup at the BARO port on the ECM, if equipped
  - A restriction in the MAP Sensor port or the BARO port, if equipped
  - Proper operation of the Positive Crankcase Ventilation (PCV) system
  - Missing, restricted or leaking exhaust components. Refer to [Restricted Exhaust](#).
  - Engine mechanical condition, for example: low compression or incorrect timing chain installation. Refer to [Symptoms - Engine Mechanical](#)
- ⇒ **If a condition is found**  
Repair or replace the component as appropriate.
- ⇓ **If no condition is found**
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down. Disconnect the B74 Manifold Absolute Pressure Sensor.
3. Test for less than 2  $\Omega$  between the low reference circuit terminal 2 and ground.
  - ⇒ **If 2  $\Omega$  or greater**

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

↓ **If less than  $2\ \Omega$**

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

⇒ **If less than 4.8 V**

- 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
- 4.2. 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
- 4.3. Test for less than  $2\ \Omega$  in the 5 V reference circuit end to end.
  - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than  $2\ \Omega$ , replace the K20 Engine Control Module.

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

⇒ **If greater than 5.2 V**

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

↓ **If between 4.8–5.2 V**

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

⇒ **If 0.5 V or greater**

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

↓ **If less than 0.5 V**

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

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

⇒ **If 4.5 V or less**

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

↓ **If greater than 4.5 V**

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

### **Component Testing**

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

**Skewed Sensor Test**

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply 17 kPa (5.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the GE-23738-A. Verify the scan tool MAP Sensor pressure parameter decreases between 13–21 kPa (1.8–3.0 PSI).
  - ⇒ **If the parameter does not decrease between 13–21 kPa (1.8–3.0 PSI)**  
Replace the B74 Manifold Absolute Pressure Sensor.
  - ⇓ **If the parameter does decrease between 13–21 kPa (1.8–3.0 PSI)**
3. Apply 34 kPa (10.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the GE-23738-A. Verify the scan tool MAP Sensor pressure parameter decreases between 30–38 kPa (4.4–5.5 PSI).
  - ⇒ **If the parameter does not decrease between 30–38 kPa (4.4–5.5 PSI)**  
Replace the B74 Manifold Absolute Pressure Sensor.
  - ⇓ **If the parameter does decrease between 30–38 kPa (4.4–5.5 PSI)**
4. All OK.

**Erratic Signal Test**

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 2 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 3 of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply between 0–15 kPa (0–4.4 in Hg) of vacuum to the sensor with the GE-23738-A.
7. Verify the voltage changes, without any spikes or dropouts, between 0.2–4.9 V.
  - ⇒ **If not between 0.2–4.9 V or has spikes or dropouts**  
Replace the B74 Manifold Absolute Pressure Sensor.
  - ⇓ **If between 0.2–4.9 V and there are no spikes or dropouts**
8. All OK.

**Repair Instructions**

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

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

DTC P0107 or P0108

Diagnostic Instructions

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

DTC Descriptors

DTC P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

Diagnostic Fault Information

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

Typical Scan Tool Data

MAP Sensor

| Circuits                                                                                                                                                                      | Short to Ground  | Open               | Short to Voltage    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------|---------------------|
| <b>Operating Conditions:</b> Engine operating in closed loop, idling, and accessories OFF<br><b>Parameter Normal Range:</b> 26–52 kPa (3.8 to 7.6 PSI) (Varies with altitude) |                  |                    |                     |
| 5 V Reference                                                                                                                                                                 | 0 kPa (0 PSI)    | 0 kPa (0 PSI)      | 127 kPa (18.4 PSI)  |
| Signal                                                                                                                                                                        | 10 kPa (1.5 PSI) | 0 kPa (0 PSI)      | 127 kPa (18.4 PSI)* |
| Low Reference                                                                                                                                                                 | —                | 127 kPa (18.4 PSI) | —                   |
| * Internal ECM or sensor damage may occur if the circuit is shorted to B+.                                                                                                    |                  |                    |                     |

| Circuits | Short to Ground | Open | Short to Voltage |
|----------|-----------------|------|------------------|
|----------|-----------------|------|------------------|

**MAP Sensor, if equipped with Turbocharger**

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

### Circuit/System Description

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

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

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

### Conditions for Running the DTC

#### **P0107**

This DTC runs continuously.

#### **P0108**

This DTC runs continuously.

### Conditions for Setting the DTC

#### **P0107**

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

#### **P0108**

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

### **Action Taken When the DTC Sets**

DTCs P0107 and P0108 are Type B DTCs.

### **Conditions for Clearing the DTC**

DTCs P0107 and P0108 are Type B DTCs.

### **Reference Information**

#### **Schematic Reference**

[Engine Controls Schematics](#)

#### **Connector End View Reference**

[Component Connector End 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

#### **Special Tools**

GE-23738-A Vacuum Pump

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

### **Circuit/System Verification**

1. Ignition ON, verify that DTC P0641 or P0651 is not set.
  - ⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.
  - ⇓ **If none of the DTCs are set**
2. Determine the current vehicle testing altitude.
3. Verify the scan tool MAP Sensor parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.
  - ⇒ **If the MAP Sensor parameter is not in range**  
Refer to Circuit/System Testing for further diagnosis.
  - ⇓ **If the MAP Sensor parameter is within range**
4. Verify the engine is equipped with a turbocharger.
  - ⇒ **If not equipped with a turbocharger**  
Refer to Step 6.
  - ⇓ **If equipped with a turbocharger**
5. Engine idling, verify the scan tool MAP Sensor voltage parameter is between 0.3–4.8 V and changes with accelerator pedal input.
  - ⇒ **If not between 0.3–4.8 V or does not change**

Refer to Circuit/System Testing.

⇓ **If between 0.3–4.8 V and changes**

Refer to Step 7.

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

⇒ **If not between 0.2–4.5 V or does not change**

Refer to Circuit/System Testing.

⇓ **If between 0.2–4.5 V and changes**

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

8. Verify the DTC does not set.

⇒ **If any DTC sets**

Refer to Circuit/System Testing.

⇓ **If no DTC sets**

9. All OK.

### Circuit/System Testing

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

⇒ **If 2  $\Omega$  or greater**

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

⇓ **If less than 2  $\Omega$**

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

⇒ **If less than 4.8 V**

- 3.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
- 3.2. 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
- 3.3. Test for less than 2  $\Omega$  in the 5 V reference circuit end to end.
- ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
- ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

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

⇒ **If greater than 5.2 V**

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

⇓ **If between 4.8–5.2 V**

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

⇒ **If 0.5 V or greater**

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

↓ **If less than 0.5 V**

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

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

⇒ **If 4.5 V or less**

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

↓ **If greater than 4.5 V**

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

### Component Testing

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

#### **Skewed Sensor Test**

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply 17 kPa (5.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the GE-23738-A. Verify the scan tool MAP Sensor pressure parameter decreases between 13–21 kPa (1.8–3.0 PSI).
  - ⇒ **If the parameter does not decrease between 13–21 kPa (1.8–3.0 PSI)**  
Replace the B74 Manifold Absolute Pressure Sensor.
  - ↓ **If the parameter does decrease between 13–21 kPa (1.8–3.0 PSI)**
3. Apply 34 kPa (10.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the GE-23738-A. Verify the scan tool MAP Sensor pressure parameter decreases between 30–38 kPa (4.4–5.5 PSI).
  - ⇒ **If the parameter does not decrease between 30–38 kPa (4.4–5.5 PSI)**  
Replace the B74 Manifold Absolute Pressure Sensor.
  - ↓ **If the parameter does decrease between 30–38 kPa (4.4–5.5 PSI)**
4. All OK.

#### **Erratic Signal Test**

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 2 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 3 of the sensor.



5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply between 0-15 kPa (0-4.4 in Hg) of vacuum to the sensor with the *GE-23738-A*.
7. Verify the voltage changes, without any spikes or dropouts, between 0.2-4.9 V.
  - ⇒ **If not between 0.2-4.9 V or has spikes or dropouts**  
Replace the B74 Manifold Absolute Pressure Sensor.
  - ⇓ **If between 0.2-4.9 V and there are no spikes or dropouts**
8. All OK.

#### **Repair Instructions**

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

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

## DTC P0111 (With Supercharger)

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P0111

Intake Air Temperature (IAT) Sensor Performance

### Diagnostic Fault Information

#### IAT Sensor 1

| Circuit       | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|---------------|-----------------|----------------------|------------------|--------------------|
| Signal        | P0112           | P0111, P0113         | P0113*           | P0111              |
| Low Reference | —               | P0111, P0113         | P0113            | P0111              |

\*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 |
|-------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------|------------------|
| <b>Operating Conditions:</b> Key ON, engine OFF<br><b>Parameter Normal Range:</b> Varies with ambient temperature |                 |                         |                  |
| Signal                                                                                                            | 140°C (284°F)   | -40°C (-40°F)           | -40°C (-40°F)*   |
| Low Reference                                                                                                     | —               | —                       | —                |

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

### Circuit/System Description

The intake air temperature (IAT) sensor is a variable resistor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5V to the IAT signal circuit, and a ground for the IAT low reference circuit. When the IAT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With

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high sensor resistance, the ECM detects a high voltage on the IAT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the IAT signal circuit.

### [Conditions for Running the DTC](#)

**Note:** Before the ECM can report DTC P0111 failed, DTC P0116 must run.

- DTCs P0112, P0113, P0117, P0118, P0128, P0502, P0503, P0601, P1621, P1627, P1680, P1681, P2610 are not set.
- The vehicle has had a minimum ignition OFF time of 8 hours.
- The ignition is ON.
- The start-up IAT is warmer than 10°C (50°F).
- The Fuel Level Sensor parameter is greater than 2.5 percent.
- This DTC runs once per ignition cycle when the enabling conditions are met.

### [Conditions for Setting the DTC](#)

**Note:** Before the ECM can report DTC P0111 failed, DTC P0116 must run.

- The ECM detects a temperature difference at power-up that indicates that the IAT sensor is 20°C (36°F) greater than the IAT sensor 2.  
OR
- The ECM detects a temperature difference at power-up that indicates that the IAT sensor is 16°C (29°F) greater than the IAT sensor 2, and the time spent cranking the engine is greater than 30 seconds, when the fuel level is greater than 2.5 percent.

### [Action Taken When the DTC Sets](#)

DTC P0111 is a Type B DTC.

### [Conditions for Clearing the MIL/DTC](#)

DTC P0111 is a Type B DTC.

### [Reference Information](#)

#### **Schematic Reference**

[Engine Controls Schematics](#)

#### **Connector End View Reference**

[Component Connector End Views](#)

#### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

#### **Powertrain Component Views**

[Powertrain Component Views](#)

#### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

#### **Scan Tool Reference**

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

### [Circuit/System Verification](#)

1. Ignition ON.
2. Verify that DTC P0641 or P0651 is not set.  
⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.  
⇓ **If the 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 20°C (36°F) of each other.
  - Start-Up IAT Sensor 1
  - IAT Sensor 2
  - Start-Up ECT⇒ **If not within 20°C (36°F)**  
Refer to Circuit/System Testing.  
⇓ **If within 20°C (36°F)**
5. Engine idling, verify the following scan tool parameters are between: -38 and +149°C (-36 and +300°F).
  - IAT Sensor 1
  - IAT Sensor 2
  - ECT Sensor⇒ **If not between: -38 and +149°C (-36 and +300°F)**  
Refer to Circuit/System Testing.  
⇓ **If between: -38 and +149°C (-36 and +300°F)**
6. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
7. Verify the DTC does not set.  
⇒ **If the DTC sets**  
Refer to Circuit/System Testing.  
⇓ **If the DTC does not set**
8. All OK

#### Circuit/System Testing

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

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

- An Intake Manifold Resonator with a leaking seal, or a cracked or broken housing

⇒ **If a condition exists**

Repair or replace component as appropriate.

⇓ **If no condition exists**

2. Ignition OFF and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75B Mass Air Flow /Intake Air Temperature sensor.
3. Test for less than 2  $\Omega$  between the low reference circuit terminal D and ground.

⇒ **If 2  $\Omega$  or greater**

- 3.1. Ignition OFF, disconnect the harness connector at the engine control module.
- 3.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open or high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$  replace the engine control module.

⇓ **If less than 2  $\Omega$**

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

⇒ **If less than 4.8 V**

- 4.1. Ignition OFF, disconnect the harness connector at the engine control module.
- 4.2. 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
- 4.3. Test for less than 2  $\Omega$  in the signal circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the 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.

- 4.1. Ignition OFF, disconnect the harness connector at the engine control module.
- 4.2. 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 engine control module.

⇓ **If between 4.8–5.2 V**

5. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ).

⇒ **If not colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ).**

Replace the engine control module.

⇓ **If colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ).**

6. Ignition OFF. Install a 3 A fused jumper wire between the signal circuit terminal E and low reference circuit terminal D.

7. Ignition ON. Verify the scan tool IAT Sensor 1 parameter is warmer than  $149^{\circ}\text{C}$  ( $300^{\circ}\text{F}$ ).

⇒ **If not warmer than  $149^{\circ}\text{C}$  ( $300^{\circ}\text{F}$ ).**

Replace the K20 Engine Control Module.

⇓ **If warmer than  $149^{\circ}\text{C}$  ( $300^{\circ}\text{F}$ ).**

8. Test or replace the B75B Mass Air Flow /Intake Air Temperature sensor.

## Component Testing

### **Mass Air Flow /Intake Air Temperature sensor**

1. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow /Intake Air Temperature 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](#) table. The resistance values should be in range of the table values.  
⇒ **If not within the table values.**  
Replace the B75B Mass Air Flow /Intake Air Temperature sensor.  
↓ **If within the table values.**
3. All OK

### **[Repair Instructions](#)**

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

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

## DTC P0112 or P0113 (With Supercharger)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0112

Intake Air Temperature (IAT) Sensor Circuit Low Voltage

#### DTC P0113

Intake Air Temperature (IAT) Sensor Circuit High Voltage

### Diagnostic Fault Information

| Circuit           | Short to Ground | Open / High Resistance | Short to Voltage | Signal Performance |
|-------------------|-----------------|------------------------|------------------|--------------------|
| IAT Sensor Signal | P0112           | P0113                  | P0113*           | —                  |
| Low Reference     | —               | P0113                  | P0113*           | —                  |

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

### Typical Scan Tool Data

#### IAT Sensor Temperature

| Circuit                                                                                                                       | Short to Ground | Open          | Short to Voltage   |
|-------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------|--------------------|
| <b>Operating Conditions:</b> Ignition ON, engine running<br><b>Parameter Normal Range:</b> Varies with intake air temperature |                 |               |                    |
| IAT Sensor Signal                                                                                                             | 150°C (302°F)   | -40°C (-40°F) | -40°C (-40°F)<br>* |
| Low Reference                                                                                                                 | —               | -40°C (-40°F) | -40°C (-40°F)      |
| * Internal ECM or sensor damage may occur if the circuit is shorted to B+.                                                    |                 |               |                    |

### Circuit/System Description

The intake air temperature (IAT) sensor, a part of the mass air flow (MAF) sensor assembly, is a variable resistor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 V to the IAT signal circuit, and a ground for the IAT low reference circuit.

### Conditions for Running the DTC

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**P0112**

- DTCs P0117, P0118, P0722, P0723 are not set.
- The engine is running for greater than 10 s.
- The engine coolant temperature (ECT) is colder than 150°C (302°F).
- This DTC runs continuously when the above conditions are met.

**P0113**

- DTCs P0101, P0102, P0103, P0117, P0118, P0722, P0723 are not set.
- The engine is running for greater than 10 s.
- The ECT is warmer than -40°C (-40°F).
- The MAF Sensor parameter is less than 512 g/s.
- This DTC runs continuously when the above conditions are met.

**Conditions for Setting the DTC****P0112**

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

**P0113**

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

**Action Taken When the DTC Sets**

DTCs P0112 and P0113 are Type B DTCs.

**Conditions for Clearing the MIL/DTC**

DTCs P0112 and P0113 are Type B DTCs.

**Diagnostic Aids**

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

**Reference Information****Schematic Reference**

[Engine Controls Schematics](#)

**Connector End View Reference**

[Component Connector End Views](#)

**Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

**Powertrain Component Views**



[Powertrain Component Views](#)**DTC Type Reference**[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)**Scan Tool Reference**

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

**[Circuit/System Verification](#)**

1. Ignition ON.
2. Verify that DTC P0641 or P0651 is not set.
  - ⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.
  - ↓ **If the 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 20°C (36°F) of each other.
  - Start-Up IAT Sensor 1
  - IAT Sensor 2
  - Start-Up ECT
  - ⇒ **If not within 20°C (36°F)**  
Refer to Circuit/System Testing.
  - ↓ **If within 20°C (36°F)**
5. Engine idling, verify the following scan tool parameters are between: –38 and +149°C (–36 and +300°F).
  - IAT Sensor 1
  - IAT Sensor 2
  - ECT Sensor
  - ⇒ **If not between: –38 and +149°C (–36 and +300°F)**  
Refer to Circuit/System Testing.
  - ↓ **If between: –38 and +149°C (–36 and +300°F)**
6. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
7. Verify the DTC does not set.
  - ⇒ **If the DTC sets**  
Refer to Circuit/System Testing.
  - ↓ **If the DTC does not set**
8. All OK

**[Circuit/System Testing](#)**

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

1. Ignition OFF and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75B Mass Air Flow /Intake Air Temperature sensor.
2. Test for less than 2 Ω between the low reference circuit terminal D and ground.
  - ⇒ **If 2 Ω or greater**

- 2.1. Ignition OFF, disconnect the harness connector at the engine control module.
- 2.2. Test for less than  $2\ \Omega$  in the low reference circuit end to end.
  - ⇒ If  $2\ \Omega$  or greater, repair the open or high resistance in the circuit.
  - ⇒ If less than  $2\ \Omega$  replace the engine control module.

↓ **If less than  $2\ \Omega$**

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

⇒ **If less than 4.8 V**

- 3.1. Ignition OFF, disconnect the harness connector at the engine control module.
- 3.2. 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
- 3.3. Test for less than  $2\ \Omega$  in the signal circuit end to end.
  - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than  $2\ \Omega$ , replace the 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.

- 3.1. Ignition OFF, disconnect the harness connector at the engine control module.
- 3.2. 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 engine control module.

↓ **If between 4.8–5.2 V**

4. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ).

⇒ **If not colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ).**

Replace the engine control module.

↓ **If colder than  $-39^{\circ}\text{C}$  ( $-38^{\circ}\text{F}$ ).**

5. Ignition OFF. Install a 3 A fused jumper wire between the signal circuit terminal E and low reference circuit terminal D.

6. Ignition ON. Verify the scan tool IAT Sensor 1 parameter is warmer than  $149^{\circ}\text{C}$  ( $300^{\circ}\text{F}$ ).

⇒ **If not warmer than  $149^{\circ}\text{C}$  ( $300^{\circ}\text{F}$ ).**

Replace the K20 Engine Control Module.

↓ **If warmer than  $149^{\circ}\text{C}$  ( $300^{\circ}\text{F}$ ).**

7. Test or replace the B75B Mass Air Flow /Intake Air Temperature sensor.

## Component Testing

### **Mass Air Flow /Intake Air Temperature sensor**

1. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow /Intake Air Temperature 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](#) table. The resistance values should be in range of the table values.

⇒ **If not within the table values.**

Replace the B75B Mass Air Flow /Intake Air Temperature sensor.

↓ **If within the table values.**

3. All OK

### **Repair Instructions**

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

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

## DTC P0112 or P0113 (Without Supercharger)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0112

Intake Air Temperature (IAT) Sensor Circuit Low Voltage

#### DTC P0113

Intake Air Temperature (IAT) Sensor Circuit High Voltage

### Diagnostic Fault Information

| Circuit                                                          | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|------------------------------------------------------------------|-----------------|----------------------|------------------|--------------------|
| Signal                                                           | P0112           | P0113                | P0113*           | —                  |
| Low Reference                                                    | —               | P0113                | P0113*           | —                  |
| *ECM or sensor damage may occur if the circuit is shorted to B+. |                 |                      |                  |                    |

### Typical Scan Tool Data

#### IAT Sensor

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

### Circuit/System Description

The intake air temperature (IAT) sensor, a part of the mass air flow (MAF) sensor assembly, is a variable resistor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 V to the IAT signal circuit, and a ground for the IAT low reference circuit.

### Conditions for Running the DTC

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**P0112**

- DTCs P0116, P0117, P0118, P0125, P0128, P0722, P0723 are not set.
- The engine is running for greater than 10 s.
- The engine coolant temperature (ECT) is colder than 150°C (302°F).
- This DTC runs continuously when the above conditions are met.

**P0113**

- DTCs P0101, P0102, P0103, P0116, P0117, P0118, P0125, P0128, P0722, P0723 are not set.
- The engine is running for greater than 10 s.
- The ECT is warmer than -40°C (-40°F).
- The MAF Sensor signal is equal to or greater than 512 g/s.
- This DTC runs continuously when the above conditions are met.

**Conditions for Setting the DTC****P0112**

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

**P0113**

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

**Action Taken When the DTC Sets**

DTCs P0112 and P0113 are Type B DTCs.

**Conditions for Clearing the MIL/DTC**

DTCs P0112 and P0113 are Type B DTCs.

**Diagnostic Aids**

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

**Reference Information****Schematic Reference**

[Engine Controls Schematics](#)

**Connector End View Reference**

[Component Connector End Views](#)

**Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

**Powertrain Component Views**[Powertrain Component Views](#)**DTC Type Reference**[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)**Scan Tool Reference**[Control Module References](#) for scan tool information**[Circuit/System Verification](#)**

1. Ignition ON.
2. Verify that DTC P0641 or P0651 is not set.  
⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.
- ↓ **If the 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 20°C (36°F) of each other.
  - Start-Up IAT Sensor 1
  - IAT Sensor 2; where equipped
  - Start-Up ECT
 ⇒ **If not within 20°C (36°F)**  
Refer to Circuit/System Testing.  
↓ **If within 20°C (36°F)**
5. Engine idling, verify the following scan tool parameters are between: -38 and +149°C (-36 and +300°F).
  - IAT Sensor 1
  - IAT Sensor 2; where equipped
  - ECT Sensor
 ⇒ **If not between: -38 and +149°C (-36 and +300°F)**  
Refer to Circuit/System Testing.  
↓ **If between: -38 and +149°C (-36 and +300°F)**
6. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
7. Verify the DTCs do not set.  
⇒ **If any DTC sets**  
Refer to Circuit/System Testing.  
↓ **If no DTC sets**
8. All OK

**[Circuit/System Testing](#)****Note:** You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75B Mass Air Flow /Intake Air Temperature sensor.
2. Test for less than 2 Ω between the low reference circuit terminal E and ground.

⇒ **If 2 Ω or greater**

- 2.1. Ignition OFF, disconnect the harness connector at the engine control module.
- 2.2. 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 engine control module.

⇓ **If less than 2 Ω**

3. Ignition ON, test for 4.8–5.2 V between the intake air temperature signal circuit terminal D and ground.

⇒ **If less than 4.8 V**

- 3.1. Ignition OFF, disconnect the harness connector at the engine control module.
- 3.2. 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
- 3.3. 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 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.

- 3.1. Ignition OFF, disconnect the harness connector at the engine control module.
- 3.2. 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 engine control module.

⇓ **If between 4.8–5.2 V**

4. Ignition ON, verify the scan tool IAT Sensor parameter is colder than –39°C (–38°F).

⇒ **If not colder than –39°C (–38°F).**

Replace the engine control module.

⇓ **If colder than –39°C (–38°F).**

5. Ignition OFF. Install a 3 A fused jumper wire between the signal circuit terminal D and low reference circuit terminal E.

6. Ignition ON. Verify the scan tool IAT Sensor parameter is warmer than 149°C (300°F).

⇒ **If not warmer than 149°C (300°F).**

Replace the K20 Engine Control Module.

⇓ **If warmer than 149°C (300°F).**

7. Test or replace the B75B Mass Air Flow /Intake Air Temperature sensor.

## Component Testing

### Mass Air Flow /Intake Air Temperature sensor

1. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow /Intake Air Temperature sensor.

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

2. Test the IAT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance](#) table. The resistance values should be in range of the table values.

⇒ **If not within the table values.**

Replace the B75B Mass Air Flow /Intake Air Temperature sensor.

⇓ **If within the table values.**

3. All OK

### **Repair Instructions**

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

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



## DTC P0117 or P0118

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0117

Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

#### DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

### Diagnostic Fault Information

| Circuit                                                         | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|-----------------------------------------------------------------|-----------------|----------------------|------------------|--------------------|
| Signal                                                          | P0117,<br>P0119 | P0118,<br>P0119      | P0118*           | P0116, P0128       |
| Low Reference                                                   | —               | P0118,<br>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  |
|--------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|-------------------|
| <b>Operating Conditions:</b> Engine operating in Closed Loop<br><b>Parameter Normal Range:</b> Varies with coolant temperature |                   |                   |                   |
| ECT Sensor Signal                                                                                                              | 140°C (284°<br>F) | -40°C (-40°<br>F) | -40°C (-40°<br>F) |
| Low Reference                                                                                                                  | —                 | -40°C (-40°<br>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

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**P0117**

This DTC runs continuously.

**P0118**

- The engine is running for greater than 10 s.  
OR
- The ignition is ON when the IAT minimum is greater than -7°C (45°F).
- 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 150°C (302°F) for greater than 5 s.

**P0118**

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

**Action Taken When the DTC Sets**

DTCs P0117 and P0118 are Type B DTCs.

**Conditions for Clearing the MIL/DTC**

DTCs P0117 and P0118 are Type B DTCs.

**Reference Information****Schematic Reference**

[Engine Controls Schematics](#)

**Connector End View Reference**

[Component Connector End 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 the scan tool ECT Sensor parameter is between -39 to + 120°C (-38 to +248°F) and changes with engine run time.  
⇒ **If not between -39 to + 120°C (-38 to +248°F) or does not change**  
Refer to Circuit/System Testing.  
⇓ **If between -39 to + 120°C (-38 to +248°F) and changes**

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

### Circuit/System Testing

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

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B34A Engine Coolant Temperature Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10  $\Omega$  between the low reference circuit terminal A and ground.
  - ⇒ **If 10  $\Omega$  or greater**
    - 2.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    - 2.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
  - ⇓ **If less than 10  $\Omega$**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is at  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ).
  - ⇒ **If warmer than  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ )**
    - 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    - 4.2. Test for infinite resistance between the signal circuit terminal B 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  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ )**
5. Install a 3 A fused jumper wire between the signal circuit terminal B and ground.
6. Verify the scan tool ECT Sensor parameter is at  $140^{\circ}\text{C}$  ( $284^{\circ}\text{F}$ ).
  - ⇒ **If colder than  $140^{\circ}\text{C}$  ( $284^{\circ}\text{F}$ )**
    - 6.1. Ignition OFF, remove the jumper, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    - 6.2. Test for less than 1 V between the signal circuit terminal B and ground.
      - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
      - ⇓ If less than 1 V
    - 6.3. Ignition OFF
    - 6.4. Test for less than 2  $\Omega$  in the signal circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
  - ⇓ **If  $140^{\circ}\text{C}$  ( $284^{\circ}\text{F}$ )**
7. Test or replace the B34A Engine Coolant Temperature Sensor.

### Component Testing

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

#### **Repair Instructions**

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

- [Engine Coolant Temperature Sensor Replacement](#)
- [Control Module References](#) for engine control module replacement, programming, and setup

## DTC P0120-P0123, P0220, P0222, P0223, or P2135 (L77, LS3)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0120

Throttle Position Sensor 1 Circuit

#### DTC P0121

Throttle Position Sensor 1 Performance

#### DTC P0122

Throttle Position Sensor 1 Circuit Low Voltage

#### DTC P0123

Throttle Position Sensor 1 Circuit High Voltage

#### DTC P0220

Throttle Position Sensor 2 Circuit

#### DTC P0222

Throttle Position Sensor 2 Circuit Low Voltage

#### DTC P0223

Throttle Position Sensor 2 Circuit High Voltage

#### DTC P2135

Throttle Position Sensors 1-2 Not Plausible

### Diagnostic Fault Information

| Circuit                           | Short to Ground     | High Resistance | Open         | Short to Voltage | Signal Performance |
|-----------------------------------|---------------------|-----------------|--------------|------------------|--------------------|
| 5 V Reference                     | P0107, P0651, P0335 | P2135           | P0122, P0222 | P0651            | P0068, P0121       |
| Throttle Position Sensor 1 Signal | P0122               | P2135           | P0122        | P0123            | P0068, P0121       |
| Throttle Position Sensor 2 Signal | P0222               | P2135           | P0223        | P0223            | P0068, P0121       |

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| Circuit       | Short to Ground | High Resistance | Open         | Short to Voltage | Signal Performance |
|---------------|-----------------|-----------------|--------------|------------------|--------------------|
| Low Reference | —               | P2135           | P0123, P0223 | —                | P0068, P0121       |

#### Typical Scan Tool Data

##### Throttle Position Sensor 1

| Circuit                                                                                                         | Short to Ground | Open  | Short to Voltage |
|-----------------------------------------------------------------------------------------------------------------|-----------------|-------|------------------|
| <b>Operating Conditions:</b> Engine running at various operating conditions<br><b>Normal Range:</b> 4.74–0.33 V |                 |       |                  |
| 5 V Reference                                                                                                   | 0 V             | 0 V   | 5 V              |
| Throttle Position Sensor 1 Signal                                                                               | 0 V             | 0 V   | 5 V              |
| Low Reference                                                                                                   | —               | 4–5 V | —                |

##### Throttle Position Sensor 2

| Circuit                                                                                                                  | Short to Ground | Open | Short to Voltage |
|--------------------------------------------------------------------------------------------------------------------------|-----------------|------|------------------|
| <b>Operating Conditions:</b> Engine running at various operating conditions<br><b>Parameter Normal Range:</b> 0.26–4.5 V |                 |      |                  |
| 5 V Reference                                                                                                            | 0 V             | 0 V  | 5 V              |
| Throttle Position Sensor 2 Signal                                                                                        | 0 V             | 5 V  | 5 V              |
| Low Reference                                                                                                            | —               | 5 V  | —                |

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#### Circuit/System Description

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

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

#### Conditions for Running the DTC

##### P0120, P0122, P0123, P0220, P0222, and P0223

- DTC P0641 or P0651 is not set.
- The run/crank or powertrain relay voltage is greater than 6 V and reduced power is not active.
- The ignition is ON or the engine is operating.

- DTCs P0120, P0122, P0123, P0220, P0222, P0223 run continuously when the above conditions are met.

**P0121**

- DTCs P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0315, P0335, P0336, or P3400 is not set.
- The engine speed is between 450–6,700 RPM.
- The engine coolant temperature (ECT) is  $-7$  to  $+125^{\circ}\text{C}$  ( $19$ – $257^{\circ}\text{F}$ ).
- The intake air temperature (IAT) is  $-20$  to  $+125^{\circ}\text{C}$  ( $-4$  to  $+257^{\circ}\text{F}$ ).
- DTC P0121 runs continuously when the above conditions are met.

**P2135**

- DTC P0120, P0122, P0123, P0220, P0222, P0223, or P0651 is not set.
- The run/crank or powertrain relay voltage is greater than 6 V and reduced power is not active.
- The ignition is ON or the engine is operating.
- DTC P2135 runs continuously when the above conditions are met.

**Conditions for Setting the DTC****P0121**

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

**P0120**

The ECM detects the throttle position sensor 1 voltage is less than 0.325 V or greater than 4.75 V for greater than 1 s.

**P0122**

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

**P0123**

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

**P0220**

The ECM detects the throttle position sensor 2 voltage is less than 0.25 V or greater than 4.59 V for greater than 1 s.

**P0222**

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

**P0223**

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

**P2135**

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

**Action Taken When the DTC Sets**

- DTC P0120, P0122, P0123, P0220, P0222, P0223, and P2135 are Type A DTCs.
- DTC P0121 is a Type B DTC.

- The ECM commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions the control module commands the engine OFF.

#### **Conditions for Clearing the MIL/DTC**

- DTCs P0120, P0122, P0123, P0220, P0222, P0223, and P2135 are Type A DTCs.
- DTC P0121 is a Type B DTC.

#### **Diagnostic Aids**

- If the Throttle Sweep Test is not available on the scan tool, observe the scan tool Throttle Position Sensor 1 and 2 Agree/Disagree parameter while performing the following tests:
  - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.
  - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.The Throttle Position Sensor 1 and 2 Agree/Disagree parameter should display Agree. If Disagree is displayed, continue diagnosis in Circuit/System Testing.
- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End Views](#)

##### **Description and Operation**

[Throttle Actuator Control \(TAC\) System Description](#)

##### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

##### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

##### **Scan Tool Reference**

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

#### **Circuit/System Verification**

1. If you were sent here from DTC P0068, P0101, P0106, or P1101 refer to Circuit/System Testing.
2. Ignition ON.
3. Verify that DTC P0641 or P0651 is not set.
  - ⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.
  - ⇓ **If none of the DTCs are set**



4. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.  
⇒ **If 90 % or greater**  
Refer to [Throttle Body Cleaning](#).  
↓ **If less than 90 %**
5. Verify the scan tool Throttle Position Sensor 1 and Throttle Position Sensor 2 voltage parameters are between 1.0–4.0 V and change with accelerator pedal input.  
⇒ **If not between 1.0–4.0 V or does not change**  
Refer to Circuit/System Testing.  
↓ **If between 1.0–4.0 V and changes**  
**Note:** If the Throttle Sweep Test is not available on the scan tool, use the accelerator to perform the test. Refer to Diagnostic Aids for further details.
6. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.  
⇒ **If Disagree**  
Refer to Circuit/System Testing.  
↓ **If Agree**
7. Clear the DTCs with the scan tool. Operate the vehicle within the Conditions for Running the DTC or within the conditions that you observed from the Freeze Frame/Failure Records.
8. Ignition ON.
9. Verify that DTC P0120 or P0220 are not the only throttle position sensor DTCs set.  
⇒ **If DTC P0120 or P0220 is the only DTCs set**  
Replace the K20 Engine Control Module  
↓ **If DTC P0120 or P0220 is not the only DTCs set**
10. Verify DTC P0120, P0121, P0122, P0123, P0220, P0222, P0223, and P2135 is not set.  
⇒ **If any of the DTCs are set**  
Refer to Circuit/System Testing.  
↓ **If none of the DTCs are set**
11. Determine the current vehicle testing altitude.
12. Verify the scan tool MAP Sensor pressure parameter is within range specified in the [Altitude Versus Barometric Pressure](#) table.  
⇒ **If the MAP Sensor pressure is not in range**  
Refer to [DTC P0106](#).  
↓ **If the MAP Sensor pressure is within range**
13. Engine idling.
14. Verify the scan tool MAP Sensor pressure parameter is between 26–52 kPa (3.8–7.5 psi) and changes with accelerator pedal input.  
⇒ **If not between 26–52 kPa (3.8–7.5 psi) or does not change**  
Refer to [DTC P0106](#).  
↓ **If between 26–52 kPa (3.8–7.5 psi) and changes**
15. 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.
  - 15.1. Engine idling
  - 15.2. Perform the scan tool snapshot function.
  - 15.3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
  - 15.4. Exit from the scan tool snapshot and review the data.
  - 15.5. Observe the MAF Sensor parameter frame by frame with a scan tool.⇒ **If the MAF Sensor parameter does not change smoothly and gradually**

Refer to [DTC P0101](#).

↓ **If the MAF Sensor parameter changes smoothly and gradually**

16. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
17. Verify a DTC does not set.
  - ⇒ **If any DTC sets**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
  - ↓ **If no DTCs set**
18. All OK

### Circuit/System Testing

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

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at Q38 Throttle Body assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5  $\Omega$  between the low reference circuit terminal C and ground.
  - ⇒ **If 5  $\Omega$  or greater**
    - 2.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    - 2.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
  - ↓ **If less than 5  $\Omega$**
3. Ignition ON.
4. Test for 4.8–5.2 V between the 5 V reference circuit terminal E and ground.
  - ⇒ **If less than 4.8 V**
    - 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    - 4.2. 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
    - 4.3. Test for less than 2  $\Omega$  in the 5 V reference circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
  - ⇒ **If greater than 5.2 V**
    - 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    - 4.2. Test for less than 1 V between the 5 V reference circuit and ground.
      - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
      - ⇒ If less than 1 V, replace the K20 Engine Control Module.
  - ↓ **If between 4.8–5.2 V**
5. Ignition ON.
6. Test for less than 1 V between the throttle position sensor 1 signal circuit terminal D and ground.
  - ⇒ **If 1.0 V or greater**
    - 6.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    - 6.2. Test for less than 1 V between the signal circuit and ground.
      - ⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

↓ **If 1.0 V or less**

7. Install a 3 A fused jumper wire between throttle position sensor 1 signal circuit terminal D and the 5 V reference circuit terminal E.

8. Verify the scan tool Throttle Position Sensor 1 voltage parameter is greater than 4.8 V.

⇒ **If 4.8 V or less**

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

8.2. 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

8.3. Test for less than 2  $\Omega$  in the signal circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

↓ **If 4.8 or greater**

9. Test for 4.8–5.2 V between the throttle position sensor 2 signal circuit terminal F and ground.

⇒ **If less than 4.8 V**

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

9.2. 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

9.3. Test for less than 2  $\Omega$  in the signal circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

⇒ **If greater than 5.2 V**

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

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

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

↓ **If between 4.8–5.2 V**

10. Test or replace the Q38 Throttle Body assembly.

### Repair Instructions

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

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

## DTC P0120-P0123, P0220, P0222, P0223, or P2135 (LSA)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0120

Throttle Position Sensor 1 Circuit

#### DTC P0121

Throttle Position Sensor 1 Performance

#### DTC P0122

Throttle Position Sensor 1 Circuit Low Voltage

#### DTC P0123

Throttle Position Sensor 1 Circuit High Voltage

#### DTC P0220

Throttle Position Sensor 2 Circuit

#### DTC P0222

Throttle Position Sensor 2 Circuit Low Voltage

#### DTC P0223

Throttle Position Sensor 2 Circuit High Voltage

#### DTC P2135

Throttle Position Sensors 1-2 Not Plausible

### Diagnostic Fault Information

| Circuit                           | Short to Ground     | High Resistance | Open         | Short to Voltage | Signal Performance |
|-----------------------------------|---------------------|-----------------|--------------|------------------|--------------------|
| 5 V Reference                     | P0107, P0651, P0335 | P2135           | P0122, P0222 | P0651            | P0068, P0121       |
| Throttle Position Sensor 1 Signal | P0122               | P2135           | P0122        | P0123            | P0068, P0121       |
| Throttle Position Sensor 2 Signal | P0222               | P2135           | P0223        | P0223            | P0068, P0121       |

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| Circuit       | Short to Ground | High Resistance | Open         | Short to Voltage | Signal Performance |
|---------------|-----------------|-----------------|--------------|------------------|--------------------|
| Low Reference | —               | P2135           | P0123, P0223 | —                | P0068, P0121       |

#### Typical Scan Tool Data

##### Throttle Position Sensor 1

| Circuit                                                                                                         | Short to Ground | Open  | Short to Voltage |
|-----------------------------------------------------------------------------------------------------------------|-----------------|-------|------------------|
| <b>Operating Conditions:</b> Engine running at various operating conditions<br><b>Normal Range:</b> 4.74–0.33 V |                 |       |                  |
| 5 V Reference                                                                                                   | 0 V             | 0 V   | 5 V              |
| Throttle Position Sensor 1 Signal                                                                               | 0 V             | 0 V   | 5 V              |
| Low Reference                                                                                                   | —               | 4–5 V | —                |

##### Throttle Position Sensor 2

| Circuit                                                                                                                  | Short to Ground | Open | Short to Voltage |
|--------------------------------------------------------------------------------------------------------------------------|-----------------|------|------------------|
| <b>Operating Conditions:</b> Engine running at various operating conditions<br><b>Parameter Normal Range:</b> 0.26–4.5 V |                 |      |                  |
| 5 V Reference                                                                                                            | 0 V             | 0 V  | 5 V              |
| Throttle Position Sensor 2 Signal                                                                                        | 0 V             | 5 V  | 5 V              |
| Low Reference                                                                                                            | —               | 5 V  | —                |

#### Circuit/System Description

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

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

#### Conditions for Running the DTC

##### P0120, P0122, P0123, P0220, P0222, and P0223

- DTC P0641 or P0651 is not set.
- The run/crank or powertrain relay voltage is greater than 6 V and reduced power is not active.
- The ignition is ON or the engine is operating.

- DTCs P0120, P0122, P0123, P0220, P0222, P0223 run continuously when the above conditions are met.

**P0121**

- DTCs P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P012C, P012D, P0315, P0335, P0336, or P3400 is not set.
- The engine speed is between 450–6,700 RPM.
- The engine coolant temperature (ECT) is between –7 to +125°C (19–257°F).
- The intake air temperature (IAT) is between –20 to +125°C (-4 to +257°F).
- DTC P0121 runs continuously when the above conditions are met.

**P2135**

- DTC P0120, P0122, P0123, P0220, P0222, P0223, or P0651 is not set.
- The run/crank or powertrain relay voltage is greater than 6 V and reduced power is not active.
- The ignition is ON or the engine is operating.
- DTC P2135 runs continuously when the above conditions are met.

**Conditions for Setting the DTC****P0121**

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

**P0120**

The ECM detects the throttle position sensor 1 voltage is less than 0.325 V or greater than 4.75 V for greater than 1 s.

**P0122**

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

**P0123**

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

**P0220**

The ECM detects the throttle position sensor 2 voltage is less than 0.25 V or greater than 4.59 V for greater than 1 s.

**P0222**

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

**P0223**

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

**P2135**

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

**Action Taken When the DTC Sets**

- DTC P0120, P0122, P0123, P0220, P0222, P0223, and P2135 are Type A DTCs.
- DTC P0121 is a Type B DTC.

- The ECM commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions the control module commands the engine OFF.

#### **Conditions for Clearing the MIL/DTC**

- DTCs P0120, P0122, P0123, P0220, P0222, P0223, and P2135 are Type A DTCs.
- DTC P0121 is a Type B DTC.

#### **Diagnostic Aids**

- If the Throttle Sweep Test is not available on the scan tool, observe the scan tool Throttle Position Sensor 1 and 2 Agree/Disagree parameter while performing the following tests:
  - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.
  - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.The Throttle Position Sensor 1 and 2 Agree/Disagree parameter should display Agree. If Disagree is displayed, continue diagnosis in Circuit/System Testing.
- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End Views](#)

##### **Description and Operation**

[Throttle Actuator Control \(TAC\) System Description](#)

##### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

##### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

##### **Scan Tool Reference**

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

#### **Circuit/System Verification**

1. If you were sent here from DTC P0068, P0101, P0106, P012B, or P1101 refer to Circuit/System Testing.
2. Ignition ON.
3. Verify that DTC P0641 or P0651 is not set.
  - ⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.
  - ⇓ **If none of the DTCs are set**

4. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.  
⇒ **If 90 % or greater**  
Refer to [Throttle Body Cleaning](#).  
↓ **If less than 90 %**
5. Verify the scan tool Throttle Position Sensor 1 and Throttle Position Sensor 2 voltage parameters are between 1.0–4.0 V and change with accelerator pedal input.  
⇒ **If not between 1.0–4.0 V or does not change**  
Refer to Circuit/System Testing.  
↓ **If between 1.0–4.0 V and changes**  
**Note:** If the Throttle Sweep Test is not available on the scan tool, use the accelerator to perform the test. Refer to Diagnostic Aids for further details.
6. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.  
⇒ **If Disagree**  
Refer to Circuit/System Testing.  
↓ **If Agree**
7. Clear the DTCs with the scan tool. Operate the vehicle within the Conditions for Running the DTC or within the conditions that you observed from the Freeze Frame/Failure Records.
8. Ignition ON.
9. Verify that DTC P0120 or P0220 are not the only throttle position sensor DTCs set.  
⇒ **If DTC P0120 or P0220 is the only DTCs set**  
Replace the K20 Engine Control Module  
↓ **If DTC P0120 or P0220 is not the only DTCs set**
10. Verify DTC P0120, P0121, P0122, P0123, P0220, P0222, P0223, and P2135 is not set.  
⇒ **If any of the DTCs are set**  
Refer to Circuit/System Testing.  
↓ **If none of the DTCs are set**
11. Determine the current vehicle testing altitude.
12. Verify the scan tool MAP Sensor pressure parameter is within range specified in the [Altitude Versus Barometric Pressure](#) table.  
⇒ **If the pressure is not within range**  
Refer to [DTC P0106](#).  
↓ **If the pressure is within range**
13. Verify the scan tool Supercharger Inlet Pressure Sensor pressure parameter is within range specified in the [Altitude Versus Barometric Pressure](#) table.  
⇒ **If the pressure is not within range**  
Refer to [DTC P012B](#) for further diagnosis.  
↓ **If the pressure is within range**
14. Verify the Supercharger Inlet Pressure Sensor pressure parameter decreases after starting the engine.  
⇒ **If the pressure does not decrease**  
Refer to [DTC P012B](#) for further diagnosis.  
↓ **If the pressure decreases**
15. Engine idling.
16. Verify the scan tool MAP Sensor pressure parameter is between 26–52 kPa (3.8–7.5 psi) and changes with accelerator pedal input.  
⇒ **If not between 26–52 kPa (3.8–7.5 psi) or does not change**  
Refer to [DTC P0106](#).



↓ **If between 26–52 kPa (3.8–7.5 psi) and changes**

17. 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.
  - 17.1. Engine idling
  - 17.2. Perform the scan tool snapshot function.
  - 17.3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
  - 17.4. Exit from the scan tool snapshot and review the data.
  - 17.5. Observe the MAF Sensor parameter frame by frame with a scan tool.

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

Refer to [DTC P0101](#).

↓ **If the MAF Sensor parameter changes smoothly and gradually**

18. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
19. Verify a DTC does not set.
  - ⇒ **If any DTC sets**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
  - ↓ **If no DTCs set**
20. All OK

### Circuit/System Testing

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

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at Q38 Throttle Body assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5  $\Omega$  between the low reference circuit terminal C and ground.
  - ⇒ **If 5  $\Omega$  or greater**
    - 2.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    - 2.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
  - ↓ **If less than 5  $\Omega$**
3. Ignition ON.
4. Test for 4.8–5.2 V between the 5 V reference circuit terminal E and ground.
  - ⇒ **If less than 4.8 V**
    - 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    - 4.2. 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
    - 4.3. Test for less than 2  $\Omega$  in the 5 V reference circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
  - ⇒ **If greater than 5.2 V**
    - 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    - 4.2. Test for less than 1 V between the 5 V reference circuit and ground.
      - ⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

↓ **If between 4.8–5.2 V**

5. Ignition ON.

6. Test for less than 1 V between the throttle position sensor 1 signal circuit terminal D and ground.

⇒ **If 1.0 V or greater**

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

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

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

↓ **If 1.0 V or less**

7. Install a 3 A fused jumper wire between throttle position sensor 1 signal circuit terminal D and the 5 V reference circuit terminal E.

8. Verify the scan tool throttle position sensor 1 voltage parameter is greater than 4.8 V.

⇒ **If 4.8 V or less**

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

8.2. 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

8.3. Test for less than 2  $\Omega$  in the signal circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

↓ **If 4.8 or greater**

9. Test for 4.8–5.2 V between the throttle position sensor 2 signal circuit terminal F and ground.

⇒ **If less than 4.8 V**

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

9.2. 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

9.3. Test for less than 2  $\Omega$  in the signal circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

⇒ **If greater than 5.2 V**

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

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

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

↓ **If between 4.8–5.2 V**

10. Test or replace the Q38 Throttle Body assembly.

## Repair Instructions

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

- [Throttle Body Assembly Replacement](#)

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

## DTC P0128

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P0128

Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

### Diagnostic Fault Information

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

### Typical Scan Tool Data

#### ECT Sensor Temperature

| Circuit           | Short to Ground | Open          | Short to Voltage |
|-------------------|-----------------|---------------|------------------|
| ECT Sensor Signal | 150°C (302°F)   | -40°C (-40°F) | -40°C (-40°F)    |
| Low Reference     | —               | -40°C (-40°F) | -40°C (-40°F)    |

### Circuit/System Description

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

The purpose of both of these rationality diagnostics are 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.

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

### Conditions for Running the DTC

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0171, P0172, P0174, P0175, P0502, P0503 are not set.
- The start-up IAT is more than 7°C (+19°F).

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- The start-up ECT is less than 70°C (158°F), when the IAT is above 10°C (50°F).
- The start-up ECT is less than 50°C (122°F), when the IAT is below 10°C (50°F).
- The engine run time is between 90 seconds and 22 minutes.
- The vehicle has traveled more than 2.4 kilometers (1.5 miles) at more than 8 km/h (5 mph).
- The accumulated airflow is between 20–75 g/s, with the minimum average airflow more than 10 g/s.
- The fuel ethanol percentage is less than 85 percent.
- This DTC runs once per ignition cycle within the enabling conditions.

#### **Conditions for Setting the DTC**

The ECM detects that the minimum ECT of 75°C (167°F) has not been met, when the IAT is more than 10°C (50°F).

OR

The ECM detects that the minimum ECT of 55°C (131°F) has not been met, when the IAT is less than 10°C (50°F).

#### **Action Taken When the DTC Sets**

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

#### **Conditions for Clearing the MIL/DTC**

DTC P0128 is 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.
- This diagnostic runs in a specific range. Measure and record the resistance of the ECT sensor at various ambient temperatures between –7 to +80°C (+19 to +176°F), then compare those measurements to the [Temperature Versus Resistance](#).
- A slight to moderate resistance in the ECT sensor signal circuit or low reference circuit will affect this diagnostic. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End Views](#)

##### **Electrical Information Reference**

- [Circuit Testing](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

## Scan Tool Reference

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

### Circuit/System Verification

1. Verify the cooling system is filled to the correct coolant level. Refer to [Cooling System Leak Testing](#) and [Cooling System Draining and Filling](#).  
⇒ **If the coolant level is not correct**  
Repair as necessary  
↓ **If the coolant level is correct**  
**Note:** A critical analysis of the operation of the thermostat is necessary to properly diagnose this DTC.
2. Verify the proper heat range and the operation of the thermostat. Refer to [Thermostat Diagnosis](#).  
⇒ **If a condition exists**  
Replace the Thermostat.  
↓ **If no conditions exist**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.  
⇒ **If the DTC sets**  
Refer to Step 1.  
↓ **If the DTC does not set**
5. All OK.

### Repair Instructions

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

- [Engine Coolant Thermostat Housing Replacement](#)
- [Engine Control Module Replacement](#) for engine control module replacement, programming, and setup

## DTC P012B

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P012B

Supercharger Inlet Pressure Sensor Performance

### Circuit/System Description

The supercharger inlet pressure sensor measures the pressure between the throttle body and the supercharger. Pressure in this area is affected by engine speed, throttle opening, air temperature, and barometric pressure (BARO). The sensor provides a signal voltage that varies relative to pressure changes that occur from the various load and operating conditions of the engine. The engine control module (ECM) supplies a regulated 5 V reference circuit, and monitors the signal circuit.

Under normal operation the highest pressure that can exist in the supercharge intake manifold is equal to BARO. This occurs when the vehicle is operated at wide-open throttle (WOT) or when the ignition is On while the engine is Off. The lowest manifold pressures occur when the vehicle is idling or decelerating. The supercharger inlet pressure can range from 20 kPa to as high as BARO.

The intake airflow system performance diagnostic provides the within-range rationality check for the mass air flow (MAF), supercharger inlet pressure, manifold absolute pressure (MAP) and the throttle position (TP) sensors. This is an explicit model-based diagnostic containing multiple models for the intake system. These models include the MAF Performance Test, MAP Performance Test 1, MAP Performance Test 2 and Throttle Position Performance Test, which are displayed on the scan tool.

The estimates of MAF, supercharger inlet pressure and throttle position from the system of models and calculations are compared to the actual measured values from the MAF, supercharger inlet pressure and the throttle position sensors to determine the appropriate DTC to fail.

### Conditions for Running the DTC

- DTC P0096, P0097, P0098, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P012C, P012D, P0335, P0336, P2227, P2228, or P2229 is not set.
- Engine speed is between 450–6,200 rpm.
- Engine coolant temperature (ECT) is between –20 to +125°C (–4 to +257°F).
- Intake air temperature (IAT) is between –7 to +125°C (+19 to +257°F).
- The DTC runs continuously when the above conditions are met.

### Conditions for Setting the DTC

The ECM detects the supercharger inlet pressure sensor is stuck within range for greater than 1 s.

### Action Taken When the DTC Sets

DTC P012B is a Type B DTC. © 2014 General Motors. All rights reserved.

## **Conditions for Clearing the MIL/DTC**

DTC P012B is a Type B DTC.

## **Diagnostic Aids**

- The harness connectors for the BARO sensor and the supercharger inlet pressure sensor are of the same configuration but are not interchangeable. Review the engine controls schematics and note the circuit colors for both sensors. Inspect the wiring harnesses of both sensors for the proper connections.
- This DTC may set due to any of the following conditions:
  - Any condition that can cause the MAF, MAP, supercharger inlet pressure, and throttle position sensors to be shifted in value
  - A resistance of 10–20  $\Omega$  on the 5 V reference or low reference circuits of the supercharger inlet pressure sensor
  - Any condition that may cause the supercharger by-pass valve to bind or stick in either the open or closed positions

## **Reference Information**

### **Schematic Reference**

[Engine Controls Schematics](#)

### **Connector End View Reference**

[Component Connector End Views](#)

### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

### **Description and Operation Reference**

- [Boost Control System Diagnosis](#)
- [Supercharger Description and Operation](#)
- [Boost Control System Description](#)

### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

### **Scan Tool Reference**

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

### **Special Tools**

GE 23738-A Vacuum Pump

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

## **Circuit/System Verification**

1. If you were sent here from DTC P0101, P0106, P0121 or P1101, refer to Circuit/System Testing.
2. Verify DTC P006D, P012C, P012D, P0641, P2227, P2228, or P2229 is not set.
  - ⇒ If a DTC is set, refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
3. Ignition On.



4. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90%.
  - ⇒ **If 90% or greater**  
Refer to [Throttle Body Cleaning](#).
  - ⇓ **If less than 90 %**  
**Note:** If the Throttle Sweep Test is not available on the scan tool, observe the scan tool Throttle Position Sensor 1 and 2 Agree/Disagree parameter while performing the following tests:
    - Slowly depress the accelerator pedal to wide open throttle (WOT) and then slowly return the pedal to closed throttle. Repeat the procedure several times.
    - Rapidly depress the accelerator pedal from the rest position to WOT and release pedal. Repeat the procedure several times.
5. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
  - ⇒ **If Disagree**  
Refer to [DTC P0120-P0123, P0220, P0222, P0223, or P2135](#).
  - ⇓ **If Agree**
6. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.
  - ⇒ **The pressure is not in range**  
Refer to [DTC P0106](#).
  - ⇓ **The pressure is within range**
7. Verify the scan tool Supercharger Inlet Pressure Sensor pressure parameter is within range specified in the [Altitude Versus Barometric Pressure](#) table.
  - ⇒ **The pressure is not in range**  
Refer to Circuit/System Testing.
  - ⇓ **The pressure is within range**
8. Verify the Supercharger Inlet Pressure Sensor pressure parameter decreases after starting the engine.
  - ⇒ **The pressure does not decrease**  
Refer to Circuit/System Testing.
  - ⇓ **The pressure decreases**
9. Verify the scan tool MAP Sensor pressure parameter is between 26–52 kPa (3.8–7.5 psi) and changes with accelerator pedal input.
  - ⇒ **If not between 26–52 kPa (3.8–7.5 psi) or does not change**  
Refer to [DTC P0106](#).
  - ⇓ **If between 26–52 kPa (3.8–7.5 psi) and changes**
10. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
  - 10.1. Engine idling
  - 10.2. Perform the scan tool snapshot function.
  - 10.3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
  - 10.4. Exit from the scan tool snapshot and review the data.
  - 10.5. Observe the MAF Sensor parameter frame by frame with a scan tool.
  - ⇒ **The parameter does not change smoothly and gradually**  
Refer to [DTC P0101](#).
  - ⇓ **The parameter changes smoothly and gradually**
11. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

12. Verify a DTC does not set.

⇒ **If any DTC sets**

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

⇓ **If no DTCs set**

13. All OK

### **Circuit/System Testing**

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

1. Verify none of the conditions listed below exist:

- Loose clamps, cracks, or other damage in the air intake duct system
- Collapsed or restricted air intake duct system
- Restricted air filter
- Splits, kinks or improper connections at the vacuum hoses
- Missing, restricted or leaking exhaust components—Refer to [Symptoms - Engine Mechanical](#).
- Vacuum leaks at the intake manifold and Q38 Throttle Body

⇒ **If a condition exists, repair as necessary.**

⇓ **If none of the conditions exist.**

2. Verify none of the conditions listed below exist with the supercharger system:

- A binding or restricted Q36 Supercharger Bypass Solenoid Valve, linkage or actuator. Refer to [Supercharger Cleaning and Inspection](#)
- Any damaged components
- Loose or improper installation of any components
- An air flow restriction
- Any vacuum leaks
- Water intrusion
- Contamination or debris blocking or restricting the B105 Supercharger Inlet Pressure Sensor port

⇒ **If a condition exists, repair as necessary.**

⇓ **If none of the conditions exist.**

3. Test or replace the B105 Supercharger Inlet Pressure Sensor.

### **Component Testing**

**Note:** You must perform the Circuit/System Testing before proceeding with the Component Testing.

1. Ignition Off, remove the B105 Supercharger Inlet Pressure Sensor.

2. Install a 3 A fused jumper wire between the 5 V reference terminal 1 of the sensor and 5 V. Install a jumper wire between the low reference terminal 2 of the sensor and ground.

3. Test for 4.9–0.4 V without any spikes or dropouts between the signal terminal 3 and the low reference terminal 2 while slowly applying vacuum to the sensor with the GE23738-4.

⇒ **If not between 4.9–0.4 V or has spikes or dropouts**

Replace the B105 Supercharger Inlet Pressure Sensor.

⇓ **If between 4.9–0.4 V and there are no spikes or dropouts**

4. All OK

### **Repair Instructions**

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

- [Supercharger Air Inlet Pressure Sensor Replacement](#)
- [Control Module References](#) for ECM replacement, programming, and setup

## DTC P012C or P012D

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P012C

Supercharger Inlet Pressure Sensor Circuit Low Voltage

#### DTC P012D

Supercharger Inlet Pressure Sensor Circuit High Voltage

### Diagnostic Fault Information

#### Supercharger Inlet Pressure Sensor

| Circuit                                   | Short to Ground                          | High Resistance | Open         | Short to Voltage                  | Signal Performance |
|-------------------------------------------|------------------------------------------|-----------------|--------------|-----------------------------------|--------------------|
| 5 V Reference                             | P0107, P012C, P0340, P0452, P0641, P2228 | P006D           | P0068, P012C | P0108, P0120, P012D, P0641, P2229 | P012B              |
| Supercharger Inlet Pressure Sensor Signal | P012B, P012C                             | P006D           | P0068, P012C | P012D                             | P012B              |
| Low Reference                             | —                                        | P006D, P012B    | P012D        | —                                 | P012B              |

### Typical Scan Tool Data

#### Supercharger Inlet Pressure Sensor

| Circuit                                                                                      | Short to Ground  | Open          | Short to Voltage   |
|----------------------------------------------------------------------------------------------|------------------|---------------|--------------------|
| <b>Operating Conditions:</b> Ignition On, Engine Off.<br><b>Parameter Normal Range:</b> BARO |                  |               |                    |
| 5 V Reference                                                                                | 1 kPa (0.14 psi) | 0 kPa (0 psi) | 127 kPa (18.4 psi) |
| Supercharger Inlet Pressure Sensor Signal                                                    | 0 kPa (0 psi)    | 0 kPa (0 psi) | 127 kPa (18.4 psi) |
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| Circuit       | Short to Ground | Open                  | Short to Voltage |
|---------------|-----------------|-----------------------|------------------|
| Low Reference | —               | 127 kPa<br>(18.4 psi) | —                |

### **Circuit Description**

The supercharger inlet pressure sensor measures the pressure after the throttle body, but before the supercharger. Pressure in this area is affected by engine speed, throttle opening, air temperature, and barometric pressure (BARO). The sensor provides a signal voltage that varies relative to pressure changes that occur from the various load and operating conditions of the engine. The engine control module (ECM) supplies a regulated 5 V reference circuit, and monitors the signal circuit.

Under normal operation the highest pressure that can exist in the supercharge intake manifold is equal to BARO. This occurs when the vehicle is operated at wide-open throttle (WOT) or when the ignition is On while the engine is Off. The lowest manifold pressures occur when the vehicle is idling or decelerating. The supercharger inlet pressure can range from 20 kPa to as much as BARO.

### **Conditions for Running the DTC**

- Ignition is On
- The DTCs run continuously when the above condition is met.

### **Conditions for Setting the DTC**

#### **P012C**

The ECM detects that the supercharger inlet pressure sensor voltage is less than 0.2 V for greater than 5 s.

#### **P012D**

The ECM detects that the supercharger inlet pressure sensor voltage is greater than 4.5 V for greater than 5 s.

### **Action Taken When the DTC Sets**

DTCs P012C and P012D are Type B DTCs.

### **Conditions for Clearing the MIL/DTC**

DTCs P012C and P012D are Type B DTCs.

### **Reference Information**

#### **Schematic Reference**

[Engine Controls Schematics](#)

#### **Connector End View Reference**

[Component Connector End 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

**Special Tools**

GE23738-A Vacuum Pump

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

**[Circuit/System Verification](#)**

1. Ignition On.
2. Verify that DTC P0641 is not set.  
⇒ **If the DTC is set** refer to [DTC P0641 or P0651](#).  
↓ **If the DTC is not set**
3. Verify the scan tool Supercharger Inlet Pressure Sensor voltage parameter is between 0.2–4.5 V.  
⇒ **If not between 0.2–4.5 V**  
Refer to Circuit/System Testing  
↓ **If between 0.2–4.5 V**
4. Engine idling, verify the scan tool Supercharger Inlet Pressure Sensor pressure parameter decreases.  
⇒ **If the pressure does not decrease**  
Refer to Circuit/System Testing  
↓ **If the pressure decreases**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify a DTC does not set.  
⇒ **If a DTC sets**  
Refer to Circuit/System Testing.  
↓ **If a DTC does not set**
7. All OK.

**[Circuit/System Testing](#)**

1. Ignition Off, disconnect the harness connector at the B105 Supercharger Inlet Pressure Sensor.
2. Ignition Off, and all vehicle systems Off. It may take up to 2 minutes for all vehicle systems to power down.
3. Test for less than 5  $\Omega$  between the low reference circuit terminal 2 and ground.  
⇒ **If 5  $\Omega$  or greater**
  - 3.1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
  - 3.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.  
⇒ If greater than the specified value, repair the open or high resistance in the circuit.  
⇒ If 2  $\Omega$  or less replace the K20 Engine Control Module.
- ↓ **If less than 5  $\Omega$**
4. Ignition On.
5. Test for 4.8–5.2 V between the 5 V reference circuit terminal 1 and ground.  
⇒ **If less than 4.8 V**

- 5.1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
- 5.2. 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
- 5.3. Test for less than 2  $\Omega$  in the 5 V reference circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
- ⇒ **If greater than 5.2 V**
  - 5.1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On.
  - 5.2. Test for less than 1 V between the 5 V reference circuit and ground.
    - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
    - ⇒ If less than 1 V, replace the K20 Engine Control Module.
- ⇓ **If between 4.8–5.2 V**
6. Verify the scan tool Supercharger Inlet Pressure Sensor parameter is less than 0.2 V.
- ⇒ **If 0.2 V or greater**
  - 6.1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On.
  - 6.2. Test for less than 1 V between the signal circuit terminal 3 and ground.
    - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
    - ⇒ If less than 1 V, replace the K20 Engine Control Module.
- ⇓ **If less than 0.2 V**
7. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1.
8. Verify the scan tool Supercharger Inlet Pressure Sensor parameter is greater than 4.5 V.
- ⇒ **If 4.5 V or less**
  - 8.1. Ignition Off, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
  - 8.2. 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
  - 8.3. Test for less than 2  $\Omega$  in the signal circuit end to end.
    - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
    - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
- ⇓ **If greater than 4.5 V**
9. Test or replace the B105 Supercharger Inlet Pressure Sensor.

### Component Testing

**Note:** You must perform the Circuit System Testing before proceeding with the Component Testing.

#### **Erratic Signal Test**

1. Ignition Off, remove the B105 Supercharger Inlet Pressure Sensor.
2. Install a 3 A fused jumper between the harness connector 5 V reference circuit terminal 1 and terminal 1 or A of the sensor.
3. Install a jumper wire between the low reference circuit terminal 2 or B of the sensor and ground.
4. Connect a DMM between terminal 3 or C of the sensor and ground.

5. Ignition On, slowly apply vacuum to the sensor with the *GE23738-A* .
6. Verify the voltage is between 0.2–4.9 V and changes without any spikes or dropouts.
  - ⇒ **If not between 0.2–4.9 V, does not change or has spikes or dropouts**  
Replace the B105 Supercharger Inlet Pressure Sensor.
  - ⇓ **If between 0.2–4.9 V, and changes without any spikes or dropouts**
7. All OK.

### Repair Instructions

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

- [Supercharger Air Inlet Pressure Sensor Replacement](#)
- [Control Module References](#) for ECM replacement, programming, and setup



## **DTC P0131, P0132, P0134, P0137, P0138, P0140, P0151, P0152, P0154, P0157, P0158, or P0160**

### **Diagnostic Instructions**

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

### **DTC Descriptors**

#### **DTC P0131**

HO2S Circuit Low Voltage Bank 1 Sensor 1

#### **DTC P0132**

HO2S Circuit High Voltage Bank 1 Sensor 1

#### **DTC P0134**

HO2S Circuit Insufficient Activity Bank 1 Sensor 1

#### **DTC P0137**

HO2S Circuit Low Voltage Bank 1 Sensor 2

#### **DTC P0138**

HO2S Circuit High Voltage Bank 1 Sensor 2

#### **DTC P0140**

HO2S Circuit Insufficient Activity Bank 1 Sensor 2

#### **DTC P0151**

HO2S Circuit Low Voltage Bank 2 Sensor 1

#### **DTC P0152**

HO2S Circuit High Voltage Bank 2 Sensor 1

#### **DTC P0154**

HO2S Circuit Insufficient Activity Bank 2 Sensor 1

#### **DTC P0157**

HO2S Circuit Low Voltage Bank 2 Sensor 2

#### **DTC P0158**

HO2S Circuit High Voltage Bank 2 Sensor 2

#### **DTC P0160**

HO2S Circuit Insufficient Activity Bank 2 Sensor 2

### **Diagnostic Fault Information**

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| Circuit            | Short to Ground                                         | High Resistance                                                                                                                         | Open                                                                                                                                                                                                                    | Short to Voltage                                                                                | Signal Performance                                                                                                                   |
|--------------------|---------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| HO2S Signal        | P0131,<br>P0137,<br>P0151,<br>P0157,<br>P1133,<br>P1153 | P0131,<br>P0132,<br>P0133,<br>P0134,<br>P0137,<br>P0140,<br>P0151,<br>P0152,<br>P0153,<br>P0154,<br>P0157,<br>P0160,<br>P1133,<br>P1153 | P013A,<br>P013B,<br>P013C,<br>P013D,<br>P013E,<br>P013F,<br>P0131,<br>P0132,<br>P0133,<br>P0134,<br>P0137,<br>P0138,<br>P0140,<br>P0151,<br>P0152,<br>P0153,<br>P0154,<br>P0157,<br>P0158,<br>P0160,<br>P1133,<br>P1153 | P0132,<br>P0134,<br>P0138,<br>P0140,<br>P0152,<br>P0154,<br>P0158,<br>P0160,<br>P1133,<br>P1153 | P013A,<br>P013B,<br>P013C,<br>P013D,<br>P013E,<br>P013F,<br>P0133,<br>P0134,<br>P0140,<br>P0153,<br>P0154,<br>P0160,<br>P1133, P1153 |
| HO2S Low Reference | P0131,<br>P0137,<br>P0151,<br>P0157                     | P0131,<br>P0132,<br>P0133,<br>P0134,<br>P0138,<br>P0140,<br>P0151,<br>P0152,<br>P0153,<br>P0154,<br>P0158,<br>P0160,<br>P1133,<br>P1153 | P013A,<br>P013B,<br>P013C,<br>P013D,<br>P013E,<br>P013F,<br>P0131,<br>P0132,<br>P0133,<br>P0134,<br>P0138,<br>P0140,<br>P0151,<br>P0152,<br>P0153,<br>P0154,<br>P0158,<br>P0160,<br>P1133,<br>P1153                     | P0134,<br>P0138,<br>P0140,<br>P0154,<br>P0158,<br>P0160,<br>P1133,<br>P1153                     | —                                                                                                                                    |

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**Typical Scan Tool Data****HO2S Sensor 1 or 2 Voltage**

| Circuit                                   | Short to Ground | Open                 | Short to Voltage       |
|-------------------------------------------|-----------------|----------------------|------------------------|
| <b>Parameter Normal Range:</b> 200–800 mV |                 |                      |                        |
| HO2S High Signal                          | 0 mV            | Approximately 470 mV | Approximately 1,100 mV |
| HO2S Low Reference                        | 455 mV          |                      |                        |

| Circuit | Short to Ground | Open                 | Short to Voltage     |
|---------|-----------------|----------------------|----------------------|
|         |                 | Approximately 450 mV | Approximately 445 mV |

### Circuit/System Description

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

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

### Conditions for Running the DTC

#### **P0131, P0137, P0151, or P0157**

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is operating in Closed Loop.
- The Ignition 1 voltage is between 10–32 V.
- The fuel level is greater than 10%.
- The throttle position (TP) is between 3–70%.
- The DTCs run continuously when the above conditions are met for 2 s.

#### **P0132, P0138, P0152, or P0158**

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is operating in Closed Loop.
- The Ignition 1 voltage is between 10–32 V.
- The fuel level is greater than 10%.
- The throttle position (TP) is between 0–70%.
- The DTCs run continuously when the above conditions are met for 2 s.

#### **P0134, P0140, P0154, or P0160**

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition 1 voltage is between 10–32 V.
- The engine run time is greater than 300 s.
- The engine is operating in Closed Loop.
- The DTCs run continuously when the above conditions are met.

### [Conditions for Setting the DTC](#)

#### **P0131, P0137, P0151, or P0157**

- The ECM detects that the HO2S voltage is less than 50 mV.
- The DTCs set within 48 s when the above condition is met.

#### **P0132, P0138, P0152, or P0158**

- The ECM detects that the HO2S voltage is greater than 1,050 mV.
- The DTCs set within 13 s when the above condition is met.

#### **P0134 or P0154**

The ECM detects that the HO2S 1 voltage is between 350–550 mV for at least 50 s.

#### **P0140 or P0160**

The ECM detects that the HO2S 2 voltage is between 410–490 mV for at least 74 s.

### [Action Taken When the DTC Sets](#)

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

### [Conditions for Clearing the MIL/DTC](#)

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

### [Reference Information](#)

#### **Schematic Reference**

[Engine Controls Schematics](#)

#### **Connector End View Reference**

[Component Connector End Views](#)

#### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

#### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

#### **Scan Tool Reference**

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

### [Circuit/System Verification](#)

1. Ignition ON.
2. Verify no HO2S heater DTCs are set.  
⇒ **If a DTC is set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
- ⇓ **If a DTC is not set**
3. Engine running.
4. Verify the scan tool HO2S Bank 1 or 2 Sensor 1 or 2 parameters are between 50–1,050 mV.  
⇒ **If not between 50–1,050 mV**

Refer to Circuit/System Testing.

⇓ **If between 50–1,050 mV**

5. Operate the vehicle within the Conditions for Running. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
  - ⇒ **If the DTC sets**  
Refer to Circuit/System Testing.
  - ⇓ **If the DTC does not set**
7. All OK.

**Circuit/System Testing**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B52 HO2S. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5  $\Omega$  between the low reference circuit terminal A and ground.
  - ⇒ **If greater than 5  $\Omega$** 
    - 2.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    - 2.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
  - ⇓ **If less than 5  $\Omega$**
3. Ignition ON.
4. Verify the scan tool heated oxygen sensor Bank 1 or 2 Sensor 1 or 2 parameter is greater than 200 mV.
  - ⇒ **If 200 mV or less**
    - 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    - 4.2. Test for infinite resistance between the signal circuit terminal B 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 200 mV**
5. Install a 3 A fused jumper wire between the signal circuit terminal B and low reference circuit terminal A.
6. Verify the scan tool heated oxygen sensor Bank 1 or 2 Sensor 1 or 2 parameter is less than 60 mV.
  - ⇒ **If 60 mV or greater**
    - 6.1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module. Ignition ON.
    - 6.2. Test for less than 1 V between the signal circuit terminal B and ground.
      - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
      - ⇓ If less than 1 V.
    - 6.3. Ignition OFF.
    - 6.4. Test for less than 2  $\Omega$  in the signal circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
  - ⇓ **If less than 60 mV**
7. Verify none of the conditions listed below exist:
  - Water intrusion in the B52 heated oxygen sensor harness connector
  - Low or high fuel system pressure—Refer to [Fuel System Diagnosis](#).

- Fuel that is contaminated—Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
- Fuel saturation of the evaporative emission (EVAP) canister
- Exhaust leaks
- Engine vacuum leaks

⇒ **If any of the conditions exist**

Repair as necessary.

⇓ **If none of the conditions exist**

8. Test or replace the B52 Heated Oxygen Sensor.

### **Repair Instructions**

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

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

## DTC P0133, P0153, P015A-P015D, or P2270-P2273 (LSA)

### Diagnostic Instructions

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

### DTC Descriptors

**DTC P0133**

HO2S Slow Response Bank 1 Sensor 1

**DTC P0153**

HO2S Slow Response Bank 2 Sensor 1

**DTC P015A**

HO2S Delayed Response Rich to Lean Bank 1 Sensor 1

**DTC P015B**

HO2S Delayed Response Lean to Rich Bank 1 Sensor 1

**DTC P015C**

HO2S Delayed Response Rich to Lean Bank 2 Sensor 1

**DTC P015D**

HO2S Delayed Response Lean to Rich Bank 2 Sensor 1

**DTC P2270**

HO2S Signal Stuck Lean Bank 1 Sensor 2

**DTC P2271**

HO2S Signal Stuck Rich Bank 1 Sensor 2

**DTC P2272**

HO2S Signal Stuck Lean Bank 2 Sensor 2

**DTC P2273**

HO2S Signal Stuck Rich Bank 2 Sensor 2

### Diagnostic Fault Information

| Circuit          | Short to Ground              | High Resistance                     | Open                                | Short to Voltage                     | Signal Performance                   |
|------------------|------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|--------------------------------------|
| HO2S High Signal | P0131,P0137,<br>P0151, P0157 | P0131,<br>P0132,<br>P0133,<br>P0134 | P0131,<br>P0132,<br>P0133,<br>P0134 | P0132,<br>P0134,<br>P0138,<br>P0140, | P0133,<br>P0153,<br>P015A,<br>P015B, |

| Circuit            | Short to Ground                  | High Resistance                                                                                                     | Open                                                                                                                | Short to Voltage                                        | Signal Performance                                                                 |
|--------------------|----------------------------------|---------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|------------------------------------------------------------------------------------|
|                    |                                  | P0137,<br>P0140,<br>P0151,<br>P0152,<br>P0153,<br>P0154,<br>P0157,<br>P0160                                         | P0137,<br>P0140,<br>P0151,<br>P0152,<br>P0153,<br>P0154,<br>P0157,<br>P0160                                         | P0152,<br>P0154,<br>P0158,<br>P0160                     | P015C,<br>P015D,<br>P0160,<br>P2270, P2271                                         |
| HO2S Low Reference | P0131,<br>P0137,<br>P0151, P0157 | P0131,<br>P0132,<br>P0133,<br>P0134,<br>P0138,<br>P0140,<br>P0151,<br>P0152,<br>P0153,<br>P0154,<br>P0158,<br>P0160 | P0131,<br>P0132,<br>P0133,<br>P0134,<br>P0138,<br>P0140,<br>P0151,<br>P0152,<br>P0153,<br>P0154,<br>P0158,<br>P0160 | P0134,<br>P0138,<br>P0140,<br>P0154,<br>P0158,<br>P0160 | P0133,<br>P0153,<br>P015A,<br>P015B,<br>P015C,<br>P015D,<br>P0160,<br>P2270, P2271 |

### Circuit/System Description

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

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

### Conditions for Running the DTC

#### **P0133, P0153, P015A, P015B, P015C, or P015D**

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine coolant temperature (ECT) is warmer than 60°C (140°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F)
- The ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The engine run time is greater than 160 s.
- The engine speed is between 1,200-3,000 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 20-55 g/s.
- The fuel system is in Closed Loop.
- The throttle position (TP) is greater than 5%.



- The DTCs run once per drive cycle when the above conditions are met.

#### **P2270 or P2272**

- DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.
- The ignition voltage is between 10–32 V.
- The engine run time is greater than 5 min.
- The engine speed is between 500–5,000 RPM.
- The mass airflow (MAF) is between 3–20 g/s.
- The vehicle speed is between 24–132 km/h (15–82 mph).
- Evap is not in control of purge.
- HO2S heater is ON for greater than 100 s.
- Power Take Off Mode is not active.
- EGR Intrusive diagnostic is not active.
- The fuel level is greater than 10%.
- The fuel system is in Closed Loop.
- The catalytic converter temperature is between 600–900°C (1,112–1,652°F).
- The DTCs run once per ignition cycle when the above conditions are met.

#### **P2271 or P2273**

- Before the ECM can report DTC P2271, or P2273 failed, DTCs P013A, P013C, P013E, P014A, P2270, and P2272 must run and pass.
- DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.
- The ignition voltage is between 10–32 V.
- The engine speed is between 1,050–2,500 RPM.
- The mass airflow (MAF) is between 3–20 g/s.
- The vehicle speed is between 71–121 km/h (44–75 mph).
- The fuel level is greater than 10%.
- The fuel system is in Closed Loop.
- Evap is not in control of purge.
- Power Take Off is not active.
- EGR Intrusive diagnostic is not active.
- The DTCs run once per ignition cycle, during decel fuel cut-off, when the above conditions are met.

#### **Conditions for Setting the DTC**

##### **P0133, P0153, P015A, P015B, P015C or P015D**

- The ECM detects that the heated oxygen sensor rich-to-lean or lean-to-rich average response time is greater than a calibrated value.
- The DTCs set within 100 s when the above condition is met.

##### **P1133 or P1153**

- The ECM detects that the heated oxygen sensor rich-to-lean counts, or the lean-to-rich counts are less than a calibrated value.
- The DTCs set within 100 s when the above condition is met.

##### **P2270 or P2272**

The ECM does not detect a heated oxygen sensor voltage greater than 800 mV before accumulated mass air flow exceeds a calibrated value.

#### **P2271 or P2273**

The ECM does not detect a heated oxygen sensor voltage less than 100 mV before accumulated mass air flow exceeds a calibrated value.

#### **Action Taken When the DTC Sets**

- DTCs P0133, P0153, and P2270-P2273 are Type B DTCs.
- DTCs P015A, P015B, P015C, and P015D are Type A DTCs.

#### **Conditions for Clearing the DTC**

- DTCs P0133, P0153, and P2270-P2273 are Type B DTCs.
- DTCs P015A, P015B, P015C, and P015D are Type A DTCs.

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End Views](#)

##### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

##### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

##### **Scan Tool Reference**

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

#### **Circuit/System Verification**

1. Ignition ON.
2. Verify no HO2S heater DTCs are set.

##### **⇒ If a DTC is set**

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

##### **⇓ If a DTC is not set**

3. Verify none of the conditions listed below exist:
  - Lean or rich fuel injectors—Refer to [Fuel Injector Diagnosis](#)
  - Water intrusion in the HO2S harness connector
  - Low or high fuel system pressure—Refer to [Fuel System Diagnosis](#)
  - Fuel that is contaminated—Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#)
  - Fuel saturation of the evaporative emission (EVAP) canister
  - Exhaust leaks
  - Engine vacuum leaks
  - Engine oil consumption—Refer to [Oil Consumption Diagnosis](#)

- Engine coolant consumption

⇒ **If any of the above conditions exist**

Repair as necessary.

↓ **If any of the conditions exist**

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

5. Verify the DTC does not set.

⇒ **If the DTC sets**

Test or replace the appropriate B52 Heated Oxygen Sensor.

↓ **If the DTC does not set**

6. All OK.

### **Repair Instructions**

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

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

## DTC P0133, P0153, P1133, P1153, or P2270-P2273 (L77, LS3)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0133

HO2S Slow Response Bank 1 Sensor 1

#### DTC P0153

HO2S Slow Response Bank 2 Sensor 1

#### DTC P1133

HO2S Insufficient Switching Bank 1 Sensor 1

#### DTC P1153

HO2S Insufficient Switching Bank 2 Sensor 1

#### DTC P2270

HO2S Signal Stuck Lean Bank 1 Sensor 2

#### DTC P2271

HO2S Signal Stuck Rich Bank 1 Sensor 2

#### DTC P2272

HO2S Signal Stuck Lean Bank 2 Sensor 2

#### DTC P2273

HO2S Signal Stuck Rich Bank 2 Sensor 2

### Diagnostic Fault Information

| Circuit          | Short to Ground                                  | High Resistance                                                                                           | Open                                                                                                      | Short to Voltage                                                                                | Signal Performance                                                                           |
|------------------|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| HO2S High Signal | P0131,P0137,<br>P0151,<br>P0157,<br>P1133, P1153 | P0131,<br>P0132,<br>P0133,<br>P0134,<br>P0137,<br>P0140,<br>P0151,<br>P0152,<br>P0153,<br>P0154,<br>P0157 | P0131,<br>P0132,<br>P0133,<br>P0134,<br>P0137,<br>P0140,<br>P0151,<br>P0152,<br>P0153,<br>P0154,<br>P0157 | P0132,<br>P0134,<br>P0138,<br>P0140,<br>P0152,<br>P0154,<br>P0158,<br>P0160,<br>P1133,<br>P1153 | P0133,<br>P0134,<br>P0140,<br>P0153,<br>P0154,<br>P0160,<br>P1133,<br>P1153,<br>P2270, P2271 |

| Circuit            | Short to Ground                  | High Resistance                                                                                                               | Open                                                                                                                                    | Short to Voltage                                                            | Signal Performance |
|--------------------|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------------------|
|                    |                                  | P0160,<br>P1133,<br>P1153                                                                                                     | P0160,<br>P1133,<br>P1153                                                                                                               |                                                                             |                    |
| HO2S Low Reference | P0131,<br>P0137,<br>P0151, P0157 | P0131,<br>P0132,<br>P0133,<br>P0134,<br>P0138,<br>P0140,<br>P0151,<br>P0152,<br>P0153,<br>P0154,<br>P0158,<br>P0160,<br>P1133 | P0131,<br>P0132,<br>P0133,<br>P0134,<br>P0138,<br>P0140,<br>P0151,<br>P0152,<br>P0153,<br>P0154,<br>P0158,<br>P0160,<br>P1133,<br>P1153 | P0134,<br>P0138,<br>P0140,<br>P0154,<br>P0158,<br>P0160,<br>P1133,<br>P1153 | —                  |

### Circuit/System Description

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

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

### Conditions for Running the DTC

#### **P0133, P0153, P1133, or P1153**

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine coolant temperature (ECT) is warmer than 60°C (140°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F)
- The ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The engine run time is greater than 160 s.
- The engine speed is between 1,200-3,000 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 20-55 g/s.
- The fuel system is in Closed Loop.
- The throttle position (TP) is greater than 5%.
- The DTCs run once per drive cycle when the above conditions are met.

**P2270 or P2272**

- DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.
- The ignition voltage is between 10–32 V.
- The engine run time is greater than 5 min.
- The engine speed is between 500–5,000 RPM.
- The mass airflow (MAF) is between 3–20 g/s.
- The vehicle speed is between 24–132 km/h (15–82 mph).
- Evap is not in control of purge.
- HO2S heater is ON for greater than 100 s.
- Power Take Off Mode is not active.
- EGR Intrusive diagnostic is not active.
- The fuel level is greater than 10%.
- The fuel system is in Closed Loop.
- The catalytic converter temperature is between 600–900°C (1,112–1,652°F).
- The DTCs run once per ignition cycle when the above conditions are met.

**P2271 or P2273**

- Before the ECM can report DTC P2271, or P2273 failed, DTCs P013A, P013C, P013E, P014A, P2270, and P2272 must run and pass.
- DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.
- The ignition voltage is between 10–32 V.
- The engine speed is between 1,050–2,500 RPM.
- The mass airflow (MAF) is between 3–20 g/s.
- The vehicle speed is between 71–121 km/h (44–75 mph).
- The fuel level is greater than 10%.
- The fuel system is in Closed Loop.
- Evap is not in control of purge.
- Power Take Off is not active.
- EGR Intrusive diagnostic is not active.
- The DTCs run once per ignition cycle, during decel fuel cut-off, when the above conditions are met.

**Conditions for Setting the DTC****P0133 or P0153**

- The ECM detects that the heated oxygen sensor rich-to-lean or lean-to-rich average response time is greater than a calibrated value.
- The DTCs set within 100 s when the above condition is met.

**P1133 or P1153**

- The ECM detects that the heated oxygen sensor rich-to-lean counts, or the lean-to-rich counts are less than a calibrated value.
- The DTCs set within 100 s when the above condition is met.

**P2270 or P2272**

The ECM does not detect a heated oxygen sensor voltage greater than 800 mV before accumulated mass air flow exceeds a calibrated value.

**P2271 or P2273**

The ECM does not detect a heated oxygen sensor voltage less than 100 mV before accumulated mass air flow exceeds a calibrated value.

**Action Taken When the DTC Sets**

DTCs P0133, P0153, P1133, P1153 and P2270-P2273 are Type B DTCs.

**Conditions for Clearing the DTC**

DTCs P0133, P0153, P1133, P1153 and P2270-P2273 are Type B DTCs.

**Reference Information****Schematic Reference**

[Engine Controls Schematics](#)

**Connector End View Reference**

[Component Connector End Views](#)

**Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

**DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

**Scan Tool Reference**

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

**Circuit/System Verification**

1. Ignition ON.
2. Verify no HO2S heater DTCs are set.

⇒ **If a DTC is set**

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

↓ **If a DTC is not set**

3. Verify none of the conditions listed below exist:

- Lean or rich fuel injectors—Refer to [Fuel Injector Diagnosis](#)
- Water intrusion in the HO2S harness connector
- Low or high fuel system pressure—Refer to [Fuel System Diagnosis](#)
- Fuel that is contaminated—Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#)
- Fuel saturation of the evaporative emission (EVAP) canister
- Exhaust leaks
- Engine vacuum leaks
- Engine oil consumption—Refer to [Oil Consumption Diagnosis](#)
- Engine coolant consumption

⇒ **If any of the above conditions exist**

Repair as necessary.

↓ **If any of the conditions exist**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.  
⇒ **If the DTC sets**  
Test or replace the appropriate B52 Heated Oxygen Sensor.  
⇓ **If the DTC does not set**
6. All OK.

### **Repair Instructions**

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

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



## DTC P0171, P0172, P0174, or P0175

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0171

Fuel Trim System Lean Bank 1

#### DTC P0172

Fuel Trim System Rich Bank 1

#### DTC P0174

Fuel Trim System Lean Bank 2

#### DTC P0175

Fuel Trim System Rich Bank 2

### Circuit/System Description

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

### Conditions for Running the DTC

- DTCs P0030, P0050, P0053, P0059, P0101, P0102, P0103, P0106, P0107, P0108, P012B, P012C, P012D, P0131, P0132, P0133, P0134, P0135, P0151, P0152, P0153, P0154, P0155, P015A, P015B, P015C, P015D, P0178, P0179, P0201-P0208, P0300, P0301-P0308, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0506, P0507, P1133, P1153, P2227, P2228, P2229, P2230, or P2269 are not set.
- The engine is in closed loop status.
- The catalyst monitor intrusive test, post O2 diagnosis intrusive test, device controls, and EVAP diagnosis leak test are not active.
- The engine coolant temperature (ECT) is between -40 and +150°C (-40 and +302°F).
- The intake air temperature (IAT) is between -7 and +150°C (19 and 302°F).
- The manifold absolute pressure (MAP) is between 10-255 kPa (1.45-37 psi).
- The engine speed is between 375-7,000 RPM.
- The mass air flow (MAF) is between 1-510 g/s.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 psi).

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- The fuel level is greater than 10 percent.
- This diagnostic runs continuously when the above conditions have been met.

#### **Conditions for Setting the DTC**

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

#### **Action Taken When the DTC Sets**

DTCs P0171, P0172, P0174, and P0175 are Type B DTCs.

#### **Conditions for Clearing the MIL/DTC**

DTCs P0171, P0172, P0174, and P0175 are Type B DTCs.

#### **Diagnostic Aids**

- Allow the engine to reach operating temperature. With the engine running, observe the HO2S parameter with a scan tool. The HO2S value should vary from approximately 40 mV to approximately 900 mV, and respond to fueling changes.
- The normal Short Term FT and Long Term FT parameters should be between +10 and -10 percent the optimum with the engine running at operating temperature.
- A fuel system delivery condition causes this DTC to set. Thoroughly inspect all items that cause a rich or a lean condition. Refer to [Fuel System Diagnosis](#).
- Any un-metered air into the engine causes this DTC to set. Thoroughly inspect all areas of the engine for vacuum leaks.
- A MAF sensor condition can cause this DTC without setting a MAF DTC. If there is a MAF sensor condition, the MAF sensor parameters will appear to be within range.
- Inspect the air filter for being the correct one for this application. Make sure that the engine oil fill cap is in place, and that it is tight. Verify that the engine oil dip stick is fully seated.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

#### **Reference Information**

##### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

##### **Scan Tool Reference**

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

#### **Circuit/System Verification**

1. Engine running, observe the DTC information with a scan tool. Verify there are no HO2S DTCs set.  
⇒ If any DTCs are set, refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
2. Ignition ON, engine OFF, observe the Manifold Absolute Pressure (MAP) Sensor parameter. The MAP sensor pressure should be within the range specified for your altitude. Refer to [Altitude Versus Barometric Pressure](#).

- ⇒ If the MAP sensor pressure is not within the range specified for your altitude, refer to [DTC P0106](#).
3. With the engine idling, observe the Mass Air Flow (MAF) Sensor parameter. The MAF Sensor parameter should be within 2–6 g/s at idle.
- ⇒ If not within the specified range, refer to [DTC P0101](#) or [DTC P0102 or P0103](#).
4. Engine at normal operating temperature, observe the scan tool Long Term FT parameter. The reading should be between –25 to +29.5 percent.
- ⇒ If not within the specified range, verify none of the conditions listed below exist:
- Split, kinked, or improperly connected vacuum hoses
  - Insufficient fuel in the tank
  - Low fuel pressure. Refer to [Fuel System Diagnosis](#).
  - Fuel contamination. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
  - Malfunctioning fuel injectors. Refer to [Fuel Injector Diagnosis](#).
  - Missing, restricted, or leaking exhaust components. Refer to [Symptoms - Engine Exhaust](#).
  - Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings
  - Leaks in the air induction system and the air intake ducts
  - Missing air filter element
  - Cracked EVAP canister
  - Evaporative pipes obstructed or leaking
  - Leaks in the crankcase ventilation system. Refer to [Crankcase Ventilation System Inspection/Diagnosis](#).
  - Collapsed or restricted air intake duct
  - Dirty or restricted air filter
  - Objects blocking the throttle body
  - Excessive fuel in the crankcase
  - Improper operation of the evaporative emissions control system
  - Excessive fuel pressure. Refer to [Fuel System Diagnosis](#).
  - Missing, restricted, or leaking exhaust components. Refer to [Symptoms - Engine Exhaust](#).
  - Malfunctioning fuel injectors. Refer to [Fuel Injector Diagnosis](#).
  - Fuel contamination. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
5. If all conditions test normal, test the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#).
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

### **[Repair Instructions](#)**

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

## DTC P0178

### Diagnostic Instructions

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

### DTC Descriptor

#### **DTC P0178**

Fuel Composition Sensor Circuit Low Frequency

### Circuit/System Description

Alcohol content information is supplied to the engine control module (ECM) from the fuel composition sensor. The fuel composition sensor has a battery positive circuit, a signal circuit, and a ground circuit. The fuel composition sensor uses a microprocessor inside the sensor to measure the ethanol percentage and changes the output signal accordingly. The signal circuit carries the ethanol percentage via the frequency signal. The ECM provides an internal pull up to 5V on the signal circuit, and the fuel composition sensor pulls the 5V to ground in pulses. The normal range of operating frequency is between 50–150 Hz. The microprocessor inside the sensor is capable of a certain amount of self-diagnosis. An output frequency between 180 Hz and 190 Hz indicates that the fuel is contaminated.

### Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The DTC runs continuously when the above condition is met.

### Conditions for Setting the DTC

The engine control module detects that the fuel composition sensor output frequency is less than 45 Hz for greater than 6 s.

### Action Taken When the DTC Sets

DTC P0178 is a Type B DTC.

### Conditions for Clearing the MIL/DTC

DTC P0178 is a Type B DTC.

### Diagnostic Aids

- The Fuel Composition Sensor scan tool parameter reacts immediately to any change in the fuel composition sensor circuits, but may not react long enough to set a DTC.
- An intermittent condition may not be detected because the sensor does not immediately power down and the connection may be restored before voltage drops below the operating threshold.
- If this DTC will not reset and the parameters are steady, thoroughly inspect all fuel composition sensor circuits for an intermittent open.

### Reference Information

#### **Schematic Reference**

#### [Engine Controls Schematics](#)

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## Connector End View Reference

[Component Connector End 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

- J38522-A Variable Signal Generator
- J44175-A Fuel Composition Tester

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

## Circuit/System Verification

1. Engine running,
2. Verify the scan tool Fuel Composition Sensor parameter is between 50–150 Hz.  
⇒ **If not between 50–150 Hz**  
Refer to Circuit/System Testing.  
↓ **If between 50–150 Hz**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.  
⇒ **If the DTC sets**  
Refer to Circuit/System Testing.  
↓ **If the DTC does not set**
5. All OK.

## Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B198 Fuel Composition Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5  $\Omega$  between the ground circuit terminal 2 and ground.  
⇒ **If 5  $\Omega$  or greater**
  - 2.1. Ignition OFF.
  - 2.2. Test for less than 2  $\Omega$  in the ground circuit end to end.  
⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
⇒ If less than 2  $\Omega$ , repair the open/high resistance in the ground connection.
- ↓ **If less than 5  $\Omega$**

3. Ignition ON.
4. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
  - ⇒ **If the test lamp does not illuminate and the circuit fuse is OK**
    - 4.1. Ignition OFF, remove the test lamp.
    - 4.2. Test for less than  $2\ \Omega$  in the B+ circuit end to end.
      - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than  $2\ \Omega$ , verify the fuse is OK and there is voltage at the fuse.
  - ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
    - 4.1. Ignition OFF, remove the test lamp.
    - 4.2. Test for infinite resistance between the B+ circuit and ground.
      - ⇒ If less than infinite resistance, repair the short to ground in the circuit.
      - ⇒ If infinite resistance, replace the B198 Fuel Composition Sensor.
- ⇓ **If the test lamp illuminates**
5. Ignition ON.
6. Test for 4.8–5.2 V between the signal circuit terminal 3 and ground.
  - ⇒ **If less than 4.8 V**
    - 6.1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module.
    - 6.2. Test for infinite resistance between the signal circuit and ground.
      - ⇒ If less than infinite resistance, repair the short to ground in the circuit.
      - ⇓ If infinite resistance
    - 6.3. Test for less than  $2\ \Omega$  in the signal circuit end to end.
      - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than  $2\ \Omega$ , replace the K20 Engine Control Module.
  - ⇒ **If greater than 5.2 V**
    - 6.1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module.
    - 6.2. Ignition ON.
    - 6.3. 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, replace the K20 Engine Control Module.
- ⇓ **If between 4.8–5.2 V**
7. Ignition OFF, connect the red lead of the J38522–A Variable Signal Generator to the signal circuit terminal 3 at the B198 fuel composition sensor harness connector.
8. Connect the battery voltage supply to B+, and the black lead to ground.
9. Set the J38522–A Variable Signal Generator Signal to 5 V, the Frequency to 60 Hz, and the Duty Cycle to Normal.
10. Ignition ON.
11. Verify the scan tool Fuel Composition Sensor parameter is at 60 Hz.
  - ⇒ **If not 60 Hz**
    - Replace the K20 Engine Control Module.
  - ⇓ **If 60 Hz**
12. Test or replace the B198 Fuel Composition Sensor.

### Component Testing

1. Test the fuel composition using the J44175–A Fuel Composition Tester and the J44175–A Instruction Manual. Record the frequency.

2. Compare the special tool test frequency and the scan tool Fuel Composition Sensor frequency parameter. The difference between the tool and the sensor should be less than 12 Hz.

⇒ If greater than the specified value, replace the B198 Fuel Composition Sensor.

### **Repair Instructions**

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

- [Flexible Fuel Sensor Replacement](#)
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup.

## DTC P0179

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P0179

Fuel Composition Sensor Circuit High Frequency

### Circuit/System Description

Alcohol content information is supplied to the engine control module (ECM) from the fuel composition sensor. The fuel composition sensor has a battery positive circuit, a signal circuit, and a ground circuit. The fuel composition sensor uses a microprocessor inside the sensor to measure the ethanol percentage and changes the output signal accordingly. The signal circuit carries the ethanol percentage via the frequency signal. The ECM provides an internal pull up to 5 V on the signal circuit, and the fuel composition sensor pulls the 5 V to ground in pulses. The normal range of operating frequency is between 50–150 Hz. The microprocessor inside the sensor is capable of a certain amount of self-diagnosis. An output frequency between 180 Hz and 190 Hz indicates that the fuel is contaminated.

### Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The DTC runs continuously when the above condition is met.

### Conditions for Setting the DTC

The engine control module detects that the fuel composition sensor output frequency is between 155–185 Hz for greater than 6 s.

### Action Taken When the DTC Sets

DTC P0179 is a Type B DTC.

### Conditions for Clearing the MIL/DTC

DTC P0179 is a Type B DTC.

### Diagnostic Aids

A momentary slug of water in the fuel system may set this DTC.

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

[Component Connector End 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

## Special Tools

- J38522-A Variable Signal Generator
- J44175-A Fuel Composition Tester

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

## Circuit/System Verification

1. Engine running.
2. Verify the scan tool Fuel Composition Sensor parameter is between 50–150 Hz.  
⇒ **If not between 50–150 Hz**  
Refer to Circuit/System Testing.  
↓ **If between 50–150 Hz**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.  
⇒ **If the DTC sets**  
Refer to Circuit/System Testing.  
↓ **If the DTC does not set**
5. All OK.

## Circuit/System Testing

1. Verify that there are no contaminants, water, or too high of a concentration of ethanol in the fuel. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) and the J44175-A Instruction Manual.
2. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B198 Fuel Composition Sensor. It may take up to 2 min for all vehicle systems to power down.
3. Test for less than 5  $\Omega$  between the ground circuit terminal 2 and ground.  
⇒ **If 5  $\Omega$  or greater**
  - 3.1. Ignition OFF.
  - 3.2. Test for less than 2  $\Omega$  in the ground circuit end to end.  
⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
⇒ If less than 2  $\Omega$ , repair the open/high resistance in the ground connection.
- ↓ **If less than 5  $\Omega$**
4. Ignition ON.
5. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.  
⇒ **If the test lamp does not illuminate and the circuit fuse is OK**

- 5.1. Ignition OFF, remove the test lamp.
- 5.2. Test for less than  $2\ \Omega$  in the B+ circuit end to end.
  - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than  $2\ \Omega$ , verify the fuse is OK and there is voltage at the fuse.
- ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
  - 5.1. Ignition OFF, remove the test lamp.
  - 5.2. Test for infinite resistance between the B+ circuit and ground.
    - ⇒ If less than infinite resistance, repair the short to ground in the circuit.
    - ⇒ If infinite resistance, replace the B198 Fuel Composition Sensor.
- ⇓ **If the test lamp illuminates**
6. Ignition ON.
7. Test for 4.8–5.2 V between the signal circuit terminal 3 and ground.
  - ⇒ **If less than 4.8 V**
    - 7.1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module.
    - 7.2. Test for infinite resistance between the signal circuit and ground.
      - ⇒ If less than infinite resistance, repair the short to ground in the circuit.
      - ⇓ If infinite resistance
    - 7.3. Test for less than  $2\ \Omega$  in the signal circuit end to end.
      - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than  $2\ \Omega$ , replace the K20 Engine Control Module.
  - ⇒ **If greater than 5.2 V**
    - 7.1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module.
    - 7.2. Ignition ON.
    - 7.3. 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, replace the K20 Engine Control Module.
  - ⇓ **If between 4.8–5.2 V**
  - 8. Ignition OFF, connect the red lead of the J38522–A Variable Signal Generator to the signal circuit terminal 3 at the B198 Fuel Composition Sensor harness connector.
  - 9. Connect the battery voltage supply to B+, and the black lead to ground.
  - 10. Set the J38522–A Variable Signal Generator Signal to 5 V, the Frequency to 60 Hz, and the Duty Cycle to Normal.
  - 11. Ignition ON.
  - 12. Verify the scan tool Fuel Composition Sensor parameter is at 60 Hz.
    - ⇒ **If not 60 Hz**  
Replace the K20 Engine Control Module.
    - ⇓ **If 60 Hz**
  - 13. Test or replace the B198 Fuel Composition Sensor.

### Component Testing

1. Test the fuel composition using the J44175–A Fuel Composition Tester and the J44175–A Instruction Manual. Record the frequency.
2. Compare the special tool test frequency and the scan tool Fuel Composition Sensor frequency parameter. The difference between the tool and the sensor should be less than 12 Hz.
  - ⇒ If greater than the specified value, replace the B198 Fuel Composition Sensor.

### **Repair Instructions**

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

- [Flexible Fuel Sensor Replacement](#)
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup.

## DTC P018B-P018D (Chassis Control Module)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P018B

Fuel Pressure Sensor Performance

#### DTC P018C

Fuel Pressure Sensor Circuit Low Voltage

#### DTC P018D

Fuel Pressure Sensor Circuit High Voltage

### Diagnostic Fault Information

| Circuit       | Short to Ground     | Open/High Resistance | Short to Voltage | Signal Performance |
|---------------|---------------------|----------------------|------------------|--------------------|
| 5 V Reference | P018C, P0641, P06A6 | P018C                | P018D            | P06A6              |
| Signal        | P018C               | P018C                | P018D            | P018B              |
| Low Reference | —                   | P018D                | —                | P06A6              |

### Circuit/System Description

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

### Conditions for Running the DTC

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

### Conditions for Setting the DTC

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

### Action Taken When the DTC Sets

DTC P018B, P018C and P018D are Type A DTCs.

### Conditions for Clearing the DTC

DTC P018B, P018C and P018D are Type A DTCs.

### Diagnostic Aids

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

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

[Component Connector End Views](#)

#### Description and Operation

[Fuel System Description](#)

#### Electrical Information Reference

- [Circuit Testing](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Connector Repairs](#)
- [Wiring Repairs](#)

#### DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

#### Scan Tool Reference

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

### Circuit/System Verification

1. Engine running.
2. Verify the scan tool Fuel Pressure Sensor Voltage parameter is between 0.2–4.8 V.  
⇒ **If not between 0.2–4.8 V**  
Refer to Circuit/System Testing.  
⇓ **If between 0.2–4.8 V**
3. All OK.

### Circuit/System Testing

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

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B47 Fuel Pressure Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10  $\Omega$  between the low reference circuit terminal 2 and ground.

⇒ **If 10  $\Omega$  or greater**

- 2.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
- 2.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K38 Chassis Control Module.

⇓ **If less than 10  $\Omega$**

3. Ignition ON.

4. Test for 4.8–5.2 V between the 5 V reference circuit terminal 3 and ground.

⇒ **If less than 4.8 V**

- 4.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
- 4.2. 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
- 4.3. Test for less than 2  $\Omega$  in the 5 V reference circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K38 Chassis Control Module.

⇒ **If greater than 5.2 V**

- 4.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
- 4.2. Test for less than 1 V between the 5 V reference circuit and ground.
  - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
  - ⇒ If less than 1 V, replace the K38 Chassis Control Module.

⇓ **If between 4.8–5.2 V**

5. Verify the scan tool Fuel Pressure Sensor Voltage parameter is less than 1 V.

⇒ **If 1 V or greater**

- 5.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
- 5.2. Test for less than 1 V between the signal circuit terminal 1 and ground.
  - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
  - ⇒ If less than 1 V, replace the K38 Chassis Control Module.

⇓ **If less than 1 V**

6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3, wait 15 seconds.

7. Verify the scan tool Fuel Pressure Sensor Voltage parameter is greater than 4.8 V.

⇒ **If 4.8 V or less**

- 7.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
- 7.2. 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
- 7.3. Test for less than 2  $\Omega$  in the signal circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K38 Chassis Control Module.

⇓ **If greater than 4.8 V**

8. Test or replace the B47 Fuel Pressure Sensor.

[Repair Instructions](#)

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

[Control Module References](#) for chassis control module replacement, programming and setup

## DTC P0196, P0197, or P0198

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0196

Engine Oil Temperature Sensor Circuit Range/Performance

#### DTC P0197

Engine Oil Temperature Sensor Circuit Low Input

#### DTC P0198

Engine Oil Temperature Sensor Circuit High Input

### Circuit/System Description

The engine oil temperature (EOT) sensor is a variable resistor that measures the temperature of the engine oil. The engine control module (ECM) supplies a 5 voltage to the EOT signal circuit and supplies a ground for the reference circuit.

### Conditions for Running the DTC

#### P0196, P0197, or P0198

- The engine has been running for more than 10 seconds.
- This DTC runs continuously within the enabling conditions.

### Conditions for Setting the DTC

#### P0196

The ECM detects that the engine EOT sensor is not within 100°C of predetermined values.

#### P0197

The ECM detects that the EOT sensor is less than -35°C of longer than 3 seconds.

#### P0198

The ECM detects that the EOT sensor is greater than 170°C for longer than 3 seconds.

### Action Taken when the DTC Sets

DTCs P0196, P0197 and P0198 are type B DTCs.

### Conditions for Clearing the MIL/DTC

DTCs P0196, P0197 and P0198 are type B DTCs.

### Reference Information

#### Schematic Reference



[Engine Controls Schematics](#)**Connector End View Reference**[Component Connector End Views](#)**Electrical Information Reference**

- [Circuit Testing](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

**Scan Tool Reference**[Control Module References](#)**[Circuit/System Verification](#)**

Inspect condition of oil system. Refer to [Oil Pressure Diagnosis and Testing](#).

**[Circuit/System Testing](#)****P0196, P0197 or P0198**

1. Ignition ON, engine OFF.
2. Disconnect the EOT sensor.
3. Measure for proper voltage range of 4.9–5.2 Volts.
  - ⇒ If the voltage is less than 4.9 volts, test the EOT sensor circuit for a short to ground or an open/high resistance.
  - ⇒ If the voltage is greater than 5.2 volts, test the EOT circuit for a short to voltage.
  - ⇒ If the EOT circuit tests normal and the voltage is not within the proper range then replace the ECM.
4. Connect a 3 amp fusible link between the signal circuit of the EOT and the low reference circuit.
  - ⇒ Observe the sensor parameters while connecting and disconnecting the link between the EOT sensor signal and the low reference circuit.
  - ⇒ the EOT should switch between the upper and lower limits.
  - ⇒ if the EOT signal does not switch between the upper and lower limits then replace the ECM..
  - ⇒ if the EOT signal does switch between the upper and lower limits then replace the EOT.

**[Component Testing](#)**

Measure and record the resistance of the EOT sensor at various temperatures and then compare those measurements to the Temperature Versus Resistance Table. Refer to [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#).

**[Repair Instructions](#)**

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

[Control Module References](#) for ECM replacement, setup and programming

## DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0201

Cylinder 1 Injector Control Circuit

#### DTC P0202

Cylinder 2 Injector Control Circuit

#### DTC P0203

Cylinder 3 Injector Control Circuit

#### DTC P0204

Cylinder 4 Injector Control Circuit

#### DTC P0205

Cylinder 5 Injector Control Circuit

#### DTC P0206

Cylinder 6 Injector Control Circuit

#### DTC P0207

Cylinder 7 Injector Control Circuit

#### DTC P0208

Cylinder 8 Injector Control Circuit

### Diagnostic Fault Information

| Circuit                 | Short to Ground                                                                       | Open/High Resistance                                                                  | Short to Voltage | Signal Performance |
|-------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|------------------|--------------------|
| Ignition Voltage        | P0201,<br>P0202,<br>P0203,<br>P0204,<br>P0205,<br>P0206,<br>P0207,<br>P0208,<br>P0300 | P0201,<br>P0202,<br>P0203,<br>P0204,<br>P0205,<br>P0206,<br>P0207,<br>P0208,<br>P0300 | —                | —                  |
| Fuel Injector 1 Control | P0201                                                                                 | P0201                                                                                 | P0201            | —                  |

| Circuit                 | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|-------------------------|-----------------|----------------------|------------------|--------------------|
| Fuel Injector 2 Control | P0202           | P0202                | P0202            | —                  |
| Fuel Injector 3 Control | P0203           | P0203                | P0203            | —                  |
| Fuel Injector 4 Control | P0204           | P0204                | P0204            | —                  |
| Fuel Injector 5 Control | P0205           | P0205                | P0205            | —                  |
| Fuel Injector 6 Control | P0206           | P0206                | P0206            | —                  |
| Fuel Injector 7 Control | P0207           | P0207                | P0207            | —                  |
| Fuel Injector 8 Control | P0208           | P0208                | P0208            | —                  |

### **Circuit/System Description**

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

### **Conditions for Running the DTC**

- The engine is running.
- The ignition voltage is greater than 11 V.
- DTC P0201–P0208 runs continuously when the above conditions are met.

### **Conditions for Setting the DTC**

The engine control module detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 s.

### **Action Taken When the DTC Sets**

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0207, and P0208 are Type B DTCs.

### **Conditions for Clearing the MIL/DTC**

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0207, and P0208 are Type B DTCs.

### **Diagnostic Aids**

- The MIL indicator flashes when there is an engine misfire.
- High resistance in the circuits of the injectors may set a misfire DTC without setting an injector DTC. Test the injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- Performing the Fuel Injector Diagnosis may help isolate an intermittent condition. Refer to [Fuel Injector Diagnosis](#).

### **Reference Information**

#### **Schematic Reference**

[Engine Controls Schematics](#)

#### **Connector End View Reference**

[Component Connector End Views](#)

## 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

- J 44603 Injector Test Lamp

### [Circuit/System Verification](#)

1. Engine idling.
  2. Verify the parameters listed below do not display Malfunction with a scan tool:
    - Cylinder 1–8 Injector Control Circuit High Voltage Test Status
    - Cylinder 1–8 Injector Control Circuit Open Test Status
    - Cylinder 1–8 Injector Control Circuit Low Voltage Test Status
- ⇒ **If Malfunction is displayed**  
Refer to Circuit/System Testing.
- ↓ **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
  4. Verify DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207 or P0208 does not set.
- ⇒ **If any of the DTCs set**  
Refer to Circuit/System Testing.
- ↓ **If none of the DTCs set**
5. All OK.

### [Circuit/System Testing](#)

1. Ignition OFF, all vehicle systems OFF, disconnect the appropriate fuel injector harness connector at the Q17 fuel injector, ignition ON. It may take up to 2 min for all vehicle systems to power down.
  2. Verify that a test lamp illuminates between the ignition voltage circuit terminal A and ground.
- ⇒ **If the test lamp does not illuminate and the circuit fuse is good**
- 2.1. Ignition OFF, remove the test lamp.
  - 2.2. Test for less than 2  $\Omega$  in the ignition circuit end to end.
    - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit
    - ⇒ If less than 2  $\Omega$ , verify the fuse is not open and there is voltage at the fuse.
- ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
- 2.1. Ignition OFF, remove the test lamp.

- 2.2. Test for infinite resistance between the ignition circuit and ground.
  - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
  - ⇒ If infinite resistance, test all components connected to the ignition circuit for a short to ground and replace as necessary.

↓ **If the test lamp illuminates**

3. Remove the test lamp.
4. Connect the *J 44603* injector test lamp between the appropriate control circuit terminal B and the ignition voltage circuit terminal A, engine cranking.
5. Verify the test lamp flashes ON and OFF.

⇒ **If the test lamp is always ON**

- 5.1. Ignition OFF, remove the *J 44603* injector test lamp, disconnect the harness connector X2 at the K20 Engine Control Module.
- 5.2. Test for infinite resistance between the appropriate control circuit and ground.
  - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
  - ⇒ If infinite resistance, replace the K20 Engine Control Module.

⇒ **If the test lamp is always OFF**

- 5.1. Ignition OFF, remove the *J 44603* injector test lamp, disconnect the harness connector X2 at the K20 Engine Control Module, Ignition ON.
- 5.2. Test for less than 1 V between the appropriate control circuit and ground.
  - ⇒ If 1 V or greater  
Repair the short to voltage in the circuit.
  - ↓ If less than 1 V
- 5.3. Ignition OFF.
- 5.4. 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 the test lamp flashes ON and OFF**

6. If all circuits test normal, test or replace the Q17 Fuel Injector.

### Component Testing

**Note:** The engine coolant temperature (ECT) sensor must be between 10–32°C (50–90°F) for an accurate measurement.

1. Ignition OFF, disconnect the harness connector at the appropriate Q17 Fuel Injector.
2. Test for 11–14 Ω between the terminals of the Q17 Fuel Injector.
  - ⇒ **If not between 11–14 Ω**  
Replace the Q17 Fuel Injector.
  - ↓ **If between 11–14 Ω**
3. Test for infinite resistance between each terminal and the injector housing/case.
  - ⇒ **If not infinite resistance**  
Replace the Q17 Fuel Injector.
  - ↓ **If infinite resistance**
4. All OK.

### Repair Instructions

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

- [Fuel Injector Replacement](#)

- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup.

## DTC P0230

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P0230

Fuel Pump Control Output Circuit

### Diagnostic Fault Information

| Circuit          | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|------------------|-----------------|----------------------|------------------|--------------------|
| Fuel Pump Enable | P0230           | P0230                | P0230            | —                  |

### Circuit/System Description

The engine control module (ECM) sends the fuel pump enable signal to the chassis control module. The ECM monitors the voltage on the fuel pump enable circuit. If the ECM detects an incorrect voltage on the fuel pump enable circuit, a fuel pump control DTC sets.

### Conditions for Running the DTC

- The ignition voltage is between 9–18 V.
- DTC P0230 runs continuously when the above condition is met.

### Conditions for Setting the DTC

- The engine control module detects that the commanded state of the driver and the actual state of the control circuit do not match.
- The above condition exists for greater than 2.5 s.

### Action Taken When the DTC Sets

DTC P0230 is a Type B DTC.

### Conditions for Clearing the MIL/DTC

DTC P0230 is a Type B DTC.

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

[Component Connector End Views](#)

#### Electrical Information Reference

- [Circuit Testing](#)

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- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

## DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

## Scan Tool Reference

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

## Circuit/System Verification

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction while commanding the Fuel Pump Enable ON and OFF with a scan tool:
  - Fuel Pump Enable Circuit High Voltage Test Status
  - Fuel Pump Enable Circuit Open Test Status
  - Fuel Pump Enable Circuit Low Voltage Test Status
- ⇒ **If Malfunction is displayed**  
Refer to Circuit/System Testing.
- ⇓ **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify DTC P0230 does not set.
- ⇒ **If the DTC sets**  
Refer to Circuit/System Testing.
- ⇓ **If the DTC does not set**
5. All OK.

## Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K38 Chassis Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Connect a test lamp between the fuel pump control circuit terminal and ground.  
**Note:** Voltage is supplied once per ignition cycle for approximately 2 s at the time of ignition ON.
3. Verify the test lamp turns ON and OFF as the ignition is turned ON.
- ⇒ **If the test lamp does not turn ON and OFF**
  - 3.1. Ignition OFF, remove the test lamp, disconnect the harness connector X1 at the K20 Engine Control Module.
  - 3.2. Test for infinite resistance between the control circuit and ground.
    - ⇒ If less than infinite resistance, replace the short to ground on the circuit.
    - ⇓ If infinite resistance
  - 3.3. Test for less than 2  $\Omega$  in the control circuit end to end.
    - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit
    - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
- ⇒ **If the test lamp stays ON**
  - 3.1. Ignition OFF, remove the test lamp, disconnect the harness connector X1 at the K20 Engine Control Module, ignition ON.
  - 3.2. Test for less than 1 V between the control circuit and ground.



⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

↓ **If test lamp turns ON and OFF**

4. Test or replace the K38 Chassis Control Module.

#### **Repair Instructions**

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

[Control Module References](#) for K20 Engine Control Module and K38 Chassis Control Module replacement, programming, and setup.

## DTC P0231, P0232, or P023F (Chassis Control Module)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0231

Fuel Pump Control Circuit Low Voltage

#### DTC P0232

Fuel Pump Control Circuit High Voltage

#### DTC P023F

Fuel Pump Control Circuit

### Diagnostic Fault Information

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

### Circuit/System Description

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

### Conditions for Running the DTC

#### P0231, P023F

The ignition voltage is between 9–18 V.

#### P0232

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

### Conditions for Setting the DTC

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

### Action Taken When the DTC Sets

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

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## Conditions for Clearing the DTC

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

## Diagnostic Aids

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

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

## Reference Information

### Schematic Reference

[Engine Controls Schematics](#)

### Connector End View Reference

[Component Connector End Views](#)

### 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 and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor Assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10  $\Omega$  between the low reference circuit terminal 2 and ground.  
⇒ **If 10  $\Omega$  or greater**
  - 2.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
  - 2.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.  
⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
⇒ If less than 2  $\Omega$ , replace the K38 Chassis Control Module.
- ⇓ **If less than 10  $\Omega$**
3. Connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
4. Ignition ON.
5. Verify the test lamp turns ON and OFF when commanding the fuel pump ON and OFF using the scan tool ECM fuel pump enable control function.  
⇒ **If the test lamp is always OFF**

- 5.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
- 5.2. 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
- 5.3. Test for less than 2  $\Omega$  in the control circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K38 Chassis Control Module.

⇒ **If the test lamp is always ON**

- 5.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
- 5.2. Test for less than 1 V between the control circuit and ground.
  - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
  - ⇒ If less than 1 V, replace the K38 Chassis Control Module.

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

6. Test or replace the A7 Fuel Pump and Level Sensor Assembly.

### **Repair Instructions**

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

[Control Module References](#) for chassis control module replacement, programming and setup

## DTC P023A

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P023A

Charge Air Cooler Coolant Pump Relay Control Circuit

### Diagnostic Fault Information

| Circuit                                                                                                                    | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|----------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------|------------------|--------------------|
| Relay Coil Ignition Voltage                                                                                                | P023A           | P023A                | —                | —                  |
| Relay Switch B+                                                                                                            | 1               | 1                    | —                | —                  |
| Relay Control                                                                                                              | P023A           | P023A                | P023A            | —                  |
| Relay Controlled Output                                                                                                    | 1               | 1                    | 2                | —                  |
| Charge Air Cooler Coolant Pump Ground                                                                                      | —               | 1                    | —                | —                  |
| 1. Charge Air Cooler Coolant Pump inoperative without a DTC.<br>2. Charge Air Cooler Coolant Pump always On without a DTC. |                 |                      |                  |                    |

### Circuit Description

The supercharger intercooler relay is a normally open relay. The relay armature is held in the open position by spring tension. The ignition voltage is supplied directly to the relay coil and to the armature contact when the ignition is On, or the engine is running. The engine control module (ECM) supplies the ground path to the relay coil control circuit via an internal integrated circuit called an output driver module. When the engine is running, the ECM commands the relay On, and the relay coil creates an electromagnetic field. This electromagnetic field overcomes the spring tension and pulls the armature contact into the stationary contact of the relay load circuit. The closing of the relay contacts allow current to flow from the battery to the supercharger charge air cooler coolant pump. When the ignition switch is turned to the Off position, power is interrupted to the output driver module in the ECM and the relay electromagnetic field collapses. This allows the spring tension to separate the relay armature contact from the relay load circuit contact, which interrupts current flow to the supercharger charge air cooler coolant pump.

### Conditions for Running the DTC

- The battery voltage is between 11–32 V.
  - The engine is running.
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- The DTC runs continuously when the above conditions are met.

### **Conditions for Setting the DTC**

The ECM detects that commanded and actual states of output driver do not match for greater than 5 s.

### **Action Taken When the DTC Sets**

DTC P023A is a Type B DTC.

### **Conditions for Clearing the MIL/DTC**

DTC P023A is a Type B DTC.

### **Diagnostic Aids**

- A resistance of 1  $\Omega$  or more on the charge air cooler coolant pump or relay circuits may cause this DTC to set.
- When disconnecting electrical connectors or removing fuses and relays from a fuse block, inspect the component electrical terminals for corrosion and the mating electrical terminals for correct tension.
- For a charge air cooler coolant pump that is inoperative or always On, without a DTC, refer to [Supercharger Intercooler Relay Diagnosis](#).

### **Reference Information**

#### **Schematic Reference**

[Engine Controls Schematics](#)

#### **Connector End View Reference**

[Component Connector End Views](#)

#### **Description and Operation**

- [Supercharger Description and Operation](#)
- [Boost Control System Description](#)

#### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)
- [Electrical Center Identification 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 a click is heard or felt from the KR18 Charge Air Cooler Coolant Pump Relay when commanding the Charge Air Cooler Coolant Pump On and Off with a scan tool.
- ⇒ **If a click is not heard or felt**  
Refer to Circuit/System Testing

⇓ **If a click is heard or felt**

3. Verify the circuit status parameters listed below do not display Malfunction when commanding the Charge Air Cooler Coolant Pump On and Off with a scan tool:
  - Charge Air Cooler Coolant Pump Relay Control Circuit High Voltage Test Status
  - Charge Air Cooler Coolant Pump Relay Control Circuit Open Test Status
  - Charge Air Cooler Coolant Pump Relay Control Circuit Low Voltage Test Status

⇒ **If Malfunction is displayed**

Refer to Circuit/System Testing

⇓ **If Malfunction is not displayed**

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

### Circuit/System Testing

1. Ignition Off, disconnect the KR18 Charge Air Cooler Coolant Pump Relay. Ignition On.
2. Verify that a test lamp illuminates between the relay coil ignition circuit terminal 85 and ground.
- ⇒ **If the test lamp does not illuminate**  
Replace the Accessory Wiring Junction Block
- ⇒ **If the test lamp illuminates**
3. Connect a test lamp between the ignition circuit terminal 85 and the control circuit terminal 86.
4. Verify the test lamp turns on and off when commanding the Charge Air Cooler Coolant Pump On and Off with a scan tool.
- ⇒ **If the test lamp is always Off**
  - 4.1. Ignition Off, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module, ignition On.
  - 4.2. 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
  - 4.3. Ignition Off.
  - 4.4. Test for less than 2  $\Omega$  in the control circuit end to end.
    - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
    - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
- ⇒ **If the test lamp is always On**
  - 4.1. Ignition Off, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
  - 4.2. Test for infinite resistance between the control circuit and ground.
    - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
    - ⇒ If infinite resistance, replace the K20 Engine Control Module.
- ⇓ **If the test lamp turns On and Off**
5. Test or replace the KR18 Charge Air Cooler Coolant Pump Relay.

## Component Testing

### Relay Test

1. Ignition Off, disconnect the KR18 Charge Air Cooler Coolant Pump Relay.
2. Test for 90–125  $\Omega$  between terminals 85 and 86.  
⇒ **If less than 90  $\Omega$  or greater than 125  $\Omega$**   
Replace the KR18 Charge Air Cooler Coolant Pump Relay.  
⇓ **If between 90–125  $\Omega$**
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 KR18 Charge Air Cooler Coolant Pump Relay.  
⇓ **If infinite resistance**
4. Install a 10 A fused jumper wire between relay terminal 85 and 12V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2  $\Omega$  between terminals 30 and 87.  
⇒ **If 2  $\Omega$  or greater**  
Replace the KR18 Charge Air Cooler Coolant Pump Relay.  
⇓ **If less than 2  $\Omega$**
6. All OK

## Repair Instructions

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

- [Accessory Wiring Junction Block Replacement](#)
- [Charge Air Cooler Coolant Pump Replacement](#)
- [Relay Replacement](#)
- [Control Module References](#) for ECM replacement, programming and setup.



## DTC P025A (Chassis Control Module)

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P025A

Fuel Pump Control Module Enable Circuit

### Diagnostic Fault Information

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

### Circuit/System Description

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

### Conditions for Running the DTC

The ignition is ON.

### Conditions for Setting the DTC

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

### Action Taken When the DTC Sets

DTC P025A is a Type A DTC.

### Conditions for Clearing the DTC

DTC P025A is a Type A DTC.

### Diagnostic Aids

Beginning in the 2014 model year the K27 Fuel Pump Control Module (FPCM) will now be called the chassis control module (CCM). The component code for the chassis control module will be K38. The chassis control module name will be used in Service Information, the Global Diagnostic System and the Service Programming System.

### Reference Information

#### Schematic Reference

#### Engine Controls Schematics

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## Connector End View Reference

[Component Connector End 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

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

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
2. Connect a test lamp between the control circuit terminal 20 and ground.
3. Verify the test lamp turns ON and OFF when commanding the fuel pump ON and OFF using the scan tool ECM fuel pump enable control function.
  - ⇒ **If the test lamp is always OFF**
    - 3.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    - 3.2. 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
    - 3.3. Test for less than 2  $\Omega$  in the control circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
  - ⇒ **If the test lamp is always ON**
    - 3.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    - 3.2. Test for less than 1 V between the control circuit and ground.
      - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
      - ⇒ If less than 1 V, replace the K20 Engine Control Module.
  - ⇓ **If the test lamp turns ON and OFF**
4. Test or replace the K38 Chassis Control Module.

## Repair Instructions

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

[Control Module References](#) for ECM or chassis control module replacement, programming and setup

## DTC P0300-P0308

### Diagnostic Instructions

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

### DTC Descriptors

#### **DTC P0300**

Engine Misfire Detected

#### **DTC P0301**

Cylinder 1 Misfire Detected

#### **DTC P0302**

Cylinder 2 Misfire Detected

#### **DTC P0303**

Cylinder 3 Misfire Detected

#### **DTC P0304**

Cylinder 4 Misfire Detected

#### **DTC P0305**

Cylinder 5 Misfire Detected

#### **DTC P0306**

Cylinder 6 Misfire Detected

#### **DTC P0307**

Cylinder 7 Misfire Detected

#### **DTC P0308**

Cylinder 8 Misfire Detected

### Circuit/System Description

The engine control module (ECM) uses information from the crankshaft position sensor and the camshaft position sensors in order to determine when an engine misfire is occurring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM is able to detect individual misfire events. A misfire rate that is high enough can cause 3-way catalytic converter damage. The malfunction indicator lamp (MIL) will flash ON and OFF when the conditions for catalytic converter damage are present. DTCs P0301 through P0308 correspond to cylinders 1 through 8. If the ECM is able to determine that a specific cylinder is misfiring, the DTC for that cylinder will set, and the corresponding fuel injector is disabled and/or add fuel. The ECM will re-enable the fuel injector after 3 crankshaft revolutions (6 for manual transmission vehicles) to determine if a misfire is still present and either disable for 3 crankshaft revolutions (6 for manual transmission vehicles) again or stay enabled, depending on whether the misfire is still present.

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**Conditions for Running the DTC**

- DTCs P0010, P0011, P0016, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0220, P0222, P0223, P0335, P0336, P0606, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2176, P3401, P3425, P3441, and P3449 are not set.
- AND
- DTC P0806, P0807, or P0808 is not set; with manual transmission.
- The engine speed is greater than 1,400 RPM.
- OR
- The engine speed is greater than 1,000 RPM and DTC P0315 is set.
- The engine coolant temperature (ECT) is between  $-7$  and  $+130^{\circ}\text{C}$  ( $19$  and  $266^{\circ}\text{F}$ ).
- If the ECT is colder than  $-7^{\circ}\text{C}$  ( $+19^{\circ}\text{F}$ ) at start-up, this diagnostic will not run until the ECT is between  $21^{\circ}\text{C}$  and  $125^{\circ}\text{C}$  ( $69$  and  $257^{\circ}\text{F}$ ).
- The ignition voltage is between 9 and 32 V.
- The vehicle is not in a decel condition.
- The ECM is not detecting a rough road signal.
- The fuel level is at least 11 %.
- The ECM is not in fuel cut-off or decel fuel cut-off mode.
- DTCs P0300 through P0308 run continuously when the above conditions exist.
- The Active Fuel Management System is not active.
- The EGR Intrusive test is not active.

**Conditions for Setting the DTC****P0300**

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

**P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308**

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

**Action Taken When the DTC Sets**

- DTCs P0300–P0308 are Type B DTCs.
- The ECM may disable up to two fuel injector's of the misfiring cylinder's when a catalyst damaging level of misfire is present. And will flash the malfunction indicator lamp (MIL).

**Conditions for Clearing the DTC**

DTCs P0300–P0308 are Type B DTCs.

**Diagnostic Aids**

- A misfire DTC could be caused by an excessive vibration from sources other than the engine. Inspect for the following possible sources:
  - A tire or wheel that is out of round or out of balance
  - Variable thickness brake rotors
  - An unbalanced drive shaft
  - Certain rough road conditions
  - Transmission operation

- Cracked Spark Plug Insulators
- Broken or weak valve spring
- A damaged or defective accessory drive component or belt; remove the belt and safely operate the engine to evaluate if misfire counts go away.
- High resistance in the circuits of the injectors may set a misfire DTC without setting an injector DTC. Test the injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- If the condition is intermittent, observing the scan tool IC Circuit Test and Fuel Injector Circuit Test Status parameters may help isolate the condition. The circuit test status parameters will change from OK or Not Run to Fault/Malfunction if a condition exists.
- A condition in the heated O2 sensor (HO2S) heater control circuits may set a DTC P0300.

## Reference Information

### Schematic Reference

[Engine Controls Schematics](#)

### Connector End View Reference

[Component Connector End Views](#)

### Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)
- [Powertrain Component Views](#)

### DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

### Scan Tool Reference

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

### Special Tools

J 26792 HEI Spark Tester

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

## Circuit/System Verification

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

1. Engine idling at the normal operating temperature.
2. Verify there is no abnormal engine noise.
  - ⇒ **If there is an abnormal engine noise**  
Refer to [Symptoms - Engine Mechanical](#).
  - ⇓ **If there is no abnormal engine noise**
3. Verify no DTCs other than P0300–P0308 are set.
  - ⇒ **If any DTCs other than P0300–P0308 are set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
  - ⇒ **If only DTCs P0300–P0308 are set**

Refer to Circuit/System Testing.

↓ **If no DTCs are set**

4. Verify the scan tool Cylinder 1–8 Current Misfire Counter parameters are not increment.

⇒ **If a Counter is incrementing**

Refer to Circuit/System Testing.

↓ **If a Counter is not incrementing**

5. Engine idling.
6. Verify the engine speed changes when performing the Cylinder Power Balance Test with a scan tool.

⇒ **If engine speed does not change**

Refer to Circuit/System Testing.

↓ **If engine speed does change**

7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
8. Verify the DTCs are not set.

⇒ **If any of the DTCs set**

Refer to Circuit/System Testing.

↓ **If none of the DTCs set**

9. All OK.

### Circuit/System Testing

1. Perform the [Crankshaft Position System Variation Learn](#) procedure. Verify the scan tool displays Learned Successful.

⇒ **If the scan tool did not display Learned Successful**

Inspect for the following conditions and repair as necessary:

- Worn crankshaft main bearings
- A damaged or misaligned reluctor wheel
- Excessive crankshaft runout
- Interference in the signal circuit of the crankshaft position sensor
- The ignition switch is in the ON position until there is insufficient system voltage.
- An ECM power disconnect with the ignition ON that may have erased the crankshaft position system variation values and set DTC P0315
- Debris between the crankshaft position sensor and the reluctor wheel

⇒ If the engine control module is still unable to complete the learn procedure, replace the K20 Engine Control Module..

↓ **If the scan tool displays Learned Successful**

2. Verify that the following conditions do not exist:

- Vacuum hose splits, kinks, and incorrect connections
- Engine vacuum leaks
- Crankcase ventilation system for vacuum leaks
- Fuel pressure that is too low or too high—Refer to [Fuel System Diagnosis](#).
- Contaminated fuel—Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
- Exhaust system restrictions

⇒ **If a condition exists**

Repair or replace as necessary.

↓ **If no conditions exist**

3. Ignition OFF, remove the T8 Ignition Coil of the misfiring cylinder, but leave the electrical connector connected.
4. Verify none of the conditions listed below exist with the boot of the T8 Ignition Coil:
  - Holes
  - Tears
  - Carbon tracking
  - Oil contamination
  - Water intrusion

⇒ **If a condition exists**

Repair or replace as necessary.

↓ **If no conditions exist**

5. Install the J 26792 (EL 26792) HEI Spark Tester to the boot of the T8 Ignition Coil and ground.

**Note:** An erratic or weak spark is considered a no spark condition.

6. Verify the J 26792 (EL 26792) HEI Spark Tester sparks while cranking or starting the engine.

⇒ **If there is no spark**

Refer to [Electronic Ignition System Diagnosis](#) for diagnosis of the ignition coil.

↓ **If there is spark**

7. Verify none of the conditions listed below exist with the spark plug:

- Holes
- Tears
- Carbon tracking
- Oil contamination
- Water intrusion

⇒ **If a condition exists**

Repair or replace as necessary.

↓ **If no conditions exist**

8. Exchange the suspected spark plug with another cylinder that is operating correctly.

9. Engine idling.

10. Verify the scan tool Cylinder 1–8 Current Misfire Counter parameter does not increment on the spark plug coil it was removed from.

⇒ **If the misfire does follow the spark plug exchange**

Replace the spark plug.

↓ **If the misfire does not follow the spark plug exchange**

11. If all conditions test normal, test or inspect for the conditions listed below:

- A lean or rich Q17 Fuel Injector—Refer to [Fuel Injector Diagnosis](#).
- An engine mechanical condition—Refer to [Symptoms - Engine Mechanical](#).

### Repair Instructions

- [Ignition Coil Replacement](#)
- [Spark Plug Replacement](#)

### Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming or setup procedures that are required when a component or module is removed or replaced.



3. Clear the DTCs.
4. Turn OFF the ignition for 60 s.
5. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to the [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) and perform the appropriate diagnostic procedure.
6. Engine idling, verify the scan tool Cylinder 1–8 Current Misfire Counter parameters do not increment.  
⇒ If the misfire counter parameters are incrementing, a misfire still exists.
7. To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420 or P0430. Refer to [DTC P0420 or P0430](#).

## DTC P0315

### Diagnostic Instructions

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

### DTC Descriptor

#### **DTC P0315**

Crankshaft Position System Variation Not Learned

### Circuit/System Description

The crankshaft position system variation learn feature is used to calculate reference period errors caused by slight tolerance variations in the crankshaft, and the crankshaft position sensor. The calculated error allows the engine control module (ECM) to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wider range of engine speed and load conditions.

The crankshaft position system variation compensating values are stored in ECM memory after a learn procedure has been performed and the ignition switch is turned to the OFF position for at least 30 s. If the actual variation is not within the crankshaft position system variation compensating values stored in the ECM, DTC P0300 may set.

If the crankshaft position system variation values are not stored in the ECM memory or a proper ECM power down does not occur after completing the Crankshaft Position Learn Procedure, DTC P0315 sets.

### Conditions for Running the DTC

DTC P0315 runs continuously.

### Conditions for Setting the DTC

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

### Action Taken When the DTC Sets

DTC P0315 is a Type A DTC.

### Conditions for Clearing the MIL/DTC

DTC P0315 is a Type A DTC.

### 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

#### **Schematic Reference**

[Engine Controls Schematics](#)

#### **Connector End Views**

[Component Connector End Views](#)**DTC Type Reference**[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)**Scan Tool Reference**

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

**[Circuit/System Testing](#)**

**Note:** The Crankshaft Position System Variation Learn Procedure may have to be repeated up to 5 times before the procedure is successful.

1. Perform the [Crankshaft Position System Variation Learn](#) procedure. The scan tool should display Learned Successful.
  - ⇒ **If, after 5 Crankshaft Position System Variation Learn Procedure attempts, the scan tool did not display Learned Successful;** inspect for the following conditions:
    - Worn crankshaft main bearings
    - A damaged or misaligned reluctor wheel
    - Excessive crankshaft runout
    - A damaged crankshaft—Refer to [Crankshaft and Bearing Cleaning and Inspection](#).
    - Interference in the signal circuit of the crankshaft position sensor
    - The ignition switch is in the ON position until there is insufficient system voltage.
    - An ECM power disconnect with the ignition ON that may have erased the crankshaft position system variation values and set DTC P0315
    - Debris between the crankshaft position sensor and the reluctor wheel
  - ⇒ **If a condition exists**
    - Repair or replace the affected component as necessary.
    - Perform the Crankshaft Position System Variation Learn Procedure.
  - ⇒ **If no conditions exist**
    - Replace the K20 Engine Control Module.
    - Perform the Crankshaft Position System Variation Learn Procedure.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
3. Verify the DTC is not set.
  - ⇒ **If any of DTC sets**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
  - ⇓ **If none of the DTCs set**
4. All OK.

**[Repair Instructions](#)**

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

[Control Module References](#) for engine control module replacement, programming, and setup

## **DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333**

### **Diagnostic Instructions**

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

### **DTC Descriptors**

#### **DTC P0325**

Knock Sensor Circuit Bank 1

#### **DTC P0326**

Knock Sensor Performance 1

#### **DTC P0327**

Knock Sensor Circuit Low Voltage Bank 1

#### **DTC P0328**

Knock Sensor Circuit High Voltage Bank 1

#### **DTC P0330**

Knock Sensor Circuit Bank 2

#### **DTC P0332**

Knock Sensor Circuit Low Voltage Bank 2

#### **DTC P0333**

Knock Sensor Circuit High Voltage Bank 2

### **Diagnostic Fault Information**

| <b>Circuit</b>               | <b>Short to Ground</b> | <b>Open/High Resistance</b> | <b>Short to Voltage</b> | <b>Signal Performance</b> |
|------------------------------|------------------------|-----------------------------|-------------------------|---------------------------|
| Knock Sensor 1 Signal        | P0327                  | P0325                       | P0328                   | P0326                     |
| Knock Sensor 2 Signal        | P0332                  | P0330                       | P0333                   | P0331                     |
| Knock Sensor 1 Low Reference | P0327                  | P0325,<br>P06B6             | P0328                   | P0326                     |
| Knock Sensor 2 Low Reference | P0332                  | P0330,<br>P06B7             | P0333                   | P0331                     |

### **Circuit/System Description**

The knock sensors enable the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The knock sensors produce an alternating current (AC) voltage signal that varies depending on the vibration level during engine operation. The ECM adjusts the spark timing based on the amplitude and the frequency of the two knock sensor signals. The ECM receives the two knock sensor signals through 2 isolated circuits. The ECM learns a minimum knock sensor noise level for all of the engine speed ranges. The ECM monitors for a normal knock sensor signal. The ECM monitors the two internal knock sensor processors by verifying a 20 KHz signal generated on the signal circuits is detected on the sensors' low reference circuits.

#### [Conditions for Running the DTCs](#)

##### **P0325 and P0330**

- Engine speed is between 500 and 8,500 RPM.
- Engine is running at least 2 s.
- The ECT is warmer than  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ).
- The IAT sensor 1 is warmer than  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ).
- The DTCs run continuously when the above conditions are met.

##### **P0327, P0328, P0332, and P0333**

- Engine speed is less than 8,500 RPM.
- The DTCs run continuously when the above condition is met.

#### [Conditions for Setting the DTCs](#)

##### **P0325 and P0330**

The ECM detects that a knock sensor signal circuit is open for longer than 6 s.

##### **P0327 and P0332**

The ECM detects that a knock sensor signal circuit is shorted to ground for longer than 6 s.

##### **P0328 and P0333**

The ECM detects that a knock sensor signal circuit is shorted to voltage for longer than 6 s.

#### [Action Taken When the DTCs Set](#)

- DTCs P0325, P0326, P0327, P0328, P0330, P0332, and P0333 are Type C DTCs.
- The ignition timing is retarded to reduce the potential of engine damaging spark knock.

#### [Conditions for Clearing the DTCs](#)

DTCs P0325, P0326, P0327, P0328, P0330, P0332, and P0333 are Type C DTCs.

#### [Diagnostic Aids](#)

- Inspect the affected knock sensor for physical damage. A sensor that is dropped or damaged may cause a DTC to set.
- The sensor mounting surface must be free of burrs, casting flash, and foreign material.
- The sensor must be clear of hoses, brackets, and engine electrical wiring.

#### [Reference Information](#)

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End Views](#)

## Electrical Information Reference

- [Testing for Intermittent Conditions and Poor Connections](#)
- [Circuit Testing](#)
- [Wiring Repairs](#)
- [Connector Repairs](#)

## DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

## Scan Tool Reference

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

## Circuit/System Verification

1. Engine running.
2. Verify that DTC P0325, P0326, P0327, P0328, P0330, P0332, or P0333, are not set.  
⇒ **If any of the DTCs are set**  
Refer to Circuit/System Testing
- ⇒ **If only DTC P0326 is set**  
Replace the K20 Engine Control Module.
- ⇓ **If none of the DTCs are set**
3. Verify the affected B68 Knock Sensor is properly tightened. Refer to [Fastener Tightening Specifications](#).
4. Move the related harnesses and connectors on the affected knock sensor circuits while observing the scan tool parameters listed below. The parameters should display NO.
  - Cylinder 1 Knock Detected
  - Cylinder 2 Knock Detected
  - Cylinder 3 Knock Detected
  - Cylinder 4 Knock Detected
  - Cylinder 5 Knock Detected
  - Cylinder 6 Knock Detected
  - Cylinder 7 Knock Detected
  - Cylinder 8 Knock Detected
- ⇒ **If the parameters change**  
Repair the wiring or the harness connectors.
- ⇓ **If none of the parameters 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.
6. All OK.

## Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B68 Knock Sensor, ignition ON.
2. Test for 1–2 V between the low reference circuit terminal 2 and ground.  
⇒ **If 1 V or less**
  - 2.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
  - 2.2. Test for infinite resistance between the low reference circuit terminal 2 and ground.  
⇒ If less than infinite resistance, repair the short to ground on the circuit.

⇓ If infinite resistance

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

⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than  $2\ \Omega$ , replace the K20 Engine Control Module.

⇓ **If greater than 2 V**

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

2.2. Test for less than 1 V between the low reference circuit and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

⇓ **If between 1–2 V**

3. Test for 2.5–3.5 V between the signal circuit terminal 1 and ground.

⇒ **If 2 V or less**

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

3.2. 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

3.3. Test for less than  $2\ \Omega$  in the signal circuit end to end.

⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than  $2\ \Omega$ , replace the K20 Engine Control Module.

⇓ **If greater than 4 V**

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

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

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

⇓ **If between 2.5–3.5 V**

4. Test or replace the appropriate B68 Knock Sensor.

### **Repair Instructions**

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

- [Knock Sensor Replacement](#)
- [Control Module References](#) for engine control module replacement, programming, and setup.

## DTC P0335 or P0336

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0335

Crankshaft Position Sensor Circuit

#### DTC P0336

Crankshaft Position Sensor Performance

### Diagnostic Fault Information

| Circuit       | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|---------------|-----------------|----------------------|------------------|--------------------|
| 5 V Reference | P0335, P0651    | P0335                | P0651            | P0336              |
| Signal        | P0335           | P0335                | P0335            | P0336              |
| Low Reference | —               | P0335                | P0335            | P0336              |

### Circuit/System Description

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

### Conditions for Running the DTC

#### P0335 Condition 1

- DTCs P0101, P0102 and P0103 are not set.
  - The airflow into the engine is greater than 3 g/s.
- OR



- The starter is engaged and the engine control module detects camshaft position sensor pulses.

**Condition 2**

- DTC P0651 is not set.
- The engine is running and starter not engaged.

**Condition 3**

- DTCs P0340, P0341, P0641, or P0651 are not set.
- The engine is running or the starter is engaged.

**P0336 Condition 1**

- DTCs P0335 or P0641 are not set.
- The airflow into the engine is greater than 3 g/s.
- The engine speed is greater than 450 RPM.

**Condition 2**

- DTC P0651 is not set.
- The engine is running and the starter is not engaged.

**Condition 3**

- DTCs P0101, P0102 and P0103 are not set.
- The airflow into the engine is greater than 3 g/s.  
OR
- The starter is engaged and the engine control module detects camshaft position sensor pulses.

**Condition 4**

- DTCs P0340, P0341, P0641, or P0651 are not set.
- The engine is running or the starter is engaged.

The DTCs run continuously once the above conditions are met.

**Conditions for Setting the DTC****P0335 Condition 1**

Engine cranking and the ECM does not detect a crankshaft position sensor pulse for greater than 4 s.

**Condition 2**

Engine running and the ECM does not detect a crankshaft position sensor pulse for greater than 0.3 s.

**Condition 3**

Engine running and the ECM does not detect a crankshaft position sensor pulse for 2 out of 10 engine revolutions.

**P0336 Condition 1**

Engine running and the ECM detects that 25 or more crankshaft resynchronizations have occurred within 20 s.

**Condition 2**

Engine running and the ECM does not detect crankshaft synchronization for greater than 0.4 s.

### Condition 3

The starter is engaged and the ECM does not detect crankshaft synchronization for greater than 1.5 s.

### Condition 4

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

### Action Taken When the DTC Sets

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

### Conditions for Clearing the DTC

DTCs P0335 and P0336 are Type B DTCs.

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

[Component Connector End Views](#)

#### Description and Operation

[Electronic Ignition System Description](#)

#### Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

#### DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

#### Scan Tool Reference

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

### Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0651 is not set.  
⇒ **If the DTC is set**  
Refer to [DTC P0641 or P0651](#).  
⇓ **If the DTC is not set**
3. Engine Running.
4. Verify the scan tool Crankshaft Position Active Counter parameter increments.  
⇒ **If the counter does not increment**  
Refer to Circuit/System Testing.

↓ **If the counter increments**

5. Verify the scan tool Crankshaft Position Resync Counter parameter displays 0 counts and the engine does not stumble or stall while moving the related harness/connectors of the B26 Crankshaft Position Sensor.

⇒ **If greater than 0 counts and the engine stumbles or stalls**

Refer to Circuit/System Testing.

↓ **If 0 counts and the engine does not stumble or stall**

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

7. Verify the DTC does not set.

⇒ **If the DTC sets**

Refer to Circuit/System Testing.

↓ **If the DTC does not set**

8. All OK.

### **Circuit/System Testing**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B26 Crankshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

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

⇒ **If 5  $\Omega$  or greater**

2.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.

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

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If 2  $\Omega$  or less, replace the K20 Engine Control Module.

↓ **If less than 5  $\Omega$**

3. Ignition ON.

4. Test for 4.8–5.2 V between the 5 V reference circuit terminal C and ground.

⇒ **If less than 4.8 V**

4.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.

4.2. 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

4.3. Test for less than 2  $\Omega$  in the 5 V reference circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

⇒ **If greater than 5.2 V**

4.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.

4.2. Test for less than 1 V between the 5 V reference and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

↓ **If between 4.8–5.2 V**

5. Test for 4.8–5.2 V between the signal circuit terminal A and ground.

⇒ **If less than 4.8 V**

5.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.

- 5.2. 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.
- 5.3. Test for less than 2  $\Omega$  in the signal circuit end to end.  
 ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
 ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

⇒ **If greater than 5.2 V**

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

⇓ **If between 4.8–5.2 V**

6. Ignition OFF, connect a 3 A fused jumper wire to the signal circuit terminal A, ignition ON.

**Note:** Additional DTCs may set when performing this test.

7. Verify the scan tool Crankshaft Position Sensor Active Counter parameter increments while rapidly tapping the fused jumper wire end to ground.

⇒ **If the counter does not increment**

Replace the K20 Engine Control Module.

⇓ **If the counter increments**

8. Verify DTC P0336 is not set.

⇒ **If the DTC is set**

Inspect for the conditions listed below:

- Excessive play or looseness of the B26 Crankshaft Position Sensor or the reluctor wheel
  - Improper installation of the B26 Crankshaft Position Sensor
  - Foreign material passing between the B26 Crankshaft Position Sensor and the reluctor wheel
  - Damaged reluctor wheel
  - Excessive air gap between the B26 Crankshaft Position Sensor and the reluctor wheel
  - Engine oil for debris
  - Timing chain, tensioner, and sprockets for wear or damage
- ⇒ If any of the conditions above are found, repair as necessary.  
 ⇒ If all components test normal, replace the B26 Crankshaft Position Sensor.

⇓ **If the DTC is not set**

9. Replace the B26 Crankshaft Position Sensor.

## Repair Instructions

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

- [Crankshaft Position Sensor Replacement](#)
- [Control Module References](#) for engine control module replacement, programming, and setup

## DTC P0340 or P0341

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0340

Camshaft Position Sensor Circuit

#### DTC P0341

Camshaft Position Sensor Performance

### Diagnostic Fault Information

| Circuit       | Short to Ground                               | Open/High Resistance | Short to Voltage | Signal Performance |
|---------------|-----------------------------------------------|----------------------|------------------|--------------------|
| 5 V Reference | P0107,<br>P0452,<br>P0522,<br>P0532,<br>P0641 | P0340                | P0641            | —                  |
| Signal        | P0340                                         | P0340                | P0340            | P0341              |
| Low Reference | —                                             | P0340                | P0340            | —                  |

### Circuit/System Description

The camshaft position sensor each has 3 circuits consisting of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The camshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the camshaft position sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency with 4 varying width output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the camshaft position sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM uses the camshaft position sensor to determine injector and ignition system synchronization. The camshaft position sensor is also used to determine camshaft to crankshaft relationship. The ECM also uses camshaft position sensor output information to determine the camshaft relative position to the crankshaft to control camshaft phasing and limp-home operation.

### Conditions for Running the DTC

#### P0340 Condition 1

- DTCs P0101, P0102 and P0103 are not set.

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- The starter is engaged and the engine control module detects camshaft position sensor pulses.
- The airflow into the engine is greater than 3 g/s.

**Condition 2**

- DTC P0641 is not set.
- The engine is running.
- The starter is not engaged.

**Condition 3**

- DTC P0335, P0336, P0641, or P0651 is not set.
- The crankshaft is synchronized.
- The starter is engaged and then disengaged.

**Condition 4**

- DTC P0335, P0336, P0641, or P0651 is not set.
- The crankshaft is synchronized.

**P0341 Condition 1**

- DTC P0335, P0336, P0641, or P0651 is not set.
- The crankshaft is synchronized.
- The starter is engaged and then disengaged.

**Condition 2**

- DTC P0335, P0336, P0641, or P0651 is not set.
- The crankshaft is synchronized.

The DTCs run continuously once the above conditions are met.

**Conditions for Setting the DTC****P0340 Condition 1**

The ECM does not detect a camshaft position sensor pulse for greater than 5.5 s or greater than 4.0 s since the time the starter has been engaged.

**Condition 2**

The ECM detects less than 4 camshaft position sensor pulses for greater than 3.0 s.

**Condition 3**

The ECM does not detect a camshaft position sensor pulse during the first 2 engine revolutions.

**Condition 4**

The ECM does not detect a camshaft position sensor pulse during 200 engine revolutions.

**P0341 Condition 1**

The ECM detects less than 2 or greater than 8 camshaft position sensor pulses for during the first 2 engine revolutions.

**Condition 2**

The ECM detects less than 398 or greater than 402 camshaft position sensor pulses during 200 engine revolutions.

### Action Taken When the DTC Sets

- DTCs P0340 and P0341 are Type B DTCs.
- The camshaft position actuator is commanded to the Home or Parked position.
- The ignition system defaults to a failed camshaft position sensor limp home mode.

### Conditions for Clearing the MIL/DTC

DTCs P0340 and P0341 are Type B DTCs.

### Diagnostic Aids

With a DTC set, the engine may crank for an extended period of time at start-up

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

[Component Connector End Views](#)

#### Description and Operation

[Electronic Ignition System Description](#)

#### Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

#### DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

#### Scan Tool Reference

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

### Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0641 or P0651 is not set.  
⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#).  
↓ **If none of the DTCs are set**
3. Engine Running.
4. Verify the scan tool Camshaft Position Active Counter parameter increments.  
⇒ **If the counter does not increment**  
Refer to Circuit/System Testing.  
↓ **If the counter increments**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.  
⇒ **If the DTC sets**

Refer to Circuit/System Testing.

↓ **If the DTC does not set**

7. All OK.

### Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B23 Camshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5  $\Omega$  between the low reference circuit terminal B and ground.  
⇒ **If 5  $\Omega$  or greater**
  - 2.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
  - 2.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.  
⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
⇒ If 2  $\Omega$  or less, replace the K20 Engine Control Module.
- ↓ **If less than 5  $\Omega$**
3. Ignition ON.
4. Test for 4.8–5.2 V between the 5 V reference circuit terminal A and ground.  
⇒ **If less than 4.8 V**
  - 4.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
  - 4.2. 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.
  - 4.3. Test for less than 2  $\Omega$  in the 5 V reference circuit end to end.  
⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
- ⇒ **If greater than 5.2 V**
  - 4.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
  - 4.2. Test for less than 1 V between the 5 V reference circuit and ground.  
⇒ If 1 V or greater, repair the short to voltage on the circuit.  
⇒ If less than 1 V, replace the K20 Engine Control Module.
- ↓ **If between 4.8–5.2 V**
5. Test for 4.8–5.2 V between the signal circuit terminal C and ground.  
⇒ **If less than 4.8 V**
  - 5.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
  - 5.2. 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.
  - 5.3. Test for less than 2  $\Omega$  in the signal circuit end to end.  
⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
- ⇒ **If greater than 5.2 V**
  - 5.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
  - 5.2. Test for less than 1 V between the signal circuit and ground.  
⇒ If 1 V or greater, repair the short to voltage on the circuit.



⇒ If less than 1 V, replace the K20 Engine Control Module.

↓ **If between 4.8–5.2 V**

6. Verify DTC P0341 is not set.

⇒ **If the DTC is set**

Inspect for the conditions listed below:

- Excessive play or looseness of the B23 Camshaft Position Sensor or the reluctor wheel
  - Improper installation of the B23 Camshaft Position Sensor
  - Foreign material passing between the B23 Camshaft Position Sensor and the reluctor wheel
  - Damaged reluctor wheel
  - Excessive air gap between the B23 Camshaft Position Sensor and the reluctor wheel
  - Engine oil for debris
  - Timing chain, tensioner, and sprockets for wear or damage
- ⇒ If any of the conditions above are found, repair as necessary.
- ⇒ If all components test normal, replace the B23 Camshaft Position Sensor.

↓ **If the DTC is not set**

7. Replace the B23 Camshaft Position Sensor.

### **Repair Instructions**

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

- [Camshaft Position Sensor Replacement](#)
- [Control Module References](#) for engine control module replacement, programming, and setup

## DTC P0351-P0358

### Diagnostic Instructions

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

### DTC Descriptors

**DTC P0351**

Ignition Coil 1 Control Circuit

**DTC P0352**

Ignition Coil 2 Control Circuit

**DTC P0353**

Ignition Coil 3 Control Circuit

**DTC P0354**

Ignition Coil 4 Control Circuit

**DTC P0355**

Ignition Coil 5 Control Circuit

**DTC P0356**

Ignition Coil 6 Control Circuit

**DTC P0357**

Ignition Coil 7 Control Circuit

**DTC P0358**

Ignition Coil 8 Control Circuit

### Diagnostic Fault Information

| Circuit                 | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|-------------------------|-----------------|----------------------|------------------|--------------------|
| Ignition Coil 1 Control | P0300, P0351    | P0300, P0351         | P0300, P0351     | P0300, P0351       |
| Ignition Coil 2 Control | P0300, P0352    | P0300, P0352         | P0300, P0352     | P0300, P0352       |
| Ignition Coil 3 Control | P0300, P0353    | P0300, P0353         | P0300, P0353     | P0300, P0353       |
| Ignition Coil 4 Control | P0300, P0354    | P0300, P0354         | P0300, P0354     | P0300, P0354       |

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| Circuit                 | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|-------------------------|-----------------|----------------------|------------------|--------------------|
| Ignition Coil 5 Control | P0300, P0355    | P0300, P0355         | P0300, P0355     | P0300, P0355       |
| Ignition Coil 6 Control | P0300, P0356    | P0300, P0356         | P0300, P0356     | P0300, P0356       |
| Ignition Coil 7 Control | P0300, P0357    | P0300, P0357         | P0300, P0357     | P0300, P0357       |
| Ignition Coil 8 Control | P0300, P0358    | P0300, P0358         | P0300, P0358     | P0300, P0358       |

### **Circuit/System Description**

The ignition system on this engine uses an individual coil for each cylinder. The engine control module (ECM) controls the spark event for each cylinder through the 8 individual ignition control circuits. When the ECM commands the ignition control circuit ON, electrical current will flow through the primary winding of the ignition coil, creating a magnetic field. When a spark event is requested, the ECM will command the ignition control circuit OFF, interrupting current flow through the primary winding. The magnetic field created by the primary winding will collapse across the secondary coil windings, producing a high voltage across the spark plug electrodes. The ECM uses information from the crankshaft position sensor, and the camshaft position sensor for sequencing and timing of the spark events. The ECM monitors each ignition control circuit for improper voltage levels.

### **Conditions for Running the DTC**

- The engine is running.
- Ignition voltage is greater than 5 V.

The DTCs run continuously when the above conditions are met.

### **Conditions for Setting the DTC**

The engine control module detects that the voltage command state of the driver and the actual state of the control circuit do not match.

### **Action Taken When the DTC Sets**

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P0357, and P0358 are Type B DTCs.

### **Conditions for Clearing the MIL/DTC**

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P0357, and P0358 are Type B DTCs.

### **Reference Information**

#### **Schematic Reference**

[Engine Controls Schematics](#)

#### **Connector End View Reference**

[Component Connector End Views](#)

#### **Description and Operation**

[Electronic Ignition System Description](#)

#### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

## DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

## Scan Tool Reference

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

## Special Tools

EL 26792 HEI Spark Tester

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

## Circuit/System Verification

1. Engine Running.
2. Verify the scan tool parameters listed below do not display Malfunction:
  - Ignition Coil 1–8 Control Circuit High Voltage Test Status
  - Ignition Coil 1–8 Control Circuit Low Voltage Test Status
  - Ignition Coil 1–8 Control Circuit Open Test Status
- ⇒ **If Malfunction is displayed**  
Refer to Circuit/System Testing.
- ↓ **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
- ⇒ **If the DTC sets**  
Refer to Circuit/System Testing.
- ↓ **If the DTC does not set**
5. All OK.

## Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate T8 Ignition Coil.
2. Engine Running.
3. Verify the appropriate scan tool Ignition Coil Control Circuit Low Voltage Test Status does not display Malfunction.
- ⇒ **If Malfunction is displayed**
  - 3.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
  - 3.2. Test for infinite resistance between the control circuit and ground.
    - ⇒ If less than infinite resistance, repair the short to ground on the control circuit.
    - ⇒ If infinite resistance, replace the K20 Engine Control Module.
- ↓ **If Malfunction is not displayed**
4. Verify the appropriate scan tool Ignition Coil Control Circuit High Voltage Test Status does not display Malfunction.
- ⇒ **If Malfunction is displayed**
  - 4.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.

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

⇒ If 1 V or greater, repair the short to voltage in the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

↓ **If Malfunction is not displayed**

5. Ignition OFF, install a 3 A fused jumper wire between the control circuit terminal C and ground, engine Running.

6. Verify the appropriate scan tool Ignition Coil Control Circuit Low Voltage Test Status displays Malfunction.

⇒ **If Malfunction is not displayed**

6.1. Ignition OFF, remove the fused jumper, and disconnect the X2 harness connector at the K20 Engine Control Module.

6.2. Test for less than 2  $\Omega$  in the control circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

↓ **If Malfunction is displayed**

7. Test or replace the T8 Ignition Coil.

### **Component Test**

**Note:** You must perform the Circuit/System Testing before proceeding with Component Testing.

1. Ignition OFF, connect the EL 26792 HEI Spark Tester to the appropriate T8 Ignition Coil.

2. Engine Running.

3. Verify the spark output of the T8 Ignition Coil.

⇒ **If no output or the output is weak**

Replace the T8 Ignition Coil.

↓ **If the output is normal**

4. All OK.

### **Repair Instructions**

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

- [Ignition Coil Replacement](#)
- [Control Module References](#) for engine control module replacement, programming, and setup

## DTC P0420 or P0430

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0420

Catalyst System Low Efficiency Bank 1

#### DTC P0430

Catalyst System Low Efficiency Bank 2

### Circuit/System Description

A 3-way catalytic converter controls emissions of hydrocarbons, carbon monoxide (CO) and nitrogen oxide (NOx). The catalyst within the converter promotes a chemical reaction, which oxidizes the hydrocarbons and the CO that are present in the exhaust gas. This process converts the hydrocarbons and the CO into water vapor and carbon dioxide (CO<sub>2</sub>), and reduces the NOx, converting the NOx into nitrogen. The catalytic converter also stores oxygen. The ECM monitors this process by using a heated oxygen sensor (HO<sub>2</sub>S) that is in the exhaust stream after the 3-way catalytic converter. The HO<sub>2</sub>S 2 produces an output signal that the ECM uses to calculate the oxygen storage capacity of the catalyst. This indicates the ability of the catalyst to convert the exhaust emissions efficiently. The ECM monitors the efficiency of the catalyst by allowing the catalyst to heat, then wait for a stabilization period while the engine is idling. The ECM then adds and removes fuel while monitoring the HO<sub>2</sub>S 2. When the catalyst is functioning properly, the HO<sub>2</sub>S 2 response to the extra fuel is slow compared to the response of the HO<sub>2</sub>S 1, which is located before the 3-way catalytic converter. When the HO<sub>2</sub>S 2 response is near that of the HO<sub>2</sub>S 1, the oxygen storage capability and efficiency of the catalyst may be degraded below an acceptable threshold.

### Conditions for Running the DTC

- DTC P0030, P0031, P0036, P0037, P0038, P0068, P0106, P0107, P0108, P0112, P0113, P0117, P0118, P0120, P0121, P0122, P0123, P0125, P0128, P0130, P0131, P0132, P0133, P0134, P0135, P0136, P0137, P0138, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0300, P0315, P0326, P0327, P0336, P0340, P0341, P0442, P0446, P0452, P0453, P0455, P0496, P0500, P0502, P0506, P0507, P0601, P0602, P0606, P0641, P0722, P0723, P1133, P1134, P1516, P1621, P2135, P2138, or P2176 is not set.
- Before the ECM performs the idle test, the vehicle must be driven under the following conditions:
  - The engine speed is greater than 1,300 RPM.
  - The engine run time is greater than 100 s.
  - Both conditions exist for greater than 16 s.
- The vehicle speed is less than 1.6 km/h (1 mph).
- The throttle position is less than 2 %.
- The Mass Air Flow (MAF) is between 2–21 g/s.
- The engine is operating in Closed Loop.
- The fuel trim learn is enabled.

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- The Engine Coolant Temperature (ECT) is between 45–129°C (113–264°F).
- The Barometric Pressure (BARO) is greater than 70 kPa.
- The Catalytic Converter Calculated Temperature parameter is between 600–900°C (1,112–1,652°F) for greater than 6 min.
- The Intake Air Temperature (IAT) is between –20 and +250°C (–4 and +482°F).
- The battery voltage is greater than 11 V.
- The transmission is in Drive Range—Automatic transmissions only.
- The short term fuel trim is between –10 and +10 %.
- The engine is idling for less than 50 s.
- This diagnostic attempts one test during each valid idle period when the above conditions have been met. This diagnostic attempts up to 8 tests during each drive cycle.

#### Conditions for Setting the DTC

The ECM has determined the catalyst efficiency has degraded below a calibrated threshold.

#### Action Taken When the DTC Sets

DTCs P0420 and P0430 are Type A DTCs.

#### Conditions for Clearing the MIL/DTC

DTCs P0420 and P0430 are Type A DTCs.

#### Reference Information

##### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

##### **Scan Tool Reference**

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

#### Circuit/System Verification

1. Ignition ON.
  2. Verify there are no other DTCs set.
- ⇒ **If a DTC is set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
- ⇓ **If a DTC is not set**
3. Operate the vehicle within the Conditions for Running the DTC.
  4. Verify the scan tool Catalyst Monitor Not At Idle Test Conditions Met parameter changes to Yes.
- ⇒ **If Yes is not displayed**  
Refer to step 3.
- ⇓ **If Yes is displayed**
5. When the conditions are safe, stop and idle the vehicle in gear (If equipped with automatic transmission) or neutral (If equipped with manual transmission).
  6. Verify the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters display Pass when performing the steps listed below:
    - 6.1. Apply the service brake.
    - 6.2. Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.
- Note:** When the test has completed, the Catalyst Monitor Test Counter Bank 1 and Bank 2 parameters will increment by one and the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters will indicate Passed, Failed or No Result.

6.3. Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.

⇒ **If the Catalyst Monitor Test Result Bank 1 or Bank 2 parameter indicates No Result**

Repeat steps 3–6 until the Test Result parameters indicate Passed or Failed

⇒ **If the Catalyst Monitor Test Result Bank 1 or Bank 2 parameter indicates Failed**

Refer to Circuit /System Testing

↓ **If the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters indicate Pass**

7. All OK.

### Circuit/System Testing

1. Verify the conditions listed below do not exist with the appropriate catalytic converter:

- Dents
- Severe discoloration caused by excessive temperatures
- Road damage
- Internal rattles caused by damaged catalyst substrate
- Restrictions

⇒ **If a condition is found**

Replace the catalytic converter

↓ **If no condition is found**

2. Verify the conditions listed below do not exist with the exhaust system:

- Leaks
- Physical damage
- Loose or missing hardware

⇒ **If a condition is found**

Repair or replace the component as necessary.

↓ **If no condition is found**

3. Verify the conditions listed below do not exist with the appropriate B52B heated oxygen sensor 2:

- The HO2S is not at the correct torque
- Damage

⇒ **If a condition is found**

Replace the B52B heated oxygen sensor 2 or repair the condition as necessary.

↓ **If no condition is found**

4. Test or replace the catalytic converter.

### Repair Instructions

**Note:** A new converter with less than 161 km (100 mi) on it may set DTC P0420 or P0430 due to out-gassing of the internal matting. Operating the vehicle at highway speeds for approximately 1 h may correct the condition.

- [Catalytic Converter Replacement - Left Side](#)
- [Catalytic Converter Replacement - Right Side](#)
- [Heated Oxygen Sensor Replacement - Bank 1 Sensor 2](#)
- [Heated Oxygen Sensor Replacement - Bank 2 Sensor 2](#)
- Perform the HO2S Heater Learn procedure with a scan tool after replacing an HO2S.
- [Exhaust Leakage](#)
- [Restricted Exhaust](#)



### Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Turn OFF the ignition for 60 s
5. Operate the vehicle within the Conditions for Running the DTC.
6. Verify the scan tool Catalyst Monitor Not At Idle Test Conditions Met parameter changes to Yes.

⇒ **If Yes is not displayed**

Refer to step 5.

↓ **If Yes is displayed**

7. When the conditions are safe, stop and idle the vehicle in gear (If equipped with automatic transmission) or neutral (If equipped with manual transmission).
8. Verify the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters display Pass when performing the steps listed below:

8.1. Apply the service brake.

8.2. Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.

**Note:** When the test has completed, the Catalyst Monitor Test Counter Bank 1 and Bank 2 parameters will increment by one and the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters will indicate Passed, Failed or No Result.

8.3. Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.

⇒ **If the Catalyst Monitor Test Result Bank 1 or Bank 2 parameter indicates No Result**

Repeat steps 5–8 until the Test Result parameters indicate Passed or Failed

⇒ **If the Catalyst Monitor Test Result Bank 1 or Bank 2 parameter indicates Failed**

Refer to Circuit /System Testing

↓ **If the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters indicate Pass**

9. All OK.

## DTC P0443

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0443

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit

### Diagnostic Fault Information

| Circuit  | Short to Ground                                                                    | Open / High Resistance            | Short to Voltage |
|----------|------------------------------------------------------------------------------------|-----------------------------------|------------------|
| Ignition | P0030, P0031, P0033, P0036, P0050, P0051, P0102, P0132, P0135, P0152, P0155, P0443 | P0030, P0031, P0050, P0051, P0443 | —                |
| Control  | P0443                                                                              | P0443                             | P0443            |

### Circuit/System Description

An ignition voltage is supplied directly to the evaporative emission (EVAP) purge solenoid valve. The EVAP purge solenoid valve is pulse width modulated (PWM). The engine control module (ECM) grounds the EVAP purge solenoid valve control circuit through an internal switch called a driver. The ECM monitors the status of the driver and displays the amount of ON time as a percentage on the scan tool.

### Conditions for Running the DTC

- The system voltage is greater than 11 V.
- DTC P0443 runs continuously when the above conditions are met.

### Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for a minimum of 0.25 s.

### Action Taken When the DTC Sets

DTC P0443 is a Type B DTC.

### Conditions for Clearing the MIL/DTC

DTC P0443 is a Type B DTC.

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)**Connector End View Reference**[Component Connector End Views](#)**Description and Operation**[Evaporative Emission Control System Description](#)**Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

**DTC Type Reference**[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)**Scan Tool Reference**

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

**[Circuit/System Verification](#)**

1. Ignition ON.
  2. Verify the parameters listed below do not display Malfunction when commanding the EVAP Purge Solenoid Valve from 0 to 50 % and back to 0 % with a scan tool.
    - EVAP Purge Solenoid Valve Control Circuit Open Test Status
    - EVAP Purge Solenoid Valve Control Circuit Low Voltage Test Status
    - EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status
- ⇒ **If Malfunction is displayed**  
Refer to Circuit/System Testing.
- ⇓ **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data
  4. Verify the DTC does not set.  
⇒ **If the DTC sets**  
Refer to Circuit/System Testing
  - ⇓ **If the DTC does not set**
  5. All OK.

**[Circuit/System Testing](#)**

1. Ignition OFF, disconnect the harness connector at the Q12 Evaporative Emission Purge Solenoid Valve, ignition ON.
2. Verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.  
⇒ **If the test lamp does not illuminate and the circuit fuse is good**
  - 2.1. Ignition OFF and all vehicle systems OFF, it may take up to 2 min for all vehicle systems to power down.
  - 2.2. Test for less than 2  $\Omega$  in the ignition circuit end to end.
    - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
    - ⇒ If less than 2  $\Omega$  verify the fuse is not open and there is voltage at the fuse.

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

- 2.1. Ignition OFF, test for infinite resistance between the ignition circuit and ground.
  - ⇒ If less than infinite resistance, repair the short to ground in the circuit.
  - ⇒ If infinite resistance, test all components connected to the fuse and replace as necessary.

⇓ **If the test lamp illuminates**

3. Verify that a test lamp does not illuminate between the ignition circuit terminal 1 and the control circuit terminal 2.

⇒ **If the test lamp illuminates**

- 3.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
- 3.2. Test for infinite resistance between the control circuit and ground.
  - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
  - ⇒ If infinite resistance, replace the K20 Engine Control Module.

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

4. Remove the test lamp.
5. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit Low Voltage Test Status parameter is OK when commanding the EVAP purge solenoid valve to 50% with a scan tool.

⇒ **If OK is not displayed**

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

⇓ **If OK is displayed**

6. Install a 3 A fused jumper wire between the control circuit terminal 2 and the ignition circuit terminal 1.
7. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit Low Voltage Test Status parameter is Malfunction when commanding the EVAP Purge Solenoid Valve to 50% with a scan tool.

⇒ **If Malfunction is not displayed**

- 7.1. 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 K20 Engine Control Module.
- 7.2. Test for less than 2  $\Omega$  in the control circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$  replace the K20 Engine Control Module.

⇓ **If Malfunction is displayed**

8. Test or replace the Q12 Evaporative Emission Purge Solenoid Valve.

### Component Testing

1. Ignition OFF, disconnect the harness connector at the Q12 Evaporative Emission Purge Solenoid Valve.
2. Test for 10–30  $\Omega$  between the control circuit terminal 2 and the ignition circuit terminal 1 of the Q12 Evaporative Emission Purge Solenoid Valve.

⇒ **If not between 10–30  $\Omega$**

Replace the Q12 Evaporative Emission Purge Solenoid Valve

⇓ **If between 10–30  $\Omega$**

3. All OK.

**Repair Instructions**

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

- [Evaporative Emission Canister Purge Solenoid Valve Replacement](#)
- [Control Module References](#) for ECM replacement, programming and setup

## DTC P0506 or P0507

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0506

Idle Speed Low

#### DTC P0507

Idle Speed High

### Circuit/System Description

The throttle actuator control (TAC) motor is controlled by the engine control module (ECM). The DC motor located in the throttle body drives the throttle blade. In order to decrease idle speed, along with spark and fuel delivery changes the ECM commands the throttle closed reducing air flow into the engine and the idle speed decreases. In order to increase idle speed, the ECM commands the throttle plate open allowing more air to pass the throttle plate.

### Conditions for Running the DTC

- DTCs P0068, P0101, P0102, P0103, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0300-P0308, P0351-P0358, P0461-P0463, P0496, P0502, P0503, P0606, P0722, P0723, P0806-P0808, P1516, P2066-P2068, P2101, P2135 are not set.
- The ignition system voltage is between 11-32 V.
- The engine is operating for at least 60 s.
- The engine is idling for greater than 10 s.
- The barometric pressure (BARO) is greater than 70 kPa (11 psi).
- The engine coolant temperature (ECT) is warmer than 60°C (140°F).
- The intake air temperature (IAT) is warmer than -20°C (-4°F).
- The vehicle speed is less than 3 km/h (2 mph).
- The commanded engine speed is steady within 25 RPM.
- The transmission is not changing gears.
- The torque converter clutch (TCC) is not changing states.
- The manual transmission clutch pedal position is between 16-88 percent - If equipped.
- The manual transmission clutch is not depressed - If equipped.
- The power take-off (PTO) is not active - If equipped.
- The transfer case is not in 4WD Low - If equipped.
- A scan tool output control is not active.
- DTC P0506 and P0507 run continuously when the above conditions are met for greater than 10 s.

### Conditions for Setting the DTC

**P0506**

The actual idle speed is approximately 91 RPM lower than the desired idle speed.

**P0507**

The actual idle speed is approximately 182 RPM greater than the desired idle speed.

**Action Taken When the DTC Sets**

DTCs P0506 and P0507 are Type B DTCs.

**Conditions for Clearing the MIL/DTC**

DTCs P0506 and P0507 are Type B DTCs.

**Diagnostic Aids**

- A stalling condition can cause DTC P0506 to set.
- An intermittent vehicle speed sensor (VSS) signal can cause DTC P0507 to set.
- An intermittent clutch pedal position sensor signal, if equipped, can cause DTC P0506 to set.

**Reference Information****Schematic Reference**

[Engine Controls Schematics](#)

**Connector End View Reference**

[Component Connector End Views](#)

**Description and Operation**

[Throttle Actuator Control \(TAC\) System Description](#)

**Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

**DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

**Scan Tool Reference**

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

**Circuit/System Verification**

1. Ignition ON.
2. Verify no other DTCs set.  
⇒ **If any other DTC is set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.  
⇓ **If no other DTC is set**
3. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.  
⇒ **If 90 % or greater**  
Refer to [Throttle Body Cleaning](#).

↓ **If less than 90 %**

4. Engine Idling at the normal operating temperature.

**Note:** The engine must run for greater than 60 s, then idle at a steady state for an additional 10 s before comparing the actual and desired engine speed parameters.

5. Verify the actual Engine Speed is not 100 RPM less than the Desired Idle Speed.

⇒ **If 100 RPM less than the Desired Idle Speed**

Refer to Circuit/System Testing.

↓ **If not 100 RPM less than the Desired Idle Speed**

6. Verify the actual Engine Speed is not 200 RPM greater than the Desired Idle Speed.

⇒ **If 200 RPM greater than the Desired Idle Speed**

Refer to Circuit/System Testing.

↓ **If not 200 RPM greater than the Desired Idle Speed**

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

8. Verify a DTC does not set.

⇒ **If any DTC sets**

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

↓ **If no DTCs set**

9. All OK

### Circuit/System Testing

#### **P0506**

1. Verify the conditions listed below do not exist.

- Restricted exhaust
- Mechanical conditions that limits engine speed
- Parasitic load on the engine—For example, a transmission condition, a belt driven accessory condition.

⇒ **If a condition is found**

Repair as necessary.

↓ **If a condition is not found**

2. All OK.

#### **P0507**

1. Verify the conditions listed below do not exist.

- Vacuum leaks
- A throttle valve that does not close correctly
- Verify the correct operation of the crankcase ventilation system. Inspect for the conditions listed below:
  - Improper routing of the positive crankcase ventilation (PCV) system
  - Vacuum leaks in the PCV system—Refer to [Crankcase Ventilation System Inspection/Diagnosis](#).

⇒ **If a condition is found**

Repair as necessary.

↓ **If a condition is not found**

2. All OK.

### Repair Instructions

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



[Throttle Body Assembly Replacement](#)

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## DTC P057B-P057D (L77 or LS3 w/LHD)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P057B

Brake Pedal Position Sensor Performance

#### DTC P057C

Brake Pedal Position Sensor Circuit Low Voltage

#### DTC P057D

Brake Pedal Position Sensor Circuit High Voltage

### Diagnostic Fault Information

| Circuit       | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|---------------|-----------------|----------------------|------------------|--------------------|
| Signal        | P057C           | P057C                | P057D            | P057B              |
| 5 V Reference | P057C<br>P0651  | P057C                | P057D,<br>P0651  | —                  |
| Low Reference | —               | P057D                | P057D            | —                  |

### Typical Scan Tool Data

#### Brake Pedal Position Sensor

| Circuit                                                                       | Short to Ground | Open | Short to Voltage |
|-------------------------------------------------------------------------------|-----------------|------|------------------|
| <b>Operating Conditions:</b> Ignition ON.<br><b>Normal Range:</b> 0.25–4.75 V |                 |      |                  |
| 5 V Reference                                                                 | 0 V             | 0 V  | —                |
| Signal                                                                        | 0 V             | 0 V  | 5 V              |
| Low Reference                                                                 | —               | 5 V  | —                |

### Circuit/System Description

The brake pedal position (BPP) sensor is part of the engine brake pedal override feature. The engine control module (ECM) continuously monitors the vehicle speed and the position of the brake pedal. These two main inputs, along with other ECM inputs are used to determine if the

vehicle is decelerating at the proper speed and rate with the brake pedal applied. When the engine brake pedal override system is active, the ECM reduces engine torque to assist in reducing vehicle speed.

The BPP sensor is a six wire sensor, and is part of a dual brake position sensor. One BPP Sensor is used for the stop lamps and the other BPP Sensor is used for the engine brake pedal override feature. The BPP Sensor for engine brake pedal override communicates with the ECM. The ECM supplies a 5 V reference circuit, low reference circuit, and signal circuit to the BPP sensor. The BPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage greater than 0.25 V when the brake pedal is released to a voltage less than 4.75 V when the brake pedal is fully applied.

For information on the Stop Lamps side of the BPP Sensor, refer to [Exterior Lighting Systems Description and Operation](#).

### **Conditions for Running the DTC**

#### **P057B**

- DTCs P057C, or P057D are not set.
- Ignition voltage is greater than 10 V.
- Shift lever has been in Park at least once during key ON.
- Shift lever is not in Park.
- Vehicle speed is 8 km/h (5 MPH) or greater.
- Accelerator Pedal Position is less than 5 %.
- DTC runs continuously when above conditions are met.

#### **P057C or P057D**

- Ignition voltage is greater than 10 V.
- DTC runs continuously when above condition is met.

### **Conditions for Setting the DTC**

#### **P057B**

ECM detects the BPP sensor signal is stuck in a range for greater than 1 s.

#### **P057C**

ECM detects the BPP sensor voltage is less than 0.25 V for 1 s.

#### **P057D**

ECM detects the BPP sensor voltage is greater than 4.75 V for 1 s.

### **Action Taken When the DTC Sets**

- P057B, P057C, and P057D are Type A DTCs.
- Brake Pedal Position Sensor parameter defaults to 0 %.

### **Conditions for Clearing the DTC**

P057B, P057C, and P057D are Type A DTCs

### **Reference Information**

#### **Schematic Reference**

- [Engine Controls Schematics](#)
- [Exterior Lights Schematics](#)

#### **Connector End View Reference**

- [Component Connector End Views](#)
- [Inline Harness Connector End 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

**Note:** The Brake Pedal Position sensor scan tool data is located in the ECM automatic transmission data list.

1. Ignition ON.
2. Verify DTC P0641, P0651, P0697, or P06A3 is not set.  
⇒ **If any of the DTCs are set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
- ↓ **If none of the DTCs are set**
3. Transmission in Park, and service brake pedal released.
4. Verify the scan tool Brake Pedal Position Sensor parameter in the ECM displays greater than 0.25 V.  
⇒ **If 0.25 V or less**  
Refer to Circuit/System Testing.
- ↓ **If greater than 0.25 V**
5. Verify the scan tool Brake Pedal Position Sensor parameter voltage changes as the brake pedal is applied and displays less than 4.75 V when the brake pedal is fully applied.  
⇒ **If the voltage does not change, or is greater than 4.74 V**  
Refer to Circuit/System Testing.
- ↓ **If the voltage changes and less than 4.75 V**
6. Verify the scan tool Brake Pedal Position Sensor Learned Release Position parameter is within 0.1 V of the Brake Pedal Position Sensor parameter when the brake pedal is fully released.  
⇒ **If difference is greater than 0.1 V**  
Perform the [Brake Pedal Position Sensor Learn](#).
- ↓ **If difference is 0.1 V or less**
7. Verify the Brake Pedal Position Sensor parameter transitions smoothly without any spikes or dropouts when slowly applying and releasing the brake pedal.  
⇒ **If parameter does not transition smoothly or has spikes or dropouts**  
Refer to Circuit/System Testing.
- ↓ **If parameter transitions smoothly and there are no spikes or dropouts**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.

⇒ **If the DTC sets**

Refer to Circuit/System Testing.

⇓ **If the DTC does not set**

10. All OK.

### Circuit/System Testing

**Note:** You must perform the Circuit/System Verification first.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B22 Brake Pedal Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

**Note:** All terminal references are for the vehicle harness brake pedal position sensor connector.

2. Test for less than 10  $\Omega$  between the low reference circuit terminal 5 and ground.

⇒ **If 10  $\Omega$  or greater**

- 2.1. Disconnect the harness connector at the K20 Engine Control Module.
- 2.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

⇓ **If less than 10  $\Omega$**

3. Ignition ON.

4. Test for 4.8–5.2 V between the 5 V reference circuit terminal 6 and ground.

⇒ **If less than 4.8 V**

- 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
- 4.2. 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.
- 4.3. Test for less than 2  $\Omega$  in the 5 V reference circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

⇒ **If greater than 5.2 V**

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

⇓ **If between 4.8–5.2 V**

5. Verify the scan tool Brake Pedal Position Sensor parameter is less than 0.25 V.

⇒ **If 0.25 V or greater**

- 5.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
- 5.2. Test for less than 0.25 V between the signal circuit terminal 4 and ground.
  - ⇒ If 0.25 V or greater, repair the short to voltage on the circuit.
  - ⇒ If less than 0.25 V, replace the K20 Engine Control Module.

⇓ **If less than 0.25 V**

6. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 6.

7. Verify the scan tool Brake Pedal Position Sensor parameter is greater than 4.8 V.

⇒ **If 4.8 V or less**

- 7.1. Ignition OFF, remove the jumper wire, and disconnect the harness connector at the K20 Engine Control Module.
- 7.2. 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.
- 7.3. Test for less than 2  $\Omega$  in the signal circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
  - ↓ **If greater than 4.8 V**

8. Replace the B22 Brake Pedal Position Sensor.

### **Repair Instructions**

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

- [Brake Pedal Position Sensor Replacement](#)
- Perform the [Brake Pedal Position Sensor Learn](#) following the replacement of the ECM or BPP sensor, or any repair that effects the BPP sensor alignment.
- [Control Module References](#) for Engine Control Module replacement, programming and setup.

## DTC P057B-P057D (L77 or LS3 w/RHD or LSA)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P057B

Brake Pedal Position Sensor Performance

#### DTC P057C

Brake Pedal Position Sensor Circuit Low Voltage

#### DTC P057D

Brake Pedal Position Sensor Circuit High Voltage

### Diagnostic Fault Information

| Circuit       | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|---------------|-----------------|----------------------|------------------|--------------------|
| Signal        | P057C           | P057C                | P057D            | P057B              |
| 5 V Reference | P057C<br>P0651  | P057C                | P0651            | —                  |
| Low Reference | —               | P057D                | P057D            | —                  |

### Typical Scan Tool Data

#### Brake Pedal Position Sensor

| Circuit                                                                       | Short to Ground | Open | Short to Voltage |
|-------------------------------------------------------------------------------|-----------------|------|------------------|
| <b>Operating Conditions:</b> Ignition ON.<br><b>Normal Range:</b> 0.25–4.75 V |                 |      |                  |
| 5 V Reference                                                                 | 0 V             | 0 V  | —                |
| Signal                                                                        | 0 V             | 0 V  | 5 V              |
| Low Reference                                                                 | —               | 5 V  | —                |

### Circuit/System Description

The brake pedal position (BPP) sensor is part of the engine brake pedal override feature. The engine control module (ECM) continuously monitors the vehicle speed and the position of the brake pedal. These two main inputs, along with other ECM inputs are used to determine if the

vehicle is decelerating at the proper speed and rate with the brake pedal applied. When the engine brake pedal override system is active, the ECM reduces engine torque to assist in reducing vehicle speed.

The BPP sensor is a six wire sensor, and is part of a dual brake position sensor. One BPP Sensor is used for the stop lamps and the other BPP Sensor is used for the engine brake pedal override feature. The BPP Sensor for engine brake pedal override communicates with the ECM. The ECM supplies a 5 V reference circuit, low reference circuit, and signal circuit to the BPP sensor. The BPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage greater than 0.25 V when the brake pedal is released to a voltage less than 4.75 V when the brake pedal is fully applied.

For information on the Stop Lamps side of the BPP Sensor, refer to [Exterior Lighting Systems Description and Operation](#).

#### **Conditions for Running the DTC**

##### **P057B**

- DTCs P057C, or P057D are not set.
- Ignition voltage is greater than 10 V.
- Shift lever has been in Park at least once during key ON.
- Shift lever is not in Park.
- Vehicle speed is 8 km/h (5 MPH) or greater.
- Accelerator Pedal Position is less than 5 %.
- DTC runs continuously when above condition is met.

##### **P057C or P057D**

- Ignition voltage is greater than 10 V.
- DTC runs continuously when above condition is met.

#### **Conditions for Setting the DTC**

##### **P057B**

ECM detects the brake pedal position sensor signal is stuck in a range for less than 1 s.

##### **P057C**

BPP sensor voltage is less than 0.25 V for 1 s.

##### **P057D**

BPP sensor voltage is greater than 4.75 V for 1 s.

#### **Action Taken When the DTC Sets**

- P057B, P057C, and P057D are Type A DTCs.
- Brake Pedal Position Sensor parameter defaults to 0 %.

#### **Conditions for Clearing the DTC**

P057B, P057C, and P057D are Type A DTCs

#### **Reference Information**

##### **Schematic Reference**

- [Engine Controls Schematics](#)
- [Exterior Lights Schematics](#)

##### **Connector End View Reference**



- [Component Connector End Views](#)
- [Inline Harness Connector End 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](#)

**Note:** The Brake Pedal Position sensor scan tool data is located in the ECM automatic transmission data list.

1. Ignition ON.
2. Verify DTC P0641, P0651, P0697, or P06A3 is not set.  
⇒ **If any of the DTCs are set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).  
⇓ **If none of the DTCs are set**
3. Transmission in Park, and service brake pedal released.
4. Verify the scan tool Brake Pedal Position Sensor parameter in the ECM displays greater than 0.25 V.  
⇒ **If 0.25 V or less**  
Refer to Circuit/System Testing.  
⇓ **If greater than 0.25 V**
5. Verify the scan tool Brake Pedal Position Sensor parameter voltage changes as the brake pedal is applied and displays less than 4.75 V when the brake pedal is fully applied.  
⇒ **If the voltage does not change, or is greater than 4.74 V**  
Refer to Circuit/System Testing.  
⇓ **If the voltage changes and less than 4.75 V**
6. Verify the scan tool Brake Pedal Position Sensor Learned Release Position parameter is within 0.1 V of the Brake Pedal Position Sensor parameter when the brake pedal is fully released.  
⇒ **If difference is greater than 0.1 V**  
Perform the [Brake Pedal Position Sensor Learn](#).  
⇓ **If difference is 0.1 V or less**
7. Verify the Brake Pedal Position Sensor parameter transitions smoothly without any spikes or dropouts when slowly applying and releasing the brake pedal.  
⇒ **If parameter does not transition smoothly or has spikes or dropouts**  
Refer to Circuit/System Testing.  
⇓ **If parameter transitions smoothly and there are no spikes or dropouts**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.

⇒ **If the DTC sets**

Refer to Circuit/System Testing.

⇓ **If the DTC does not set**

10. All OK.

### Circuit/System Testing

**Note:** You must perform the Circuit/System Verification first.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B22 Brake Pedal Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

**Note:** All terminal references are for the vehicle harness brake pedal position sensor connector.

2. Test for less than 10  $\Omega$  between the low reference circuit terminal 6 and ground.

⇒ **If 10  $\Omega$  or greater**

- 2.1. Disconnect the harness connector at the K20 Engine Control Module.
- 2.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

⇓ **If less than 10  $\Omega$**

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**

- 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
- 4.2. 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.
- 4.3. Test for less than 2  $\Omega$  in the 5 V reference circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

⇒ **If greater than 5.2 V**

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

⇓ **If between 4.8–5.2 V**

5. Verify the scan tool Brake Pedal Position Sensor parameter is less than 0.25 V.

⇒ **If 0.25 V or greater**

- 5.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
- 5.2. Test for less than 0.25 V between the signal circuit terminal 4 and ground.
  - ⇒ If 0.25 V or greater, repair the short to voltage on the circuit.
  - ⇒ If less than 0.25 V, replace the K20 Engine Control Module.

⇓ **If less than 0.25 V**

6. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 5.

7. Verify the scan tool Brake Pedal Position Sensor parameter is greater than 4.8 V.

⇒ **If 4.8 V or less**

7.1. Ignition OFF, remove the jumper wire, and disconnect the harness connector at the K20 Engine Control Module.

7.2. 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.

7.3. Test for less than 2  $\Omega$  in the signal circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

↓ **If greater than 4.8 V**

8. Replace the B22 Brake Pedal Position Sensor.

### **Repair Instructions**

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

- [Brake Pedal Position Sensor Replacement](#)
- Perform the [Brake Pedal Position Sensor Learn](#) following the replacement of the ECM or BPP sensor, or any repair that effects the BPP sensor alignment.
- [Control Module References](#) for Engine Control Module replacement, programming and setup.

## **DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 (ECM)**

### **Diagnostic Instructions**

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

### **DTC Descriptors**

#### **DTC P0601**

Control Module Read Only Memory Performance

#### **DTC P0602**

Control Module Not Programmed

#### **DTC P0603**

Control Module Long Term Memory Reset

#### **DTC P0604**

Control Module Random Access Memory Performance

#### **DTC P0606**

Control Module Processor Performance

#### **DTC P0607**

Control Module Performance

#### **DTC P060D**

Control Module Accelerator Pedal (APP) Position System Circuitry Performance

#### **DTC P062F**

Control Module Long Term Memory Performance

#### **DTC P2610**

Control Module Ignition Off Timer Performance

### **Circuit/System Description**

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). This diagnostic also addresses if the ECM is not programmed.

### **Conditions for Running the DTCs**

#### **P0601**

DTC P0601 runs continuously when the ignition is ON.

#### **P0602, P0603, P062F**

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These DTCs run during ECM power up.

**P0604**

DTC P0604 runs continuously when the ignition is ON for greater than 30 s.

**P0606, P0607**

- The system voltage is greater than 6.0 V.
- Reduced Engine Power is not active.
- These DTCs run continuously when the above conditions are met.

**P060D**

- The engine is running
- The system voltage is greater than 6.0 V.
- Reduced Engine Power is not active.
- DTC P060D runs continuously when the above conditions are met.

**P2610**

- The intake air temperature is between  $-40$  to  $+125^{\circ}\text{C}$  ( $-40$  to  $+257^{\circ}\text{F}$ ).
- DTC P2610 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, P0604, P0606, and P060D are Type A DTCs.
- DTCs P0603, P0607, and P062F are Type C DTCs.
- DTC P2610 is a Type B DTC.

**Conditions for Clearing the MIL/DTC**

- DTCs P0601, P0602, P0604, P0606, and P060D are Type A DTCs.
- DTCs P0603, P0607, and P062F are Type C DTCs.
- DTC P2610 is a Type B DTC.

**Diagnostic Aids**

Low voltage or a momentary loss of power or ground to the ECM may cause a DTC to set.

- Verify that the battery cables are clean and tight, and the battery is fully charged. Refer to [Battery Inspection/Test](#).
- Verify the ECM ground circuits do not have an open or high resistance.
- Verify the ECM power circuits do not have an open, short to ground, or high resistance.

**Reference Information****Schematic Reference**

[Engine Controls Schematics](#)

**Connector End View Reference**

[Component Connector End Views](#)

**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. Observe the DTC information with a scan tool. DTC P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, or P2610 should not set.
2. Operate the vehicle within the conditions for running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

**[Circuit/System Testing](#)**

1. Ignition ON, clear the DTC information with a scan tool. Observe the scan tool DTC information.
  - ⇒ If DTC P0602 is set, reprogram the K20 Engine Control Module. Refer to [Control Module References](#). If DTC P0602 resets, replace the K20 Engine Control Module.
2. Observe the DTC information with a scan tool. Verify that DTC P0601, P0603, P0604, P0605, P0606, P0607, P060D, P062F, or P2610 does not set.
  - ⇒ If a DTC failed this ignition, replace the K20 Engine Control Module.

**[Repair Instructions](#)**

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

[Control Module References](#) for ECM replacement, programming and setup

## DTC P0601-P0606, P060A, P062F, or P262B (Chassis Control Module)

### Diagnostic Instructions

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

### DTC Descriptors

**DTC P0601**

Control Module Read Only Memory Performance

**DTC P0602**

Control Module Not Programmed

**DTC P0603**

Control Module Long Term Memory Reset

**DTC P0604**

Control Module Random Access Memory Performance

**DTC P0606**

Control Module Processor Performance

**DTC P062F**

Control Module Long Term Memory Performance

### Circuit/System Description

The internal fault detection is handled inside the chassis control module. No external circuits are involved.

### Conditions for Running the DTC

The chassis control module runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

### Conditions for Setting the DTC

The chassis control module has detected an internal malfunction.

### Action Taken When the DTC Sets

DTC P0601, P0602, P0603, P0604, P0606 and P062F are type A DTCs.

### Conditions for Clearing the DTC

DTC P0601, P0602, P0603, P0604, P0606 and P062F are type A DTCs.

### Reference Information

**Schematic Reference**

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[Engine Controls Schematics](#)**Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

**DTC Type Reference**[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)**[Circuit/System Verification](#)**

**Note:** This DTC may be stored as a history DTC without affecting the operation of the module.  
If stored only as a history DTC and not retrieved as a current DTC, do not replace the module.

1. Ignition ON.
2. Verify DTC P0602 is not set.  
⇒ **If DTC P0602 is set**
  - 2.1. Program the K38 Chassis Control Module.
  - 2.2. Verify the DTC does not set.  
⇒ If the DTC sets, replace the K38 Chassis Control Module.  
⇓ If the DTC does not set.
  - 2.3. All OK.  
⇓ **If DTC P0602 is not set**
3. Verify DTC P0601, P0603, P0604, P0606, or P062F is not set.  
⇒ **If any of the DTCs are set**  
Replace the K38 Chassis Control Module.  
⇓ **If none of the DTCs are set**
4. All OK

**[Repair Instructions](#)**

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

[Control Module References](#) for chassis control module replacement, programming, and setup



## DTC P0641 or P06A6 (Chassis Control Module)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0641

5V Reference Circuit

#### DTC P06A6

5V Reference 1 Performance

### Diagnostic Fault Information

| Circuit       | Short to Ground           | Open/High Resistance | Short to Voltage          | Signal Performance |
|---------------|---------------------------|----------------------|---------------------------|--------------------|
| 5 V Reference | P018C,<br>P0641,<br>P06A6 | P018C                | P018D,<br>P0641,<br>P06A6 | P06A6              |
| Signal        | P018C                     | P018B,<br>P018C      | P018D                     | P018B              |
| Low Reference | —                         | P0641,<br>P06A6      | —                         | P06A6              |

### Circuit/System Description

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

### Conditions for Running the DTC

The ignition is ON.

### Conditions for Setting the DTC

The chassis control module detects that the fuel pressure 5 V reference is above or below a predetermined voltage threshold.

### Action Taken When the DTC Sets

DTCs P0641 and P06A6 are Type A DTCs.

### Conditions for Clearing the DTC

DTCs P0641 and P06A6 are Type A DTCs.

### Diagnostic Aids

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

## Reference Information

### Schematic Reference

[Engine Controls Schematics](#)

### Connector End View Reference

[Component Connector End 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 and all vehicle systems OFF, disconnect the harness connector at the B47 Fuel Pressure Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10  $\Omega$  between the low reference circuit terminal 2 and ground.  
⇒ **If 10  $\Omega$  or greater**
  - 2.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
  - 2.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.  
⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
⇒ If less than 2  $\Omega$ , replace the K38 Chassis Control Module.
- ⇓ **If less than 10  $\Omega$**
3. Ignition ON.
4. Test for 4.8–5.2 V between the 5 V reference circuit terminal 3 and ground.  
⇒ **If less than 4.8 V**
  - 4.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
  - 4.2. 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
  - 4.3. Test for less than 2  $\Omega$  in the 5 V reference circuit end to end.  
⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
⇒ If less than 2  $\Omega$ , replace the K38 Chassis Control Module.
- ⇒ **If greater than 5.2 V**

4.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.

4.2. Test for less than 1 V between the 5 V reference circuit and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K38 Chassis Control Module.

↓ **If between 4.8–5.2 V**

5. Verify the scan tool Fuel Pressure Sensor Voltage parameter is less than 1 V.

⇒ **If 1 V or greater**

5.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.

5.2. Test for less than 1 V between the signal circuit terminal 1 and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K38 Chassis Control Module.

↓ **If less than 1 V**

6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3, wait 15 seconds.

7. Verify the scan tool Fuel Pressure Sensor Voltage parameter is greater than 4.8 V.

⇒ **If 4.8 V or less**

7.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.

7.2. 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

7.3. Test for less than 2  $\Omega$  in the signal circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the K38 Chassis Control Module.

↓ **If greater than 4.8 V**

8. Test or replace the B47 Fuel Pressure Sensor.

### Repair Instructions

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

[Control Module References](#) for chassis control module replacement, programming and setup

## DTC P0641 or P0651 (ECM, without Supercharger)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0641

5V Reference 1 Circuit

#### DTC P0651

5V Reference 2 Circuit

### Circuit/System Description

The engine control module (ECM) has 2 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

- Reduced Engine Power is not active.
- The ignition voltage is greater than 6 V.
- DTCs P0641 and P0651 run continuously when the above conditions are met.

### Conditions for Setting the DTC

The ECM detects a short to ground or voltage on the 5V reference 1 or 2 circuit for greater than 0.5 s.

### Action Taken when the DTC Sets

DTCs P0641 and P0651 are Type A DTCs.

### Conditions for Clearing the MIL/DTC

DTCs P0641 and P0651 are Type A DTCs.

### Diagnostic Aids

#### P0641

The 5V reference 1 circuit provides 5 V to the sensors listed below:

- Accelerator pedal position sensor 2
- Air conditioning (A/C) refrigerant pressure sensor
- Camshaft position sensor
- Engine oil pressure sensor
- Manifold absolute pressure sensor

#### P0651

The 5V reference 2 circuit provides 5 V to the sensors listed below:

- Accelerator pedal position sensor 1
- Brake booster vacuum sensor
- Brake pedal position sensor (automatic transmission)
- Clutch pedal position sensor (manual transmission)
- Crankshaft position sensor
- Throttle position sensor 1 and 2

Disconnecting one component at a time from the affected 5V reference circuit while observing the scan tool 5V Reference Circuit Status parameter may help locate the fault. The scan tool parameter will change from Malfunction to OK when the source of the fault is disconnected. If all 5V reference components have been disconnected and a fault is still indicated, the fault may exist in the wiring harness.

## [Reference Information](#)

### **Schematic Reference**

[Engine Controls Schematics](#)

### **Connector End View Reference**

[Component Connector End Views](#)

### **Component View Reference**

[Powertrain Component Views](#)

### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

### **Scan Tool Reference**

[Control Module References](#)

## [Circuit/System Verification](#)

1. Observe the scan tool 5V Reference 1 and 2 Circuit Status parameters. Verify the parameters display OK.
2. Ignition ON, observe the DTC information with a scan tool. DTC P0641 and P0651 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

## [Circuit/System Testing](#)

**Note:** Additional DTCs will set when disconnecting the components.

1. Ignition ON, disconnect the harness connector of all appropriate sensors for the applicable DTC. Refer to Diagnostic Aids for the appropriate sensors.
2. Ignition ON, measure for 4.8–5.2 V between one of the 5V reference circuits and ground.
  - ⇒ If less than the specified range, test for a short to ground on the 5V reference circuit for each affected sensor. If all circuits test normal, replace the K20 ECM.
  - ⇒ If greater than the specified range, test for a short to voltage on the 5V reference circuit for each affected sensor. If all circuits test normal, replace the K20 ECM.

**Note:** A short to voltage on the signal circuit of certain components may cause this DTC to set.

3. Connect each component associated with the 5V reference circuit, one at a time, while monitoring the voltage. Verify the voltage remains between 4.8–5.2 V.
  - ⇒ If not within the specified range when a component is connected, test the signal circuit for a short to voltage. If the circuit tests normal, replace the component.

### **Repair Instructions**

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

- [Accelerator Pedal Position Sensor Replacement](#)
- [Air Conditioning \(A/C\) Refrigerant Pressure Sensor Replacement](#)
- [Brake Pedal Position Sensor Replacement](#)
- [Camshaft Position Sensor Replacement](#)
- [Clutch Pedal Position Switch Replacement](#)
- [Crankshaft Position Sensor Replacement](#)
- [Engine Oil Pressure Sensor and/or Switch Replacement](#)
- [Manifold Absolute Pressure Sensor Replacement](#)
- [Power Brake Booster Pressure Sensor Replacement](#) for brake booster vacuum sensor replacement.
- [Throttle Body Assembly Replacement](#)
- [Control Module References](#) for ECM replacement, programming, and setup.

## DTC P0641 or P0651 (ECM, with Supercharger)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0641

5V Reference 1 Circuit

#### DTC P0651

5V Reference 2 Circuit

### Circuit/System Description

The engine control module (ECM) has 2 internal 5V reference circuits. Each internal reference circuit provides a 5V reference for more than one sensor. A short to ground or short to voltage on one of the external 5V reference circuits can affect all the components connected to the same internal 5V reference circuit.

### Conditions for Running the DTC

- The ignition voltage is greater than 6 V.
- Reduced Engine Power is not active.
- DTCs P0641 and P0651 run continuously when the above conditions are met.

### Conditions for Setting the DTC

The ECM detects a short to ground or voltage on the 5V reference 1 or 2 circuit for greater than 0.5 s.

### Action Taken When the DTC Sets

DTCs P0641 and P0651 are Type A DTCs.

### Conditions for Clearing the MIL/DTC

DTCs P0641 and P0651 are Type A DTCs.

### Diagnostic Aids

#### DTC P0641

The 5V reference 1 circuit provides 5V to the sensors listed below:

- Accelerator pedal position sensor 2
- Air conditioning (A/C) refrigerant pressure sensor
- Barometric pressure sensor (throttle inlet absolute pressure sensor)
- Camshaft position sensor
- Engine oil pressure sensor
- Manifold absolute pressure sensor (supercharger air outlet pressure sensor)
- Supercharger air inlet pressure sensor

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**DTC P0651**

The 5V reference 2 circuit provides 5 V to the sensors listed below:

- Accelerator pedal position sensor 1
- Brake pedal position sensor (automatic transmission)
- Clutch pedal position sensor (manual transmission)
- Crankshaft position sensor
- Throttle position sensor 1 and 2

Disconnecting one component at a time from the affected 5V reference circuit while observing the scan tool 5V Reference Circuit Status parameter may help locate the fault. The scan tool parameter will change from Malfunction to OK when the source of the fault is disconnected. If all 5V reference components have been disconnected and a fault is still indicated, the fault may exist in the wiring harness.

**Reference Information****Schematic Reference**

[Engine Controls Schematics](#)

**Connector End View Reference**

[Component Connector End Views](#)

**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. Observe the scan tool 5V Reference 1 and 2 Circuit Status parameters. Verify the parameters display OK.
2. Ignition ON, observe the DTC information with a scan tool. DTCs P0641 and P0651 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

**Circuit/System Testing**

**Note:** Additional DTCs will set when disconnecting the components.

1. Ignition OFF, disconnect the harness connector of all the sensors for the applicable DTC. Refer to Diagnostic Aids for the appropriate sensors.
2. Ignition ON, measure for 4.8–5.2 V between one of the 5V reference circuits and ground.



- ⇒ If less than the specified range, test for a short to ground on the 5V reference circuit for each affected component. If all circuits test normal, replace the K20 engine control module.
- ⇒ If greater than the specified range, test for a short to voltage on the 5V reference circuit for each affected component. If all circuits test normal, replace the K20 engine control module.

**Note:** A short to voltage on the signal circuit of certain components may cause this DTC to set.

3. Connect each component associated with the 5V reference circuit, one at a time, while monitoring the appropriate scan tool 5V Reference Voltage parameter. Verify the voltage remains between 4.8–5.2 V.
  - ⇒ If not within the specified range when a component is connected, test the signal circuit for a short to voltage. If the circuit tests normal, replace the component.

### **Repair Instructions**

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

- [Accelerator Pedal Position Sensor Replacement](#)
- [Air Conditioning \(A/C\) Refrigerant Pressure Sensor Replacement](#)
- [Barometric Pressure Sensor Replacement](#)
- [Brake Pedal Position Sensor Replacement](#)
- [Camshaft Position Sensor Replacement](#)
- [Clutch Pedal Position Switch Replacement](#)
- [Crankshaft Position Sensor Replacement](#)
- [Engine Oil Pressure Sensor and/or Switch Replacement](#)
- [Supercharger Air Inlet Pressure Sensor Replacement](#)
- [Supercharger Air Outlet Pressure Sensor Replacement](#) for manifold absolute pressure sensor replacement.
- [Throttle Body Assembly Replacement](#)
- [Control Module References](#) for ECM replacement, setup, and programming

## DTC P0650

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P0650

Malfunction Indicator Lamp (MIL) Control Circuit

### Diagnostic Fault Information

| Circuit              | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|----------------------|-----------------|----------------------|------------------|--------------------|
| Ignition Voltage     | P0650           | P0650                | —                | —                  |
| Control              | P0650*          | P0650                | P0650            | —                  |
| * The MIL remains ON |                 |                      |                  |                    |

### Circuit/System Description

The malfunction indicator lamp (MIL) illuminates to inform the driver that an emission system fault has occurred and the powertrain control system requires service. Ignition voltage is supplied directly to the MIL. The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit when the emission system fault occurs. Under normal operating conditions, the MIL should be ON only when the ignition is ON and the engine is OFF.

### Conditions for Running the DTC

- The ignition is in the Run or Crank position.
- The ignition voltage is between 11–32 V.
- DTC P0650 runs continuously when the above conditions are met .

### Conditions for Setting the DTC

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

### Action Taken When the DTC Sets

DTC P0650 is a Type B DTC.

### Conditions for Clearing the DTC

DTC P0650 is a Type B DTC.

### 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 will

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change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

## Reference Information

### Schematic Reference

- [Engine Controls Schematics](#)
- [Instrument Cluster Schematics](#)

### Connector End View Reference

[Component Connector End 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 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.

⇓ **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.

⇓ **If Malfunction is not displayed**
5. Verify the malfunction indicator lamp turns ON and OFF when commanding the Malfunction Indicator Lamp On and Off with a scan tool.

⇒ **If the malfunction indicator lamp does not turn ON and OFF**  
Refer to Circuit/System Testing.

⇓ **If the malfunction indicator lamp turns ON and OFF**

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

⇒ **If the DTC sets**

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

⇓ **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**

3.1. Test for infinite resistance between the control circuit terminal X1 68 and ground.

⇒ If less than infinite resistance, repair the short to ground in the circuit.

⇒ If infinite resistance, replace the P16 Instrument Cluster.

⇓ **If the malfunction indicator lamp does not illuminate**

4. Connect a 3 A fused jumper wire between the control circuit terminal X1 68 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**

5.1. Test for less than 1 V between the control circuit terminal X1 68 and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇓ If less than 1 V

5.2. Ignition OFF.

5.3. Test for less than 2  $\Omega$  in the control circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇓ If less than 2  $\Omega$ .

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 10 and ground.

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

7.1. Ignition OFF.

7.2. 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 the test lamp does not illuminate and the circuit fuse is good**

7.1. Ignition OFF.

7.2. Test for less than 2  $\Omega$  in the ignition voltage circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇓ **If the test lamp illuminates**

8. Replace the P16 Instrument Cluster.

### **Repair Instructions**

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

- [Instrument Cluster Replacement](#)

- [Control Module References](#) for control module replacement, programming, and setup

## DTC P0685, P0689, P0690, or P1682

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P0685

Engine Controls Ignition Relay Control Circuit

#### DTC P0690

Engine Controls Ignition Relay Feedback Circuit High Voltage

#### DTC P1682

Ignition 1 Switch Circuit 2

### Diagnostic Fault Information

#### Powertrain Relay

| Circuit                   | Short to Ground | Open/High Resistance | Short to Voltage    |
|---------------------------|-----------------|----------------------|---------------------|
| Relay Coil Supply Voltage | P0685           | P0685                | —                   |
| Relay Control Circuit     | P0685           | P0685, P1682         | P0685, P0690, P1682 |
| Relay Feedback Circuit    | —               | —                    | P0690               |

### Typical Scan Tool Data

#### Engine Controls Ignition Relay Control Circuit Low Voltage, Open, and High Voltage Test Status—Component Commanded OFF

| Circuit                                                                                                                                                                                                                                                                                                                                                                                             | Short to Ground | Open        | Short to Voltage |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------|------------------|
| <b>Operating Conditions:</b> Component commanded OFF<br><b>Parameter Normal Range:</b> The following illustrates the normal parameter state with no circuit conditions: <ul style="list-style-type: none"> <li>• Component OFF – OK for Open/Low Voltage test and Not Run for High Voltage test</li> <li>• Component ON – Not Run for Open/Low Voltage test and OK for High Voltage test</li> </ul> |                 |             |                  |
| B+                                                                                                                                                                                                                                                                                                                                                                                                  | —               | 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 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------|------------------|
| <b>Operating Conditions:</b> Component commanded ON<br><b>Parameter Normal Range:</b> The following illustrates the normal parameter state with no circuit conditions: <ul style="list-style-type: none"> <li>• Component OFF – OK for Open/Low Voltage test and Not Run for High Voltage test</li> <li>• Component ON – Not Run for Open/Low Voltage test and OK for High Voltage test</li> </ul> |                 |         |                  |
| B+                                                                                                                                                                                                                                                                                                                                                                                                 | —               | Not Run | —                |
| Control                                                                                                                                                                                                                                                                                                                                                                                            | Not Run         | Not Run | Malfunction      |

#### Circuit/System Description

There are 2 ignition voltage circuits supplied to the engine control module (ECM). One is supplied by the powertrain relay and the other is supplied by the ignition relay. The ECM monitors and compares the ignition voltage supplied by the 2 relays.

#### Conditions for Running the DTC

##### **P0685**

- The ignition is ON.
- The ignition voltage is between 11–32 V.
- The DTC runs continuously when the above conditions are met.

##### **P0690**

- P0685 is not set.
- The powertrain relay is commanded ON.
- The DTC runs continuously when the above conditions are met.

##### **P1682**

- The powertrain relay is commanded ON.
- System 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.

##### **P0690**

- The ECM detects the engine controls ignition relay feedback circuit is greater than 3 V when the relay is commanded OFF.
- The ECM detects the engine controls ignition relay feedback circuit is greater than 18 V when the relay is commanded ON.
- The condition is present for greater than 4 s.

**P1682**

The ECM detects that the voltage level difference is greater than 3 V between the 2 ignition voltage circuits for less than 1 s.

**Action Taken When the DTC Sets**

- DTCs P0685 and P0690 are Type C DTCs.
- DTC P1682 is a Type A DTC.

**Conditions for Clearing the DTC**

- DTCs P0685 and P0690 are Type C DTCs.
- DTC P1682 is a Type A DTC.

**Diagnostic Aids**

The powertrain relay may also be labeled the engine controls ignition relay, the engine control module relay, or the main relay. The ignition relay may also be labeled the ignition run relay, the ignition main relay, the ignition 1 relay, or the run/crank relay.

**Reference Information****Schematic Reference**

- [Engine Controls Schematics](#)
- [Power Distribution Schematics](#)

**Connector End View Reference**

[Component Connector End Views](#)

**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 other DTCs are set, diagnose those DTCs first.
- If you were sent here from Engine Cranks But Does Not Run, proceed to Circuit/System Testing.

1. Ignition ON, command the engine controls ignition relay ON and OFF with a scan tool while observing the following parameters:
  - Engine Controls Ignition Relay Control Circuit Low Voltage Test Status
  - Engine Controls Ignition Relay Control Circuit Open Test Status



- Engine Controls Ignition Relay Control Circuit High Voltage Test Status  
Each parameter should display OK or Not Run in each commanded state.
- 2. Ignition ON, view the DTC information with a scan tool. DTC P0685, P0690, or P1682 should not set.
- 3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

### Circuit/System Testing

**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 powertrain relay.
2. Verify a test lamp illuminates between ground and the relay circuit terminals listed below:
  - Terminal 85
  - Terminal 30
 ⇒ If the test lamp does not illuminate, test the relay battery voltage circuit for an open/high resistance.

**Note:** High resistance in the circuit/underhood fuse block for either the powertrain relay or the ignition relay can cause DTC P1682 to set.

3. Ignition ON, verify that a test lamp does not illuminate between the ignition voltage circuit terminal 87 and ground.
  - ⇒ If the test lamp illuminates, test the ignition voltage circuit for a short to voltage.
4. Connect a 20 A fused jumper wire between the relay switch B+ circuit terminal 30 and the relay switch ignition voltage circuit terminal 87.
5. Ignition ON, observe the scan tool Engine Controls Ignition Relay Feedback Signal parameter. The ECM should communicate, and the parameter should display B+.
  - ⇒ If not the specified value, or the ECM does not communicate, test the ignition voltage circuit between the powertrain relay and the ECM for a short to ground or for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
6. Ignition OFF, connect a DMM set to the diode setting between control circuit terminal 86 and ground. Verify the DMM displays OL.
  - ⇒ If not the specified value, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
7. Ignition ON, verify the DMM displays less than 1 V.
  - ⇒ If not the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
8. If all circuits test normal, replace the powertrain relay.

### Component Testing

**Note:** Depending on the application, the relay coil resistance will be within one of the following ranges.

1. Test for one of the following resistance specifications between terminals 85 and 86 of the powertrain relay:
  - 70–110  $\Omega$
  - 200–250  $\Omega$
 ⇒ If not within the specified range, replace the relay.
2. Test for infinite resistance between the following terminals of the relay:
  - 30 and 86
  - 30 and 87
  - 30 and 85
  - 85 and 87

⇒ If not the specified value, replace the relay.

3. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2  $\Omega$  between terminals 30 and 87.

⇒ If greater than the specified range, replace the relay.

### **Repair Instructions**

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

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

## DTC P069E

### Diagnostic Instructions

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

### DTC Descriptor

#### **DTC P069E**

Fuel Pump Control Module Requested MIL Illumination

### Circuit/System Description

The fuel pump control module constantly monitors the fuel pump control system for any condition which may adversely affect vehicle emissions. If a condition is detected, the fuel pump control module sets a DTC and sends a serial data message to the engine control module (ECM). The ECM sets DTC P069E to inform the technician that the fuel pump control module has set the emission related DTC. The serial data message sent by the fuel pump control module also contains a request for the ECM to illuminate the malfunction indicator lamp (MIL).

The technician can observe the DTC that was set by the fuel pump control module by reviewing the ECM Freeze Frame records on the scan tool. The ECM Freeze Frame records also contain the engine operating conditions present when the fuel pump control module DTC set.

### Conditions for Running the DTC

The ignition is ON, or the engine is running for greater than 3 s.

### Conditions for Setting the DTC

The ECM receives a serial data message from the fuel pump control module indicating that an emission related DTC has set in the fuel pump control module.

### Action Taken When the DTC Sets

- DTC P069E is a Type A DTC.
- DTC P069E will continue to be current or active as long as the fuel pump control module is requesting MIL illumination.

### Conditions for Clearing the DTC

DTC P069E is a Type A DTC.

### Diagnostic Aids

Communication codes, U-codes, as well as powertrain codes, P-codes, set in the fuel pump control module will cause the fuel pump control module to request DTC P069E to be set in the ECM.

### Reference Information

#### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

#### **Scan Tool Reference**

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

### **Circuit/System Verification**

**Note:**

- Do not replace the engine control module for this DTC. DTC P069E is an informational DTC.
- Correct any engine control and communication DTCs before diagnosing fuel pump control module DTCs.

1. Verify there are no engine control or communication DTCs set.

⇒ **If a DTC is set**

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

↓ **If a DTC is not set**

2. Verify there are no fuel pump control module DTCs set.

⇒ **If a DTC is set**

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

↓ **If a DTC is not set**

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

4. Verify the DTC does not set.

⇒ **If the DTC sets**

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

↓ **If the DTC does not set**

5. All OK.

### **Repair Instructions**

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

## DTC P0700

### [Diagnostic Instructions](#)

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

### [DTC Descriptor](#)

#### **DTC P0700**

Transmission Control Module Requested MIL Illumination

### [Circuit/System Description](#)

The transmission control module (TCM) constantly monitors the transmission system for any condition which may adversely affect vehicle emissions. If a condition is detected, the TCM sets a DTC and sends a serial data message to the engine control module (ECM). The ECM sets DTC P0700 to inform the technician that the TCM has set the emission related DTC. The serial data message sent by the TCM also contains a request for the ECM to illuminate the malfunction indicator lamp (MIL).

The technician can observe the DTC that was set by the TCM by reviewing the ECM Freeze Frame records on the scan tool. The ECM Freeze Frame records also contain the engine operating conditions present when the transmission DTC set.

### [Conditions for Running the DTC](#)

- The ignition is ON or the engine is operating.
- DTC P0700 runs continuously.

### [Conditions for Setting the DTC](#)

The ECM receives a serial data message from the TCM indicating that an emission related DTC has set in the TCM.

### [Action Taken When the DTC Sets](#)

DTC P0700 is a Type A DTC.

### [Conditions for Clearing the MIL/DTC](#)

DTC P0700 is a Type A DTC.

### [Diagnostic Aids](#)

Communication codes, U-codes, as well as powertrain codes, P-codes, set in the TCM can cause the TCM to request DTC P0700 to be set in the ECM.

### [Reference Information](#)

#### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

#### **Scan Tool Reference**

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

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### Circuit/System Verification

**Note:**

- Do not replace the engine control module for this DTC. DTC P0700 is an informational DTC.
- Correct any engine controls and communication DTCs before diagnosing transmission control module DTCs.

1. Verify there are no engine control or communication DTCs set.

⇒ **If a DTC is set**

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

⇓ **If a DTC is not set**

2. Verify there are no transmission control module DTCs set.

⇒ **If a DTC is set**

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

⇓ **If a DTC is not set**

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

4. Verify the DTC does not set.

⇒ **If the DTC sets**

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

⇓ **If the DTC does not set**

5. All OK.

### Repair Instructions

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

[2014 Holden VF Sedan](#) | [VF/WN - Sedan, Ute, Sportwagon, Caprice, Lumina, HSV Service Manual 5617662](#) | [Engine/Propulsion](#) | [Engine Controls and Fuel - 6.0L L77 or 6.2L LS3 LSA](#) | [Diagnostic Information and Procedures](#) |

**Document ID: 3287380**

## DTC P1255 or P064A (Chassis Control Module)

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P064A

Fuel Pump Control Module Performance

#### DTC P1255

Fuel Pump Control Module Driver High Temperature

### Circuit/System Description

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

### Conditions for Running the DTC

The engine is running.

### Conditions for Setting the DTC

The chassis control module detects an over-temperature fault.

### Action Taken When the DTC Sets

DTCs P064A and P1255 are Type A DTCs.

### Conditions for Clearing the DTC

DTCs P064A and P1255 are Type A DTCs.

### Diagnostic Aids

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

Beginning in the 2014 model year the K27 Fuel Pump Control Module (FPCM) will now be called the chassis control module (CCM). The component code for the chassis control module will be K38. The chassis control module name will be used in Service Information, the Global Diagnostic System and the Service Programming System.

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

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[Component Connector End Views](#)**Description and Operation**[Fuel System Description](#)**Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

**DTC Type Reference**[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)**Scan Tool Reference**

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

**[Circuit/System Verification](#)**

1. Ignition ON.
2. Verify DTC P0231, P0232 or P023F is not set.  
⇒ **If any of the DTCs are set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).  
⇓ **If none of the DTCs are set**
3. Verify that the area where the K38 Chassis Control Module is located is free of debris, clutter, or any insulating material that would cause the K38 Chassis Control Module to overheat.  
⇒ **If any debris, clutter, or other material is found**
  - 3.1. Clear the area where the K38 Chassis Control Module is located.
  - 3.2. Clear the DTC and test drive the vehicle.
  - 3.3. Verify DTC P1255 or P064A is not set.  
⇒ If DTC P1255 or P064A is set, replace the K38 Chassis Control Module.  
⇓ If DTC P1255 or P064A is not set
  - 3.4. All OK.  
⇓ **If no debris, clutter, or other material is found**
4. Clear the DTC and test drive the vehicle.
5. Verify DTC P1255 or P064A is not set.  
⇒ **If DTC P1255 or P064A is set**  
Replace the K38 Chassis Control Module.  
⇓ **If DTC P1255 or P064A is not set.**
6. All OK.

**[Repair Instructions](#)**

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

[Control Module References](#) for chassis control module replacement, programming and setup



## DTC P1380 or P1381

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P1380

Misfire Detected – Rough Road Data Not Available

#### DTC P1381

Misfire Detected – No Communication with Brake Control Module

### System Description

The engine control module (ECM) detects engine misfire by detecting variations in crankshaft deceleration between firing strokes. For accurate detection of engine misfire, the ECM must distinguish between crankshaft deceleration caused by actual misfire and deceleration caused by rough road conditions. The antilock brake system (ABS) can detect if the vehicle is on a rough road based on wheel acceleration/deceleration data supplied by the wheel speed sensors. If the ABS detects rough road above predetermined threshold, this information is sent to the ECM. The ECM uses the rough road information when calculating engine misfire. If the ABS is malfunctioning and cannot detect rough roads, the misfire diagnostic will continue to run; however, if an engine misfire DTC sets, this DTC also sets indicating that rough road data was not available, or there was no communication with the brake control module during the misfire calculation due to an ABS malfunction.

### Conditions for Running the DTC

- The vehicle speed is greater than 8 km/h (5 mph).
- The engine speed is less than 7,000 RPM.
- The engine load is less than 60 percent.
- Engine misfire is detected and DTC P0300 sets with the MIL illuminated.
- DTCs P1380 and P1381 run continuously when the above conditions are met.

### Conditions for Setting the DTC

#### P1380

- The ABS controller sends a message to the ECM indicating that a failure has occurred in the ABS module.
- Engine misfire is detected and DTC P0300 set.

#### P1381

- An ABS malfunction exists for more than 10 seconds, preventing the ECM from receiving rough road detection data.
- Engine misfire is detected and DTC P0300 set.

### Action Taken When the DTC Sets

DTCs P1380 and P1381 are Type C DTCs.

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### **Conditions for Clearing the DTC**

DTCs P1380 and P1381 are Type C DTCs.

### **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**

Monitor the ABS DTCs on the scan tool.

- ⇒ If any ABS DTCs are set, diagnose those first. Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
- ⇒ If there are no ABS DTCs set, refer to the following:

[Symptoms - Antilock Brake System](#)

## DTC P1400

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P1400

Cold Start Emission Reduction Control System

### Circuit/System Description

The catalyst must be warmed to efficiently reduce the emissions. The cold start strategy is to reduce the amount of time it takes to warm the catalyst. During a cold start, the engine spark timing is altered to allow the catalyst to warm quickly. This diagnostic monitors the following to build an exhaust energy model:

- Spark advance
- Engine airflow
- Engine coolant temperature
- Engine run time
- Engine idle speed
- Catalyst temperature

The actual model is then compared to the expected exhaust energy model.

### Conditions for Running the DTC

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0114, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0201-P0208, P0220, P0222, P0223, P0300-P0308, P0335, P0336, P050A, P050B, P0502, P0503, P0506, P0507, P0606, P0722, P0723, and P2135 are not set.
- The engine is running, and a cold start has been detected.
- Vehicle speed is less than 2 km/h (1 MPH).
- The engine is at idle with no input from the accelerator pedal.
- The engine coolant temperature (ECT) is between -17-43°C (63-109°F).
- The calculated 3-way catalyst temperature is colder than 300°C (572°F).
- The barometric (BARO) pressure is greater than 75 kPa.
- The engine control module (ECM) will exit the diagnostic if the calculated 3-way catalyst temperature is greater than 800°C (1472°F) when the engine run time is greater than 1 s.
- The ECM will exit the diagnostic if the engine run time is greater than a calibrated value.
- This DTC runs for 10 s within the first 2 min of start-up. This diagnostic runs once per trip when a cold start has been determined.

### Conditions for Setting the DTC

The actual exhaust energy model does not match the expected exhaust energy model.

### [Action Taken When the DTC Sets](#)

DTC P1400 is a Type A DTC.

### [Conditions for Clearing the DTC](#)

DTC P1400 is a Type A DTC.

### [Reference Information](#)

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

[Component Connector End 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. Vehicle OFF, allow the engine to cool to be within the temperatures listed in the Conditions for Running the DTC.
2. Engine running.
3. Operate the vehicle within the Conditions for Running the DTC. 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**

5. Verify that none of the conditions listed below exists with the air intake system:

- Damage, restriction, or modification
- Dirty or deteriorating air filter element
- Crankcase ventilation system for correct operation—Refer to [Crankcase Ventilation System Inspection/Diagnosis](#).
- Water intrusion
- Vacuum leak and other unmetered air downstream of the mass air flow (MAF) sensor
- Intake manifold leak

#### ⇒ **If any of the conditions exist**

Repair as necessary.

#### ⇓ **If none of the conditions exist**

6. Verify that none of the conditions listed below exists with the exhaust system:

- Exhaust leak
- Damaged, restricted, or modified exhaust system – Refer to [Symptoms - Engine Exhaust](#).

⇒ **If any of the above conditions exist**

Repair as necessary.

⇓ **If none of the conditions exist**

7. If all of the above conditions test normal, inspect for an engine mechanical condition that could alter the air flow into the combustion chamber. Refer to [Symptoms - Engine Mechanical](#).

⇓ **If the DTC does not set**

8. All OK.

### **[Repair Instructions](#)**

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

## DTC P150C

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P150C

Transmission Control Module Engine Speed Request Signal Message Counter Incorrect

### Circuit/System Description

To improve vehicle shift feel, the transmission control module (TCM) is constantly sending the ECM serial data messages with requests to modify engine speed or torque. These serial data messages are sent through two circuits which are part of a communication network called the controller area network (CAN). The ECM sets DTC P150C when it detects a discrepancy in the structure of this message causing its integrity to be questioned.

An intermittent fault in the controller area network (CAN) circuits will cause DTC P150C to set.

### Conditions for Running the DTC

- DTCs P0506, P0507, or U0101 are not set.
- The engine is running for greater than 0.5 s.
- The DTC runs continuously when the above conditions are met.

### Conditions for Setting the DTC

The ECM detects that the TCM engine speed request does not match the expected engine speed request.

### Action Taken When the DTC Sets

DTC P150C is a Type B DTC.

### Conditions for Clearing the DTC

DTC P150C is a Type B DTC.

### Reference Information

#### Description and Operation

[Data Link Communications Description and Operation](#)

#### DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

#### Scan Tool Reference

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

### Circuit/System Verification

#### Note:

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- DTC P150C is an informational DTC.
- Diagnose all other engine control module DTCs prior to DTC P150C.

1. Verify that no other DTCs are set except for DTC P150C.

⇒ **If any other DTCs are set**

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

↓ **If only DTC P150C is set**

2. Replace the K71 Transmission Control Module.

3. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

4. Verify the DTC does not set.

⇒ **If the DTC sets**

Replace the K20 Engine Control Module.

↓ **If the DTC does not set**

5. All OK.

### Repair Instructions

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

[Control Module References](#) for ECM or TCM replacement, programming, and setup

## DTC P1516, P2101, P2119, or P2176

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P1516

Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance

#### DTC P2101

Throttle Actuator Position Performance

#### DTC P2119

Throttle Closed Position Performance

#### DTC P2176

Minimum Throttle Position Not Learned

### Diagnostic Fault Information

| Circuit                  | Short to Ground | Open/High Resistance | Short to Voltage    | Signal Performance  |
|--------------------------|-----------------|----------------------|---------------------|---------------------|
| TAC Motor Control Closed | P1516, P2101    | P1516, P2101         | P0690, P1516, P2101 | P1516, P2101, P2119 |
| TAC Motor Control Open   | P1516, P2101    | P1516, P2101         | P0690, P1516, P2101 | P1516, P2101, P2119 |

### Circuit/System Description

The Engine Control Module (ECM) controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the throttle position sensors 1 and 2 to determine the actual throttle valve position.

### Conditions for Running the DTC

#### P1516

- DTC P0606 or P1682 is not set.
- The run/crank or powertrain relay voltage is greater than 6.0 V and reduced power is not active.
- DTC P1516 runs continuously when the above conditions are met.

#### P2101

- DTC P0606 or P1682 is not set.



- The run/crank or powertrain relay voltage is greater than 6.0 V and reduced power is not active.
- The engine is running or the following conditions are met:
  - The engine is not running.
  - The ignition voltage is greater than 11 V.
  - The TAC system is not in the Battery Saver mode.
  - The ECM is commanding the throttle.
  - The ECM has learned the minimum throttle position.
- DTC P2101 runs continuously when the above conditions are met.

**P2119**

- DTC P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0651, or P2135 is not set.
- The ignition is ON.
- The run/crank or powertrain relay voltage is greater than 5.5 V and reduced power is not active.
- DTC P2119 runs continuously when the above conditions are met.

**P2176**

- DTCs P0120, P0121, P0122, P0123, P0220, P0222, P0223, P1682, or P2135 is not set.
- The ignition is ON.
- The run/crank or powertrain relay voltage is greater than 6.0 V and reduced power is not active.
- The ECM enable the minimum throttle learn procedure.
- DTC P2176 run continuously when the above conditions are met.

**Conditions for Setting the DTC****P1516**

- The ECM detects a difference, greater than 6 %, between the predicted and actual throttle positions for greater than 0.2 s
- The ECM detects the throttle position is greater than 39 % for at least 0.2 seconds, during a throttle learn or reduced power event.
- The ECM detects a difference, greater than 2 % for 0.5 s or greater, between the desired and actual throttle positions, when the desired throttle position is steady within 0.25 % for 4 s or greater.

**P2101**

- The ECM detects a difference, greater than 6 %, between the predicted and actual throttle positions for greater than 0.2 s
- The ECM detects the throttle position is greater than 39 % for at least 0.2 s, during a throttle learn or reduced power event.

**P2119**

The ECM detects the throttle blade did not return to the default position when the TAC motor is de-energized for greater than 0.5 s.

**P2176**

The ECM detects that both throttle position sensors were greater than a predetermined voltage during the minimum throttle learn procedure for greater than 2 s.

**Action Taken When the DTC Sets**

- DTCs P2101, and P2176 are Type A DTCs.

- DTC P1516 is a Type B DTC.
- DTC P2119 is a Type C DTC.
- The control module commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions, the control module commands the engine OFF.

#### **Conditions for Clearing the MIL/DTC**

- DTCs P2101, and P2176 are Type A DTCs.
- DTC P1516 is a Type B DTC.
- DTC P2119 is a Type C DTC.

#### **Diagnostic Aids**

- Depending on the Start Up ECT, the Desired Throttle Position percentage maybe greater or less than the Throttle Position with the TAC motor at rest. When the ignition is initially turned ON, or when the engine is cranking or running the Desired and Actual Throttle positions should closely match.
- Inspect for a condition in which the throttle valve may have been held open. For example, ice may have formed in the throttle bore causing the throttle valve not to close.
- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- A low battery condition may cause a DTC to set.

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End Views](#)

##### **Description and Operation**

[Throttle Actuator Control \(TAC\) System Description](#)

##### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

##### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

##### **Scan Tool Reference**

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

#### **Circuit/System Verification**

1. Ignition ON.

**Note:** A low battery voltage or charging system condition may cause a DTC to set.

2. Verify DTC P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0562, P0621, P0622, or P2135 is not set.

- ⇒ **If any of the DTCs are set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
- ⇓ **If none of the DTCs are set**
- 3. Verify the scan tool Throttle Body Idle Air flow Compensation parameter is less than 90 %.
- ⇒ **If 90 % or greater**  
Refer to [Throttle Body Cleaning](#).
- ⇓ **If less than 90 %**
- 4. Clear the DTCs with a scan tool.
- 5. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
- 6. Ignition ON.
- 7. Verify the scan tool TAC Motor parameter displays Enabled while slowly depressing the accelerator pedal.
- ⇒ **If Enabled is not displayed**  
Refer to Circuit/System Testing.
- ⇓ **If Enabled is displayed**
- 8. Verify DTC P1516, P2101, P2119, or P2176 is not set.
- ⇒ **If any of the DTCs are set**  
Refer to Circuit/System Testing.
- ⇓ **If none of the DTCs are set**  
**Note:** If there is a condition with the throttle body, the TAC Motor Command parameter will go to 99 % for a predetermined amount of time and then a DTC sets. Once a DTC is set, the TAC Motor Command parameter will go to 0 % and the TAC Motor parameter will display Disabled.
- 9. Verify the scan tool TAC Motor parameter displays Enabled while performing the Throttle Sweep Test with a scan tool.
- ⇒ **If Enabled is not displayed**  
Replace the Q38 Throttle Body.
- ⇓ **If Enabled is displayed**
- 10. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
- 11. Verify a DTC does not set.
- ⇒ **If any DTC sets**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
- ⇓ **If no DTCs set**
- 12. All OK.

### Circuit/System Testing

1. Ignition OFF.  
**Warning:** Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.
2. Verify the conditions listed below do not exist with the Q38 Throttle Body:  
**Note:**
  - The rest position is defined as the actual Throttle Position percentage when the ignition is OFF or with the ignition ON for greater than 30 seconds.
  - When the ignition is OFF, spring tension should hold the throttle plate in the rest position. You should be able to open the throttle plate to wide open throttle (WOT) or push the throttle plate to the fully closed position. In each case, the throttle plate should return to the rest position without assistance.

- A throttle blade that is not in the rest position
- A throttle blade that is binding open or closed
- A throttle blade that is free to move open or closed without spring pressure

⇒ **If a condition is found**

Replace the Q38 Throttle Body.

⇓ **If a condition is not found**

**Note:** Disconnecting the throttle body harness connector may cause additional DTCs to set.

3. Disconnect the harness connector at the Q38 Throttle Body Assembly, ignition ON.

**Note:** The test lamp may illuminate briefly when the ignition switch is turned on, but should not remain illuminated.

4. Verify that a test lamp does Not illuminate continuously between each motor control circuit listed below and ground.
- TAC Motor Control Closed circuit terminal A
  - TAC Motor Control Open circuit terminal B

⇒ **If the test lamp is always ON**

- 4.1. Ignition OFF, remove the test lamp. Disconnect the harness connector X2 at the K20 Engine Control Module, ignition ON

- 4.2. Test for less than 1 V between the motor control circuit and ground.

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

⇓ **If the test lamp is always OFF**

5. Verify that a test lamp does not illuminate between each motor control circuit listed below and B+.

- TAC Motor Control Closed circuit terminal A
- TAC Motor Control Open circuit terminal B

⇒ **If the test lamp illuminates**

- 5.1. Ignition OFF, remove the test lamp. Disconnect the harness connector X2 at the K20 Engine Control Module.

- 5.2. Test for infinite resistance between the control circuit and ground.

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

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

6. Ignition OFF, remove the test lamp. Set the DMM to the 40 V scale, select the Min/Max Recording Mode, and set the Peak Min/Max response time to 1 ms.

**Note:**

- The test lamp must be connected to circuit before turning ignition on or incorrect diagnosis may occur.
- The ignition must be OFF and the ECM completely powered down before testing each circuit or a lower voltage will be recorded. It may take up to 2 min for all vehicle systems to power down.
- The DMM Min/Max Recording Mode and the response time of 1 ms must be reset after testing each circuit or a lower voltage will be recorded.

7. Verify the Max voltage is within 3 V of B+ while using DMM Min/Max Recording Mode function on each control circuit listed below as the ignition is turned ON.

- TAC Motor Control Closed circuit terminal A
- TAC Motor Control Open circuit terminal B

⇒ **If not within 3 V of B+**

- 7.1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.

7.2. Test for less than 2  $\Omega$  in the control circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

↓ **If within 3 V of B+**

8. Replace the Q38 Throttle Body.

### **Repair Instructions**

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

### **Repair Verification**

1. Ignition OFF.
2. Install any components that have been removed or replaced during diagnosis.
3. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
4. Ignition ON.
5. Clear the DTCs with a scan tool.
6. Turn the ignition OFF for 60 s.
7. Ignition ON.
8. Verify the scan tool TAC Motor parameter displays Enabled while performing the Throttle Sweep Test with a scan tool.
  - ⇒ **If Enabled is not displayed**  
Replace the Q38 Throttle Body.
  - ↓ **If Enabled is displayed**
9. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not set.
  - ⇒ **If DTC sets**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
  - ↓ **If DTC does not set**
10. All OK.

## DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P2120

Accelerator Pedal Position (APP) Sensor 1 Circuit

#### DTC P2122

Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

#### DTC P2123

Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage

#### DTC P2125

Accelerator Pedal Position (APP) Sensor 2 Circuit

#### DTC P2127

Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage

#### DTC P2128

Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

#### DTC P2138

Accelerator Pedal Position (APP) Sensors 1-2 Not Plausible

### Diagnostic Fault Information

| Circuit                    | Short to Ground                          | High Resistance | Open  | Short to Voltage | Signal Performance |
|----------------------------|------------------------------------------|-----------------|-------|------------------|--------------------|
| APP Sensor 1 5 V Reference | P0651                                    | P2138           | P2122 | P0651, P2135     | P2138              |
| APP Sensor 2 5 V Reference | P0106, P0107, P0452, P0522, P0532, P0641 | P2138           | P2127 | P0641            | P2138              |
| APP Sensor 1 Signal        | P2122                                    | P2138           | P2122 | P2123            | P2138              |
| APP Sensor 2 Signal        | P2127                                    | P2138           | P2127 | P2128            | P2138              |

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| Circuit                    | Short to Ground | High Resistance | Open  | Short to Voltage | Signal Performance |
|----------------------------|-----------------|-----------------|-------|------------------|--------------------|
| APP Sensor 1 Low Reference | —               | P2138           | P2123 | —                | P2138              |
| APP Sensor 2 Low Reference | —               | P2138           | P2128 | —                | P2138              |

#### Typical Scan Tool Data

##### APP Sensor 1

| Circuit                                                                                                                  | Short to Ground | Open   | Short to Voltage |
|--------------------------------------------------------------------------------------------------------------------------|-----------------|--------|------------------|
| <b>Operating Conditions:</b> The engine is operating at idle.<br><b>Parameter Normal Range:</b> APP Sensor 1 0.88–1.08 V |                 |        |                  |
| APP Sensor 1 5 V Reference                                                                                               | 0.00 V          | 0.00 V | 2–4 V            |
| APP Sensor 1 Signal                                                                                                      | 0.00 V          | 0.00 V | 4–5 V            |
| APP Sensor 1 Low Reference                                                                                               | —               | 4–5 V  | —                |

##### APP Sensor 2

| Circuit                                                                                                                  | Short to Ground | Open   | Short to Voltage |
|--------------------------------------------------------------------------------------------------------------------------|-----------------|--------|------------------|
| <b>Operating Conditions:</b> The engine is operating at idle.<br><b>Parameter Normal Range:</b> APP Sensor 2 0.39–0.59 V |                 |        |                  |
| APP Sensor 2 5 V Reference                                                                                               | 0.00 V          | 0.00 V | 1–3 V            |
| APP Sensor 2 Signal                                                                                                      | 0.00 V          | 0.00 V | 2–5 V            |
| APP Sensor 2 Low Reference                                                                                               | —               | 4–5 V  | —                |

#### Circuit/System Description

The accelerator pedal assembly contains 2 accelerator pedal position (APP) sensors. The APP sensors are mounted to the accelerator pedal assembly and are not serviceable. The APP sensors provide a signal voltage that changes relative to pedal position. The engine control module (ECM) supplies each APP sensor with a 5 V reference circuit, a low reference circuit, and a signal circuit.

#### Conditions for Running the DTC

##### P2120, P2122, P2123, P2125, P2127, P2128

- DTC P0641 and P0651 are not set.
- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.0 V and reduced power is not active.
- DTC 2120, P2122, P2123, P2125, P2127, P2128 run continuously when the above conditions are met.

**P2138**

- DTC P0641, P0651, P2120, P2122, P2123, P2125, P2127, and P2128 are not set.
- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.0 V and reduced power is not active.
- DTC P2138 runs continuously when the above conditions are met.

**Conditions for Setting the DTC****P2120**

The ECM detects the APP sensor 1 voltage is less than 0.46 V or greater than 4.75 V for greater than 1 s.

**P2122**

The ECM detects the APP sensor 1 voltage is less than 0.46 V for greater than 1 s.

**P2123**

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

**P2125**

The ECM detects the APP sensor 2 voltage is less than 0.32 V or greater than 2.6 V for greater than 1 s.

**P2127**

The ECM detects the APP sensor 2 voltage is less than 0.32 V for greater than 1 s.

**P2128**

The ECM detects the APP sensor 2 voltage is greater than 2.6 V for greater than 1 s.

**P2138**

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

**Action Taken When the DTC Sets**

- DTCs P2120, P2122, P2123, P2125, P2127, P2128, and P2138 are Type A DTCs.
- The control module commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions the control module commands the engine OFF.

**Conditions for Clearing the MIL/DTC**

DTCs P2120, P2122, P2123, P2125, P2127, P2128, and P2138 are Type A DTCs.

**Diagnostic Aids**

- A high resistance condition on the accelerator pedal sensor circuits could cause a DTC to set.
- Ensure that the in-line harness connector seals are installed correctly. Improper installation could result in water intrusion into the connector and cause a DTC to set.

**Reference Information****Schematic Reference**

[Engine Controls Schematics](#)



## Connector End View Reference

[Component Connector End Views](#)

## Description and Operation

[Throttle Actuator Control \(TAC\) System Description](#)

## Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

## DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

## Scan Tool Reference

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

## Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0641 or P0651 is not set.  
⇒ **If any of the DTCs are set**  
Refer to [DTC P0641 or P0651](#) for further diagnosis.  
↓ **If none of the DTCs are set**
3. Verify the scan tool APP Sensor 1 voltage parameter is between 0.46–4.75 V and changes with accelerator pedal input.  
⇒ **If not between 0.46–4.75 V or does not change**  
Refer to Circuit/System Testing  
↓ **If between 0.46–4.75 V and changes**
4. Verify the scan tool APP Sensor 2 voltage parameter is between 0.32–2.6 V and changes with accelerator pedal input.  
⇒ **If not between 0.32–2.6 V or does not change**  
Refer to Circuit/System Testing  
↓ **If between 0.32–2.6 V and changes**
5. Verify the scan tool APP Sensor 1 and 2 Agree/Disagree parameter displays Agree while performing the tests listed below:
  - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.
  - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.⇒ **If Disagree**  
Refer to Circuit/System Testing  
↓ **If Agree**
6. Verify that DTC P2120, P2122, P2123, P2125, P2127, P2128, or P2138 is not set.  
⇒ **If any of the DTCs are set**  
Refer to Circuit/System Testing  
↓ **If none of the DTCs set**

7. Clear the DTCs with the scan tool. Operate the vehicle within the Conditions for Running the DTC, or within the conditions that you observed from the Freeze Frame/Failure Records.
8. Ignition ON.
9. Verify DTC P2120 or P2125 are not the only APP sensor DTCs set.
  - ⇒ **If DTC P2120 or P2125 is the only DTC set**
    - ⇒ Replace the K20 Engine Control Module.
  - ⇓ **If DTC P2120 or P2125 is not the only DTC set**
10. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
11. Verify a DTC does not set.
  - ⇒ **If any DTC sets**
    - Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
  - ⇓ **If no DTCs set**
12. All OK

### **Circuit/System Testing**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B107 Accelerator Pedal Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5  $\Omega$  between the appropriate low reference circuit terminal listed below and ground.
  - APP sensor 1 low reference circuit terminal 4 or D
  - APP sensor 2 low reference circuit terminal 3 or A
  - ⇒ **If 5  $\Omega$  or greater**
    - 2.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    - 2.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
  - ⇓ **If less than 5  $\Omega$**
3. Ignition ON.
4. Test for 4.8–5.2 V between the appropriate 5 V reference circuit terminal listed below and ground.
  - APP sensor 1, 5 V reference circuit terminal 6 or F
  - APP sensor 2, 5 V reference circuit terminal 1 or C
  - ⇒ **If less than 4.8 V**
    - 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    - 4.2. 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
    - 4.3. Test for less than 2  $\Omega$  in the 5 V reference circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.
  - ⇒ **If greater than 5.2 V**
    - 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    - 4.2. Test for less than 1 V between the 5 V reference circuit and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

↓ **If between 4.8–5.2 V**

5. Verify the scan tool APP sensor 1 and APP sensor 2 voltage parameters are less than 0.3 V.

⇒ **If 0.3 V or greater**

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

5.2. Test for less than 1 V between the signal circuit terminal listed below and ground.

◦ APP sensor 1 signal circuit terminal 5 or E

◦ APP sensor 2 signal circuit terminal 2 or B

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K20 Engine Control Module.

↓ **If less than 0.3 V**

6. Install a 3 A fused jumper wire between the appropriate signal circuit terminal listed below and the 5 V reference circuit terminal 1 or C.

◦ APP sensor 1 signal circuit terminal 5 or E

◦ APP sensor 2 signal circuit terminal 2 or B

7. Verify the scan tool APP Sensor 1 or APP Sensor 2 voltage parameter is greater than 4.8 V.

⇒ **If 4.8 V or less**

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

7.2. Test for infinite resistance between the signal circuit terminal and ground.

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

↓ If infinite resistance

7.3. Test for less than 2  $\Omega$  in the signal circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

↓ **If greater than 4.8 V**

8. Test or replace the B107 Accelerator Pedal Position Sensor.

### **Repair Instructions**

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

- [Accelerator Pedal Position Sensor Replacement](#)
- [Control Module References](#) for engine control module replacement, programming, and setup

## DTC P2227

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P2227

Barometric Pressure (BARO) Sensor Performance

### Diagnostic Fault Information

| Circuit                    | Short to Ground     | High Resistance | Open         | Short to Voltage    | Signal Performance |
|----------------------------|---------------------|-----------------|--------------|---------------------|--------------------|
| 5 V Reference Circuit      | P006D, P0641, P2228 | P006D           | P006D, P2228 | P006D, P0641, P2229 | P2227              |
| BARO Sensor Signal Circuit | P006D, P2228        | P006D           | P006D, P2228 | P006D, P2229        | P2227              |
| Low Reference Circuit      | —                   | P006D           | P006D, P2229 | —                   | P2227              |

### Typical Scan Tool Data

#### BARO Sensor

| Circuit                                                                                | Short to Ground | Open               | Short to Voltage   |
|----------------------------------------------------------------------------------------|-----------------|--------------------|--------------------|
| <b>Operating Conditions:</b> The Ignition is On<br><b>Parameter Normal Range:</b> BARO |                 |                    |                    |
| 5 V Reference Circuit                                                                  | 0 kPa (0 psi)   | 0 kPa (0 psi)      | 128 kPa (18.6 psi) |
| BARO Sensor Signal Circuit                                                             | 0 kPa (0 psi)   | 1 kPa (0.15 psi)   | 128 kPa (18.6 psi) |
| Low Reference Circuit                                                                  | —               | 128 kPa (18.6 psi) | —                  |

### Circuit/System Description

The barometric pressure (BARO) sensor measures the pressure of the atmosphere. This pressure is affected by altitude and weather conditions. A diaphragm within the BARO sensor is displaced by the pressure changes that occur from varying altitudes and weather conditions.

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The sensor translates this diaphragm action into the voltage signal input that is used by the engine control module (ECM) for diagnostics, emissions control, and to calculate fuel delivery.

The ECM provides the BARO sensor with a 5 V reference circuit, a low reference circuit and a signal circuit. The BARO sensor provides a voltage signal to the ECM relative to barometric pressure changes.

#### **Conditions for Running the DTC**

- DTC P0068, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P012B, P012C, P012D, P0220, P0222, P0223, P1516, P2101, P2135, P2228, or P2229 is not set.
- Ignition is On for greater than 10 s.
- Vehicle speed is greater than 100 km/h (62 mph).

#### **Conditions for Setting the DTC**

The ECM detects that the difference between the current BARO sensor reading and the previous BARO sensor reading is greater than 10 kPa (1.5 psi) for 5 s.

#### **Action Taken When the DTC Sets**

DTC P2227 is a Type B DTC.

#### **Conditions for Clearing the MIL/DTC**

DTC P2227 is a Type B DTC.

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End 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

##### **Special Tools**

GE 23738-A Vacuum Pump

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

#### **Circuit/System Verification**

1. Verify that DTC P2228, or P2229 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**

2. Ignition On
3. Verify the scan tool BARO parameter remains constant and is within the range specified in the [Altitude Versus Barometric Pressure](#) table.
  - ⇒ **If not constant or not within the specified range**  
Refer to Circuit/System Testing
  - ⇓ **If constant and within the specified range**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
  - ⇒ **If the DTC sets**  
Refer to Circuit/System Testing
  - ⇓ **If the DTC does not set**
6. All OK

#### **Circuit/System Testing**

1. Verify none of the conditions listed below exist with the B17 Barometric Pressure Sensor:
  - Moisture or debris in the inlet port
  - Damage
- ⇒ **If a condition exists**  
Repair the condition or replace the B17 Barometric Pressure Sensor as necessary.
- ⇓ **If none of the conditions exist**
2. Test or replace the B17 Barometric Pressure Sensor.

#### **Component Testing**

**Note:** You must perform the Circuit/System Testing before proceeding with the Component Test.

##### **Erratic Signal Test**

1. Ignition Off, remove the B17 Barometric Pressure Sensor.
2. Install a 3 A fused jumper between the harness connector 5 V reference circuit terminal 1 and terminal 1 of the sensor. Install a jumper wire between the low reference terminal 2 of the sensor and ground.
3. Ignition On, test for 5.2–0 V without any spikes or dropouts between the signal terminal 3 and the low reference terminal 2 while slowly applying vacuum to the sensor with the *GE 23738-A*.
- ⇒ **If not between 5.2 and 0 V or has spikes or dropouts**  
Replace the B17 Barometric Pressure Sensor.
- ⇓ **If between 5.2 and 0 V and there are no spikes or dropouts**
4. All OK

#### **Repair Instructions**

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

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

DTC P2228 or P2229

Diagnostic Instructions

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

DTC Descriptors

DTC P2228

Barometric Pressure (BARO) Sensor Circuit Low Voltage

DTC P2229

Barometric Pressure (BARO) Sensor Circuit High Voltage

Diagnostic Fault Information

| Circuit            | Short to Ground     | High Resistance | Open         | Short to Voltage    | Signal Performance |
|--------------------|---------------------|-----------------|--------------|---------------------|--------------------|
| 5 V Reference      | P006D, P0641, P2228 | P006D           | P006D, P2228 | P006D, P0641, P2229 | P2227              |
| BARO Sensor Signal | P006D, P2228        | P006D           | P006D, P2228 | P006D, P2229        | P2227              |
| Low Reference      | —                   | P006D           | P006D, P2229 | —                   | P2227              |

Typical Scan Tool Data

| BARO Sensor                                                                            |                 |                    |                    |
|----------------------------------------------------------------------------------------|-----------------|--------------------|--------------------|
| Circuit                                                                                | Short to Ground | Open               | Short to Voltage   |
| <b>Operating Conditions:</b> The Ignition is On<br><b>Parameter Normal Range:</b> BARO |                 |                    |                    |
| 5 V Reference Circuit                                                                  | 0 kPa (0 psi)   | 0 kPa (0 psi)      | 128 kPa (18.6 psi) |
| BARO Sensor Signal Circuit                                                             | 0 kPa (0 psi)   | 1 kPa (0.15 psi)   | 128 kPa (18.6 psi) |
| Low Reference Circuit                                                                  | —               | 128 kPa (18.6 psi) | —                  |

Circuit/System Description

The barometric pressure (BARO) sensor has a 5 V reference circuit, a low reference circuit, and a signal circuit. The engine control module (ECM) supplies 5 V to the BARO sensor on a 5 V reference circuit, and provides a ground on a low reference circuit. The BARO sensor provides a voltage signal to the ECM on a signal circuit relative to barometric pressure changes.

#### **Conditions for Running the DTC**

- The ignition is On.
- The DTCs run continuously when the above condition is met.

#### **Conditions for Setting the DTC**

##### **P2228**

The ECM detects that the BARO sensor signal is less than 51 kPa (7.4 psi) for 1 s.

##### **P2229**

The ECM detects that the BARO sensor signal is greater than 115 kPa (16.7 psi) for 1 s.

#### **Action Taken When the DTC Sets**

DTCs P2228 and P2229 are Type B DTCs.

#### **Conditions for Clearing the MIL/DTC**

DTCs P2228 and P2229 are Type B DTCs.

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End Views](#)

##### **Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)
- [Measuring Frequency](#)

##### **DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

##### **Scan Tool Reference**

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

##### **Special Tools**

GE23738-A Vacuum Pump

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

#### **Circuit/System Verification**

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



Refer to [DTC P0641 or P0651](#).

↓ **If the DTC is not set**

3. Verify the scan tool BARO pressure parameter is within the range specified in the [Altitude Versus Barometric Pressure](#) table.

⇒ **If not within the specified range**

Refer to Circuit/System Testing.

↓ **If within the specified range**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
5. Verify a DTC does not set.

⇒ **If a DTC sets**

Refer to Circuit/System Testing.

↓ **If a DTC does not set**

6. All OK.

### [Circuit/System Testing](#)

1. Verify the conditions listed below do not exist with the B17 Barometric Pressure Sensor:

- Damage
- Restrictions in the inlet port

⇒ **If a condition exists**

Repair or replace the B17 Barometric Pressure Sensor as necessary.

↓ **If none of the conditions exist**

2. Ignition Off, and all vehicle systems Off, it may take up to 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B17 Barometric Pressure Sensor.
3. Test for less than 5  $\Omega$  between the low reference circuit terminal 2 and ground.

⇒ **If 5  $\Omega$  or greater**

- 3.1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
- 3.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.
  - ⇒ If greater than the specified value, repair the open or high resistance in the circuit.
  - ⇒ If 2  $\Omega$  or less replace the K20 Engine Control Module.

↓ **If less than 5  $\Omega$**

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**

- 5.1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
- 5.2. 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
- 5.3. Test for less than 2  $\Omega$  in the 5 V reference circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

⇒ **If greater than 5.2 V**

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

↓ **If between 4.8–5.2 V**

6. Verify the scan tool BARO Sensor parameter is less than 0.2 V.

⇒ **If 0.2 V or greater**

- 6.1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On.
- 6.2. Test for less than 1 V between the signal circuit terminal 3 and ground.
  - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
  - ⇒ If less than 1 V, replace the K20 Engine Control Module.

↓ **If less than 0.2 V**

7. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1.
8. Verify the scan tool BARO Sensor parameter is greater than 4.5 V.

⇒ **If 4.5 V or less**

- 8.1. Ignition Off, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
- 8.2. 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
- 8.3. Test for less than 2  $\Omega$  in the signal circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

↓ **If greater than 4.5 V**

9. Test or replace the B17 Barometric Pressure Sensor.

### Component Testing

**Note:** You must perform the Circuit/System Testing before proceeding with the Component Test.

1. Ignition Off, remove the B17 Barometric Pressure sensor.
2. Install a 3 A fused jumper between the harness connector 5 V reference circuit terminal 1 and terminal 1 of the sensor.
3. Install a jumper wire between the low reference terminal 2 of the sensor and ground
4. Connect a DMM between terminal 3 of the sensor and ground.
5. Ignition On, slowly apply vacuum to the sensor with the GE23738-A .
6. Verify the voltage is between 0.2–4.9 V and changes without any spikes or dropouts.
  - ⇒ **If not between 0.2–4.9 V, does not change or has spikes or dropouts**  
Replace the B17 Barometric Pressure Sensor.
  - ↓ **If between 0.2–4.9 V, and changes without any spikes or dropouts**
7. All OK.

### Repair Instructions

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

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

## DTC P2269

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P2269

Water in Fuel

### Circuit/System Description

Alcohol content information is supplied to the engine control module (ECM) from the fuel composition sensor. The fuel composition sensor has a battery positive circuit, a signal circuit, and a ground circuit. The fuel composition sensor uses a microprocessor inside the sensor to measure the ethanol percentage and changes the output signal accordingly. The signal circuit carries the ethanol percentage via the frequency signal. The ECM provides an internal pull up to 5 V on the signal circuit, and the fuel composition sensor pulls the 5 V to ground in pulses. The normal range of operating frequency is between 50–150 Hz. The microprocessor inside the fuel composition sensor is capable of a certain amount of self-diagnosis. An output frequency between 180 Hz and 190 Hz indicates that the fuel is contaminated.

### Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The DTC runs continuously when the above condition is met.

### Conditions for Setting the DTC

The engine control module detects that the fuel composition sensor output frequency is greater than 185 Hz for greater than 6 s.

### Action Taken When the DTC Sets

DTC P2269 is a Type B DTC.

### Conditions for Clearing the MIL/DTC

DTC P2269 is a Type B DTC.

### Diagnostic Aids

A momentary slug of water in the fuel system may set this DTC.

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

[Component Connector End 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

## Special Tools

- J38522-A Variable Signal Generator
- J44175-A Fuel Composition Tester

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

## Circuit/System Verification

1. Engine running.
2. Verify the scan tool Fuel Composition Sensor parameter is between 50–150 Hz.  
⇒ **If not between 50–150 Hz**  
Refer to Circuit/System Testing.  
⇓ **If between 50–150 Hz**
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 is set**  
Refer to Circuit/System Testing.  
⇓ **If DTC is not set**
5. All OK.

## Circuit/System Testing

1. Verify that there are no contaminants, water, or too high of a concentration of ethanol in the fuel. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) and the J44175-A Instruction Manual.  
⇒ **If the fuel tested is not within acceptable levels**  
Refer to [Fuel System Cleaning](#).  
⇓ **If the fuel tested within acceptable levels**
2. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B198 Fuel Composition Sensor. It may take up to 2 min for all vehicle systems to power down.
3. Test for less than 5  $\Omega$  between the ground circuit terminal 2 and ground.  
⇒ **If 5  $\Omega$  or greater**
  - 3.1. Ignition OFF.
  - 3.2. Test for less than 2  $\Omega$  in the ground circuit end to end.  
⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
⇒ If less than 2  $\Omega$ , repair the ground connection.
- ⇓ **If less than 5  $\Omega$**

4. Ignition ON.
5. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
  - ⇒ **If the test lamp does not illuminate and the fuse is not opened**
    - 5.1. Ignition OFF, remove the test lamp.
    - 5.2. Test for less than  $2\ \Omega$  in the B+ circuit end to end.
      - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than  $2\ \Omega$ , verify the fuse is good and voltage is supplied to the fuse.
  - ⇒ **If the test lamp does not illuminate and the fuse is opened**
    - 5.1. Ignition OFF, remove the test lamp.
    - 5.2. Test for infinite resistance between the B+ circuit and ground
      - ⇒ If less than infinite, repair the short to ground in the circuit.
      - ⇒ If infinite, test all the components connected to the circuit, and repair or replace as necessary.
- ⇓ **If the test lamp illuminates**
6. Remove the test lamp.
7. Ignition ON, test for 4.8–5.2 V between the signal circuit terminal 3 and ground.
  - ⇒ **If less than 4.8 V**
    - 7.1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module.
    - 7.2. Test for less than  $2\ \Omega$  in the signal circuit end to end.
      - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than  $2\ \Omega$ , test or replace the K20 Engine Control Module.
  - ⇒ **If greater than 5.2 V**
    - 7.1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module, ignition ON.
    - 7.2. Test for less than 1 V between the signal circuit and ground.
      - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
      - ⇒ If less than 1 V, test or replace the K20 Engine Control Module.
- ⇓ **If between 4.8–5.2 V**
8. Ignition OFF, connect the red lead of the J38522–A Variable Signal Generator to the signal circuit terminal 3 at the B198 Fuel Composition Sensor harness connector. Connect the battery voltage supply to B+, and the black lead to ground.
9. Set the J38522–A Variable Signal Generator Signal to 5 V, the Frequency to 60 Hz, and the Duty Cycle to Normal, ignition ON.
10. Verify the scan tool Fuel Composition Sensor parameter is at 60 Hz.
  - ⇒ **If not 60 Hz**
    - Test or replace the K20 Engine Control Module.
  - ⇓ **If 60 Hz**
11. Test or replace the B198 Fuel Composition Sensor.

### Component Testing

1. Test the fuel composition using the J44175–A Fuel Composition Tester and the J44175–A Instruction Manual. Record the frequency.
2. Compare the special tool test frequency and the scan tool Fuel Composition Sensor frequency parameter. The difference between the tool and the sensor should be less than 12 Hz.
  - ⇒ If greater than the specified value, replace the B198 Fuel Composition Sensor.

### Repair Instructions

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

- [Flexible Fuel Sensor Replacement](#)
- [Fuel System Cleaning](#)
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup.

## DTC P2534 or P2535 (Chassis Control Module)

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P2534

Ignition On/Start Switch Circuit Low Voltage

#### DTC P2535

Ignition On/Start Switch Circuit High Voltage

### Diagnostic Fault Information

| Circuit  | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|----------|-----------------|----------------------|------------------|--------------------|
| Ignition | P2534           | P2534                | P2535            | —                  |

### Circuit/System Description

The chassis control module monitors the ignition voltage circuit in order to determine if the voltage is within the normal operating range.

### Conditions for Running the DTC

The engine is running.

### Conditions for Setting the DTC

The chassis control module detects that the ignition voltage is less than 6.0 V.

### Action Taken When the DTC Sets

DTC P2534 and P2535 are Type A DTCs.

### Conditions for Clearing the DTC

DTC P2534 and P2535 are Type A DTCs.

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

[Component Connector End 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 ON.
2. Verify DTC P0562 is not set.  
⇒ **If the DTC is set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).  
⇓ **If the DTC is not set**
3. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
4. Verify a test lamp illuminates between the ignition circuit terminal 21 and ground.  
⇒ **If the test lamp does not illuminate and the circuit fuse is good**
  - 4.1. Ignition OFF.
  - 4.2. Test for less than 2  $\Omega$  in the ignition circuit end to end.  
⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
⇒ If less than 2  $\Omega$ , refer to [Power Mode Mismatch](#).  
⇒ **If the test lamp does not illuminate and the circuit fuse is open**
  - 4.1. Ignition OFF.
  - 4.2. 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 K38 Chassis Control Module.  
⇓ **If the test lamp illuminates**
5. Replace the K38 Chassis Control Module.

## Repair Instructions

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

[Control Module References](#) for chassis control module replacement, programming and setup



## DTC P2544

### Diagnostic Instructions

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

### DTC Descriptors

#### **DTC P2544**

Transmission Torque Request Signal Message Counter Incorrect

### Circuit/System Description

To improve shift feel, the transmission control module (TCM) is constantly sending the engine control module (ECM) serial data messages with 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](#).

↓ **If only DTC P2544 is set**

2. Replace the K71 Transmission Control Module.

3. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

4. Verify the DTC does not set.

⇒ **If DTC sets**

Replace the K20 Engine Control Module.

↓ **If DTC does not set**

5. All OK.

### **Repair Instructions**

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

[Control Module References](#) for ECM or TCM replacement, programming, and setup

## DTC P2548

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P2548

Vehicle Dynamics System Torque Request Signal Message Counter Incorrect

### Circuit/System Description

The electronic brake control module and the engine control module simultaneously control the vehicle performance launch. During a performance launch the electronic brake control module sends a serial data message to the engine control module requesting torque reduction. If the engine control module receives corrupt data from the electronic brake control module, DTC P2548 will set in the engine control module. The engine control module then sends a serial data message to the electronic brake control module that torque reduction is not allowed.

### Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is greater than 8 V.

### Conditions for Setting the DTC

The engine control module detects a corrupted data message from the electronic brake control module.

### Action Taken When the DTC Sets

- The ABS remains functional.
- The traction/stability control indicator turns ON.
- A message may be displayed on the driver information center.

### Conditions for Clearing the DTC

DTC P2548 is a Type B DTC.

### Diagnostic Aids

Inspect the serial data circuits and connections at the engine control module and the electronic brake control module. They should be free from sources of electromagnetic interference and the connections should be clean and tight.

### Reference Information

#### Schematic Reference

[Antilock Brake System Schematics](#)

#### Connector End View Reference

[Component Connector End Views](#)

#### Description and Operation

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[ABS Description and Operation](#)**Electrical Information Reference**

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

**Scan Tool Reference**

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

**[Circuit/System Verification](#)****Note:**

- DTC P2548 is an informational DTC.
- Diagnose all other engine control module DTCs prior to DTC P2548.

1. Verify that no other DTCs are set except for DTC P2548.

⇒ **If any other DTCs are set**

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

⇓ **If only DTC P2548 is set**

2. Replace the K17 Electronic Brake Control Module.

3. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.

⇒ **If DTC sets**

Replace the K20 Engine Control Module.

⇓ **If DTC does not set**

4. All OK.

**[Repair Instructions](#)**

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

[Control Module References](#) for Electronic Brake Control Module and Engine Control Module replacement, programming and setup.

## DTC P2635 (Chassis Control Module)

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P2635

Fuel Pump Flow Performance

### Diagnostic Fault Information

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

### Circuit/System Description

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

### Conditions for Running the DTC

- DTC P018B, P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.
- DTC P0641 has not failed this ignition cycle.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The system voltage is greater than 11 V.
- The engine has been running for more than 30 seconds.
- Low fuel level warning not present.

### Conditions for Setting the DTC

This DTC sets when the chassis control module detects a predetermined fuel pressure performance degradation between the desired fuel pressure and the current fuel pressure.

### Action Taken When the DTC Sets

DTC P2635 is a Type B DTC.

### Conditions for Clearing the DTC

DTC P2635 is a Type B DTC.

### Diagnostic Aids

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

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

## Reference Information

### Schematic Reference

[Engine Controls Schematics](#)

### Connector End View Reference

[Component Connector End 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

**Note:** Do not replace the chassis control module based on a history DTC P2635. The DTC P2635 may be stored but that does not indicate a failure of the chassis control module. Refer to [Strategy Based Diagnosis](#) for further history DTC diagnostics.

1. Ignition ON.
2. Verify DTC P018B, P018C, P018D, P0231, P0232 or P023F is not set.  
⇒ **If any of the DTCs are set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).  
⇓ **If none of the DTCs are set**
3. Verify the proper fuel system pressure. Perform the fuel system pressure test, refer to [Fuel System Diagnosis](#).  
⇒ **If the fuel system pressure test is not normal**  
Replace the A7 Fuel Pump and Level Sensor Assembly.  
⇓ **If the fuel system pressure test is normal**
4. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor Assembly. It may take up to 2 minutes for all vehicle systems to power down.
5. Test for less than 10  $\Omega$  between the low reference circuit terminal 2 and ground.  
⇒ **If 10  $\Omega$  or greater**
  - 5.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
  - 5.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the K38 Chassis Control Module.

↓ **If less than 10  $\Omega$**

6. Connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.

7. Ignition ON.

8. Verify the test lamp turns ON and OFF when commanding the fuel pump ON and OFF using the scan tool ECM fuel pump enable control function.

⇒ **If the test lamp is always OFF**

8.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.

8.2. 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

8.3. Test for less than 2  $\Omega$  in the control circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 2  $\Omega$ , replace the K38 Chassis Control Module.

⇒ **If the test lamp is always ON**

8.1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.

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

⇒ If 1 V or greater, repair the short to voltage on the circuit.

⇒ If less than 1 V, replace the K38 Chassis Control Module.

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

9. All OK.

### **Repair Instructions**

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

[Control Module References](#) for chassis control module replacement, programming, and setup.

## DTC P3400

### Diagnostic Instructions

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

### DTC Descriptor

#### DTC P3400

Cylinder Deactivation System

### Diagnostic Fault Information

| Circuit                                            | Short to Ground                                         | Open/High Resistance                          | Short to Voltage | Signal Performance |
|----------------------------------------------------|---------------------------------------------------------|-----------------------------------------------|------------------|--------------------|
| Ignition 1 Voltage                                 | P0102,<br>P069E,<br>P3401,<br>P3425,<br>P3441,<br>P3449 | P3400,<br>P3401,<br>P3425,<br>P3441,<br>P3449 | —                | P3400              |
| Cylinder 1 Deactivation Solenoid Control Circuit 1 | P0300,<br>P3401                                         | P0300,<br>P3400,<br>P3401                     | P0300,<br>P3401  | P3400              |
| Cylinder 4 Deactivation Solenoid Control Circuit 2 | P0300,<br>P3425                                         | P0300,<br>P3400,<br>P3425                     | P0300,<br>P3425  | P3400              |
| Cylinder 6 Deactivation Solenoid Control Circuit 3 | P0300,<br>P3441                                         | P0300,<br>P3400,<br>P3441                     | P0300,<br>P3441  | P3400              |
| Cylinder 7 Deactivation Solenoid Control Circuit 4 | P0300,<br>P3449                                         | P0300,<br>P3400,<br>P3449                     | P0300,<br>P3449  | P3400              |

### Circuit/System Description

The cylinder deactivation system is used to deactivate 4 cylinders of the engine under light load driving conditions. The engine control module (ECM) commands the cylinder deactivation solenoid valves ON to deactivate engine cylinders 1, 7, 6, and 4, switching to 4 cylinders or V4 mode. The cylinder deactivation solenoid valves control the oil flow to the appropriate valve lifters. The engine operates on 8 cylinders or V8 mode, during engine starting, engine idling, and medium to heavy throttle conditions.

Ignition voltage is supplied directly to the cylinder deactivation solenoid valves. The ECM controls the cylinder deactivation solenoid valves by grounding the control circuit with a solid state device called a driver.



The Cylinder Deactivation System Performance diagnostic is a test of the internal mechanical condition of the engine, during operation in V4 mode. The ECM determines the internal mechanical condition of the engine through the actual measured values of the mass airflow (MAF) sensor, the intake manifold absolute pressure (MAP) sensor, and the throttle position sensor. The actual measured values of the 3 sensors are then compared to the calculated values for V4 mode, stored in the ECM. If the measured values are incorrect for V4 mode, the ECM may set DTC P3400, and return to V8 mode operation.

#### **Conditions for Running the DTC**

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0335, P0336, P0340, P0341, P0502, P0503, P0521, P0522, P0523, P0556, P0557, P0558, P0685, P0686, P0687, P0689, P0690 P3401, P3425, P3441, or P3449 are not set.
- The engine speed is between 450–5,800 RPM.
- The ECT sensor parameter is between 70 - 125°C (158 - 257°F).
- The IAT sensor parameter is between –20 to 125°C (–4 to 257°F).
- The engine is not in reduced power.
- DTC P3400 runs continuously when the above conditions are met.

#### **Conditions for Setting the DTC**

The engine control module detects that the actual measured values from the MAF sensor, MAP sensor, and throttle position sensor, are not within the range of the calculated values for V4 mode.

#### **Action Taken When the DTC Sets**

- DTC P3400 is a Type B DTC.
- The engine will return to V8 mode.

#### **Conditions for Clearing the DTC**

DTC P3400 is a Type B DTC.

#### **Diagnostic Aids**

- This DTC will not set during engine idling conditions. The vehicle will need to be driven for the DTC to set.
- The valve lifter oil manifold assembly solenoids are assigned to the following engine cylinders:
  - Cylinder Deactivation Solenoid Valve #1 = Cylinder #1
  - Cylinder Deactivation Solenoid Valve #2 = Cylinder #4
  - Cylinder Deactivation Solenoid Valve #3 = Cylinder #6
  - Cylinder Deactivation Solenoid Valve #4 = Cylinder #7

#### **Reference Information**

##### **Schematic Reference**

[Engine Controls Schematics](#)

##### **Connector End View Reference**

[Component Connector End Views](#)

##### **Description and Operation**

[Cylinder Deactivation \(Active Fuel Management\) 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

EN-46999 Displacement On Demand Tester

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

## Circuit/System Verification

**Note:** The engine oil level and the oil pressure are critical to the correct operation of the Cylinder Deactivation System. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic. Refer to [Oil Pressure Diagnosis and Testing](#). Inspect the Valve Lifter Oil Filter for a restriction or blockage. Refer to [Valve Lifter Oil Filter Replacement](#).

1. Ignition ON, observe the scan tool DTC information.
2. Verify with a scan tool that DTC P0201–P0208, P0351–P0358, P3401, P3403, P3404, P3425, P3427, P3428, P3441, P3443, P3444, P3449, P3451, or P3452 is not set.
  - ↓ **If a DTC is set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
  - ↓ **If a DTC is not set**
3. Engine idling at the normal operating temperature.
4. Verify there is no abnormal engine noise.
  - ⇒ **If there is an abnormal engine noise**  
Refer to [Symptoms - Engine Mechanical](#) for further diagnosis.
  - ↓ **If no abnormal engine noise**
5. Verify the [Cylinder Deactivation \(Active Fuel Management\) System Compression Test](#) passes the compression test.
  - ⇒ **If compression test failed**  
Test the Q43 Valve Lifter Oil Manifold Assembly, refer to [Cylinder Deactivation \(Active Fuel Management\) Valve Lifter Oil Manifold Diagnosis and Testing](#).
  - ↓ **If compression test passes**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
7. Verify the DTC does not set.
  - ⇒ **If the DTC sets**  
Refer to Circuit/System Testing.
  - ↓ **If the DTC is not set**
8. All OK.

## Circuit/System Testing

1. Ignition OFF, remove the Q43 Valve Lifter Oil Manifold Assembly ignition fuse from the underhood fuse block.

**Note:** Probe each terminal at the underhood fuse block with a test lamp connected to ground to determine what terminal to connect the DMM. The test lamp should not illuminate on the circuit that needs to be tested.

2. Connect a DMM between the ignition circuit fuse terminal going to the Q43 Valve Lifter Oil Manifold Assembly and the K20 Engine Control Module housing.
3. Ignition ON, command the Cylinder Deactivation System ON and OFF with the scan tool.
4. Verify the resistance of each cylinder deactivation solenoid valve is between 11–18  $\Omega$  with the solenoid valves commanded ON.
  - ⇒ **If greater than 18  $\Omega$  for all cylinder deactivation solenoid valves**, test the ignition circuit for an open/high resistance.
    - 4.1. Ignition OFF.
    - 4.2. Test for less than 2  $\Omega$  on the ignition circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than 2  $\Omega$ , refer to [Cylinder Deactivation \(Active Fuel Management\) Valve Lifter Oil Manifold Diagnosis and Testing](#).
  - ⇒ **If greater than 18  $\Omega$  for one or more but not all cylinder deactivation solenoid valves**
    - 4.1. Ignition OFF.
    - 4.2. Test for less than 2  $\Omega$  on the appropriate control circuit end to end.
      - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇓ If less than 2  $\Omega$
    - 4.3. Test for 11–18  $\Omega$  between the ignition circuit and the appropriate control circuit at the Q43 Valve Lifter Oil Manifold Assembly.
      - ⇒ If not within the specified value, test or replace the Q43 Valve Lifter Oil Manifold Assembly.
      - ⇒ If within the specified value, test or replace the K20 Engine Control Module.
  - ⇓ **If between 11–18  $\Omega$**
5. Refer to [Cylinder Deactivation \(Active Fuel Management\) Valve Lifter Oil Manifold Diagnosis and Testing](#) for further mechanical diagnosis of Q43 Valve Lifter Oil Manifold Assembly.

## Component Testing

### Static Test

1. Ignition OFF, disconnect the harness connector at the Q43 Valve Lifter Oil Manifold Assembly.
2. Connect the harness that is labeled resistance from the Displacement On Demand (DOD) Tester to the Q43 Valve Lifter Oil Manifold Assembly connector.
3. Connect the power leads from the DOD tester to B+ and ground.
4. Test for 11–18  $\Omega$  on each valve lifter oil manifold solenoid.
  - ⇒ **If not between 11–18  $\Omega$**   
Replace the Q43 Valve Lifter Oil Manifold Assembly.
  - ⇓ **If between 11–18  $\Omega$**
  - 5. Test for infinite resistance between each valve lifter oil manifold circuit terminal and the valve lifter oil manifold housing.
    - ⇒ **If less than infinite resistance**  
Replace the Q43 Valve Lifter Oil Manifold Assembly.
    - ⇓ **If infinite resistance**
6. All OK.

### Dynamic Test

1. Ignition OFF, disconnect the harness connector at the Q43 Valve Lifter Oil Manifold Assembly.
2. Connect the cable that is labeled power from the Displacement On Demand (DOD) Tester to the connector.
3. Connect the power leads from the DOD tester to B+ and ground.
4. Command each valve lifter oil manifold solenoid ON and OFF using the DOD tester.
5. Verify and audible click is heard for each solenoid turn when commanded ON and OFF.  
⇒ **If the function does not perform as specified**  
Replace the Q43 Valve Lifter Oil Manifold Assembly.  
⇓ **If the function performs as specified**
6. All OK.

### Repair Instructions

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

- [Valve Lifter Oil Manifold Replacement](#)
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup.

## DTC P3401, P3425, P3441, or P3449

### Diagnostic Instructions

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

### DTC Descriptors

#### DTC P3401

Cylinder 1 Deactivation Solenoid Control Circuit

#### DTC P3425

Cylinder 4 Deactivation Solenoid Control Circuit

#### DTC P3441

Cylinder 6 Deactivation Solenoid Control Circuit

#### DTC P3449

Cylinder 7 Deactivation Solenoid Control Circuit

### Diagnostic Fault Information

| Circuit                                            | Short to Ground                                         | Open/High Resistance                          | Short to Voltage | Signal Performance |
|----------------------------------------------------|---------------------------------------------------------|-----------------------------------------------|------------------|--------------------|
| Ignition 1 Voltage                                 | P0102,<br>P069E,<br>P3401,<br>P3425,<br>P3441,<br>P3449 | P3400,<br>P3401,<br>P3425,<br>P3441,<br>P3449 | —                | P3400              |
| Cylinder 1 Deactivation Solenoid Control Circuit 1 | P0300,<br>P3401                                         | P0300,<br>P3400,<br>P3401                     | P0300,<br>P3401  | P3400              |
| Cylinder 4 Deactivation Solenoid Control Circuit 2 | P0300,<br>P3425                                         | P0300,<br>P3400,<br>P3425                     | P0300,<br>P3425  | P3400              |
| Cylinder 6 Deactivation Solenoid Control Circuit 3 | P0300,<br>P3441                                         | P0300,<br>P3400,<br>P3441                     | P0300,<br>P3441  | P3400              |
| Cylinder 7 Deactivation Solenoid Control Circuit 4 | P0300,<br>P3449                                         | P0300,<br>P3400,<br>P3449                     | P0300,<br>P3449  | P3400              |

### Typical Scan Tool Data

**Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Open, Low and High Voltage Test Status – Component Commanded OFF**

| Circuit                                                                                                                                                                                                                                                                                                                                                                                             | Short to Ground | Open        | Short to Voltage |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------|------------------|
| <b>Operating Conditions:</b> Component Commanded OFF<br><b>Parameter Normal Range:</b> The following illustrates the normal parameter state with no circuit conditions: <ul style="list-style-type: none"> <li>• Component OFF – OK for Open/Low Voltage test and Not Run for High Voltage Test</li> <li>• Component ON – Not Run for Open/Low Voltage Test and OK for High Voltage Test</li> </ul> |                 |             |                  |
| Ignition Voltage                                                                                                                                                                                                                                                                                                                                                                                    | Malfunction     | Malfunction | —                |
| Cylinder 1, 4, 6, or 7 Deactivation Solenoid Control                                                                                                                                                                                                                                                                                                                                                | Malfunction     | Malfunction | Not Run          |

**Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Open, Low and High Voltage Test Status – Component Commanded ON**

| Circuit                                                                                                                                                                                                                                                                                                                                                                                            | Short to Ground | Open    | Short to Voltage |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------|------------------|
| <b>Operating Conditions:</b> Component Commanded ON<br><b>Parameter Normal Range:</b> The following illustrates the normal parameter state with no circuit conditions: <ul style="list-style-type: none"> <li>• Component OFF – OK for Open/Low Voltage test and Not Run for High Voltage Test</li> <li>• Component ON – Not Run for Open/Low Voltage Test and OK for High Voltage Test</li> </ul> |                 |         |                  |
| Ignition Voltage                                                                                                                                                                                                                                                                                                                                                                                   | Not Run         | Not Run | —                |
| Cylinder 1, 4, 6, or 7 Deactivation Solenoid Control                                                                                                                                                                                                                                                                                                                                               | Not Run         | Not Run | Malfunction      |

**Circuit/System Description**

The cylinder deactivation system is used to deactivate 4 cylinders of the engine under light load driving conditions. The engine control module (ECM) commands the cylinder deactivation solenoids ON to deactivate engine cylinders 1, 7, 6, and 4, switching to 4 cylinders or V4 mode. The cylinder deactivation solenoids controls the oil flow to the appropriate valve lifters. The engine operates on 8 cylinders or V8 mode, during engine starting, engine idling, and medium to heavy throttle conditions.

Ignition voltage is supplied directly to the 4 cylinder deactivation solenoids. The ECM controls the 4 cylinder deactivation solenoids by grounding the control circuit with a solid state device called a driver.

**Conditions for Running the DTC**

- The engine speed is greater than 400 RPM.
- The ignition voltage is between 11–18 V.
- DTCs P3401, P3425, P3441, and P3449 run continuously when the above conditions are met.

**Conditions for Setting the DTC**

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

#### Action Taken When the DTC Sets

- DTC P3401, P3425, P3441, and P3449 are Type B DTCs.
- The engine will return to V8 mode.
- The engine control module disables the fuel injector for the cylinder that set a cylinder deactivation DTC, resulting in an engine misfire.

#### Conditions for Clearing the DTC

DTC P3401, P3425, P3441, and P3449 are Type B DTCs.

#### Diagnostic Aids

The valve lifter oil manifold assembly solenoids are assigned to the following engine cylinders:

- Cylinder Deactivation Solenoid Valve #1 = Cylinder #1
- Cylinder Deactivation Solenoid Valve #2 = Cylinder #4
- Cylinder Deactivation Solenoid Valve #3 = Cylinder #6
- Cylinder Deactivation Solenoid Valve #4 = Cylinder #7

#### Reference Information

##### Schematic Reference

[Engine Controls Schematics](#)

##### Connector End View Reference

[Component Connector End Views](#)

##### Description and Operation

[Cylinder Deactivation \(Active Fuel Management\) 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

EN-46999 Displacement On Demand Tester

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

#### Circuit/System Verification

**Note:** DTC P3401, P3425, P3441, and P3449 set with an open ignition circuit fuse.

1. Ignition ON, command the Cylinder Deactivation System ON and OFF with a scan tool:
2. Verify the follow parameters display OK or Not Run during each command.

- Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit High Voltage Test Status
- Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Open Test Status
- Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Low Voltage Test Status

⇒ **If any parameter displays Malfunction**

Refer to Circuit/System Testing.

⇓ **If each parameter displays OK or Not Run**

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 P3401, P3425, P3441, or P3449 does not set.

⇒ **If a DTC set**

Refer to Circuit/System Testing.

⇓ **If a DTC does not set**

5. All OK.

### Circuit/System Testing

**Note:** If any of the scan tool circuit status parameters displayed "Malfunction" during the Circuit/System Verification, inspect the wiring harness for signs of binding, chaffing or pinching before intake manifold removal.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the Q43 Valve Lifter Oil Manifold Assembly. It may take up to 2 min for all vehicle systems to power down.

2. Ignition ON.

3. Verify that a test lamp illuminates between the ignition circuit terminal 4 and ground.

⇒ **If the test lamp does not illuminate and the fuse is good.**

- 3.1. Ignition OFF, remove the test lamp.
- 3.2. Test for less than 5  $\Omega$  between the ignition circuit terminal 4 and the fuse.
  - ⇒ If 5  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 5  $\Omega$ , verify there is voltage at the fuse and the fuse is good.

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

- 3.1. Ignition OFF, remove the test lamp.
- 3.2. Test for infinite resistance between the ignition circuit terminal 4 and ground.
  - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
  - ⇒ If infinite resistance, test all the components connected to the ignition circuit and repair or replace as necessary.

⇓ **If the test lamp illuminates**

4. Verify that a test lamp does not illuminate between the ignition circuit terminal 4 and the appropriate cylinder deactivation solenoid valve control circuit terminal listed below.

- Cylinder 1 Deactivation Solenoid Valve 1 terminal 3
- Cylinder 4 Deactivation Solenoid Valve 2 terminal 1
- Cylinder 6 Deactivation Solenoid Valve 3 terminal 2
- Cylinder 7 Deactivation Solenoid Valve 4 terminal 5

⇒ **If the test lamp illuminates**

- 4.1. Ignition OFF, remove the test lamp, disconnect the harness connector X3 at the K20 Engine Control Module.
- 4.2. Test for infinite resistance between the appropriate cylinder deactivation solenoid valve control circuit and ground.



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

⇒ If infinite resistance, replace the K20 Engine Control Module.

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

5. Verify that a test lamp does not illuminate between ground and the appropriate cylinder deactivation solenoid valve control circuit terminal listed below.

- Cylinder 1 Deactivation Solenoid Valve 1 terminal 3
- Cylinder 4 Deactivation Solenoid Valve 2 terminal 1
- Cylinder 6 Deactivation Solenoid Valve 3 terminal 2
- Cylinder 7 Deactivation Solenoid Valve 4 terminal 5

⇒ **If the test lamp illuminates**

5.1. Ignition OFF, remove the test lamp, disconnect the harness connector X3 at the K20 Engine Control Module, ignition ON.

5.2. Test for less than 1 V between the appropriate cylinder deactivation solenoid valve 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.

6. Connect a test lamp between the ignition circuit terminal E and the appropriate cylinder deactivation solenoid valve control circuit terminal listed below.

- Cylinder 1 Deactivation Solenoid Valve 1 terminal 3
- Cylinder 4 Deactivation Solenoid Valve 2 terminal 1
- Cylinder 6 Deactivation Solenoid Valve 3 terminal 2
- Cylinder 7 Deactivation Solenoid Valve 4 terminal 5

7. Command the Cylinder Deactivation System ON with a scan tool.

8. Verify the test lamp illuminates with each command.

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

8.1. Ignition OFF, remove the test lamp, disconnect the harness connector X3 at the K20 Engine Control Module.

8.2. Test the appropriate cylinder deactivation solenoid valve control circuit for less than 5  $\Omega$  end to end.

⇒ If 5  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇒ If less than 5  $\Omega$ , replace the K20 Engine Control Module.

↓ **If the test lamp illuminates**

9. Test or replace the Q43 Valve Lifter Oil Manifold Assembly.

## **Component Testing**

### **Static Test**

1. Ignition OFF, disconnect the harness connector at the Q43 Valve Lifter Oil Manifold Assembly.

2. Connect the harness that is labeled resistance from the Displacement On Demand (DOD) Tester to the Q43 Valve Lifter Oil Manifold Assembly connector.

3. Connect the power leads from the DOD tester to B+ and ground. Test for 11–18  $\Omega$  on each cylinder deactivation solenoid valve.

⇒ **If not between 11–18  $\Omega$**

Replace the Q43 Valve Lifter Oil Manifold Assembly.

↓ **If between 11–18  $\Omega$**

4. Test for infinite resistance between each valve lifter oil manifold circuit terminal and the valve lifter oil manifold housing.

⇒ **If less than infinite resistance**

Replace the Q43 Valve Lifter Oil Manifold Assembly.

↓ **If infinite resistance**

5. Perform the Dynamic Test.

#### Dynamic Test

1. Ignition OFF, disconnect the harness connector at the Q43 Valve Lifter Oil Manifold Assembly.
2. Connect the cable that is labeled power from the Displacement On Demand (DOD) Tester to the connector.
3. Connect the power leads from the DOD tester to B+ and ground.
4. Command each cylinder deactivation solenoid valve ON and OFF using the DOD tester. You should be able to hear each solenoid turn ON and OFF.

⇒ **If the function does not perform as specified**

Replace the Q43 Valve Lifter Oil Manifold Assembly.

↓ **If the function performs as specified**

5. All OK.

#### Repair Instructions

- [Valve Lifter Oil Manifold Replacement](#)
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup.

#### Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
  2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
  3. Clear the DTCs.
  4. Turn OFF the ignition for 60 s.
  5. Engine running, command each cylinder deactivation solenoid ON and OFF with a scan tool.
  6. Verify the follow parameters display OK or Not Run during each command.
    - Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit High Voltage Test Status
    - Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Open Test Status
    - Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Low Voltage Test Status
- ⇒ **If any parameter displays Malfunction**  
Refer to Circuit/System Testing.
- ↓ **If each parameter displays OK or Not Run**
7. Verify no DTCs are set.
- ⇒ **If any DTCs are set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) and perform the appropriate diagnostic procedure.
- ↓ **If no DTCs are set**
8. All OK.

## Symptoms - Engine Controls (Without Supercharger)

### Diagnostic Instructions

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

### Symptoms Description

Symptoms cover conditions that are not covered DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause certain symptoms are listed separately under Additional Symptoms Test. Perform the Symptoms Testing before using the Additional Symptoms Tests. Poor Fuel Fill Quality test may be performed separately from the Symptoms Testing and Additional Symptoms Tests procedures.

### Symptoms Definition

#### Backfire

Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

#### Cuts Out, Misses

A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

#### Detonation/Spark Knock

A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening. Engine Control Module (ECM) Commanded Reduced Engine Power

#### Dieseling, Run-On

The engine continues to run after the key is turned OFF, but runs very rough.

#### Engine Control Module (ECM) Commanded Reduced Engine Power

The ECM illuminates the Reduced Engine Power lamp and will limit engine power under potential engine/vehicle damaging or emissions related conditions. A DTC may not be set.

#### Fuel Odor

A noticeable smell of unburned fuel.

#### Hard Start

Engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stalls.

#### Hesitation, Sag, Stumble

Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to

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make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

### **Lack of Power, Sluggishness, or Sponginess**

The engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way.

### **Poor Fuel Economy**

Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

### **Rough, Unstable, or Incorrect Idle and Stalling**

The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle may vary in speed. Either condition may be severe enough to stall the engine.

### **Surges/Chuggles**

Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

## **Symptoms Verification**

Before using the Symptom tables, perform the following inspections:

- Verify that the engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.
- Verify that there are no DTCs that are stored.
- Verify that the scan tool data is within a normal operating range. Refer to [Control Module References](#) for scan tool information.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.

### **Identifying Intermittent Conditions**

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

- Moisture and water intrusion in connectors, terminals, and components
- Incomplete connector mating
- Poor terminal contact
- High circuit or component resistance—High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness that is too short or tight.
- Wire insulation that is chaffed or cut.
- High or low ambient temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surfaces

- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of aftermarket, add on accessories

### Visual/Physical Check

- Verify that the control module grounds are clean, tight, and correctly located. Refer to [Wiring Repairs](#).
- Verify that the vacuum hoses are not split or kinked, and are properly connected, as shown on the Vehicle Emission Control Information label.
- Verify that the air filter is clean and free from restrictions.
- Verify that there is no water intrusion in connectors terminals and components.
- Inspect the air intake ducts for the following conditions:
  - Collapsed
  - Damaged areas
  - Looseness
  - Incorrect installation
  - Leaking
- Inspect for air leaks at the throttle body mounting area, the mass air flow (MAF) sensor and intake manifold sealing surfaces.
- Inspect the wiring harness for the following conditions:
  - Poor connections
  - Pinches
  - Cuts
- Inspect for loose, damaged, unseated, or missing sensors/components.
- Inspect the terminals for corrosion and correct contact.

### Symptoms Testing

**Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Engine Control Module (ECM) Commanded Reduced Engine Power, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges/Chuggles**

1. Test for the following conditions:
  - Incorrectly operating fuel system. Inspect for the following:
    - Incorrect fuel system operation and pressure—Refer to [Fuel System Diagnosis](#)
    - Leaking or incorrectly operating fuel injectors—Refer to [Fuel Injector Diagnosis](#).
    - Incorrectly connected fuel injectors. Verify that each fuel injector is connected to the proper fuel injector harness connector.
    - Contaminated or poor quality fuel—Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
  - Incorrectly operating ignition system. Inspect for the following:
    - Spark plugs with incorrect heat range or an abnormal condition—Refer to [Spark Plug Inspection](#) and [Ignition System Specifications](#).
    - Coolant or oil fouled spark plugs—For diagnosis, refer to [Coolant in Combustion Chamber](#) or [Oil Consumption Diagnosis](#).
    - Secondary ignition system susceptible to moisture. Wet down the secondary ignition system with water from a spray bottle to help locate damaged or deteriorated components. Look/listen for arcing or misfiring as the water is applied.
    - Weak spark using the J 26792 spark tester—Refer to [Electronic Ignition System Diagnosis](#).

- Incorrectly operating cylinder deactivation system, if equipped. Refer to [Cylinder Deactivation \(Active Fuel Management\) System Diagnosis](#) and [Cylinder Deactivation \(Active Fuel Management\) System Description](#).
- Incorrectly operating transmission torque converter clutch (TCC)—The scan tool should indicate an engine speed drop when the TCC is commanded ON.
- Incorrectly operating A/C compressor
- Items that can cause an engine to run rich or lean. Refer to [DTC P0171, P0172, P0174, or P0175](#).
- Slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to different throttle positions.

**Caution:** Refer to [Heated Oxygen and Oxygen Sensor Caution](#).

- Water intrusion in the HO2S connector

**Note:** The embossed arrows on the mass airflow (MAF) sensor indicate the direction of the intake air flow. The arrows must point toward the engine.

- Incorrect MAF sensor installation. A MAF sensor that is incorrectly installed may cause a hard start. Install the MAF in the proper direction. Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#).
- Incorrect or loose MAF sensor connections.
- Engine oil contaminated by fuel
- Split or kinked vacuum hoses—Verify that the routing and connections are as shown on the Vehicle Emission Control Information label.
- Excessive knock sensor system spark retard activity—Refer to [DTC P0325, P0327, P0328, P0330, P0332, or P0333](#).
- Incorrectly operating exhaust system. Test the components for the following:
  - Physical damage or possible internal failure
  - Restricted three-way catalytic converters
 For more information, refer to [Symptoms - Engine Exhaust](#).
- Electromagnetic interference (EMI) on the reference circuit, which can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition control circuit if a condition exists.
- Incorrectly operating crankcase ventilation valve—Refer to [Crankcase Ventilation System Inspection/Diagnosis](#).
- A stuck open evaporative emission (EVAP) canister purge solenoid
- Incorrectly operating engine cooling system. Test for the following conditions:
  - A thermostat with incorrect heat range. Refer to [Thermostat Diagnosis](#).
  - Incorrect engine coolant level—Refer to [Cooling System Draining and Filling](#).
- An engine mechanical condition. Inspect for the following:
  - Excessive oil in the combustion chamber or leaking valve seals
  - Incorrect cylinder compression
  - Sticking or leaking valves
  - Worn camshaft lobes
  - Incorrect valve timing
  - Worn rocker arms
  - Broken valve springs
  - Excessive carbon buildup in the combustion chambers—Clean the chambers with top engine cleaner, if necessary. Follow the instructions on the can.
  - Incorrect engine parts

For more information, refer to [Symptoms - Engine Mechanical](#).

2. If the above conditions do not address the symptom, refer to the additional symptoms tests.

### **Additional Symptoms Tests**

#### **Detonation/Spark Knock**

- Test the engine for an overheating condition. Refer to [Symptoms - Engine Cooling](#).
- Inspect for excessive carbon buildup in the combustion chambers. Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.
- If there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicle minimum octane requirements.

#### **Engine Control Module (ECM) Commanded Reduced Engine Power**

Under certain conditions the engine control module may limit engine power by reducing engine torque and, for some vehicles, fuel pressure as well. For most, but not all of the conditions, the engine control module will illuminate the reduced engine power lamp on the instrument cluster, however a DTC may not be set.

A repair may not be necessary. Observe the scan tool Reduced Engine Power History parameter, if applicable, or refer to [K20 Engine Control Module: Scan Tool Information](#) to determine the reason for the reduced engine power event.

Verify or inspect for the following:

- Vehicle being driven inappropriately. Towing heavy loads up an incline for an extended period of time or operating the vehicle at sustained, excessively high engine speeds may cause the engine oil or coolant to overheat. Inspect the airflow passageways in front of the engine for obstructions and clear away any debris or foreign material that is found. If no obstructions are found, review approved driving habits with the customer. The customer may need to operate the vehicle at a higher engine speed to improve cooling system performance, or, at a slower engine speed to reduce engine load.
- If equipped with the OnStar® feature, reduced engine power may be due to OnStar® remote command. A repair may not be necessary. Verify the vehicle is not in the OnStar® initiated Stolen Vehicle Slowdown mode.
- A cooling fan condition which may cause the ECM to reduce engine power. Refer to [Cooling Fan Description and Operation](#) and [Cooling System Description and Operation](#)

#### **Fuel Odor**

- Inspect for damaged, deteriorated, or leaking fuel lines and components.
- Inspect for a saturated EVAP canister—Refer to [Evaporative Emission Control System Description](#).
- Inspect for a condition with the internal components of the fuel tank assembly—Refer to [Fuel System Description](#).

#### **Hard Start**

- Observe the Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 90 % may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary. Refer to [Throttle Body Cleaning](#).
- Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within  $\pm 3^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to [Temperature Versus Resistance](#) for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to [Engine Coolant Temperature Sensor Replacement](#). If the sensor is within the specification, test the ECT circuits for a high resistance.



- Verify that the fuel pump operates and provides adequate pressure for engine startup. The fuel pump should turn ON for 2 s when the ignition is turned to ON. Refer to [Fuel System Diagnosis](#) for fuel pressure specifications and testing procedures.

#### **Hesitation, Sag, Stumble**

- Test the fuel pressure. Refer to [Fuel System Diagnosis](#).
- Test the manifold absolute pressure (MAP) sensor. Refer to [DTC P0106](#).
- Test the generator. Refer to [Symptoms - Engine Electrical](#). Repair the charging system if the generator output voltage is less than 9 V or more than 16 V.

#### **Lack of Power, Sluggishness, or Sponginess**

- Verify that each injector harness is connected to the correct injector.
- Inspect the engine electrical system for incorrect operation. Refer to [Symptoms - Engine Electrical](#).
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#).

#### **Poor Fuel Economy**

- Inspect for heavy loads being carried or towed.
- Inspect for acceleration rate too much or too often.
- Inspect for incorrect operation of the speedometer.
- Observe the Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 90 % may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary. Refer to [Throttle Body Cleaning](#).
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#).
- Inspect the brake system for brake drag.

#### **Rough, Unstable or Incorrect Idle and Stalling**

- Observe the Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 90 % may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary. Refer to [Throttle Body Cleaning](#).
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#).
- Inspect the engine mounts. Refer to [Engine Mount Inspection](#).
- An excessively high idle may be due to the floor mat interfering with the accelerator pedal. With this condition present, it may not be possible to shift the transmission into gear. Inspect the accelerator pedal for binding and verify that the floor mat is not interfering with the accelerator pedal movement.
- Inspect the intake and exhaust manifolds for casting flash.

#### **Surges/Chuggles**

- Verify that each injector harness is connected to the correct injector.
- Inspect for slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The ECM reduces the amount of fuel delivered to the engine, causing a driveability condition.



## Symptoms - Engine Controls (With Supercharger)

### Diagnostic Instructions

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

### Symptoms Description

Symptoms cover conditions that are not covered DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause certain symptoms are listed separately under Additional Symptoms Test. Perform the Symptoms Testing before using the Additional Symptoms Tests. Poor Fuel Fill Quality test may be performed separately from the Symptoms Testing and Additional Symptoms Tests procedures.

### Symptoms Definition

#### Backfire

Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

#### Cuts Out, Misses

A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

#### Detonation/Spark Knock

A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

#### Dieseling, Run-On

The engine continues to run after the key is turned OFF, but runs very rough.

#### Engine Control Module (ECM) Commanded Reduced Engine Power

The engine control module illuminates the reduced engine power lamp and will limit engine power under engine damaging or emissions related conditions. A DTC may not be set.

#### Hard Start

Engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stalls.

#### Hesitation, Sag, Stumble

Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

#### Lack of Power, Sluggishness, or Sponginess

The engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way.

### **Poor Fuel Economy**

Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

### **Rough, Unstable, or Incorrect Idle and Stalling**

The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle may vary in speed. Either condition may be severe enough to stall the engine.

### **Surges/Chuggles**

Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

## **Symptoms Verification**

Before using the Symptom tables, perform the following inspections:

- Verify that the engine control module and malfunction indicator lamp are operating correctly.
- Verify that there are no DTCs that are stored.
- Verify that the scan tool data is within a normal operating range. Refer to [Control Module References](#) for scan tool information.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.

### **Identifying Intermittent Conditions**

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

- Moisture and water intrusion in connectors, terminals, and components
- Incomplete connector mating
- Poor terminal contact
- High circuit or component resistance—High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness that is too short or tight.
- Wire insulation that is chaffed or cut.
- High or low ambient temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surfaces
- Electro-magnetic interference from relays, solenoids or other electrical surge
- Incorrect installation of aftermarket, add on accessories

### **Visual/Physical Check**

- Verify that the control module grounds are clean, tight, and correctly located. Refer to [Wiring Repairs](#).
- Verify that the vacuum hoses are not split or kinked, and are properly connected, as shown on the Vehicle Emission Control Information label.
- Verify that the air filter is clean and free from restrictions.
- Verify that there is no water intrusion in connectors terminals and components.
- Inspect the air intake ducts for the following conditions:
  - Collapsed
  - Damaged areas
  - Looseness
  - Incorrect installation
  - Leaking
- Inspect for air leaks at the throttle body mounting area, the mass air flow sensor and intake manifold sealing surfaces.
- Inspect the wiring harness for the following conditions:
  - Poor connections
  - Pinches
  - Cuts
- Inspect for loose, damaged, unseated, or missing sensors/components.
- Inspect the terminals for corrosion and correct contact.

### **Symptoms Testing**

**Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Engine Control Module (ECM) Commanded Reduced Engine Power, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges/Chuggles**

- Test/Inspect the fuel system for the following:
  - Correct operation and fuel pressure—Refer to [Fuel System Diagnosis](#).
  - Leaking or incorrectly operating fuel injectors—Refer to [Fuel Injector Diagnosis](#).
  - Contaminated or poor fuel quality condition—Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
- Test/Inspect the ignition system for the following:
  - Spark plugs with incorrect heat range or an abnormal condition—Refer to [Spark Plug Inspection](#) and [Ignition System Specifications](#).
  - Coolant or oil fouled spark plugs. For diagnosis, refer to [Coolant in Combustion Chamber](#) or [Oil Consumption Diagnosis](#).
  - Secondary ignition system susceptible to moisture. Engine running, wet down the secondary ignition system with water from a spray bottle to help locate damaged or deteriorated components. Look/listen for arcing or misfiring as the water is applied.
  - Weak spark using the J 26792 spark tester—Refer to [Electronic Ignition System Diagnosis](#).
- Test/Inspect the supercharger system for the following conditions:
  - Damaged, worn or misaligned supercharger belt and belt tensioner. Repair or replace only if necessary.
  - Excessively worn, loose, or damaged components
  - Sticking or binding components
  - Leaking supercharger intake manifold and plenum gaskets and seals
  - Split, kinked, or improperly connected vacuum hoses

- Incorrectly operating supercharger intercooler pump or pump relay. Refer to [Supercharger Intercooler Relay Diagnosis](#).
- Excessive noise. Operate the vehicle at idle and at various stages of acceleration and compare the supercharger noise levels to those heard while operating a comparable vehicle at comparable conditions. For an explanation of typical supercharger system noises, refer to [Supercharger Noise Diagnosis](#).
- Improper operation—Refer to [Supercharger Description and Operation](#), [Boost Control System Description](#), and [Boost Control System Diagnosis](#) for additional information.
- Inspect for the following conditions:
  - Incorrectly operating transmission torque converter clutch—The scan tool should indicate an engine speed drop when the torque converter clutch is commanded ON.
  - Incorrectly operating A/C compressor
  - Items that can cause an engine to run rich or lean.
  - Slow responding heated oxygen sensors. The heated oxygen sensors should respond quickly to different throttle positions.
  - Water intrusion in the heated oxygen sensors connector
- Note:** The embossed arrows on the mass airflow (MAF) sensor indicate the direction of the intake air flow. The arrows must point toward the engine.
- Incorrect mass airflow sensor installation. A mass airflow sensor that is incorrectly installed may cause a hard start. Install the mass airflow in the proper direction. Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#).
- Incorrect mass airflow sensor connections.
- Engine oil contaminated by fuel
- Split or kinked vacuum hoses—Verify that the routing and connections are as shown on the Vehicle Emission Control Information label.
- Excessive knock sensor system spark retard activity—Refer to [DTC P0324, P0325, P0326, P0327, P0328, P0330, P0332, or P0333](#).
- Electromagnetic interference on the reference circuit, which can cause a misfire condition. You can usually detect electromagnetic interference with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that electromagnetic interference is present. Inspect the high voltage components near the ignition control circuit if a condition exists.
- Incorrectly operating crankcase ventilation valve—Refer to [Crankcase Ventilation System Inspection/Diagnosis](#).
- Stuck open evaporative emission canister purge solenoid
- Inspect the engine cooling system for the following conditions:
  - A thermostat with incorrect heat range. Refer to [Thermostat Diagnosis](#).
  - Improper engine coolant level—Refer to [Cooling System Draining and Filling](#).
- Inspect the exhaust system components for the following:
  - Physical damage or possible internal failure.
  - Restricted three-way catalytic converters—Refer to [Symptoms - Engine Exhaust](#).
- Inspect the engine for the following mechanical failures—Refer to [Symptoms - Engine Mechanical](#):
  - Excessive oil in the combustion chamber or leaking valve seals
  - Oil consumption
  - Incorrect cylinder compression
  - Sticking or leaking valves
  - Worn camshaft lobes
  - Incorrect valve timing
  - Worn rocker arms

- Broken valve springs
- Excessive carbon buildup in the combustion chambers—Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.
- Incorrect engine parts
- If the above conditions do not address the symptom, refer to the additional symptoms tests.

### **Additional Symptoms Tests**

#### **Detonation/Spark Knock**

- Test the engine for an overheating condition. Refer to [Symptoms - Engine Cooling](#).
- Verify that the engine coolant temperature (ECT) has not shifted in value. Allow the engine to run and reach operating temperature. Observe the ECT Sensor parameter with a scan tool and compare the reading to that parameter listed on the [K20 Engine Control Module: Scan Tool Information](#) list. If the reading is not in the range specified in the list, test the resistance of the engine coolant temperature sensor. Refer to [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#) for resistance specifications. Replace the engine coolant temperature sensor if the resistance is not within specification. Refer to [Engine Coolant Temperature Sensor Replacement](#). If the sensor is within the specification, test the engine coolant temperature sensor circuits for high resistance.
- Inspect for excessive carbon buildup in the combustion chambers. Clean the combustion chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can
- Inspect for an incorrectly operating supercharger intercooler pump or pump relay. Refer to [Supercharger Intercooler Relay Diagnosis](#).
- If there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicle minimum octane requirements.

#### **Engine Control Module (ECM) Commanded Reduced Engine Power**

Under certain conditions the engine control module may limit engine power by reducing engine torque and, for some vehicles, fuel pressure as well. For most, but not all of the conditions, the engine control module will illuminate the reduced engine power lamp on the instrument panel cluster, however a DTC may not be set.

A repair may not be necessary. Observe the scan tool Reduced Engine Power History parameter, if applicable, or refer to [K20 Engine Control Module: Scan Tool Information](#) to determine the reason for the reduced engine power event.

Verify or inspect for the following:

- Vehicle being driven inappropriately. Towing heavy loads up an incline for an extended period of time or operating the vehicle at sustained, excessively high engine speeds may cause the engine oil or coolant to overheat. Inspect the airflow passageways in front of the engine for obstructions and clear away any debris or foreign material that is found. If no obstructions are found, review approved driving habits with the customer. The customer may need to operate the vehicle at a higher engine speed to improve cooling system performance, or, at a slower engine speed to reduce engine load.
- If equipped with the OnStar® feature, reduced engine power may be due to OnStar® remote command. A repair may not be necessary. Verify the vehicle is not in the OnStar® initiated Stolen Vehicle Slowdown mode.
- A cooling fan condition which may cause the engine control module to reduce engine power. Refer to [Cooling Fan Description and Operation](#) and [Cooling System Description and Operation](#) to verify correct operation of the cooling fan.
- Maximum recommended engine oil life exceeded. Refer to the Owners Manual for scheduled maintenance recommendations.
- High pressure fuel system condition. Refer to [Fuel System Diagnosis](#) and [Fuel System Description](#) to verify high pressure fuel system operation.

- Supercharger boost pressure out of range. Refer to [Boost Control System Diagnosis](#), [Boost Control System Description](#) and [Supercharger Description and Operation](#).

#### Fuel Odor

- Inspect for a saturated evaporative emission canister—Refer to [Evaporative Emission Control System Description](#).
- Inspect for a condition with the internal components of the fuel tank assembly—Refer to [Fuel System Description](#).
- Inspect for leaking, damaged, or deteriorated fuel lines and components.

#### Hard Start

- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary. Refer to [Throttle Body Cleaning](#).
- Test the engine coolant temperature sensor. Compare the engine coolant temperature sensor value to the intake air temperature sensor value on a cold engine. The engine coolant temperature and intake air temperature sensor values should be within  $\pm 3^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ). If the engine coolant temperature sensor is out of range with the intake air temperature sensor, test the resistance of the engine coolant temperature sensor. Refer to [Temperature Versus Resistance](#) for resistance specifications. Replace the engine coolant temperature sensor if the resistance is not within specification. Refer to [Engine Coolant Temperature Sensor Replacement](#). If the sensor is within the specification, test the engine coolant temperature circuits for a high resistance.
- Verify that the fuel system has adequate pressure for engine start-up. With a scan tool, compare the Fuel Pressure Sensor parameter value to the Desired Fuel Pressure parameter value when the ignition key is first turned to ON. Refer to [Fuel System Diagnosis](#) for additional information.

#### Hesitation, Sag, Stumble

- Test the fuel pressure. Refer to [Fuel System Diagnosis](#).
- Test the manifold absolute pressure (MAP) sensor. Refer to [DTC P0106](#).
- Test the generator. Refer to [Symptoms - Engine Electrical](#). Repair the charging system if the generator output voltage is less than 9 volts or more than 16 volts.

#### Lack of Power, Sluggishness, or Sponginess

- Inspect the engine electrical system for incorrect operation. Refer to [Symptoms - Engine Electrical](#).
- Verify that each injector harness is connected to the correct injector.
- Inspect for incorrect operation of the supercharger boost control solenoid and by-pass valve. Refer to [Boost Control System Diagnosis](#), [Boost Control System Description](#) and [Supercharger Description and Operation](#).
- Inspect for an incorrectly operating supercharger intercooler pump or pump relay. Refer to [Supercharger Intercooler Relay Diagnosis](#).

#### Poor Fuel Economy

- Inspect for heavy loads being carried or towed.
- Inspect for acceleration rate too much or too often.
- Inspect for incorrect operation of the speedometer.
- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary. Refer to [Throttle Body Cleaning](#).



- Inspect for a stuck closed supercharger boost control solenoid valve. Refer to [Boost Control System Description](#) and [Boost Control System Diagnosis](#).
- Inspect for a restricted exhaust system, which may cause a supercharger over-boost condition. Refer to [Restricted Exhaust](#), [Boost Control System Description](#) and [Boost Control System Diagnosis](#).
- Inspect the brake system for brake drag.

#### **Rough, Unstable, or Incorrect Idle and Stalling**

- Inspect the engine mounts—Refer to [Engine Mount Inspection](#)
- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary. Refer to [Throttle Body Cleaning](#).
- Inspect the intake and exhaust manifolds for casting flash.
- An excessively high idle may be due to the floor mat interfering with the accelerator pedal. With this condition present, it may not be possible to shift the transmission into gear. Inspect the accelerator pedal for binding and verify that the floor mat is not interfering with the accelerator pedal movement.

#### **Surges/Chuggles**

- Inspect for slow responding heated oxygen sensors (HO2S). The heated oxygen sensors should respond quickly to a change in throttle position. If the heated oxygen sensors do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The engine control module reduces the amount of fuel delivered to the engine, causing a driveability condition.
- Verify that each injector harness is connected to the correct injector.

## Boost Control System Diagnosis

### Diagnostic Instructions

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

### Circuit Description

Supercharger boost pressure is regulated under certain conditions to prevent engine and drive train damage. When the engine is operating under high boost conditions, the engine control module (ECM) can limit boost pressure to 83 kPa (12 psi) or less.

The ECM disables boost under the following conditions:

- Reverse gear is selected.
- Intercooler pump failure is detected.
- Electronic throttle control fault is detected.
- Intake air temperature (IAT) sensor 2 is equal to or greater than 120.5°C (248°F). Boost pressure is limited to 145 kPa (7 psi).
- Engine coolant temperature (ECT) is greater than 125°C (257°F).
- Drivetrain abuse is detected.
- Vehicle speeds exceed 256 km/h (159 mph) in second, third or fourth gear for greater than 150 s.

The ECM controls boost pressure by a pulse-width modulated (PWM) ground signal to the supercharger bypass solenoid valve. The bypass valve is a normally open valve. Under most conditions, the ECM commands the bypass solenoid to operate at a 99–100 % duty cycle. This keeps the bypass valve closed and allows only inlet vacuum from the supercharger plenum to the bypass valve actuator to control the position of the bypass valve. At idle, engine vacuum is applied to the upper side of the bypass valve actuator, counteracting spring tension to hold the bypass valve open. When the engine load is increased, the engine vacuum is decreased, causing the spring in the bypass valve actuator to overcome the applied vacuum, closing the bypass valve and allowing the boost pressure to increase. The bypass valve starts to close when the vacuum is 33.9 kPa (10 in Hg) and is fully closed at 11.9 kPa (3.5 in Hg). When reduced boost pressure is desired, the ECM commands the bypass solenoid to operate at a 0 % duty cycle, but may command a partial duty cycle, approximately 62 %, depending on the operating conditions. This opens the bypass solenoid and allows boost pressure to enter the bypass valve actuator at the lower side to counteract the spring tension, opening the bypass valve and re-circulating excess boost pressure back into the supercharger inlet.

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

[Component Connector End Views](#)

#### Description and Operation

- [Supercharger Description and Operation](#)
- [Boost Control System Description](#)

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**DTC Type Reference**

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

**Scan Tool Reference**

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

**Special Tools**

GE-23738-A Vacuum Pump

**Circuit/System Verification**

1. Verify that the charge air cooler coolant is at the proper level. Refer to [Charge Air Cooling System Coolant Level Inspection](#).
2. Verify that the vacuum lines to the supercharger components are properly routed. Refer to [Boost Control System Description](#).
3. Ignition ON. Verify the KR18 Charge Air Cooler Coolant Pump Relay clicks and the M10 Charge Air Cooler Coolant Pump turns ON and OFF when commanding the Charge Air Cooler Coolant Pump ON and OFF with a scan tool.
  - ⇒ **If the relay does not click or the pump does not turn ON and OFF**  
Refer to [Supercharger Intercooler Relay Diagnosis](#)
  - ↓ **If the relay clicks and the pump turns ON and OFF**
4. Engine running, verify the supercharger bypass valve actuator linkage moves when commanding the Supercharger Bypass Solenoid Valve between 0–90 % with a scan tool.
  - ⇒ **If the linkage does not move**  
Refer to Circuit/System Testing.
  - ↓ **If the linkage moves**
5. All OK.

**Circuit/System Testing**

1. Verify the conditions listed below do not exist:
  - Damaged or improperly installed Q36 Supercharger Bypass Solenoid Valve
  - Damaged, restricted or improperly installed supercharger bypass valve actuator
  - Damaged, restricted or improperly installed supercharger bypass valve actuator linkage
  - Leaks at the supercharger manifold gaskets and supercharger intake plenum.
  - Damaged or worn supercharger components or cover. Refer to [Supercharger Cleaning and Inspection](#)
  - Leaking or restricted vacuum hoses and connections
  - ⇒ **If a condition exists**  
Repair or replace the component as necessary.
  - ↓ **If none of the conditions exist**
2. Ignition OFF, disconnect the vacuum source hose from the Q36 Supercharger Bypass Solenoid Valve and connect the GE-23738-A to the hose.
3. Engine running, verify the vacuum is 50.8 kPa (15 in Hg ) or greater.
  - ⇒ **If the vacuum is less than 50.8 kPa (15 in Hg )**  
Repair the vacuum source.
  - ↓ **If the vacuum is 50.8 kPa (15 in Hg ) or greater**
4. Ignition OFF, reconnect the vacuum source hose to the Q36 Supercharger Bypass Solenoid Valve.

5. Disconnect the boost signal hose from the Q36 Supercharger Bypass Solenoid Valve and connect the GE-23738-A to the solenoid hose barb.
6. Engine running, verify the vacuum is 3.4 kPa (1 in Hg ) or less.
  - ⇒ **If greater than 3.4 kPa (1 in Hg )**  
Test or replace the Q36 Supercharger Bypass Solenoid Valve.
  - ⇓ **If 3.4 kPa (1 in Hg ) or less.**
7. Verify the vacuum is 50.8 kPa (15 in Hg ) or greater when commanding the Supercharger Bypass Solenoid Valve to 0 % with a scan tool.
  - ⇒ **If the vacuum is less than 50.8 kPa (15 in Hg )**  
Test or replace the Q36 Supercharger Bypass Solenoid Valve.
  - ⇓ **If the vacuum is 50.8 kPa (15 in Hg ) or greater**
8. Disconnect the boost signal hose from the supercharger bypass valve actuator, and connect the GE-23738-A to the hose barb.
9. Engine idling.
10. Verify the bypass valve actuator rod extends when slowly applying 67.7 kPa (20 in Hg ) of vacuum.
  - ⇒ **If the rod does not extend**
    - 10.1. Ignition OFF. Disconnect the actuator rod from the actuator linkage.
    - 10.2. Engine idling, verify the bypass valve actuator rod extends when slowly applying 50.8 kPa (15 in Hg ) of vacuum.
      - ⇒ If the rod does not extend, replace the supercharger bypass valve actuator.
      - ⇒ If the rod extends, replace the supercharger.
  - ⇓ **If the rod extends**
11. Ignition OFF, disconnect the inlet vacuum signal hose from the bypass valve actuator and connect the GE-23738-A to the hose barb.
12. Verify the bypass valve actuator rod retracts when slowly applying 50.8 kPa (15 in Hg ) of vacuum.
  - ⇒ **If the rod does not retract**
    - 12.1. Disconnect the actuator rod from the actuator linkage.
    - 12.2. Verify the bypass valve actuator rod retracts when slowly applying 50.8 kPa (15 in Hg ) of vacuum.
      - ⇒ If the rod does not retract, replace the supercharger bypass valve actuator.
      - ⇒ If the rod retracts, replace the supercharger.
  - ⇓ **If the rod retracts**
13. Replace the supercharger.

### **Repair Instructions**

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

- [Charge Air Bypass Regulator Solenoid Valve Replacement](#) for supercharger bypass solenoid valve replacement.
- [Supercharger and Gasket Replacement](#)
- [Supercharger Bypass Valve Actuator Replacement](#)

## Supercharger Intercooler Relay Diagnosis

### Diagnostic Instructions

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

### Diagnostic Fault Information

| Circuit                                                                                                                    | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|----------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------|------------------|--------------------|
| Relay Coil Ignition Voltage                                                                                                | P023A           | P023A                | —                | —                  |
| Relay Switch B+                                                                                                            | 1               | 1                    | —                | —                  |
| Coolant Pump Relay Coil Control                                                                                            | P023A           | P023A                | P023A            | —                  |
| Coolant Pump Control                                                                                                       | 1               | 1                    | 2                | —                  |
| Ground                                                                                                                     | —               | 1                    | —                | —                  |
| 1. Charge Air Cooler Coolant Pump inoperative without a DTC.<br>2. Charge Air Cooler Coolant Pump always On without a DTC. |                 |                      |                  |                    |

### Circuit Description

The supercharger intercooler relay is a normally open relay. The relay armature is held in the open position by spring tension. The ignition 1 voltage is supplied directly to the relay coil and to the armature contact when the ignition is On, or the engine is running. The engine control module (ECM) supplies the ground path to the relay coil control circuit via an internal integrated circuit called an output driver module. When the engine is running, the ECM commands the relay On, and the relay coil creates an electromagnetic field. This electromagnetic field overcomes the spring tension and pulls the armature contact into the stationary contact of the relay load circuit. The closing of the relay contacts allow current to flow from the battery to the supercharger intercooler pump. When the ignition switch is turned to the Off position, power is interrupted to the output driver module in the ECM and the relay electromagnetic field collapses. This allows the spring tension to separate the relay armature contact from the relay load circuit contact, which interrupts current flow to the supercharger charge air cooler coolant pump.

### Diagnostic Aids

When disconnecting electrical connectors or removing fuses and relays from a fuse block, inspect the component electrical terminals for corrosion and the mating electrical terminals for correct tension.

### Reference Information

#### Schematic Reference

[Engine Heating/Cooling Schematics](#)

## Connector End View Reference

### [Component Connector End Views](#)

## Description and Operation

- [Supercharger Description and Operation](#)
- [Boost Control System Description](#)

## Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)
- [Electrical Center Identification Views](#)

## Scan Tool Reference

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

### [Circuit/System Verification](#)

1. Ignition On.
2. Verify that DTC P023A is not set.  
⇒ **If the DTC is set**  
Refer to [DTC P023A](#)  
↓ **If the DTC is not set**
3. Verify the KR18 Charge Air Cooler Coolant Pump Relay clicks and the M10 Charge Air Cooler Coolant Pump turns On and Off when commanding the Charge Air Cooler Coolant Pump On and Off with a scan tool.  
⇒ **If the relay does not click or the pump does not turn On and Off**  
Refer to Circuit/System Testing  
↓ **If the relay clicks and the pump turns On and Off**
4. All OK

### [Circuit/System Testing](#)

1. Ignition Off, disconnect the KR18 Charge Air Cooler Coolant Pump Relay. Ignition On.
2. Verify a test lamp illuminates between the relay switch B+ circuit terminal 30 and ground.  
⇒ **If the test lamp does not illuminate**  
Replace the accessory wiring junction block. Refer to [Accessory Wiring Junction Block Replacement](#).  
↓ **If the test lamp illuminates**
3. Verify a test lamp does not illuminate between the relay switch B+ circuit terminal 87 and ground.  
⇒ **If the test lamp illuminates**  
Repair the short to voltage on the circuit.  
↓ **If the test lamp does not illuminate**
4. Connect the KR18 Charge Air Cooler Coolant Pump Relay.
5. Ignition Off. Disconnect the harness connector at the M10 Charge Air Cooler Coolant Pump.
6. Test for less than 10  $\Omega$  between the M10 Charge Air Cooler Coolant Pump ground circuit terminal 4 and ground.  
⇒ **If 10  $\Omega$  or greater**

- 6.1. Ignition Off.
- 6.2. Test for less than  $2\ \Omega$  in the ground circuit end to end.
  - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than  $2\ \Omega$ , repair the open/high resistance in the ground connection.

↓ **If less than  $10\ \Omega$**

- 7. Ignition On, connect a test lamp between the charge air motor voltage circuit terminal 5 and ground.
- 8. Verify the test lamp turns On and Off when commanding the Charge Air Cooler Coolant Pump On and Off with a scan tool.
  - ⇒ **If the test lamp is always Off and the circuit fuse is good**
    - 8.1. Ignition Off
    - 8.2. Test for less than  $2\ \Omega$  in the circuit end to end.
      - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
      - ⇒ If less than  $2\ \Omega$ , test or replace the KR18 Charge Air Cooler Coolant Pump Relay
  - ⇒ **If the test lamp is always Off and the circuit fuse is open**
    - 8.1. Ignition Off, replace the fuse.
    - 8.2. 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, test or replace the M10 Charge Air Cooler Coolant Pump.
  - ⇒ **If the test lamp is always On**
    - 8.1. Ignition On
    - 8.2. Test for less than 1 V between the circuit and ground.
      - ⇒ If 1 V or greater, repair the short to voltage on the circuit.
      - ⇒ If less than 1 V, Test or replace the KR18 Charge Air Cooler Coolant Pump Relay.
- ↓ **If the test lamp turns On and Off**
- 9. Connect a test lamp between the logic circuit terminal 1 and ground.
- 10. Verify the test lamp illuminates when commanding the Charge Air Cooler Coolant Pump On with a scan tool.
  - ⇒ **If the test lamp does not illuminate**
    - 10.1. Ignition Off
    - 10.2. Test for less than  $2\ \Omega$  in the circuit end to end.
      - ⇒ If  $2\ \Omega$  or greater, repair the open/high resistance in the circuit.
  - ↓ **If the test lamp illuminates**
- 11. Test or replace the M10 Charge Air Cooler Coolant Pump.

## Component Testing

### **Coolant Pump Relay**

- 1. Ignition Off, disconnect the KR18 Charge Air Cooler Coolant Pump Relay.
- 2. Test for  $90\text{--}125\ \Omega$  between terminals 85 and 86.
  - ⇒ If less than  $90\ \Omega$  or greater than  $125\ \Omega$   
Replace the KR18 Charge Air Cooler Coolant Pump Relay.
  - ↓ If between  $90\text{--}125\ \Omega$
- 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 KR18 Charge Air Cooler Coolant Pump Relay.

⇓ If infinite resistance

4. Install a 10 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  $2\ \Omega$  between terminals 30 and 87.

⇒ If  $2\ \Omega$  or greater

Replace the KR18 Charge Air Cooler Coolant Pump Relay.

⇓ If less than  $2\ \Omega$

6. All OK

#### Charge Air Cooler Coolant Pump Dynamic Test

1. Ignition On.

2. Install a jumper wire between the B+ terminal 5 and the logic circuit terminal 1. Install a 10 A fused jumper wire between the B+ circuit terminal 5 and 12 V. Install a jumper wire between the ground circuit terminal 4 and ground.

3. Verify the M10 Charge Air Cooler Coolant Pump activates.

⇒ **If the pump does not activate**

Replace the M10 Charge Air Cooler Coolant Pump.

⇓ **If the pump activates**

4. All OK

#### Repair Instructions

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

- [Relay Replacement](#)
- [Charge Air Cooler Coolant Pump Replacement](#)

## Malfunction Indicator Lamp (MIL) Diagnosis

### Diagnostic Instructions

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

### Circuit/System Description

The malfunction indicator lamp (MIL) illuminates to inform the driver that an emission system fault has occurred and the powertrain control system requires service. Ignition voltage is supplied directly to the MIL. The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit when the emission system fault occurs. Under normal operating conditions, the MIL should be ON only when the ignition is ON and the engine is OFF.

### Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors while monitoring the scan tool MIL control circuit status parameters. Perform this test with the ignition ON and the engine OFF, and with the engine running. The MIL control circuit status parameters will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

### Reference Information

#### Schematic Reference

- [Engine Controls Schematics](#)
- [Instrument Cluster Schematics](#)

#### Connector End View Reference

##### [Component Connector End Views](#)

#### Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

#### Scan Tool Reference

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

### Circuit/System Verification

1. Ignition ON.
2. Verify 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](#)

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↓ **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

↓ **If Malfunction is not displayed**

5. Verify the malfunction indicator lamp turns ON and OFF when commanding the Malfunction Indicator Lamp On and Off with a scan tool.

⇒ **If the malfunction indicator lamp does not turn ON and OFF**

Refer to Circuit/System Testing

↓ **If the malfunction indicator lamp turns ON and OFF**

6. All OK.

### Circuit/System Testing

**Note:** Any malfunction indicator lamp requesting DTCs that may be set should be diagnosed first.

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**

3.1. Test for infinite resistance between the control circuit terminal X1 68 and ground.

⇒ If less than infinite resistance, repair the short to ground in the circuit.

⇒ If infinite resistance, replace the P16 Instrument Cluster.

↓ **If the malfunction indicator lamp does not illuminate**

4. Connect a 3 A fused jumper wire between the control circuit terminal X1 68 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**

5.1. Test for less than 1 V between the control circuit terminal X1 68 and ground.

⇒ If 1 V or greater, repair the short to voltage on the circuit.

↓ If less than 1 V

5.2. Ignition OFF.

5.3. Test for less than 2  $\Omega$  in the control circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

↓ If less than 2  $\Omega$ .

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 10 and ground.

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

7.1. Ignition OFF.

7.2. 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 the test lamp does not illuminate and the circuit fuse is good**

7.1. Ignition OFF.

7.2. Test for less than 2  $\Omega$  in the ignition voltage circuit end to end.

⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.

⇓ **If the test lamp illuminates**

8. Replace the P16 Instrument Cluster.

### **Repair Instructions**

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

- [Instrument Cluster Replacement](#)
- [Control Module References](#) for control module replacement, programming, and setup

## Engine Cranks But Does Not Run (Without Supercharger)

### Diagnostic Instructions

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

### Circuit/System Description

This Engine Cranks but Does Not Run diagnostic is an organized approach to identify a condition which causes the engine to crank but does not continue to run. This diagnostic directs the service technician to the appropriate system diagnosis. This diagnostic assumes the vehicle system voltage levels are adequate for starter motor operation. Refer to [Battery Inspection/Test](#) and [Engine Cranks Slowly](#). The fuel level supply must be adequate, and the fuel quality must be able to sustain the combustion process.

### Diagnostic Aids

Inspect for any of the following conditions:

- Insufficient fuel can cause a no start condition. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.
- Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition.
- There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK and fuel spray is detected, the fuel injector ON time may be inadequate. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Observe all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle.
- Observe the Engine Speed parameter while cranking the engine. The scan tool should indicate a steady 200–300 RPM while cranking. If erratic values such as sudden spikes in the engine speed are displayed, the engine reference signal is not stable enough for the engine to start and run properly.
- Inspect the engine for good secure electrical grounds.
- If the engine almost starts and then stalls, inspect for an open in the ground circuits of the CKP sensor and the camshaft position (CMP) sensor.
- Water or foreign material in the fuel can cause a no start or engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 minutes in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.
- A vehicle that starts and runs after being brought to the repair shop for a no start condition may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring in order to verify for an engine starting or will not stay running concern.
- When disconnecting electrical connectors or removing fuses and relays, always inspect electrical terminals for corrosion and for adequate terminal tension.

- Use the J-35616 terminal test kit for any test that requires probing the underhood electrical center terminals, component wire harness terminals, or the controller wire harness terminals.

## [Reference Information](#)

### Schematic Reference

[Engine Controls Schematics](#)

### Connector End View Reference

- [Component Connector End Views](#)
- [Electrical Center Identification 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

### Special Tools

- CH-48027 Digital Pressure Gauge.
- J 26792 HEI Spark Tester

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

## [Circuit/System Verification](#)

**Note:** This diagnostic assumes the following:

- The battery is completely charged. Refer to [Battery Inspection/Test](#).
- The engine cranking speed is acceptable. Refer to [Engine Cranks Slowly](#).
- There is adequate fuel in the fuel tank.

1. Engine cranking for 15 seconds, observe the DTC information with a scan tool. Verify that DTC P0117, P0118, P0122, P0123, P0201–P0208, P0222, P0223, P0300–P0308, P0335, P0336, P0351–P0358, P0562, P0563, P0601–P0604, P0606, P0607, P062F, P0633, P0685, P0690, P1631, P1682, or P2610 is not set.

⇒ If any DTCs are set, refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).

2. Ignition ON, view the security indicator. The security indicator should not remain illuminated after the vehicle bulb check has completed.

⇒ If the security indicator remains illuminated after the bulb check, refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#), and diagnose any theft deterrent DTCs set as current.

3. Engine cranking, observe the scan tool Engine Speed parameter. The scan tool should indicate an engine speed greater than 0 RPM.

⇒ If the engine speed is 0 RPM, refer to [DTC P0335 or P0336](#) for further diagnosis.

**Note:**

- Perform the following spark test on at least one cylinder of each cylinder bank.
- An erratic or weak spark is considered a no spark condition.

4. Disconnect a spark plug wire from a spark plug.
5. Connect a J 26792 spark tester between the boot of the spark plug wire and ground.
6. Verify that the spark tester sparks while cranking the engine.
  - ⇒ If the spark tester does not spark, refer to [Electronic Ignition System Diagnosis](#) for further diagnosis.
- Note:** Additional DTCs may set when using the fuel pump output control.
7. Ignition ON, command the Fuel Pump Enable ON with a scan tool. You should hear the fuel pump turn ON.
  - ⇒ If the fuel pump does not turn ON, refer to [Fuel System Diagnosis](#).
8. Ignition OFF, install the CH-48027 pressure gauge. Refer to [Fuel Pressure Gauge Installation and Removal](#).
  - Note:**
    - The fuel pump may need to be commanded ON several times in order to obtain the highest possible fuel pressure.
    - Do NOT start the engine for this test.
9. Ignition ON, command the Fuel Pump Enable ON with a scan tool.
10. Verify the fuel pressure is between 345–414 kPa (50–60 psi) and does not decrease greater than 34 kPa (5 psi) within 1 min.
  - ⇒ If not within the specified range, refer to [Fuel System Diagnosis](#).
11. Verify the following conditions do not exist:
  - Collapsed air intake duct to the throttle body
  - Restricted air filter element
  - Spark plugs for being fouled
  - A skewed manifold absolute pressure (MAP) sensor—Refer to [DTC P0106](#).
  - A skewed engine coolant temperature (ECT) sensor—Refer to [DTC P0117 or P0118](#).
  - Exhaust system restricted—Refer to [Restricted Exhaust](#).
  - Fuel contamination—Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
  - Engine mechanical condition—Refer to [Symptoms - Engine Mechanical](#) or [Engine Compression Test](#).

### Repair Instructions

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

## Engine Cranks But Does Not Run (With Supercharger)

### Diagnostic Instructions

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

### Circuit/System Description

This Engine Cranks but Does Not Run diagnostic is an organized approach to identify a condition which causes the engine to crank but does not continue to run. This diagnostic directs the service technician to the appropriate system diagnosis. This diagnostic assumes the vehicle system voltage levels are adequate for starter motor operation. Refer to [Battery Inspection/Test](#) and [Engine Cranks Slowly](#). The fuel level supply must be adequate, and the fuel quality must be able to sustain the combustion process.

### Diagnostic Aids

Inspect for any of the following conditions:

- Insufficient fuel can cause a no start condition. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.
- Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition.
- There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK and fuel spray is detected, the fuel injector ON time may be inadequate. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Observe all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle.
- Observe the Engine Speed parameter while cranking the engine. The scan tool should indicate a steady 200–300 RPM while cranking. If erratic values such as sudden spikes in the engine speed are displayed, the engine reference signal is not stable enough for the engine to start and run properly.
- Inspect the engine for good secure electrical grounds.
- If the engine almost starts and then stalls, inspect for an open in the ground circuits of the CKP sensor and the camshaft position (CMP) sensor.
- Water or foreign material in the fuel can cause a no start or engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 minutes in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.
- A vehicle that starts and runs after being brought to the repair shop for a no start condition may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring in order to verify for an engine starting or will not stay running concern.
- When disconnecting electrical connectors or removing fuses and relays, always inspect electrical terminals for corrosion and for adequate terminal tension.

- Use the J-35616 terminal test kit for any test that requires probing the underhood electrical center terminals, component wire harness terminals, or the controller wire harness terminals.

## Reference Information

### Schematic Reference

[Engine Controls Schematics](#)

### Connector End View Reference

- [Component Connector End Views](#)
- [Electrical Center Identification 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

### Special Tools

- CH-48027 Digital Pressure Gauge.
- J 26792 HEI Spark Tester

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

## Circuit/System Verification

**Note:** This diagnostic assumes the following:

- The battery is completely charged.
- The engine cranking speed is acceptable.
- There is adequate fuel in the fuel tank.

1. Crank the engine for up to 15 seconds.
  2. Verify that DTC P0117, P0118, P0122, P0123, P0201–P0208, P0222, P0223, P0300–P0308, P0335, P0336, P0351–P0358, P0562, P0563, P0601–P0604, P0606, P0607, P062F, P0633, P0685, P0690, P1631, P1682, or P2610 is not set.
- ⇒ **If any of the DTCs are set**  
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
- ⇓ **If none of the DTCs are set**
3. Ignition ON.
  4. Verify the security indicator on the instrument cluster illuminates momentarily.
- ⇒ **If the security indicator stays ON or is Flashing**  
Review the [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for immobilizer system DTCs. For additional information, refer to [Immobilizer Description and Operation](#).
- ⇓ **If the security indicator illuminates momentarily**
5. Verify the scan tool Engine Speed parameter displays greater than 0 RPM while cranking the engine.

⇒ **If 0 RPM**Refer to [DTC P0335 or P0336](#).⇓ **If greater than 0 RPM****Note:**

- Perform the following spark test on at least one cylinder of each cylinder bank.
- An erratic or weak spark is considered a no spark condition.

6. Ignition OFF, disconnect a spark plug wire from a spark plug.

7. Connect a J 26792 spark tester between the boot of the spark plug wire and ground.

8. Verify that the spark tester sparks while cranking the engine.

⇒ **If the spark tester does not spark**Refer to [Electronic Ignition System Diagnosis](#).⇓ **If the spark tester sparks**

9. Ignition ON.

**Note:** Additional DTCs may set when using the fuel pump output control.

10. Verify the fuel pump turns ON while commanding the Fuel Pump Enable ON with a scan tool.

⇒ **If fuel pump does not turn ON**Refer to [Fuel System Diagnosis](#).⇓ **If fuel pump turns ON**

11. Ignition OFF.

12. Install the CH-48027 pressure gauge. Refer to [Fuel Pressure Gauge Installation and Removal](#).

13. Ignition ON.

**Note:**

- The fuel pump may need to be commanded ON several times in order to obtain the highest possible fuel pressure.
- Do NOT start the engine for this test.

14. Command the Fuel Pump Enable ON with a scan tool.

15. Verify the fuel pressure is between 380–520 kPa (55–76 psi) and does not decrease greater than 34 kPa (5 psi) within 1 min.

⇒ **If not within the specified range**Refer to [Fuel System Diagnosis](#).⇓ **If within the specified range**

16. Verify none of the conditions listed below exist:

- Collapsed air intake duct to the throttle body
- Restricted air filter element
- Spark plugs for being fouled
- A skewed manifold absolute pressure (MAP) sensor—Refer to [DTC P0106](#).
- A skewed engine coolant temperature (ECT) sensor—Refer to [DTC P0117 or P0118](#).
- Exhaust system restricted—Refer to [Restricted Exhaust](#).
- Fuel contamination—Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
- Engine mechanical condition—Refer to [Symptoms - Engine Mechanical](#) or [Engine Compression Test](#).

⇒ **If a condition exists**

Repair or replace a snecessary.

⇓ **If no condition exists**

17. All OK.

**Repair Instructions**

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



## Fuel Injector Diagnosis (Without Supercharger)

### Diagnostic Instructions

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

### Circuit/System Description

The engine control module (ECM) enables the appropriate fuel injector pulse for each cylinder. The ignition voltage is supplied directly to the fuel injectors. The ECM controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. A fuel injector control circuit DTC may not set, but a misfire may be apparent. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

When performing the fuel injector balance test, the scan tool is first used to energize the fuel pump. The fuel injector tester or the scan tool is then used to pulse each fuel injector for a precise amount of time, allowing a measured amount of the fuel to be injected. This causes a drop in the system fuel pressure that can be recorded and used to compare each fuel injector.

### Diagnostic Aids

- Monitoring the misfire current counters, or misfire graph, may help to isolate the fuel injector that is causing the condition.
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition.
- Perform the fuel injector coil test within the conditions of the customer's concern. A fuel injector condition may only be apparent at a certain temperature, or under certain conditions.

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

[Component Connector End 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

## Special Tools

- CH-48027 Digital Pressure Gauge
- J-39021 Fuel Injector Coil and Balance Tester
- J-44602 Injector Test Adapter
- CH-47976 Active Fuel Injector Tester

For equivalent regional tools, refer to [Special Tools](#)

## Circuit/System Verification

### Note:

- The resistance test must be performed at the Fuel Injector or mis-diagnosis will occur.
- The DMM and test leads must be calibrated to 0  $\Omega$  in order to prevent mis-diagnosis.

Verify the resistance of each fuel injector:

### Fuel Injector Coil Test

- Ignition ON, verify the scan tool ECT temperature is between 10–32°C (50–90°F).
  - ⇒ **If not within the specified range**
    - 1.1. Measure and record the resistance of each Q17 Fuel Injector with a DMM.
    - 1.2. Subtract the lowest resistance value from the highest resistance value.
    - 1.3. Verify the difference between the lowest value and the highest value is 3  $\Omega$  or less.
      - ⇒ If the difference is greater than 3  $\Omega$ 
        - 1.3.1. Add all of the Q17 Fuel Injector resistance values to obtain a total resistance value.
        - 1.3.2. Divide the total resistance by the number of fuel injectors to obtain an average resistance value.
        - 1.3.3. Subtract the lowest individual fuel injector resistance value from the average resistance value
        - 1.3.4. Subtract the average resistance value from the highest individual fuel injector resistance value.
        - 1.3.5. Replace the Q17 Fuel Injector that displays the greatest difference above or below the average value.
  - ⇒ **If within the specified range**
- Test for 11–14  $\Omega$  between terminal A and terminal B of each Q17 Fuel Injector.
  - ⇒ **If not between 11–14  $\Omega$** 
    - Replace the Q17 Fuel Injector.
  - ⇒ **If between 11–14  $\Omega$**
- Verify infinite resistance between each terminal at the Q17 Fuel Injector and the fuel injector housing/case.
  - ⇒ **If less than infinite resistance**
    - Replace the Q17 Fuel Injector
  - ⇒ **If infinite resistance**
- Perform the Fuel Injector Balance Test - Fuel Pressure Test.

### Fuel Injector Balance Test - Fuel Pressure Test

#### Note:

- DO NOT perform this test if the engine coolant temperature (ECT) is above 94°C (201°F). Irregular fuel pressure readings may result due to hot soak fuel boiling.

- Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.
  - Before proceeding with this test review the User Manual CH48027-5 for Safety Information and Instructions.
1. Install a CH-48027 pressure gauge. Refer to [Fuel Pressure Gauge Installation and Removal](#).
  2. Ignition ON, engine OFF.
 

**Note:**

    - The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.
    - DO NOT start the engine.
  3. Command the Fuel Pump Enable ON with a scan tool.
  4. Verify the fuel pressure is 345–414 kPa (50–60 psi) with the fuel pump commanded ON.
 

⇒ **If not between 345–414 kPa (50–60 psi)**

Refer to [Fuel System Diagnosis](#)

↓ **If between 345–414 kPa (50–60 psi)**
  5. Verify the fuel pressure does not decrease greater than 34 kPa (5 psi) within 1 minute.
 

⇒ **If the fuel pressure decreases greater than 34 kPa (5 psi)**

Refer to [Fuel System Diagnosis](#).

↓ **If the fuel pressure does not decrease greater than 34 kPa (5 psi)**
  6. Perform the appropriate Fuel Injector Balance Test.

### Circuit/System Testing

#### **Fuel Injector Balance Test with Special Tool**

1. Install a CH-48027 pressure gauge. Refer to [Fuel Pressure Gauge Installation and Removal](#).
2. Set the amperage supply selector switch on the J-39021 fuel injector coil and balance tester to 0.5–2.5 amp position.
3. Connect the J-39021 fuel injector coil and balance tester to a Q17 Fuel Injector with a J-44602 test adapter.
4. Command the Fuel Pump Enable ON three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each Q17 Fuel Injector.
5. Command the Fuel Pump Enable ON one more time and energize the Q17 Fuel Injector by depressing the Push to Start Test button on the J-39021 fuel injector coil and balance tester at the previously selected pressure.
6. After the Q17 Fuel Injector stops pulsing, select Min from the Display Mode on the CH-48027 pressure gauge and record the Min pressure.
 

**Note:** New test results will not be recorded if the Min/Max results are not cleared after each injector is tested.
7. Clear the Min/Max results on the CH-48027 pressure gauge.
8. Select Normal from the Display Mode on the CH-48027 pressure gauge.
9. Repeat steps 2 and 4 through 7 for each Q17 Fuel Injector.
10. Subtract the minimum pressure from the starting pressure for each fuel injector. The result is the pressure drop value.
11. Obtain a pressure drop value for each Q17 Fuel Injector.
12. Add all of the individual pressure drop values except for the fuel injector suspected of being faulty. This is the total pressure drop.
13. Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop.

14. Verify the difference of any individual fuel injector pressure drop is 20 kPa (3 psi) or less than the calculated average pressure drop.

⇒ **If greater than the specified value**

Replace the appropriate Q17 Fuel Injector(s) E-85 only. All other engines, refer to [Fuel Injector Cleaning](#).

#### Fuel Injector Balance Test with Scan Tool

1. Ignition ON.
2. Command the Fuel Pump Enable ON and then OFF three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each Q17 Fuel Injector.
3. Select the Fuel Injector Balance Test function within the Special Functions of the scan tool menu.
4. Select a Q17 Fuel Injector to be tested.
5. Press Enter to prime the fuel system.
6. Energize the Q17 Fuel Injector by depressing the Pulse Injector button on the scan tool at the previously selected starting pressure.
7. After the Q17 Fuel Injector stops pulsing, select Min from the Display Mode on the CH 48027 Gauge and record the Min pressure.

**Note:** New test results will not be recorded if the Min/Max results are not cleared after each injector is tested.

8. Clear the Min/Max results on the CH 48027 Gauge.
9. Select Normal from the Display Mode on the CH 48027 Gauge.
10. Press Enter on the scan tool to bring you back to the Select Injector screen.
11. Repeat steps 3 through 9 for each Q17 Fuel Injector.
12. Subtract the minimum recorded pressure from the starting pressure of each Q17 Fuel Injector. Record the value as the pressure drop for each fuel injector.
13. Obtain a pressure drop value for each Q17 Fuel Injector.
14. Add all of the individual pressure drop values except for the Q17 Fuel Injector suspected of being faulty. This is the total pressure drop.
15. Divide the total pressure drop by the number of Q17 Fuel Injectors that were added together. This is the average pressure drop.
16. Verify the difference of any individual Q17 Fuel Injector pressure drop is 20 kPa (3 psi) or less than the calculated average pressure drop.

⇒ **If greater than the specified value**

Replace the appropriate Q17 Fuel Injector(s) E-85 only. All other engine, refer to [Fuel Injector Cleaning](#).

⇓ **If all fuel injectors are within the specified value**

17. All OK.

#### Fuel Injector Balance Test with Active Fuel Injector Tester

**Note:**

- DO NOT perform this test if the engine coolant temperature (ECT) is above 94°C (201°F). Irregular fuel pressure readings may result due to hot soak fuel boiling.
- Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.

1. Verify the battery is fully charged and all accessories are OFF.
2. Ignition OFF, all vehicle systems OFF. Install the CH-47976 Active Fuel Injector Tester, refer to the Active Fuel Injector Tester User Guide. It may take up to 2 minutes for all vehicle systems to power down.
3. Turn ON the Active Fuel Injector Tester and select the vehicle.

4. Ignition ON, perform the Injector Test with the Active Fuel Injector Tester.
  - ⇒ **If the Active Fuel Injector Tester aborts testing due to fuel pressure or fuel leak down**  
Refer to [Fuel System Diagnosis](#).
  - ⇓ **If the Active Fuel Injector Tester does not abort testing**
5. Compare the test results with the appropriate recommended tolerance.
  - ⇒ **If any fuel injector exceeds the recommended tolerance**  
Replace the appropriate Q17 Fuel Injector(s) E-85 only. All other engines, refer to [Fuel Injector Cleaning](#).
  - ⇓ **If all fuel injectors are within the recommended tolerance**
6. All OK.

#### **[Repair Instructions](#)**

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

[Fuel Injector Replacement](#)

## Fuel Injector Diagnosis (With Supercharger)

### Diagnostic Instructions

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

### Circuit/System Description

The engine control module (ECM) enables the appropriate fuel injector pulse for each cylinder. The ignition voltage is supplied directly to the fuel injectors. The ECM controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. A fuel injector control circuit DTC may not set, but a misfire may be apparent. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

When performing the fuel injector balance test, the scan tool is first used to energize the fuel pump. The fuel injector tester or the scan tool is then used to pulse each fuel injector for a precise amount of time, allowing a measured amount of the fuel to be injected. This causes a drop in the system fuel pressure that can be recorded and used to compare each fuel injector.

### Diagnostic Aids

- Monitoring the misfire current counters, or misfire graph, may help to isolate the fuel injector that is causing the condition.
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition.
- Perform the fuel injector coil test within the conditions of the customer's concern. A fuel injector condition may only be apparent at a certain temperature, or under certain conditions.

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

[Component Connector End 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

### Special Tools

- CH-48027 Digital Pressure Gauge
- J-39021 Fuel Injector Coil and Balance Tester
- J-44602 Injector Test Adapter
- CH-47976 Active Fuel Injector Tester

For equivalent regional tools, refer to [Special Tools](#)

### Circuit/System Verification

#### Note:

- The resistance test must be performed at the Fuel Injector or mis-diagnosis will occur.
- The DMM and test leads must be calibrated to 0  $\Omega$  in order to prevent mis-diagnosis.

Verify the resistance of each fuel injector:

#### Fuel Injector Coil Test

- Ignition ON, verify the scan tool ECT temperature is between 10–32°C (50–90°F).
  - ⇒ **If not within the specified range**
    - 1.1. Measure and record the resistance of each Q17 Fuel Injector with a DMM.
    - 1.2. Subtract the lowest resistance value from the highest resistance value.
    - 1.3. Verify the difference between the lowest value and the highest value is 3  $\Omega$  or less.
      - ⇒ If the difference is greater than 3  $\Omega$ 
        - 1.3.1. Add all of the Q17 Fuel Injector resistance values to obtain a total resistance value.
        - 1.3.2. Divide the total resistance by the number of fuel injectors to obtain an average resistance value.
        - 1.3.3. Subtract the lowest individual fuel injector resistance value from the average resistance value
        - 1.3.4. Subtract the average resistance value from the highest individual 11–14  $\Omega$  resistance value.
        - 1.3.5. Replace the Q17 Fuel Injector that displays the greatest difference above or below the average value.
  - ⇒ **If within the specified range**
- Test for 11–14  $\Omega$  between terminal A and terminal B of each Q17 Fuel Injector.
  - ⇒ **If not between 11–14  $\Omega$** 
    - Replace the Q17 Fuel Injector.
  - ⇒ **If between 11–14  $\Omega$**
- Verify infinite resistance between each terminal at the Q17 Fuel Injector and the fuel injector housing/case.
  - ⇒ **If less than infinite resistance**
    - Replace the Q17 Fuel Injector
  - ⇒ **If infinite resistance**
- Perform the Fuel Injector Balance Test - Fuel Pressure Test.

#### Fuel Injector Balance Test - Fuel Pressure Test

##### Note:

- DO NOT perform this test if the engine coolant temperature (ECT) is above 94°C (201°F). Irregular fuel pressure readings may result due to hot soak fuel boiling.

- Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.
  - Before proceeding with this test review the User Manual CH48027-5 for Safety Information and Instructions.
1. Install a CH-48027 pressure gauge. Refer to [Fuel Pressure Gauge Installation and Removal](#).
  2. Ignition ON, engine OFF.
 

**Note:**

    - The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.
    - DO NOT start the engine.
  3. Command the Fuel Pump Enable ON with a scan tool.
  4. Verify the fuel pressure is 380–520 kPa (55–76 psi) with the fuel pump commanded ON.
 

⇒ **If not between 380–520 kPa (55–76 psi)**

Refer to [Fuel System Diagnosis](#)

↓ **If between 380–520 kPa (55–76 psi)**
  5. Verify the fuel pressure does not decrease greater than 34 kPa (5 psi) within 1 minute.
 

⇒ **If the fuel pressure decreases greater than 34 kPa (5 psi)**

Refer to [Fuel System Diagnosis](#).

↓ **If the fuel pressure does not decrease greater than 34 kPa (5 psi)**
  6. Perform the appropriate Fuel Injector Balance Test.

### Circuit/System Testing

#### **Fuel Injector Balance Test with Special Tool**

1. Install a CH-48027 pressure gauge. Refer to [Fuel Pressure Gauge Installation and Removal](#).
2. Set the amperage supply selector switch on the J-39021 fuel injector coil and balance tester to 0.5–2.5 amp position.
3. Connect the J-39021 fuel injector coil and balance tester to a Q17 Fuel Injector with a J-44602 test adapter.
4. Command the Fuel Pump Enable ON three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each Q17 Fuel Injector.
5. Command the Fuel Pump Enable ON one more time and energize the Q17 Fuel Injector by depressing the Push to Start Test button on the J-39021 fuel injector coil and balance tester at the previously selected pressure.
6. After the Q17 Fuel Injector stops pulsing, select Min from the Display Mode on the CH-48027 pressure gauge and record the Min pressure.
 

**Note:** New test results will not be recorded if the Min/Max results are not cleared after each injector is tested.
7. Clear the Min/Max results on the CH-48027 pressure gauge.
8. Select Normal from the Display Mode on the CH-48027 pressure gauge.
9. Repeat steps 2 and 4 through 7 for each Q17 Fuel Injector.
10. Subtract the minimum pressure from the starting pressure for each fuel injector. The result is the pressure drop value.
11. Obtain a pressure drop value for each Q17 Fuel Injector.
12. Add all of the individual pressure drop values except for the fuel injector suspected of being faulty. This is the total pressure drop.
13. Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop.



14. Verify the difference of any individual fuel injector pressure drop is 20 kPa (3 psi) or less than the calculated average pressure drop.

⇒ **If greater than the specified value**

Replace the appropriate Q17 Fuel Injector(s) E-85 only. All other engines, refer to [Fuel Injector Cleaning](#).

#### Fuel Injector Balance Test with Scan Tool

1. Ignition ON.
2. Command the Fuel Pump Enable ON and then OFF three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each Q17 Fuel Injector.
3. Select the Fuel Injector Balance Test function within the Special Functions of the scan tool menu.
4. Select a Q17 Fuel Injector to be tested.
5. Press Enter to prime the fuel system.
6. Energize the Q17 Fuel Injector by depressing the Pulse Injector button on the scan tool at the previously selected starting pressure.
7. After the Q17 Fuel Injector stops pulsing, select Min from the Display Mode on the CH 48027 Gauge and record the Min pressure.

**Note:** New test results will not be recorded if the Min/Max results are not cleared after each injector is tested.

8. Clear the Min/Max results on the CH 48027 Gauge.
9. Select Normal from the Display Mode on the CH 48027 Gauge.
10. Press Enter on the scan tool to bring you back to the Select Injector screen.
11. Repeat steps 3 through 9 for each Q17 Fuel Injector.
12. Subtract the minimum recorded pressure from the starting pressure of each Q17 Fuel Injector. Record the value as the pressure drop for each fuel injector.
13. Obtain a pressure drop value for each Q17 Fuel Injector.
14. Add all of the individual pressure drop values except for the Q17 Fuel Injector suspected of being faulty. This is the total pressure drop.
15. Divide the total pressure drop by the number of Q17 Fuel Injectors that were added together. This is the average pressure drop.
16. Verify the difference of any individual Q17 Fuel Injector pressure drop is 20 kPa (3 psi) or less than the calculated average pressure drop.

⇒ **If greater than the specified value**

Replace the appropriate Q17 Fuel Injector(s) E-85 only. All other engine, refer to [Fuel Injector Cleaning](#).

⇓ **If all fuel injectors are within the specified value**

17. All OK.

#### Fuel Injector Balance Test with Active Fuel Injector Tester

**Note:**

- DO NOT perform this test if the engine coolant temperature (ECT) is above 94°C (201°F). Irregular fuel pressure readings may result due to hot soak fuel boiling.
- Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.

1. Verify the battery is fully charged and all accessories are OFF.
2. Ignition OFF, all vehicle systems OFF. Install the CH-47976 Active Fuel Injector Tester, refer to the Active Fuel Injector Tester User Guide. It may take up to 2 minutes for all vehicle systems to power down.
3. Turn ON the Active Fuel Injector Tester and select the vehicle.

4. Ignition ON, perform the Injector Test with the Active Fuel Injector Tester.
  - ⇒ **If the Active Fuel Injector Tester aborts testing due to fuel pressure or fuel leak down**  
Refer to [Fuel System Diagnosis](#).
  - ⇓ **If the Active Fuel Injector Tester does not abort testing**
5. Compare the test results with the appropriate recommended tolerance.
  - ⇒ **If any fuel injector exceeds the recommended tolerance**  
Replace the appropriate Q17 Fuel Injector(s) E-85 only. All other engines, refer to [Fuel Injector Cleaning](#).
  - ⇓ **If all fuel injector are within the recommended tolerance**
6. All OK.

#### **[Repair Instructions](#)**

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

[Fuel Injector Replacement](#)

## Fuel System Diagnosis (with Supercharger)

### Diagnostic Instructions

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

### Circuit/System Description

The engine control module (ECM) supplies a signal to the chassis control module when the ECM detects that the ignition is ON. The signal from the ECM to the chassis control module remains active for 2 s, unless the engine is in Crank or Run. While this signal is being received, the chassis control module closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel rail pressure.

The fuel system is a returnless on-demand design. The fuel pressure regulator is a part of the fuel tank fuel pump module, eliminating the need for a return pipe from the engine. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

The fuel tank stores the fuel supply. An electric turbine style fuel pump attaches to the fuel tank fuel pump module inside the fuel tank. The fuel pump supplies high pressure fuel through the fuel feed pipe to the fuel injection system. The fuel pump provides fuel at a higher rate of flow than is needed by the fuel injection system. The fuel pump also supplies fuel to a venturi pump located on the bottom of the fuel tank fuel pump module. The function of the venturi pump is to fill the fuel pump module reservoir. The fuel pressure regulator, a part of the fuel tank fuel pump module, maintains the correct fuel pressure to the fuel injection system. The fuel tank fuel pump module contains a reverse flow check valve. The check valve and the fuel pressure regulator maintain fuel pressure in the fuel feed pipe and the fuel rail in order to prevent long cranking times.

### Reference Information

#### Description and Operation

#### [Fuel System Description](#)

#### Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

#### Scan Tool Reference

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

#### Special Tools

- CH-48027 Digital Pressure Gauge
- J 37287 Fuel Line Shut-off Adapter

### Circuit/System Verification

**Note:**

- Repair all fuel system related DTCs before performing this diagnostic, unless instructed here from a DTC diagnostic.
- Inspect the fuel system for damage or external leaks before proceeding.
- Verify that adequate fuel is in the fuel tank before proceeding.
- The fuel pump may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.
- Before proceeding with this test review the User Manual CH 48027-5 for Safety Information and Instructions.

1. Ignition OFF, all accessories OFF, install a *CH-48027* digital pressure gauge. Refer to [Fuel Pressure Gauge Installation and Removal](#).
2. Ignition ON, engine OFF, command the Fuel Pump Enable ON with a scan tool.
3. Verify the fuel pressure is between 380–520 kPa (55–76 psi) and does not decrease more than 34 kPa (5 psi) in 1 min.
  - ⇒ **If greater than the 520 kPa (76 psi)**  
Replace the G12 Fuel Pump.
  - ⇒ **If less than 380 kPa (55 psi)**  
Refer to Circuit/System Testing - Fuel Pressure Leaks Down.
  - ⇓ **If between 380–520 kPa (55–76 psi)**

**Note:** The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.
4. Verify that the fuel pressure does not decrease greater than 34 kPa (5 psi) in 1 minute.
  - ⇒ **If the fuel pressure decreases greater than 34 kPa (5 psi)**  
Refer to Circuit/System Testing — Fuel Pressure Leaks Down.
  - ⇓ **If the fuel pressure does not decrease greater than 34 kPa (5 psi)**
5. Relieve the fuel pressure to 69 kPa (10 psi), refer to [Fuel Pressure Relief](#).
6. Verify that the fuel pressure does not decrease greater than 14 kPa (2 psi) in 5 minutes.
  - ⇒ **If the fuel pressure decreases greater than 14 kPa (2 psi)**  
Replace the G12 Fuel Pump.
  - ⇓ **If the fuel pressure does not decrease greater than 14 kPa (2 psi)**

**Warning:** Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.
7. Operate the vehicle within the conditions of the customer's concern while monitoring the fuel pressure with the *CH-48027* Digital Fuel Pressure Gauge.
8. Verify the fuel pressure does not drop off during acceleration, cruise or hard cornering.
  - ⇒ **If the fuel pressure drops off**  
Refer to Circuit/System Testing — Fuel Pressure Drops OFF.
  - ⇓ **If the fuel pressure does not drop off**
9. If the fuel system components test normal, refer to [Symptoms - Engine Controls](#) and [Fuel Injector Diagnosis](#).

**Circuit/System Testing****Fuel Pressure Low**

1. Verify none of the conditions listed below exist:
  - Restricted fuel feed pipe
  - Restricted or plugged strainer
  - Poor connections at the fuel pump harness connector and the ground circuits.

⇒ **If a condition exist**

Repair as necessary.

⇓ **If none of the conditions exist**

2. Test or replace the G12 Fuel Pump.

**Fuel Pressure Leaks Down**

1. Ignition OFF, relieve the fuel pressure. Refer to [Fuel Pressure Relief](#).
2. Install the J 37287 Fuel Line Shut-Off Adapter between the fuel feed pipe and the fuel rail.
3. Open the valve on the J 37287 Fuel Line Shut-Off Adapter.
4. Ignition ON, command the Fuel Pump Enable ON with a scan tool and bleed the air from the fuel pressure gauge.
5. Close the valve on the J 37287 Fuel Line Shut-Off Adapter.
6. Verify that the fuel pressure does not decrease greater than 34 kPa (5 psi) in 1 minute.

⇒ **If the fuel pressure drops**

Locate and replace the leaking Q17 Fuel Injector, refer to [Fuel Injector Diagnosis](#)

⇓ **If the fuel pressure does not drop**

7. Test or replace the G12 Fuel Pump.

**Fuel Pressure Drops OFF**

1. Verify none of the conditions listed below exist:
  - Restricted fuel feed pipe
  - Restricted or plugged strainer
  - Poor connections at the Fuel Pump harness connector and the ground circuit.

⇒ **If a condition exist**

Repair as necessary.

⇓ **If a condition does not exist**

2. Test or replace the G12 Fuel Pump.

**Repair Instructions**

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

- [Primary Fuel Tank Module Replacement](#) for G12 Fuel Pump Replacement
- [Fuel Injection Fuel Feed Hose Replacement](#)
- [Fuel Line Replacement - Chassis](#)

## Fuel System Diagnosis (without Supercharger)

### Diagnostic Instructions

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

### Circuit/System Description

The engine control module (ECM) supplies a signal to the chassis control module when the ECM detects that the ignition is ON. The signal from the ECM to the chassis control module remains active for 2 s, unless the engine is in Crank or Run. While this signal is being received, the chassis control module closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel rail pressure.

The fuel system is a returnless on-demand design. The fuel pressure regulator is a part of the fuel tank fuel pump module, eliminating the need for a return pipe from the engine. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

The fuel tank stores the fuel supply. An electric turbine style fuel pump attaches to the fuel tank fuel pump module inside the fuel tank. The fuel pump supplies high pressure fuel through the fuel feed pipe to the fuel injection system. The fuel pump provides fuel at a higher rate of flow than is needed by the fuel injection system. The fuel pump also supplies fuel to a venturi pump located on the bottom of the fuel tank fuel pump module. The function of the venturi pump is to fill the fuel pump module reservoir. The fuel pressure regulator, a part of the fuel tank fuel pump module, maintains the correct fuel pressure to the fuel injection system. The fuel tank fuel pump module contains a reverse flow check valve. The check valve and the fuel pressure regulator maintain fuel pressure in the fuel feed pipe and the fuel rail in order to prevent long cranking times.

### Reference Information

#### Description and Operation

#### [Fuel System Description](#)

#### Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

#### Scan Tool Reference

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

#### Special Tools

- CH-48027 Digital Pressure Gauge
- J 37287 Fuel Line Shut-off Adapter

### Circuit/System Verification

**Note:**

- Repair all fuel system related DTCs before performing this diagnostic, unless instructed here from a DTC diagnostic.
- Inspect the fuel system for damage or external leaks before proceeding.
- Verify that adequate fuel is in the fuel tank before proceeding.
- The fuel pump may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.
- Before proceeding with this test review the User Manual CH 48027-5 for Safety Information and Instructions.

1. Ignition OFF, all accessories OFF, install a *CH-48027* digital pressure gauge. Refer to [Fuel Pressure Gauge Installation and Removal](#).
2. Ignition ON, engine OFF, command the Fuel Pump Enable ON with a scan tool.
3. Verify the fuel pressure is between 345–414 kPa (50–60 psi) and does not decrease more than 34 kPa (5 psi) in 1 min.
  - ⇒ **If greater than the 414 kPa (60 psi)**  
Replace the G12 Fuel Pump.
  - ⇒ **If less than 345 kPa (50 psi)**  
Refer to Circuit/System Testing - Fuel Pressure Leaks Down.
  - ⇓ **If between 345–414 kPa (50–60 psi)**  
**Note:** The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.
4. Verify that the fuel pressure does not decrease greater than 34 kPa (5 psi) in 1 minute.
  - ⇒ **If the fuel pressure decreases greater than 34 kPa (5 psi)**  
Refer to Circuit/System Testing — Fuel Pressure Leaks Down.
  - ⇓ **If the fuel pressure does not decrease greater than 34 kPa (5 psi)**
5. Relieve the fuel pressure to 69 kPa (10 psi), refer to [Fuel Pressure Relief](#).
6. Verify that the fuel pressure does not decrease greater than 14 kPa (2 psi) in 5 minutes.
  - ⇒ **If the fuel pressure decreases greater than 14 kPa (2 psi)**  
Replace the G12 Fuel Pump.
  - ⇓ **If the fuel pressure does not decrease greater than 14 kPa (2 psi)**  
**Warning:** Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.
7. Operate the vehicle within the conditions of the customer's concern while monitoring the fuel pressure with the *CH-48027* Digital Fuel Pressure Gauge.
8. Verify the fuel pressure does not drop off during acceleration, cruise or hard cornering.
  - ⇒ **If the fuel pressure drops off**  
Refer to Circuit/System Testing — Fuel Pressure Drops OFF.
  - ⇓ **If the fuel pressure does not drop off**
9. If the fuel system components test normal, refer to [Symptoms - Engine Controls](#) and [Fuel Injector Diagnosis](#).

**Circuit/System Testing****Fuel Pressure Low**

1. Verify none of the conditions listed below exist:
  - Restricted fuel feed pipe
  - Restricted or plugged strainer
  - Poor connections at the fuel pump harness connector and the ground circuits.

⇒ **If a condition exist**

Repair as necessary.

↓ **If none of the conditions exist**

2. Test or replace the G12 Fuel Pump.

**Fuel Pressure Leaks Down**

1. Ignition OFF, relieve the fuel pressure. Refer to [Fuel Pressure Relief](#).
2. Install the J 37287 Fuel Line Shut-Off Adapter between the fuel feed pipe and the fuel rail.
3. Open the valve on the J 37287 Fuel Line Shut-Off Adapter.
4. Ignition ON, command the Fuel Pump Enable ON with a scan tool and bleed the air from the fuel pressure gauge.
5. Close the valve on the J 37287 Fuel Line Shut-Off Adapter.
6. Verify that the fuel pressure does not decrease greater than 34 kPa (5 psi) in 1 minute.

⇒ **If the fuel pressure drops**

Locate and replace the leaking Q17 Fuel Injector, refer to [Fuel Injector Diagnosis](#)

↓ **If the fuel pressure does not drop**

7. Test or replace the G12 Fuel Pump.

**Fuel Pressure Drops OFF**

1. Verify none of the conditions listed below exist:
  - Restricted fuel feed pipe
  - Restricted or plugged strainer
  - Poor connections at the Fuel Pump harness connector and the ground circuit.

⇒ **If a condition exist**

Repair as necessary.

↓ **If a condition does not exist**

2. Test or replace the G12 Fuel Pump.

**Repair Instructions**

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

- [Primary Fuel Tank Module Replacement](#) for G12 Fuel Pump Replacement
- [Fuel Injection Fuel Feed Hose Replacement](#)
- [Fuel Line Replacement - Chassis](#)



## Alcohol/Contaminants-in-Fuel Diagnosis

### Diagnostic Instructions

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

### Circuit/System Description

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10% in non-blended gasoline or greater than 85% with E85 blended gasoline for flexible fuel applications can cause driveability conditions such as hesitation, lack of power, stalling, or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

### Reference Information

#### Special Tools

CH 44175-A Alcohol Tester Kit

### Circuit/System Verification

1. Remove a sample of fuel from the bottom of the fuel tank and place in a clean, clear container.
2. Place the sample on a level surface for 2 minutes.
3. Verify the sample is clear and bright in color.
  - ⇒ **If the sample appears cloudy, or contaminated with water, as indicated by a water layer at the bottom of the sample**  
Refer to Circuit/System Testing — Particulate Contaminants in Fuel.
  - ⇒ **If alcohol contamination is suspected**  
Refer to Circuit/System Testing — Alcohol in Fuel Testing.
  - ↓ **If the sample remains clear and bright**
4. All OK.

### Circuit/System Testing

#### Alcohol in Fuel Testing with Special Tool

1. Test the fuel composition using CH 44175-A Alcohol Tester Kit and Instruction Manual.
2. Verify no water appears in the fuel sample.
  - ⇒ **If water appears in the fuel sample**  
Clean the fuel system.
  - ↓ **If no water appears in the fuel sample**
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.

4. Verify the non-blended gasoline fuel sample does not measure greater than 15% or an E85 blended gasoline fuel sample measures greater than 91% ethanol.

⇒ **If greater than the specified value**

- 4.1. Add fresh regular gasoline to the vehicle's fuel tank.
- 4.2. Remove a new sample of fuel from the tank.
- 4.3. Test the fuel composition using *CH 44175-A* Alcohol Tester Kit and Instruction Manual.
- 4.4. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.
- 4.5. Verify the non-blended gasoline fuel sample does not measure greater than 15% or an E85 blended gasoline fuel sample measures greater than 91% ethanol.
  - ⇒ If additional testing indicates that the ethanol percentage is still above 15% for a non-blended gasoline sample, drain and replace the vehicle's fuel. Refer to [Fuel Tank Draining](#).
  - ⇒ If additional testing indicates that the E85 blended gasoline sample still measures above 91%, continue adding fresh, regular gasoline until the ethanol content is 85% or less.

⇓ **If the specified value or less**

5. All OK.

### Alcohol in Fuel Testing without Special Tool

**Note:** This procedure is for non-blended gasoline only. If excessive alcohol content is suspected with E85 fuel add 15% tank volume of fresh, regular gasoline to the fuel tank.

1. Using a 100 ml (3.38 oz) specified cylinder with 1 ml (0.034 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.
2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.38 oz) and install a stopper.
3. Shake the cylinder vigorously for 10–15 seconds.
4. Carefully loosen the stopper in order to release the pressure.
5. Re-install the stopper and shake the cylinder vigorously again for 10–15 seconds.
6. Put the cylinder on a level surface for approximately 5 minutes in order to allow adequate liquid separation. If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be more than 10 ml (0.34 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5% alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.
7. Verify the non-blended gasoline fuel sample does not measure greater than 15%.

⇒ **If greater than the specified value**

- 7.1. Add fresh regular gasoline to the vehicle's fuel tank.
- 7.2. Remove a new sample of fuel from the tank.
- 7.3. Test the fuel composition of the new sample.
- 7.4. Verify the non-blended gasoline fuel sample does not measure greater than 15% .
  - ⇒ If greater than the specified value, drain and replace the vehicle's fuel. Refer to [Fuel Tank Draining](#).
  - ⇒ If the specified value or less, all OK.

⇓ **If the specified value or less**

8. All OK.

### Particulate Contaminants in Fuel

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel from the bottom of the fuel tank.

2. Place the container on a level surface for approximately 5 minutes in order to allow settling of the particulate contamination. Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles.
3. Verify there are no physical contaminants or water present in the fuel sample.
  - ⇒ **If any physical contaminants or water are present**  
Clean the fuel system.
  - ⇓ **If no physical contaminants or water are present**
4. All OK.

#### **Repair Instructions**

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

[Fuel System Cleaning](#)

## Electronic Ignition System Diagnosis

### Diagnostic Instructions

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

### Circuit/System Description

This ignition system uses an individual ignition coil for each cylinder. The engine control module (ECM) controls the spark events by transmitting the timing pulses on the ignition control (IC) circuits to the individual ignition coil in firing order sequence.

### Diagnostic Aids

- This engine application may use 2 fuses, one for each bank, to supply ignition voltage to the ignition coils and also to the fuel injectors. A good indication that a fuse is open is that all misfire counters are incrementing on one side of the engine.
- An open/high resistance on the low reference circuit to the ignition coil may cause a misfire.
- An erratic or weak spark is considered a no spark condition.

### Reference Information

#### Schematic Reference

[Engine Controls Schematics](#)

#### Connector End View Reference

[Component Connector End Views](#)

#### Description and Operation

[Electronic Ignition System Description](#)

#### Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

#### Scan Tool Reference

[Control Module References](#)

#### Special Tools

EL 26792 HEI Spark Tester

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

### Circuit/System Verification

Verify the following conditions. Refer to [Spark Plug Wire Inspection](#) and [Ignition System Specifications](#).

- The ignition coils and spark plug wires are correctly connected
- The spark plug wire resistance is within specifications
- The correct spark plug type
- The correct spark plug gap
- The correct spark plug torque

⇒ **If a condition was found**

Repair or replace as necessary.

⇓ **If a condition was not found**

Refer to Circuit/System Testing.

### Circuit/System Testing

**Note:** Do not perform this diagnostic procedure unless you were sent here from a misfire DTC or the Engine Cranks But Does Not Run diagnostic.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate T8 Ignition Coil. It may take up to 2 min for all vehicle systems to power down.

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

⇒ **If 5  $\Omega$  or greater**

- 2.1. Ignition OFF.
- 2.2. Test for less than 2  $\Omega$  in the ground circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , repair the open/high resistance in the ground connection.

⇓ **If less than 5  $\Omega$**

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

⇒ **If 5  $\Omega$  or greater**

- 3.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
- 3.2. Test for less than 2  $\Omega$  in the low reference circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , replace the K20 Engine Control Module.

⇓ **If less than 5  $\Omega$**

4. Ignition ON.

5. Verify a test lamp illuminates between the ignition circuit terminal D and ground.

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

- 5.1. Ignition OFF.
- 5.2. Test for less than 2  $\Omega$  in the ignition circuit end to end.
  - ⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.
  - ⇒ If less than 2  $\Omega$ , verify the fuse is not open and there is voltage at the fuse.

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

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

- 5.1. Ignition OFF, remove the test lamp, and disconnect all components on the circuit.
- 5.2. 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

- 5.3. Replace the fuse, ignition ON.
- 5.4. Verify the fuse is good after connecting each of the components one at a time.

⇒ If the fuse opens, replace the component that opens the fuse when connected.

⇒ If the fuse is good, all OK.

↓ **If the test lamp illuminates**

6. Ignition OFF, exchange the suspect T8 Ignition Coil with the T8 Ignition Coil of a known functioning cylinder.

7. Engine Running.

8. Verify the scan tool Cylinder 1-8 Current Misfire Counter does not increment for the same cylinder that the suspect T8 Ignition Coil was removed from.

⇒ **If increments**

Replace the K20 Engine Control Module.

↓ **If does not increment**

9. Test or replace the T8 Ignition Coil.

### Component Testing

**Note:** You must perform the Circuit/System Testing before proceeding with Component Testing.

1. Ignition OFF, connect the EL 26792 HEI Spark Tester to the appropriate T8 Ignition Coil.

2. Engine Running.

3. Verify the spark output of the T8 Ignition Coil.

⇒ **If no output or the output is weak**

Replace the T8 Ignition Coil

↓ **If the output is good**

4. All OK.

### Repair Instructions

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

- [Ignition Coil Replacement](#)
- [Spark Plug Replacement](#)
- [Spark Plug Wire Replacement](#)
- [Control Module References](#) for engine control module replacement, programming, and setup.

## Cylinder Deactivation (Active Fuel Management) System Diagnosis

### Diagnostic Instructions

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

### Circuit Description

To provide maximum fuel economy under light load driving conditions, the engine control module (ECM) will command the valve lifter oil manifold assembly solenoids ON, to deactivate engine cylinders 1 and 7 on the left bank, and cylinders 4 and 6 on the right bank. The valve lifter oil manifold assembly consists of 4 electrically operated normally closed solenoids, which directs pressurized engine oil to 8 deactivating valve lifters. All 4 valve lifter oil manifold assembly solenoids are connected in parallel to a fused ignition circuit supplied by the powertrain relay. The control circuit for each solenoid is connected to an individual low side driver internal to the ECM. When enabling conditions for V4 mode are met, the ECM will command each low side driver to turn ON, in engine firing order sequence.

### Typical Scan Tool Data

| Inhibit Parameter                                                                                                                  | Status |
|------------------------------------------------------------------------------------------------------------------------------------|--------|
| <b>Operating Conditions:</b> Engine running within cylinder deactivation operating parameters<br><b>Parameter Normal Range:</b> No |        |
| Cylinder Deactivation Inhibit – Acceleration Request                                                                               | Yes/No |
| Cylinder Deactivation Inhibit – A/C Compressor Clutch On                                                                           | Yes/No |
| Cylinder Deactivation Inhibit – APP High                                                                                           | Yes/No |
| Cylinder Deactivation Inhibit – APP Rate High                                                                                      | Yes/No |
| Cylinder Deactivation Inhibit – Axle Torque Limiting                                                                               | Yes/No |
| Cylinder Deactivation Inhibit – Brake Booster Weak Vacuum                                                                          | Yes/No |
| Cylinder Deactivation Inhibit – Calculated Torque                                                                                  | Yes/No |
| Cylinder Deactivation Inhibit – Catalyst Temperature Low                                                                           | Yes/No |
| Cylinder Deactivation Inhibit – Catalyst Overtemperature Protection                                                                | Yes/No |
| Cylinder Deactivation Inhibit – Deceleration Fuel Cut-Off                                                                          | Yes/No |
| Cylinder Deactivation Inhibit – ECT                                                                                                | Yes/No |
| Cylinder Deactivation Inhibit – Engine Oil Pressure                                                                                | Yes/No |

| Inhibit Parameter                                                  | Status |
|--------------------------------------------------------------------|--------|
| Cylinder Deactivation Inhibit – Engine Oil Temperature             | Yes/No |
| Cylinder Deactivation Inhibit – Engine Overtemperature Protection  | Yes/No |
| Cylinder Deactivation Inhibit – Engine Speed                       | Yes/No |
| Cylinder Deactivation Inhibit – Heater Performance                 | Yes/No |
| Cylinder Deactivation Inhibit – HO2S 2 Test                        | Yes/No |
| Cylinder Deactivation Inhibit – Hot Coolant Mode                   | Yes/No |
| Cylinder Deactivation Inhibit – Ignition Voltage                   | Yes/No |
| Cylinder Deactivation Inhibit – Injector Stable Time               | Yes/No |
| Cylinder Deactivation Inhibit – Intake Manifold Weak Vacuum        | Yes/No |
| Cylinder Deactivation Inhibit – Maximum Deactivation Time Exceeded | Yes/No |
| Cylinder Deactivation Inhibit – Maximum Throttle Exceeded          | Yes/No |
| Cylinder Deactivation Inhibit – Minimum Time After TAC DTC         | Yes/No |
| Cylinder Deactivation Inhibit – Minimum Time On All Cylinders      | Yes/No |
| Cylinder Deactivation Inhibit – Oil Aeration                       | Yes/No |
| Cylinder Deactivation Inhibit – Piston Protection                  | Yes/No |
| Cylinder Deactivation Inhibit – RPM Limit                          | Yes/No |
| Cylinder Deactivation Inhibit – Scan Tool Override                 | Yes/No |
| Cylinder Deactivation Inhibit – Torque Reduction                   | Yes/No |
| Cylinder Deactivation Inhibit – Transmission Gear                  | Yes/No |
| Cylinder Deactivation Inhibit – Transmission Range                 | Yes/No |
| Cylinder Deactivation Inhibit – Transmission Shifting              | Yes/No |
| Cylinder Deactivation Inhibit – Vehicle Speed Too Low              | Yes/No |

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#### Diagnostic Aids

- Observe the scan tool Cylinder Deactivation Inhibit reasons to assist in determining the cause of the concern.



- Review scan tool Cylinder Deactivation Disable History to determine reason for disabling cylinder deactivation.
- The valve lifter oil manifold assembly solenoids are assigned to the following engine cylinders:
  - Solenoid #1 – Cylinder #1
  - Solenoid #2 – Cylinder #4
  - Solenoid #3 – Cylinder #6
  - Solenoid #4 – Cylinder #7

## Reference Information

### Schematic Reference

[Engine Controls Schematics](#)

### Connector End View Reference

[Component Connector End Views](#)

### Description and Operation

[Cylinder Deactivation \(Active Fuel Management\) 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-46999 Active Fuel Management Tester

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

## Circuit/System Testing

**Note:** The engine oil level and the oil pressure are critical to the correct operation of the Cylinder Deactivation System. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic. Refer to [Oil Pressure Diagnosis and Testing](#). Inspect the valve lifter oil filter for a restriction or blockage. Refer to [Valve Lifter Oil Filter Replacement](#).

1. If sent here from [DTC P0300-P0308](#), continue with testing. Ignition ON, observe the scan tool DTC information.

2. Verify with a scan tool that no DTCs are set.

⇒ **If a DTC is set**

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

⇓ **If a DTC is not set**

3. Engine idling at the normal operating temperature.

4. Verify there is no abnormal engine noise.

⇒ **If there is an abnormal engine noise**

Refer to [Symptoms - Engine Mechanical](#) for further diagnosis.

⇓ **If no abnormal engine noise**

5. Verify the [Cylinder Deactivation \(Active Fuel Management\) System Compression Test](#) passes the compression test.
- ⇒ **If compression test failed**  
Test the Q43 Valve Lifter Oil Manifold Assembly. Refer to [Cylinder Deactivation \(Active Fuel Management\) Valve Lifter Oil Manifold Diagnosis and Testing](#).
- ⇓ **If compression test passes**
6. Ignition OFF, remove the Q43 Valve Lifter Oil Manifold Assembly ignition fuse from the underhood fuse block.
- Note:** Probe each terminal at the underhood fuse block with a test lamp connected to ground to determine what terminal to connect the DMM. The test lamp should not illuminate on the circuit that needs to be tested.
7. Connect a DMM between the ignition circuit fuse terminal going to the Q43 Valve Lifter Oil Manifold Assembly and the K20 Engine Control Module housing.
8. Ignition ON, command each Cylinder 1, 4, 6, and 7 Deactivation Solenoid ON and OFF with the scan tool.
9. Verify the resistance of each solenoid is between 11–18  $\Omega$  with the solenoid commanded ON.
- ⇒ **If greater than 18  $\Omega$  for all cylinder deactivation solenoids**, test the ignition circuit for an open/high resistance.
- 9.1. Ignition OFF.
- 9.2. Test for less than 2  $\Omega$  on the ignition circuit end to end.  
⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
⇒ If less than 2  $\Omega$ , refer to [Cylinder Deactivation \(Active Fuel Management\) Valve Lifter Oil Manifold Diagnosis and Testing](#).
- ⇒ **If greater than 18  $\Omega$  for one or more but not all cylinder deactivation solenoids**
- 9.1. Ignition OFF.
- 9.2. Test for less than 2  $\Omega$  on the appropriate control circuit end to end.  
⇒ If 2  $\Omega$  or greater, repair the open/high resistance in the circuit.  
⇓ If less than 2  $\Omega$
- 9.3. Test for 11–18  $\Omega$  between the ignition circuit and the appropriate control circuit at the Q43 Valve Lifter Oil Manifold Assembly.  
⇒ If not between 11–18  $\Omega$ , test or replace the Q43 Valve Lifter Oil Manifold Assembly.  
⇒ If between 11–18  $\Omega$ , test or replace the K20 Engine Control Module.
- ⇓ **If between 11–18  $\Omega$**
- Warning:** Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.
10. Operate the vehicle within the conditions of the customer's concern while monitoring the Cylinder Deactivation Inhibit parameters.
11. Verify all Cylinder Deactivation Inhibit parameters display NO.
- ⇒ **If any parameter displays YES**  
Refer to the appropriate vehicle system to determine the cause for cylinder deactivation inhibit.
- [Symptoms - Engine Controls](#)
  - [Symptoms - Engine Cooling](#)
  - [Symptoms - Engine Electrical](#)
  - [Symptoms - Engine Mechanical](#)
- ⇓ **If none of the parameters display YES**

12. Refer to [Cylinder Deactivation \(Active Fuel Management\) Valve Lifter Oil Manifold Diagnosis and Testing](#).

### **Repair Instructions**

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

- [Valve Lifter Oil Manifold Replacement](#)
- [Control Module References](#) for K20 Engine Control Module replacement, programming, and setup

## Brake Pedal Position Sensor Learn

Brake Pedal Position Sensor Learn is a procedure for the ECM to determine the position of the brake pedal position (BPP) sensor when the brake pedal is in the released position.

**Note:** The Brake Pedal Position Sensor Learn procedure is required when the following service procedures have been performed:

- An Engine Control Module Replacement
- A BPP Sensor Replacement
- Any repair procedure that effects the BPP Sensor alignment

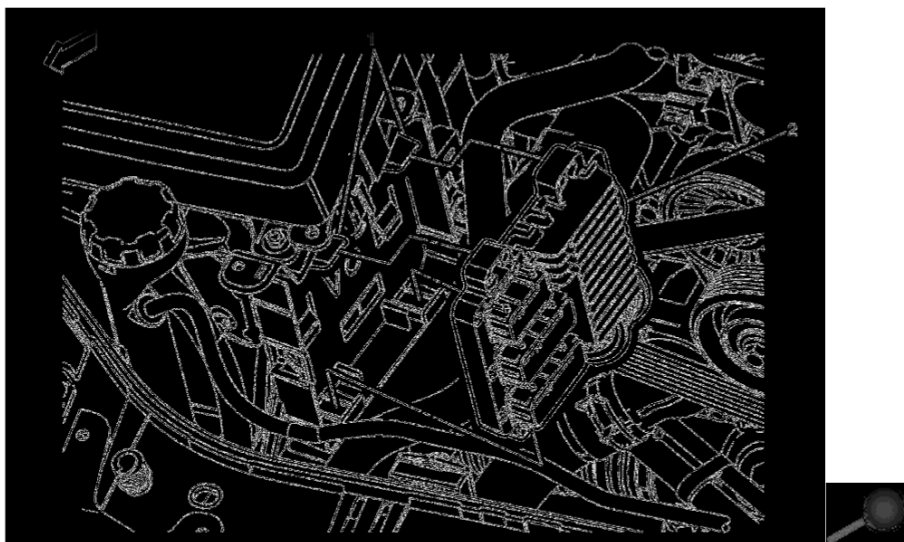
1. Ignition ON, Engine OFF. Verify with the scan tool, that no DTCs are set in the ECM or other control modules on the vehicle. If other DTCs are set, repair those DTCs first. Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
2. Clear the ECM of all DTCs.
3. Ignition OFF for 2 minutes. Open and close the driver's door.
4. Perform the following procedure twice:

**Note:** Do not allow your foot to rest on the brake pedal in the fully release position when performing the following steps.

- 4.1. Ignition ON, Engine OFF, transmission in Park, brake pedal in the fully released position.
- 4.2. Depress the brake pedal fully. Release the brake and wait 10 seconds.
- 4.3. Again, depress the brake pedal fully for a second time and release the brake pedal.
- 4.4. Ignition OFF for 2 minutes. Open and close the driver's door.
5. After performing the steps for a second time, the brake pedal sensor should be at the true minimum learned position.
6. Ignition ON, Engine OFF. Verify with a scan tool, the BPP Sensor Learn Position parameter value does not change values, after several brake pedal applications.
7. Perform the Body Control Module (BCM) brake pedal position sensor calibration. Refer to [Brake Pedal Position Sensor Calibration](#).

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## Engine Control Module Replacement



Engine Control Module Replacement

| Callout                                                                                                                                                                                                                                                                                                 | Component Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b> <ol style="list-style-type: none"><li>1. Prepare control module for removal. Refer to <a href="#">Control Module References</a>.</li><li>2. Disconnect the negative battery cable. Refer to <a href="#">Battery Negative Cable Disconnection and Connection</a>.</li></ol> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 1                                                                                                                                                                                                                                                                                                       | Retaining Tab (Qty: 2)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 2                                                                                                                                                                                                                                                                                                       | <p>Engine Control Module</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Caution:</b> Always turn the ignition off when installing or removing the ECM connectors in order to prevent damage to the components.</p> <p><b>Caution:</b></p> <ul style="list-style-type: none"><li>• 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.</li><li>• 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.</li></ul> |

| Callout | Component Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | <ul style="list-style-type: none"><li>• In order to prevent any possible electrostatic discharge damage to the control module, do not touch the connector pins or the soldered components on the circuit board.</li><li>• 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.</li><li>• The replacement control module must be programmed.</li></ul> <p><b>Procedure</b></p> <ol style="list-style-type: none"><li>1. Disconnect the electrical connectors.</li><li>2. If replacing, program the ECM. Refer to <a href="#">Control Module References</a>.</li></ol> <p><b>Note:</b> 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.</p> |

[2014 Holden VF Sedan](#) | [VF/WN - Sedan, Ute, Sportwagon, Caprice, Lumina, HSV Service Manual 5617662](#) |  
[Engine/Propulsion](#) | [Engine Controls and Fuel - 6.0L L77 or 6.2L LS3 LSA](#) | [Repair Instructions](#) |

**Document ID: 1914775**

## Crankshaft Position System Variation Learn

**Note:** The Crankshaft Position System Variation Learn procedure is required when the following service procedures have been performed, regardless of whether DTC P0315 is set:

- A crankshaft position sensor replacement
- An engine control module (ECM) replacement
- An engine replacement
- A crankshaft balancer replacement
- A crankshaft replacement
- Any engine repairs which disturb the crankshaft to crankshaft position sensor relationship.

**Note:** The ECM monitors certain component signals to determine if all the conditions are met to continue with the Crankshaft Position System Variation Learn Procedure.

1. Ignition ON, observe the DTC information with a scan tool. Verify no other DTCs are set, except DTCs P0300–P0308, or P0315.  
⇒ If DTCs are set, except DTCs P0300–P0308, or P0315, refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
2. Select the Crankshaft Position Variation Learn Procedure with a scan tool and follow the on screen instructions:
3. Verify DTC P0315 does not set.  
⇒ **If DTC P0315 set, or another DTC is present** refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for the applicable DTC that set.  
⇓ **If the DTC does not set**
4. All OK.

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## Q38 Throttle Body: Throttle/Idle Learn

### Description

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

An engine that had a heavily coked throttle body that has been cleaned or replaced may take several drive cycles to unlearn the coking. To accelerate the process, the scan tool has the ability to reset all learned values back to zero. A new ECM will also have values set to zero.

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

### Conditions for Running the Throttle Learn Procedure

#### Scan tool Idle Learn or Idle Learn Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, or P2176 are not set.
- Ignition ON, engine OFF.
- The vehicle speed sensor (VSS) is 0 km/h (0 mph).

#### Service Bay/On Road Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, or P2176 are not set.
- The engine speed is between 450-4,000 RPM.
- The manifold absolute pressure (MAP) is greater than 5 kPa.
- The mass air flow (MAF) is greater than 2 g/s.
- The ignition voltage is greater than 10 volts.

### Throttle Learn

#### Scan Tool Idle Learn or Idle Learn Reset Procedure – Performed after the throttle body is cleaned or replaced

1. Ignition ON, engine OFF, perform the Idle Learn or Idle Learn Reset in Configuration/Reset or Module Setup.
2. Engine idling, observe the scan tool Throttle Body Idle Airflow Compensation parameter. The Throttle Body Idle Airflow Compensation value should equal 0 % and the engine should be idling at a normal idle speed.
3. Clear the DTCs and return to the diagnostic that referred you here.

#### Service Bay/On Road Idle Learn Procedure – Performed after the ECM is programmed or replaced

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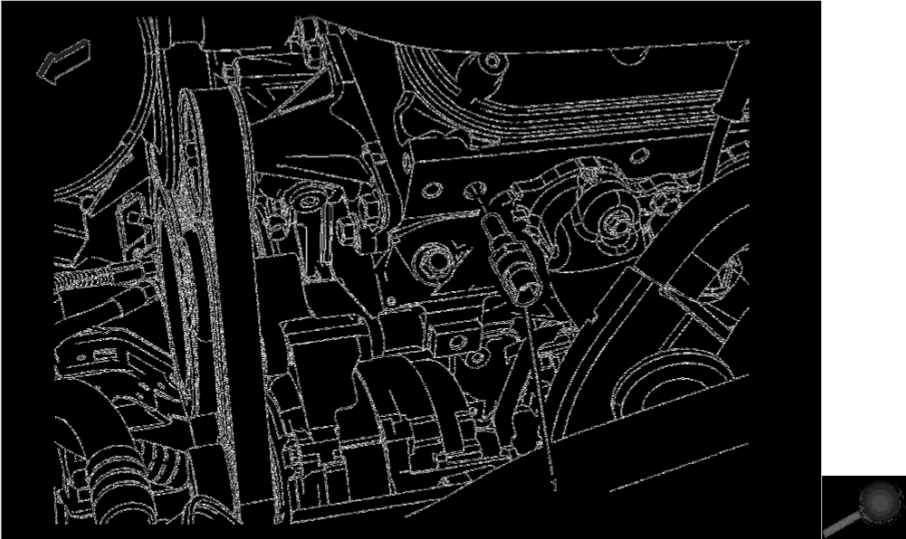
**Note:** Do NOT perform this procedure if DTCs are set. Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).

1. Engine idling for 3 min.
2. Observe the scan tool Desired Idle Speed and the actual Engine Speed parameters.
3. The ECM will start to learn the new idle cells and the Desired Idle Speed should start to decrease.
4. Ignition OFF for 60 s.
5. Start and idle the engine for 3 min.
6. After the 3 min run time the engine should be idling normal.

**Note:** During the drive cycle the check engine light may come on with idle speed DTCs. If idle speed codes are set, clear codes so the ECM can continue to learn.

- ⇒ If the engine idle speed has not been learned the vehicle will need to be driven at speeds above 70 km/h (44 mph) with several decelerations and extended idles.
7. After the drive cycle, the engine should be idling normally.
    - ⇒ If the engine idle speed has not been learned, turn OFF the ignition for 60 s and repeat step 6.
  8. Once the engine speed has returned to normal, clear DTCs and return to the diagnostic that referred you here.

Engine Coolant Temperature Sensor Replacement

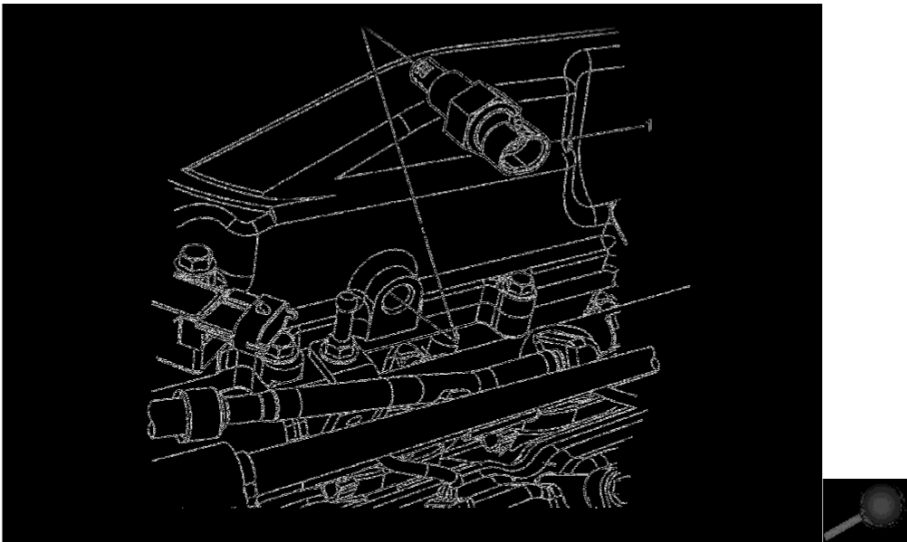


Engine Coolant Temperature Sensor Replacement

| Callout                                                                                                                                                                                                                             | Component Name                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedures</b><br><br>1. Drain the engine coolant. Refer to <a href="#">Cooling System Draining and Filling</a> .<br>2. Remove the air cleaner assembly. Refer to <a href="#">Air Cleaner Assembly Replacement</a> . |                                                                                                                                                                                                                                              |
| 1                                                                                                                                                                                                                                   | Coolant Temperature Sensor<br><b>Caution:</b> Refer to <a href="#">Component Fastener Tightening Caution</a> .<br><b>Procedure</b><br>Disconnect the coolant temperature sensor electrical connector.<br><b>Tighten</b><br>20 N•m (15 lb ft) |

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Intake Air Temperature Sensor Replacement (LSA)

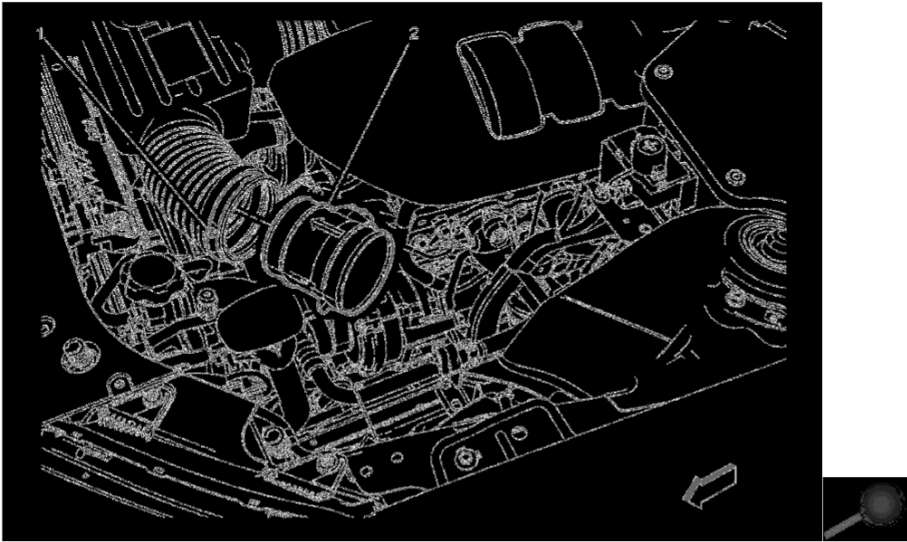


Intake Air Temperature Sensor Replacement

| Callout                                                                                                                                      | Component Name                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the front intake manifold cover. Refer to <a href="#">Intake Manifold Cover Replacement - Front</a> . |                                                                                                                                                                                                                                                 |
| 1                                                                                                                                            | Intake Air Temperature Sensor<br><b>Caution:</b> Refer to <a href="#">Component Fastener Tightening Caution</a> .<br><b>Procedure</b><br>Disconnect the intake air temperature sensor harness connector.<br><b>Tighten</b><br>20 N•m (15 lb ft) |

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Mass Airflow Sensor with Intake Air Temperature  
Sensor Replacement (L77 or LS3)

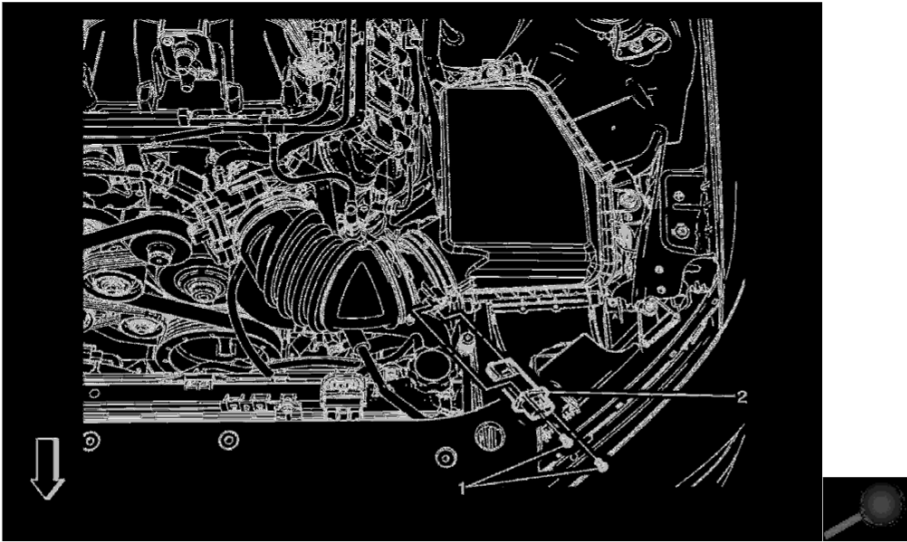


Mass Airflow Sensor with Intake Air Temperature Sensor Replacement

| Callout                                                                                                          | Component Name                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Procedure</b><br>Remove the air cleaner assembly. Refer to <a href="#">Air Cleaner Assembly Replacement</a> . |                                                                                                                                                                                                                                                                                                                                                                        |
| 1                                                                                                                | Air Cleaner Outlet Duct Clamp<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> .<br><b>Tighten</b><br>2 N•m (18 lb in)                                                                                                                                                                                                                                     |
| 2                                                                                                                | Mass Airflow with Air Intake Temperature Sensor<br><b>Note:</b> Pay close attention to the direction arrow on the MAF/IAT sensor. The arrow MUST point toward the engine.<br><b>Procedure</b><br>1. Disconnect the mass airflow with air intake sensor electrical connector.<br>2. If re-programming is required, refer to <a href="#">Control Module References</a> . |

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Mass Airflow Sensor with Intake Air Temperature Sensor Replacement (LSA)

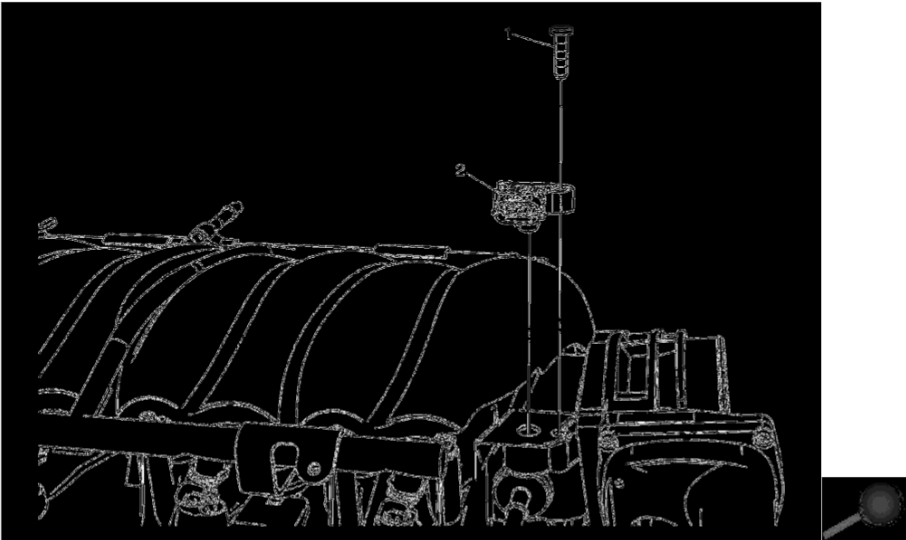


Mass Airflow Sensor with Intake Air Temperature Sensor Replacement

| Callout | Component Name                                                                                        |
|---------|-------------------------------------------------------------------------------------------------------|
| 1       | Mass Airflow Sensor Fasteners (Qty: 2)<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> . |
| 2       | Mass Airflow Sensor<br><b>Procedure</b><br>Disconnect the electrical connector.                       |

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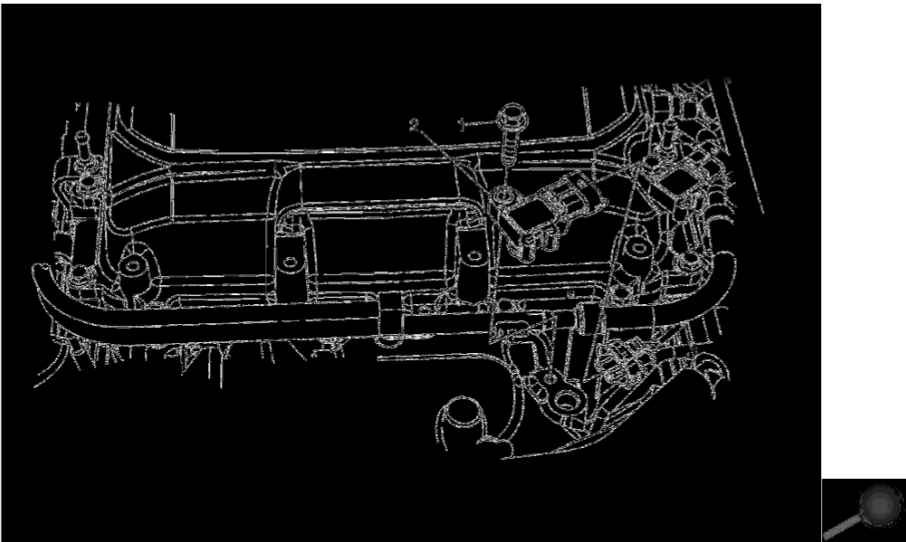
Manifold Absolute Pressure Sensor Replacement (L77 or LS3)



Manifold Absolute Pressure Sensor Replacement

| Callout                                                                                                            | Component Name                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the engine front cover. Refer to <a href="#">Engine Cover Replacement</a> . |                                                                                                                                                 |
| 1                                                                                                                  | Manifold Absolute Pressure Sensor Fastener<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> .<br><b>Tighten</b><br>5 N•m (44 lb in) |
| 2                                                                                                                  | Manifold Absolute Pressure Sensor<br><b>Procedure</b><br>Disconnect the manifold absolute pressure sensor electrical connector.                 |

Manifold Absolute Pressure Sensor Replacement (LSA)

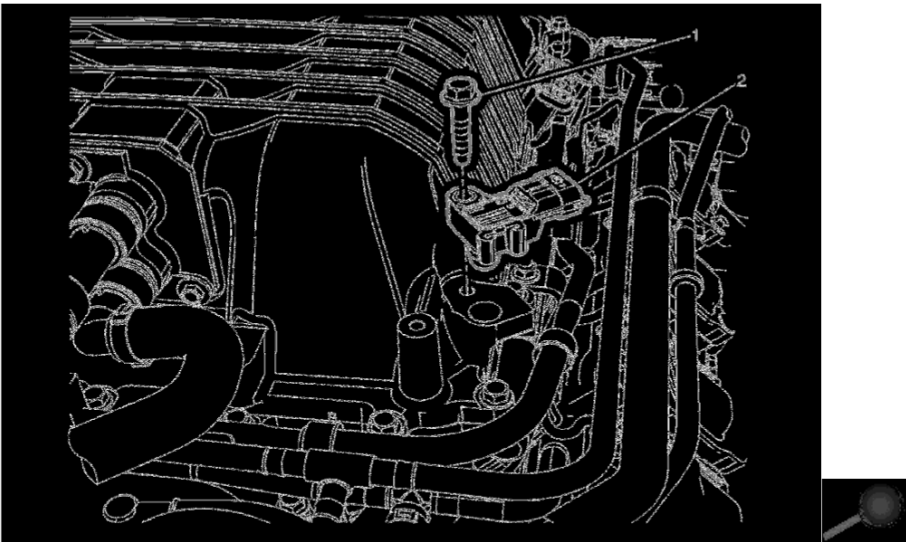


Manifold Absolute Pressure Sensor Replacement

| Callout                                                                                                                                | Component Name                                                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the intake manifold cover. Refer to <a href="#">Intake Manifold Cover Replacement - Front</a> . |                                                                                                                                                                                                                                                                                                                 |
| 1                                                                                                                                      | Manifold Absolute Pressure Sensor Fastener<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> .<br><b>Tighten</b><br>4.5 N•m (40 lb in)                                                                                                                                                               |
| 2                                                                                                                                      | Manifold Absolute Pressure Sensor<br><b>Procedure</b><br><ol style="list-style-type: none"><li>1. Disconnect the electrical wiring harness connector from the manifold absolute pressure sensor.</li><li>2. If re-installing the sensor, inspect the sensor seal for damage and replace as necessary.</li></ol> |

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Barometric Pressure Sensor Replacement (LSA)



Barometric Pressure Sensor Replacement

| Callout                                                                                                                                        | Component Name                                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the intake manifold cover — front. Refer to <a href="#">Intake Manifold Cover Replacement - Front</a> . |                                                                                                                                                                                                                                                          |
| 1                                                                                                                                              | Barometric Pressure Sensor Fastener<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> .<br><b>Tighten</b><br>10 N•m (89 lb in)                                                                                                                |
| 2                                                                                                                                              | Barometric Pressure Sensor<br><b>Procedure</b><br><ol style="list-style-type: none"><li>1. Disconnect the electrical wiring harness connector from the barometric pressure sensor.</li><li>2. Install the NEW O-ring provided with the sensor.</li></ol> |

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## Heated Oxygen Sensor Replacement - Bank 1 Sensor 1

### Removal Procedure

**Warning:** Refer to [Exhaust Service Warning](#).

**Warning:** Refer to [Protective Goggles and Glove Warning](#).

**Caution:** The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.

Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

**Caution:** Remove oxygen sensors with the engine temperature above 48°C (120°F). Otherwise the oxygen sensors may be difficult to remove.

1. Ignition OFF.

**Warning:** Refer to [Battery Disconnect Warning](#).

2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



4. Disconnect the heated oxygen sensor (HO2S) electrical connector.

**Caution:** Handle the oxygen sensors carefully in order to prevent damage to the component. Keep the electrical connector and the exhaust inlet end free of contaminants. Do not use cleaning solvents on the sensor. Do not drop or mishandle the sensor.

**Note:** If the harness retainer is damaged during removal, it must be replaced.

5. Disconnect the heated oxygen sensor (HO2S) harness retainer (2).
6. Remove the HO2S (1).

## Installation Procedure



**Caution:** A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

1. Install the HO2S (1) and tighten to **42N•m (31 lb ft)**.
- Note:** If the harness retainer was damaged during removal, it must be replaced.
2. Connect the heated oxygen sensor (HO2S) harness retainer (2).
3. Connect the HO2S electrical connector.
4. Lower the vehicle.
5. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

## Heated Oxygen Sensor Replacement - Bank 1 Sensor 2

### Removal Procedure

**Warning:** Refer to [Exhaust Service Warning](#).

**Warning:** Refer to [Protective Goggles and Glove Warning](#).

**Caution:** The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.

Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

**Caution:** Remove oxygen sensors with the engine temperature above 48°C (120°F). Otherwise the oxygen sensors may be difficult to remove.

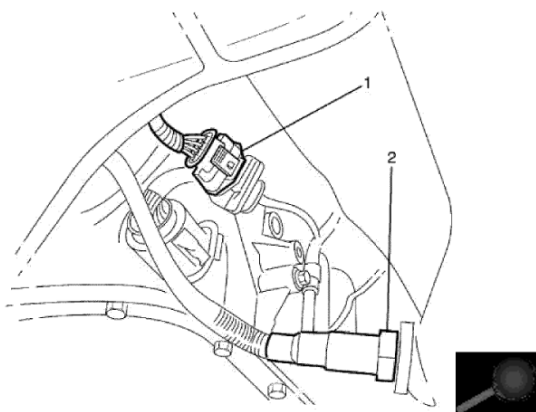
1. Ignition OFF.

**Warning:** Refer to [Battery Disconnect Warning](#).

2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

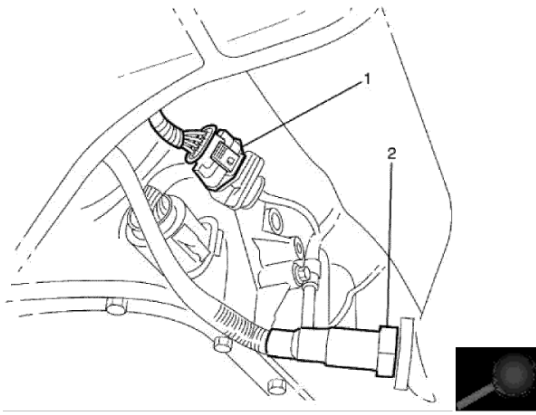


4. Disconnect the heated oxygen sensor (HO2S) electrical connector (1).

**Caution:** Handle the oxygen sensors carefully in order to prevent damage to the component. Keep the electrical connector and the exhaust inlet end free of contaminants. Do not use cleaning solvents on the sensor. Do not drop or mishandle the sensor.

5. Remove the HO2S (2) from the exhaust crossover pipe assembly.

### Installation Procedure



**Caution:** A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

1. Install the HO2S (2) to the exhaust crossover pipe assembly and tighten to **42N•m (31 lb ft)**.
2. Connect the HO2S electrical connector (1).
3. Lower the vehicle.
4. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

## Heated Oxygen Sensor Replacement - Bank 2 Sensor 1

### Removal Procedure

**Warning:** Refer to [Exhaust Service Warning](#).

**Warning:** Refer to [Protective Goggles and Glove Warning](#).

**Caution:** The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.

Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

**Caution:** Remove oxygen sensors with the engine temperature above 48°C (120°F). Otherwise the oxygen sensors may be difficult to remove.

1. Ignition OFF.

**Warning:** Refer to [Battery Disconnect Warning](#).

2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



4. Disconnect the heated oxygen sensor (HO2S) electrical connector.

**Caution:** Handle the oxygen sensors carefully in order to prevent damage to the component. Keep the electrical connector and the exhaust inlet end free of contaminants. Do not use cleaning solvents on the sensor. Do not drop or mishandle the sensor.

5. Remove the HO2S (1).

### Installation Procedure



**Caution:** A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

1. Install the HO2S (1) and tighten to **42N•m (31 lb ft)**.

**Note:** Route the HO2S electrical wiring harness under the engine harness as shown.

2. Connect the HO2S electrical connector.
3. Lower the vehicle.
4. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

## Heated Oxygen Sensor Replacement - Bank 2 Sensor 2

### Removal Procedure

**Warning:** Refer to [Exhaust Service Warning](#).

**Warning:** Refer to [Protective Goggles and Glove Warning](#).

**Caution:** The Heated Oxygen Sensor (HO2S) and the Oxygen Sensor use a permanently attached pigtail and connector. Do not remove this pigtail from the Heated Oxygen Sensor. Damage or the removal of the pigtail or the connector could affect the proper operation of the sensor.

Take care when handling the HO2S and the O2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Also avoid using cleaning solvents of any type. Do not drop the HO2S or the O2S. Do not roughly handle the HO2S or the O2S.

**Caution:** Remove oxygen sensors with the engine temperature above 48°C (120°F). Otherwise the oxygen sensors may be difficult to remove.

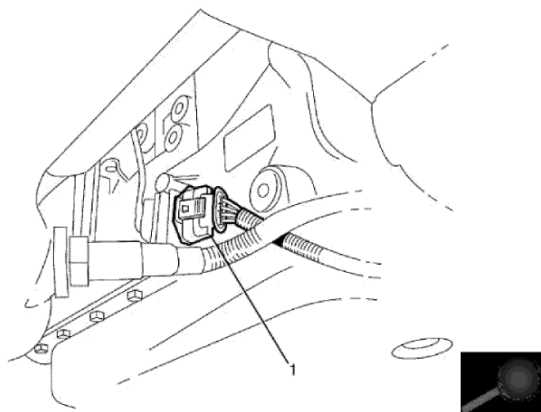
1. Ignition OFF.

**Warning:** Refer to [Battery Disconnect Warning](#).

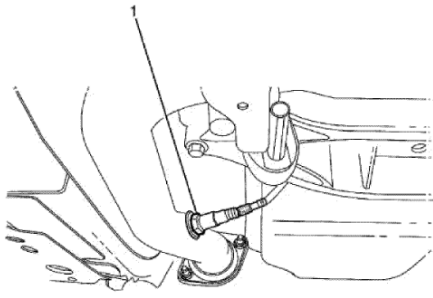
2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



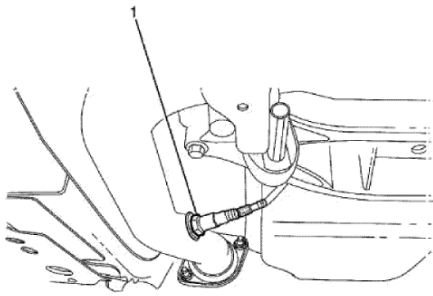
4. Disconnect the heated oxygen sensor (HO2S) electrical connector (1).



**Caution:** Handle the oxygen sensors carefully in order to prevent damage to the component. Keep the electrical connector and the exhaust inlet end free of contaminants. Do not use cleaning solvents on the sensor. Do not drop or mishandle the sensor.

5. Remove the HO2S (1) from the exhaust crossover pipe assembly.

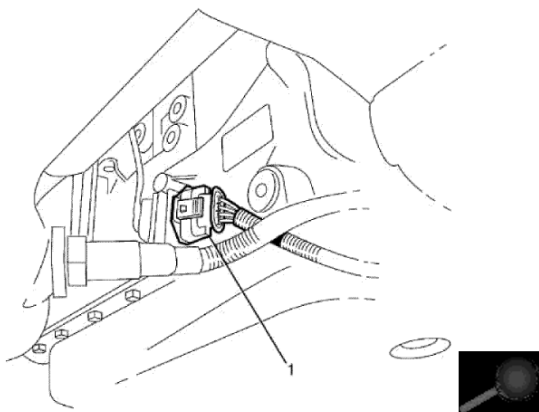
#### Installation Procedure



**Caution:** A special anti-seize compound is used on the oxygen sensor threads. New service sensors should already have the compound applied to the threads. Coat the threads of a reused sensor with anti-seize compound P/N 5613695 or equivalent.

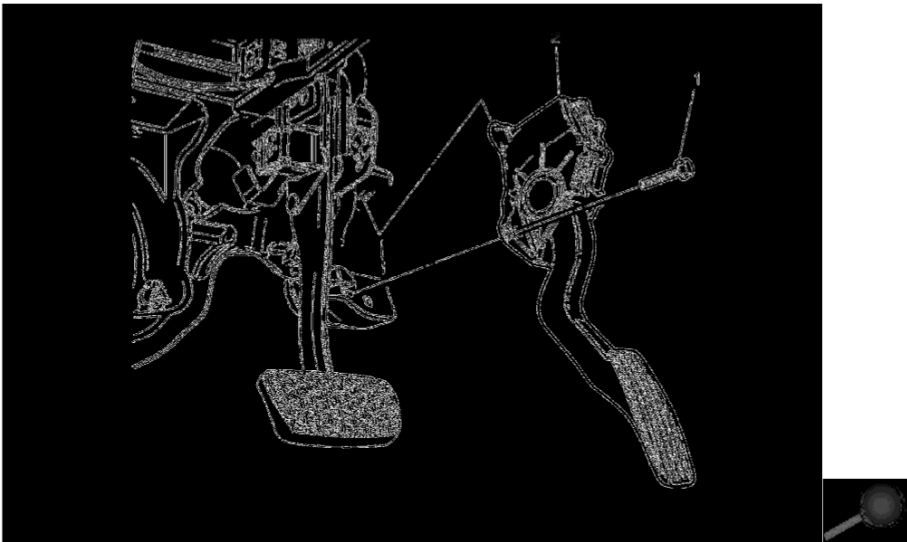
1. Install the HO2S (1) to the exhaust crossover pipe assembly and tighten to **42N•m (31 lb ft)**.





2. Connect the HO2S electrical connector (1).
3. Lower the vehicle.
4. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Accelerator Pedal Position Sensor Replacement

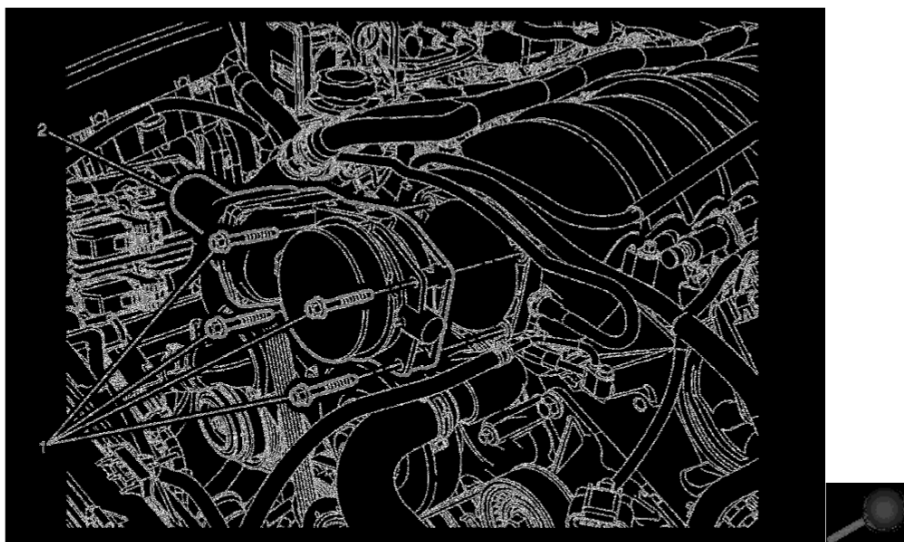


Accelerator Pedal Position Sensor Replacement

| Callout                                                                                                                                                                                            | Component Name                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the instrument panel lower trim panel insulator right side. Refer to <a href="#">Instrument Panel Lower Trim Panel Insulator Replacement - Right Side</a> . |                                                                                                                                           |
| 1                                                                                                                                                                                                  | Accelerator Pedal Position Sensor Bolt<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a><br><b>Tighten</b><br>9 N•m (80 lb in) |
| 2                                                                                                                                                                                                  | Accelerator Pedal Position Sensor<br><b>Procedure</b><br>Disconnect the electrical connector.                                             |

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## Throttle Body Assembly Replacement (L77 or LS3)

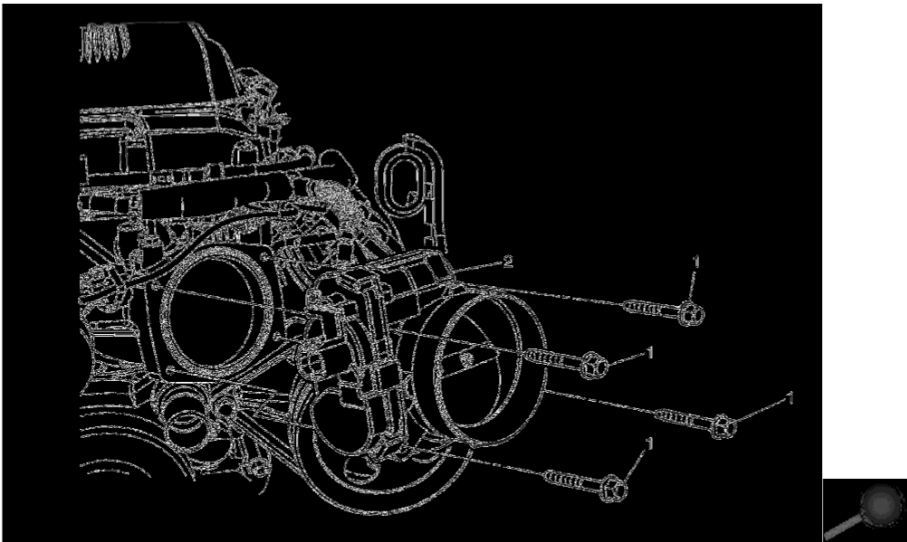


Throttle Body Assembly Replacement

| Callout                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Component Name                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Caution:</b> Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.</p> <p><b>Preliminary Procedures</b></p> <ol style="list-style-type: none"><li>1. Remove the engine cover. Refer to <a href="#">Engine Cover Replacement</a>.</li><li>2. Remove the air cleaner outlet duct. Refer to <a href="#">Air Cleaner Outlet Duct Replacement</a>.</li><li>3. An 8-digit part identification number is stamped on the throttle body casting. Refer to this number if servicing, or if a part replacement is required.</li></ol> |                                                                                                                                                                                                                                                                                    |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <p>Throttle Body Fastener (Qty: 4)</p> <p><b>Caution:</b> Refer to <a href="#">Fastener Caution</a>.</p> <p><b>Note:</b> In order to prevent possible contamination, cover or plug any opening when servicing the throttle body.</p> <p><b>Tighten</b></p> <p>12 N•m (9 lb ft)</p> |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <p>Throttle Body</p> <p><b>Caution:</b> Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"><li>1. Disconnect the throttle body harness connector.</li></ol>   |

| Callout | Component Name                                                                                                                                                                                                                                                                                  |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | <p>2. Perform the throttle learn procedure. Refer to <a href="#">Q38 Throttle Body: Throttle/Idle Learn</a>.</p> <p><b>Note:</b> The throttle body gasket is one time use and should be replaced when the throttle body is removed.</p> |

Throttle Body Assembly Replacement (LSA)



Throttle Body Assembly Replacement

| Callout                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Component Name                                                                                                                                                                                                                                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Caution:</b> Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.</p> <p><b>Preliminary Procedures</b></p> <ol style="list-style-type: none"><li>1. Remove the intake manifold cover. Refer to <a href="#">Intake Manifold Cover Replacement - Front</a>.</li><li>2. Remove the air cleaner resonator and outlet duct. Refer to <a href="#">Air Cleaner Outlet Duct Replacement</a>.</li><li>3. An 8-digit part identification number is stamped on the throttle body casting. Refer to this number if servicing, or if a part replacement is required.</li></ol> |                                                                                                                                                                                                                                                                                  |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <p>Throttle Body Fastener (Qty: 4)</p> <p><b>Caution:</b> Refer to <a href="#">Fastener Caution</a>.</p> <p><b>Note:</b> In order to prevent possible contamination, cover or plug any opening when servicing the throttle body.</p> <p><b>Tighten</b><br/>10 N•m (89 lb in)</p> |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <p>Throttle Body</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"><li>1. Disconnect the throttle body harness connector.</li></ol>                                                                                                                                  |

| Callout | Component Name                                                                                                                                                                                                                          |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | <p>2. Perform the throttle learn procedure. Refer to <a href="#">Q38 Throttle Body: Throttle/Idle Learn</a>.</p> <p><b>Note:</b> The throttle body gasket is one time use and should be replaced when the throttle body is removed.</p> |

## Throttle Body Cleaning

**Note:** Over extended time and mileage, deposits may accumulate on the back of the throttle valve plate. Occasionally the deposit may accumulate to a point where perceived pedal effort is affected. This procedure should not be performed on vehicles with low mileage, under 80 450 kilometers (50,000 miles).

1. Remove the air outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

**Caution:** Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

2. Inspect the throttle body bore and inspect the throttle valve plate for deposits. The throttle valve must be opened in order to inspect all surfaces.

**Caution:** Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

3. Clean the throttle body bore and the throttle valve plate using a clean shop towel with an approved top engine cleaner.
4. Install the air inlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
5. Perform the Throttle/Idle Learn procedure. Refer to [Q38 Throttle Body: Throttle/Idle Learn](#).

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## Fuel Pressure Gauge Installation and Removal (L77 & LS3)

### Special Tools

EN-338-AU Fuel Pressure Gauge

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

### Fuel Pressure Gauge Installation

**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#).

**Warning:** Refer to [Relieving Fuel Pressure Warning](#).

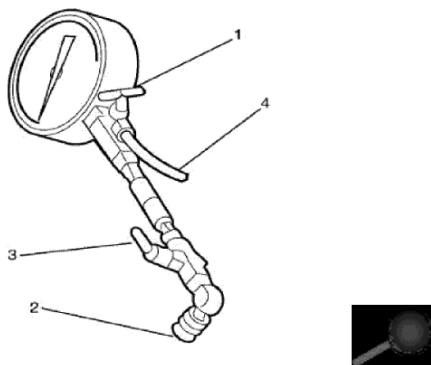
**Warning:** Refer to [Safety Glasses Warning](#).

1. Ignition OFF.

**Warning:** Refer to [Battery Disconnect Warning](#).

2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

3. Remove the engine cover. Refer to [Engine Cover Replacement](#)



4. Turn the fuel gauge assembly valve (3) to the open position.

**Note:** Wrap a shop towel around the schrader valve (2) when connecting the fuel gauge assembly to the fuel pressure inspection valve on the fuel feed pipe to avoid fuel spilling.

**Note:** Screw on the schrader valve quickly to avoid fuel spillage.

5. Connect the schrader valve (2) to the fuel pressure inspection valve on the fuel feed pipe.

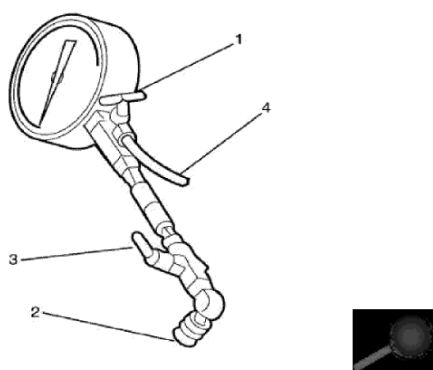
6. Place the bleed hose (4) into an approved container.

7. Open the bleed valve (1) to bleed any pressurized fuel.

8. Close the bleed valve (1) when the fuel pressure has dropped to 0 kPa (psi).

### Fuel Pressure Gauge Removal





1. Close the fuel gauge assembly valve (3).
2. Place the bleed hose (4) into an approved container.
3. Open the bleed valve (1) to bleed any pressurized fuel.
4. Close the bleed valve (1).

**Note:** Wrap a shop towel around the schrader valve when disconnecting the fuel gauge assembly from the fuel pressure inspection valve to avoid fuel spilling.

**Note:** Unscrew the schrader valve quickly to avoid fuel spillage.

5. Disconnect the schrader valve (2) from the fuel pressure inspection valve on the fuel feed pipe.
6. Remove the fuel gauge assembly from the vehicle.
7. Empty any excess fuel from the fuel gauge and hose assembly.
8. Install the engine cover. Refer to [Engine Cover Replacement](#)
9. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
10. Inspect for leaks.

## Fuel Pressure Gauge Installation and Removal (LSA)

### Special Tools

EN-338-AU Fuel Pressure Gauge

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

### Fuel Pressure Gauge Installation

**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#).

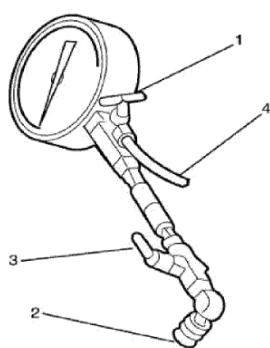
**Warning:** Refer to [Relieving Fuel Pressure Warning](#).

**Warning:** Refer to [Safety Glasses Warning](#).

1. Ignition OFF.

**Warning:** Refer to [Battery Disconnect Warning](#).

2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
3. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).



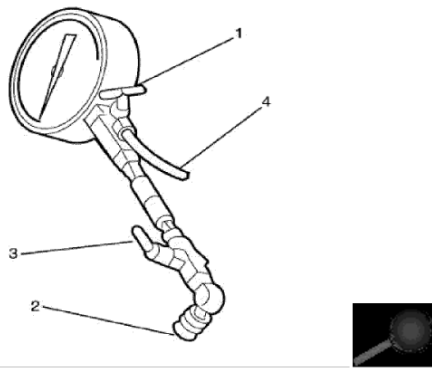
4. Turn the fuel gauge assembly valve (3) to the open position.

**Note:** Wrap a shop towel around the schrader valve (2) when connecting the fuel gauge assembly to the fuel pressure inspection valve on the fuel feed pipe to avoid fuel spilling.

**Note:** Screw on the schrader valve quickly to avoid fuel spillage.

5. Connect the schrader valve (2) to the fuel pressure inspection valve on the fuel feed pipe.
6. Place the bleed hose (4) into an approved container.
7. Open the bleed valve (1) to bleed any pressurized fuel.
8. Close the bleed valve (1) when the fuel pressure has dropped to 0 kPa (psi).

### Fuel Pressure Gauge Removal



1. Close the fuel gauge assembly valve (3).
  2. Place the bleed hose (4) into an approved container.
  3. Open the bleed valve (1) to bleed any pressurized fuel.
  4. Close the bleed valve (1).
- Note:** Wrap a shop towel around the schrader valve when disconnecting the fuel gauge assembly from the fuel pressure inspection valve to avoid fuel spilling.
- Note:** Unscrew the schrader valve quickly to avoid fuel spillage.
5. Disconnect the schrader valve (2) from the fuel pressure inspection valve on the fuel feed pipe.
  6. Remove the fuel gauge assembly from the vehicle.
  7. Empty any excess fuel from the fuel gauge and hose assembly.
  8. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).
  9. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
  10. Inspect for leaks.

## Fuel Pressure Relief

**Warning:** Fuel that flows out at high pressure can cause serious injury to the skin and eyes.  
ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.

**Note:** If a scan tool is not available, WAIT at LEAST 2 hours after the engine has been run, before removing the high pressure fuel line.

1. Install a scan tool to the vehicle and command the fuel pump relay OFF, allowing the low pressure fuel pump to shut off.
2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 20-30 seconds.
3. Turn the ignition OFF.
4. Using the scan tool, verify that there is little to no fuel pressure, if there still is fuel pressure repeat step 2.

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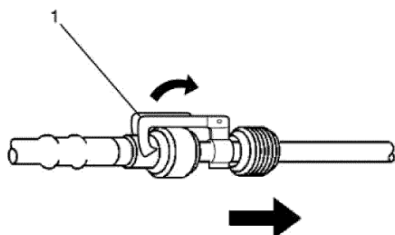
## Metal Collar Quick Connect Fitting Service

### Special Tools

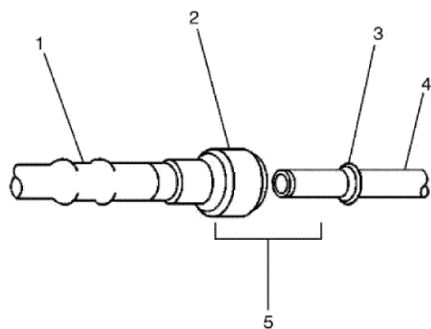
- 7370 Fuel Line Quick Connect Separator
- 7371 Quick Connect Release Tool
- J 41769 Fuel Line Quick Disconnect Tool
- J 41623-B Cooler Quick Connect Tool

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

### Removal Procedure Quick Connect Fitting Type 1



1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
2. Slide the dust cover from the quick-connect fitting if a dust cover is fitted.
3. Clean any grime from the metal collar quick connect fitting.
4. Detach the metal collar quick connect fitting verifier clip (1).



5. Choose the correct special tool and install the special tool onto the male connector pipe (4).

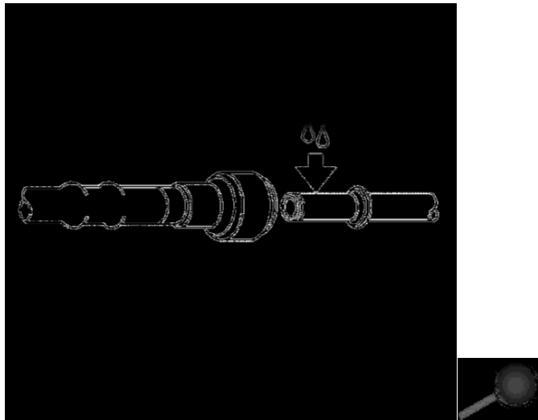
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6. Apply suitable pressure and push the special tool into the female connector (2) to release the retaining tabs.
7. Pull the female connector pipe (1) away from the male connector pipe (4).
8. Remove the special tool from the metal collar quick connect fitting.

**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.

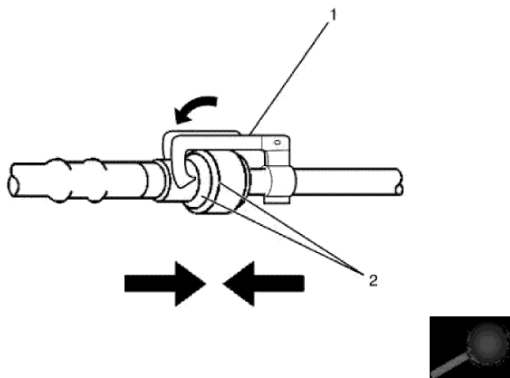
9. Clean the metal collar quick connect fittings using a clean shop towel.
10. Inspect the metal collar quick connect fittings for damage. Replace any damaged metal collar quick connect fittings.

#### Installation Procedure Quick Connect Fitting Type 1



**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 metal collar quick connect fitting.

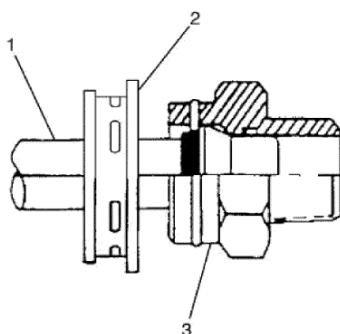


**Note:** Apply suitable pressure to both ends of the metal collar quick connect fitting to make sure that the retaining tabs snap into place.

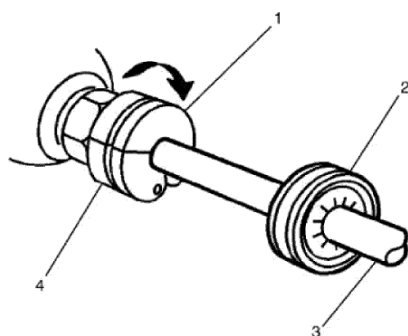
**Note:** Listen for an audible click to confirm the correct installation of the metal collar quick connect fitting.

2. Connect the metal collar quick connect fittings (2).
3. Install the metal collar quick connect fitting verifier clip (1).
4. Slide the dust cover into position if fitted.

#### Removal Procedure Quick Connect Fitting Type 2



1. Detach the verifier cap (2) by pulling the verifier cap back along the male connector pipe (1).



2. Install the quick connect release tool J 41623-B cooler quick connect tool (1) onto the male connector pipe (3).
3. Apply suitable pressure while pushing and turning the quick connect release tool J 41623-B cooler quick connect tool into the female connector (4) to release the retaining tabs.
4. Pull the male connector pipe (3) away from the female connector (4).
5. Remove the quick connect release tool J 41623-B cooler quick connect tool from the male connector pipe (3).

**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. Clean the metal collar quick connect fittings using a clean shop towel.



7. Remove the quick connect retainer if required.
8. Inspect the metal collar quick connect fittings for damage. Replace any damaged metal collar quick connect fitting components.

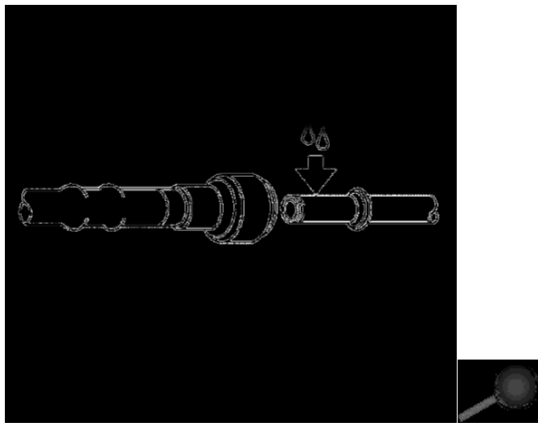
#### Installation Procedure Quick Connect Fitting Type 2



**Note:** The new quick connect retainer should align with the three slots of the quick connect fitting.

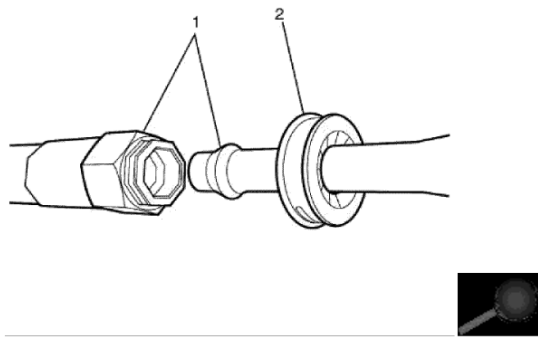
1. If required, install a new quick connect retainer by rotating the new quick connect retainer around the fitting until the new quick connect retainer is seated correctly.





**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.

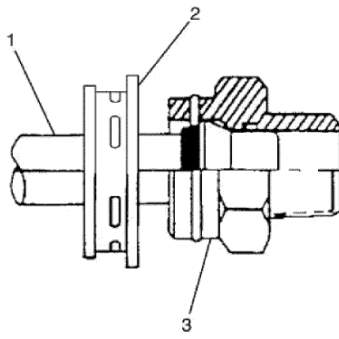
2. Apply a few drops of clean engine oil to the metal collar quick connect fitting.



**Note:** Apply suitable pressure to both ends of the metal collar quick connect fitting to make sure that the retaining tabs snap into place.

**Note:** Listen for an audible click to confirm the correct installation of the metal collar quick connect fitting.

3. Connect the metal collar quick connect fittings (1).



**Note:** To Install the metal collar quick connect fitting verifier cap (2), slide the metal collar quick connect fitting verifier cap (2) along the pipe.

4. Install the metal collar quick connect fitting verifier cap (2) to the metal collar quick connect fitting (3).

## Plastic Collar Quick Connect Fitting Service

### Special Tools

EN-46843 Quick Connect Release Tool

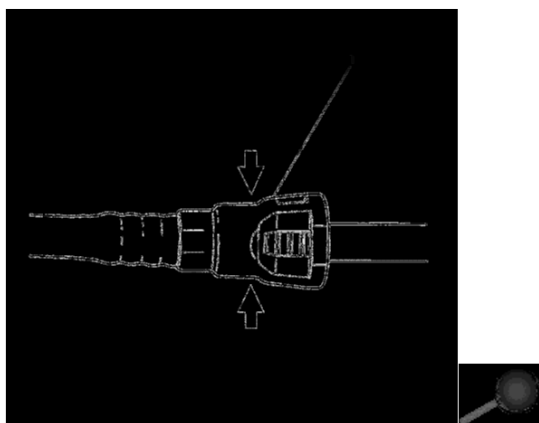
For equivalent regional tools, refer to [Special Tools](#).

### Removal Procedure Quick Connect Fitting Type 1

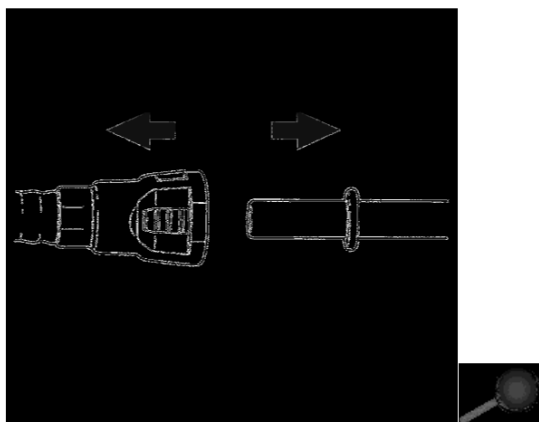
**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#).

**Warning:** Refer to [Safety Glasses Warning](#).

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).



2. Clean the quick connect fitting (1) using compressed air.
3. Install the quick connect release tool EN-46843 quick connect release tool over the quick connect fitting (1).



4. Disconnect the quick connect fitting from the connecting pipe.
5. Dry the quick connect fitting and the connecting pipe with a clean shop towel.

6. Inspect the quick connect fitting and the connecting pipe for damage.
7. Replace damaged parts as required.

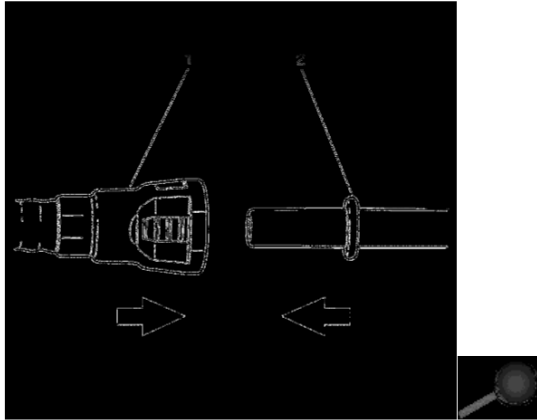
#### **Installation Procedure Quick Connect Fitting Type 1**

**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 quick connect fitting.



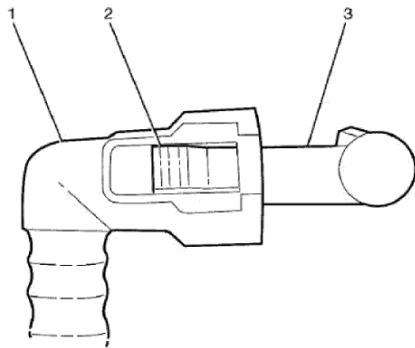
2. Push the quick connect fitting (1) over the connecting pipe (2). Listen for and audible click to confirm correct installation of the quick connect fitting (1).
3. Inspect for leaks using the following procedure:
  - 3.1. Turn the ignition ON, with the engine OFF for 2 seconds.
  - 3.2. Turn the ignition OFF, for 10 seconds.
  - 3.3. Turn the ignition ON, with the engine OFF for 2 seconds.
  - 3.4. Turn the ignition OFF.
  - 3.5. Inspect for leaks.

#### **Removal Procedure Quick Connect Fitting Type 2**

**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#).

**Warning:** Refer to [Safety Glasses Warning](#).

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).



2. Clean the quick connect fitting (1) using compressed air.
3. Push the quick connect fitting (1) towards the connecting pipe (3).
4. Grasp the quick connect fitting release tabs (2) and disconnect the quick connect fitting (1) from the connecting pipe (3).
5. Dry the quick connect fitting (1) and the connecting pipe (3) with a clean shop towel.
6. Inspect the quick connect fitting (1) and the connecting pipe (3) for damage.
7. Replace damaged parts as required.

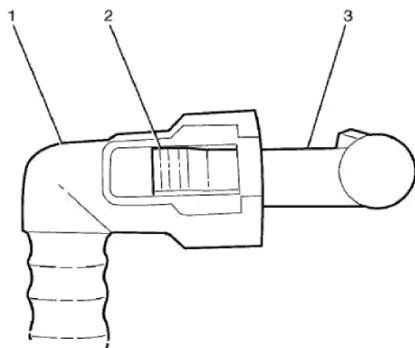
#### **Installation Procedure Quick Connect Fitting Type 2**

**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 quick connect fitting.



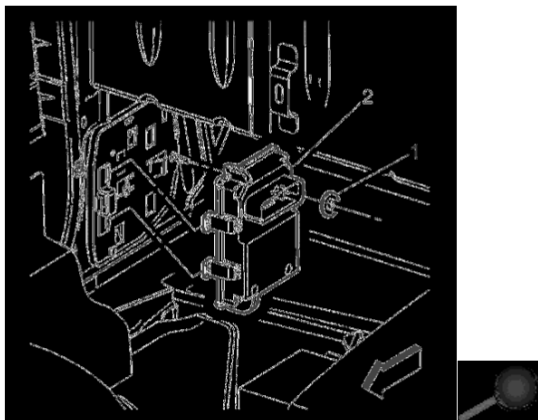
2. Push the quick connect fitting (1) over the connecting pipe (3). Listen for and audible click to confirm the correct installation of the quick connect fitting (1).
3. Inspect for leaks using the following procedure:
  - 3.1. Turn the ignition ON, with the engine OFF for 2 seconds.
  - 3.2. Turn the ignition OFF, for 10 seconds.

- 3.3. Turn the ignition ON, with the engine OFF for 2 seconds.
- 3.4. Turn the ignition OFF.
- 3.5. Inspect for leaks.

## Chassis Control Module Replacement

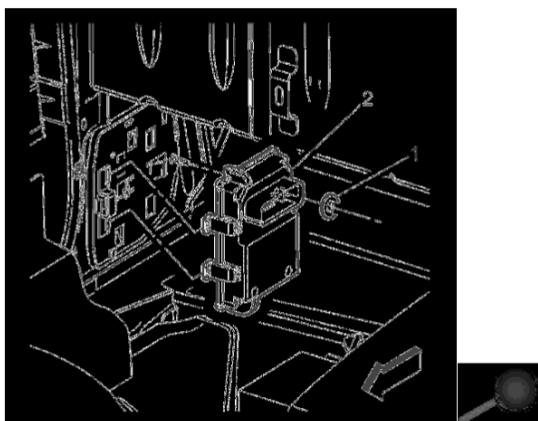
### Removal Procedure

1. Remove the rear window panel trim. Refer to [Rear Window Panel Trim Replacement](#).
2. Unplug the chassis control module electrical connector(s).



3. Remove the chassis control module retaining fastener (1).
- Note:** Do not damage the chassis control module retaining tabs.
4. Remove the chassis control module (2) by disengaging it from its retaining tabs.

### Installation Procedure



1. Install the chassis control module (2) by inserting the modules retaining tabs into their slots.
- Caution:** Refer to [Fastener Caution](#).
2. Hand start the chassis control module fastener (1) then tighten to **9 N·m (80 lb in)**
  3. Connect the chassis control module electrical connector(s).
  4. Install the rear window panel trim. Refer to [Rear Window Panel Trim Replacement](#).

5. Program the chassis control module. Refer to [Chassis Control Module Programming and Setup](#).



## Fuel Tank Draining

### Special Tools

- J-42960-2 Fuel Flapper Door Holder
- J-45004 Fuel Tank Drain Hose
- Commercially Available Fuel Pump

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

### Fuel Tank Draining Method 1

1. Ignition OFF.

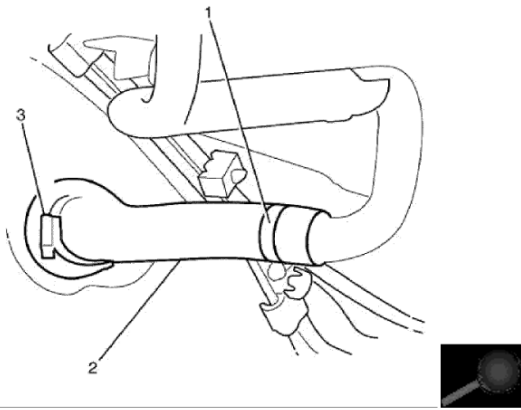
**Warning:** Refer to [Battery Disconnect Warning](#).

2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

**Danger:** To avoid any vehicle damage, serious personal injury or death, always use the jackstands to support the vehicle when lifting the vehicle with a jack.

**Warning:** Refer to [Safety Glasses Warning](#).

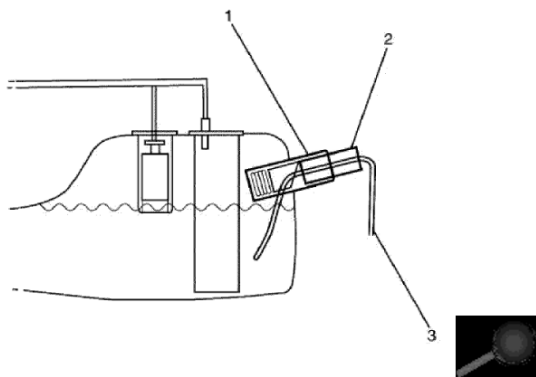
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
4. Remove the right rear wheel. Refer to [Tire and Wheel Removal and Installation](#).



**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#).

**Warning:** Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

5. Remove the retaining hose clamp (1) from the fuel filler hose (2).
6. Remove the retaining hose clamp (3) from the fuel filler hose (2).
7. Remove the fuel filler hose (2) from the vehicle.

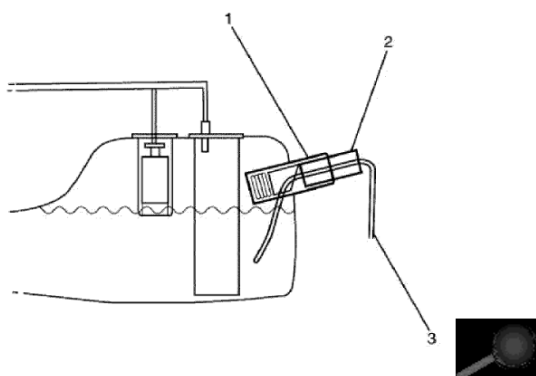


**Note:** Up to approximately 36 litres (8 gallons) of residual fuel may remain in the secondary side of the fuel tank.

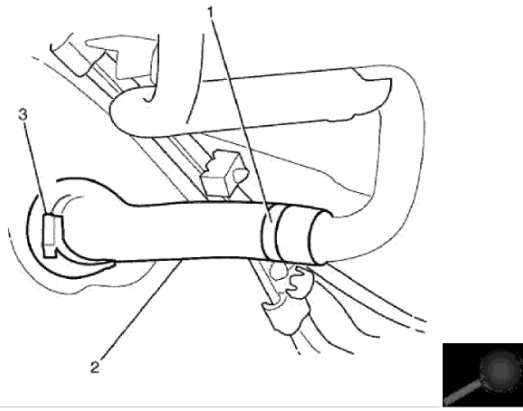
**Note:** The J-42960-2 fuel flapper door holder (2) is used to keep the roll over anti spill valve open.

8. Install the J-42960-2 fuel flapper door holder (2) to the fuel tank fuel filler pipe (1).
9. Insert the J-45004 fuel tank drain hose (3) through the J-42960-2 fuel flapper door holder (2) until the J-45004 fuel tank drain hose (3) reaches the bottom of the tank.
10. Use a commercially available pump to drain the fuel from the fuel tank.

#### Adding The Drained Fuel to The Fuel Tank for Method 1



1. Remove the J-45004 fuel tank drain hose (3) from the J-42960-2 fuel flapper door holder (2).
2. Remove the J-42960-2 fuel flapper door holder (2) from the fuel tank fuel filler pipe (1).



**Warning:** Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

3. Install the fuel filler hose (2) to the vehicle.

**Caution:** Refer to [Fastener Caution](#).

4. Install the retaining hose clamp (3) to the fuel filler hose (2) and tighten to **4 N•m (35 lb in)**.
5. Install the retaining hose clamp (1) to the fuel filler hose (2) and tighten to **4 N•m (35 lb in)**.
6. Install the right rear wheel. Refer to [Tire and Wheel Removal and Installation](#).
7. Lower the vehicle to the ground. Refer to [Lifting and Jacking the Vehicle](#).
8. Add the drained fuel to the fuel tank.
9. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

#### **Fuel Tank Draining Method 2**

1. Install the fuel pressure gauge to the vehicle. Refer to [Fuel Pressure Gauge Installation and Removal](#).
  2. Place the bleed hose of the fuel pressure gauge into a suitable container.
- Note:** Do not leave the vehicle unattended when performing this procedure.
3. Command the fuel pump ON with a scan tool.
- Note:** Do not fully open the bleed valve on the fuel pressure gauge. To drain both sides of the fuel tank simultaneously there should be a restriction on the flow rate at the bleed hose.
4. Open the bleed valve on the fuel pressure gauge just enough to cause a restriction to the flow of the fuel rate at the bleed hose.
- Note:** To avoid damage to the fuel pump do not allow the fuel pump to run dry while the fuel pump is in the ON state.
5. Command the fuel pump OFF with the scan tool as soon as it is observed that no more fuel is coming out of the bleed hose.
  6. Remove the fuel pressure gauge from the vehicle. Refer to [Fuel Pressure Gauge Installation and Removal](#).

#### **Adding The Drained Fuel to The Fuel Tank for Method 2**

1. Lower the vehicle to the ground. Refer to [Lifting and Jacking the Vehicle](#).
2. Add the drained fuel to the fuel tank.

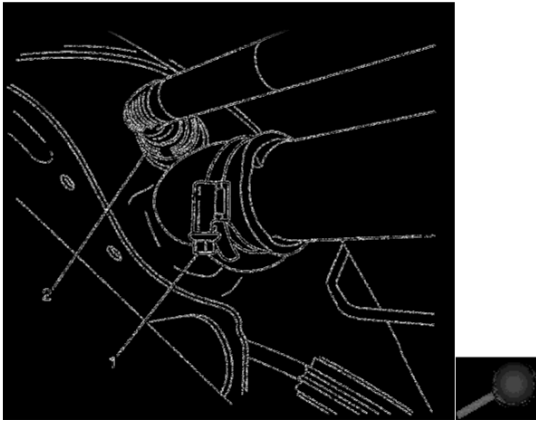
## Filler Tube Replacement

### Removal Procedure

**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

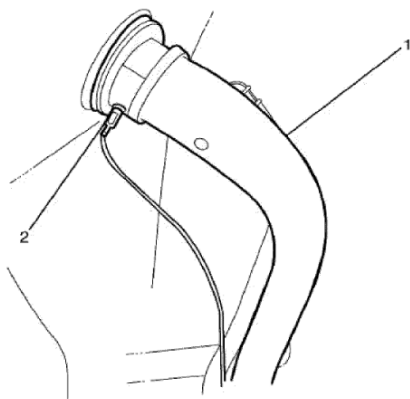
**Warning:** Refer to [Safety Glasses Warning](#).

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the fuel filler cap.
3. Drain the fuel tank below the level of the fuel filler hose. Refer to [Fuel Tank Draining](#).
4. Remove the right rear wheel. Refer to [Tire and Wheel Removal and Installation](#).
5. Remove the rear bumper fascia. Refer to [Rear Bumper Fascia Replacement](#).
6. Remove the rear wheelhouse liner. Refer to [Rear Wheelhouse Liner Replacement](#).

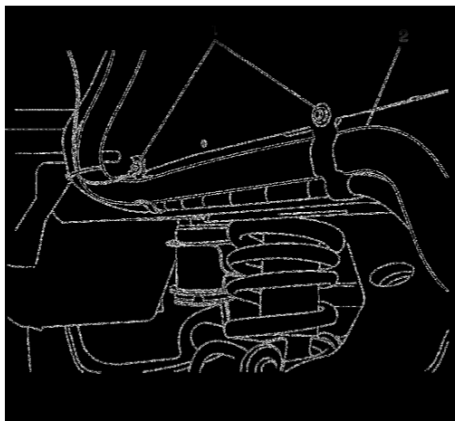


7. Loosen the fuel filler tube to fuel tank neck retaining clamp (1).
8. Remove the fuel filler tube to fuel tank neck.
9. Disconnect the fuel filler vent tube (2) from the fuel tank. Refer to [Plastic Collar Quick Connect Fitting Service](#).

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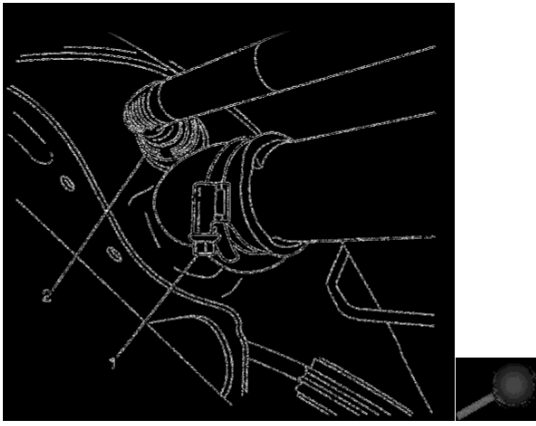
10. Remove the fuel filler tube to upper fuel filler neck rubber seal surround.
11. Remove the earth lead connector (2) to upper fuel filler neck.



12. Remove the fuel filler tube to chassis retaining bolts (1).
13. Remove the fuel filler tube from the vehicle (2).

#### Installation Procedure

1. Install the fuel filler tube to the vehicle.



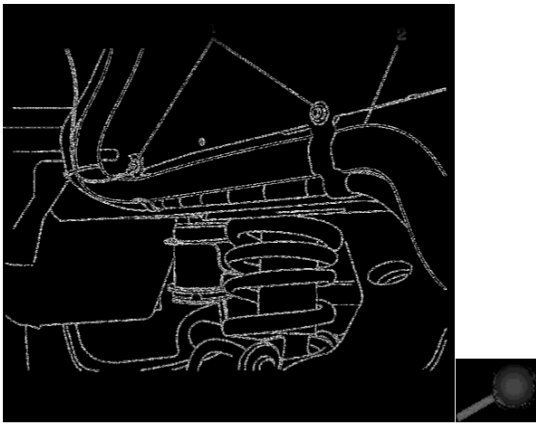
**Caution:** Refer to [Fastener Caution](#).

2. Install the fuel filler tube to fuel tank neck retaining clamp (1).

**Tighten**

Tighten the clamp to 3.5 N•m (31 lb in).

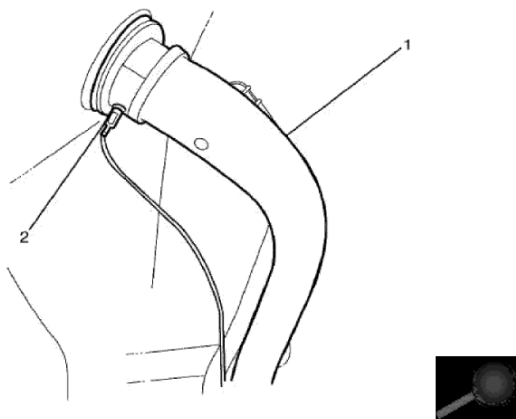
3. Connect the fuel filler vent tube (2) to the fuel tank. Refer to [Plastic Collar Quick Connect Fitting Service](#).



4. Install the fuel filler tube to chassis retaining bolts (1).

**Tighten**

Tighten the bolts to 9 N•m (80 lb in).



5. Install the fuel filler tube to upper fuel filler neck rubber seal surround.
6. Install the earth lead connector (2) to upper filler neck.
7. Install the rear wheelhouse liner. Refer to [Rear Wheelhouse Liner Replacement](#).
8. Install the rear bumper fascia. Refer to [Rear Bumper Fascia Replacement](#).
9. Install the right rear wheel. Refer to [Tire and Wheel Removal and Installation](#).
10. Add fuel to the fuel tank.
11. Inspect for fuel leaks.
12. Install the fuel filler cap.

## Fuel Tank Replacement

### Special Tools

EN-48536 Engine Support Tool (Engine Lower 65 MM Kit)

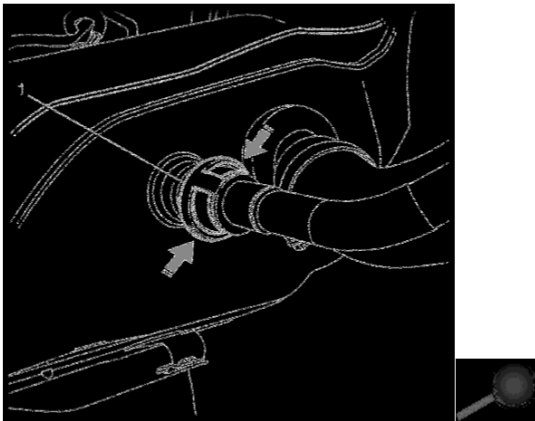
For equivalent regional tools, refer to [Special Tools](#).

### Removal Procedure

**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#).

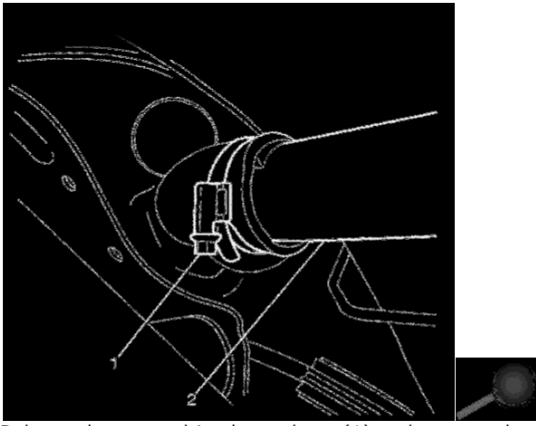
**Warning:** Refer to [Safety Glasses Warning](#).

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Drain the fuel tank. Refer to [Fuel Tank Draining](#).
3. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
4. Remove the exhaust system. Refer to [Exhaust System Replacement](#).
5. Remove the propeller shaft. Refer to [Propeller Shaft Replacement](#).
6. Remove the right rear wheel. Refer to [Tire and Wheel Removal and Installation](#).

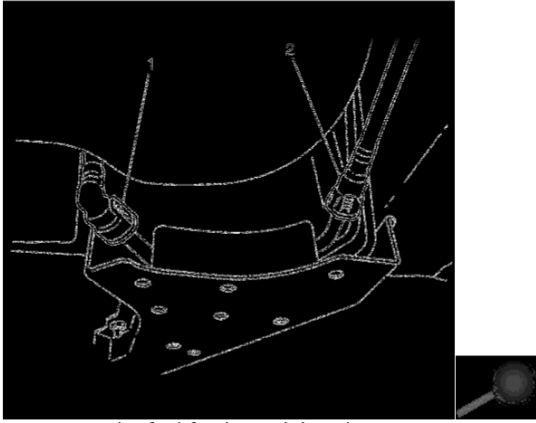


7. Disconnect the evaporative emission (EVAP) hose (1), by squeezing both sides of the hose (as indicated in the illustration) and pulling it toward the rear of the vehicle.

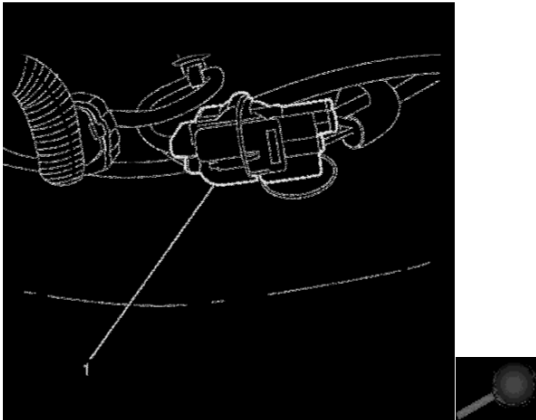




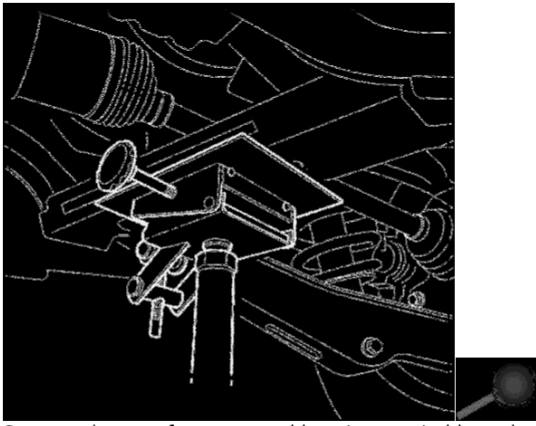
8. Release the worm drive hose clamp (1) and remove the filler tube (2).



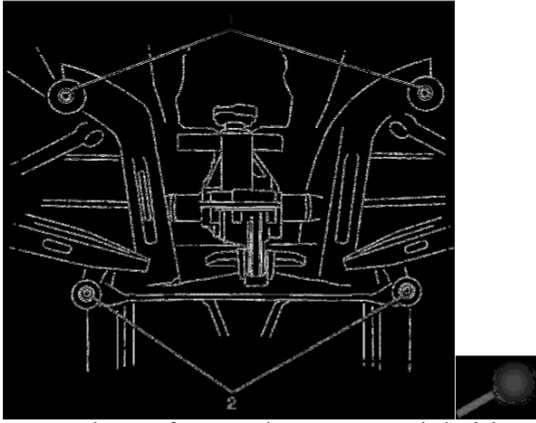
9. Disconnect the fuel feed pipe (1) and EVAP emission pipe (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).



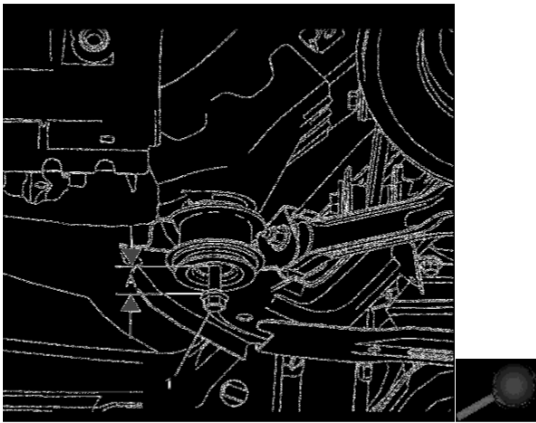
10. Disconnect the fuel tank electrical connector (1).



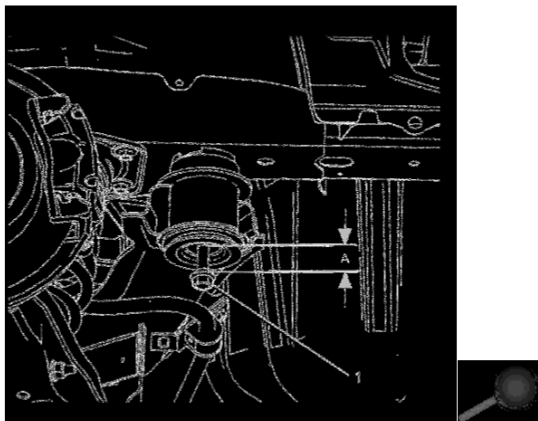
11. Support the rear frame assembly using a suitable tool.



12. Remove the rear frame to chassis retaining bolts (1) and (2) and discard.

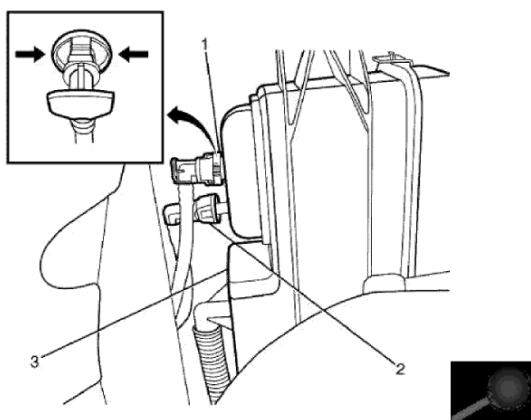


13. Support the rear frame using the frame support tool *EN-48536* Engine Support Tool (Engine Lower 65 MM Kit) (1). Repeat for the opposite side.

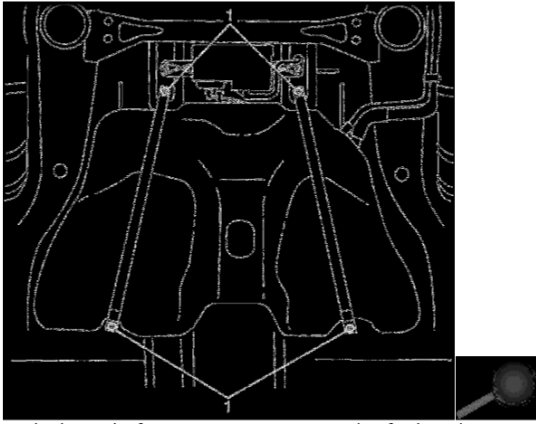


**Note:** When lowering the rear frame use care not to over extend the rear brake hoses.

14. Support the rear frame using the frame support tool *EN-48536* Engine Support Tool (Engine Lower 65 MM Kit) (1). Repeat for the opposite side.
15. Lower the rear frame approximately 50 millimeters (2 in) (A) at the rear mounting surface between the rear frame and the chassis.
16. Remove the fuel tank heat shield. Refer to [Fuel Tank Heat Shield Replacement](#).
17. Disconnect the park brake rear cables from the park brake front actuator cable. Refer to [Parking Brake Actuator Cable Replacement](#).



18. Disconnect the EVAP emission pipe (2) from the EVAP emission canister (3). Refer to [Plastic Collar Quick Connect Fitting Service](#).

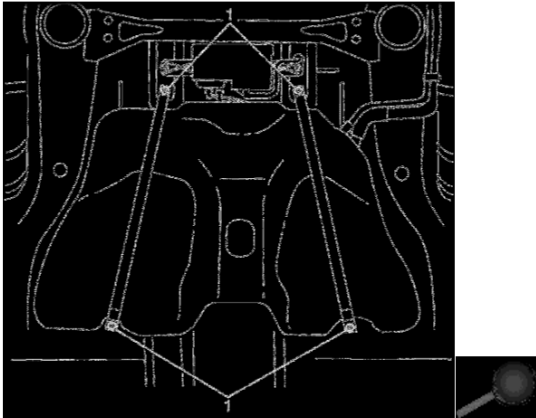


19. With the aid of an assistant support the fuel tank
20. Remove the fuel tank strap to chassis retaining bolts (1).
21. Remove the fuel tank straps.
- Note:** Do not damage the fuel tank wiring harness or fuel tank hoses.
22. With the aid of an assistant, remove the fuel tank from the vehicle.
23. Remove the following components from the fuel tank if the fuel tank is to be replaced.
  - The primary fuel tank module—Refer to [Primary Fuel Tank Module Replacement](#).
  - The secondary fuel tank module—Refer to [Secondary Fuel Tank Module Replacement](#).

#### **Installation Procedure**

1. Install the following components to the fuel tank if the fuel tank was replaced.
  - The primary fuel tank module – Refer to [Primary Fuel Tank Module Replacement](#).
  - The secondary fuel tank module – Refer to [Secondary Fuel Tank Module Replacement](#).

- Note:** Make sure the following are correctly:
- The fuel tank wiring harness.
  - The fuel tank pipes.



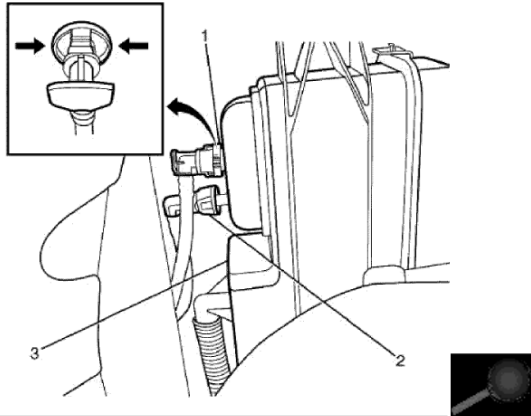
2. With the aid of an assistant, install the fuel tank to the vehicle.
3. With the aid of an assistant support the fuel tank and install the fuel tank straps.

**Caution:** Refer to [Fastener Caution](#).

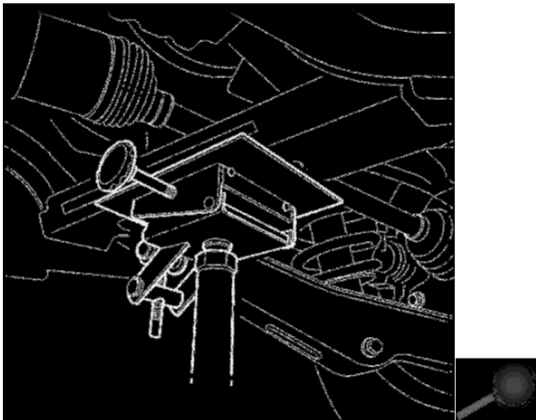
4. Install the fuel tank strap retaining bolts (1).

**Tighten**

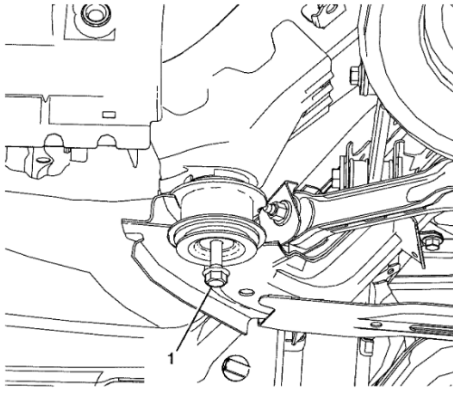
Tighten the bolts to **30N•m (22 lb ft)**.



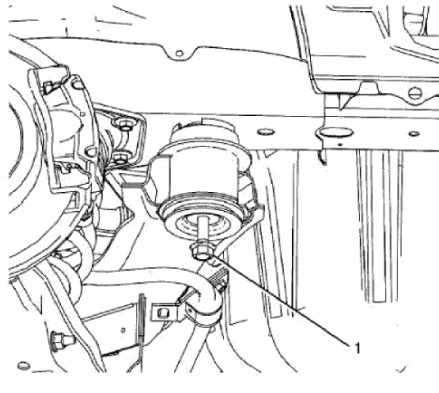
5. Connect the EVAP emission pipe (2) to the EVAP emission canister (3). Refer to [Plastic Collar Quick Connect Fitting Service](#).
6. Install the fuel tank heat shield. Refer to [Fuel Tank Heat Shield Replacement](#).



7. Raise the rear frame assembly using suitable tool.

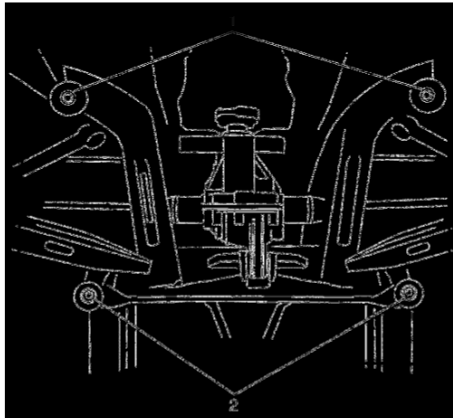


8. Remove the frame support tool *EN-48536* Engine Support Tool (Engine Lower 65 MM Kit) (1) from the rear frame. Repeat for the opposite side.



9. Remove the frame support tool *EN-48536* Engine Support Tool (Engine Lower 65 MM Kit) (1) from the rear frame. Repeat for the opposite side.

10. Using a suitable tool clean the threaded holes in the rear chassis.



**Note:** Rear frame retaining bolts must not be fully tightened at this stage.

11. Install the NEW rear frame to chassis retaining bolts (1 and 2).

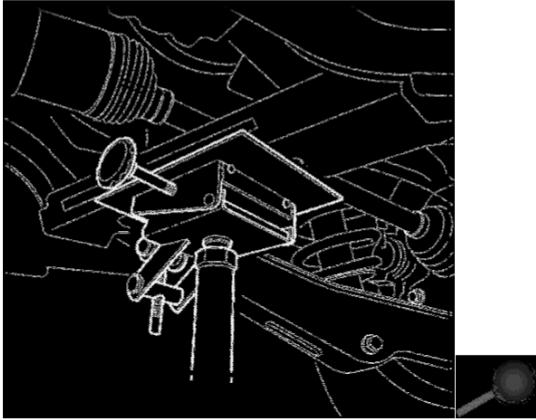
Do not fully tighten at this stage.

12. After retaining bolts (1 and 2) are installed tighten to.

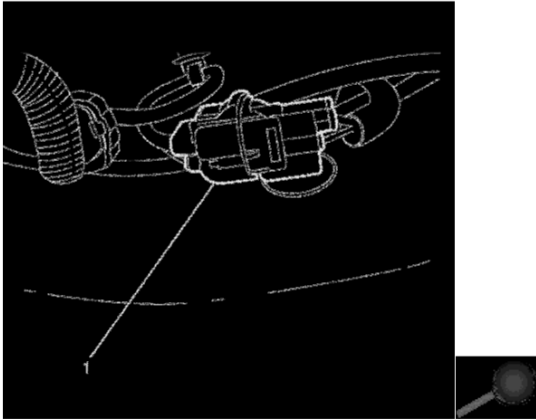
**Tighten**

First Pass: Tighten the bolts to **60 N•m (44 lb ft)**.

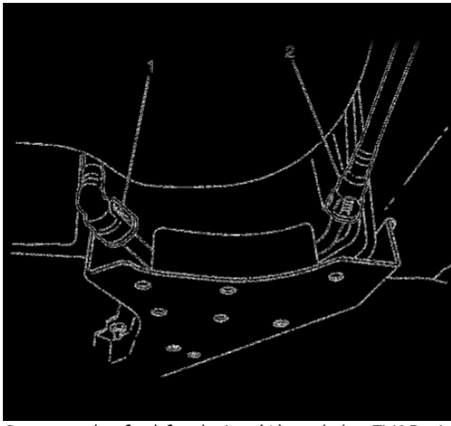
Final Pass: Tighten the bolts a further 125 degrees.



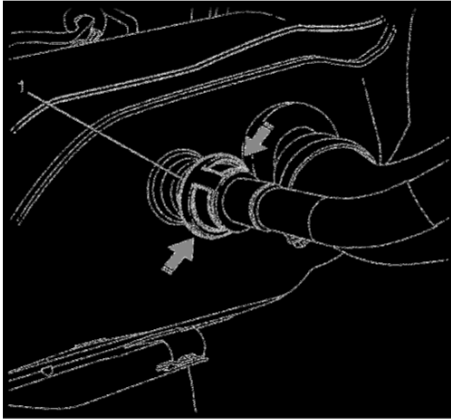
13. Remove the support tool.



14. Connect the fuel tank electrical connector (1).

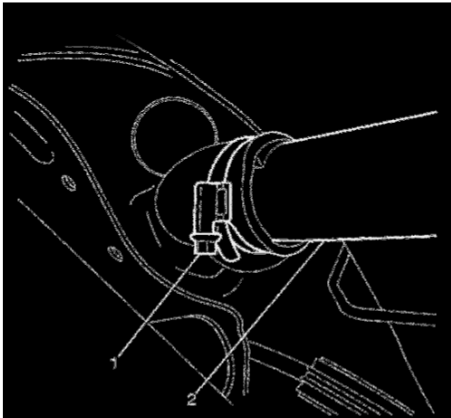


15. Connect the fuel feed pipe (1) and the EVAP pipe (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).



**Note:** Listen for an audible click to confirm correct installation of the EVAP emission hose (1).

16. Install the EVAP emission hose (1).





17. Connect the filler hose (2) to the fuel tank.

**Tighten**

Tighten the fuel filler tube hose clamp (1) to **4 N•m (35 lb in)**.

18. Connect the park brake rear cables to the park brake front actuator cable. Refer to [Parking Brake Actuator Cable Replacement](#).
19. Install the propeller shaft. Refer to [Propeller Shaft Replacement](#).
20. Install the exhaust system. Refer to [Exhaust System Replacement](#).
21. Install the right rear wheel. Refer to [Tire and Wheel Removal and Installation](#).
22. Refill the fuel tank.
23. Inspect for fuel leaks.

[2014 Holden VF Sedan](#) | [VF/WN - Sedan, Ute, Sportwagon, Caprice, Lumina, HSV Service Manual 5617662](#) |  
[Engine/Propulsion](#) | [Engine Controls and Fuel - 6.0L L77 or 6.2L LS3 LSA](#) | [Repair Instructions](#) |

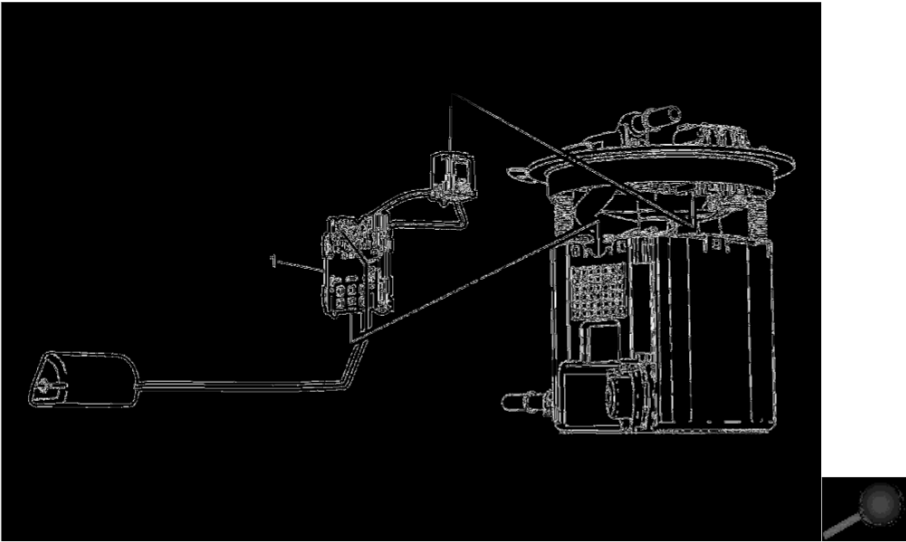
**Document ID: 3282847**

## Fuel Level Sensor Replacement

The fuel level sensor is an integral part of the secondary fuel tank module assembly. For replacement refer to [Secondary Fuel Tank Module Replacement](#).

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Fuel Tank Fuel Pump Module Fuel Level Sensor Replacement



Fuel Tank Fuel Pump Module Fuel Level Sensor Replacement

| Callout                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Component Name                                                                                                                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Danger:</b> To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.</p> <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <ol style="list-style-type: none"><li>1. Remove the primary fuel tank fuel pump module. Refer to <a href="#">Primary Fuel Tank Module Replacement</a>.</li><li>2. Disconnect the electrical connector.</li></ol> |                                                                                                                                |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p>Primary Fuel Level Sensor</p> <p><b>Procedure</b></p> <p>Release tabs and slide primary fuel level sensor up to remove.</p> |

## Primary Fuel Tank Module Replacement

### Special Tools

CH 45722 Fuel Tank Sender Wrench

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

### Removal Procedure

1. Ignition OFF.

**Warning:** Refer to [Battery Disconnect Warning](#).

2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

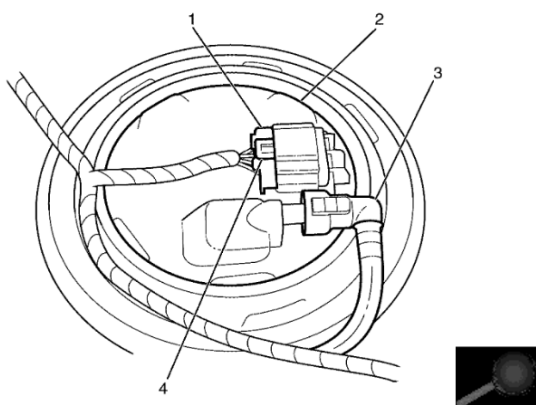
**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

**Warning:** Refer to [Safety Glasses Warning](#).

**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#).

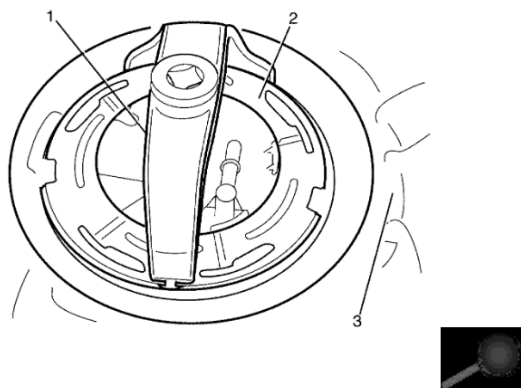
**Warning:** Refer to [Relieving Fuel Pressure Warning](#).

3. Relieve the low side fuel pressure. Refer to [Fuel Pressure Relief](#).
4. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
5. Remove the fuel tank assembly. Refer to [Fuel Tank Replacement](#).



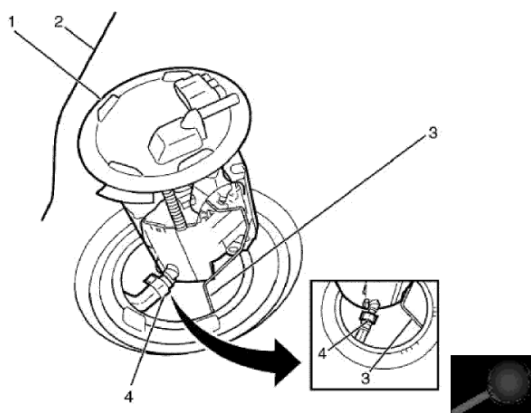
**Note:** Press the locking tang (4) to release the electrical harness connector (1) from the primary fuel tank module (2).

6. Disconnect the electrical harness connector (1) from the primary fuel tank module (2).
7. Detach the fuel feed pipe (3) from the primary fuel tank module (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).



**Note:** The cam lock ring (2) is a single use item and must be discarded after removal.

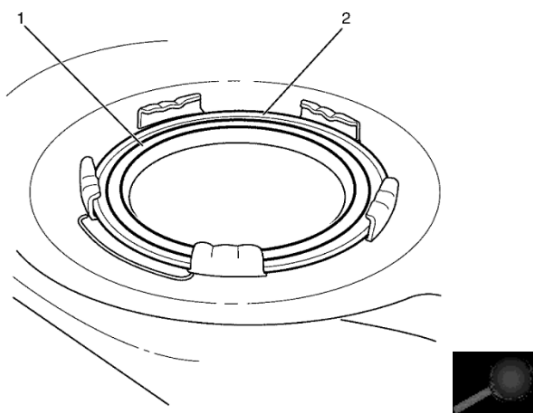
8. Remove the cam lock ring (2) from the fuel tank assembly (3) by rotating the cam lock ring (2) counter-clockwise using the fuel tank sender wrench CH 45722 fuel tank sender wrench (1).
9. Discard the cam lock ring (2).



**Note:** To release the transfer tube connector (4) from the primary fuel tank module (1), squeeze the releasing buttons on the transfer tube connector (4).

**Note:** Note the orientation of the primary fuel tank module (1) in relation to the fuel tank assembly (2).

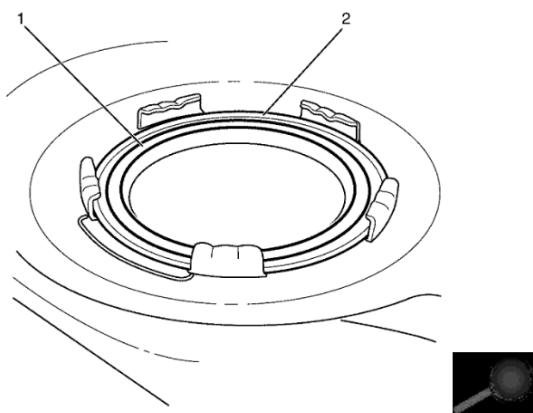
10. Carefully lift the primary fuel tank module (1) from the fuel tank assembly (2), allowing enough clearance to disconnect the transfer tube connector (4) from the primary fuel tank module (1).
11. Disconnect the transfer tube connector (4) from the primary fuel tank module (1).
- Note:** Care should be taken not to damage the fuel level sensor float rod (3) when removing the primary fuel tank module (1) from the fuel tank assembly (2).
12. Carefully manoeuvre the primary fuel tank module (1) from the fuel tank assembly (2)



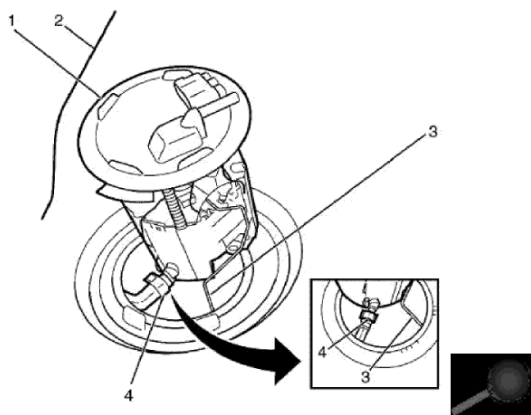
**Note:** The primary fuel tank module seal ring (1) is a single use item and must be discarded after removal.

13. Remove the primary fuel tank module seal ring (1) from the fuel tank assembly (2).
14. Discard the primary fuel tank module seal ring (1).

#### Installation Procedure



1. Install a NEW primary fuel tank module seal ring (1) to the fuel tank assembly (2).

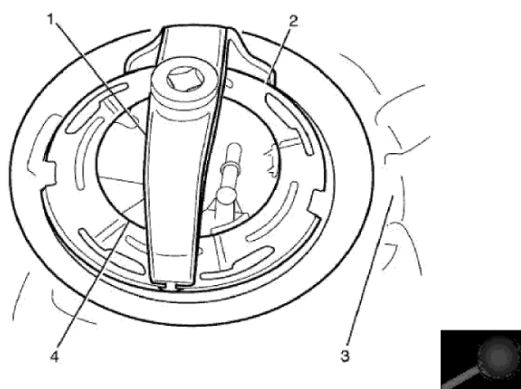


**Note:** Care should be taken not to damage the fuel level sensor float rod (3) when installing the primary fuel tank module (1) to the fuel tank assembly (2).

2. Carefully lower the primary fuel tank module (1) into the fuel tank assembly (2), enough to connect the transfer tube connector (4) to the primary fuel tank module (1).

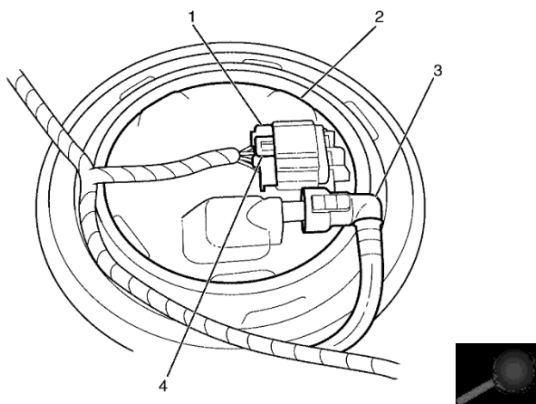
**Note:** Listen for an audible click to confirm the correct installation of the transfer tube connector (4) to the primary fuel tank module (1).

3. Connect the transfer tube connector (4) to the primary fuel tank module (1).
4. Install the primary fuel tank module (1) to the fuel tank assembly (2).



**Note:** Apply suitable pressure onto the primary fuel tank module (4) to hold the primary fuel tank module (4) in place while installing the NEW cam lock ring (2).

5. Hold the primary fuel tank module (4) in place while installing the NEW cam lock ring (2) to the fuel tank assembly (3) by rotating the cam lock ring (2) clockwise using the fuel tank sender wrench CH 45722 fuel tank sender wrench (1).



**Note:** Listen for an audible click to confirm the correct installation of the electrical harness connector (1) to the primary fuel tank module (2).

6. Connect the electrical harness connector (1) to the primary fuel tank module (2).
7. Connect the fuel feed pipe (3) to the primary fuel tank module (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).
8. Install the fuel tank assembly. Refer to [Fuel Tank Replacement](#).
9. Lower the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
10. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).



## Secondary Fuel Tank Module Replacement

### Special Tools

CH-48482 Fuel Tank Sender Wrench

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

### Removal Procedure

1. Ignition OFF.

**Warning:** Refer to [Battery Disconnect Warning](#).

2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

**Warning:** Refer to [Safety Glasses Warning](#).

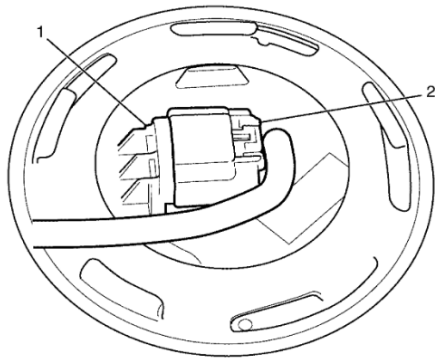
**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#).

**Warning:** Refer to [Relieving Fuel Pressure Warning](#).

3. Relieve the low side fuel pressure. Refer to [Fuel Pressure Relief](#).

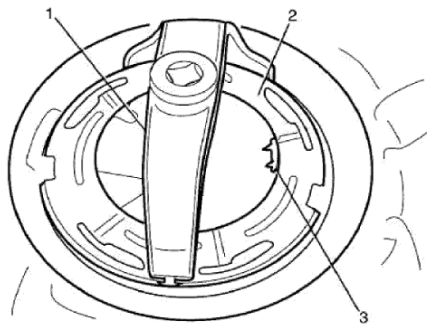
**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

4. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
5. Remove the fuel tank assembly. Refer to [Fuel Tank Replacement](#).



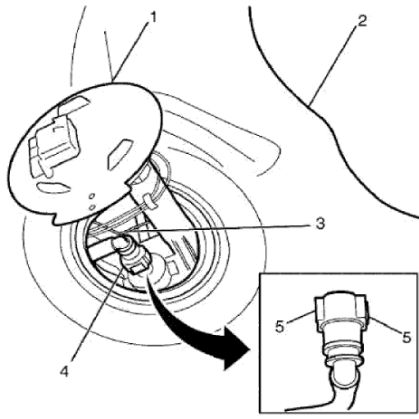
6. Disconnect the electrical harness connector (2) from the secondary fuel tank module (1).





**Note:** The cam lock ring is a single use item and must be replaced after it was removed.

7. Remove the cam lock ring (2) from the secondary fuel tank module (3) by rotating the cam lock ring (2) counter-clockwise using the fuel tank sender wrench CH-48482 fuel tank sender wrench (1).
8. Discard the cam lock ring (2).

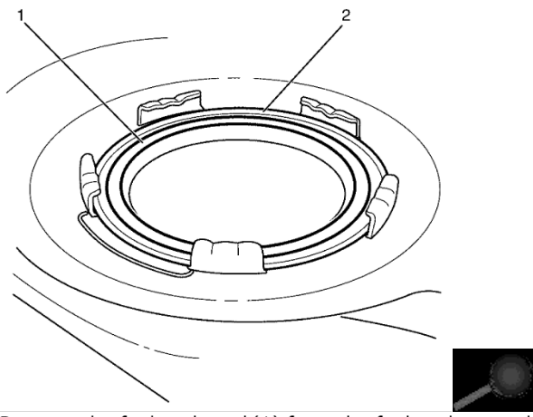


**Note:** To release the transfer tube (4) from the secondary fuel tank module (1), squeeze the releasing buttons (5) on the transfer tube (4).

**Note:** Note the orientation of the secondary fuel tank module (1) in relation to the fuel tank assembly (2).

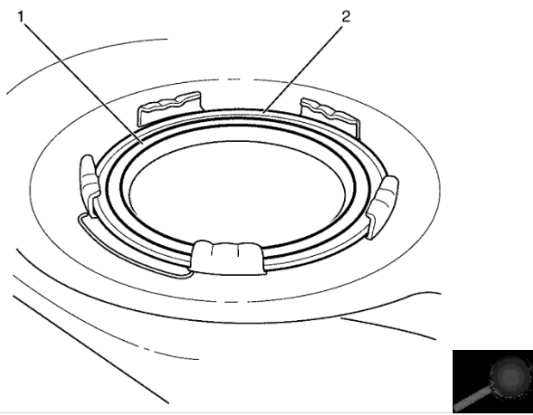
**Note:** Do not damage the fuel level sensor float rod (3) when removing the secondary fuel tank module (1) from the fuel tank.

9. Carefully lift the secondary fuel tank module (1) from the fuel tank assembly (2), enough to disconnect the transfer tube (4) from the secondary fuel tank module (1).
10. Disconnect the transfer tube (4) from the secondary fuel tank module (1).
11. Carefully manoeuvre the secondary fuel tank module (1) from the fuel tank assembly (2).

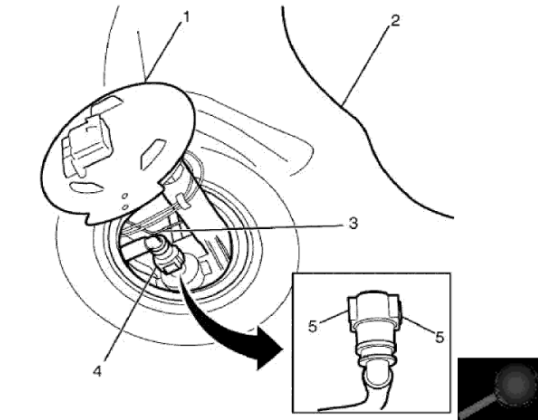


12. Remove the fuel tank seal (1) from the fuel tank assembly (2).
13. Discard the fuel tank seal (1).

#### **Installation Procedure**



1. Install a NEW fuel tank seal (1) to the fuel tank assembly (2).

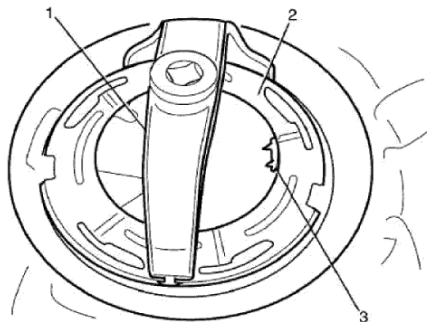


**Note:** Do not damage the fuel level sensor float rod (3) when installing the secondary fuel tank module (1).

2. Carefully install the secondary fuel tank module (1) into the fuel tank (2), enough to connect the transfer tube (4) to the secondary fuel tank module (1).

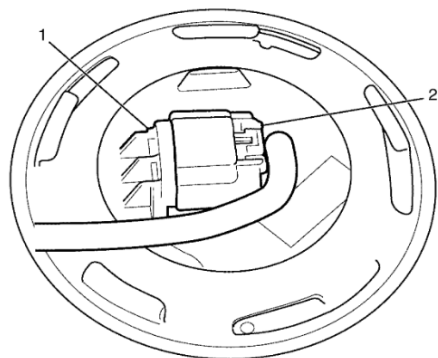
**Note:** Listen for an audible click to confirm the correct installation of the transfer tube connector (4) to the secondary fuel tank module (1).

3. Connect the transfer tube (4) to the secondary fuel tank module (1).
4. Carefully manoeuvre and install the secondary fuel tank module (1) to the fuel tank assembly (2).



**Note:** Apply suitable pressure onto the secondary fuel tank module (3) to hold the secondary fuel tank module (3) in position while installing the NEW cam lock ring (2).

5. Install a NEW cam lock ring (2) to the secondary fuel tank module (3) by rotating the cam lock ring (2) clockwise using the fuel tank sender wrench CH-48482 fuel tank sender wrench (1).



**Note:** Listen for an audible click to confirm the correct installation of the electrical harness connector (2) to the secondary fuel tank module (1).

6. Connect the electrical harness connector (2) to the secondary fuel tank module (1).
7. Install the fuel tank assembly to the vehicle. Refer to [Fuel Tank Replacement](#).
8. Lower the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
9. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

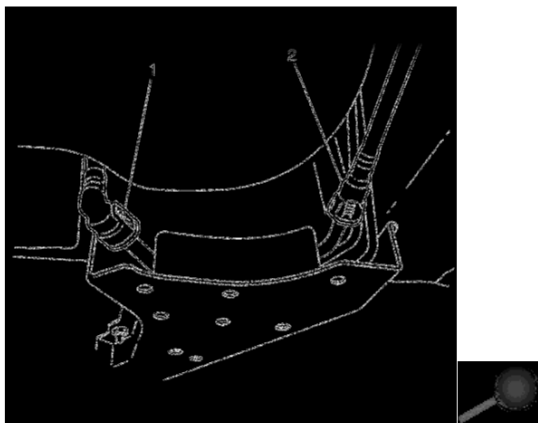
## Fuel Line Replacement - Chassis

### Removal Procedure

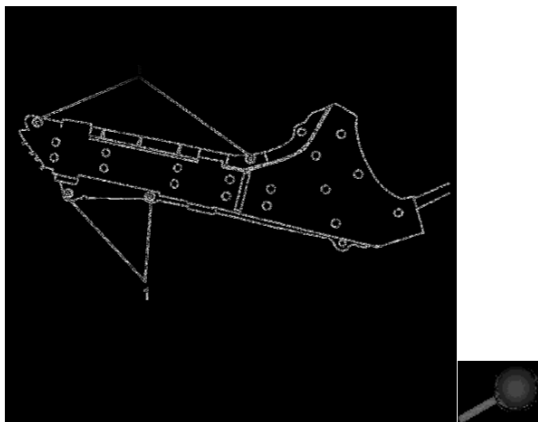
**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

**Note:** The fuel system pipes can be serviceable individually or as a complete fuel/brake pipe assembly. The following is the procedure for servicing the fuel pipes individually.

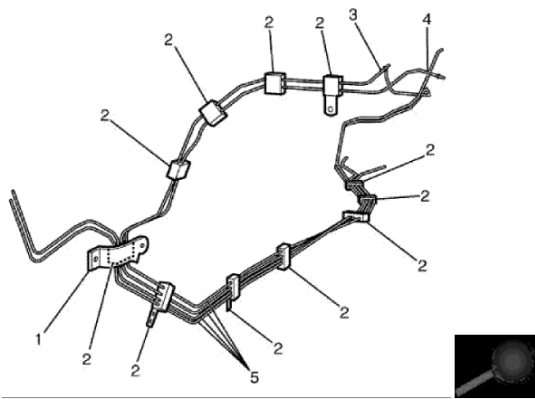
1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Relieve the fuel system pressure. Refer to the [Fuel Pressure Relief](#).
3. Remove the exhaust system. Refer to [Exhaust System Replacement](#).
4. Remove the engine. Refer to [Engine Replacement](#).
5. Remove the appropriate heat shields for access to the fuel/brake pipe assembly.



6. Disconnect the fuel pipe connector (1).



7. Remove the rear fuel/brake pipe assembly stone guard retaining nuts (1).
8. Remove the rear fuel/brake pipe assembly stone guard from the vehicle.

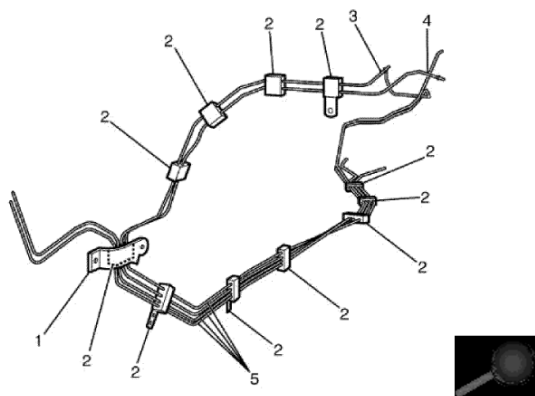


9. Remove the front fuel/brake pipe assembly protection plate (1) from the vehicle.

**Note:** Mark the positions of the fuel/brake pipe retainers (2) before removing the fuel/brake pipe retainers (2) from the fuel/brake pipes assembly.

10. Remove all the fuel/brake pipe retainers (2) from the fuel/brake pipe assembly (5).
11. Manoeuvre and remove the fuel pipe (4) from the vehicle.

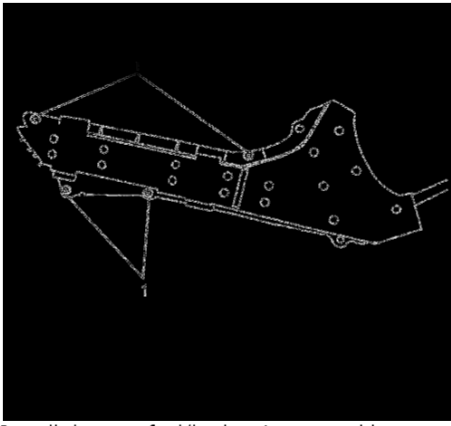
#### Installation Procedure



1. Manoeuvre and install the fuel pipe (4) to the vehicle.

**Note:** Observe the marked positions for the fuel/brake pipe retainers (2) when installing the fuel/brake pipe retainers (2) to the fuel/brake pipe assembly (5).

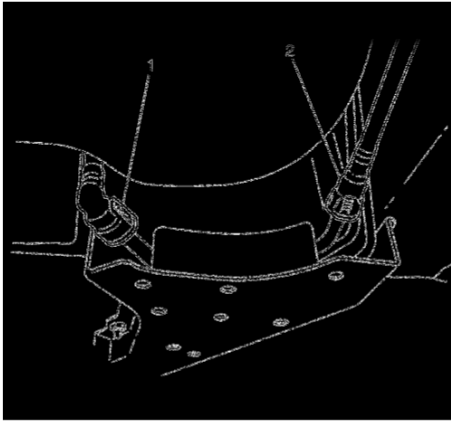
2. Install all the fuel/brake pipe retainers (2) to the fuel/brake pipes assembly (5).
3. Install the front fuel/brake pipe assembly protection plate (1) to the vehicle.



4. Install the rear fuel/brake pipe assembly stone guard to the vehicle.

**Caution:** Refer to [Fastener Caution](#).

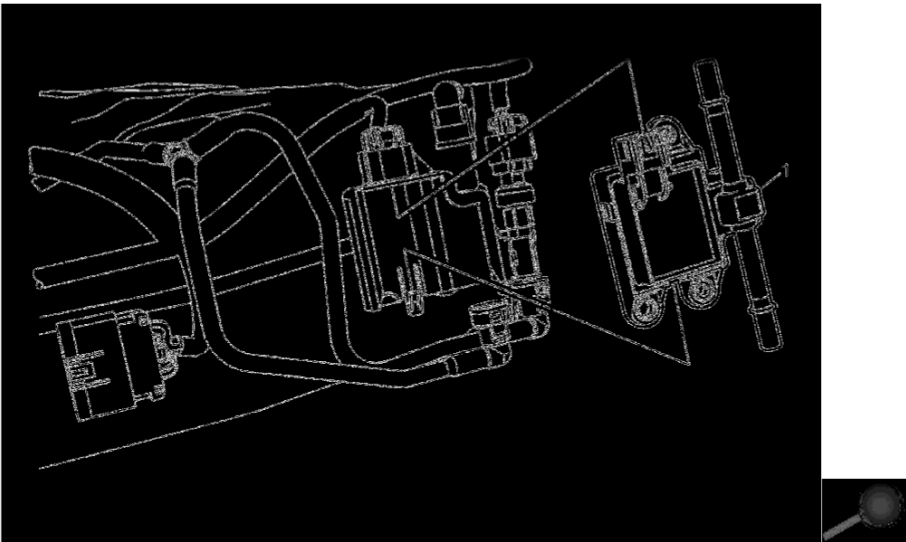
5. Install the rear fuel/brake pipe assembly stone guard retaining nuts (1) and tighten to **4 N•m (35 lb in)**.



**Note:** Listen for an audible click to confirm correct installation of the fuel pipe connector.

6. Connect the fuel pipe connector (1).
7. Install the removed heat shields.
8. Install the engine. Refer to [Engine Replacement](#).
9. Install the exhaust system. Refer to [Exhaust System Replacement](#).
10. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Flexible Fuel Sensor Replacement

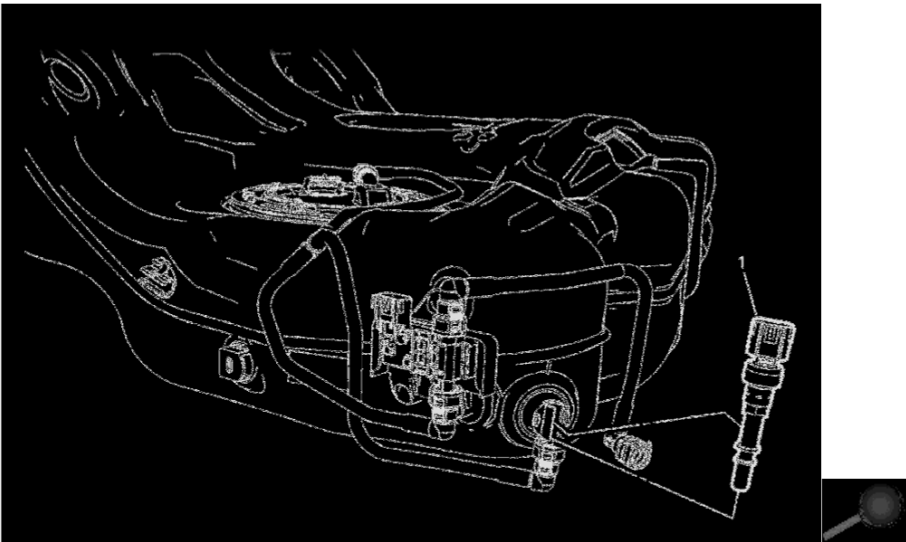


Flexible Fuel Sensor Replacement

| Callout                                                                                                                                                                                                                                                                                                                                     | Component Name                                                                                                                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br><br>1. Relieve the fuel system pressure. Refer to <a href="#">Fuel Pressure Relief</a> .<br>2. Raise and support the vehicle. Refer to <a href="#">Lifting and Jacking the Vehicle</a> .<br>3. Disconnect the fuel line connectors. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a> . |                                                                                                                                  |
| 1                                                                                                                                                                                                                                                                                                                                           | Flexible Fuel Sensor<br><b>Procedure</b><br><br>1. Release the plastic retaining tab.<br>2. Disconnect the electrical connector. |



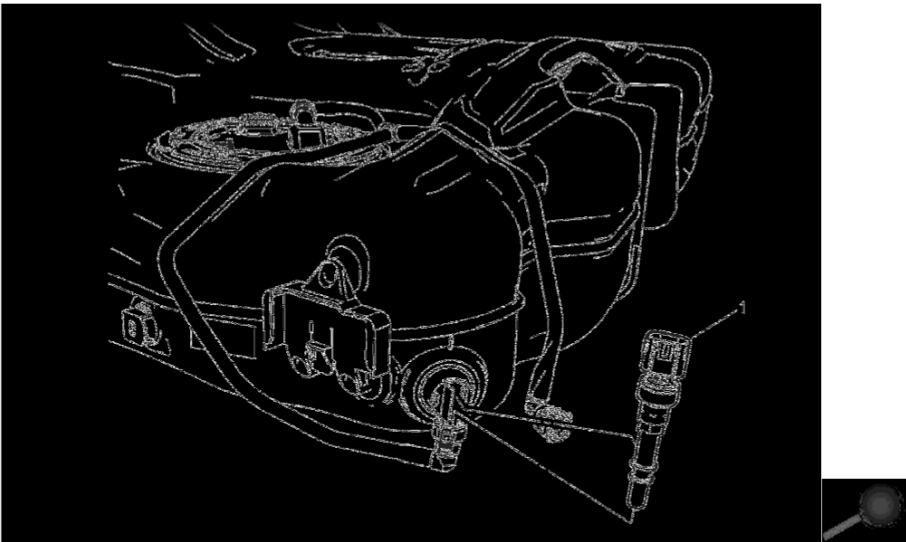
Fuel Pressure Sensor Replacement (L77 or LS3)



Fuel Pressure Sensor Replacement

| Callout                                                                                                                                                                                                                                                                                                                                                                                                                         | Component Name                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <ol style="list-style-type: none"><li>1. Relieve the fuel pressure. Refer to <a href="#">Fuel Pressure Relief</a>.</li><li>2. Raise and support the vehicle. Refer to <a href="#">Lifting and Jacking the Vehicle</a>.</li></ol> |                                                                                                                                                                                                                                                                                                                                                                          |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                               | <p>Fuel Pressure Sensor</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"><li>1. Disconnect the fuel feed hose from the fuel pressure sensor. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a>.</li><li>2. Disconnect the electrical connector.</li><li>3. Disconnect the fuel pressure sensor from the retainer on the tank.</li></ol> |

Fuel Pressure Sensor Replacement (LSA)



Fuel Pressure Sensor Replacement

| Callout                                                                                                                                                                                                                                                                                                                                                                                                                         | Component Name                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <ol style="list-style-type: none"><li>1. Relieve the fuel pressure. Refer to <a href="#">Fuel Pressure Relief</a>.</li><li>2. Raise and support the vehicle. Refer to <a href="#">Lifting and Jacking the Vehicle</a>.</li></ol> |                                                                                                                                                                                                                                                                                                                                                                          |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                               | <p>Fuel Pressure Sensor</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"><li>1. Disconnect the fuel feed hose from the fuel pressure sensor. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a>.</li><li>2. Disconnect the electrical connector.</li><li>3. Disconnect the fuel pressure sensor from the retainer on the tank.</li></ol> |

## Fuel System Cleaning (L77 & LS3)

1. Ignition OFF.

**Warning:** Refer to [Battery Disconnect Warning](#).

2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

**Warning:** Refer to [Safety Glasses Warning](#).

**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#).

**Warning:** Refer to [Relieving Fuel Pressure Warning](#).

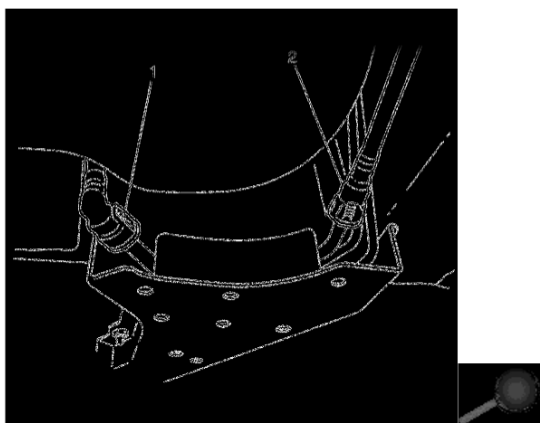
**Warning:** Refer to [Safety Glasses and Compressed Air Warning](#).

3. Remove the engine cover. Refer to [Engine Cover Replacement](#).

4. Relieve the fuel pressure. Refer to [Fuel Pressure Relief](#).

**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

5. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



**Note:** The following procedure covers the disassembly and the inspection of the complete fuel supply system. If the fuel system is contaminated, the fuel system can be cleaned. The extent of the contamination can be determined during the disassembly procedure.

6. Detach the fuel feed line connector (1) and inspect for contamination. Refer to [Plastic Collar Quick Connect Fitting Service](#).

7. Remove the fuel tank if contamination is found. Refer to [Fuel Tank Replacement](#).

8. Remove the fuel tank module assemblies. Refer to:

- [Primary Fuel Tank Module Replacement](#).
- [Secondary Fuel Tank Module Replacement](#).

9. Place the fuel tank in a suitable work area away from any heat or any source of ignition.

10. Perform the following procedures:

- Inspect the primary fuel tank module for contamination. Replace the primary fuel tank module if contamination is found.

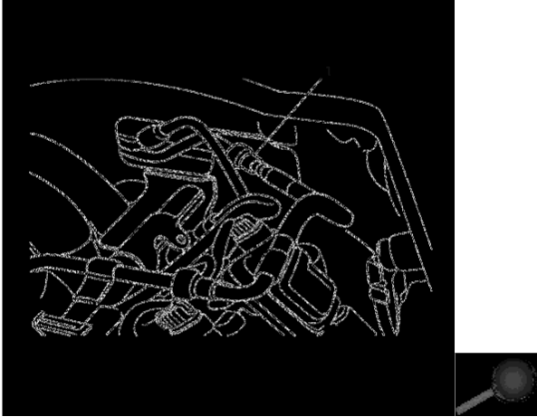
- Do not replace the primary fuel level sensor. Clean the primary level sensor with hot water.
- Inspect the secondary fuel tank module for contamination. Clean the secondary fuel tank module with hot water if contamination is found.
- Inspect the transfer tube for contamination. Clean the transfer tube with compressed air.

**Note:** The fuel and water mixture is a hazardous material. Observe local, state, and federal laws and regulations when discarding hazardous materials.

11. Flush the fuel tank with hot water.

**Note:** Make sure that all the water is removed from the fuel tank after the fuel tank has been cleaned from all contamination.

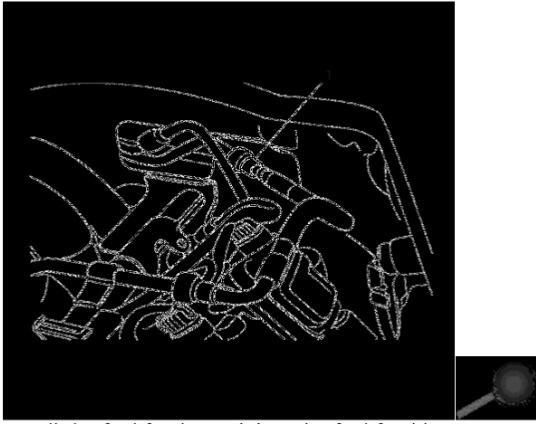
12. Pour the water out of the fuel tank at the fuel tank module openings by rocking the fuel tank several times.



13. Detach the fuel feed pipe (1) from the fuel feed line.
14. Clean the fuel feed lines with compressed air.
15. Remove the fuel injectors and fuel rails. Refer to [Fuel Injection Fuel Rail Assembly Replacement](#).
16. Clean the fuel injectors and fuel rails with compressed air.
17. Inspect the fuel injectors. Replace damaged fuel injectors.

#### **Installation Procedure**

1. Install the fuel tank module assemblies. Refer to:
  - [Primary Fuel Tank Module Replacement](#).
  - [Secondary Fuel Tank Module Replacement](#).
2. Install the fuel tank. Refer to [Fuel Tank Replacement](#).
3. Install the fuel injectors and fuel rails. Refer to [Fuel Injection Fuel Rail Assembly Replacement](#).



4. Install the fuel feed pipe (1) to the fuel feed line.
5. Install the engine cover. Refer to [Engine Cover Replacement](#).
6. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

## Fuel System Cleaning (LSA)

1. Ignition OFF.

**Warning:** Refer to [Battery Disconnect Warning](#).

2. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

**Warning:** Refer to [Safety Glasses Warning](#).

**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#).

**Warning:** Refer to [Relieving Fuel Pressure Warning](#).

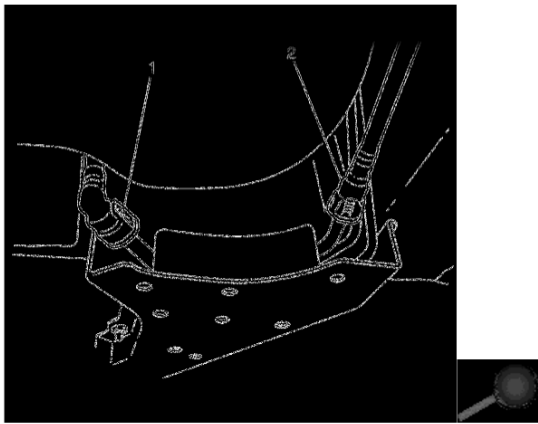
**Warning:** Refer to [Safety Glasses and Compressed Air Warning](#).

3. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).

4. Relieve the fuel pressure. Refer to [Fuel Pressure Relief](#).

**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

5. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



**Note:** The following procedure covers the disassembly and the inspection of the complete fuel supply system. If the fuel system is contaminated, the fuel system can be cleaned. The extent of the contamination can be determined during the disassembly procedure.

6. Detach the fuel feed line connector (1) and inspect for contamination. Refer to [Fuel Pressure Relief](#).
7. Remove the fuel tank if contamination is found. Refer to [Fuel Tank Replacement](#).
8. Remove the fuel tank module assemblies. Refer to:
  - [Primary Fuel Tank Module Replacement](#).
  - [Secondary Fuel Tank Module Replacement](#).
9. Place the fuel tank in a suitable work area away from any heat or any source of ignition.
10. Perform the following procedures:
  - Inspect the primary fuel tank module for contamination. Replace the primary fuel tank module if contamination is found.

- Do not replace the primary fuel level sensor. Clean the primary level sensor with hot water.
- Inspect the secondary fuel tank module for contamination. Clean the secondary fuel tank module with hot water if contamination is found.
- Inspect the transfer tube for contamination. Clean the transfer tube with compressed air.

**Note:** The fuel and water mixture is a hazardous material. Observe local, state, and federal laws and regulations when discarding hazardous materials.

11. Flush the fuel tank with hot water.

**Note:** Make sure that all the water is removed from the fuel tank after the fuel tank has been cleaned from all contamination.

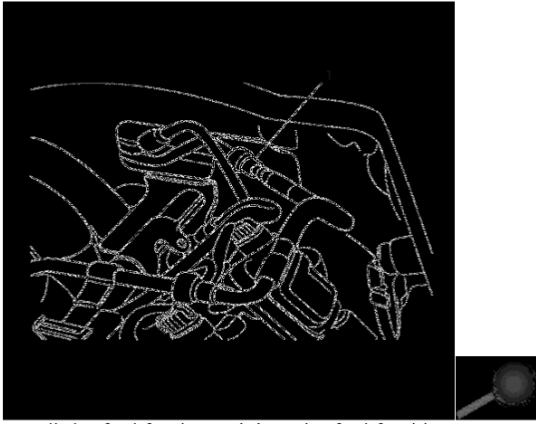
12. Pour the water out of the fuel tank at the fuel tank module openings by rocking the fuel tank several times.



13. Detach the fuel feed pipe (1) from the fuel feed line.
14. Clean the fuel feed lines with compressed air.
15. Remove the fuel injectors and fuel rails. Refer to [Fuel Injection Fuel Rail Assembly Replacement](#).
16. Clean the fuel injectors and fuel rails with compressed air.
17. Inspect the fuel injectors. Replace damaged fuel injectors.

#### Installation Procedure

1. Install the fuel tank module assemblies. Refer to:
  - [Primary Fuel Tank Module Replacement](#).
  - [Secondary Fuel Tank Module Replacement](#).
2. Install the fuel tank. Refer to [Fuel Tank Replacement](#).
3. Install the fuel injectors and fuel rails. Refer to [Fuel Injection Fuel Rail Assembly Replacement](#).



4. Install the fuel feed pipe (1) to the fuel feed line.
5. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).
6. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).



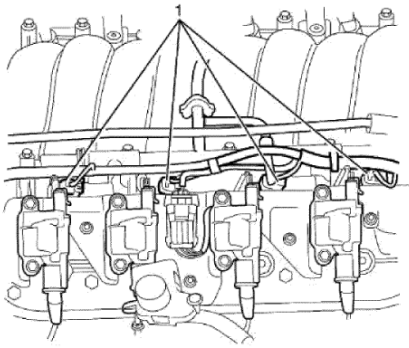
## Fuel Injection Fuel Rail Assembly Replacement (L77 & LS3)

### Removal Procedure

1. Remove the engine cover. Refer to [Engine Cover Replacement](#).
2. Relieve the fuel system pressure. Refer to the [Fuel Pressure Relief](#).
3. Clean the fuel rail assembly before disconnection the fuel connections.

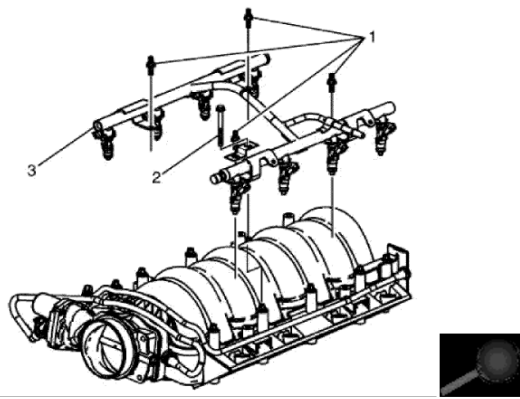
**Caution:**

- Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.
  - Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering open pipes and passages.
4. Disconnect the fuel feed hose from the fuel rail. Refer to [Fuel Injection Fuel Feed Hose Replacement](#).

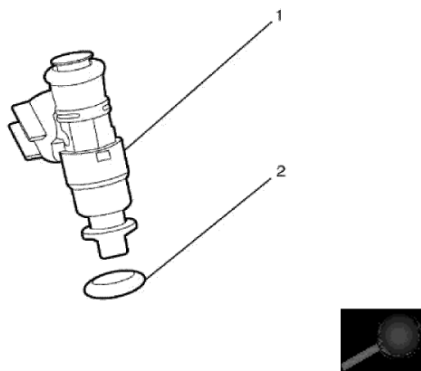


**Note:** Observe the order sequence of the fuel injector electrical connectors (1).

5. Disconnect the fuel injector electrical connectors (1) from the fuel injectors.



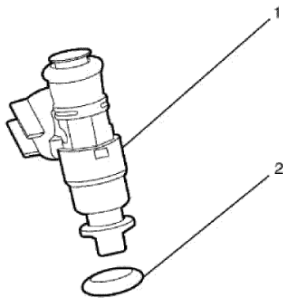
6. Using a suitable tool detach the engine electrical wiring harness from the fuel rail.
7. Remove the fuel rail ground strap to intake manifold retaining bolt (2).
8. Remove the fuel rail to intake manifold retaining bolts (1).
9. Simultaneously lift both sides of the fuel rail (3) and remove the fuel rail assembly from the intake manifold.



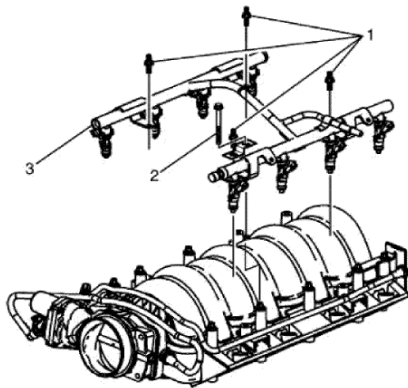
**Note:** The fuel injector seals are single use items and must be replaced after the fuel injectors has been removed.

10. Remove the fuel injector seals (2) from the fuel injectors (1) and discard.

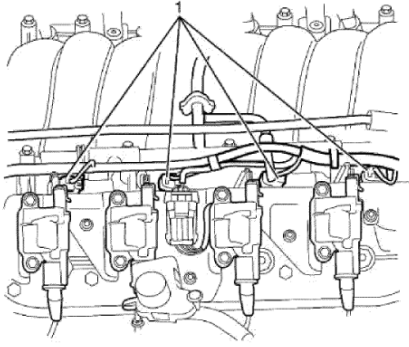
#### Installation Procedure



1. Lubricate the NEW fuel injector seals (2) with clean engine oil.
2. Install the NEW fuel injector seals (2) to the fuel injectors (1).



3. Install the fuel rail assembly (3) to the intake manifold.
4. Apply a 0.5 mm (0.02 in) band of GM approved threadlock to the threads of the fuel rail retaining bolts (1).
- Caution:** Refer to [Fastener Caution](#).
5. Install the fuel rail to intake manifold retaining bolts (1) and tighten to **10 N•m (89 lb in)**.
6. Install the fuel rail ground strap to intake manifold retaining bolt (2) and tighten to **10 N•m (89 lb in)**.



**Note:** Do not damage the engine wiring harness.

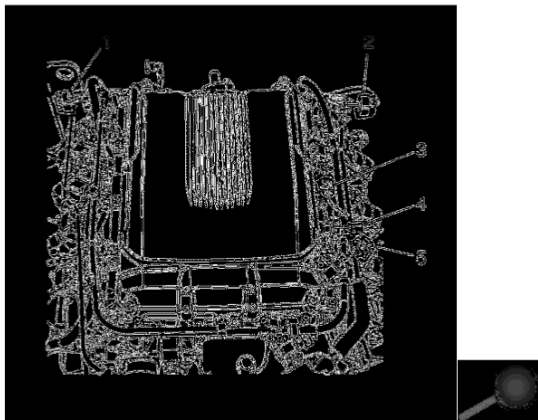
**Note:** Observe the order sequence of the fuel injector electrical connectors (1).

7. Connect the fuel injector electrical connectors (1) to the fuel injectors.
8. Install the engine wiring electrical harness to the fuel rail.
9. Connect the fuel feed hose to the fuel rail. Refer to [Fuel Injection Fuel Feed Hose Replacement](#).
10. Connect the negative battery cable.
11. Inspect for leaks.
  - 11.1. Turn ON the ignition for 2 seconds.
  - 11.2. Turn OFF the ignition for 10 seconds.
  - 11.3. Turn ON the ignition.
  - 11.4. Inspect for fuel leaks.
12. Install the engine cover. Refer to [Engine Cover Replacement](#).

## Fuel Injection Fuel Rail Assembly Replacement (LSA)

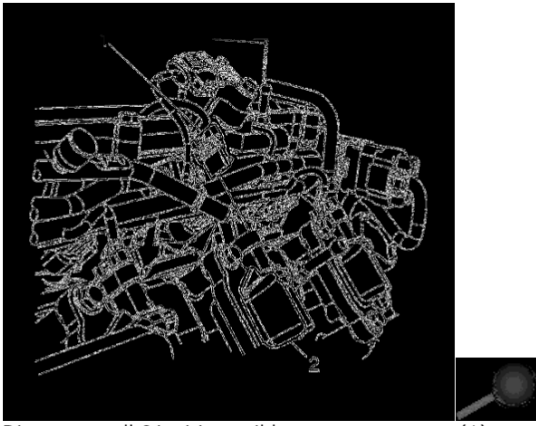
### Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
3. Remove the positive crankcase ventilation hose/pipe/tube. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).
4. Disconnect the fuel pipe from the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).

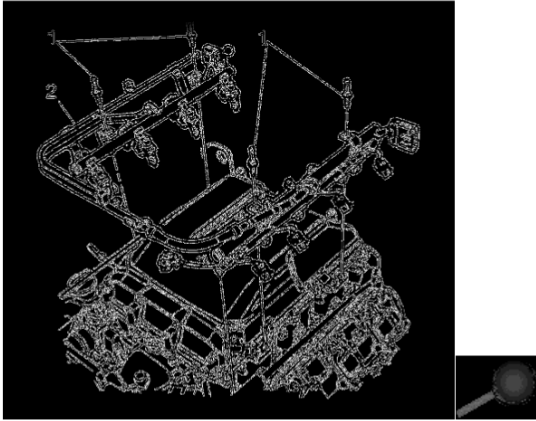


5. Disconnect the fuel injection Harness connectors (1, 2).
6. Disconnect the BARO sensor harness connector (5).
7. Disconnect the intake temperature sensor harness connector (4).
8. Disconnect the supercharger air outlet pressure sensor harness connector (3).
9. Disconnect the mass airflow sensor electrical connector.
10. Disconnect the engine harness retainers at the fuel rail.

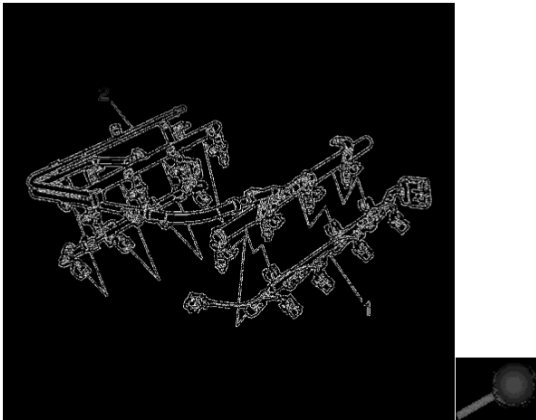
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11. Disconnect all 8 ignition coil harness connectors (1).



12. Remove the front fuel rail fastener.  
13. Remove the fuel rail ball stud fasteners (1).  
14. Carefully disengage the fuel injectors from the supercharger.  
15. Remove the fuel rail with the fuel injector harness from the engine.

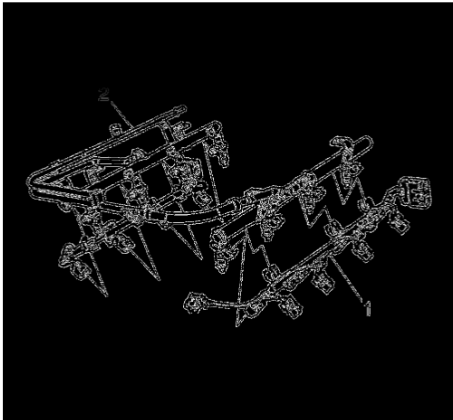


16. Remove the fuel injection wiring harness (1, 2) from the fuel rail and fuel injectors.

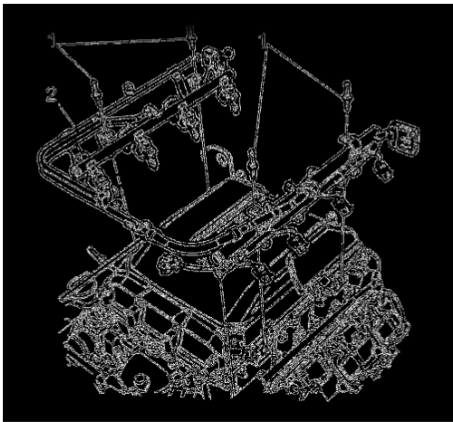
17. If replacing the fuel rail, replace the fuel injectors. Refer to [Fuel Injector Replacement](#).

### **Installation Procedure**

1. Install the fuel injectors if removed. Refer to [Fuel Injector Replacement](#).



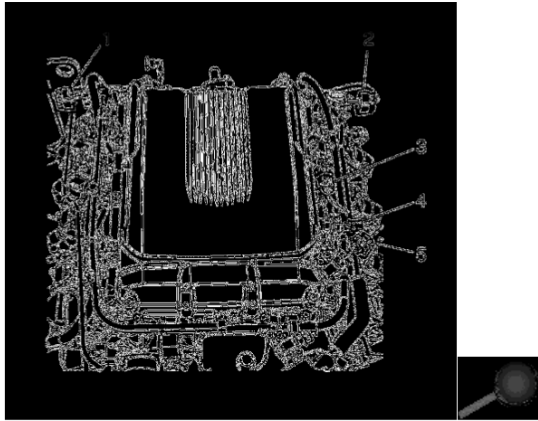
2. Install the fuel injection wiring harness (1, 2) to the fuel rail and fuel injectors.



3. Install the fuel rail with the fuel injector harness (2) to the engine.
4. Carefully locate the fuel injectors into the supercharger. Install the left side first and then the right side.
5. Apply threadlock to the ball stud and fastener threads. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
- Caution:** Refer to [Fastener Caution](#).
6. Install the ball studs (1) and the forward fastener and tighten to **10 N•m (89 lb in)**



7. Connect all 8 ignition coil harness connectors (1).



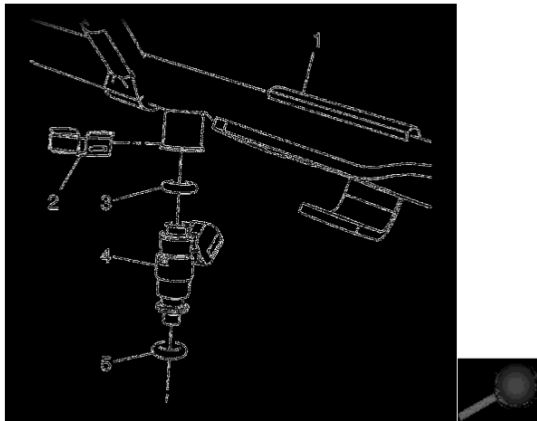
8. Connect the engine harness retainers at the fuel rail.
9. Connect the mass airflow sensor electrical connector.
10. Connect the fuel injection harness connectors (1, 2).
11. Connect the barometric pressure sensor harness connector (5).
12. Connect the supercharger air output sensor harness connector (3).
13. Connect the intake temperature sensor harness connector (4).
14. Connect the fuel pipe to the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#).
15. Install the positive crankcase ventilation hose/pipe/tube. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).
16. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
17. Pressure the fuel system and check for fuel leaks.



## Fuel Injector Replacement (L77 & LS3)

### Removal Procedure

1. Remove the fuel rail assembly. Refer to [Fuel Injection Fuel Rail Assembly Replacement](#).

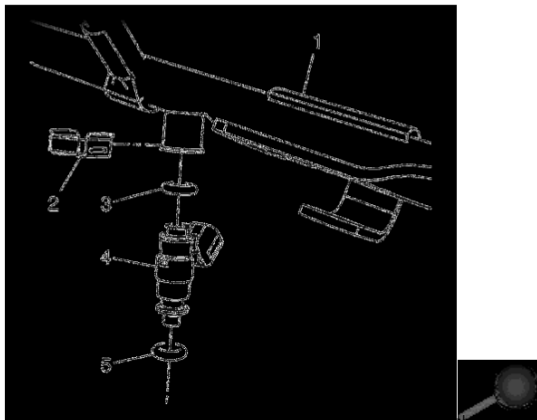


2. Remove the fuel injector to fuel rail assembly retaining clips (2).

**Caution:** Use care in removing the fuel injectors in order to prevent damage to the fuel injector electrical connector pins or the fuel injector nozzles. Do not immerse the fuel injector in any type of cleaner. The fuel injector is an electrical component and may be damaged by this cleaning method.

3. Remove the fuel injector (4) from the fuel rail (1).
4. Remove the injector lower O-ring seal (5) from the spray tip end of each injector and discard.
5. Remove the injector upper O-ring seal (3) from the fuel rail end of each injector and discard.

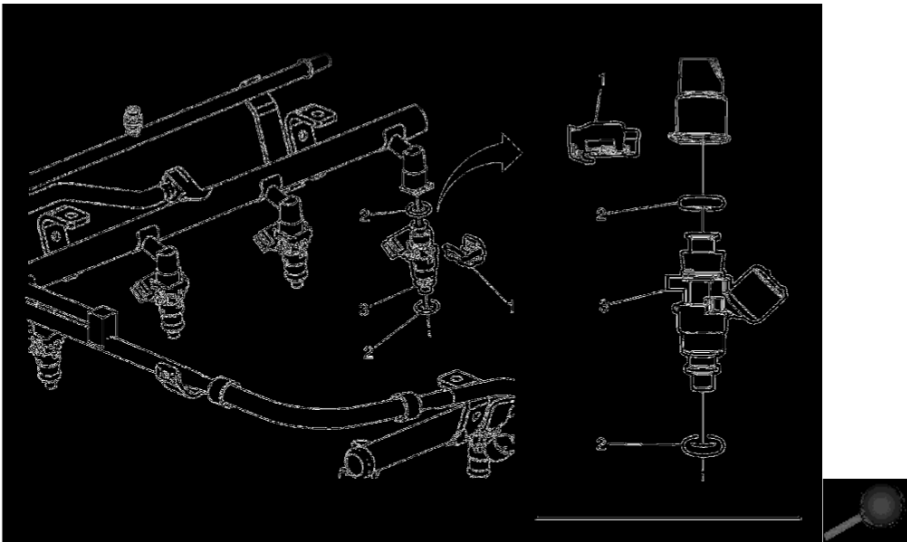
### Installation Procedure



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1. Apply a small amount of clean motor oil to the O-rings (3) and (5), before installing the new fuel injector.
2. Install the NEW injector upper O-ring seals (3) to the injectors.
3. Install the NEW injector lower O-ring seals (5) to the injectors.
4. Install the fuel injector (4) in the fuel rail (1).
5. Install the retaining clips for the fuel injector (3).
6. Install the fuel rail assembly. Refer to [Fuel Injection Fuel Rail Assembly Replacement](#).
  - 6.1. Turn the ignition switch ON for 2 seconds.
  - 6.2. Turn the ignition switch OFF for 10 seconds.
  - 6.3. Turn the ignition switch ON.
  - 6.4. Inspect for fuel leaks.

Fuel Injector Replacement (LSA)



Fuel Injector Replacement

| Callout                                                                                                                        | Component Name                                                                                                                                                         |
|--------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the fuel rail. Refer to <a href="#">Fuel Injection Fuel Rail Assembly Replacement</a> . |                                                                                                                                                                        |
| 1                                                                                                                              | Fuel Injector Retainer<br><b>Note:</b> A flat bladed tool can be used to release the retainer.                                                                         |
| 2                                                                                                                              | Fuel Injector Seals<br>Remove and replace the injector O ring seals whenever the injector is removed.                                                                  |
| 3                                                                                                                              | Fuel Injector<br><b>Note:</b> Do not use tools on the body of the injector as it may cause damage to the injector. Be sure to also keep injector tips clear of debris. |

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## Fuel Injector Cleaning

### Special Tools

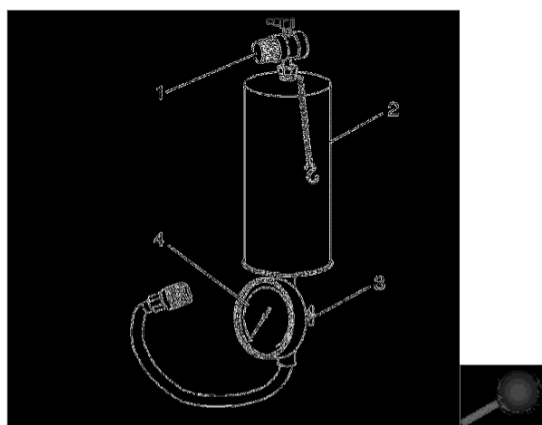
J 35800-A Fuel Injector Cleaner

For equivalent regional tools, refer to [Special Tools](#)

### Caution:

- GM Upper Engine and Fuel Injector Cleaner is the only injector cleaning agent recommended. DO NOT USE OTHER CLEANING AGENTS AS THEY MAY CONTAIN METHANOL, WHICH CAN DAMAGE FUEL SYSTEM COMPONENTS.
- Under NO circumstances should the GM Upper Engine and Fuel Injector Cleaner be added to the vehicle fuel tank, as it may damage the fuel pump and other system components.
- Do not exceed the recommended cleaning solution concentration. Higher concentrations may damage fuel system components. Testing has demonstrated that exceeding the recommended cleaning solution concentration does not improve the effectiveness of this procedure.

**Note:** Vehicles with less than 160 km (100 mi) on the odometer should not have the injectors cleaned. These vehicles should have the injectors replaced.



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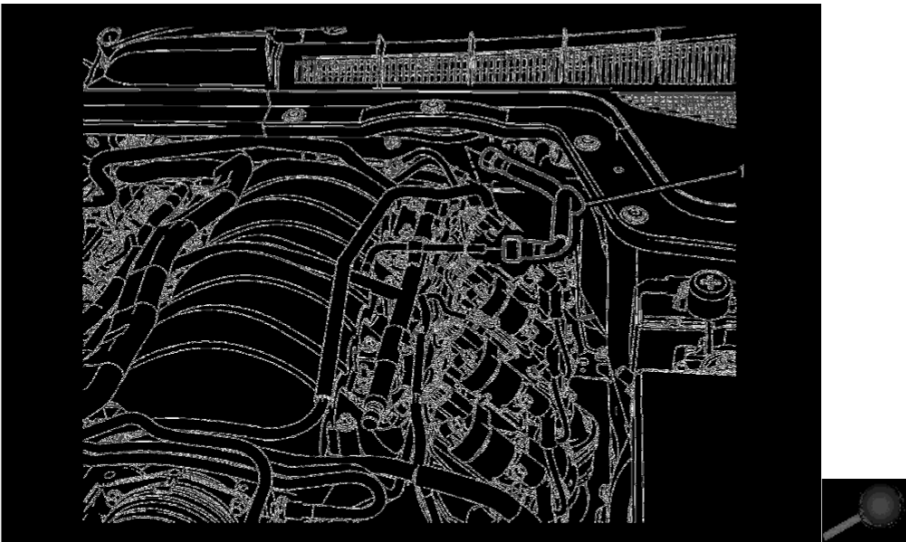
**Note:** Make sure that you read with the operating instructions of the J 35800-A fuel injector cleaner.

1. Close the valve (3).
2. Add 60 ml (2 oz) of GM Upper Engine and Fuel Injector Cleaner into the J 35800-A fuel injector cleaner tank.
3. Add 420 ml (14 oz) of fuel to the J 35800-A fuel injector cleaner tank.
4. Fill the J 35800-A fuel injector cleaner tank with fuel.
5. Relief the fuel pressure. Refer to [Fuel Pressure Relief](#).
6. Disable the fuel pump by removing the fuel pump relay.
7. Disconnect the fuel feed pipe from the fuel feed lines. Refer to [Metal Collar Quick Connect Fitting Service](#).
8. Connect the J 35800-A fuel injector cleaner to the fuel feed pipe.

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9. Open the valve (3).
  10. Pressurize the J 35800-A fuel injector cleaner to 510 kPa (75 psi).
  11. Start and idle the engine until it stalls.
  12. Turn the ignition OFF.
- Note:** The fuel injectors are clean if the injector restriction is zero.
13. Test-flow the injectors. If further cleaning is required, repeat the above procedure.
  14. Close the valve (3).
  15. Disconnect the J 35800-A fuel injector cleaner from the fuel feed pipe.
  16. Connect the fuel feed pipe to the fuel feed lines. Refer to [Metal Collar Quick Connect Fitting Service](#).
  17. Install the fuel pump relay.
  18. Start and idle the vehicle for two minutes to allow the residual injector cleaner to flush from the fuel rail and fuel injectors.
  19. Add GM Fuel System Treatment Plus into the fuel tank and fill the fuel tank with fuel. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).

Fuel Injection Fuel Feed Hose Replacement (L77 or LS3)

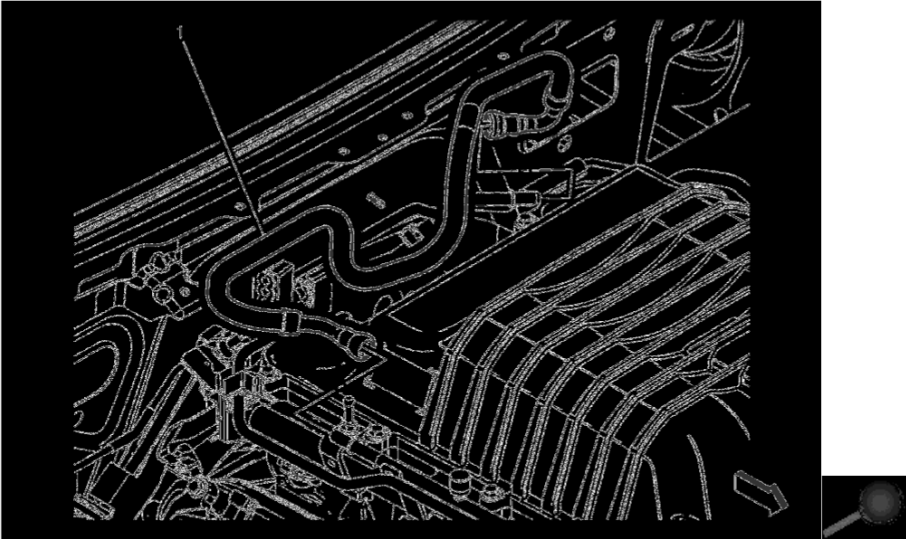


Fuel Injection Fuel Feed Hose Replacement

| Callout                                                                                                                                                                                                                                                                                                                                                                  | Component Name                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <p>1. Remove the engine cover. Refer to <a href="#">Engine Cover Replacement</a>.</p> <p>2. Relieve the fuel pressure. Refer to <a href="#">Fuel Pressure Relief</a>.</p> |                                                                                                                                                                                 |
| 1                                                                                                                                                                                                                                                                                                                                                                        | <p>Fuel Injection Fuel Feed Hose</p> <p><b>Procedure</b></p> <p>Disconnect the quick connect fittings. Refer to <a href="#">Metal Collar Quick Connect Fitting Service</a>.</p> |

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Fuel Injection Fuel Feed Hose Replacement (LSA)



Fuel Injection Fuel Feed Hose Replacement

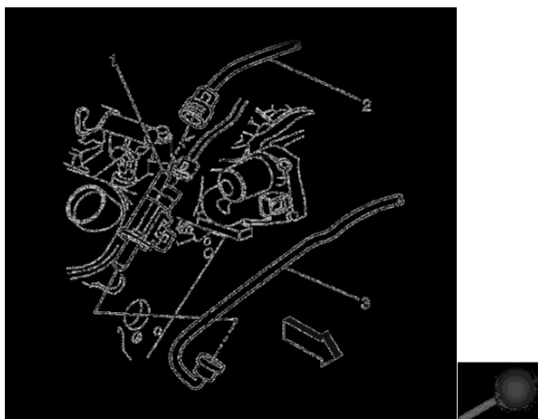
| Callout                                                                                                                                                                                                                                                                                                                                                                                            | Component Name                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <p>1. Remove the intake manifold cover. Refer to <a href="#">Intake Manifold Cover Replacement - Front</a>.</p> <p>2. Relieve the fuel pressure. Refer to <a href="#">Fuel Pressure Relief</a>.</p> |                                                                                                                                                                                 |
| 1                                                                                                                                                                                                                                                                                                                                                                                                  | <p>Fuel Injection Fuel Feed Hose</p> <p><b>Procedure</b></p> <p>Disconnect the quick connect fittings. Refer to <a href="#">Metal Collar Quick Connect Fitting Service</a>.</p> |

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## Evaporative Emission Canister Purge Solenoid Valve Replacement (L77 or LS3)

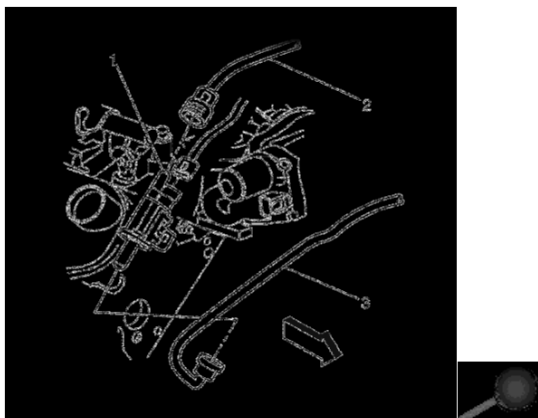
### Removal Procedure

1. Remove the engine cover. Refer to [Engine Cover Replacement](#).



2. Disconnect the EVAP engine pipe (2) to EVAP chassis tube. Refer to [Plastic Collar Quick Connect Fitting Service](#).
3. Disconnect the EVAP engine tube (3) to throttle body. Refer to [Plastic Collar Quick Connect Fitting Service](#).
4. Disconnect the wiring connector from the EVAP purge solenoid.
5. Remove the EVAP purge solenoid (1) from the vehicle.

### Installation Procedure

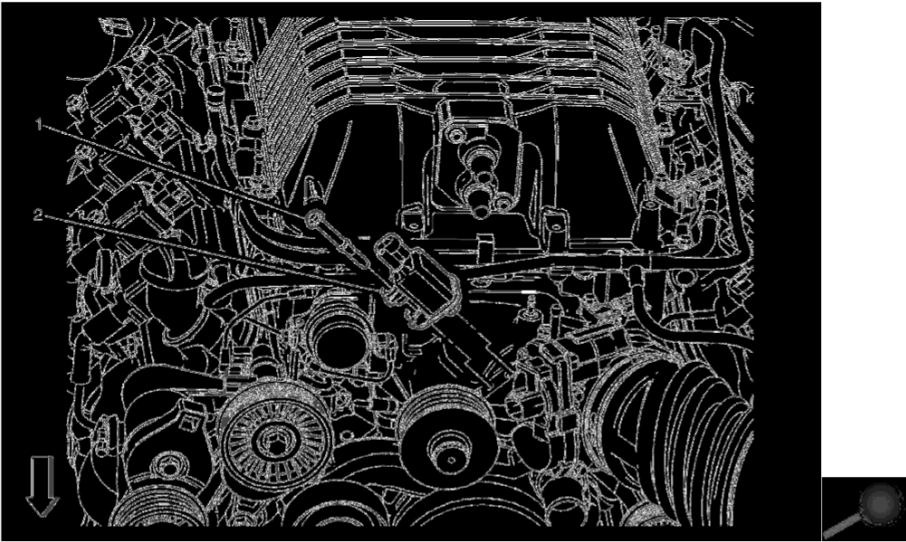


1. Install the EVAP purge solenoid (1) to the vehicle.
2. Connect the wiring connector to the EVAP purge solenoid.



3. Connect the EVAP engine tube (3) to throttle body. Refer to [Plastic Collar Quick Connect Fitting Service](#).
4. Connect the EVAP engine pipe (2) to EVAP chassis tube. Refer to [Plastic Collar Quick Connect Fitting Service](#).
5. Install the engine cover. Refer to [Engine Cover Replacement](#).

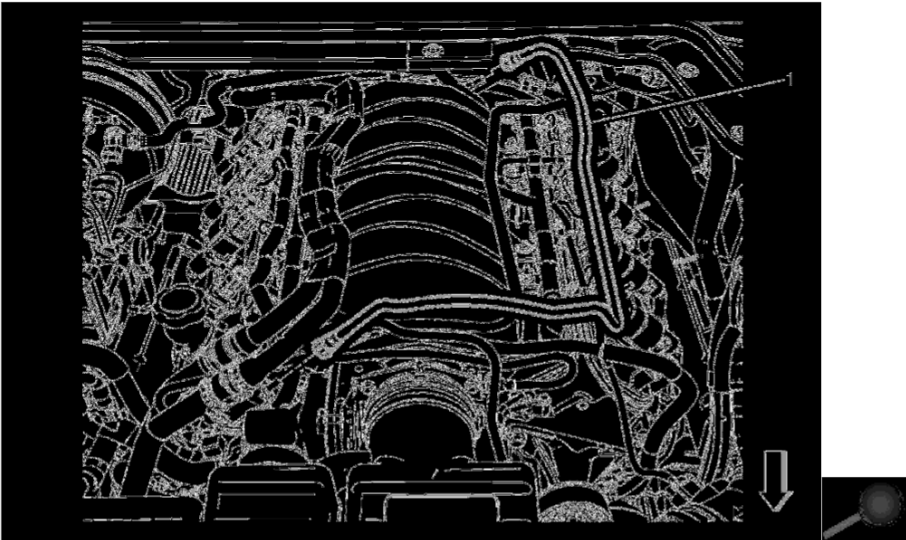
Evaporative Emission Canister Purge Solenoid Valve Replacement (LSA)



Evaporative Emission Canister Purge Solenoid Valve Replacement

| Callout                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Component Name                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <p>1. Remove the intake manifold cover. Refer to <a href="#">Intake Manifold Cover Replacement - Front</a>.</p> <p>2. Disconnect the EVAP hose from the purge valve. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a>.</p> <p>3. Disconnect the electrical connector.</p> |                                                                                                                                                        |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | EVAP Emission Canister Purge Solenoid Valve Bolt<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> .<br><b>Tighten</b><br>10 N•m (89 lb in) |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | EVAP Emission Canister Purge Solenoid Valve                                                                                                            |

Evaporative Emission Canister Purge Solenoid Valve  
Hose Replacement (L77 or LS3)



Evaporative Emission Canister Purge Solenoid Valve Hose Replacement

| Callout                                                                                                                                                                                                                                                                           | Component Name                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <p>Remove the engine cover. Refer to <a href="#">Engine Cover Replacement</a>.</p> |                                                                                                                                                                                                      |
| 1                                                                                                                                                                                                                                                                                 | <p>EVAP Emission Canister Purge Solenoid Valve Hose</p> <p><b>Procedure</b></p> <p>Disconnect the quick connect fittings. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a>.</p> |

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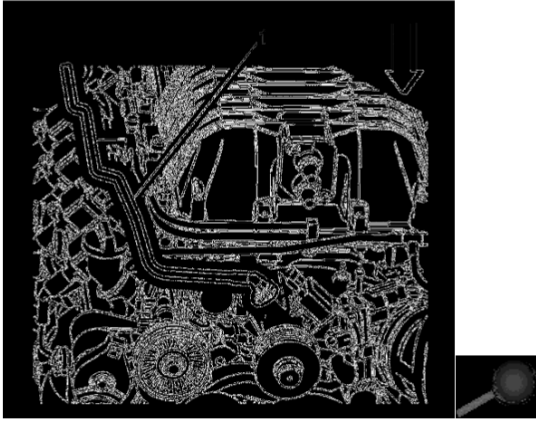
## Evaporative Emission Canister Purge Solenoid Valve Hose Replacement (LSA)

### Removal Procedure

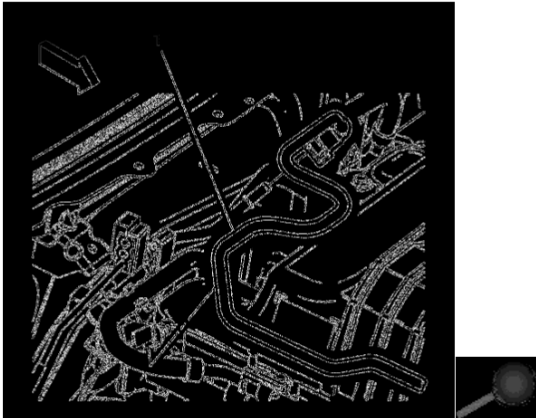
**Warning:** Refer to [Gasoline/Gasoline Vapors Warning](#).

**Warning:** Refer to [Safety Glasses Warning](#).

1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).



2. Disconnect the EVAP emission canister purge solenoid valve hose (1) from the purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#).

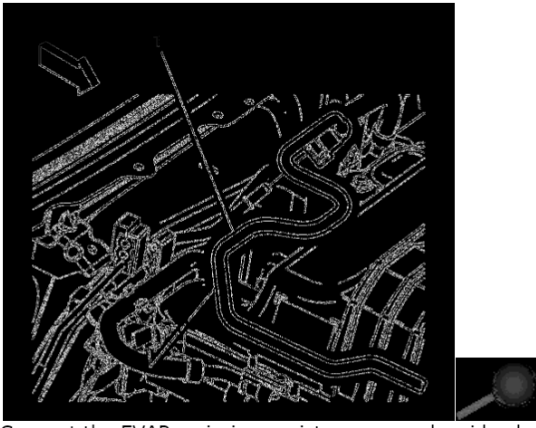


3. Disconnect the EVAP emission canister purge solenoid valve hose (1) from the EVAP pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).
4. Remove the EVAP emission canister purge solenoid valve hose from the vehicle.

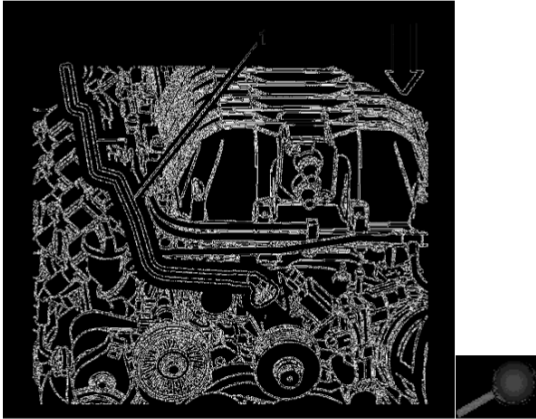
### Installation Procedure

1. Install the EVAP emission canister purge solenoid valve hose from the vehicle.

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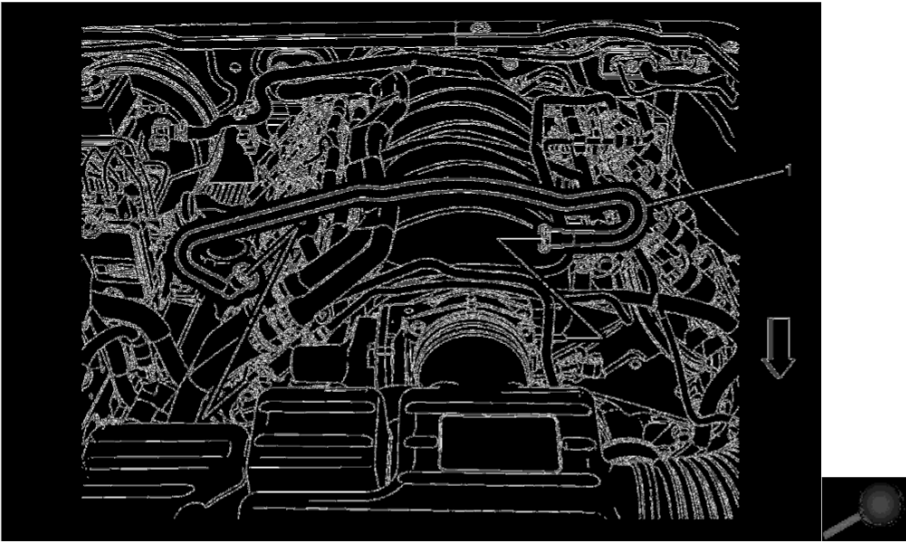


2. Connect the EVAP emission canister purge solenoid valve hose (1) to the EVAP pipe. Refer to [Plastic Collar Quick Connect Fitting Service](#).



3. Connect the EVAP emission canister purge solenoid valve hose (1) to the purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#).
4. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).

Evaporative Emission Canister Purge Tube Replacement  
(L77 or LS3)



Evaporative Emission Canister Purge Tube Replacement

| Callout                                                                                                                                                                                                                                                                           | Component Name                                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <p>Remove the engine cover. Refer to <a href="#">Engine Cover Replacement</a>.</p> |                                                                                                                                                                                       |
| 1                                                                                                                                                                                                                                                                                 | <p>EVAP Emission Canister Purge Tube</p> <p><b>Procedure</b></p> <p>Disconnect the quick connect fittings. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a>.</p> |

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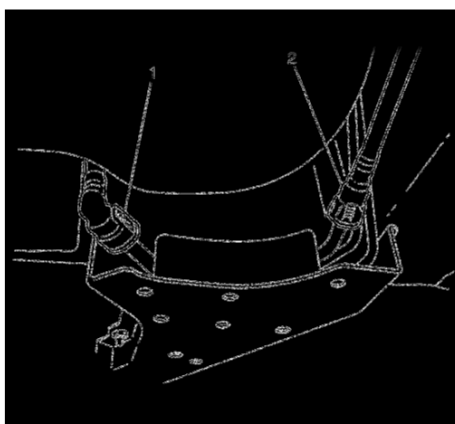
## Evaporative Emission Line Replacement - Chassis

### Removal Procedure

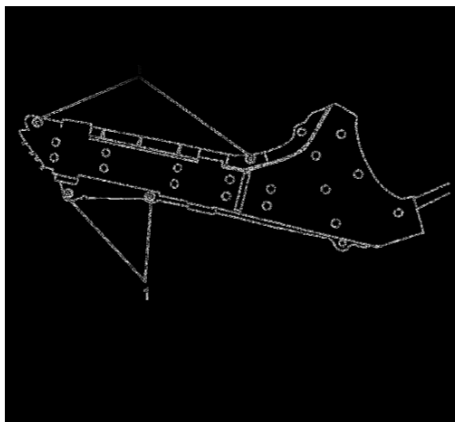
**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

**Note:** The evaporative emission (EVAP) lines can be serviceable individually or as a complete fuel/brake/EVAP pipe/line assembly. The following is the procedure for servicing the EVAP line individually.

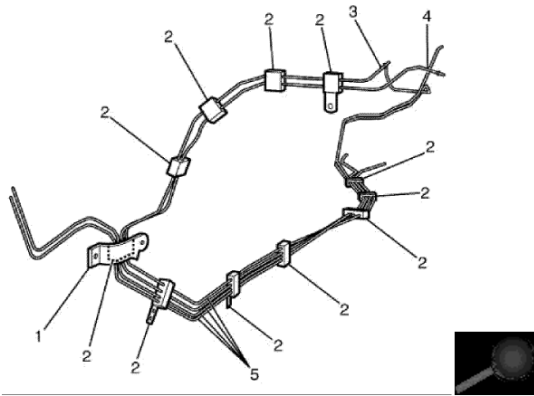
1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#)
2. Relieve the fuel system pressure. Refer to the [Fuel Pressure Relief](#)
3. Remove the exhaust system. Refer to [Fuel Pressure Relief](#)
4. Remove the engine. Refer to [Engine Replacement](#)
5. Remove the appropriate heat shields for access to the fuel/brake/EVAP pipe/line assembly.



6. Disconnect the EVAP line connector (2) from the fuel/brake/EVAP pipe/line assembly.



7. Remove the rear fuel/brake/EVAP pipe/line assembly stone guard retaining nuts (1).
8. Remove the rear fuel/brake/EVAP pipe/line assembly stone guard from the vehicle.

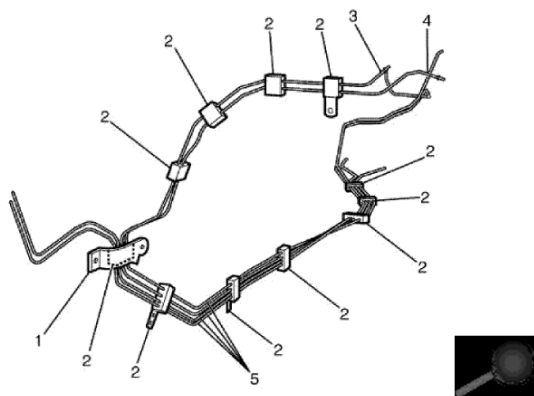


9. Remove the front fuel/brake/EVAP pipe/line assembly protection plate (1) from the vehicle.

**Note:** Mark the positions of the retainers (2) before removing the retainers (2) from the fuel/brake/EVAP pipe/line assembly.

10. Remove all the retainers (2) from the fuel/brake/EVAP pipe/line assembly (5).
11. Manoeuvre and remove the EVAP line (3) from the vehicle.

### Installation Procedure



1. Manoeuvre and install the EVAP line (3) to the vehicle.

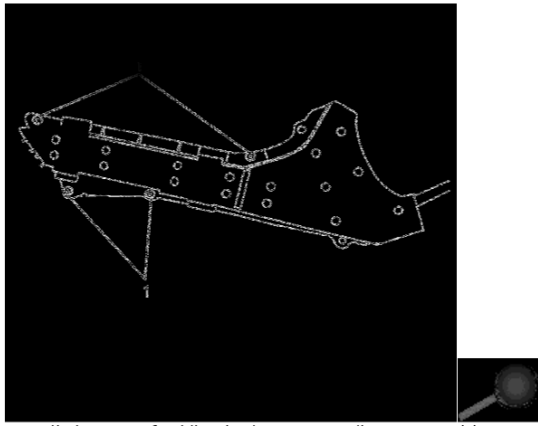
**Note:** Observe the marked positions for the retainers (2) when installing the retainers (2) to the fuel/brake/EVAP pipe/line assembly (5).

2. Install all the retainers (2) to the fuel/brake/EVAP pipe/line assembly (5).

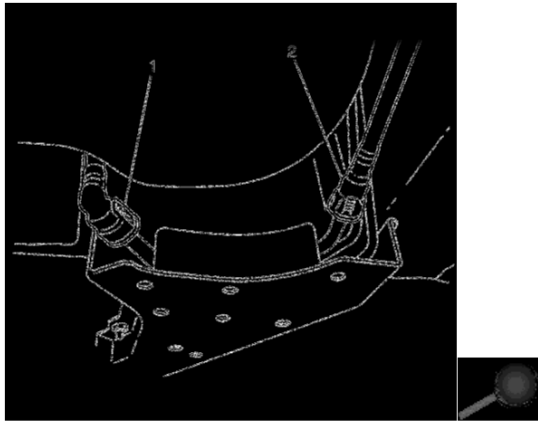
**Caution:** Refer to [Fastener Caution](#).

3. Install the front fuel/brake/EVAP pipe/line assembly protection plate (1) to the vehicle and tighten the bolts to **22 N·m (16 lb ft)**.





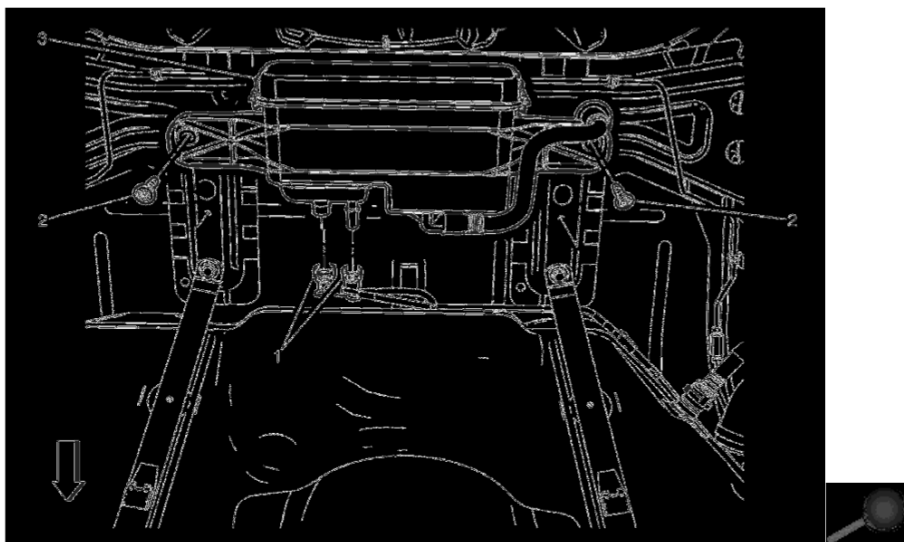
4. Install the rear fuel/brake/EVAP pipe/line assembly stone guard to the vehicle.
5. Install the rear fuel/brake/EVAP pipe/line assembly stone guard retaining nuts (1) and tighten to **4 N·m (35 lb in)**.



**Note:** Listen for an audible click to confirm correct installation of the EVAP line connector.

6. Connect the EVAP line connector (2) to the fuel/brake/EVAP pipe/line assembly.
7. Install the removed heat shields.
8. Install the engine. Refer to [Engine Replacement](#) Engine Replacement.
9. Install the exhaust system. Refer to [Fuel Pressure Relief](#) Exhaust System Replacement.
10. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#) Battery Negative Cable Disconnection and Connection.

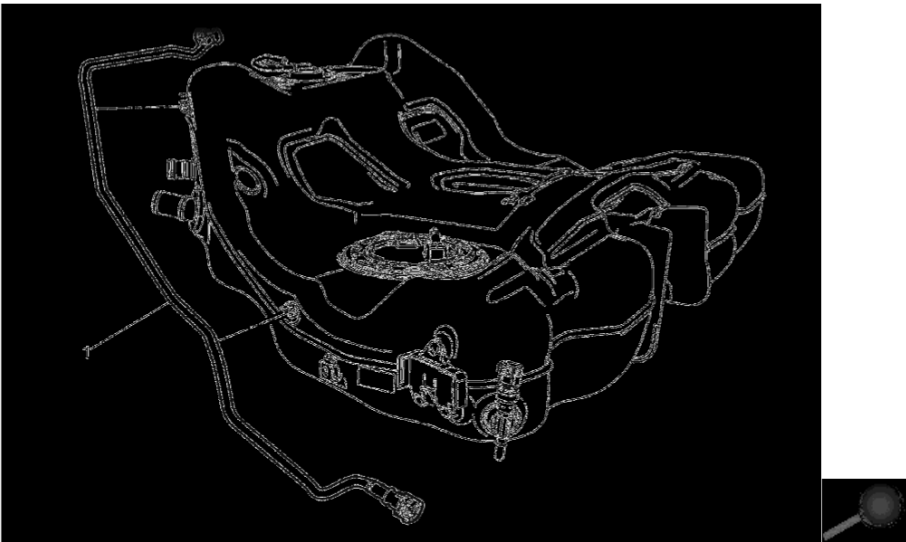
## Evaporative Emission Canister Replacement



Evaporative Emission Canister Replacement

| Callout                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Component Name                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Danger:</b> To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.</p> <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <ol style="list-style-type: none"><li>1. Raise and support the vehicle. Refer to <a href="#">Lifting and Jacking the Vehicle</a>.</li><li>2. Remove the rear suspension support. Refer to <a href="#">Rear Suspension Support Removal and Installation</a>.</li></ol> |                                                                                                                                                                      |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | EVAP Emission Hoses<br><b>Procedure</b><br>Disconnect the EVAP hoses from the EVAP canister. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a> . |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | EVAP Emission Canister Fasteners (Qty: 2)<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> .                                                             |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | EVAP Emission Canister                                                                                                                                               |

Evaporative Emission Canister Purge Pipe Replacement



Evaporative Emission Canister Purge Pipe Replacement

| Callout                                                                                                                                                                                                                                                                     | Component Name                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <p>Remove the fuel tank. Refer to <a href="#">Fuel Tank Replacement</a>.</p> |                                                                                                                                                                           |
| 1                                                                                                                                                                                                                                                                           | <p>EVAP Emission Canister Purge Pipe</p> <p><b>Procedure</b></p> <p>Disconnect the EVAP emission canister purge pipe from the EVAP pipe to fuel tank retaining clips.</p> |

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## Evaporative Emission System Cleaning

### Special Tools

GE 41413-200 Evaporative Emission System Tester

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

### Inspection Procedure

**Caution:** Use the Evaporative Emission (EVAP) System Tester (EEST) GE 41413-A in order to provide a clean, dry, low pressure nitrogen gas source. Do not substitute any other pressurized source, gas or otherwise. Damage may result to the EVAP system, test equipment or cause a safety risk.

**Note:** Proceed with the following procedure only if referenced by an evaporative emission (EVAP) diagnostic or repair procedure.

1. Turn OFF the ignition.
2. Remove the EVAP canister purge valve. Refer to [Evaporative Emission Canister Purge Solenoid Valve Replacement](#).
3. Lightly tap the EVAP canister purge valve on a hard surface.
4. Inspect for carbon particles exiting either of the vacuum ports.
  - If no carbon particles were detected, but a blockage was detected during a diagnostic procedure, install the original EVAP canister purge valve. Continue with the cleaning procedure.
  - If carbon particles are found during the inspection procedure, continue with the cleaning procedure.
  - If a diagnostic procedure directed you to replace the EVAP canister purge valve and no carbon particles were detected, replace the EVAP canister purge valve. Return to the published service procedure.

### Cleaning Procedure

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the EVAP canister. Refer to [Evaporative Emission Canister Replacement](#).
3. Turn OFF the main valve on the GE 41413-200 evaporative emission system tester.
4. Disconnect the hose from the diagnostic station pressure regulator.
5. Using a section of vacuum hose, connect one end onto the EVAP pressure/purge diagnostic station pressure regulator.
6. Connect the other end of the vacuum hose to the canister side of the purge pipe.
7. Turn ON the main nitrogen cylinder valve and continue to discharge nitrogen for 15 seconds.
8. If the nitrogen does not clear the blockage, replace the purge pipe.
9. Return the EVAP pressure/purge diagnostic station to the stations original condition.
10. Install a new EVAP canister. Refer to [Evaporative Emission Canister Replacement](#).
11. Lower the vehicle.
12. Install a new EVAP canister purge valve. Refer to [Evaporative Emission Canister Purge Solenoid Valve Replacement](#).
13. Return to the diagnostic table that sent you here.

Ignition Coil Replacement (LSA)



Ignition Coil Replacement

| Callout | Component Name                                                                                                                                                                                                                                                             |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | <p>Ignition Coil Fastener (Qty: 2)</p> <p><b>Caution:</b> Refer to <a href="#">Fastener Caution</a>.</p> <p><b>Procedure</b></p> <p>Remove ignition coil fasteners retaining the ignition coil and bracket as necessary.</p> <p><b>Tighten</b></p> <p>12 N•m (9 lb ft)</p> |
| 2       | <p>Power Brake Boost Vacuum Hose Bracket</p> <p><b>Procedure</b></p> <p>Reposition the power brake boost vacuum hose bracket.</p>                                                                                                                                          |
| 3       | <p>Ignition Coil</p> <p><b>Procedure</b></p> <p>1. Relocate wiring harnesses and hoses as necessary.</p> <p>2. Disconnect the electrical wiring harness connector from the ignition coil.</p> <p>3. Disconnect the spark plug wire from the ignition coil.</p>             |

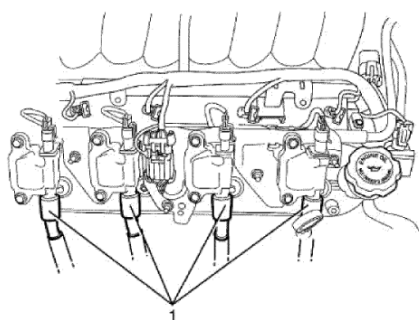
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## Ignition Coil Replacement (L77 or LS3)

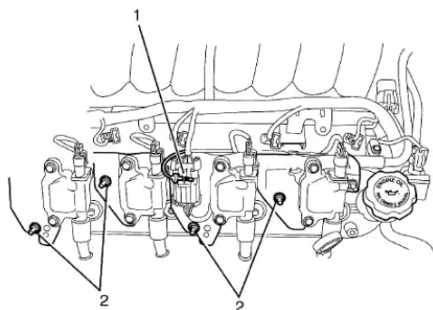
### Removal Procedure

**Warning:** Refer to [Battery Disconnect Warning](#).

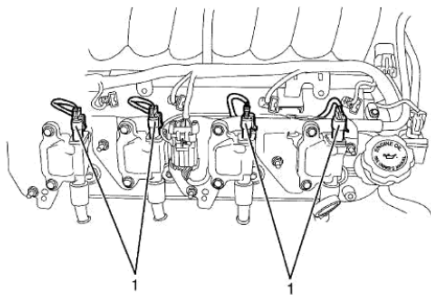
1. Disconnect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the engine cover. Refer to [Engine Cover Replacement](#).
3. Remove the fuel injection fuel feed hose. Refer to [Fuel Injection Fuel Feed Hose Replacement](#).
4. If replacing the right side coils, remove the evaporative emission canister purge solenoid valve hose. Refer to [Evaporative Emission Canister Purge Solenoid Valve Hose Replacement](#).
5. Reposition the engine wire harness as necessary.



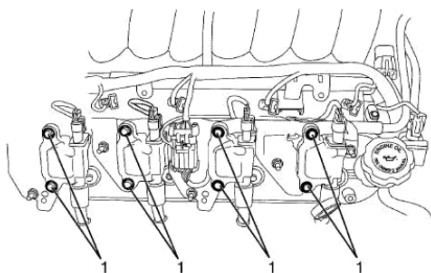
6. Disconnect the spark plug wires (1) from the ignition coils.



7. Disconnect the main ignition coil harness connector (1) from the ignition coil assembly.
8. Remove the ignition coil assembly to rocker cover retaining bolts (2).

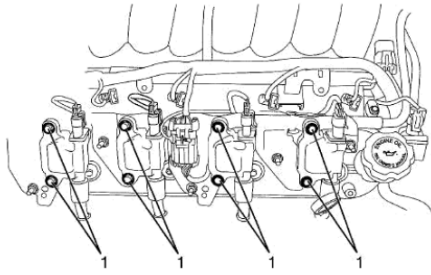


9. Remove the ignition coil assembly from the engine.
10. Disconnect the ignition coil to ignition coil wiring harness connectors (1).



11. Remove the ignition coil to ignition coil assembly retaining bolts (1).
12. Remove the ignition coils from the ignition coil assembly.

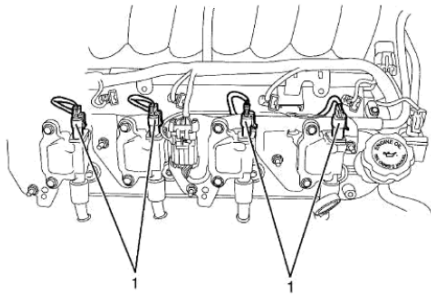
#### [Installation Procedure](#)



1. Install the ignition coil assembly.

**Caution:** Refer to [Fastener Caution](#).

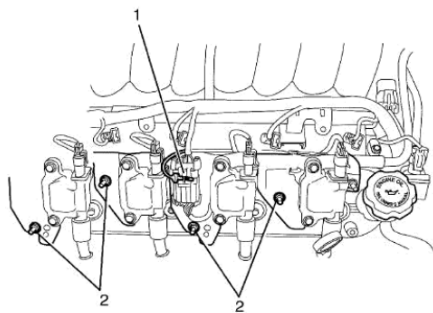
2. Install the ignition coil to ignition coil assembly retaining bolts (1) and tighten to **12 N•m (106 lb in)**.



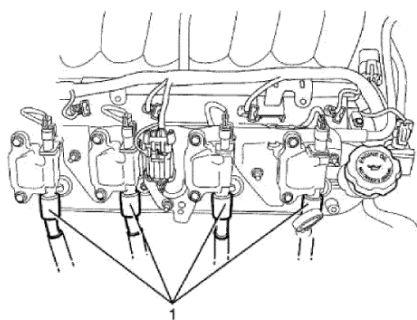
3. Connect the ignition coil to ignition coil wiring harness connectors (1).

4. Install the ignition coil assembly to the engine.





5. Install the ignition coil assembly to rocker cover retaining bolts (2) and tighten to **12 N•m (106 lb in)**.
6. Connect the main ignition coil harness connector (1) to the ignition coil assembly.



7. Connect the spark plug wires (1) to the ignition coils.
8. Install the engine cover. Refer to [Engine Cover Replacement](#).
9. Connect the battery ground cable to the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
10. If the right side coils were replaced, install the evaporative emission canister purge solenoid valve hose. Refer to [Evaporative Emission Canister Purge Solenoid Valve Hose Replacement](#).
11. Install the fuel injection fuel feed hose. Refer to [Fuel Injection Fuel Feed Hose Replacement](#).

## Spark Plug Wire Inspection

Spark plug wire integrity is vital for proper engine operation. A thorough inspection will be necessary to accurately identify conditions that may affect engine operation. Inspect for the following conditions:

1. Any signs of cracks or splits in the wires.
2. Inspect each boot for the following conditions:
  - Tearing
  - Piercing
  - Arcing
  - Carbon tracking
  - Corroded terminal

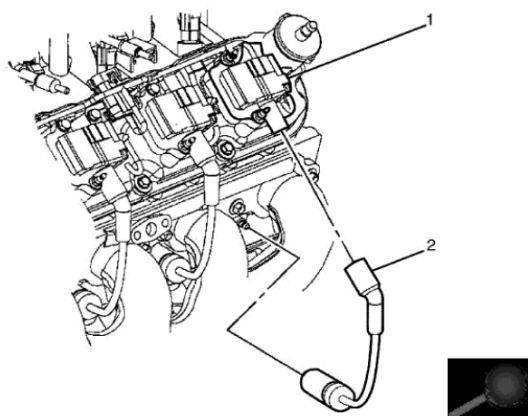
If corrosion, carbon tracking, or arcing are indicated on a spark plug wire boot or on a terminal, replace the wire and the component connected to the wire.

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## Spark Plug Wire Replacement (L77 & LS3)

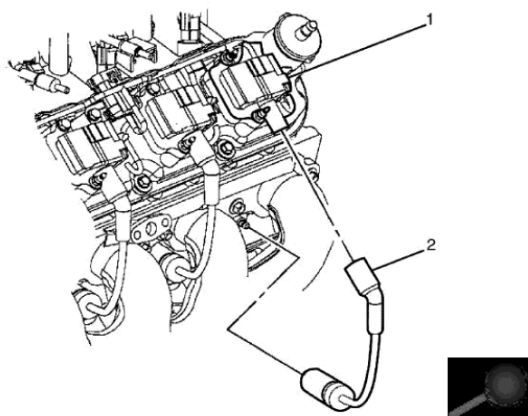
### Removal Procedure

1. Remove the engine cover. Refer to [Engine Cover Replacement](#).



2. Disconnect the spark plug wire (2) to the spark plug.
  - Twist each spark plug boot 1/2 turn.
  - Pull only on the boot in order to remove the wire from each spark plug.
3. Disconnect the spark plug wire from the ignition coil (1).
  - Twist each spark plug boot 1/2 turn.
  - Pull only on the boot in order to remove the wire from the ignition coil.

### Installation Procedure

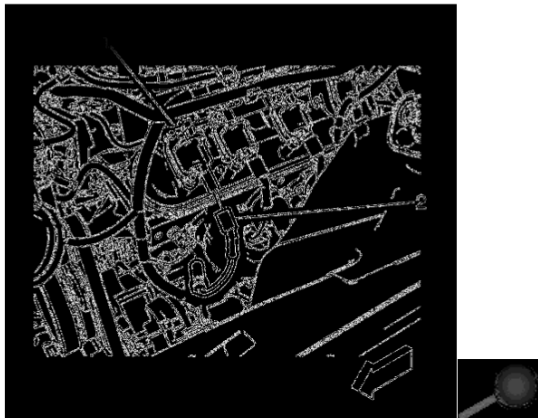


1. Install the spark plug wire to the ignition coil (1).
2. Inspect the inside of the ignition coil rubber boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure:

- 2.1. Apply a thin coating of dielectric grease evenly to the inside of the ignition coil rubber boot, up to a depth of 15 mm from the end of the boot. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
  - 2.2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.
3. Install the spark plug wire (2) to the spark plug.
4. Inspect the spark plug wire for proper installation:
  - Push sideways on each spark plug boot in order to inspect the seating.
  - Reinstall any loose spark plug boot.
5. Install the engine cover. Refer to [Engine Cover Replacement](#).

## Spark Plug Wire Replacement (LSA)

### Removal Procedure



1. Disconnect the spark plug wire (2) to the spark plug.
  - Twist each spark plug boot 1/2 turn.
  - Pull only on the boot in order to remove the wire from each spark plug.
2. Disconnect the spark plug wire from the ignition coil (1).
  - Twist each spark plug boot 1/2 turn.
  - Pull only on the boot in order to remove the wire from the ignition coil.

### Installation Procedure



1. Install the spark plug wire to the ignition coil (1).
2. Inspect the inside of the ignition coil rubber boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure:

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- 2.1. Apply a thin coating of dielectric grease evenly to the inside of the ignition coil rubber boot, up to a depth of 15 mm from the end of the boot. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
  - 2.2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.
3. Install the spark plug wire (2) to the spark plug.
4. Inspect the spark plug wire for proper installation:
  - Push sideways on each spark plug boot in order to inspect the seating.
  - Reinstall any loose spark plug boot.

## Spark Plug Inspection

### Spark Plug Usage

Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to the Electronic Parts Catalog.

### Spark Plug Inspection



- Inspect the terminal post (1) for damage.
  - Inspect for a bent or broken terminal post (1).
  - Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.
- Inspect the insulator (2) for flashover or carbon tracking, soot. This condition is often mistakenly identified as a cracked insulator. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
  - Inspect the spark plug boot for damage.
  - Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant, or water. A spark plug boot that is saturated causes arcing to ground.
- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).
- Inspect for evidence of improper arcing.
 

**Note:** To avoid damage to the iridium tip on the centre electrode, DO NOT attempt to adjust spark plug gap. If the spark plug gap does not meet specifications, replace the spark plug. Refer to [Ignition System Specifications](#). Refer to [Spark Plug Replacement](#).

  - Measure the gap between the center electrode (4) and the side electrode (3) terminals. This must be done carefully in order to avoid damaging the small diameter Iridium center electrode. Refer to [Ignition System Specifications](#). An excessively wide electrode gap can prevent correct spark plug operation.
  - Inspect for the correct spark plug torque. Refer to [Ignition System Specifications](#). Insufficient torque can prevent correct spark plug operation. An over torqued spark plug, causes the insulator (2) to crack.

- Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
- Inspect for a broken or worn side electrode (3).
- Inspect for a broken, worn, or loose center electrode (4) by shaking the spark plug.
  - A rattling sound indicates internal damage.
  - A loose center electrode (4) reduces the spark intensity.
- Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
- Inspect for worn or missing platinum pads on the electrodes (3, 4) If equipped.
- Inspect for excessive fouling.
- Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

#### **Spark Plug Visual Inspection**

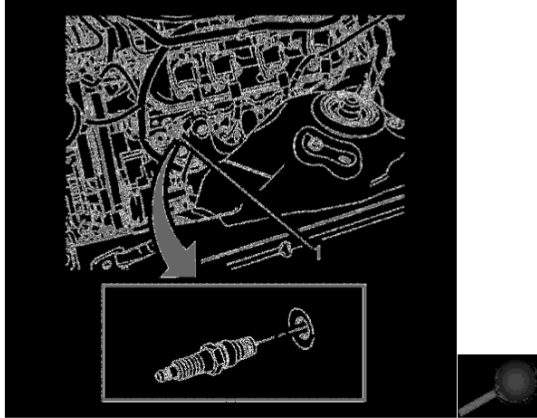
- Normal operation—Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives. Reddish orange deposits can indicate MMT fuel additive which is still used in some markets around the world (will cause misfire and cannot be burned off). MMT fuel additive use should be avoided.
- Carbon Fouled—Dry, fluffy black carbon, or soot caused by the following conditions:
  - Rich fuel mixtures
    - Leaking fuel injectors
    - Excessive fuel pressure
    - Restricted air filter element
    - Incorrect combustion
  - Reduced ignition system voltage output
    - Weak coils
    - Worn ignition wires
    - Incorrect spark plug gap
  - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
- Deposit Fouling—Oil, coolant, or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.



## Spark Plug Replacement (L77 or LS3)

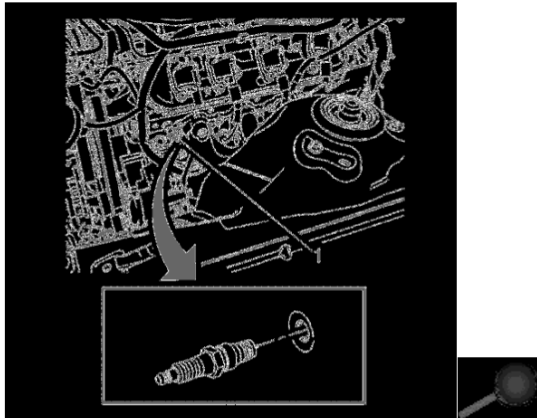
### Removal Procedure

1. Remove the engine cover. Refer to [Engine Cover Replacement](#).
2. If the left side spark plugs are being serviced, remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).
3. Remove the spark plug wires. Refer to [Spark Plug Wire Replacement](#).



4. Loosen each spark plug 1 or 2 turns.
5. Use a brush, or use compressed air in order to remove any dirt from the spark plugs.
6. Remove the spark plugs one at a time and place each plug in a tray marked with the corresponding cylinder numbers.

### Installation Procedure



1. If reusing spark plugs, Refer to [Spark Plug Inspection](#).

**Note:** If using NEW spark plugs, do NOT attempt to check gap. Plugs come pre-gapped.

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2. Hand start the spark plugs in the corresponding cylinders.

**Caution:** Refer to [Fastener Caution](#).

3. Tighten the spark plugs. Tighten the engine spark plug on a NEW cylinder head to **20 N•m (15 lb ft)** and the engine spark plug on subsequent installations to **15 N•m (11 lb ft)**.

4. Install the spark plug wires. Refer to [Spark Plug Wire Replacement](#).

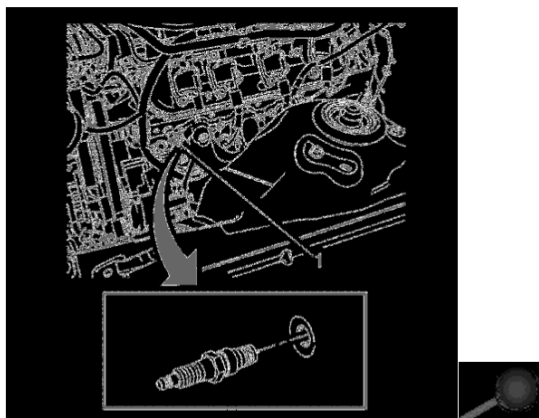
5. Install the engine cover. Refer to [Engine Cover Replacement](#).

6. If the left side spark plugs are being serviced, install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).

## Spark Plug Replacement (LSA)

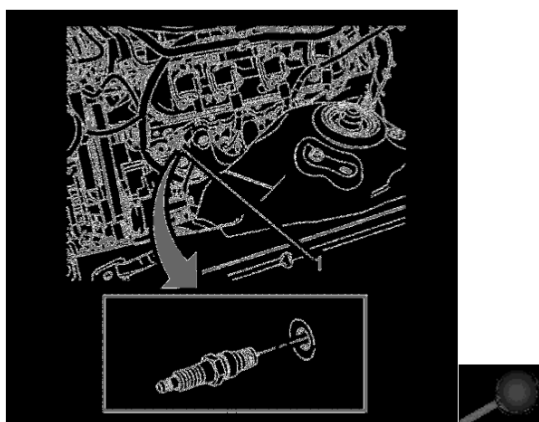
### Removal Procedure

1. If the left side spark plugs are being serviced, remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).
2. Remove the spark plug wires. Refer to [Spark Plug Wire Replacement](#).



3. Loosen each spark plug (1) approximately 1 or 2 turns.
4. Use a brush, or use compressed air in order to remove any dirt from the spark plugs.
5. Remove the spark plugs one at a time and place each plug in a tray marked with the corresponding cylinder numbers.

### Installation Procedure



**Note:** The spark plug comes pre-gapped. Do not change the spark plug gap from 1.01 mm (0.040 in).

1. Inspect each spark plug gap. Refer to [Ignition System Specifications](#).

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2. Hand start the spark plugs (1) in the corresponding cylinders.

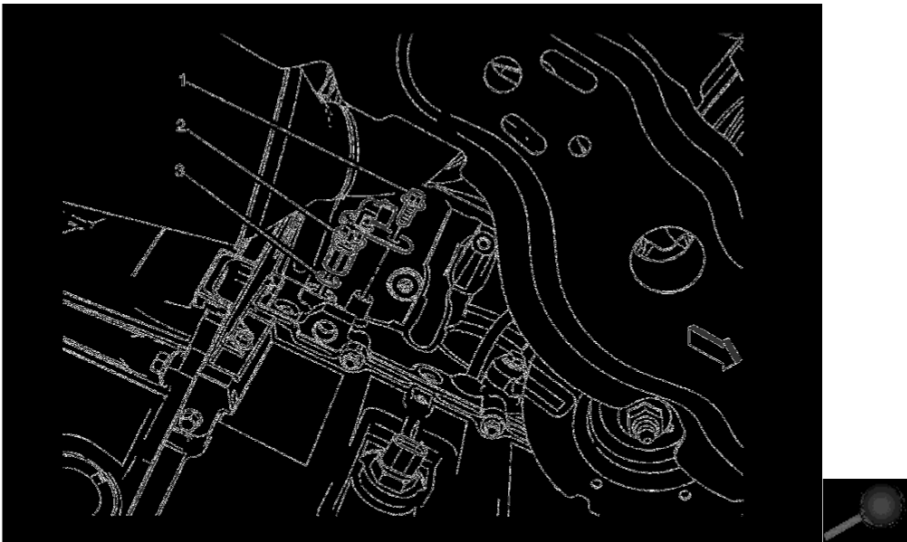
**Caution:** Refer to [Fastener Caution](#).

3. Tighten the spark plugs. Tighten the engine spark plug on a NEW cylinder head to **20 N•m (15 lb ft)** and the engine spark plug on subsequent installations to **15 N•m (11 lb ft)**.

4. Install the spark plug wires. Refer to [Spark Plug Wire Replacement](#).

5. If the left side spark plugs are being serviced, install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).

Crankshaft Position Sensor Replacement



Crankshaft Position Sensor Replacement

| Callout                                                                                            | Component Name                                                                                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the starter. Refer to <a href="#">Starter Replacement</a> . |                                                                                                                                                                                                                                                                                                          |
| 1                                                                                                  | Crankshaft Position Sensor Fastener<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> .<br><b>Tighten</b><br>25 N•m (18 lb ft)                                                                                                                                                                |
| 2                                                                                                  | Crankshaft Position Sensor<br><b>Procedure</b><br>1. Disconnect the crankshaft position sensor electrical connector.<br>2. Perform the crankshaft position system variation learn after installing the crankshaft position sensor. Refer to <a href="#">Crankshaft Position System Variation Learn</a> . |
| 3                                                                                                  | Crankshaft Position Sensor Seal<br><b>Note:</b> If reinstalling the sensor, inspect the seal for damage and replace as needed.                                                                                                                                                                           |

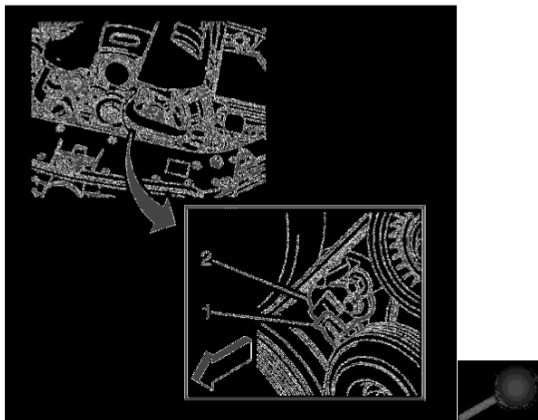
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## Camshaft Position Sensor Replacement (L77 or LS3)

### Removal Procedure

**Warning:** Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).



3. Disconnect the camshaft position (CMP) sensor electrical connector (1).



4. Remove the CMP sensor to engine front cover retaining bolt (1).
5. Remove the CMP sensor (2) from the engine front cover.
6. Remove and DISCARD the CMP sensor O-ring (3).

### Installation Procedure



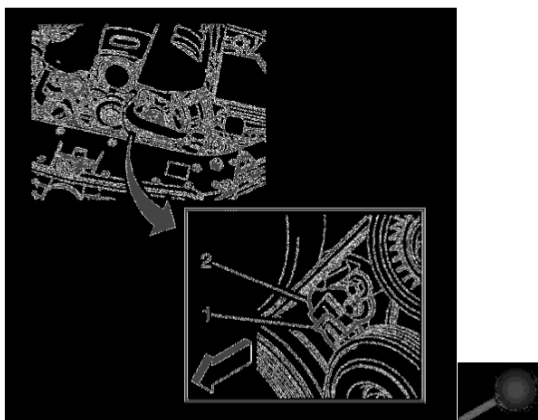
**Note:** Install a NEW O-ring to the camshaft sensor

**Note:** Before installing the camshaft sensor, apply a small amount of clean motor oil to the O-ring (3).

1. Install a NEW O-ring (3) to the CMP sensor.
2. Install the CMP sensor (2) to the engine front cover.

**Caution:** Refer to [Fastener Caution](#).

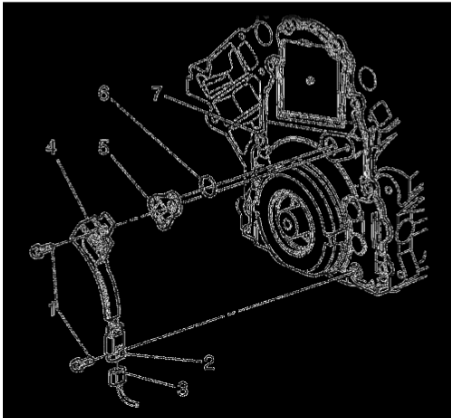
3. Install the CMP sensor to engine front cover retaining bolt (1) and tighten to **9 N·m (80 lb in)**.



4. Connect the CMP sensor electrical connector (1) to wiring harness.
5. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
6. Connect the battery ground cable to the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
7. If re-programming is required, refer to [Control Module References](#).

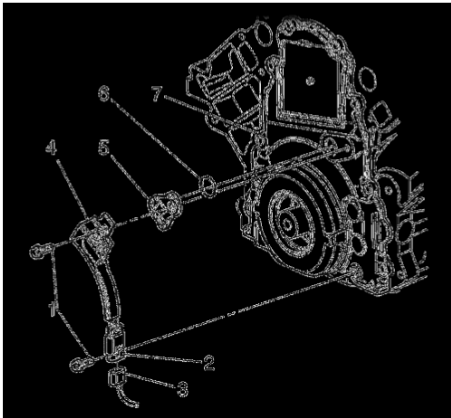
## Camshaft Position Sensor Replacement (LSA)

### Removal Procedure



1. Remove the generator bracket assembly. Refer to [Generator Bracket Replacement](#).
2. Remove the camshaft position sensor mounting bolts (1).
3. Remove the camshaft position sensor assembly (4, 5, 6) from the front cover (7).
4. Disconnect the camshaft position sensor jumper harness (2) and the engine harness (3) electrical connectors.
5. Remove the camshaft sensor assembly (4, 5, 6).
6. Disconnect camshaft position sensor (5) from the jumper harness (4).

### Installation Procedure



1. Reconnect the camshaft sensor (5) and the jumper harness (4).
2. Install the O-ring (6) on the camshaft sensor assembly (4 and 5).



3. Reconnect the camshaft position sensor assembly (4, 5 and 6) and the engine harness connector (3).

**Note:** Before installing the camshaft sensor assembly, apply a small amount of clean motor oil to the O-ring (6).

4. Install the camshaft position sensor assembly (4, 5 and 6) in the front cover (7).

**Caution:** Refer to [Fastener Caution](#).

5. Install the camshaft position sensor mounting bolts and tighten to **25 N•m (18 lb ft)**.
6. Install the generator assembly. Refer to [Generator Bracket Replacement](#).

## Knock Sensor Replacement (Right Bank)

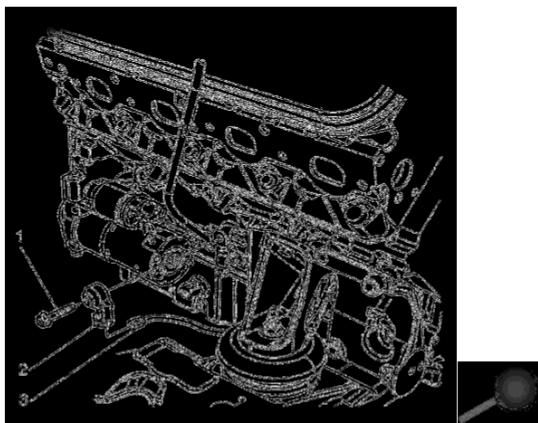
### Removal Procedure

**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

**Warning:** Refer to [Protective Goggles and Glove Warning](#).

**Warning:** Refer to [Battery Disconnect Warning](#).

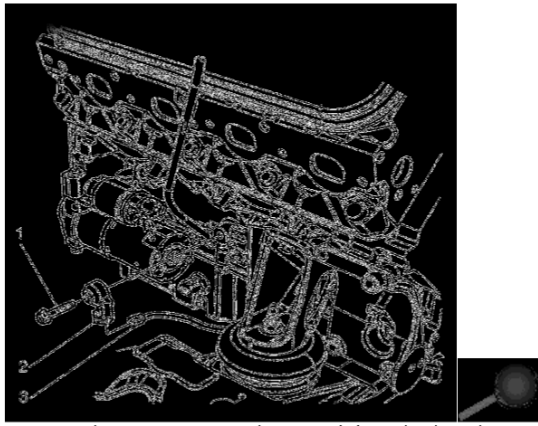
1. Disconnect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the oil pan shield. Refer to [Oil Pan Shield Replacement](#).



3. Disconnect the engine wiring harness (3) from the knock sensor (2).
4. Remove the knock sensor to engine block retaining bolt (1).
5. Remove the knock sensor (2) from the engine block.

### Installation Procedure

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1. Connect the engine wiring harness (3) to the knock sensor (2).
2. Position the knock sensor (2) on the engine block.
- Caution:** Refer to [Fastener Caution](#).
3. Install the knock sensor to engine block retaining bolt (1) and tighten to **25 N•m (18 lb ft)**.
4. Install the oil pan shield. Refer to [Oil Pan Shield Replacement](#).
5. Connect the battery ground cable to the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

## Knock Sensor Replacement (Left Bank)

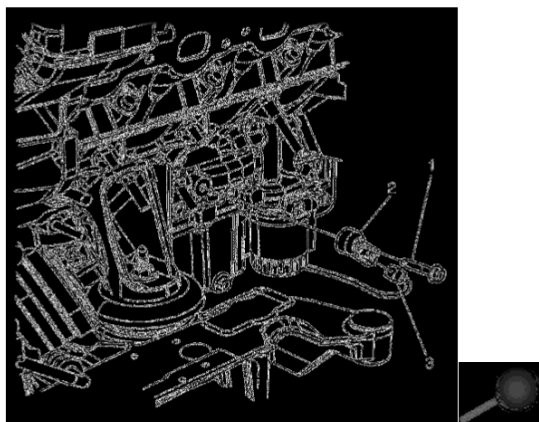
### Removal Procedure

**Danger:** To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

**Warning:** Refer to [Protective Goggles and Glove Warning](#).

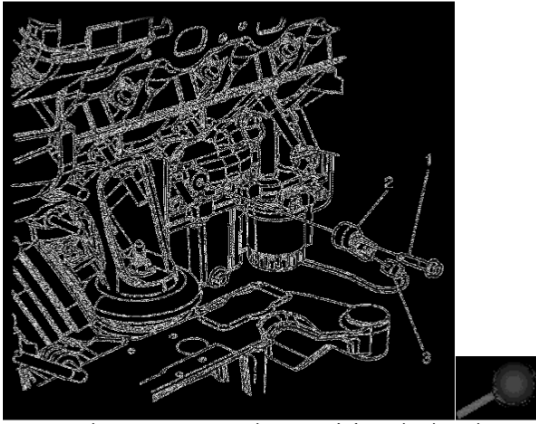
**Warning:** Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the oil pan shield. Refer to [Oil Pan Shield Replacement](#).



4. Disconnect the engine wiring harness (3) from the knock sensor (2).
5. Remove the knock sensor to engine block retaining bolt (1).
6. Remove the knock sensor (2) from the engine block.

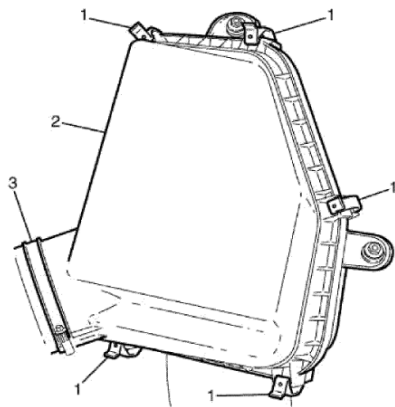
### Installation Procedure



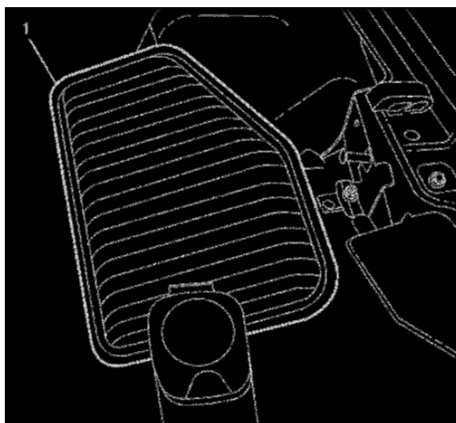
1. Connect the engine wiring harness (3) to the knock sensor (2).
2. Position the knock sensor (2) on the engine block.
- Caution:** Refer to [Fastener Caution](#).
3. Install the knock sensor to engine block retaining bolt (1) and tighten to **25 N•m (18 lb ft)**.
4. Install the oil pan shield. Refer to [Oil Pan Shield Replacement](#).
5. Connect the battery ground cable to the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

## Air Cleaner Element Replacement

### [Removal Procedure](#)

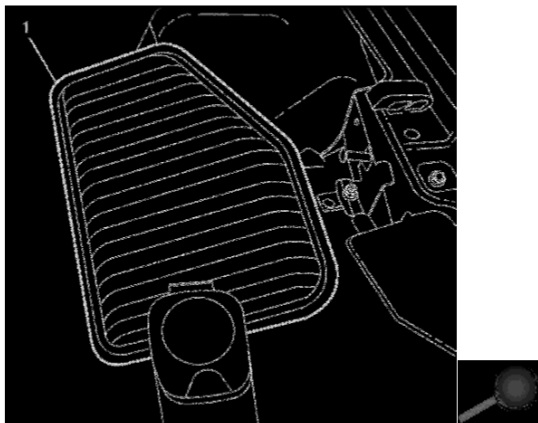


1. Remove the air cleaner outlet duct to air cleaner upper housing retaining clamp (3).
2. Release the air cleaner lower housing retainers (1) and remove the air cleaner upper housing (2) from the air cleaner assembly.

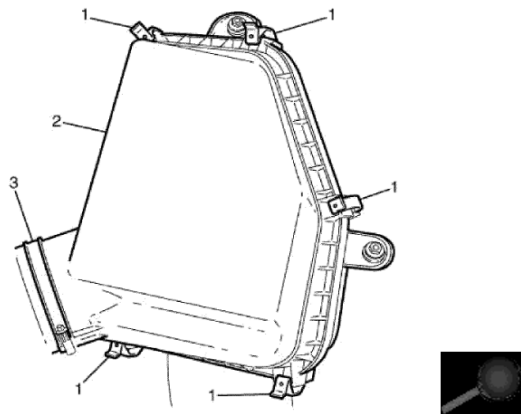


3. Remove the air cleaner element (1) from the air cleaner assembly.

### [Installation Procedure](#)



1. Install the NEW air cleaner element (1) to the air cleaner assembly.



2. Install the air cleaner upper housing (2) to the air cleaner assembly.

**Note:** Listen for an audible click to confirm correct installation of the air cleaner lower housing retainers (1).

3. Install the air cleaner lower housing retainers (1) to the air cleaner upper housing (2).
4. Install the air cleaner outlet duct to air cleaner upper housing retaining clamp (3).

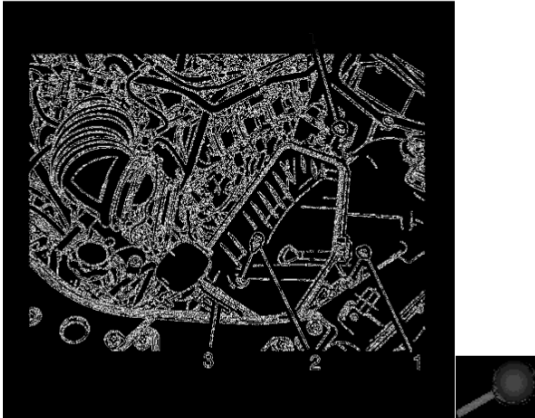
**Caution:** Refer to [Fastener Caution](#).

5. Install the air cleaner outlet duct to air cleaner upper housing retaining clamp (3) and tighten to **2 N·m (18 lb in)**.

## Air Cleaner Assembly Replacement

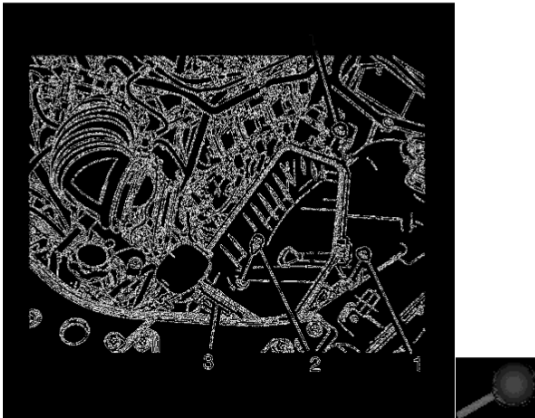
### Removal Procedure

1. Ignition OFF.



2. Remove the air cleaner element. Refer to [Air Cleaner Element Replacement](#).
3. Remove the air cleaner assembly to chassis retaining bolts (1).
4. Apply suitable upward pressure to the air cleaner lower housing (3) to release the retainer (2).
5. Remove the air cleaner lower housing (3) from the vehicle.

### Installation Procedure



1. Install the air cleaner lower housing (3) to the vehicle.
2. Apply suitable downward pressure to the air cleaner lower housing (3) to engage the retainer (2).
3. Install the air cleaner to chassis retaining bolts (1) and tighten to **10N•m (89 lb in)**.

**Caution:** Refer to [Fastener Caution](#).

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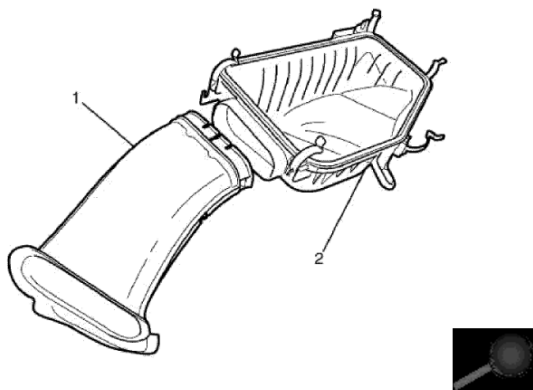


4. Install the air cleaner element Refer to [Air Cleaner Element Replacement](#).

## Air Cleaner Inlet Duct Replacement

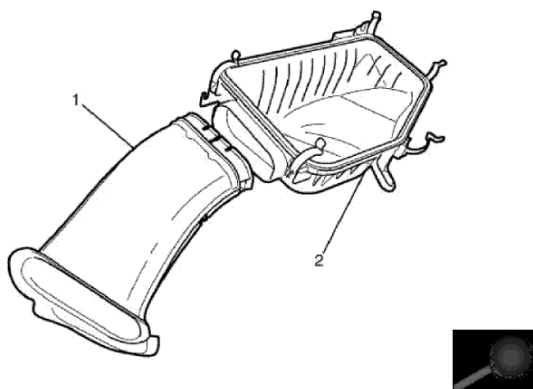
### Removal Procedure

1. Remove the air cleaner assembly from the vehicle. Refer to [Air Cleaner Assembly Replacement](#).



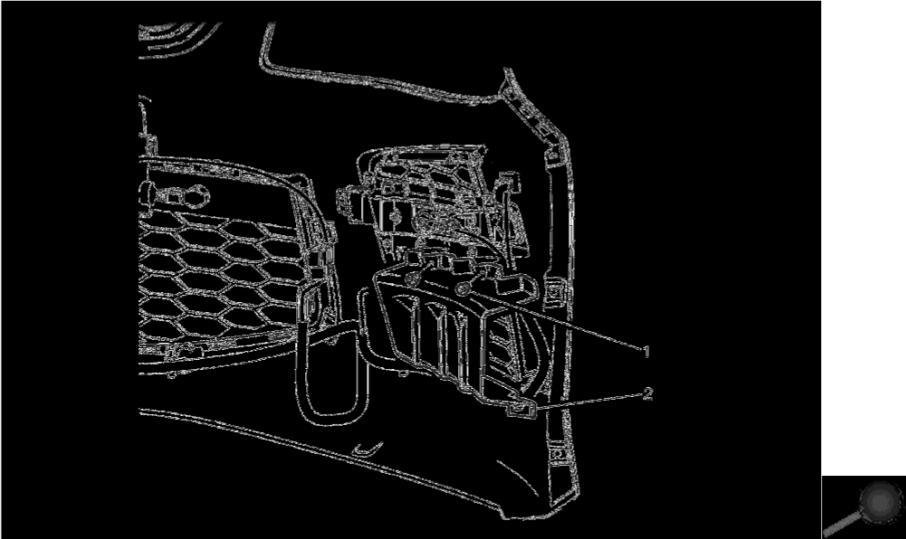
2. Using a suitable tool separate the air cleaner inlet duct (1) from the air cleaner lower housing (2).

### Installation Procedure



1. Install the air cleaner inlet duct (1) to the air cleaner lower housing (2).
2. Install the air cleaner assembly to the vehicle. Refer to [Air Cleaner Assembly Replacement](#).

Front Intake Air Duct Replacement - Lower (GTS)

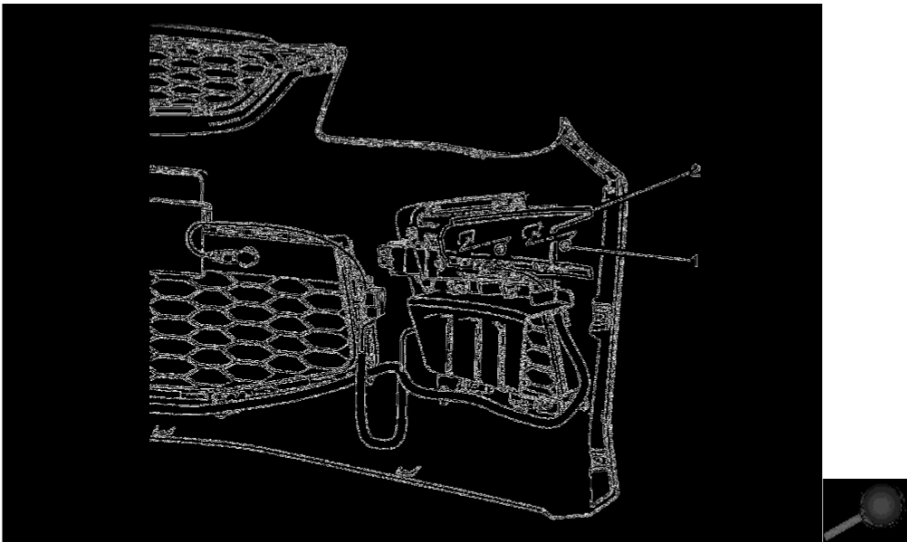


Front Intake Air Duct Replacement - Lower

| Callout                                                                                                                                        | Component Name                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the front intake air duct - upper. Refer to <a href="#">Front Intake Air Duct Replacement - Upper</a> . |                                                                                                             |
| 1                                                                                                                                              | Front Intake Air Duct - Lower Screw (Qty: 2)<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> . |
| 2                                                                                                                                              | Front Intake Air Duct - Lower                                                                               |

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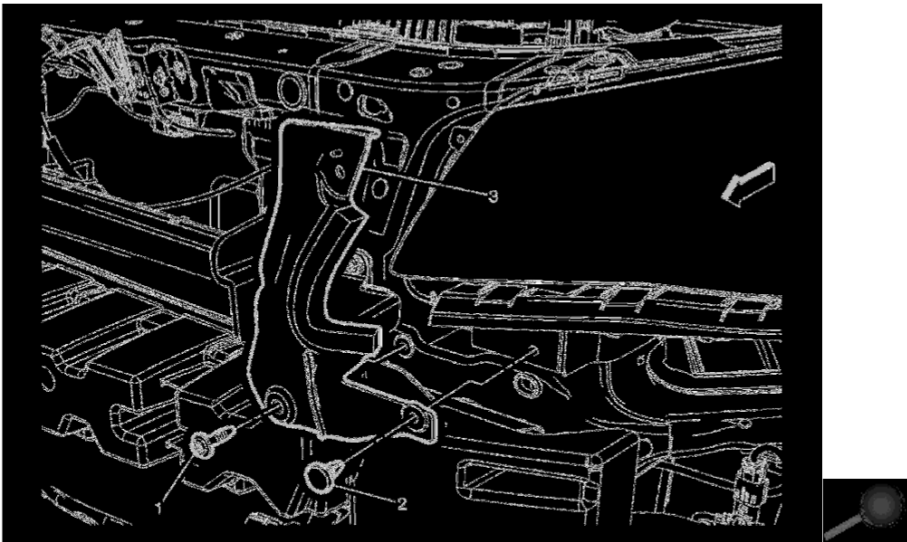
Front Intake Air Duct Replacement - Upper (GTS)



Front Intake Air Duct Replacement - Upper

| Callout                                                                                                                    | Component Name                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the front bumper fascia. Refer to <a href="#">Front Bumper Fascia Replacement</a> . |                                                                                                             |
| 1                                                                                                                          | Front Intake Air Duct - Upper Screw (Qty: 2)<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> . |
| 2                                                                                                                          | Front Intake Air Duct - Upper                                                                               |

Intake Air Baffle Replacement

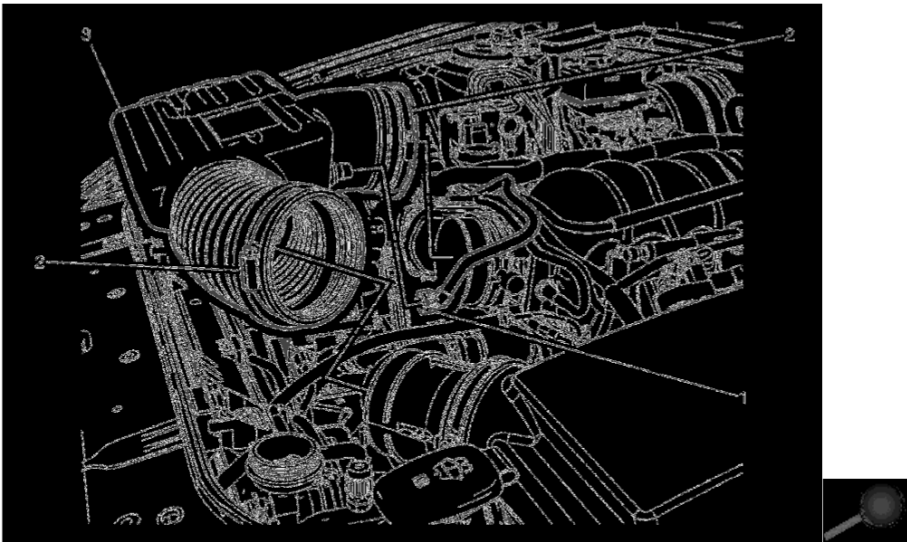


Intake Air Baffle Replacement

| Callout                                                                                                                                                            | Component Name                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the radiator air upper baffle and deflector. Refer to <a href="#">Radiator Air Upper Baffle and Deflector Replacement</a> . |                                                                                                                                   |
| 1                                                                                                                                                                  | Intake Air Baffle Fastener<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> .<br><b>Tighten</b><br>4.5 N·m (40 lb in) |
| 2                                                                                                                                                                  | Intake Air Baffle Retainer                                                                                                        |
| 3                                                                                                                                                                  | Intake Air Baffle                                                                                                                 |

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Air Cleaner Outlet Duct Replacement (L77 or LS3)

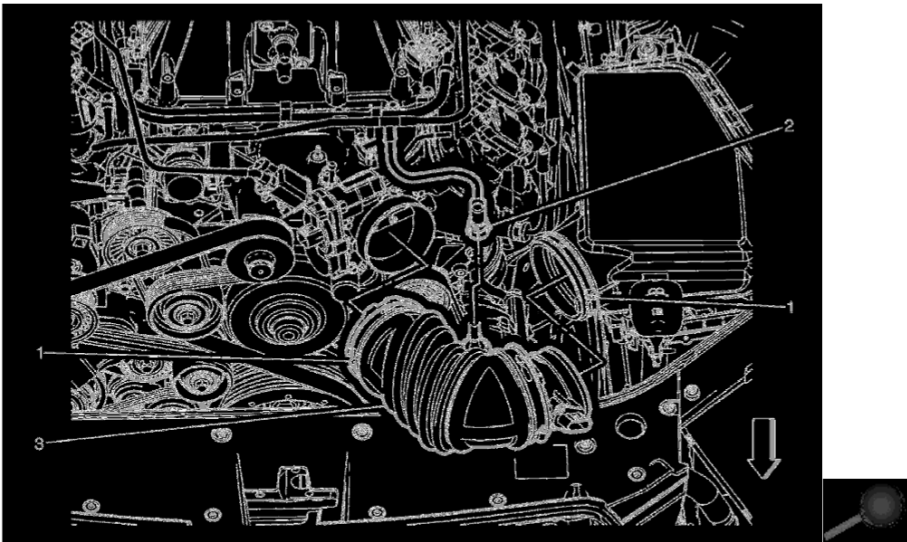


Air Cleaner Outlet Duct Replacement

| Callout | Component Name                                                                                         |
|---------|--------------------------------------------------------------------------------------------------------|
| 1       | PCV Tube Quick Connect Fitting                                                                         |
| 2       | Air Cleaner Outlet Duct Clamps (Qty: 2)<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> . |
| 3       | Air Cleaner Outlet Duct                                                                                |

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Air Cleaner Outlet Duct Replacement (LSA)

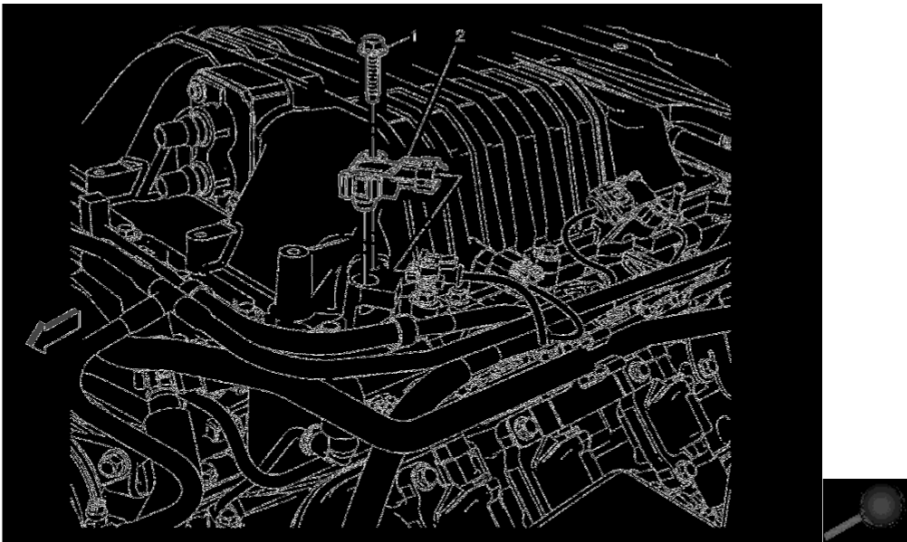


Air Cleaner Outlet Duct Replacement

| Callout | Component Name                                                                                         |
|---------|--------------------------------------------------------------------------------------------------------|
| 1       | Air Cleaner Outlet Duct Clamps (Qty: 2)<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> . |
| 2       | PCV Tube Quick Connect Fitting                                                                         |
| 3       | Air Cleaner Outlet Duct<br><b>Procedure</b><br>Disconnect the electrical connector.                    |

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Supercharger Air Inlet Pressure Sensor Replacement



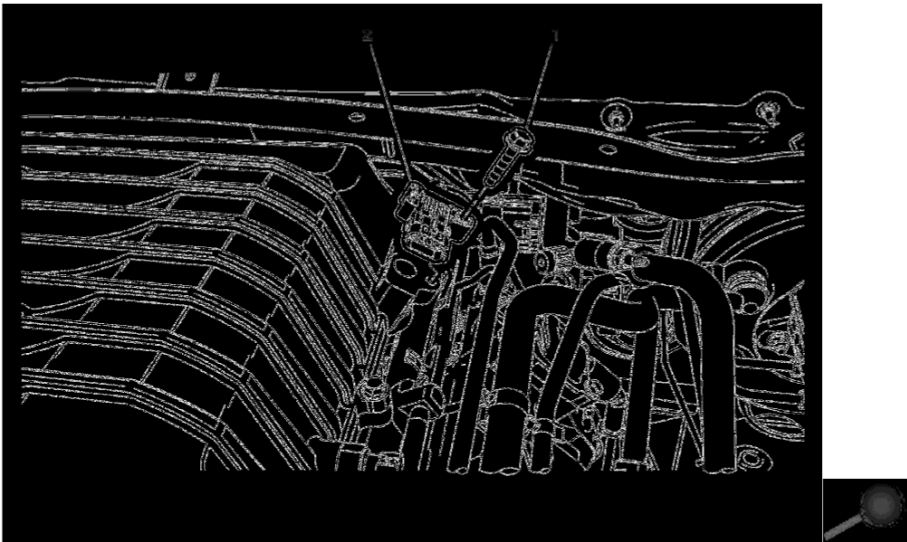
Supercharger Air Inlet Pressure Sensor Replacement

| Callout                                                                                                                               | Component Name                                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the front manifold cover. Refer to <a href="#">Intake Manifold Cover Replacement - Front</a> . |                                                                                                                                                                                                                               |
| 1                                                                                                                                     | Super Charger Air Pressure Sensor Bolt<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> .<br><b>Tighten</b><br>10 N•m (7 lb ft)                                                                                   |
| 2                                                                                                                                     | Super Charger Air Inlet Pressure Sensor<br><b>Procedure</b><br>Disconnect the super charger pressure sensor harness connector.<br><b>Note:</b> Always install the NEW O-ring provided with the super charger pressure sensor. |

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Supercharger Air Outlet Pressure Sensor Replacement

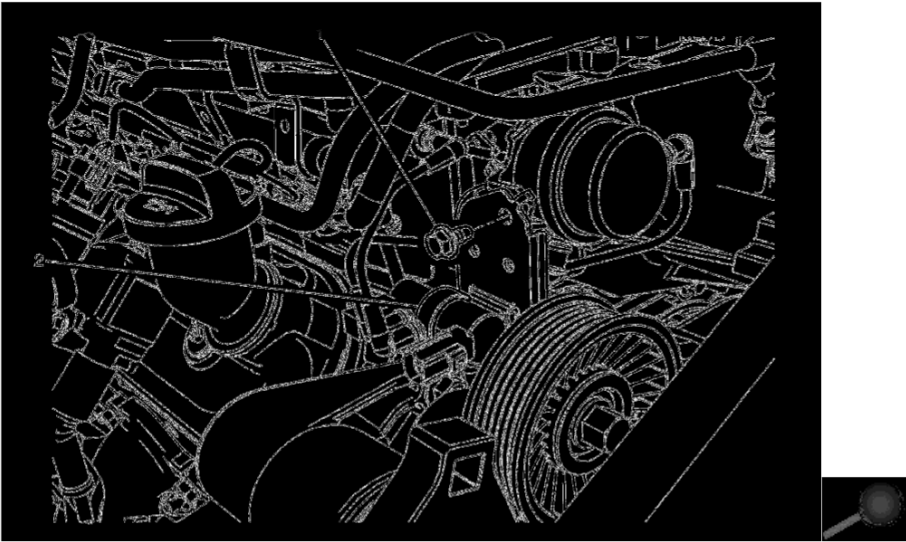


Supercharger Air Outlet Pressure Sensor Replacement

| Callout                                                                                                                                | Component Name                                                                                                                                                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the intake manifold cover. Refer to <a href="#">Intake Manifold Cover Replacement - Front</a> . |                                                                                                                                                                                                                               |
| 1                                                                                                                                      | Supercharger Air Outlet Pressure Sensor Fastener<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> .<br><b>Tighten</b><br>10 N•m (89 lb in)                                                                        |
| 2                                                                                                                                      | Supercharger Air Outlet Pressure Sensor<br><b>Procedure</b><br>1. Disconnect the electrical wiring harness connector from the supercharger air outlet pressure sensor.<br>2. Install the NEW O-ring provided with the sensor. |

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Charge Air Bypass Regulator Solenoid Valve Replacement

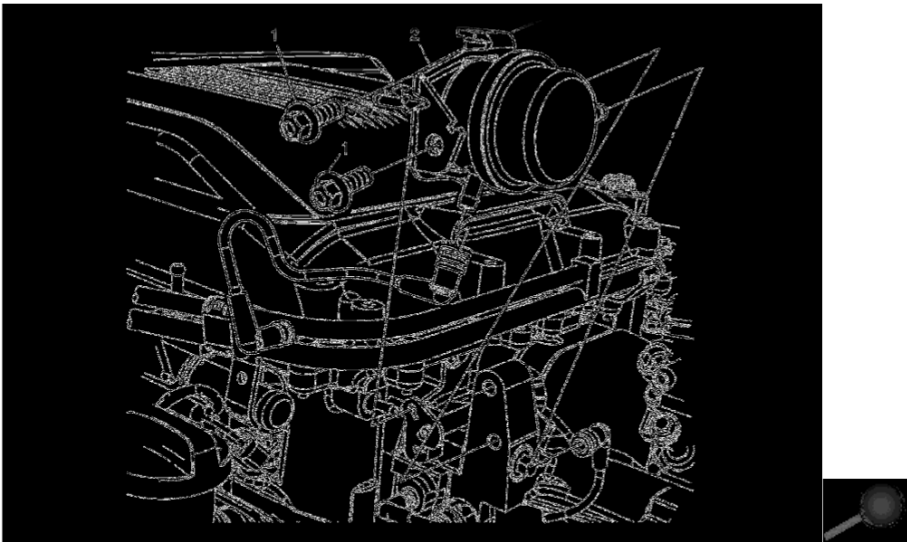


Charge Air Bypass Regulator Solenoid Valve Replacement

| Callout                                                                                                                                | Component Name                                                                                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the intake manifold cover. Refer to <a href="#">Intake Manifold Cover Replacement - Front</a> . |                                                                                                                                                                                                                                                                     |
| 1                                                                                                                                      | Charge Air Bypass Regulator Solenoid Valve Fastener<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> .<br><b>Tighten</b><br>10 N•m (89 lb in)                                                                                                           |
| 2                                                                                                                                      | Charge Air Bypass Regulator Solenoid Valve<br><b>Procedure</b><br>1. Disconnect the electrical wiring harness connector from the charge air bypass regulator solenoid valve.<br>2. Disconnect the vacuum lines from the charge air bypass regulator solenoid valve. |

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Supercharger Bypass Valve Actuator Replacement

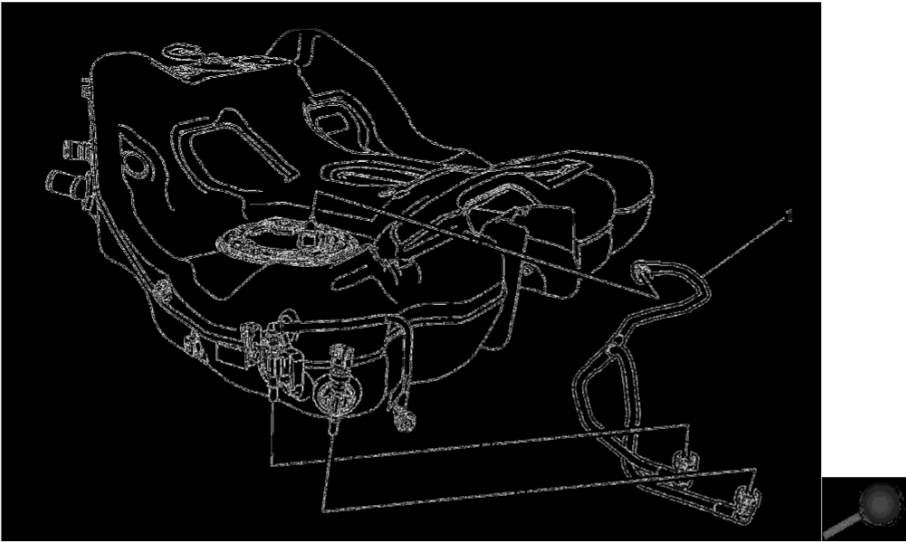


Supercharger Bypass Valve Actuator Replacement

| Callout                                                                                                                                                          | Component Name                                                                                                                                                                                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the charge air bypass regulator solenoid. Refer to <a href="#">Charge Air Bypass Regulator Solenoid Valve Replacement</a> |                                                                                                                                                                                                                            |
| 1                                                                                                                                                                | Supercharger Bypass Valve Actuator Fasteners (Qty: 2)<br><b>Caution:</b> Refer to <a href="#">Fastener Caution</a> .<br><b>Tighten</b><br>10 N•m (89 lb in)                                                                |
| 2                                                                                                                                                                | Supercharger Bypass Valve Actuator<br><b>Procedure</b><br>1. Disconnect the vacuum lines from the supercharger air bypass actuator.<br>2. Adjust the actuator, as needed. Refer to <a href="#">Supercharger Assemble</a> . |

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Fuel Feed Hose Replacement (Flex Sensor to Module to Fuel Pressure Sensor L77 or LS3)

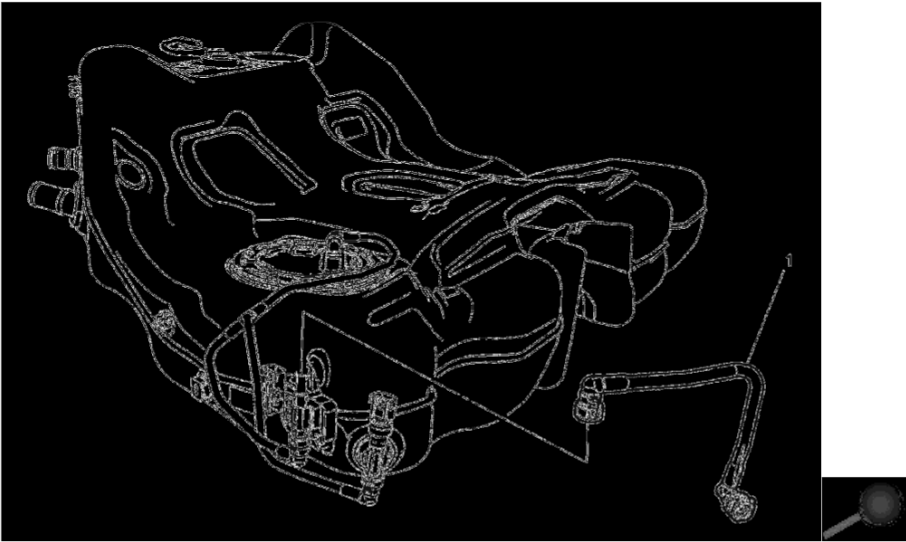


Fuel Feed Hose Replacement

| Callout                                                                                                                                                                                                                                                                     | Component Name                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <p>Remove the fuel tank. Refer to <a href="#">Fuel Tank Replacement</a>.</p> |                                                                                                                                                                    |
| 1                                                                                                                                                                                                                                                                           | <p>Fuel Feed Hose</p> <p><b>Procedure</b></p> <p>Disconnect the quick connect fittings. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a>.</p> |

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Fuel Feed Hose Replacement (Flex Sensor to Pipe L77 or LS3)

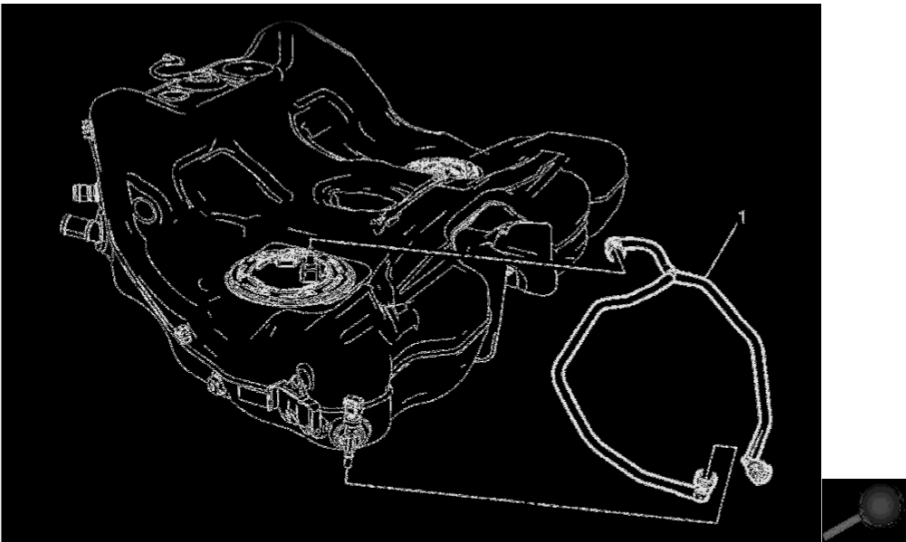


Fuel Feed Hose Replacement

| Callout                                                                                                                                                                                                                                                                     | Component Name                                                                                                                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <p>Remove the fuel tank. Refer to <a href="#">Fuel Tank Replacement</a>.</p> |                                                                                                                                                                   |
| 1                                                                                                                                                                                                                                                                           | <p>Fuel Feed Hose</p> <p><b>Procedure</b></p> <p>Disconnect the quick connect fitting. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a>.</p> |

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Fuel Feed Hose Replacement (Module to Pipe LSA)



Fuel Feed Hose Replacement

| Callout                                                                                                                                                                                                                                                                     | Component Name                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Warning:</b> Refer to <a href="#">Gasoline/Gasoline Vapors Warning</a>.</p> <p><b>Warning:</b> Refer to <a href="#">Safety Glasses Warning</a>.</p> <p><b>Preliminary Procedures</b></p> <p>Remove the fuel tank. Refer to <a href="#">Fuel Tank Replacement</a>.</p> |                                                                                                                                                                    |
| 1                                                                                                                                                                                                                                                                           | <p>Fuel Feed Hose</p> <p><b>Procedure</b></p> <p>Disconnect the quick connect fittings. Refer to <a href="#">Plastic Collar Quick Connect Fitting Service</a>.</p> |

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## Temperature Versus Resistance

Temperature Versus Resistance

| °C                                             | °F  | OHMS  |
|------------------------------------------------|-----|-------|
| Temperature vs Resistance Values (Approximate) |     |       |
| 150                                            | 302 | 47    |
| 140                                            | 284 | 60    |
| 130                                            | 266 | 77    |
| 120                                            | 248 | 100   |
| 110                                            | 230 | 132   |
| 100                                            | 212 | 177   |
| 90                                             | 194 | 241   |
| 80                                             | 176 | 332   |
| 70                                             | 158 | 467   |
| 60                                             | 140 | 667   |
| 50                                             | 122 | 973   |
| 45                                             | 113 | 1188  |
| 40                                             | 104 | 1459  |
| 35                                             | 95  | 1802  |
| 30                                             | 86  | 2238  |
| 25                                             | 77  | 2796  |
| 20                                             | 68  | 3520  |
| 15                                             | 59  | 4450  |
| 10                                             | 50  | 5670  |
| 5                                              | 41  | 7280  |
| 0                                              | 32  | 9420  |
| -5                                             | 23  | 12300 |

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| °C  | °F  | OHMS   |
|-----|-----|--------|
| -10 | 14  | 16180  |
| -15 | 5   | 21450  |
| -20 | -4  | 28680  |
| -30 | -22 | 52700  |
| -40 | -40 | 100700 |



## Altitude Versus Barometric Pressure

Altitude Versus Barometric Pressure

| Altitude Measured<br>in Meters (m)                                                                  | Altitude Measured<br>in Feet (ft) | Barometric<br>Pressure Measured<br>in Kilopascals<br>(kPa) | Barometric<br>Pressure Measured<br>in Pounds Per<br>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                                                             |

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## Ignition System Specifications

**Ignition System Specifications**

| Application                | Specification                                               |
|----------------------------|-------------------------------------------------------------|
| Ignition Type              | Individual Ignition Coils                                   |
| Firing Order               | 1-8-7-2-6-5-4-3                                             |
| Spark Plug Wire Resistance | 170–220 $\Omega$ per 25.4 mm (1.0 in)                       |
| Spark Plug Torque          | Refer to <a href="#">Fastener Tightening Specifications</a> |
| Spark Plug Gap             | Refer to <a href="#">Engine Mechanical Specifications</a>   |
| Spark Plug Type            | Refer to Electronic Parts Catalog                           |

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## Adhesives, Fluids, Lubricants, and Sealers

### Sealers, Adhesives, and Lubricants

| Application                | Type Of Material | GM Part Number |        |
|----------------------------|------------------|----------------|--------|
|                            |                  | United States  | Canada |
| Fuel System Treatment Plus | Cleaner          | 88861011       | —      |

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## Fastener Tightening Specifications

Fastener Tightening Specifications

| Application                                                         | Specifications |           |
|---------------------------------------------------------------------|----------------|-----------|
|                                                                     | Metric         | English   |
| Accelerator Pedal Position (APP) Sensor to Body Retaining Bolt      | 9 N•m          | 80 lb in  |
| Air Cleaner Outlet Duct to Air Box Upper Cover Retaining Clamp      | 2 N•m          | 18 lb in  |
| Air Cleaner Outlet Duct to Throttle Body Retaining Clamp            | 2 N•m          | 18 lb in  |
| Air Cleaner Lower Housing to Body Retaining Bolt                    | 10 N•m         | 89 lb in  |
| Camshaft Position (CMP) Sensor to Engine Front Cover Retaining Bolt | 9 N•m          | 80 lb in  |
| Crankshaft Position (CKP) Sensor to Engine Block Retaining Bolt     | 25 N•m         | 18 lb ft  |
| Engine Coolant Temperature (ECT) Sensor                             | 20 N•m         | 15 lb ft  |
| Evaporative Emission (EVAP) Canister to Underbody Retaining Bolt    | 6 N•m          | 53 lb in  |
| Filler Tube Support Bracket to Body Retaining Bolt                  | 9 N•m          | 80 lb in  |
| Fuel Tank Hose to Filler Tube Clamp                                 | 4 N•m          | 35 lb in  |
| Fuel Pipe Stone Guard to Underbody Retaining Nut                    | 5 N•m          | 44 lb in  |
| Fuel Filler Pipe to Chassis Retaining Bolt                          | 9 N•m          | 80 lb in  |
| Fuel Rail to Inlet Manifold Retaining Bolt                          | 10 N•m         | 89 lb in  |
| Fuel Rail Ground Strap To Intake Manifold Retaining Bolt            | 10 N•m         | 89 lb in  |
| Fuel Tank Strap to Underbody Retaining Bolt                         | 30 N•m         | 22 lb ft  |
| Heated Oxygen Sensor (HO2S)                                         | 42 N•m         | 31 lb ft  |
| Ignition Coil to Ignition Bracket Assembly Retaining Bolt           | 12 N•m         | 106 lb in |
| Ignition Coil Bracket to Valve Rocker Arm Cover Retaining Bolt      | 12 N•m         | 106 lb in |

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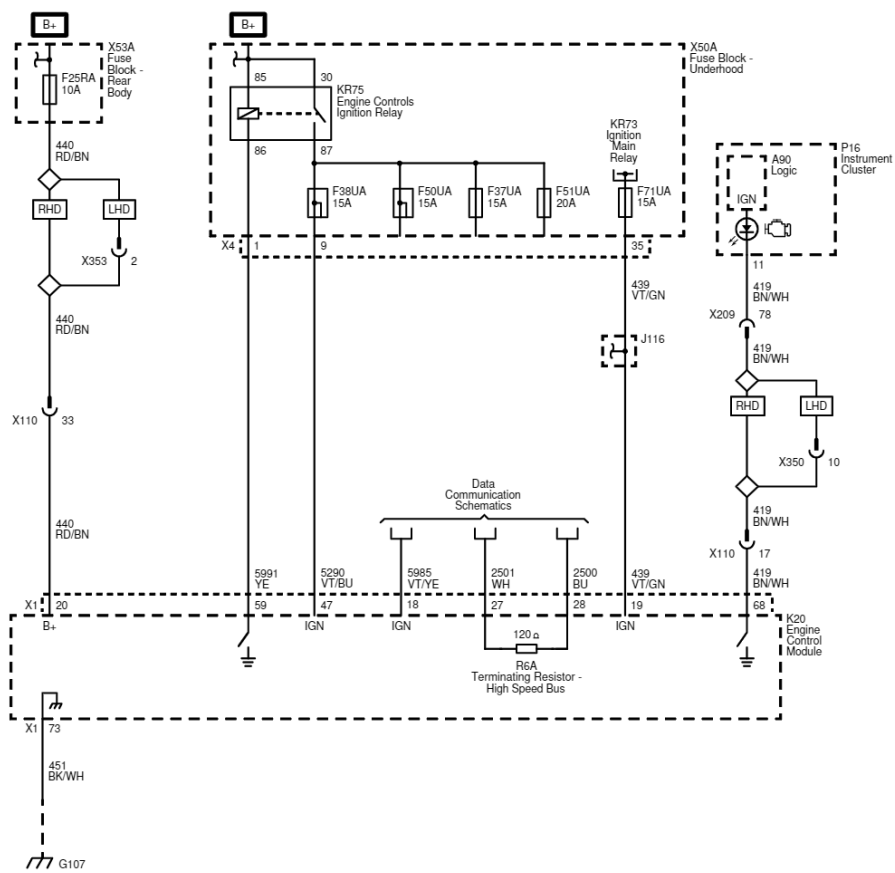
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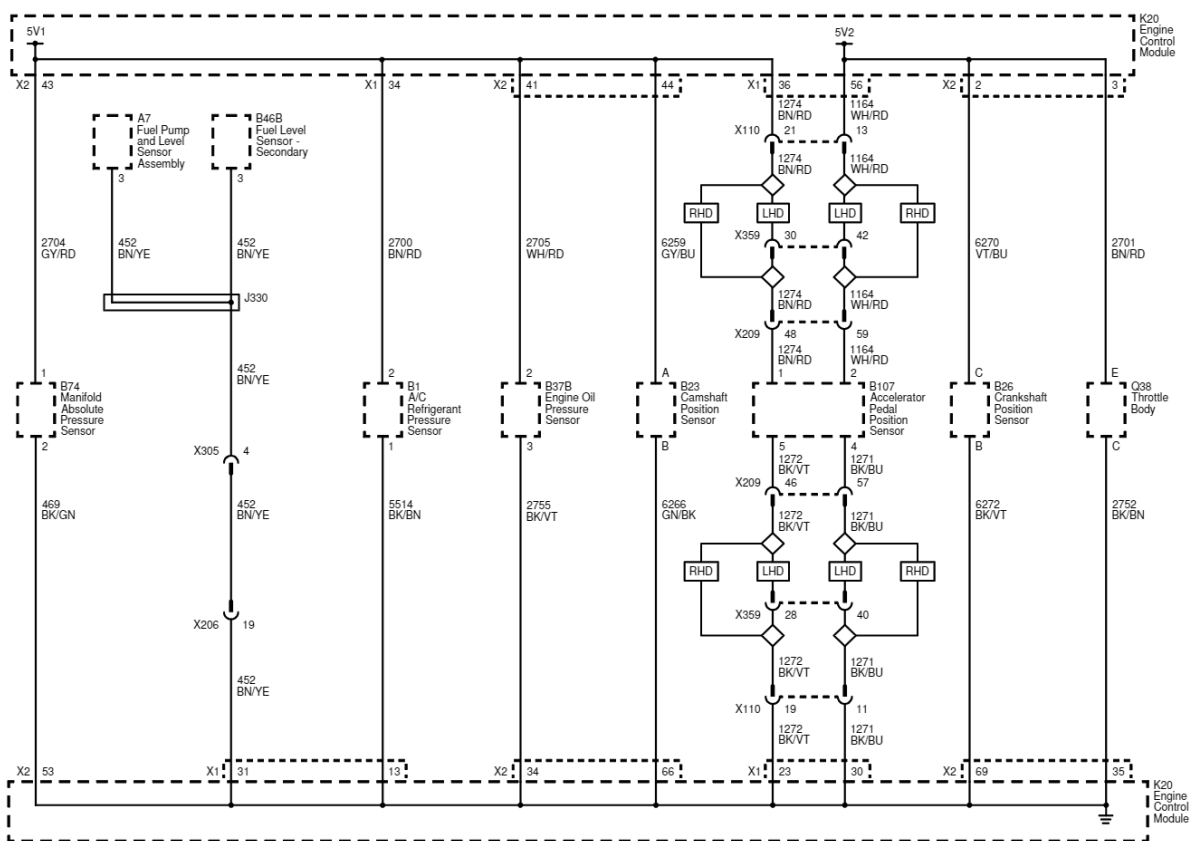
| Application                                                                                            | Specifications |           |
|--------------------------------------------------------------------------------------------------------|----------------|-----------|
|                                                                                                        | Metric         | English   |
| Knock Sensor (KS) to Engine Block Retaining Bolt                                                       | 25 N•m         | 18 lb ft  |
| Mass Airflow Sensor with Intake Air Temperature (MAF) Sensor to Air Cleaner Inlet Duct Retaining Clamp | 2 N•m          | 18 lb in  |
| Rear Frame to Underbody Retaining Bolt                                                                 |                |           |
| • First pass                                                                                           | 65 N•m         | 48 lb ft  |
| • Final pass                                                                                           | + 120 Degrees  |           |
| Spark Plug                                                                                             |                |           |
| • Fit New Spark Plug                                                                                   | 20 N•m         | 15 lb ft  |
| • Refit Existing Spark Plug                                                                            | 15 N•m         | 11 lb ft  |
| Throttle Body to Intake Manifold Retaining Bolt                                                        | 12 N•m         | 106 lb in |

## Engine Controls Schematics (L77/LS3)

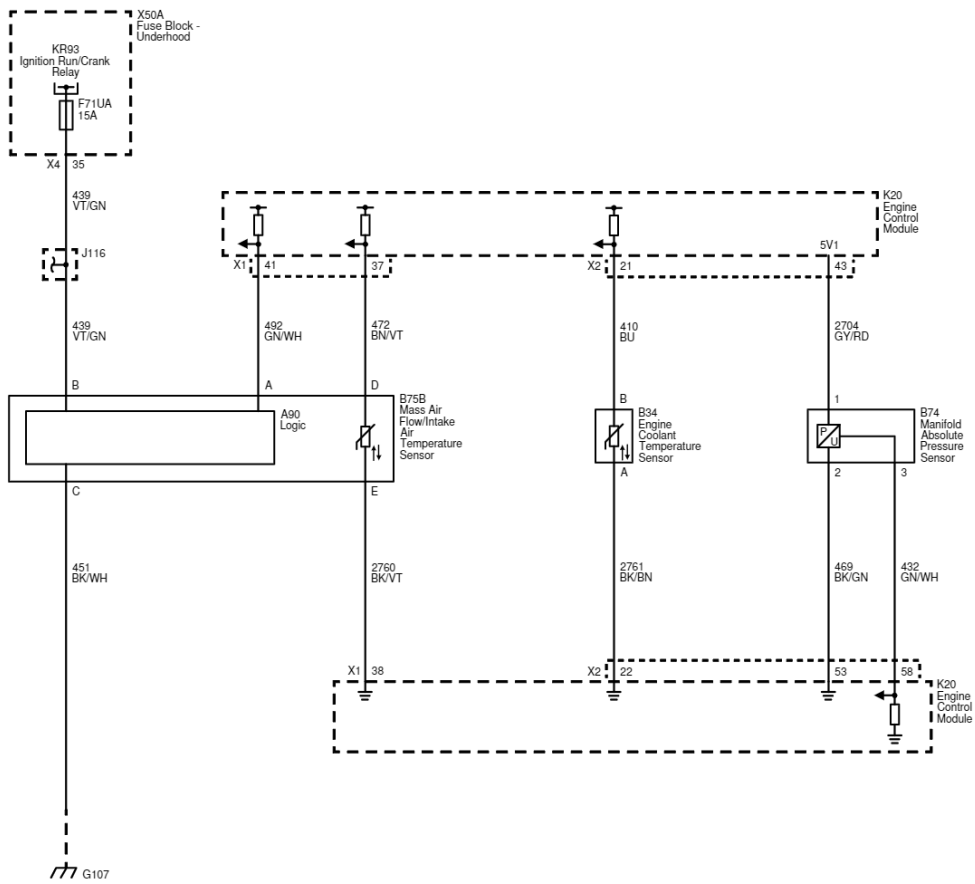
- Figure 1:** [Module Power, Ground, and Serial Data](#)
- Figure 2:** [5V and Low Reference Bus](#)
- Figure 3:** [Engine Data Sensors - Pressure and Temperature](#)
- Figure 4:** [Engine Data Sensors - Throttle Controls](#)
- Figure 5:** [Engine Data Sensors - Oxygen Sensors](#)
- Figure 6:** [Ignition Controls - Ignition Coils 1, 3, 5, and 7](#)
- Figure 7:** [Ignition Controls - Ignition Coils 2, 4, 6, and 8](#)
- Figure 8:** [Ignition Controls - Brake Booster, Camshaft, Crankshaft, Knock Sensors, and Valve Lifter](#)
- Figure 9:** [Fuel Controls - Fuel Injectors](#)
- Figure 10:** [Fuel Controls - Fuel Pump Flow Control and Fuel Pressure Sensor](#)
- Figure 11:** [Fuel Controls - Fuel Pump](#)
- Figure 12:** [Fuel Controls - Fuel Composition Sensor and Evaporative Emission](#)
- Figure 13:** [Controlled/Monitored Subsystem References](#)

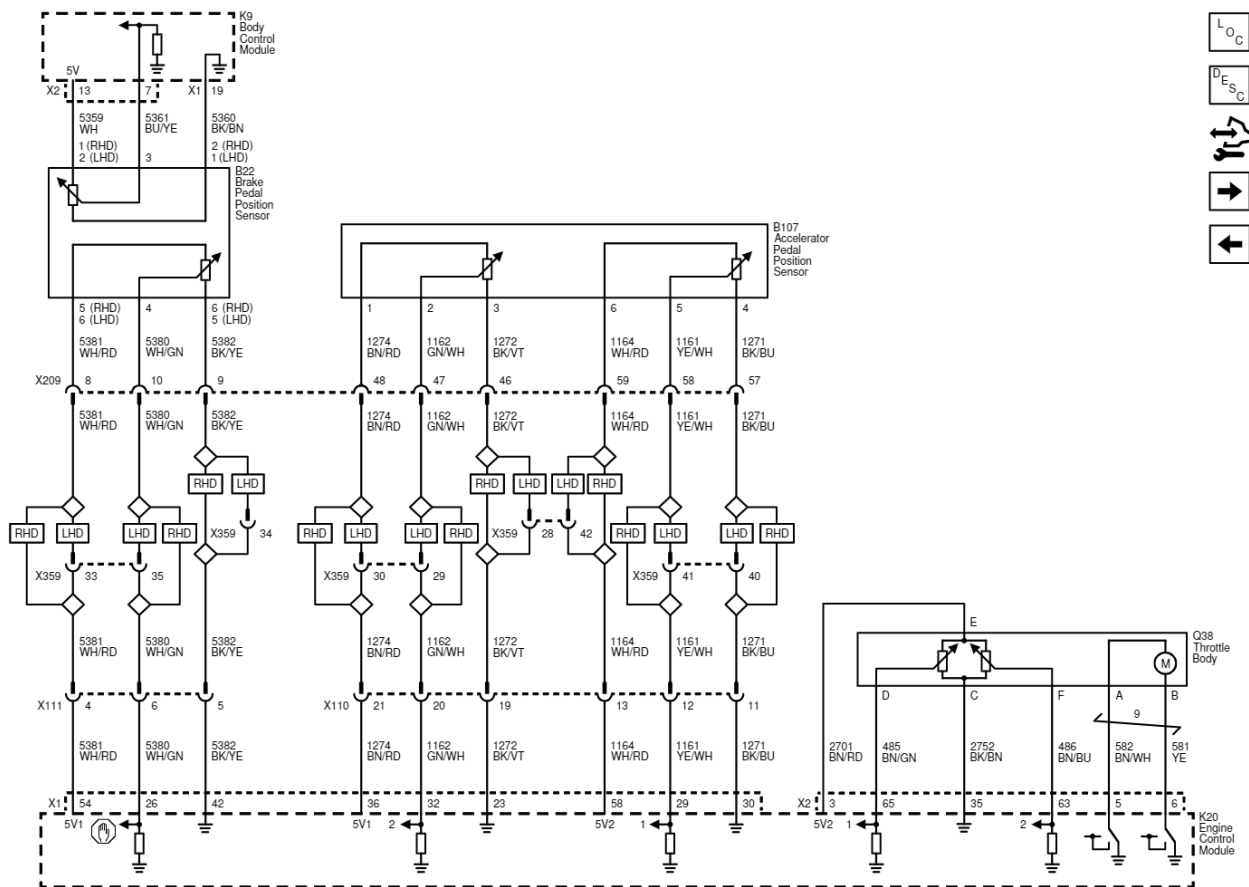
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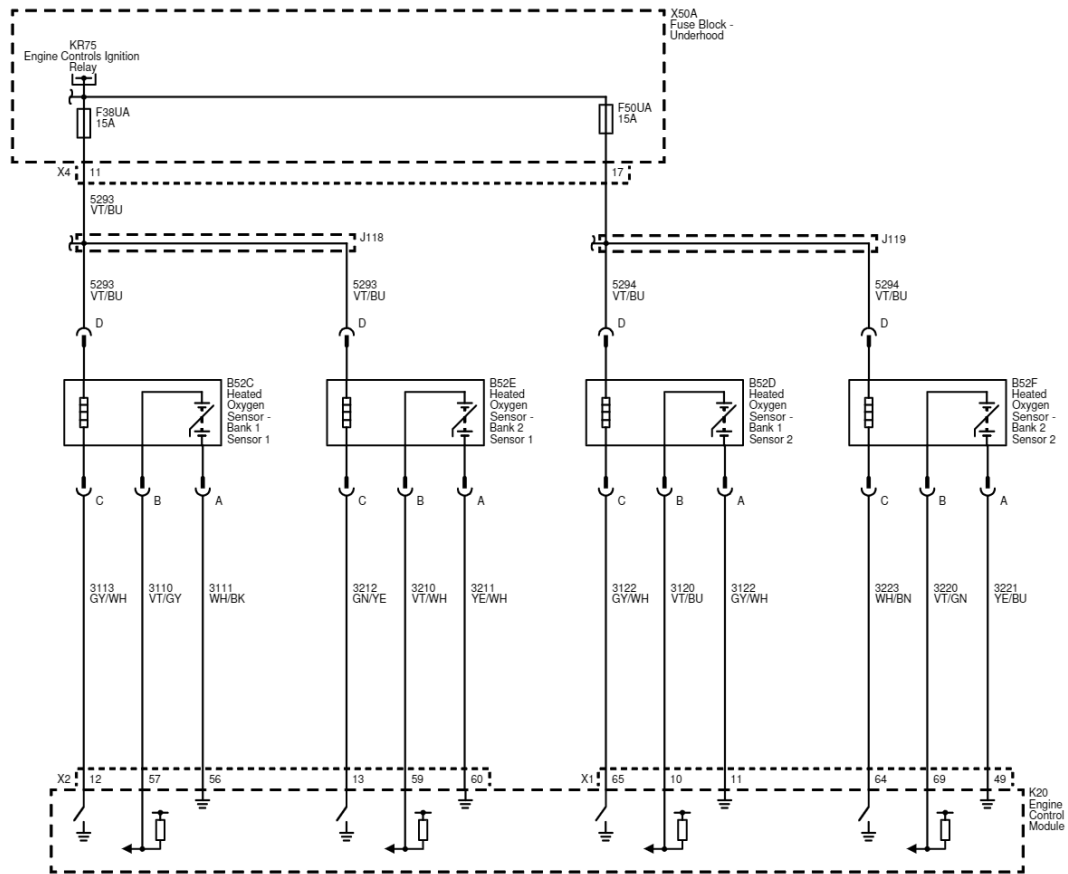


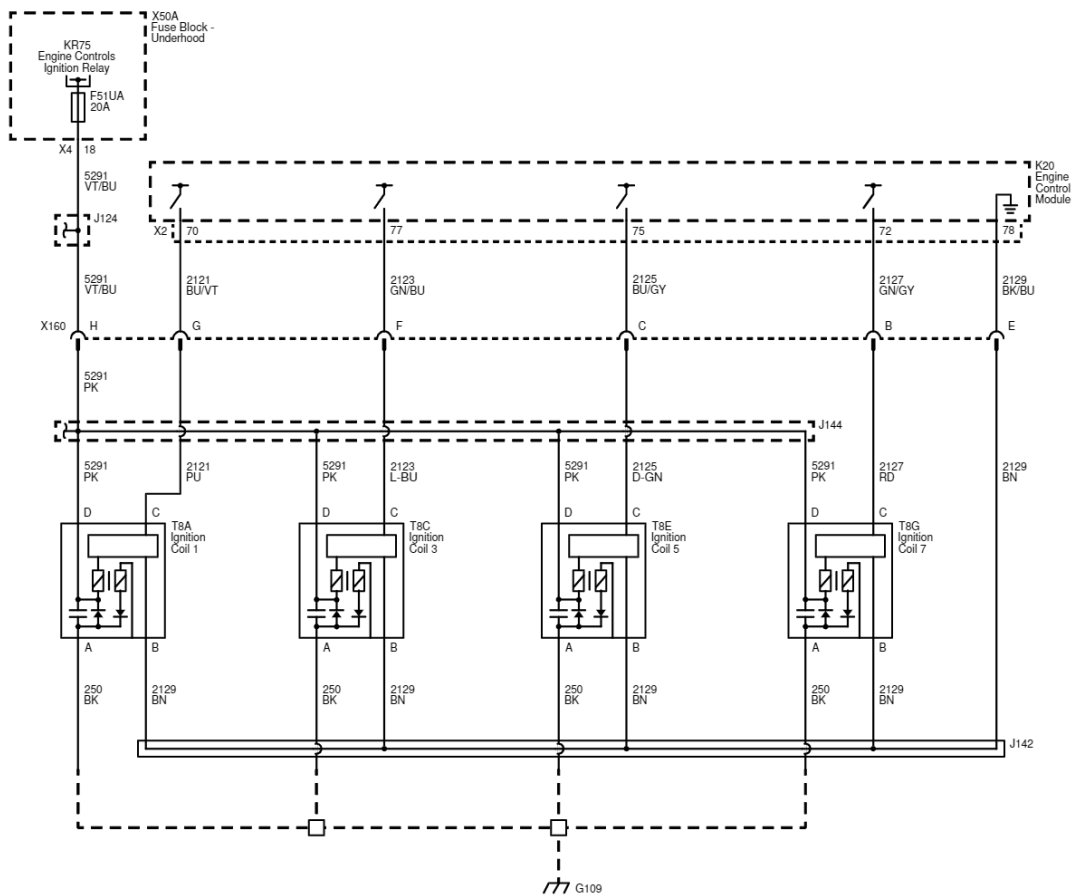


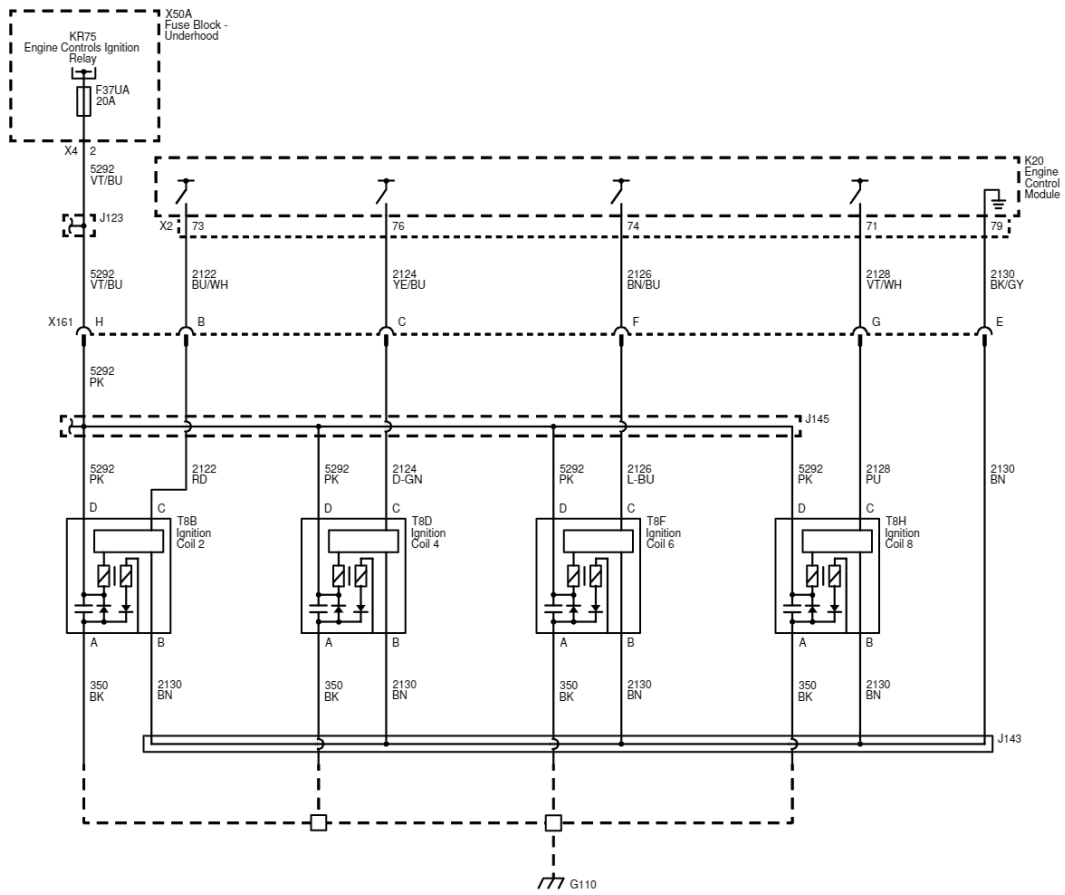




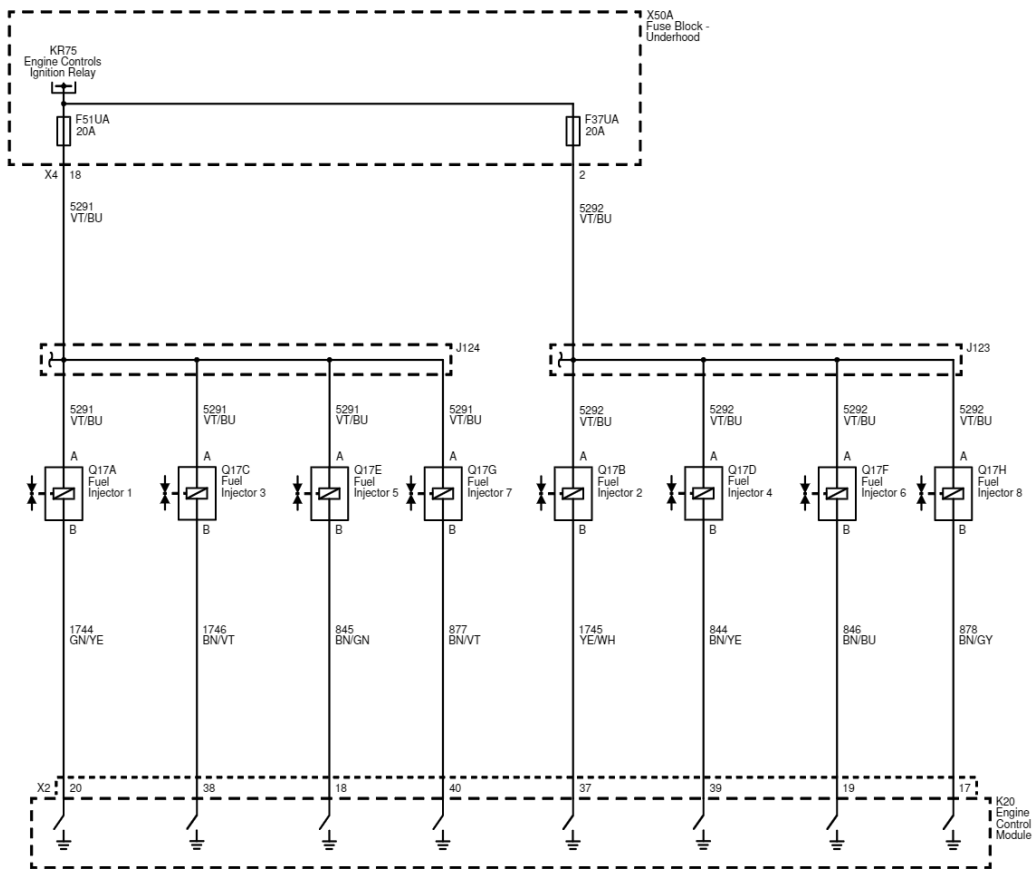


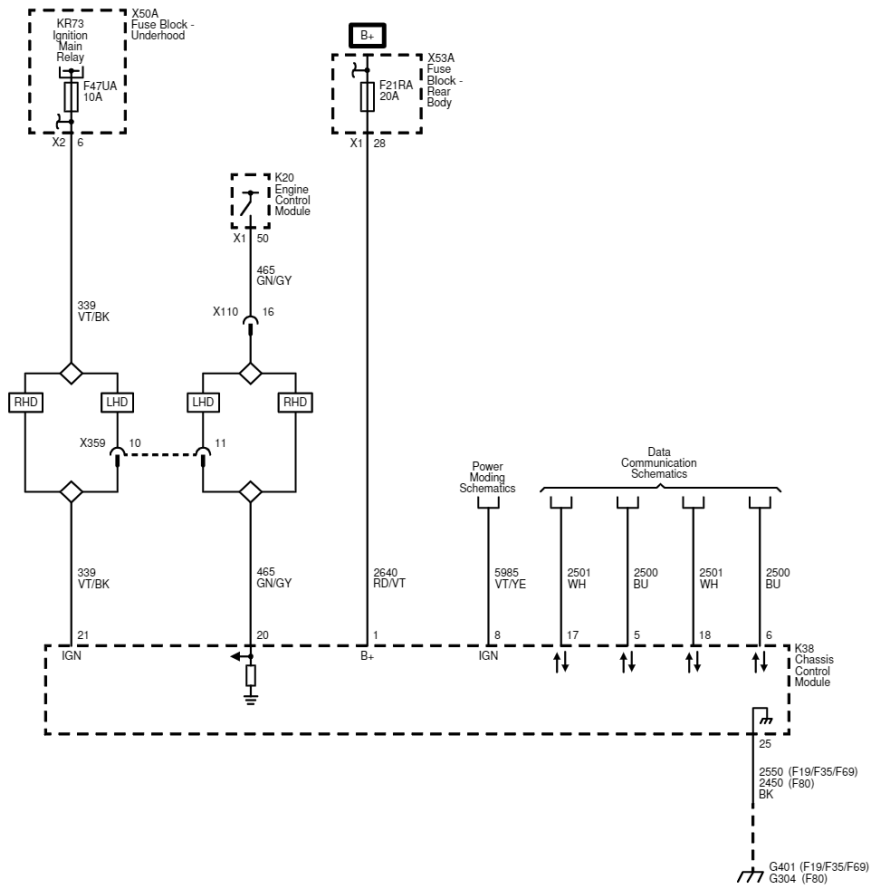




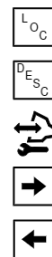
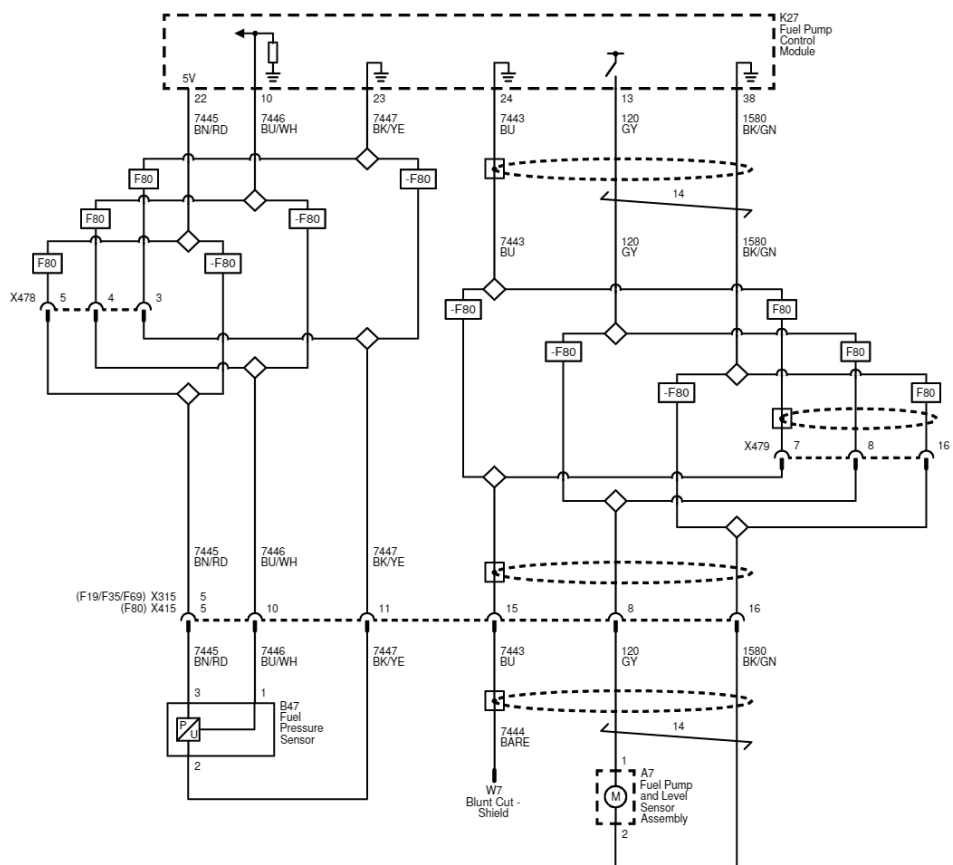


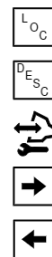
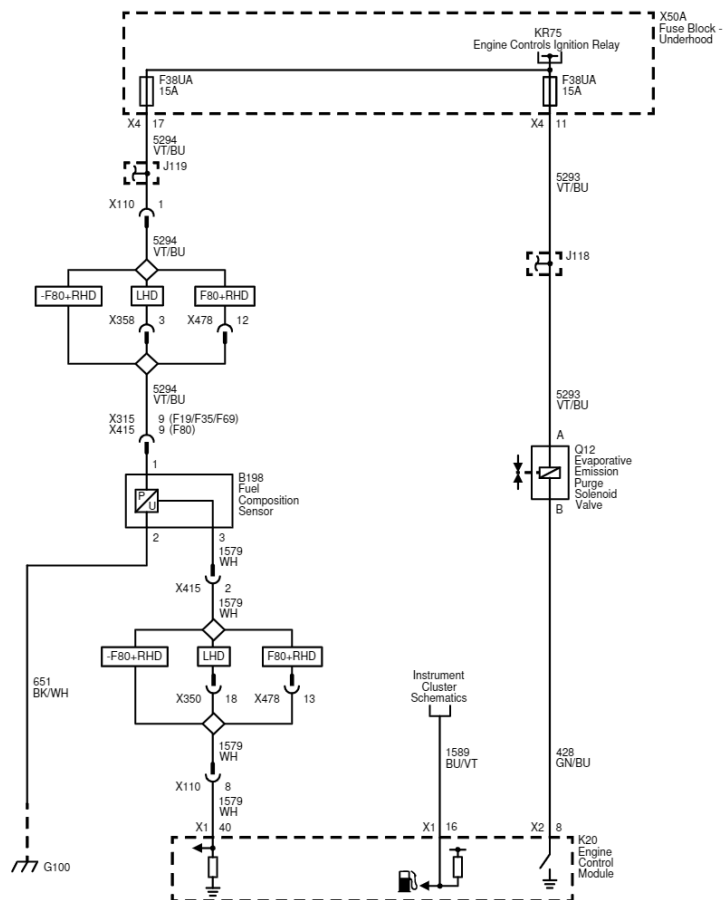














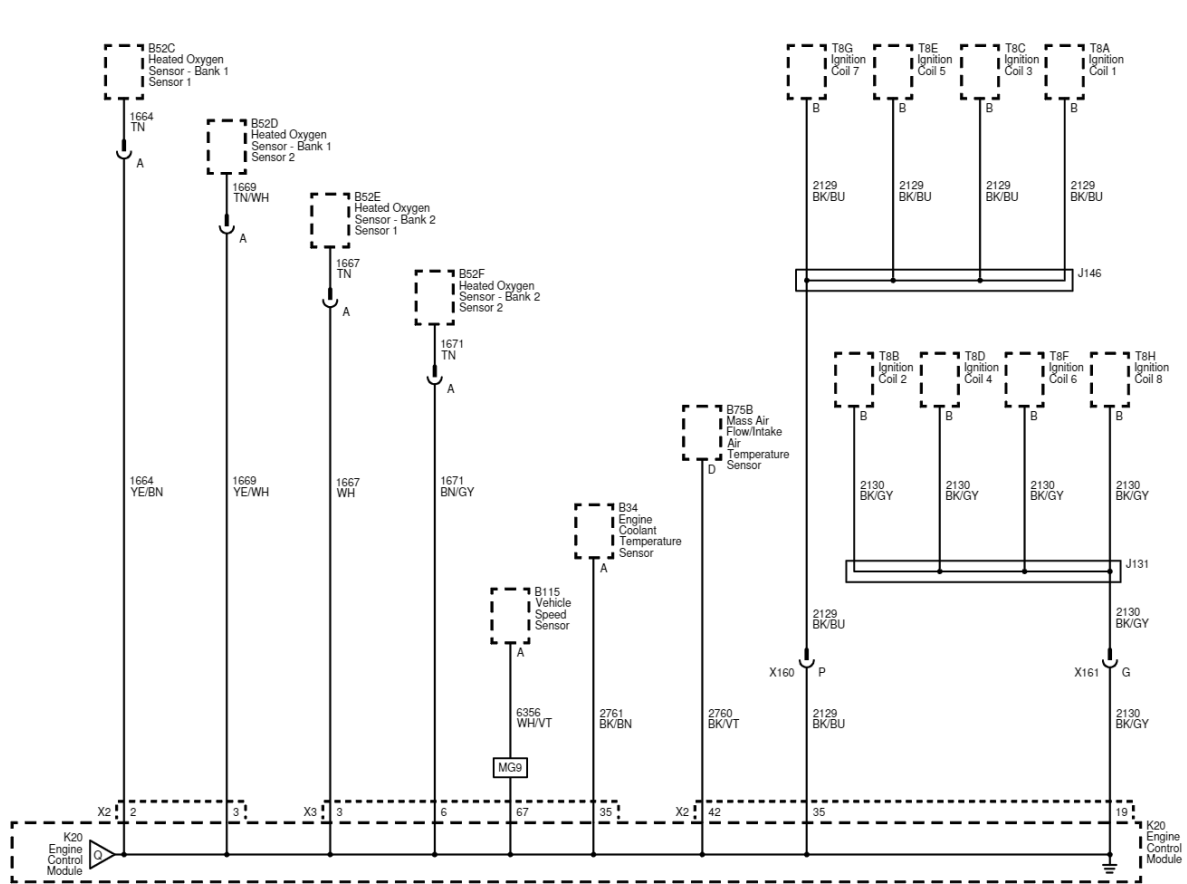
## Engine Controls Schematics (LSA)

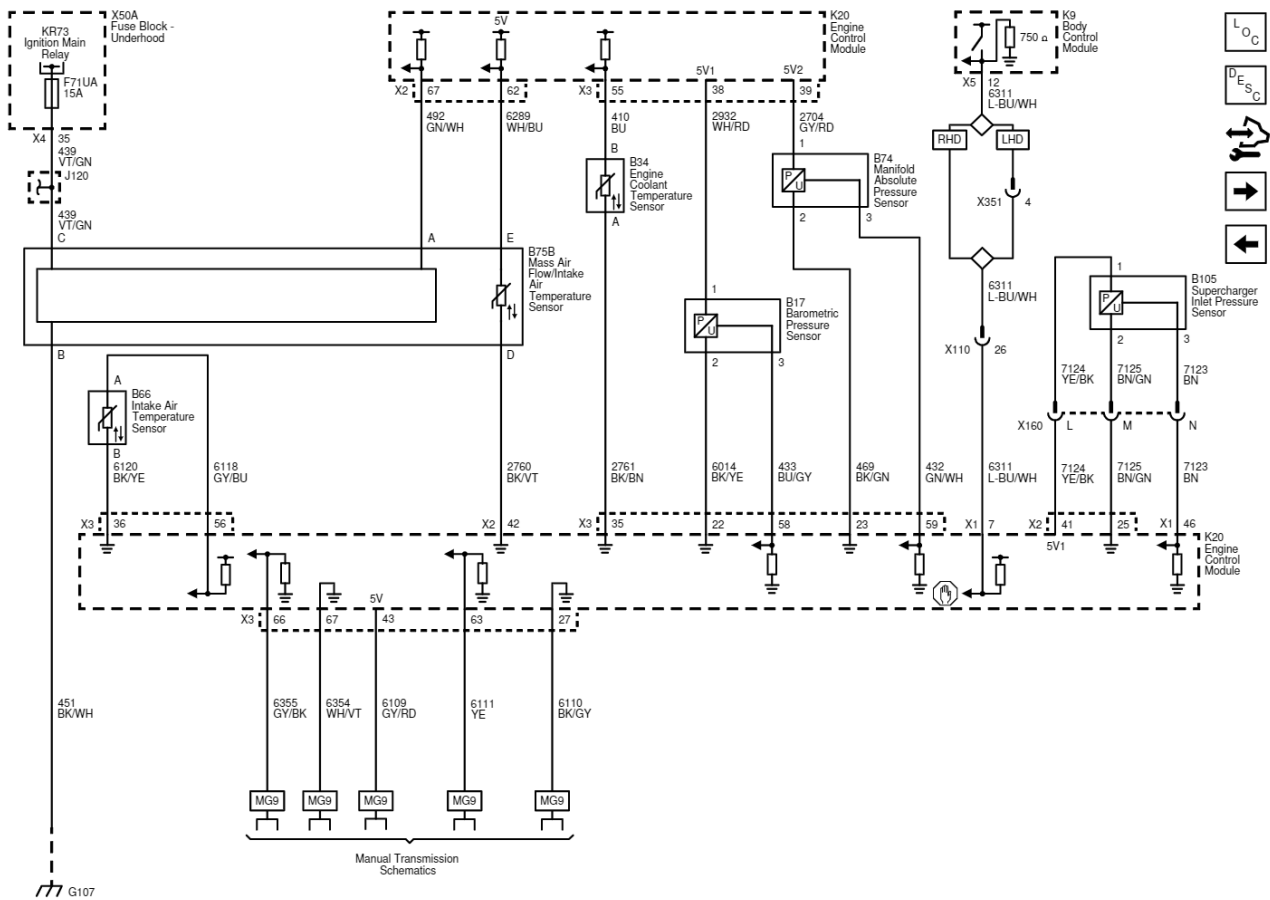
- Figure 1:** [Module Power, Ground, and Serial Data](#)
- Figure 2:** [5V1, 5V2, and Low Reference Bus \(1 of 2\)](#)
- Figure 3:** [Low Reference Bus \(2 of 2\)](#)
- Figure 4:** [Engine Data Sensors - Pressure and Temperature](#)
- Figure 5:** [Engine Data Sensors - Throttle Controls](#)
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- Figure 9:** [Ignition Controls - Camshaft, Crankshaft, and Knock Sensors](#)
- Figure 10:** [Fuel Controls - Fuel Injectors](#)
- Figure 11:** [Fuel Controls - Module Power, Ground, and Serial Data](#)
- Figure 12:** [Fuel Controls - Fuel Pump and Fuel Pressure Sensor](#)
- Figure 13:** [Fuel Controls - Supercharger Bypass Solenoid Valve and Evaporative Emission](#)
- Figure 14:** [Controlled/Monitored Subsystem References](#)

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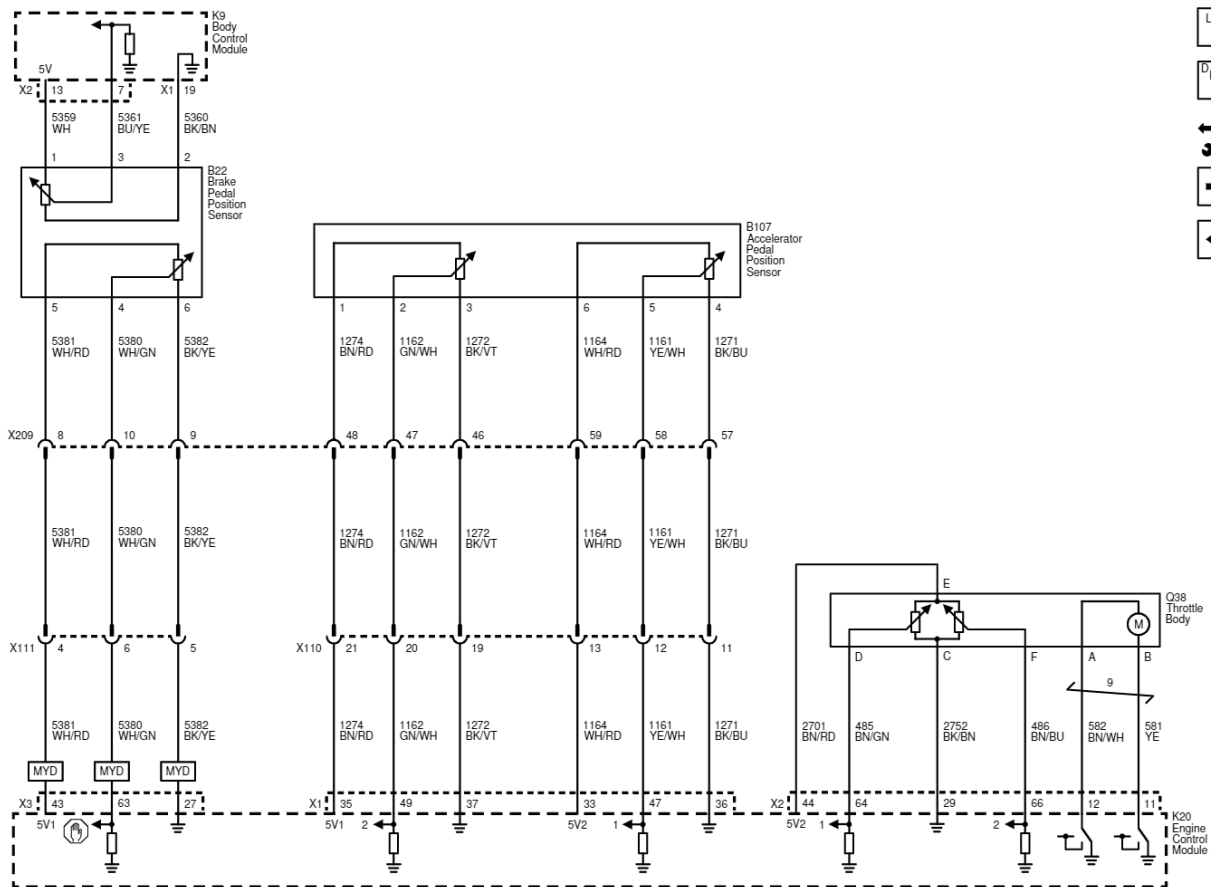


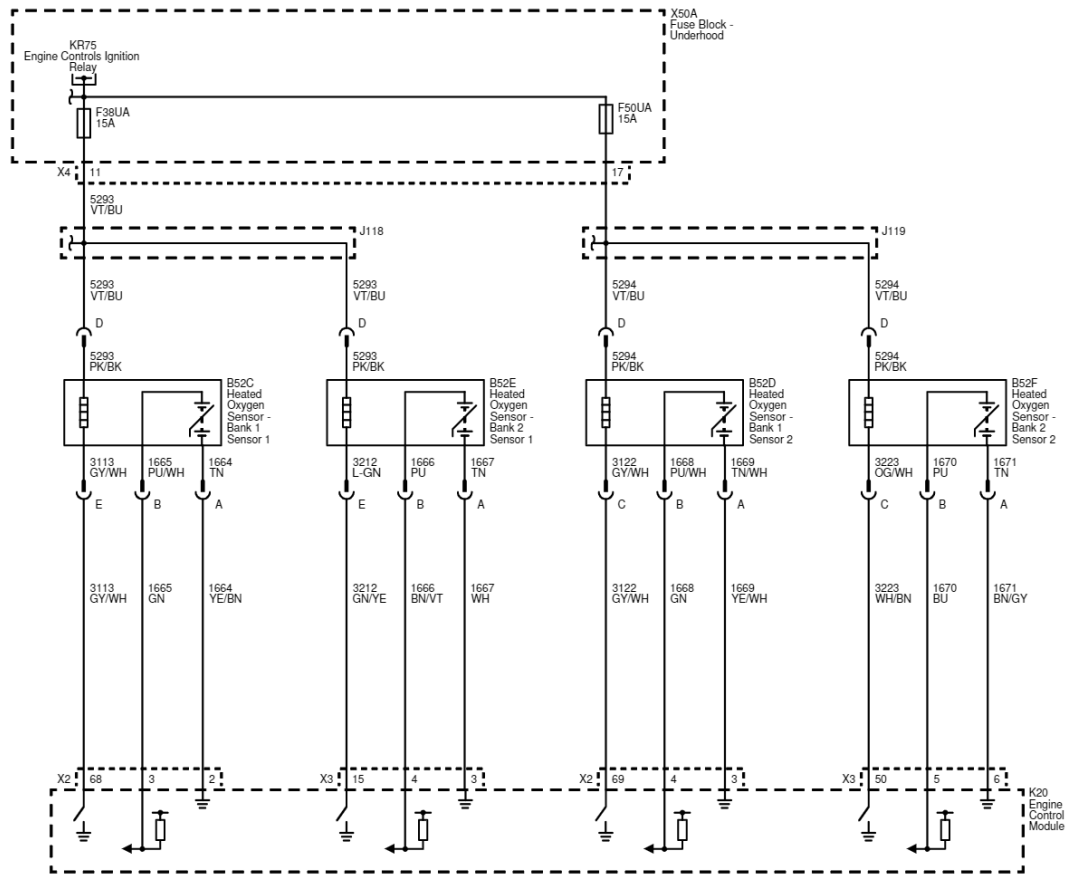


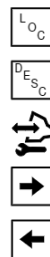
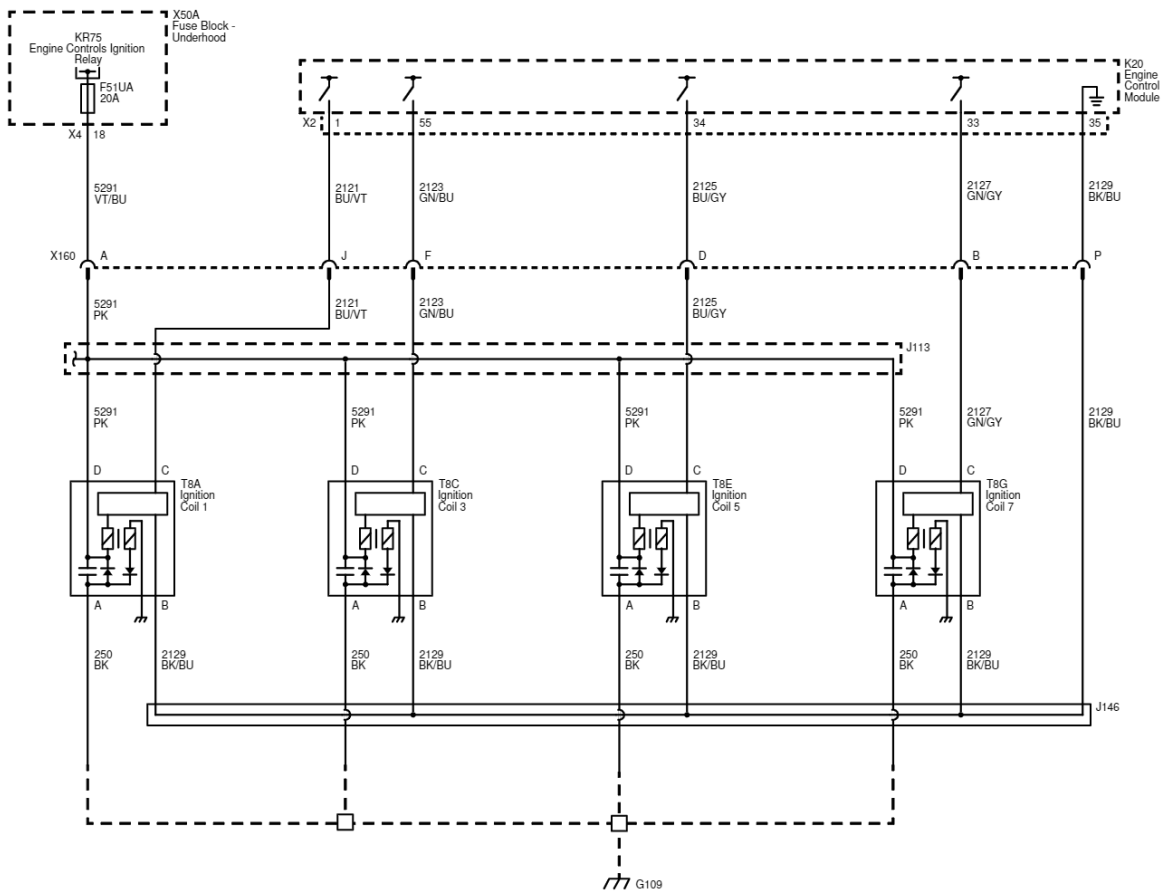


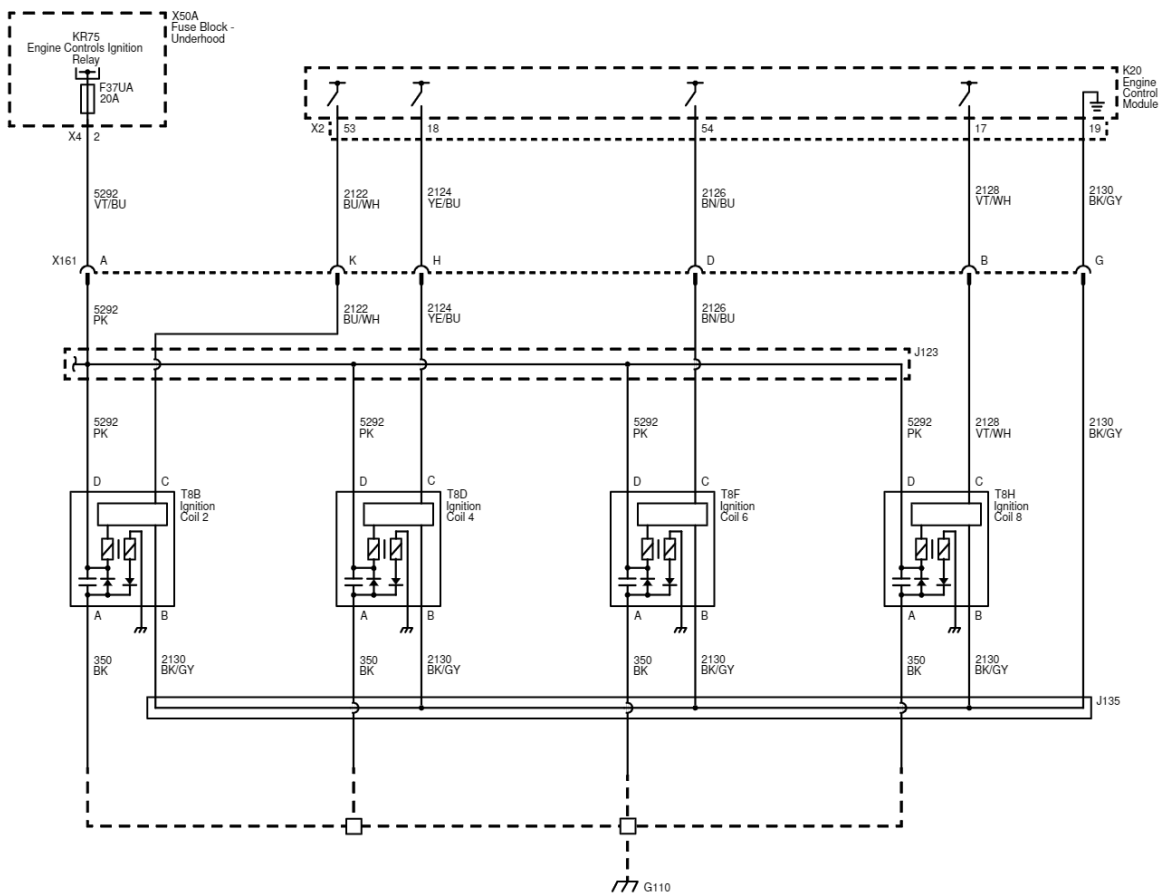


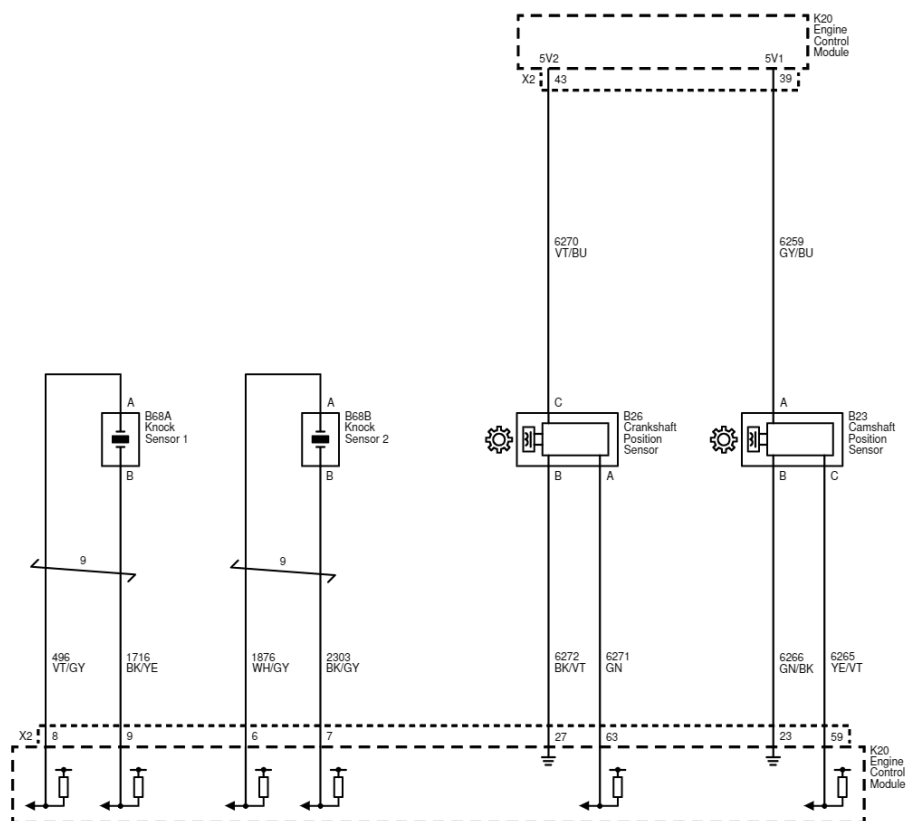








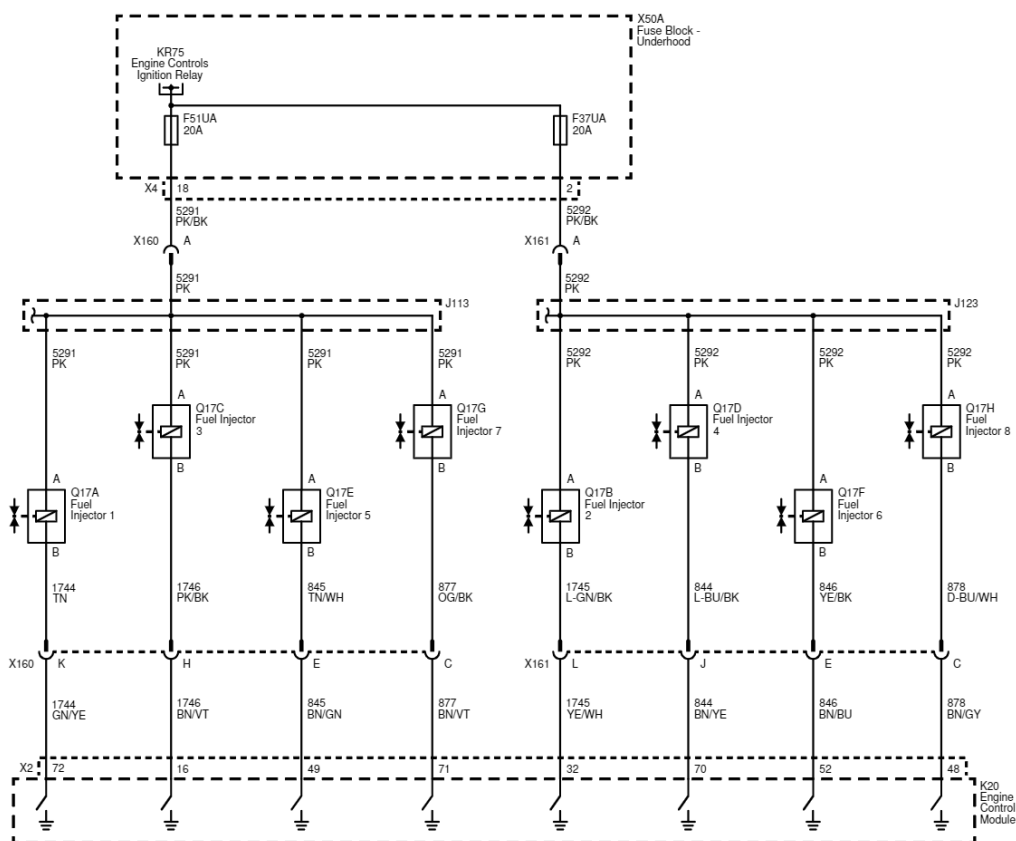


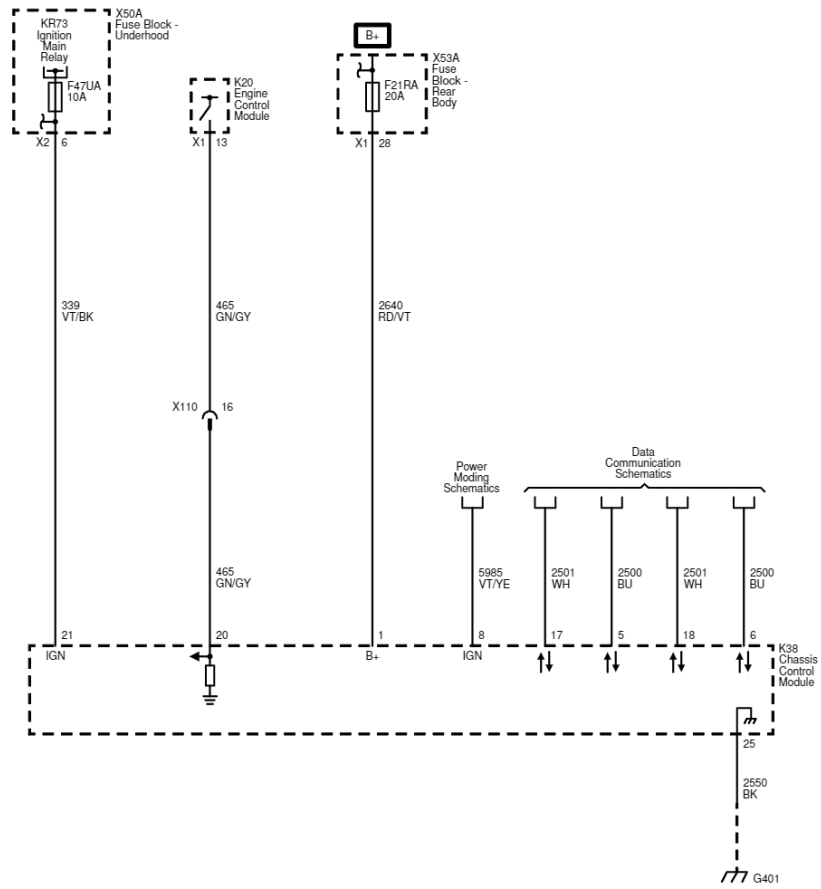


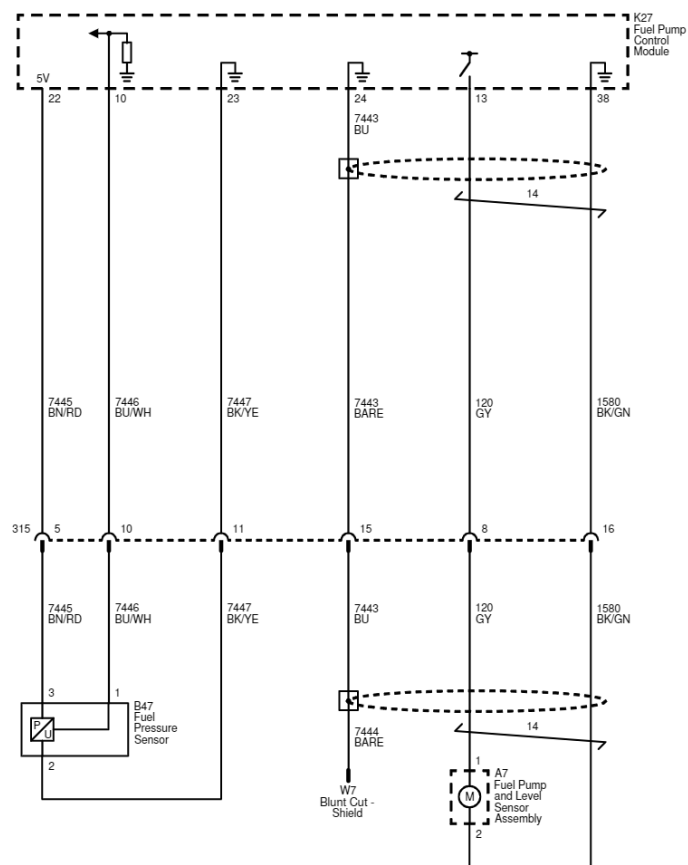
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DESIGN







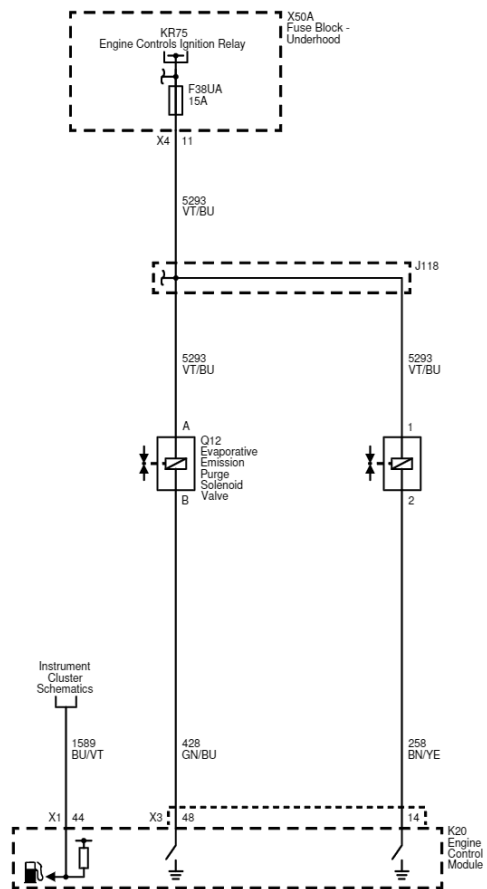


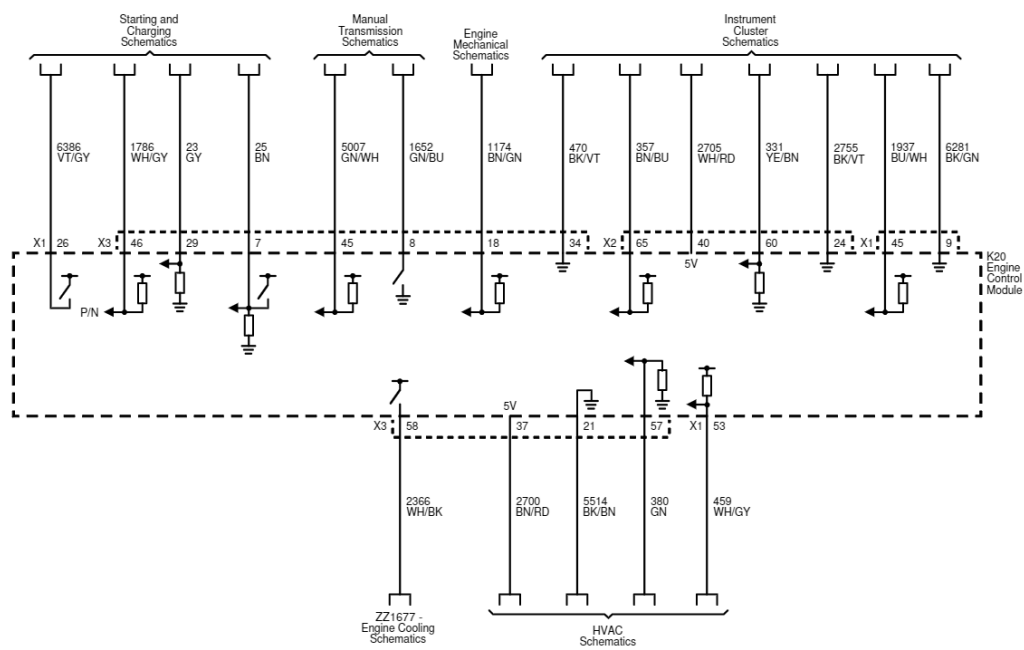
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DESC







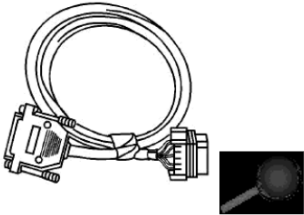


LOG

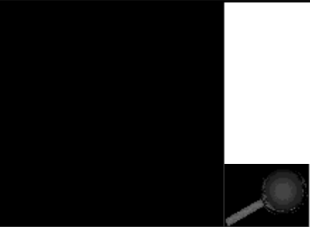
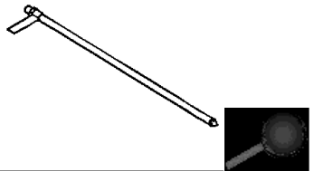
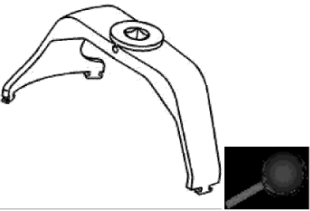
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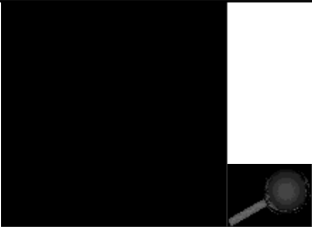
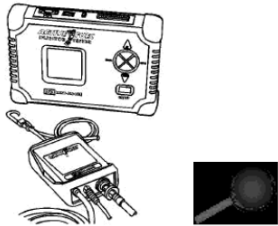
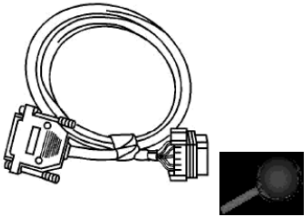
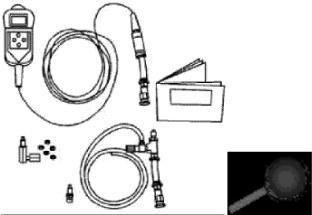
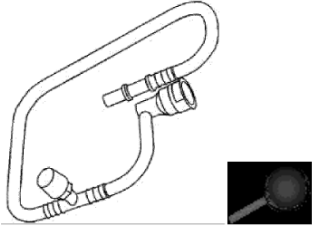


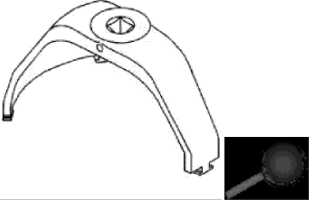
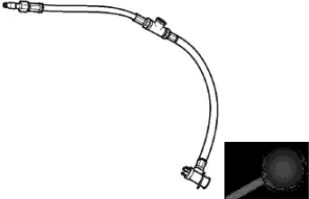
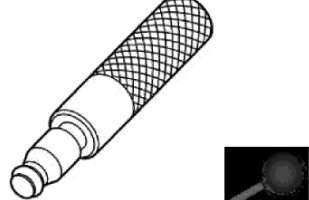
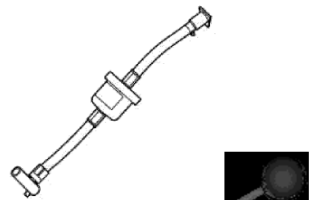
## Special Tools (Diagnostic Tools)

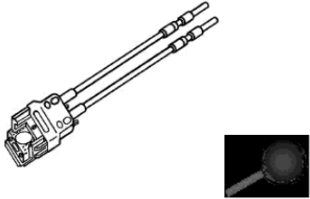
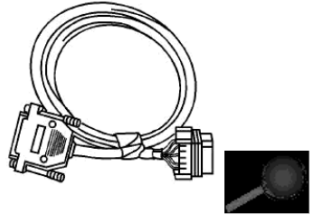
| Illustration                                                                        | Tool Number/Description                                           |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------|
|    | CH-34730-2C<br>J-34730-2C<br>Injector Test Lamp                   |
|    | CH-38641-B<br>J-38641-B<br>Diesel Fuel Quality Tester             |
|   | CH-39021-301<br>J-39021-301<br>Fuel Injector Harness Adapter      |
|  | CH-39021-460<br>J-39021-460<br>Fuel Injector Test Adapter         |
|  | CH-41415-30<br>GE-41415-30<br>J-41415-30<br>Fuel Tank Cap Adapter |

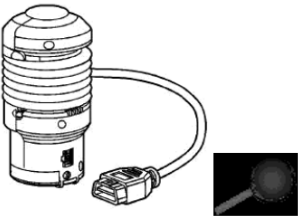
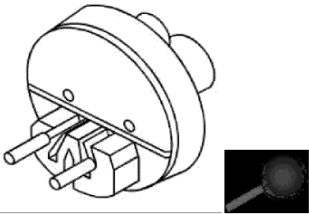
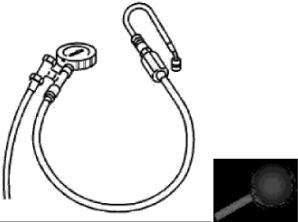
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| Illustration                                                                        | Tool Number/Description                             |
|-------------------------------------------------------------------------------------|-----------------------------------------------------|
|    | CH-42960-2<br>J-42960-2<br>Fuel Flapper Door Holder |
|    | CH-42982<br>J-42982<br>Fuel Pressure Gauge Adapter  |
|    | CH-44175-A<br>J-44175-A<br>Fuel Composition Tester  |
|   | CH-45004<br>J-45004<br>Fuel Tank Drain Hose         |
|  | CH-45722<br>J-45722<br>Fuel Sender Lock Ring Wrench |
|                                                                                     | CH-45873<br>J-45873<br>Fuel Return Volume Test Kit  |

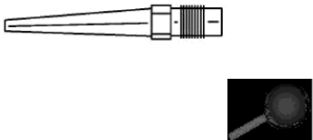
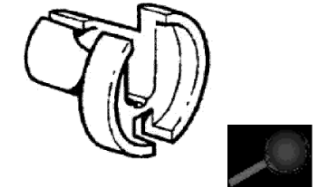
| Illustration                                                                        | Tool Number/Description                        |
|-------------------------------------------------------------------------------------|------------------------------------------------|
|    |                                                |
|    | CH-47976<br>Active Fuel Injector Tester (AFIT) |
|    | CH-47976-75<br>Fuel Injector Harness Adapter   |
|   | CH-48027<br>Fuel Pressure Gauge                |
|  | CH-48096<br>EVAP Service Access Port Tool      |
|                                                                                     | CH-48482<br>Fuel Sender Lock Ring Wrench       |

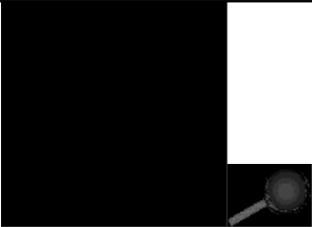
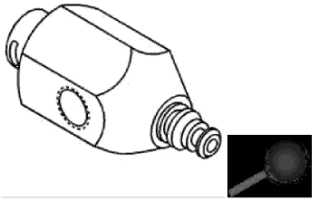
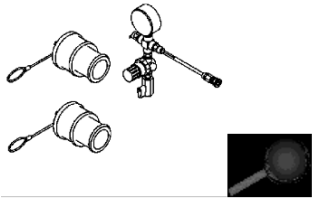
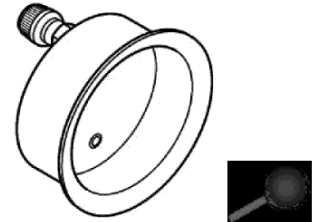
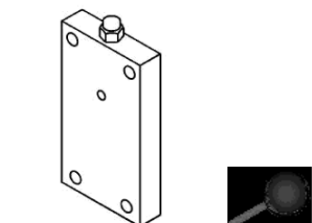
| Illustration                                                                        | Tool Number/Description                                  |
|-------------------------------------------------------------------------------------|----------------------------------------------------------|
|    |                                                          |
|    | CH-50375<br>Diesel Injector Return Line Pressure Adapter |
|    | CH-50377-A<br>Injector Return Line Cap                   |
|   | CH-50378<br>Injector Return Leakage Test Adapter         |
|  | EL-26792<br>J-26792<br>HEI Spark Tester                  |
|                                                                                     | EL-34730-405<br>J-34730-405<br>Injector Test Lamp        |

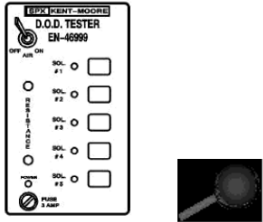
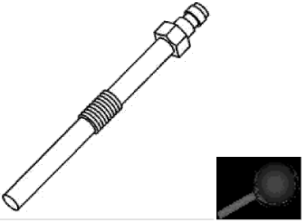
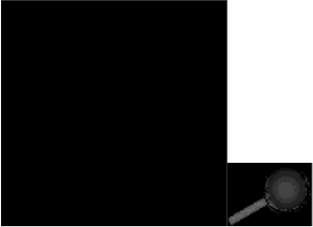
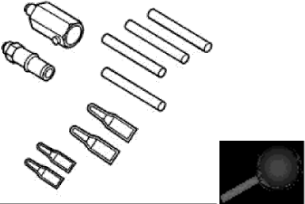
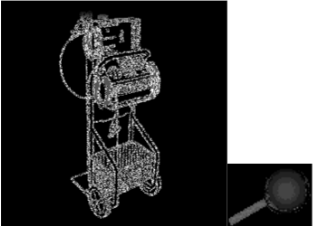
| Illustration                                                                        | Tool Number/Description                                   |
|-------------------------------------------------------------------------------------|-----------------------------------------------------------|
|    |                                                           |
|    | EL-36169-HD<br>Heavy Duty Fused Jumper                    |
|    | EL-38522-A<br>J-38522-A<br>Variable Signal Generator      |
|   | EL-39021<br>J-39021<br>Fuel Injector Coil Balance Tester  |
|  | EL-39021-460<br>J-39021-460<br>Fuel Injector Test Adapter |
|                                                                                     | EL-42598-B<br>J-42598-B<br>Vehicle Data Recorder          |

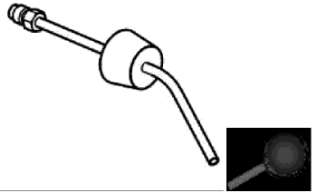
| Illustration                                                                        | Tool Number/Description                                       |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------|
|    |                                                               |
|    | EL-43244<br>J-43244<br>Relay Puller Pliers                    |
|    | EL-44603<br>J-44603<br>Injector Test Lamp                     |
|   | EN-34730-91<br>J-34730-91<br>KM-J-34730-91<br>Pressure Tester |
|  | EN-36012-A<br>J-36012-A<br>Ignition System Diagnosis Harness  |
|                                                                                     | EN-37287<br>J-37287<br>Fuel Line Shut-off Adapters            |

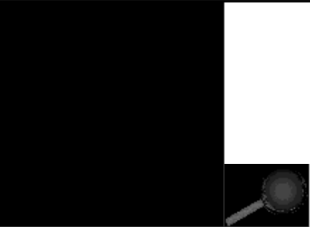


| Illustration                                                                        | Tool Number/Description                                              |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------|
|    |                                                                      |
|    | EN-39021-210<br>J-39021-210<br>Injector Tester Adapter Box           |
|    | EN-41413-311<br>J-41413-311<br>EVAP Plug                             |
|   | EN-41413-VLV<br>J-41413-VLV<br>EVAP Service Port Vent Fitting        |
|  | EN-41769<br>J-41769<br>KM-41769<br>Fuel Line Quick Connect Separator |
|                                                                                     | EN-44602<br>J-44602<br>Injector Test Adapter                         |

| Illustration                                                                        | Tool Number/Description                                            |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------|
|    |                                                                    |
|    | EN-45873-30<br>J-45873-30<br>Injector Flow Test Adapter            |
|    | EN-46091<br>J-46091<br>Charge Air Cooler Tester                    |
|   | EN-46091-15A<br>J-46091-15A<br>Diesel Engine Pressure Test Adapter |
|  | EN-46091-5<br>J-46091-5<br>Charge Air Cooler Tester Adapter        |
|                                                                                     | EN-46999<br>Displacement On Demand Electric Tool                   |

| Illustration                                                                        | Tool Number/Description                                                             |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|    |                                                                                     |
|    | EN-47603<br>Compression Gauge Adapter                                               |
|    | GE-23738-A<br>J-23738-A<br>Vacuum Pump                                              |
|   | GE-41413-300<br>EN-41413-300<br>J-41413-300<br>EVAP Cap and Plug Kit                |
|  | GE-41413-A<br>EN-41413-A<br>J-41413-A<br>Evaporative Emissions System Tester (EEST) |
|                                                                                     | GE-41413-SPT<br>J-41413-SPT<br>High Intensity White Light                           |

| Illustration                                                                        | Tool Number/Description                                                               |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|    |                                                                                       |
|    | GE-41415-50<br>J-41415-50<br>Fuel Tank Cap Adapter                                    |
|    | GE-41415-60<br>Engine Induction System Leak Test<br>Adapter/Capless Fuel Fill Adapter |
|   | J-25070<br>Heat Gun 260–399°C (500–750°F)                                             |
|  | J-34730-375<br>Injector Test Lamp                                                     |
|                                                                                     | J-44581<br>Fuel Line Disconnect Tool                                                  |

| Illustration                                                                      | Tool Number/Description |
|-----------------------------------------------------------------------------------|-------------------------|
|  |                         |