Temperature Versus Resistance

IAT Sensor

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
150	302	47
140	284	60
130	266	78
120	248	101
110	230	133
100	212	178
90	194	242
80	176	334
70	158	469
60	140	671
50	122	980
40	104	1465
30	86	2240
20	68	3511
10	50	5658
0	32	9399
-10	14	16120
-20	-4	28583
-30	-22	52594
-40	-40	100866

ECT Sensor

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
150	302	57
140	284	71
120	248	113
100	212	186
80	176	323
60	140	596
40	104	1175
25	86	2057
20	68	2500
0	32	5896

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-20	-4	15462
-40	-40	45313

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Altitude Versus Barometric Pressure

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)
Determine your altitude by contacting a local weather station or by using another reference source.		
4 267	14,000	56-64
3 962	13,000	58-66
3 658	12,000	61-69
3 353	11,000	64-72
3 048	10,000	66-74
2 743	9,000	69-77
2 438	8,000	71-79
2 134	7,000	74-82
1 829	6,000	77-85
1 524	5,000	80-88
1 219	4,000	83-91
914	3,000	87-95
610	2,000	90-98
305	1,000	94-102
0	0 Sea Level	96-104
-305	-1,000	101-105

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Ignition System Specifications

Application	Specification	
	Metric	English
Firing Order	1-2-3-4-5-6	
Spark Plug Gap	1.10 mm	0.0433 in
Spark Plug Torque	18 N·m	13 lb ft
Refer to Engine Mechanical Specifications .		

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Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Pedal Bolt	10 N·m	89 lb in
Air Cleaner Assembly Bolt	6 N·m	53 lb in
Air Cleaner Inlet Duct Bolt	6 N·m	53 lb in
Air Cleaner Outlet Duct Clamp	3 N·m	27 lb in
Camshaft Position (CMP) Actuator Solenoid Valve Bolt	10 N·m	89 lb in
Camshaft Position (CMP) Sensor Bolt	10 N·m	89 lb in
Crankshaft Position (CKP) Sensor Bolt	10 N·m	89 lb in
Engine Coolant Temperature (ECT) Sensor	22 N·m	16 lb ft
Evaporative Emission (EVAP) Canister Nut	8 N·m	71 lb in
Evaporative Emission (EVAP) Purge Solenoid Bracket Bolt	10 N·m	89 lb in
Fuel Fill Pipe Hose Clamp	5 N·m	44 lb in
Fuel Pressure Sensor	15 N·m	11 lb ft
Fuel Pump Flow Control Module Bolt	10 N·m	89 lb in
Fuel Rail Bolt	10 N·m	89 lb in
Fuel Tank Fill Pipe Bracket Nut	4 N·m	35 lb in
Fuel Tank Fill Pipe Housing to Fuel Tank Fill Pipe Screw	10 N·m	89 lb in
Fuel Tank Strap Bolt	20 N·m	15 lb ft
Heated Oxygen Sensor (HO2S)	42 N·m	31 lb ft
Ignition Coil Bolt	10 N·m	89 lb in
Knock Sensor Bolt	23 N·m	17 lb ft
Manifold Absolute Pressure (MAP) Sensor Bolt	10 N·m	89 lb in
Mass Air Flow (MAF)/Intake Air Temperature Sensor Bolt	4 N·m	35 lb in
Rear Brake Pipe Fitting to Brake Pressure Modulator Valve (BPMV)	21 N·m	16 lb ft
Rear Brake Pipe Fitting to Rear Brake Crossover Pipe Fitting	18 N·m	13 lb ft
Rear Brake Pipe Fitting to Rear Brake Hose Fitting	18 N·m	13 lb ft
Spark Plug	20 N·m	15 lb ft
Throttle Body Bolt	10 N·m	89 lb in

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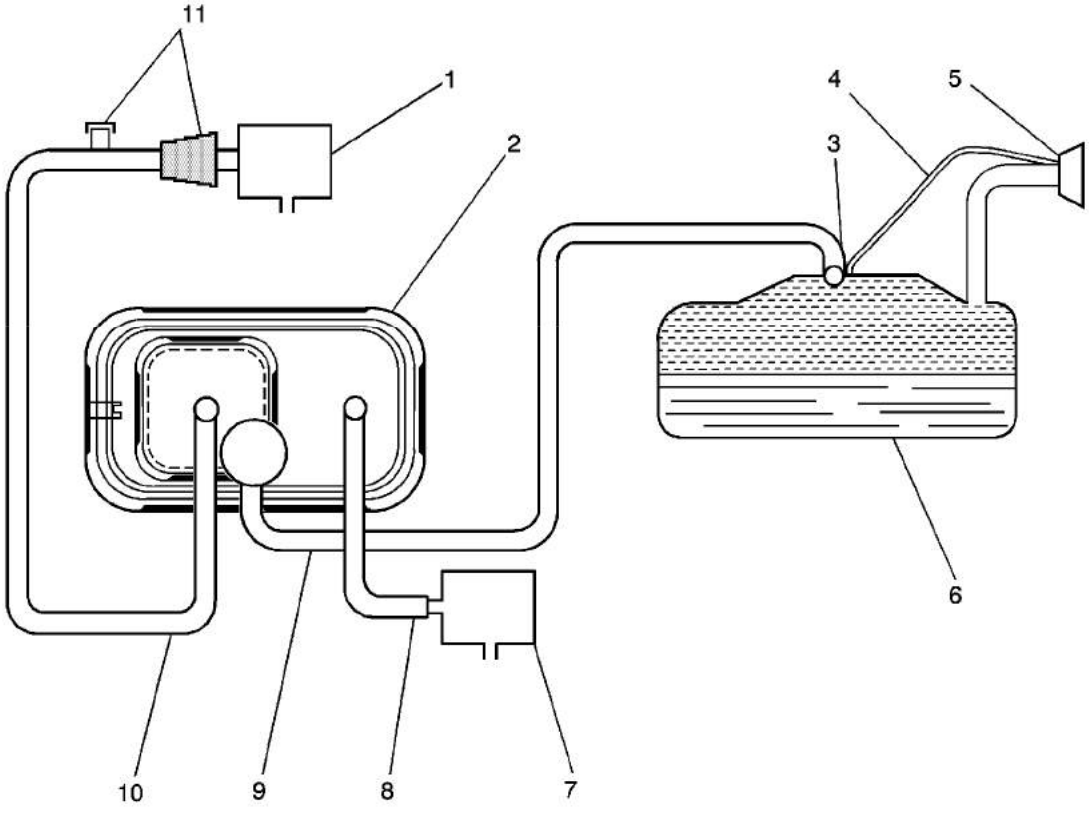
Evaporative Emissions Hose Routing Diagram



(1) EVAP Canister Purge Solenoid Valve
(2) EVAP Canister
(3) Fluid Level Vent Valve
(4) Vapor Recirculation tube
(5) Fuel Fill Neck and Fill Cap
(6) Fuel Tank
(7) EVAP Canister Vent Valve
(8) Vent Hose/Pipe
(9) EVAP Vapor tube
(10) EVAP Purge tube
(11) EVAP Service Port or Service Access Connector

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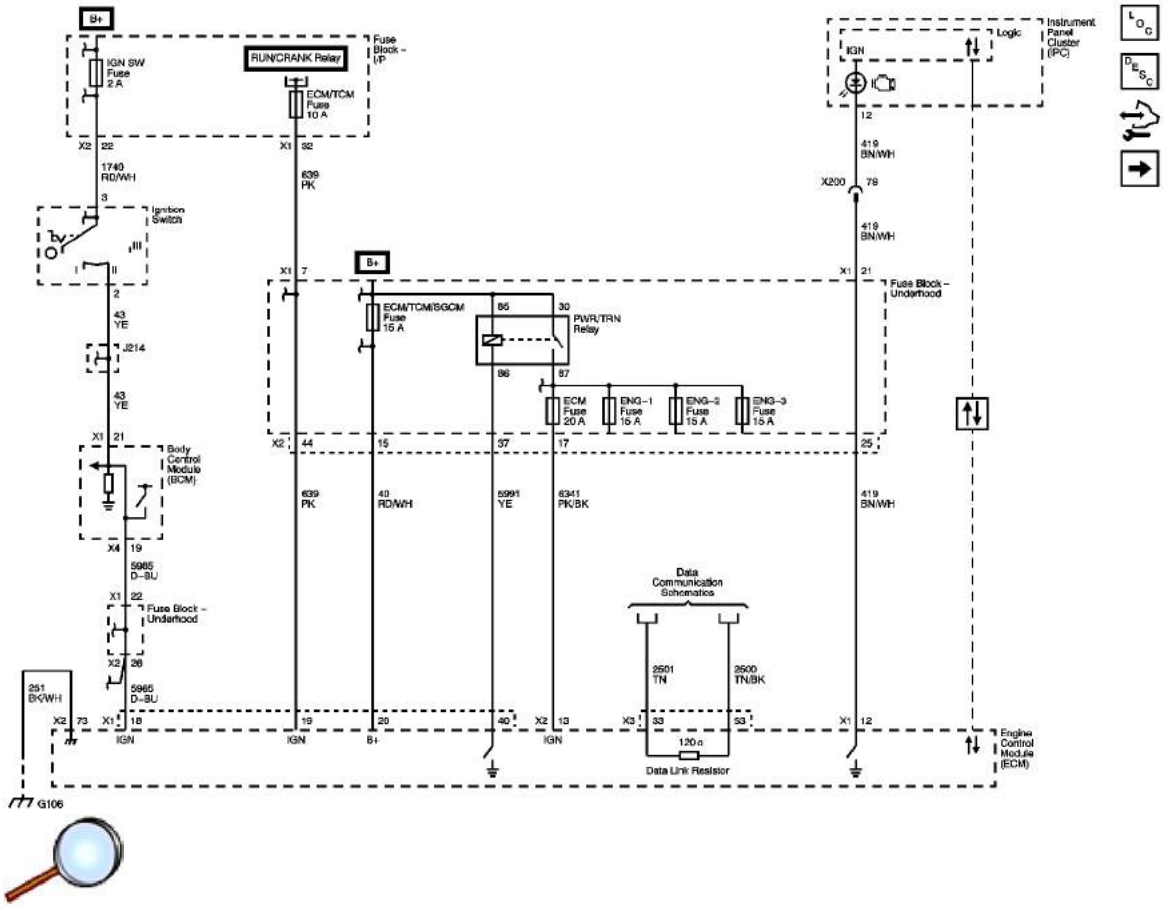
Module Power, Ground, Serial Data and MIL (LY7)



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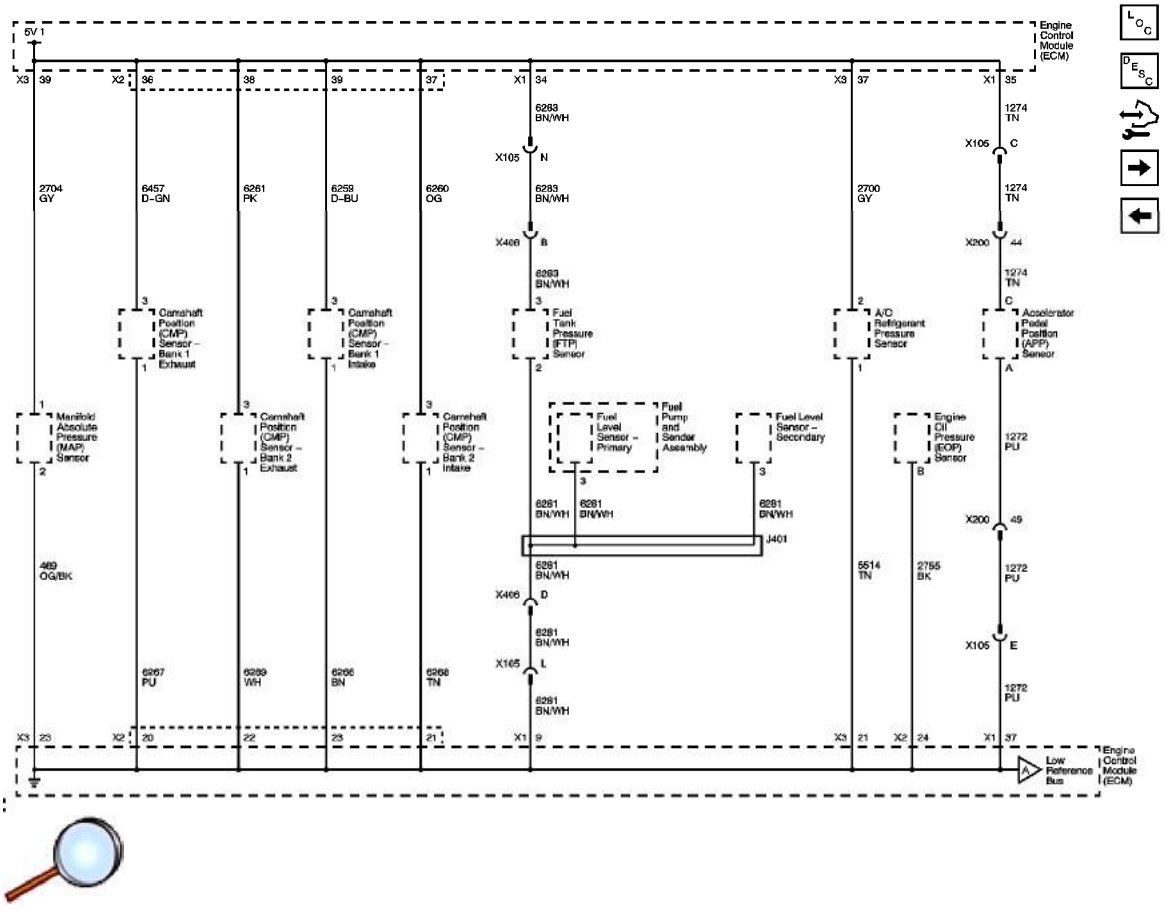
Engine Data Sensors - 5-Volt 1 and Low Reference (LY7)



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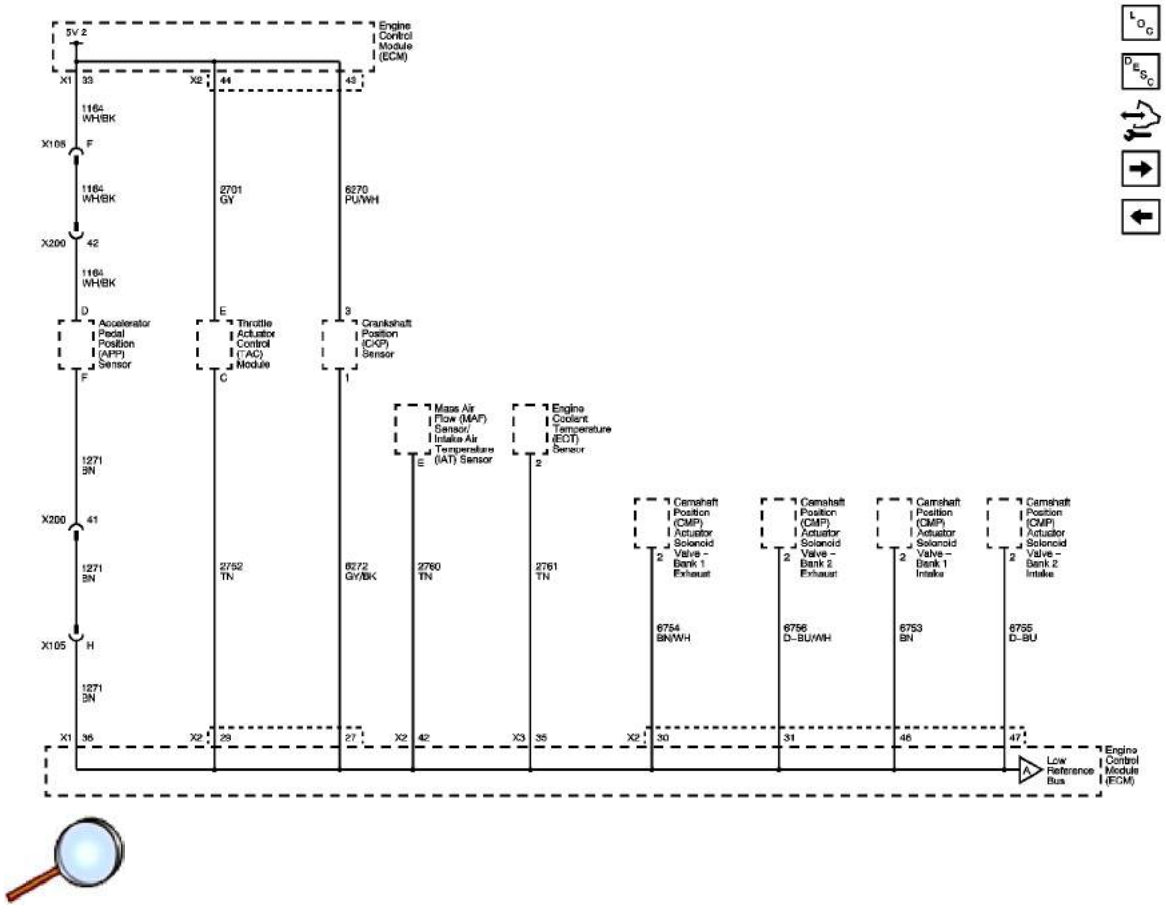
Engine Data Sensors - 5-Volt 2 and Low Reference (LY7)



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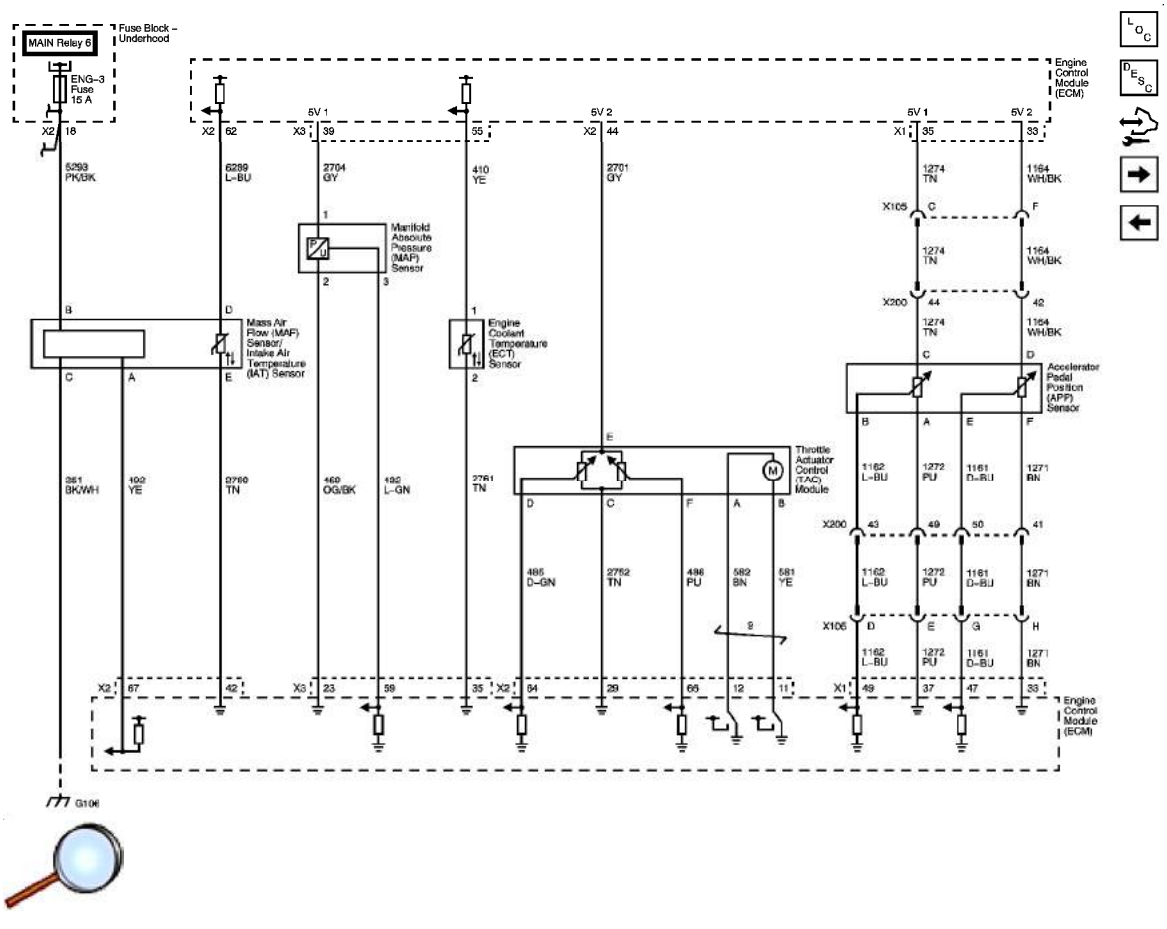
Engine Data Sensors - Pressure, Temperature (LY7)



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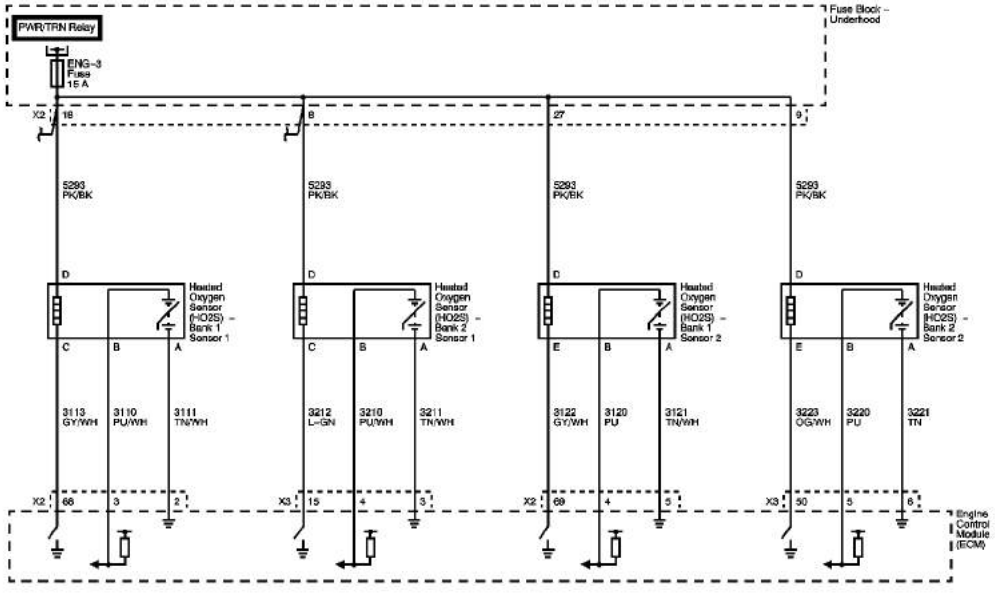
Engine Data Sensors - Heated Oxygen Sensors (HO2S) (LY7)



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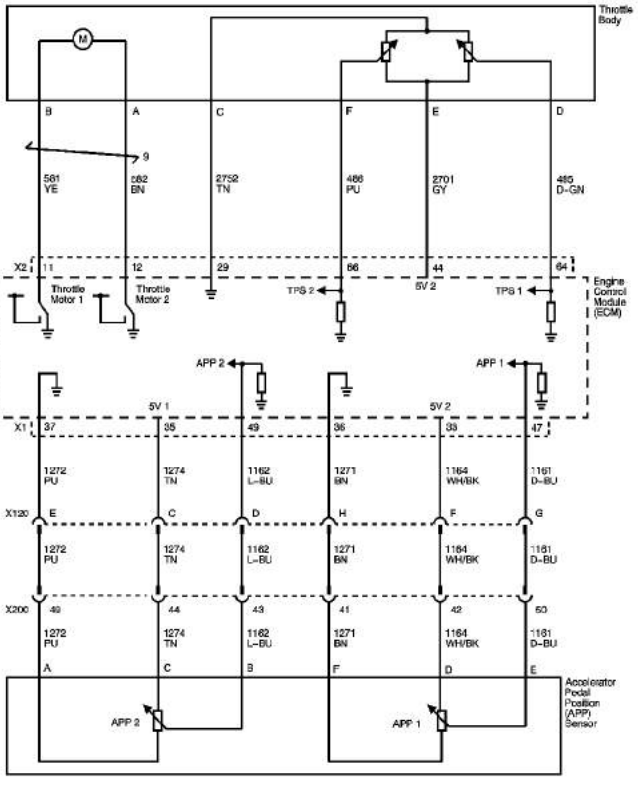
Engine Data Sensors - Accelerator Pedal Position (APP) and Throttle Controls (LY7)



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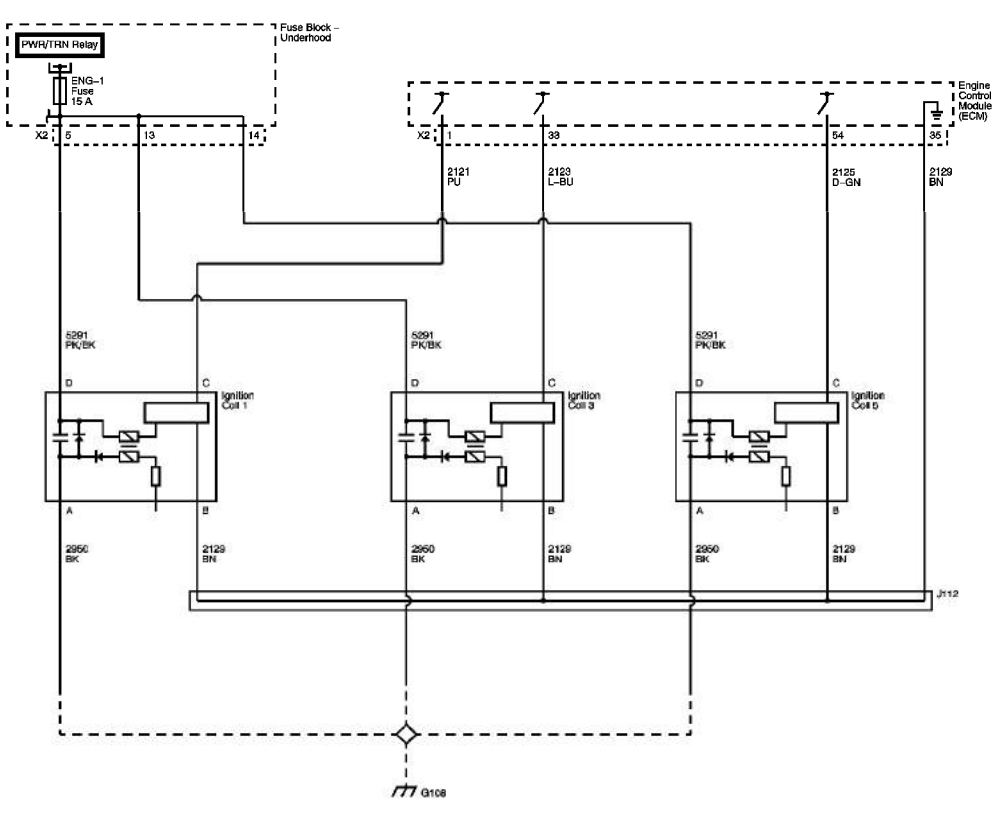
Ignition Controls - Ignition System Coils Bank 1 (LY7)



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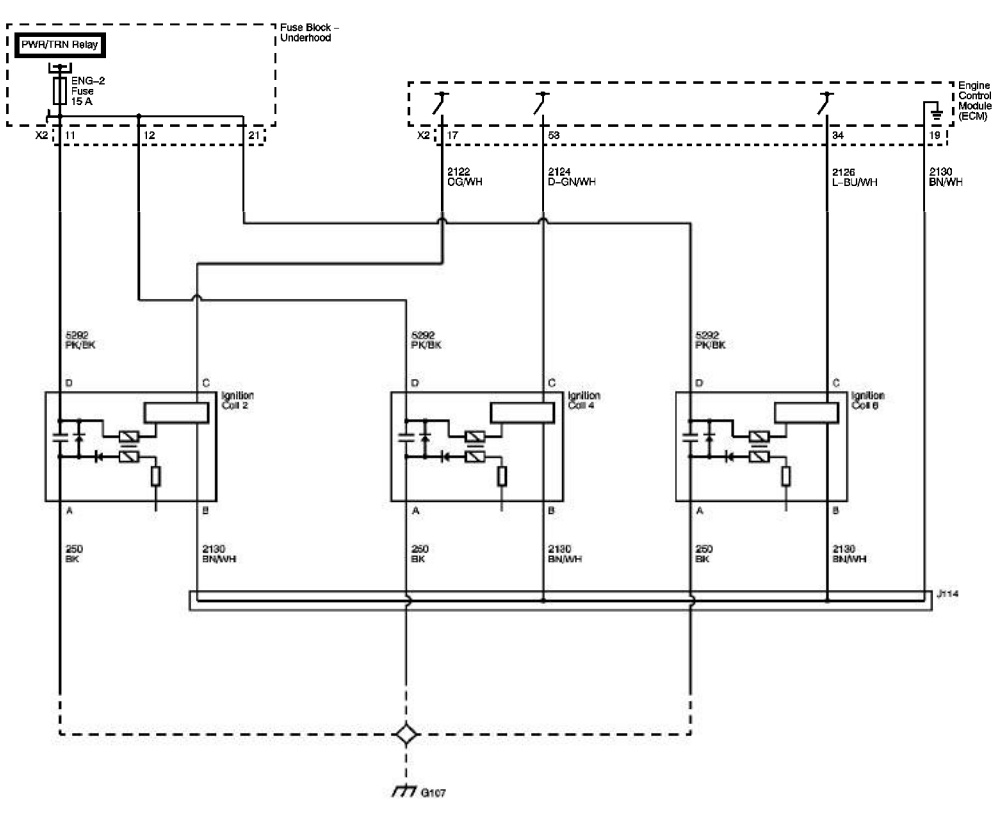
Ignition Controls - Ignition System Coils Bank 2 (LY7)



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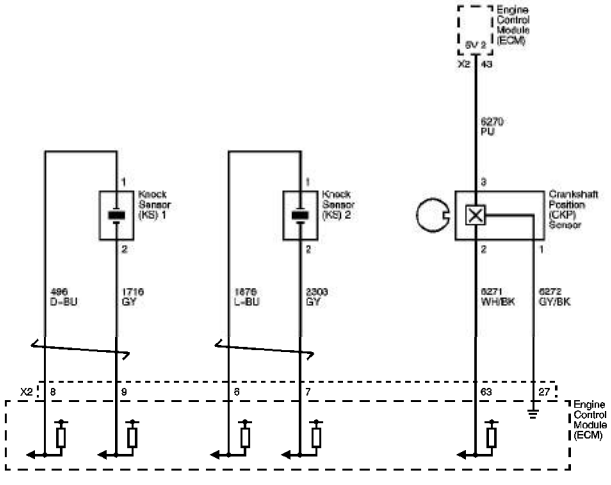
Ignition Controls - Crankshaft Position (CKP) and Knock (KS) Sensors (LY7)



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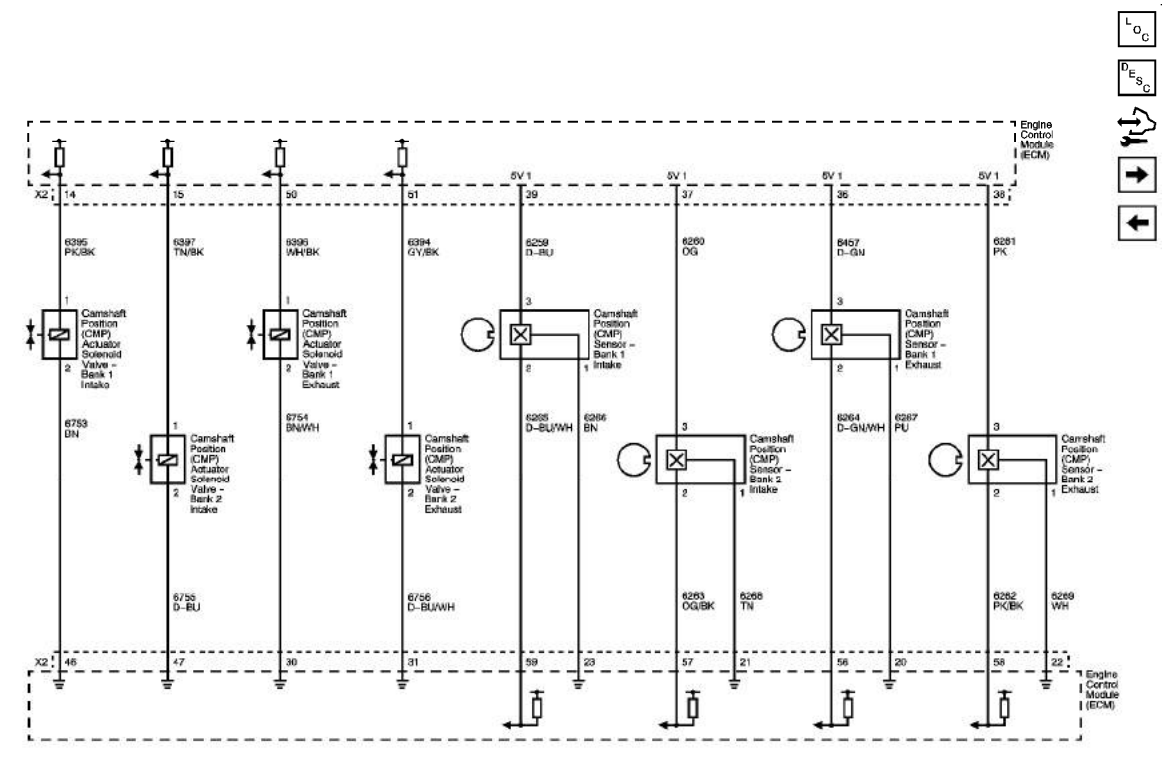
Ignition Controls - Camshaft Position (CMP) Sensors and Actuator Solenoids (LY7)



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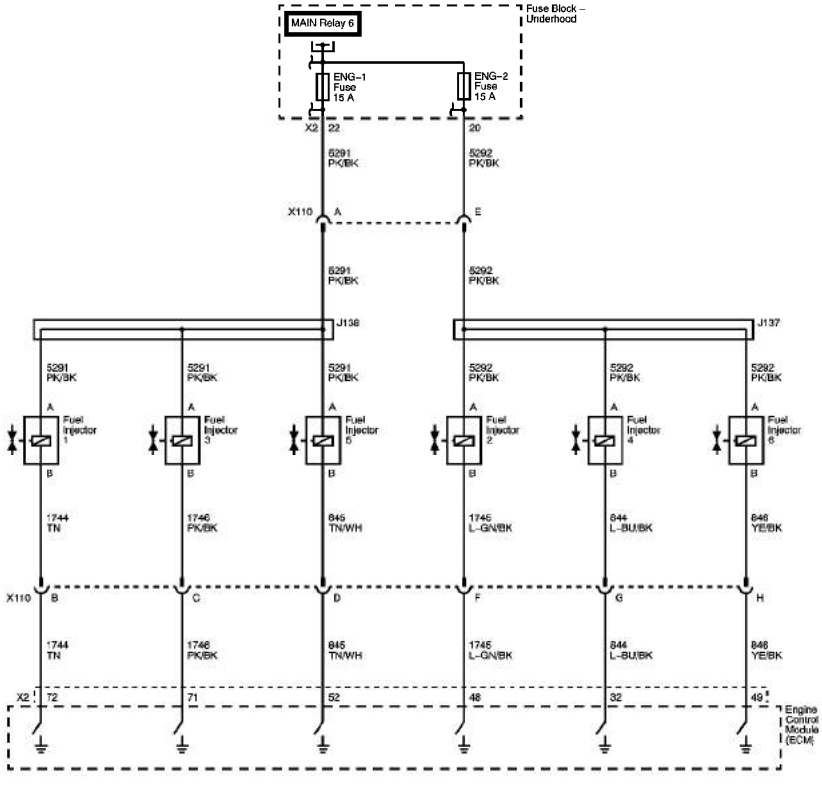
Fuel Controls - Fuel Injectors (LY7)



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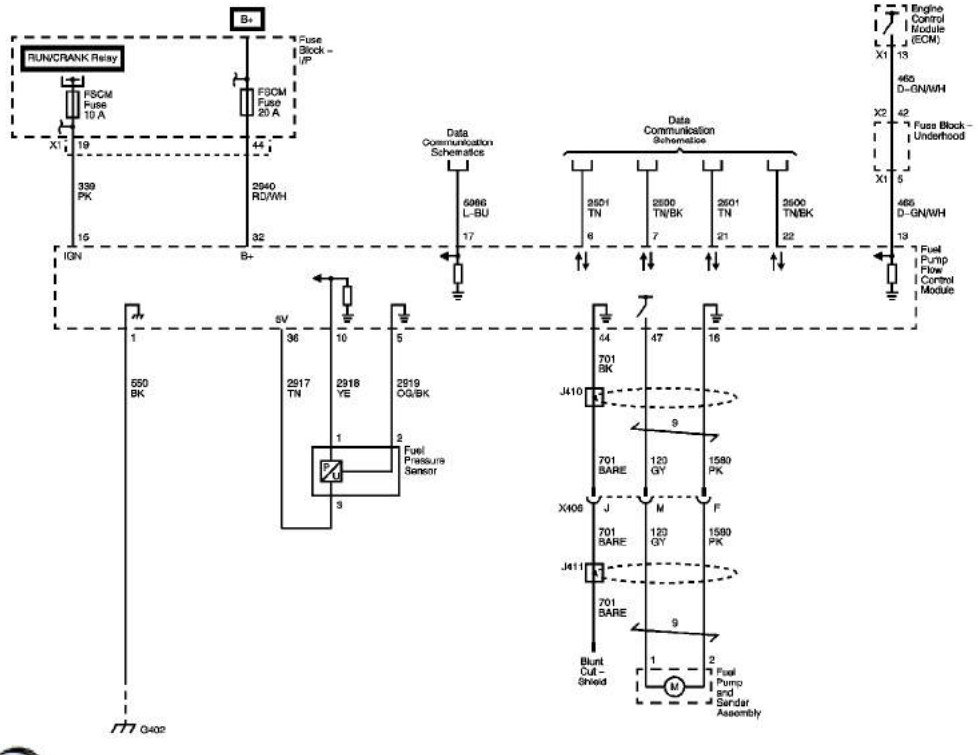
Fuel Controls - Fuel Pump Controls (LY7)



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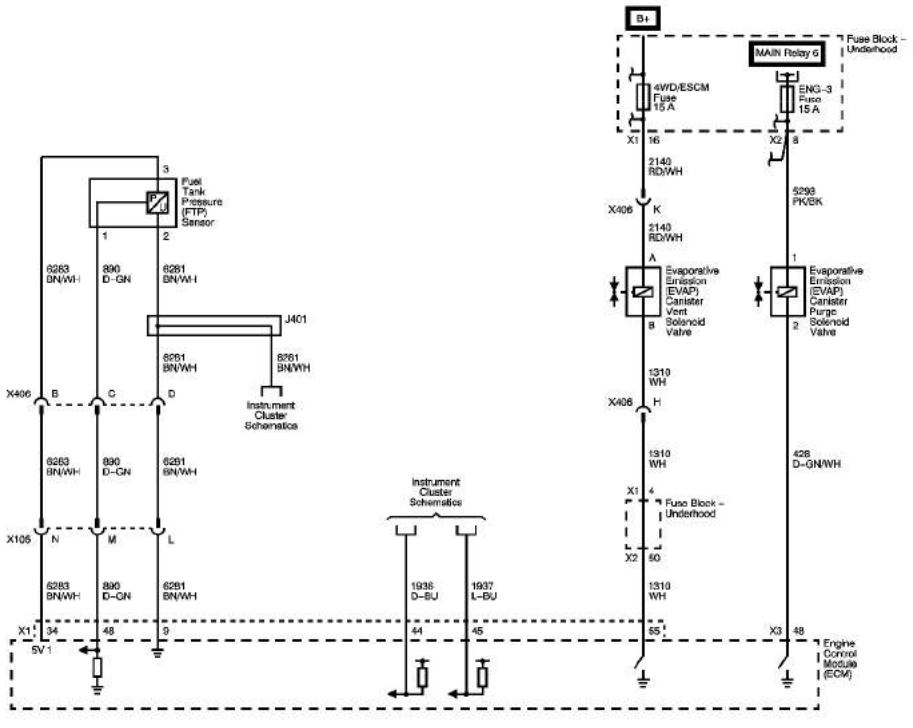
Fuel Controls - Evaporative Emissions (EVAP) Controls (LY7)



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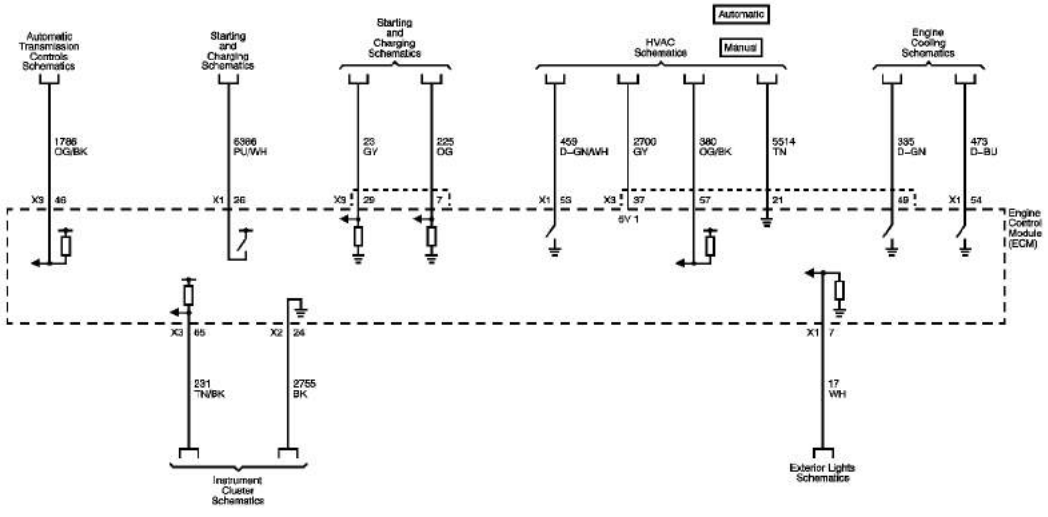
Controlled / Monitored Subsystem References (LY7)



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Crankshaft Position System Variation Learn

Note: The Crankshaft Position (CKP) system variation learn procedure is also required when the following service procedures have been performed, regardless of whether DTC P0315 is set:

- An engine replacement
- A engine control module (ECM) replacement
- A crankshaft balancer replacement
- A crankshaft replacement
- A CKP sensor replacement
- Any engine repairs which disturb the crankshaft to CKP sensor relationship.

Note: The ECM monitors certain component signals to determine if all the conditions are met to continue with the CKP System Variation Learn Procedure. The scan tool only displays the condition that inhibits the procedure. The scan tool displays the signals of the following components:

- CKP sensors activity--If there is a CKP sensor condition, refer to the applicable DTC that set.
- Camshaft position (CMP) signal activity--If there is a CMP signal condition, refer to the applicable DTC that set.
- Engine coolant temperature (ECT)--If the engine coolant temperature is not warm enough, idle the engine until the engine coolant temperature reaches the correct temperature.

1. Install a scan tool.
2. Monitor the ECM for DTCs with a scan tool. If other DTCs are set, except DTC P0315, refer to Diagnostic Trouble Code (DTC) List - Vehicle for the applicable DTC that set.
3. With a scan tool, select the CKP System Variation Learn Procedure and perform the following:
   3.1. Block drive wheels.
   3.2. Set parking brake.
   3.3. DO NOT apply brake pedal.
   3.4. Cycle ignition from OFF to ON.
   3.5. Apply and hold brake pedal for the duration of the procedure.
   3.6. Start and idle engine.
   3.7. Turn the air conditioning (A/C) OFF.
   3.8. The vehicle must remain in Park or Neutral.

   Note: While the learn procedure is in progress, release the throttle immediately when the engine starts to decelerate. The engine control is returned to the operator and the engine responds to throttle position after the learn procedure is complete.

   3.9. Accelerate to wide open throttle (WOT) and release when the fuel cut-off occurs.
4. The scan tool displays Learn Status: Learned this Ignition. If the scan tool indicates that DTC P0315 ran and passed, the CKP variation learn procedure is complete. If the scan tool indicates DTC P0315 failed or did not run, or another DTC is present, refer to Diagnostic Trouble Code (DTC) List - Vehicle and perform the appropriate diagnostic procedure.
5. Turn OFF the ignition for 30 seconds after the learn procedure is completed successfully in order to store the CKP system variation values in the ECM memory.

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Engine Control Module Replacement

Caution:

- Turn the ignition OFF when installing or removing the control module connectors and disconnecting or reconnecting the power to the control module (battery cable, powertrain control module (PCM)/engine control module (ECM)/transaxle control module (TCM) pigtail, control module fuse, jumper cables, etc.) in order to prevent internal control module damage.
- Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control module, using battery booster cables, or when charging the vehicle battery.
- In order to prevent any possible electrostatic discharge damage to the control module, do no touch the connector pins or the soldered components on the circuit board.
- Remove any debris from around the control module connector surfaces before servicing the control module. Inspect the control module connector gaskets when diagnosing or replacing the control module. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the control module.
- The replacement control module must be programmed.

Note:

- It is necessary to record the remaining engine oil life. If the replacement module is not programed with the remaining engine oil life, the engine oil life will default to 100 percent. If the replacement module is not programmed with the remaining engine oil life, the engine oil will need to be changed at 5 000 km (3,000 mi) from the last engine oil change.
- It is necessary to record the remaining automatic transmission fluid life. If the replacement module is not programed with the remaining automatic transmission fluid life, the automatic transmission fluid life will default to 100 percent. If the replacement module is not programmed with the remaining automatic transmission fluid life, the automatic transmission fluid will need to be changed at 83 000 km (50,000 mi) from the last automatic transmission fluid change.

Removal Procedure

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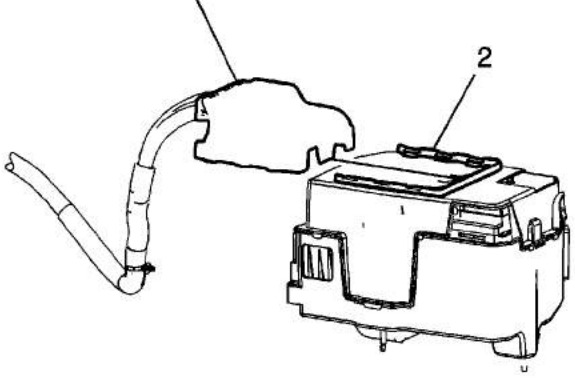
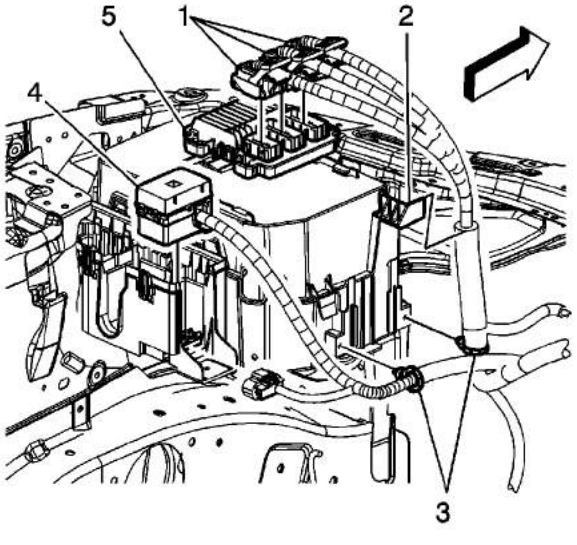


1. Using a scan tool, retrieve the percentage of remaining engine oil and the remaining automatic transmission fluid life. Record the remaining engine oil and the remaining automatic transmission fluid life.
2. Release the electronic control module (ECM) bracket (1) from the battery cover (2).



3. Release the retaining tabs on the ECM bracket and slide the ECM out of it.
4. Disconnect the engine wiring harness electrical connectors (1) from the ECM (5).

Installation Procedure

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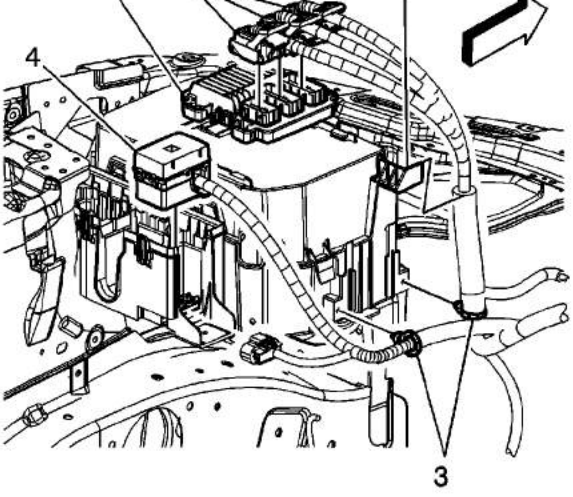
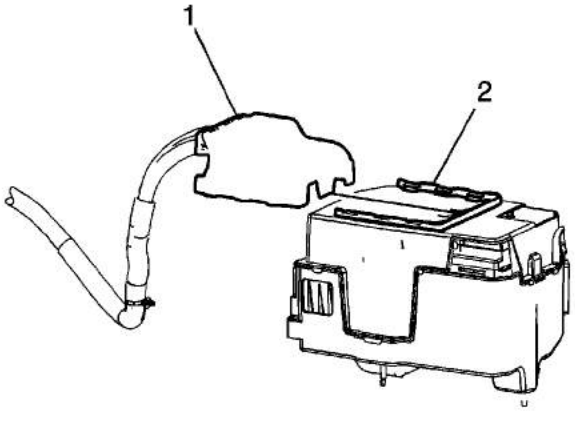


1. Connect the engine wiring harness electrical connectors (1) to the ECM (5).
2. Slide the ECM into the ECM bracket until it locks into place.



3. Install the ECM bracket (1) onto the air cleaner assembly cover (2) until it locks in place.
4. If replacing the ECM, program the ECM. Refer to Control Module References.

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Throttle 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 coking. Anytime the throttle body airflow rate changes, for example due to cleaning or replacing, the values must be relearned.

A vehicle that had a heavily coked throttle body that has been cleaned or replaced may take several drive cycles to learn out 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

With Scan Tool - Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0220, P0222, P0223, P0300, P0351, P0352, P0353, 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).

Without Scan Tool - Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0220, P0222, P0223, P0300, P0351, P0352, P0353, 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 1 voltage is greater than 10 volts.

Throttle Learn

With Scan Tool - Reset Procedure

1. Ignition ON, engine O[redacted]eset in Module Setup.

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speed.
3. Clear the DTCs and return to the diagnostic that referred you here.

Without Scan Tool - Learn Procedure

Important: Do NOT perform this procedure if DTCs are set. Refer to Diagnostic Trouble Code (DTC) List - Vehicle.

1. Start and idle the engine in PARK for 3 minutes.
2. With a scan tool, monitor desired and actual RPM.
3. The ECM will start to learn the new idle cells and Desired RPM should start to decrease.
4. Ignition OFF for 60 seconds.
5. Start and idle the engine in PARK for 3 minutes.
6. After the 3 minute run time the engine should be idling normal.

Important: 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 seconds and repeat step 6.
8. Once the engine speed has returned to normal, clear DTCs and return to the diagnostic that referred you here.

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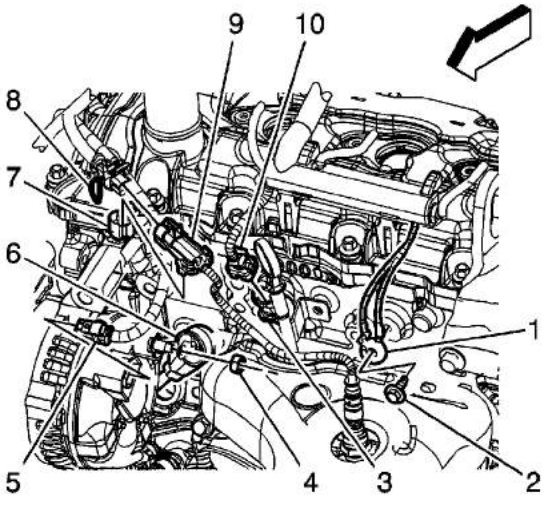
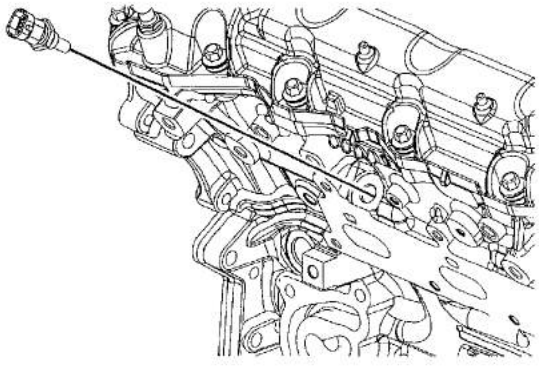
Engine Coolant Temperature Sensor Replacement

Removal Procedure



1. Partially drain the cooling system. Refer to Cooling System Draining and Filling

   Disconnect the engine wiring harness electrical connector (10) from the engine coolant temperature (ECT) sensor (3).



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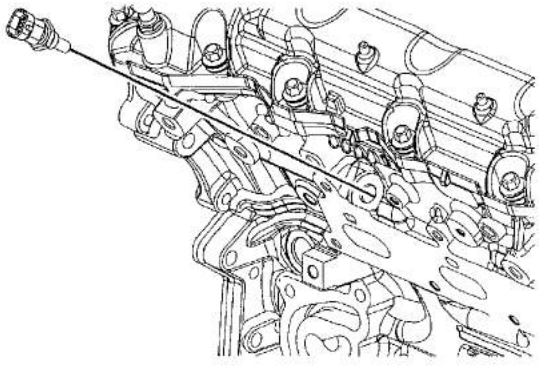
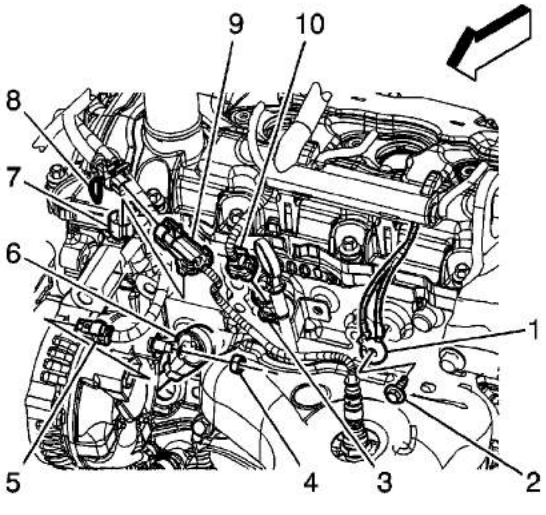
2. Remove the ECT sensor.

Installation Procedure

Caution: Refer to Fastener Caution in the Preface section.



1. Install the ECT sensor. Tighten the sensor to **22 N·m (16 lb ft).**



2. Connect the engine wiring harness electrical connector (10) to the ECT sensor (3).
3. Fill the cooling system. Refer to Cooling System Draining and Filling

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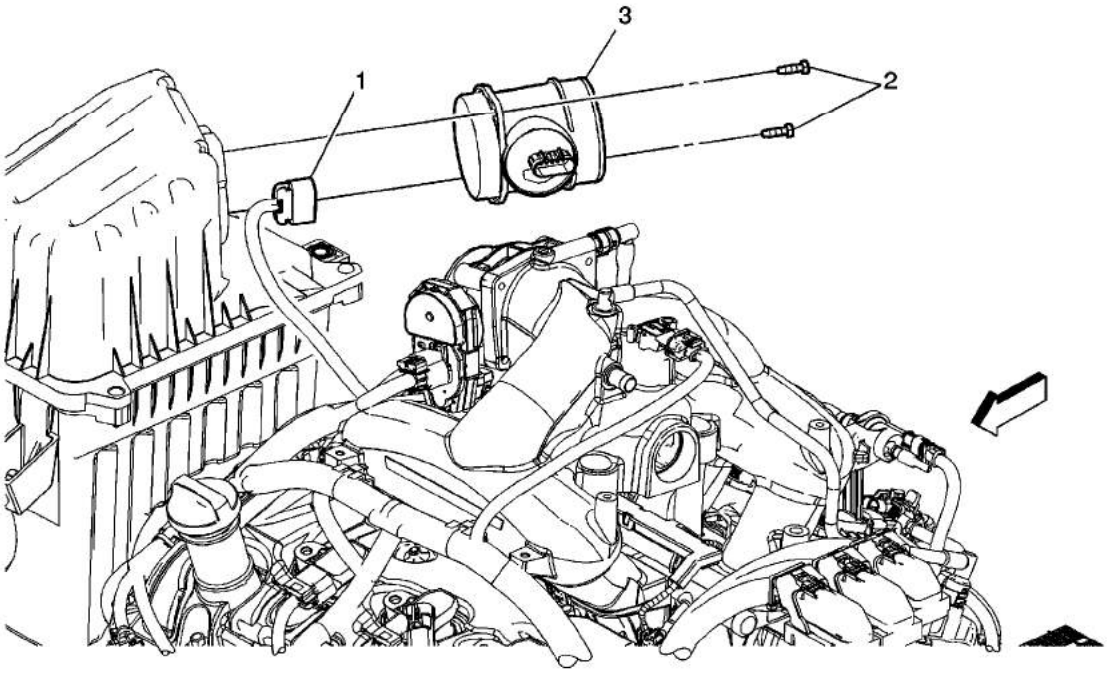
Mass Airflow Sensor with Intake Air Temperature Sensor Replacement



Callout	Component Name
Preliminary Procedure Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.	
1	Mass Airflow Sensor/Intake Air Temperature Sensor Electrical Connector
2	Mass Airflow Sensor/Intake Air Temperature Sensor Bolt (Qty: 2) **Caution:** Refer to Fastener Caution in the Preface section. **Tighten** 4 N·m (34 lb in)
3	Mass Airflow Sensor/Intake Air Temperature Sensor

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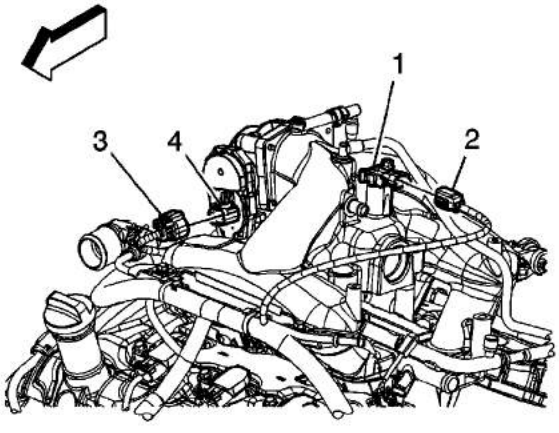
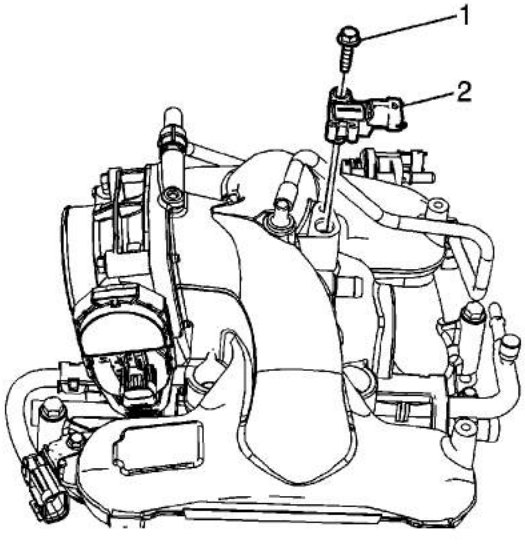
Manifold Absolute Pressure Sensor Replacement

Removal Procedure



1. Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.
2. Disconnect the engine wiring harness electrical connector (2) from the manifold absolute pressure (MAP) sensor (1).



3. Remove the MAP sensor bolt (1) and sensor (2).

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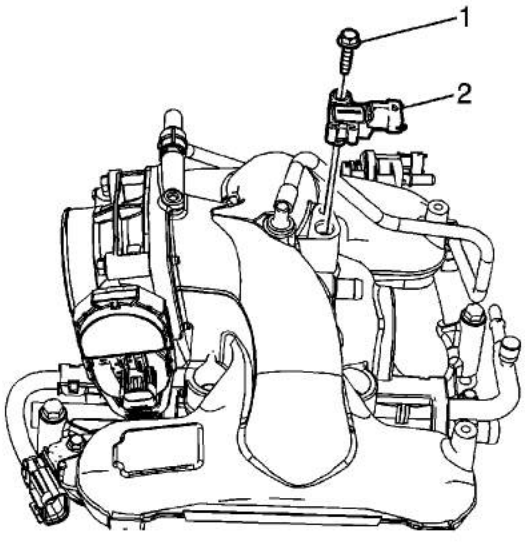
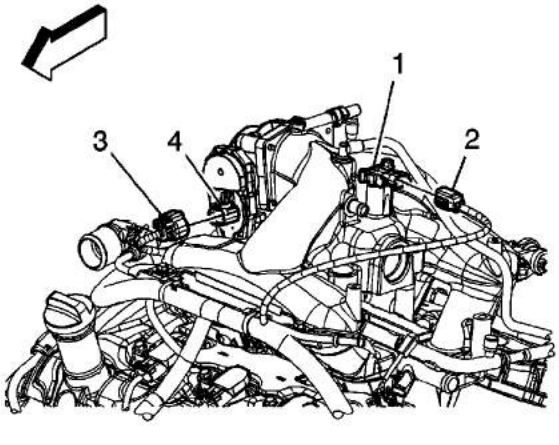


1. Lubricate the MAP sensor O-ring seal with clean engine oil.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the MAP sensor (2) and bolt (1). Tighten the bolt to **10 N·m (89 lb in).**



3. Connect the engine wiring harness electrical connector (2) to the MAP sensor (1).
4. Install the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.

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Heated Oxygen Sensor Replacement - Bank 1 Sensor 1

Removal Procedure

Caution: Do not remove the pigtail from either the heated oxygen sensor (HO2S) or the oxygen sensor (O2S). Removing the pigtail or the connector will affect sensor operation.

Handle the oxygen sensor carefully. Do not drop the HO2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Do not use cleaning solvents of any type.

Do not repair the wiring, connector or terminals. Replace the oxygen sensor if the pigtail wiring, connector, or terminal is damaged.

This external clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors, or terminals could result in the obstruction of the air reference and degraded sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor causing poor performance.
- Do not damage the sensor pigtail and harness wires in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Ensure the sensor or vehicle lead wires are not bent sharply or kinked. Sharp bends or kinks could block the reference air path through the lead wire.
- Do not remove or defeat the oxygen sensor ground wire, where applicable. Vehicles that utilize the ground wired sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will cause poor engine performance.
- Ensure that the peripheral seal remains intact on the vehicle harness connector in order to prevent damage due to water intrusion. The engine harness may be repaired using Packard's Crimp and Splice Seals Terminal Repair Kit. Under no circumstances should repairs be soldered since this could result in the air reference being obstructed.

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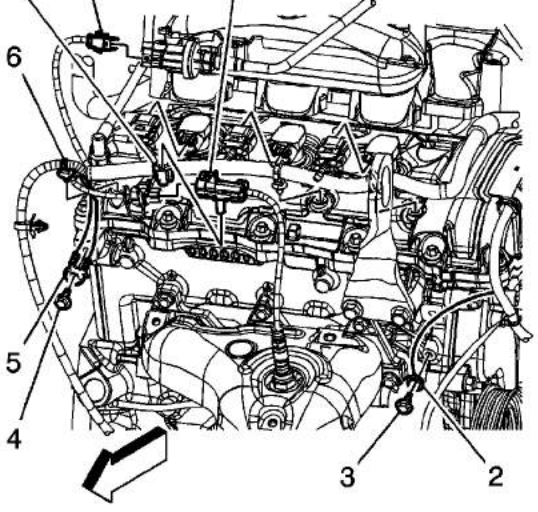
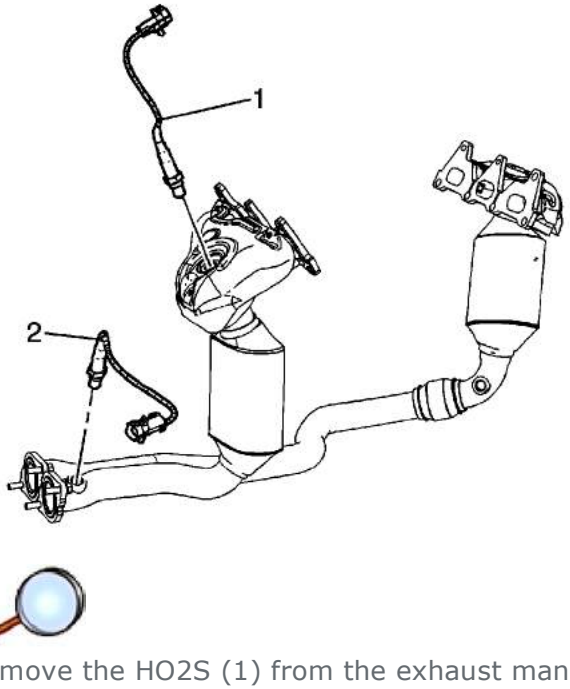


1. Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.
2. Remove the connector position assurance (CPA) retainer.
3. Disconnect the engine wiring harness electrical connector from the heated oxygen sensor (HO2S) electrical connector (1).
4. Remove the HO2S electrical connector retainer from the harness clip (7).



5. Remove the HO2S (1) from the exhaust manifold.

Installation Procedure

Note: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason

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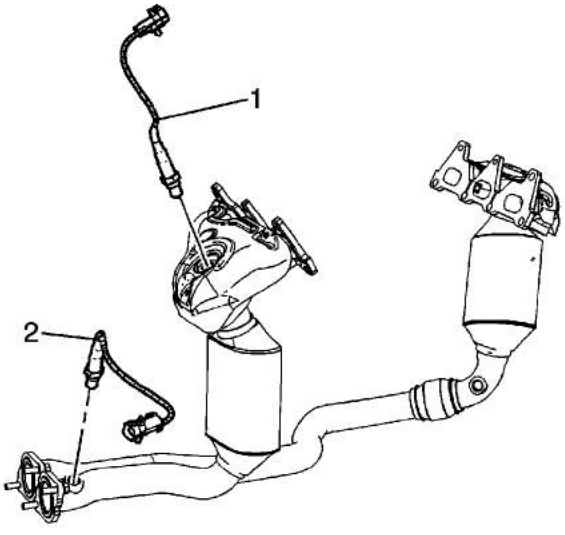
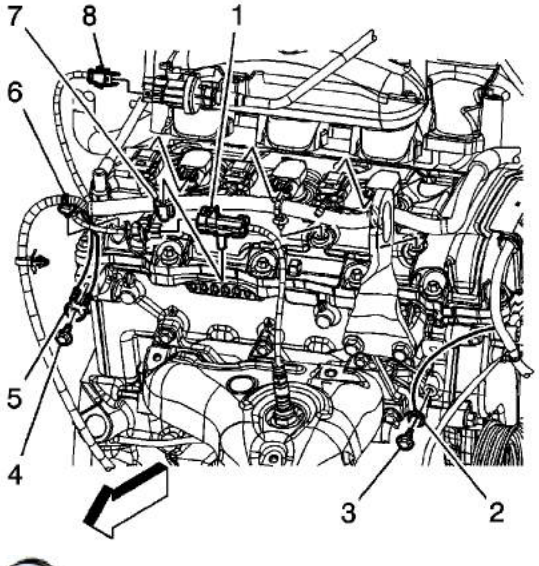


1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953, or equivalent.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the HO2S (1) to the exhaust manifold. Tighten the sensor to **42 N·m (31 lb ft).**



3. Connect the engine wiring harness electrical connector to the HO2S electrical connector (1).
4. Install the HO2S electrical connector retainer to the harness clip (7).
5. Install the CPA retainer.

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Heated Oxygen Sensor Replacement - Bank 1 Sensor 2

Removal Procedure

Caution: Do not remove the pigtail from either the heated oxygen sensor (HO2S) or the oxygen sensor (O2S). Removing the pigtail or the connector will affect sensor operation.

Handle the oxygen sensor carefully. Do not drop the HO2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Do not use cleaning solvents of any type.

Do not repair the wiring, connector or terminals. Replace the oxygen sensor if the pigtail wiring, connector, or terminal is damaged.

This external clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors, or terminals could result in the obstruction of the air reference and degraded sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor causing poor performance.
- Do not damage the sensor pigtail and harness wires in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Ensure the sensor or vehicle lead wires are not bent sharply or kinked. Sharp bends or kinks could block the reference air path through the lead wire.
- Do not remove or defeat the oxygen sensor ground wire, where applicable. Vehicles that utilize the ground wired sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will cause poor engine performance.
- Ensure that the peripheral seal remains intact on the vehicle harness connector in order to prevent damage due to water intrusion. The engine harness may be repaired using Packard's Crimp and Splice Seals Terminal Repair Kit. Under no circumstances should repairs be soldered since this could result in the air reference being obstructed.

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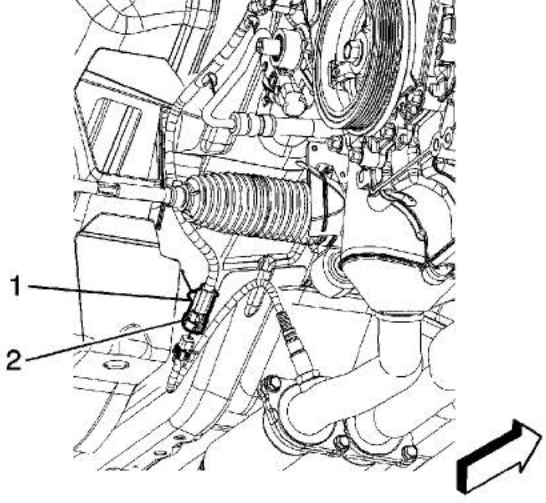
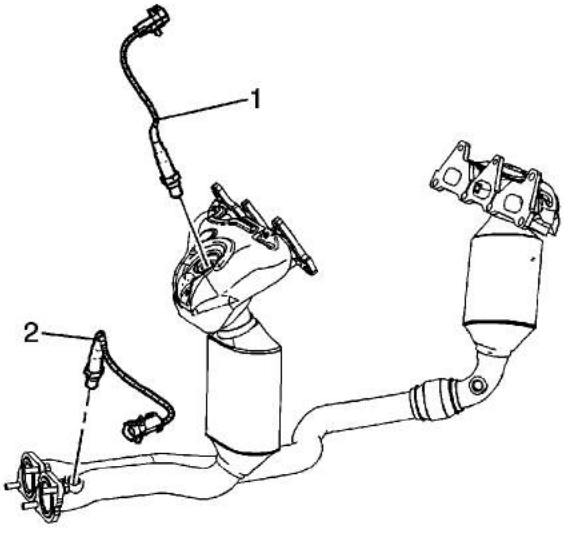


1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the connector position assurance (CPA) retainer.
3. Disconnect the heated oxygen sensor (HO2S) electrical connector (2) from the engine wiring harness electrical connector.



4. Remove the HO2S (2) from the catalytic converter.

Installation Procedure

Note: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to reinstalled, the threads must have anti-seize compound applied before the

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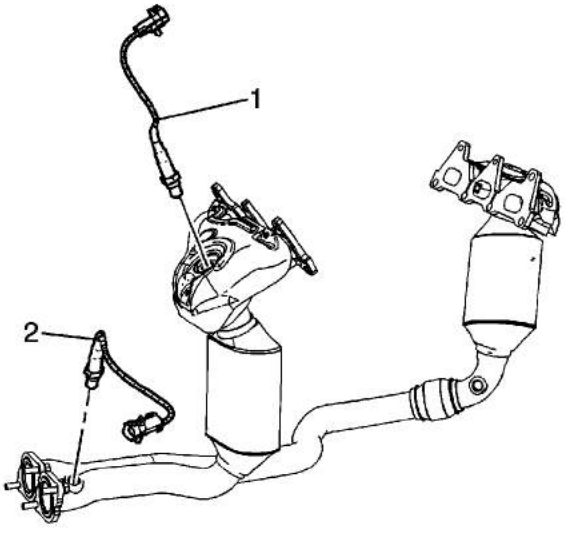
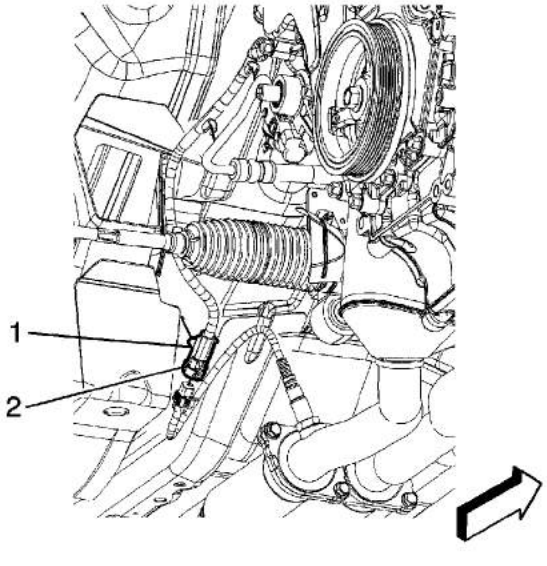


1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953, or equivalent.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the HO2S (2) to the catalytic converter. Tighten the sensor to **42 N·m (31 lb ft).**



3. Connect the HO2S electrical connector (2) to the engine wiring harness electrical connector.
4. Install the CPA retainer.
5. Lower the vehicle.

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Heated Oxygen Sensor Replacement - Bank 2 Sensor 1

Removal Procedure

Caution: Do not remove the pigtail from either the heated oxygen sensor (HO2S) or the oxygen sensor (O2S). Removing the pigtail or the connector will affect sensor operation.

Handle the oxygen sensor carefully. Do not drop the HO2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Do not use cleaning solvents of any type.

Do not repair the wiring, connector or terminals. Replace the oxygen sensor if the pigtail wiring, connector, or terminal is damaged.

This external clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors, or terminals could result in the obstruction of the air reference and degraded sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor causing poor performance.
- Do not damage the sensor pigtail and harness wires in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Ensure the sensor or vehicle lead wires are not bent sharply or kinked. Sharp bends or kinks could block the reference air path through the lead wire.
- Do not remove or defeat the oxygen sensor ground wire, where applicable. Vehicles that utilize the ground wired sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will cause poor engine performance.
- Ensure that the peripheral seal remains intact on the vehicle harness connector in order to prevent damage due to water intrusion. The engine harness may be repaired using Packard's Crimp and Splice Seals Terminal Repair Kit. Under no circumstances should repairs be soldered since this could result in the air reference being obstructed.

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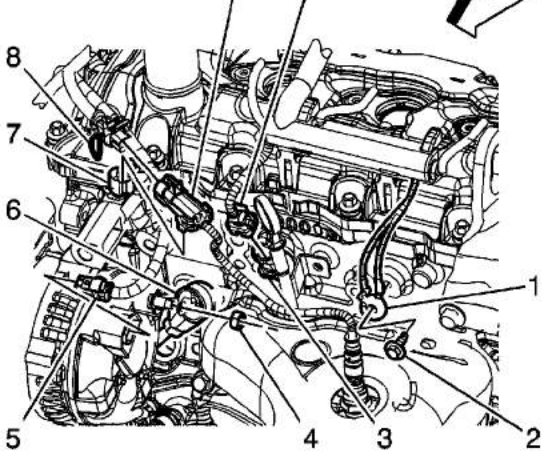
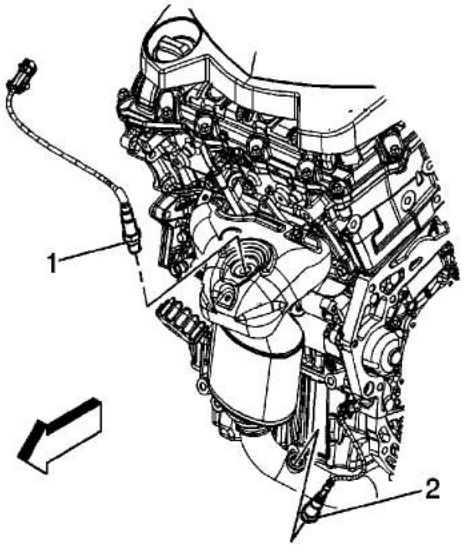


1. Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.
2. Remove the connector position assurance (CPA) retainer.
3. Disconnect the engine wiring harness electrical connector from the heated oxygen sensor (HO2S) electrical connector (9).
4. Remove the HO2S electrical connector retainer from the harness clip (7).



5. Remove the HO2S (1) from the exhaust manifold.

Installation Procedure

Note: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason

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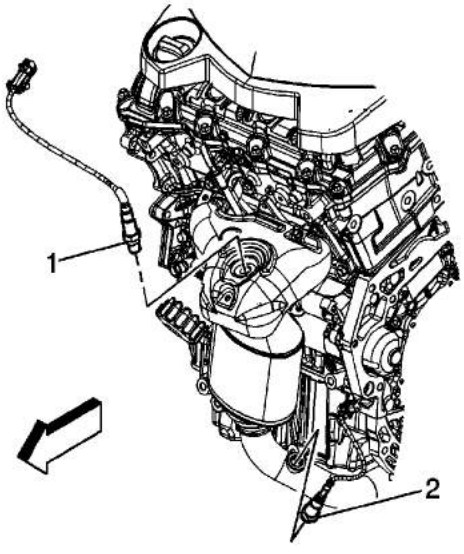
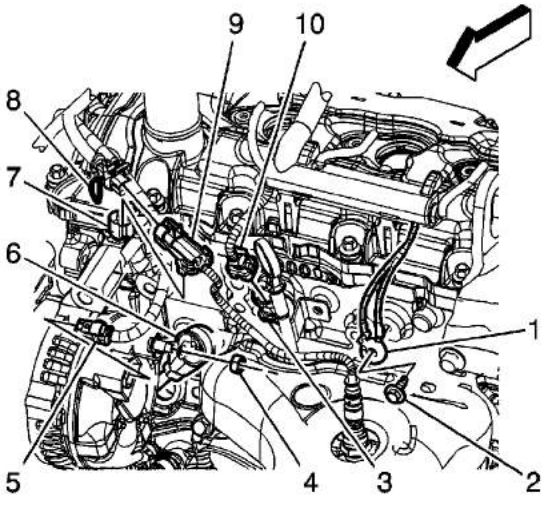


1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953, or equivalent.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the HO2S (1) to the exhaust manifold. Tighten the sensor to **42 N·m (31 lb ft).**



3. Connect the engine wiring harness electrical connector to the HO2S electrical connector (9).
4. Install the HO2S electrical connector retainer to the harness clip (7).
5. Install the CPA retainer.

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Heated Oxygen Sensor Replacement - Bank 2 Sensor 2

Removal Procedure

Caution: Do not remove the pigtail from either the heated oxygen sensor (HO2S) or the oxygen sensor (O2S). Removing the pigtail or the connector will affect sensor operation.

Handle the oxygen sensor carefully. Do not drop the HO2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Do not use cleaning solvents of any type.

Do not repair the wiring, connector or terminals. Replace the oxygen sensor if the pigtail wiring, connector, or terminal is damaged.

This external clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors, or terminals could result in the obstruction of the air reference and degraded sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor causing poor performance.
- Do not damage the sensor pigtail and harness wires in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Ensure the sensor or vehicle lead wires are not bent sharply or kinked. Sharp bends or kinks could block the reference air path through the lead wire.
- Do not remove or defeat the oxygen sensor ground wire, where applicable. Vehicles that utilize the ground wired sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will cause poor engine performance.
- Ensure that the peripheral seal remains intact on the vehicle harness connector in order to prevent damage due to water intrusion. The engine harness may be repaired using Packard's Crimp and Splice Seals Terminal Repair Kit. Under no circumstances should repairs be soldered since this could result in the air reference being obstructed.

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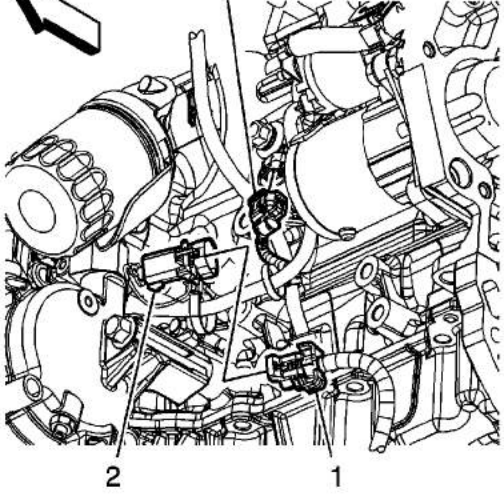
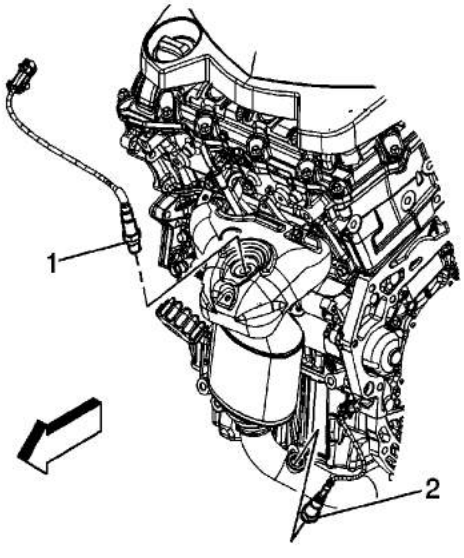


1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Remove the connector position assurance (CPA) retainer.
3. Disconnect the heated oxygen sensor (HO2S) electrical connector (1) from the engine wiring harness electrical connector (2).



4. Remove the HO2S (2) from the catalytic converter.

Installation Procedure

Note: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to reinstalled, the threads must have anti-seize compound applied before the

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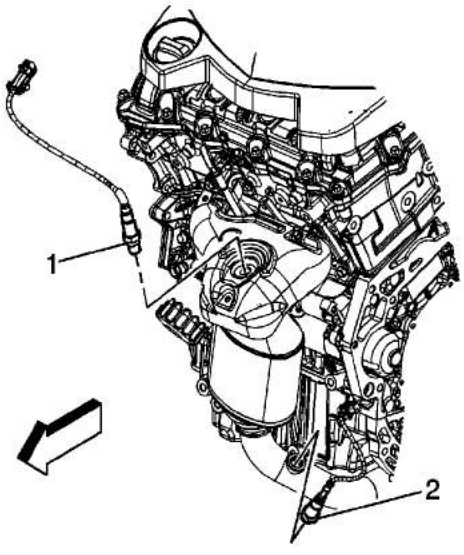
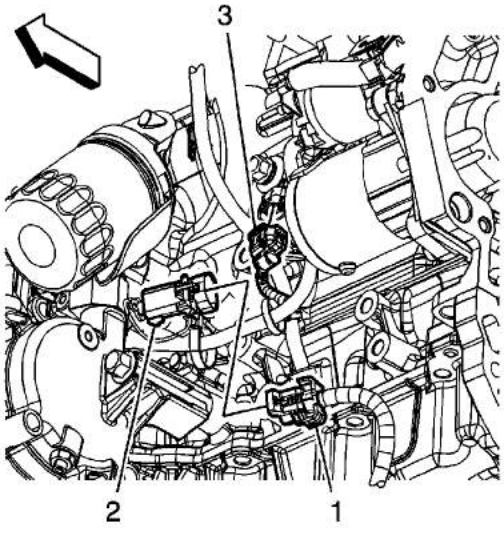


1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953, or equivalent.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the HO2S (2) to the catalytic converter. Tighten the sensor to **42 N·m (31 lb ft).**



3. Connect the HO2S electrical connector (1) to the engine wiring harness electrical connector (2).
4. Install the CPA retainer.
5. Lower the vehicle.

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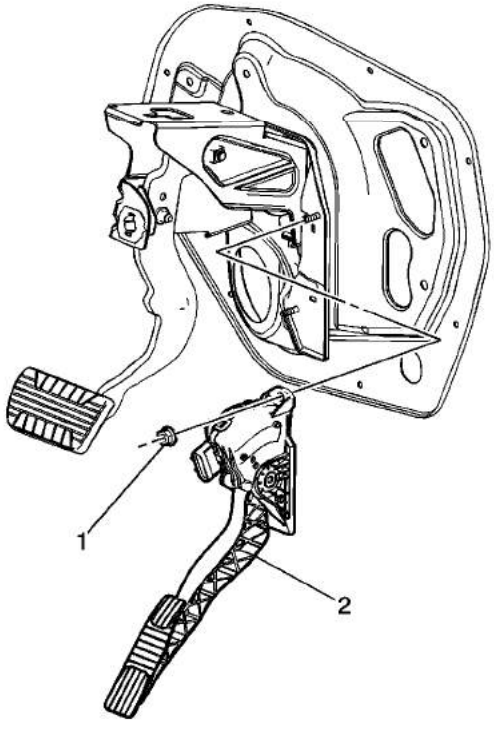
Accelerator Pedal Position Sensor Replacement



Callout	Component Name
1	Accelerator Pedal Position Sensor Nut (Qty: 2) **Caution:** Refer to Fastener Caution in the Preface section. **Tighten** 10 N·m (89 lb in)
2	Accelerator Pedal Position Sensor **Procedure** Disconnect the electrical connector.

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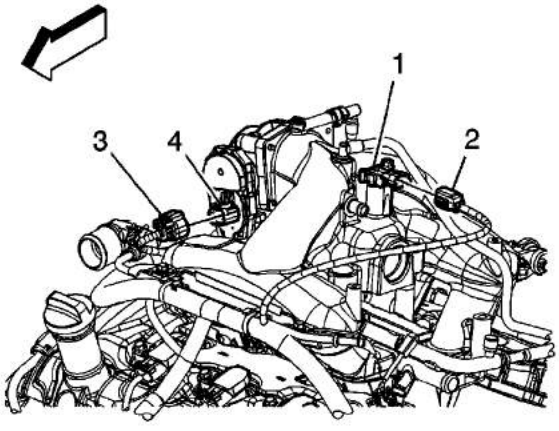
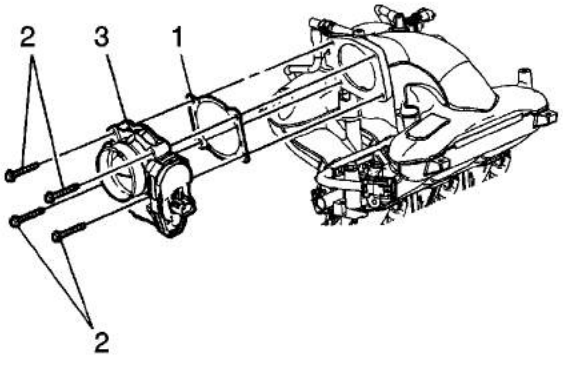
Throttle Body Assembly Replacement

Removal Procedure



1. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
2. Disconnect the engine wiring harness electrical connector (3) from the throttle body (4).



3. Remove the throttle body bolts (2).
4. Remove the throttle body (3) and gasket (1). Discard the gasket.

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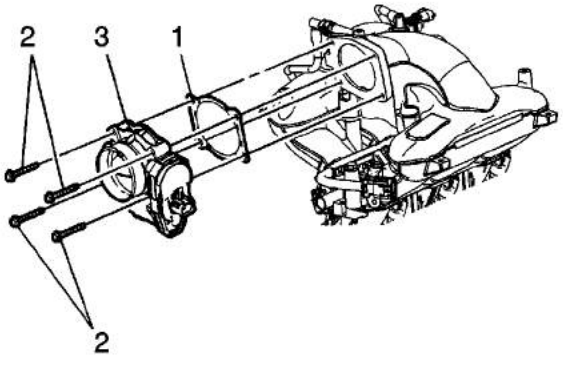
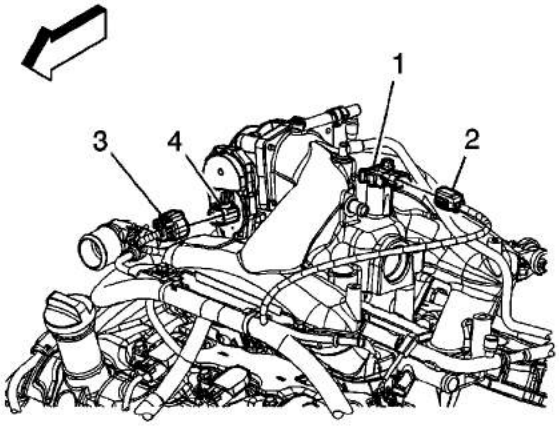


1. Position a NEW throttle body gasket (1) to the upper intake manifold.
2. Position the throttle body (3) to the upper intake manifold.

Caution: Refer to Fastener Caution in the Preface section.

3. Install the throttle body bolts (1). Tighten the bolts to **10 N·m (89 lb in).**



4. Connect the engine wiring harness electrical connector (3) to the throttle body (4).
5. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.

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Throttle Body Inspection and Cleaning

Note: Over extended time and mileage, deposits may accumulate on the back of the throttle valve plate. The source of the deposit is exhaust gas recirculation (EGR) gas. Typically these deposits pose no problem. Occasionally the deposit may accumulate to a point where perceived pedal effort or throttle valve movement is effected. This procedure should not be performed on vehicles with mileage under 80 450 km (50,000 mi).

1. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.

   Warning: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

   Caution: Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

2. Inspect the throttle body bore and the throttle valve plate for deposits. You will need to open the throttle valve in order to inspect all surfaces.

   Caution: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

3. Clean the throttle body bore and the throttle valve plate using a clean shop towel with GM top engine cleaner, GM P/N 1052626 (Canadian P/N 993026) or AC-Delco Carburetor Tune-Up Conditioner, P/N X66-P, or an equivalent product.
4. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.

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Fuel Pressure Relief (w/o CH 48027-100)

Warning: Refer to Gasoline/Gasoline Vapors Warning in the Preface section.

Warning: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

1. Loosen the fuel fill cap in order to relieve the fuel tank vapor pressure.
2. Remove the engine cover, if required.
3. Remove the fuel rail service port cap.
4. Wrap a shop towel around the fuel rail service port and using a small flat bladed tool, depress (open) the fuel rail test port valve.
5. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
6. Install the fuel rail service port cap.
7. Install the engine cover, if required.
8. Tighten the fuel fill cap.

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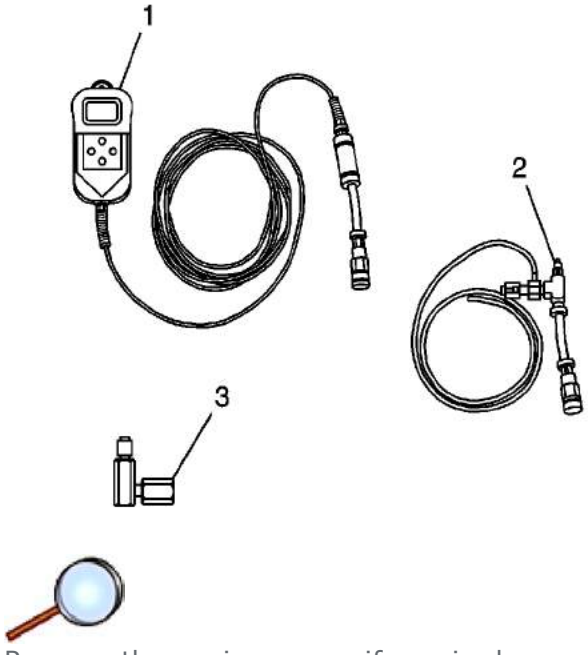
Fuel Pressure Relief (with CH 48027-100)

Special Tools

CH-48027-100 Digital Pressure Gage

Warning: Refer to Gasoline/Gasoline Vapors Warning in the Preface section.

Warning: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.



1. Remove the engine cover, if required.
2. Loosen the fuel fill cap in order to relieve the fuel tank vapor pressure.
3. Remove the fuel rail service port cap.

Warning: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gage. Place the towel in an approved container when the connection of the fuel pressure gage is complete.

4. Wrap a shop towel around the fuel rail service port.
5. Connect the CH-48027-3 (3) to the fuel rail service port.
6. Connect the CH-48027-2 (2) to the CH-48027-3 (3).
7. Place the hose on the CH-48027-2 (2) into an approved gasoline container.
8. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.

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Caution: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- The fuel pipe connections
- The hose connections
- The areas surrounding the connections

Note: If relieving the fuel pressure for the fuel pressure gage installation and removal, it is NOT necessary to proceed with the following steps.

11. Disconnect the CH-48027-2 (2) from the CH-48027-3 (3).
12. Disconnect the CH-48027-3 (3) from the fuel rail service port.
13. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
14. Install the fuel rail service port cap.
15. Install the engine cover, if required.
16. Tighten the fuel fill cap.

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Fuel Pressure Gage Installation and Removal

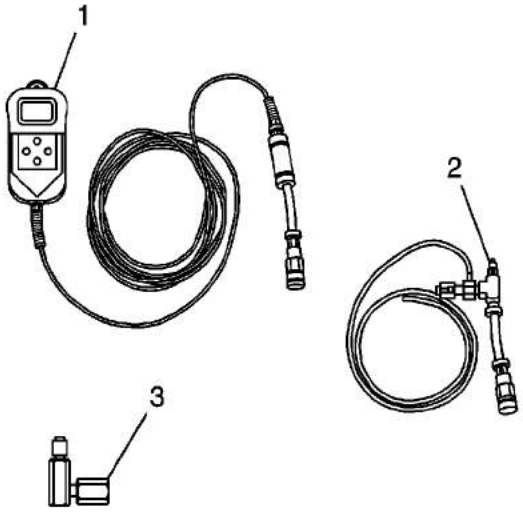
Special Tools

CH-48027-100 Digital Pressure Gage

Installation Procedure

Warning: Refer to Gasoline/Gasoline Vapors Warning in the Preface section.

Warning: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.



1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief.
2. Connect the CH-48027-1 (1) to the CH-48027-2 (2).
3. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
4. Perform any tests and/or diagnostics as needed. For the proper usage of the CH-48027-100 , refer to the manufacture's directions.

Removal Procedure

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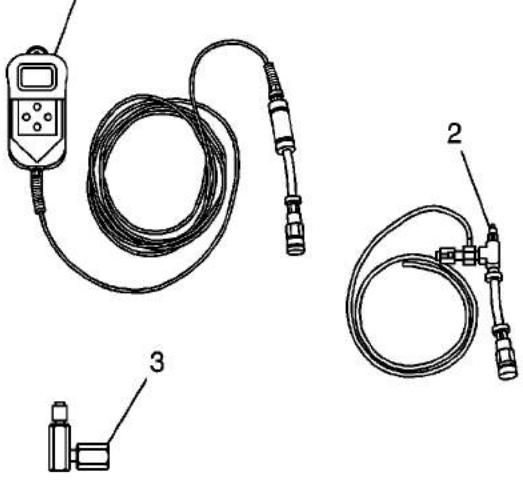

1. Relieve the fuel system pressure, if required. Perform the following steps:

   Warning: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gage. Place the towel in an approved container when the connection of the fuel pressure gage is complete.

   1.1. Wrap a shop towel around the fuel rail service port.
   1.2. Place the hose on the CH-48027-2 (2) into an approved gasoline container.
   1.3. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.
   1.4. Close the valve on the CH-48027-2 (2).
   1.5. Remove the hose on the CH-48027-2 (2) from the approved gasoline container.
   1.6. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.

   Caution: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

   - The fuel pipe connections
   - The hose connections
   - The areas surrounding the connections

2. Disconnect the CH-48027-1 (1) from the CH-48027-2 (2).
3. Disconnect the CH-48027-2 (2) from the CH-48027-3 (3).
4. Disconnect the CH-48027-3 (3) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. Install the engine cover, if required.
7. Tighten the fuel fill cap.

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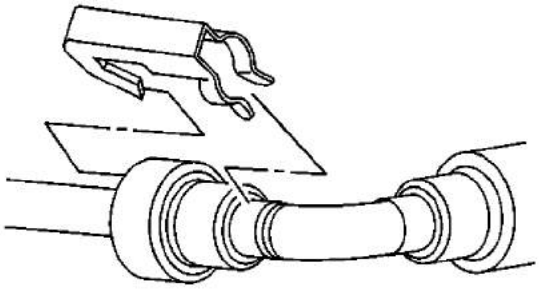
Metal Collar Quick Connect Fitting Service

Special Tools

J 37088-A Fuel Line Disconnect Tool Set

Removal Procedure

Warning: Refer to Gasoline/Gasoline Vapors Warning in the Preface section.



1. Relieve the fuel system pressure. Refer to the Fuel Pressure Relief.
2. Remove the fuel feed line quick connect fitting retainer.

   Warning: Refer to Safety Glasses Warning in the Preface section.

   Caution: Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution in the Preface section.

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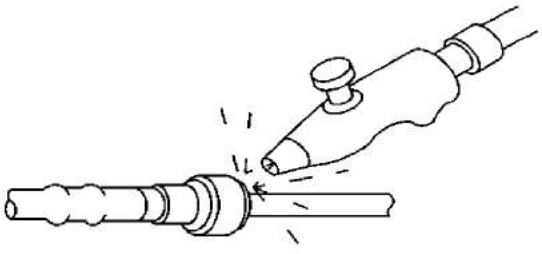
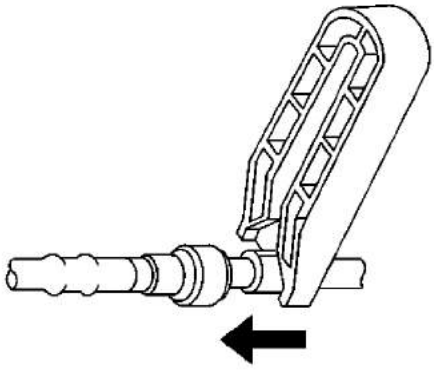


3. Blow dirt out of the fitting using compressed air.



4. Choose the correct tool from the J 37088-A for the size of the fitting. Insert the tool into the female connector, then push inward in order to release the locking tabs.

   Warning: Refer to Relieving Fuel Pressure Warning in the Preface section.

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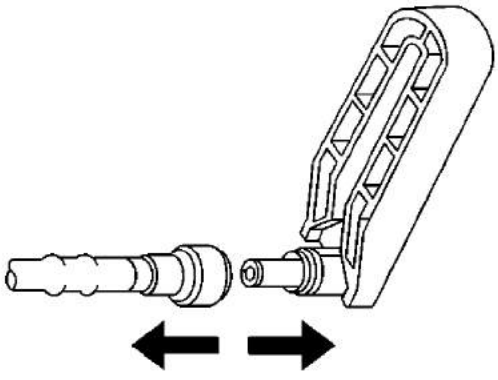
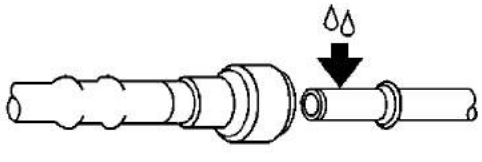


5. Pull the connection apart.
6. Use a clean shop towel in order to wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components as required.

Installation Procedure

Warning: Refer to Fuel Pipe Fitting Warning in the Preface section.



1. Apply a few drops of clean engine oil to the male pipe end.

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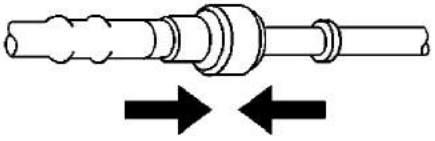
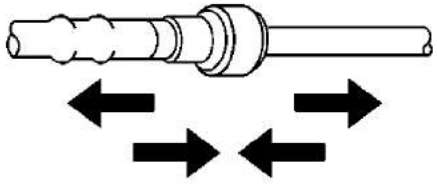


2. Push both sides of the fitting together in order to snap the retaining tabs into place.



3. Once installed, pull on both sides of the fitting in order to make sure the connection is secure.

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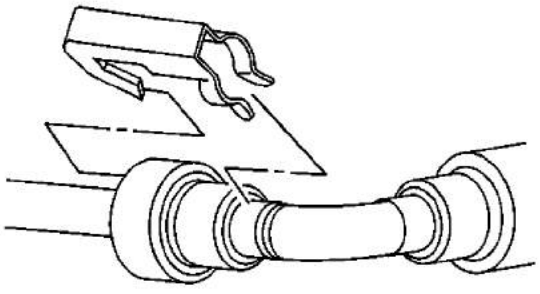

4. Install the retainer to the quick-connect fitting.

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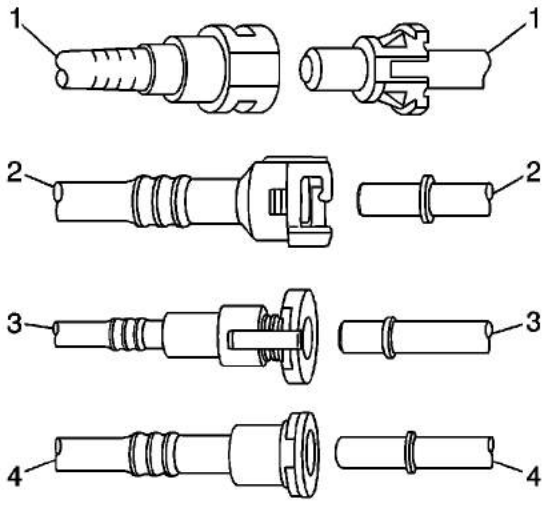
Plastic Collar Quick Connect Fitting Service

Removal Procedure

Warning: Refer to Gasoline/Gasoline Vapors Warning in the Preface section.



Note: There are several types of plastic collar fuel and evaporative emission quick connect fittings used on this vehicle.

- Bartholomew (1)
- Q Release (2)
- Squeeze to Release (3)
- Sliding Retainer (4)

The following instructions apply to all of these types of plastic collar quick connect fittings except where indicated.

1. Relieve the fuel system pressure. Refer to the Fuel Pressure Relief.

   Warning: Refer to Safety Glasses Warning in the Preface section.

   Caution: Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution in the Preface section.

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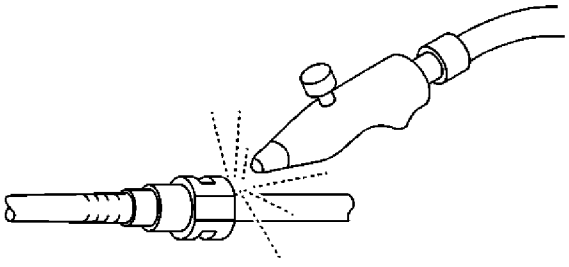
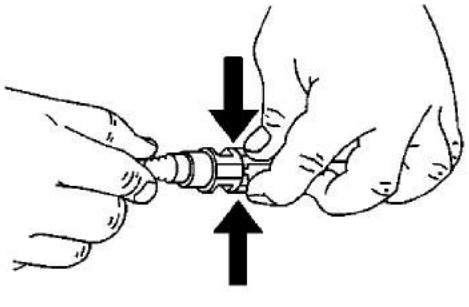


2. Using compressed air, blow any dirt out of the quick-connect fitting.



3. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick connect fitting release tabs.

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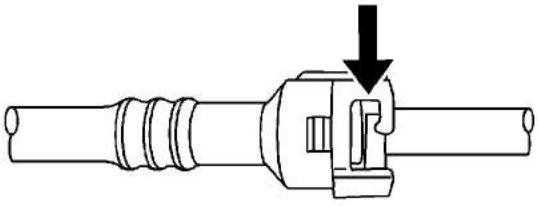
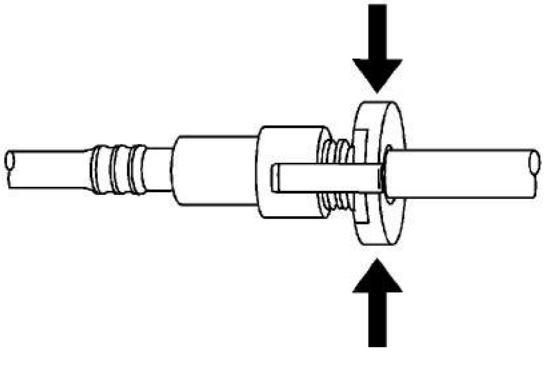


4. This step applies to Q Release style connectors ONLY. Release the fitting by pushing the tab toward the other side of the slot in the fitting.



5. This step applies to Squeeze to Release style connectors ONLY. Squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick connect fitting.

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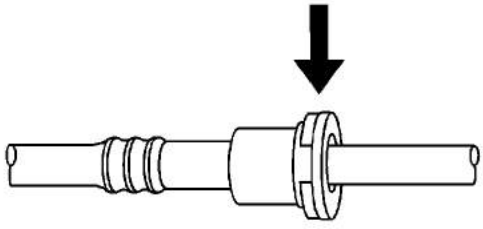
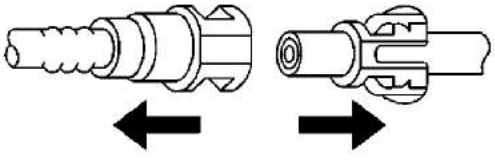


6. This step applies to Sliding Retainer style connectors ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab doesn't move try pressing the tab in from the opposite side. The tab will only move in one direction.

   Warning: Refer to Relieving Fuel Pressure Warning in the Preface section.



7. Pull the connection apart.

Installation Procedure

Warning: Refer to Fuel Pipe Fitting Warning in the Preface section.

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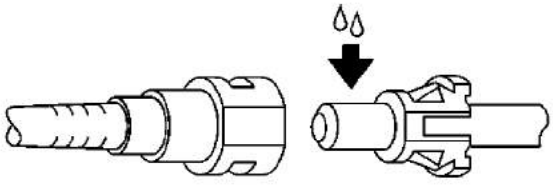
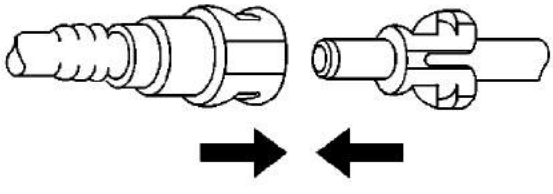


1. Apply a few drops of clean engine oil to the male connection end.



2. Push both sides of the quick-connect fitting together in order to cause the retaining feature to snap into place.

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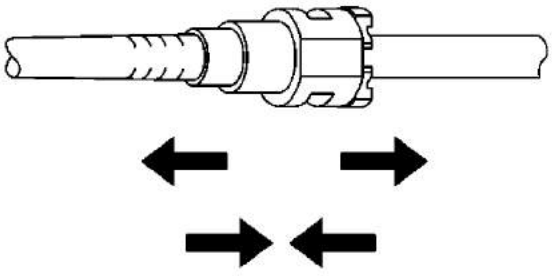

3. Once installed, pull on both sides of the quick-connect fitting in order to make sure the connection is secure.

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Fuel Tank Draining

Tools Required

- SA9127E-7 Fuel Pressure/Flow Adapter
- SA9804E Fuel Tank Drain Hose

For any operation requiring removal of the fuel tank, there should be no more than 11.4 L (3 gal) of fuel remaining. This minimizes the weight of the fuel tank assembly and eases handling. The fuel level can be determined by reading the fuel level gage. A reading below 1/4 full indicates that no more than 11.4 L (3 gal) are remaining.

Using The Fuel Pump

Warning: Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

Warning: Never drain or store fuel in an open container due to the possibility of fire or explosion.

Using the fuel pump to drain the tank is the easiest procedure if the fuel pump is operable. The fuel can be pumped out with the vehicle on the ground or on a hoist.

On The Ground

Warning: Fuel supply lines will remain pressurized for long periods of time after the engine is shutdown. This pressure must be relieved before servicing the fuel system.

1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief.

   Warning: Whenever fuel line fittings are loosened or removed, wrap a shop cloth around the fitting and have an approved container available to collect any fuel.

2. Disconnect the fuel feed quick connect fitting from the fuel rail. Refer Metal Collar Quick Connect Fitting Service.
3. Install the 3/8 in. x 1/4 in fitting from the SA9127E-7 into the fuel feed quick connect fitting.
4. Connect a suitable drain hose to the other end of the adapter and connect the drain hose to a certified fuel handling cart.
5. Connect a scan tool to the vehicle diagnostic connector and turn the ignition ON.
6. Energize the fuel pump using the scan tool.
7. Pump out the fuel until no more than 1/4 tank of fuel remains.

On The Hoist

Warning: Fuel supply lines will remain pressurized for long periods of time after the engine is shutdown. This pressure must be relieved before servicing the fuel system.

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Warning: Ensure that the vehicle is properly supported and squarely positioned. To help avoid personal injury when a vehicle is on a hoist, provide additional support for the vehicle on the opposite end from which the components are being removed.

3. Raise the vehicle on a hoist to a comfortable working height, keeping the scan tool outside of the vehicle and accessible from under the car.

   Warning: Whenever fuel line fittings are loosened or removed, wrap a shop cloth around the fitting and have an approved container available to collect any fuel.

4. Disconnect the fuel tank fuel feed line quick connect fitting from the chassis fuel feed pipe. Refer Plastic Collar Quick Connect Fitting Service.
5. Install the 3/8 in. x 1/4 in fitting from the SA9127E-7 into the fuel feed quick connect fitting.
6. Connect a suitable drain hose to the other end of the adapter and connect the drain hose to a certified fuel handling cart.
7. Energize the fuel pump using the scan tool.
8. Pump out the fuel until no more than 1/4 tank of fuel remains.

Siphoning The Fuel Tank

Warning: Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

If the fuel pump is inoperative, the tank can be drained by siphoning from the tank. A suitable means is through the fuel fill pipe with the correct type and stiffness of tubing as used with the SA9804E .

Warning: Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
2. Open the fuel fill door and remove the gas cap.

   Caution: Do not attempt to insert any other type of siphon hose or tube into the fuel filler pipe. The design of the inlet check valve at the end of the fuel filler tube restricts the insertion of a hose and, most importantly, prevents the removal of this hose. See Fuel Inlet Check Valve in this section. If the siphon hose becomes stuck in the check valve, the fuel filler pipe will not be able to be removed from the fuel tank without damage to the fill pipe or fuel tank.

3. Insert the siphon hose guide/funnel into the fuel fill pipe opening.

   Note: The siphon hose will reach the bottom of the tank on the primary side only, within about 25.4 cm (10 in) of the end fitting and tag. When connecting the siphon hose to another length of hose that is connected to the drain tank, DO NOT insert the siphon hose into the fill pipe funnel past the tag at the fitting end. If inserted too far, the upper portion of the siphon

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4. Insert the hose into the guide funnel and into the fuel fill pipe. Some resistance may be encountered when the tip of the siphon hose reaches the inlet check valve. Repeated probing may be necessary to slide the hose tip through the check valve cage.

   Warning: Whenever fuel lines are removed, catch fuel in an approved container. Container opening must be a minimum of 300 mm (12 in) diameter to adequately catch the fluid.

   Note: The fuel flow rate from the siphon hose will range from 1.1 L/min (0.3 gal/min) up to 3.8 L/min (1 gal/min), depending on whether it is gravity siphoned or with an air-powered pump.

5. Begin the fuel siphoning process. Place the fuel into an approved fuel container.
6. Remove the siphon hose from the fuel fill pipe after draining is complete.

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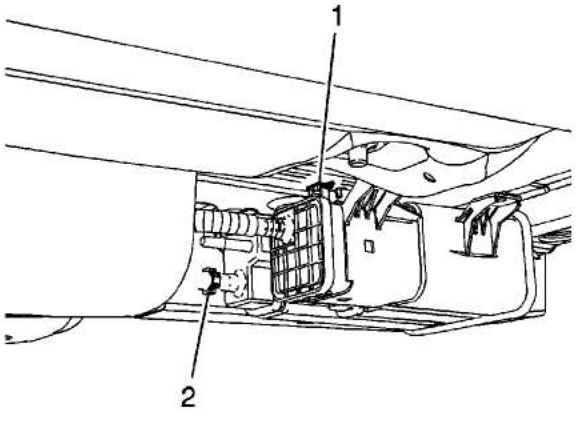
Fuel Tank Replacement

Removal Procedure

Warning: Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

Warning: Fuel supply lines will remain pressurized for long periods of time after the engine is shutdown. This pressure must be relieved before servicing the fuel system.



1. Disconnect the fuel tank wiring harness electrical connector (1) from the EVAP canister vent solenoid valve.

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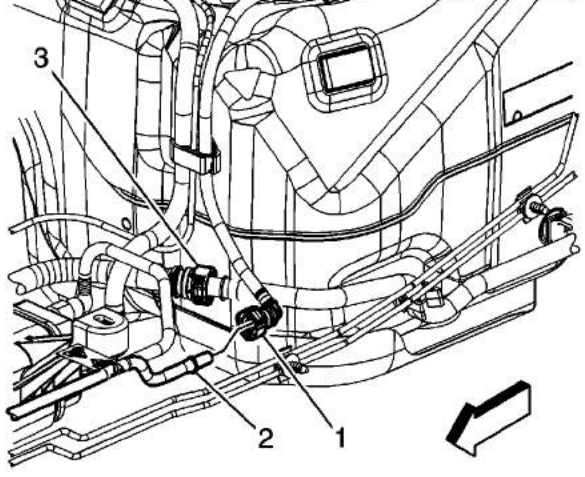
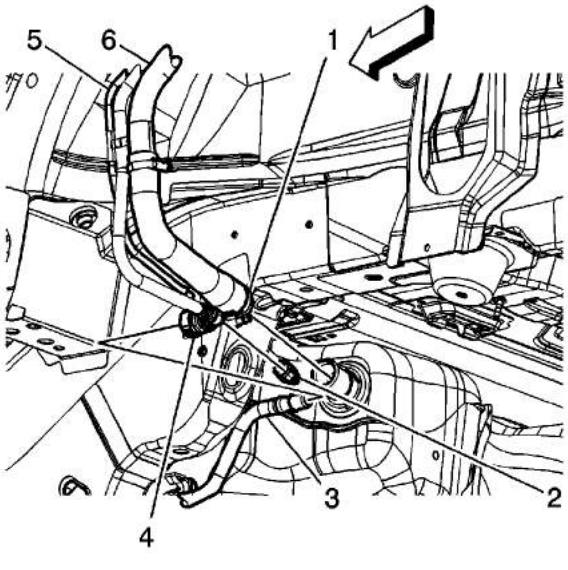


Warning: Whenever fuel lines are removed, catch fuel in an approved container. Container opening must be a minimum of 300 mm (12 in) diameter to adequately catch the fluid.

Caution: Clean all fuel pipe connections and surrounding areas before disconnecting the fuel pipes to avoid contamination of the fuel system.

2. Disconnect the fuel tank fuel feed line quick connect fitting (1) from the chassis fuel feed line (2), if necessary. Refer to Plastic Collar Quick Connect Fitting Service.



3. Disconnect the fill pipe vent line quick connect fitting (4) from the fuel tank fresh air line (3). Refer to Plastic Collar Quick Connect Fitting Service.
4. Disconnect the fuel tank vapor line quick connect fitting (2) from the fill pipe recirculation line (5). Refer to Plastic Collar Quick Connect Fitting Service.

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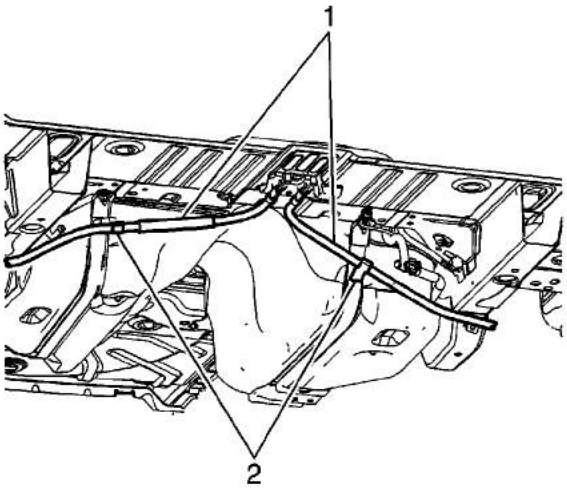
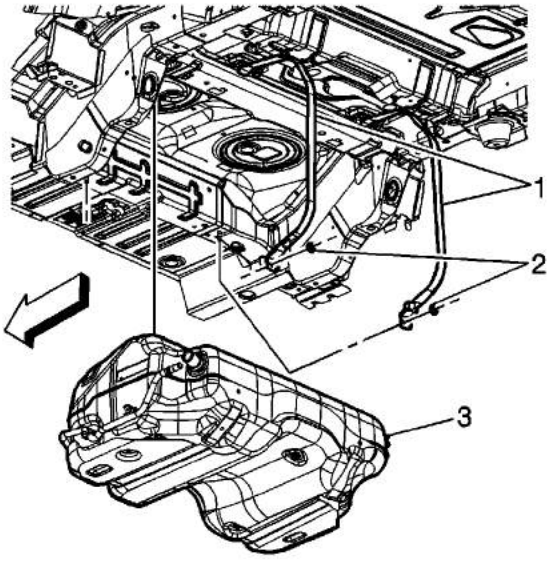


7. Using a suitable adjustable jack, support the fuel tank.
8. Remove the park brake cables (1) from the retainers (2) on the fuel tank straps.



Caution: Do not bend the fuel tank straps. Bending the fuel tank straps may cause damage to the straps.

9. Remove the fuel tank strap nuts (2) and straps (1).

Note: It is not necessary to remove the rear drive module (RDM) in order to remove the fuel tank.

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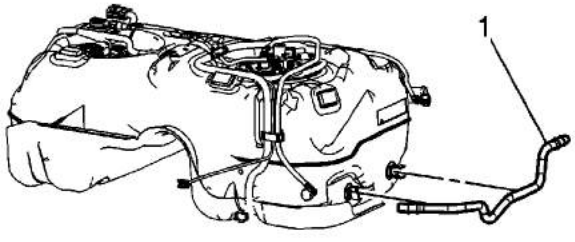
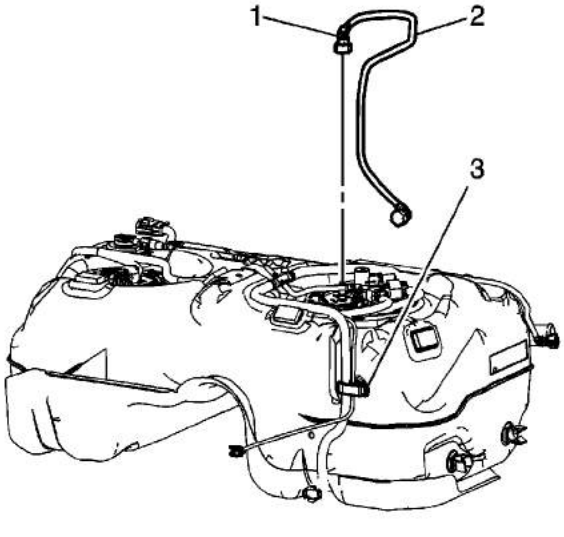
11. If replacing the fuel tank perform the following steps, otherwise proceed to the installation procedure.

Disassembly Procedure



1. Disengage the fresh air line (1) from the fuel tank clips and remove the fresh air line.



2. Disconnect the fuel feed line quick connect fitting (1) from the fuel tank fuel pump module. Refer to Plastic Collar Quick Connect Fitting Service.
3. Open the retaining clip (3) on the fuel tank and remove the fuel feed line (2).

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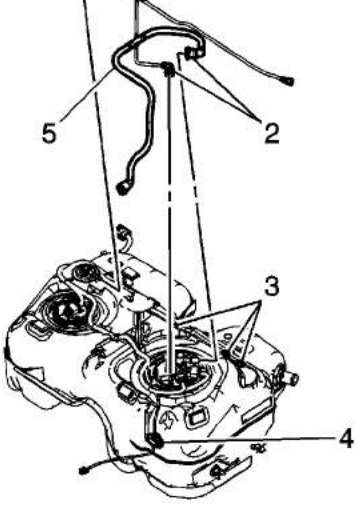
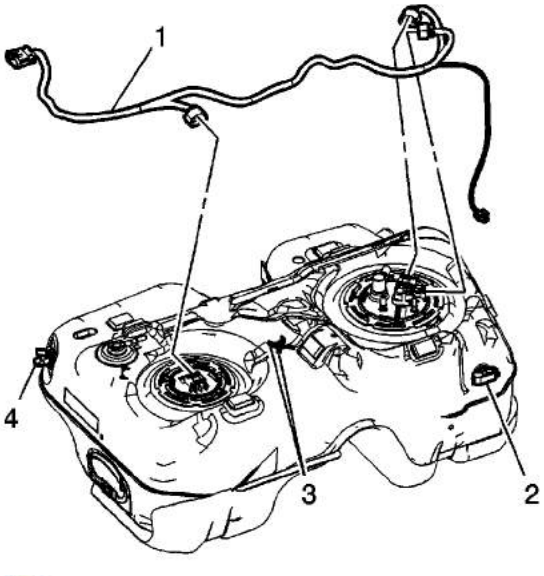


4. Disconnect the vapor line quick connect fitting (1) from the fuel tank vent valve. Refer to Plastic Collar Quick Connect Fitting Service.
5. Disconnect the vapor line quick connect fittings (2) from the fuel tank fuel pump module. Refer to Plastic Collar Quick Connect Fitting Service.
6. Remove the vapor line (5) from the retaining clip (4) and the retaining features (3) molded into the fuel tank.



7. Disconnect the fuel tank wiring harness (1) electrical connectors from the following:
   - Primary fuel tank fuel pump module
   - Fuel tank pressure sensor
   - Secondary fuel tank fuel pump module
8. Remove the fuel tank wiring harness from the retaining clips (2 and 4) and the retaining features (3) molded into the fuel tank.

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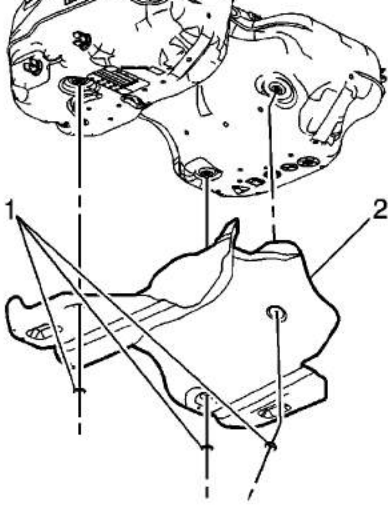
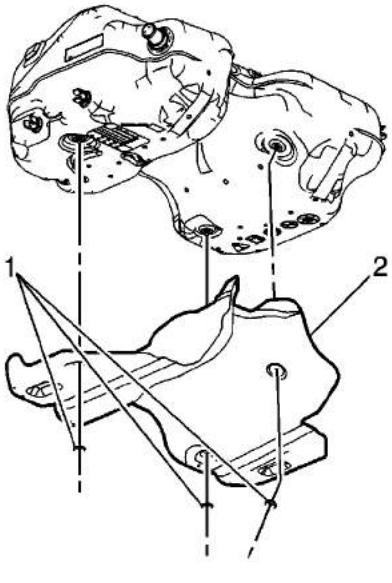


9. Remove the fuel tank shield retainers (1) and shield (2).
10. Remove the fuel tank fuel pump modules. Refer to Fuel Tank Fuel Pump Module Replacement and Fuel Tank Fuel Pump Module Replacement - Secondary.

Assembly Procedure



1. Install the fuel tank fuel pump modules. Refer to Fuel Tank Fuel Pump Module Replacement and Fuel Tank Fuel Pump Module Replacement - Secondary.
2. Install the fuel tank shield (2) and retainers (1).

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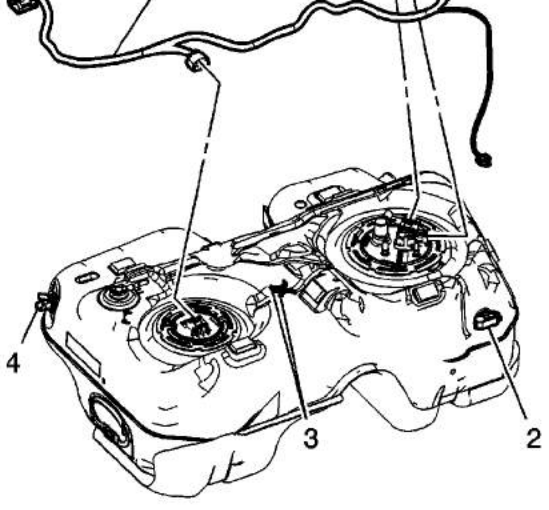
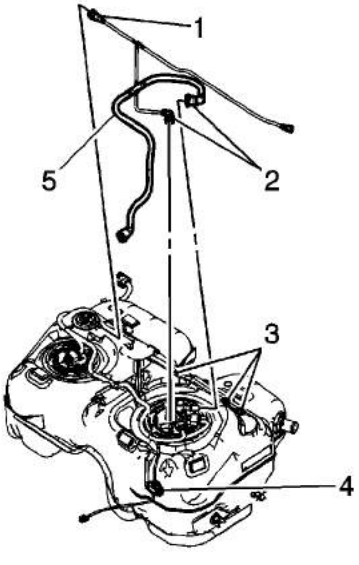


3. Connect the fuel tank wiring harness (1) electrical connectors to the following:
   - Secondary fuel tank fuel pump module
   - Fuel tank pressure sensor
   - Primary fuel tank fuel pump module
4. Install the fuel tank wiring harness to the retaining clips (2 and 4) and the retaining features (3) molded into the fuel tank.



5. Lay the vapor line (5) into position and connect the vapor line quick connect fittings (2) to the fuel tank fuel pump module. Refer to Plastic Collar Quick Connect Fitting Service.
6. Connect the vapor line quick connect fitting (1) to the fuel tank vent valve. Refer to Plastic Collar Quick Connect Fitting Service.
7. Install the vapor line to the retaining clip (4) and the retaining features (3) molded into the fuel tank.

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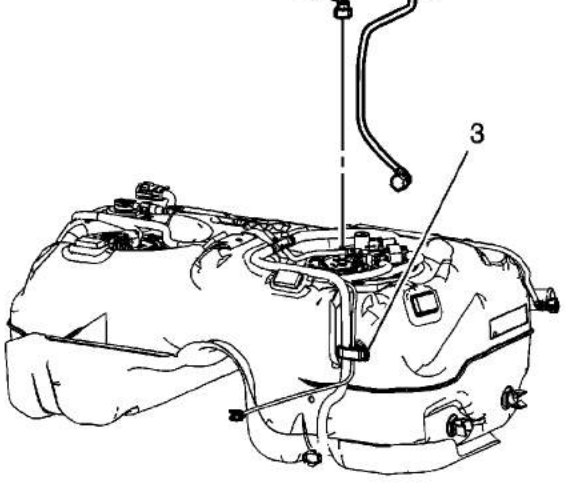
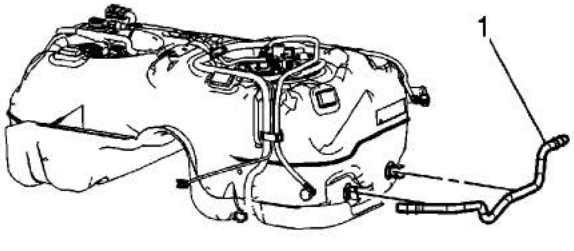


8. Lay the fuel feed line (2) into position and connect the fuel feed line quick connect fitting (1) to the fuel tank fuel pump module. Refer to Plastic Collar Quick Connect Fitting Service.
9. Close the retaining clip (3) on the fuel tank.



10. Position the fresh air line (1) to the fuel tank clips and install the fresh air line.

Installation Procedure

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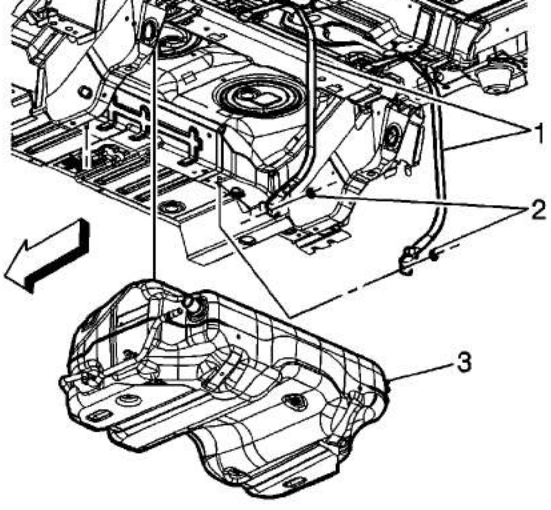
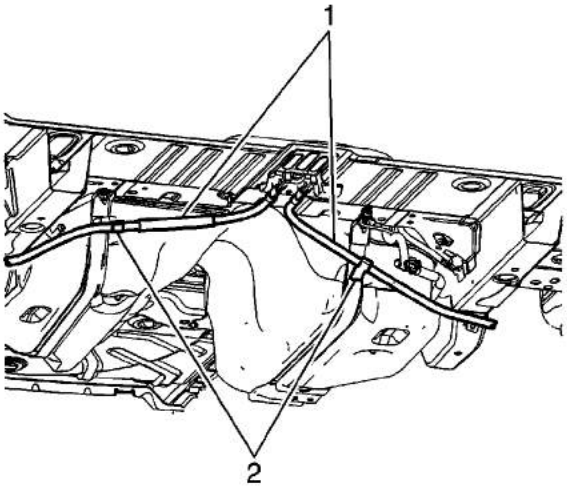


1. Using the adjustable jack, slowly raise and reposition the fuel tank (3) in order to install the tank to the vehicle.

   Caution: Refer to Fastener Caution in the Preface section.

   Caution: Do not bend the fuel tank straps. Bending the fuel tank straps may cause damage to the straps.

2. Install the fuel tank straps (1) and nuts (2). Tighten the nuts to **20 N·m (15 lb ft).**
3. Remove the adjustable jack from under the fuel tank.



4. Install the park brake cables (1) to the retainers (2) on the fuel tank straps.

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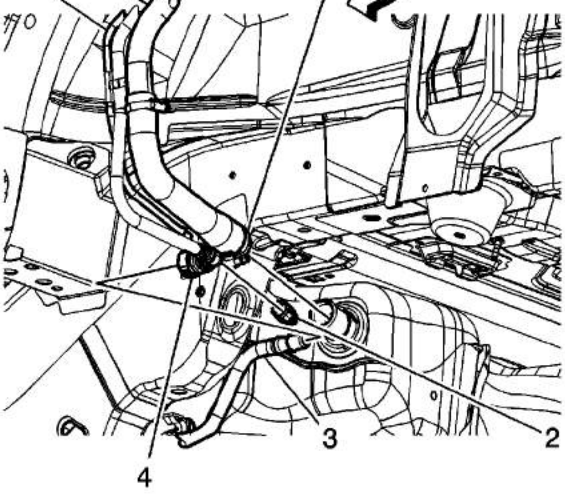
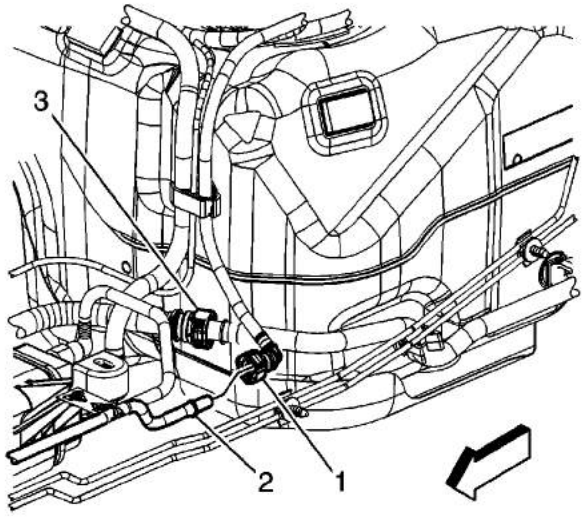


Note: Ensure that the notch in the fuel fill pipe hose aligns with the locating tab on the fuel tank.

5. Install the fuel fill pipe (6) hose to the fuel tank.
6. Tighten the fuel fill pipe hose clamp (1) at the fuel tank. Tighten the clamp to **5 N·m (44 lb in).**
7. Connect the fuel tank vapor line quick connect fitting (2) to the fill pipe recirculation line (5). Refer to Plastic Collar Quick Connect Fitting Service.
8. Connect the fill pipe vent line quick connect fitting (4) to the fuel tank fresh air line (3). Refer to Plastic Collar Quick Connect Fitting Service.



9. Connect the fuel tank fuel feed line quick connect fitting (1) to the chassis fuel feed line (2). Refer to Plastic Collar Quick Connect Fitting Service.

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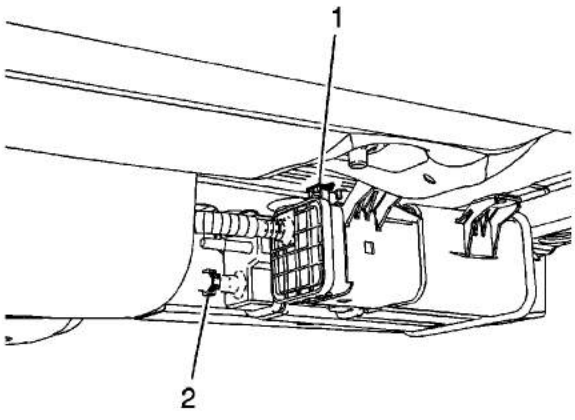
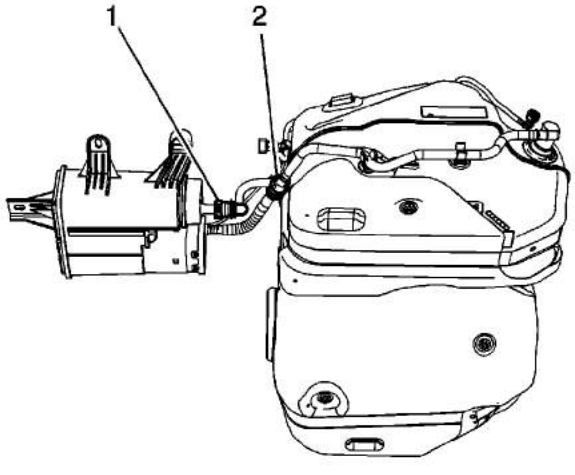


10. Connect the fuel tank wiring harness electrical connector (1) to the EVAP canister vent solenoid valve.



11. Connect the EVAP canister fresh air line quick connect fitting (2) to the fuel tank fresh air line. Refer to Plastic Collar Quick Connect Fitting Service.
12. Connect the fuel tank vapor line quick connect fitting (1) to the EVAP canister. Refer to Plastic Collar Quick Connect Fitting Service.
13. If equipped with AWD, install the propeller shaft. Refer to Propeller Shaft Replacement.
14. Install the muffler. Refer to Exhaust Muffler Replacement.
15. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
16. Perform the following procedure in order to inspect for leaks.
    - Turn the ignition ON, with the engine OFF, for 2 seconds.
    - Turn the ignition OFF for 10 seconds.

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- Inspect for fuel leaks.

17. Install the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.

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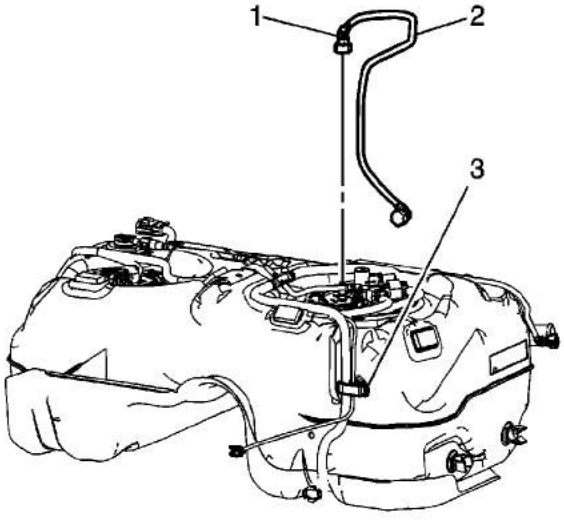
Fuel Tank Fuel Pump Module Replacement

Special Tools

J 45722 Fuel Sender Lock Ring Wrench

Removal Procedure

Caution: Do not bend the fuel tank straps. Bending the fuel tank straps may cause damage to the straps.



1. Remove the secondary fuel tank fuel pump module. Refer to Fuel Tank Fuel Pump Module Replacement - Secondary.
2. Disconnect the fuel feed line quick connect fitting (1) from the fuel tank fuel pump module. Refer to Plastic Collar Quick Connect Fitting Service.
3. Open the retaining clip (3) on the fuel tank and remove the fuel feed line (2).

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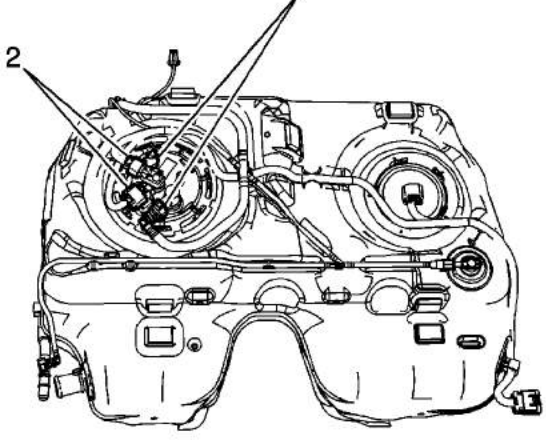
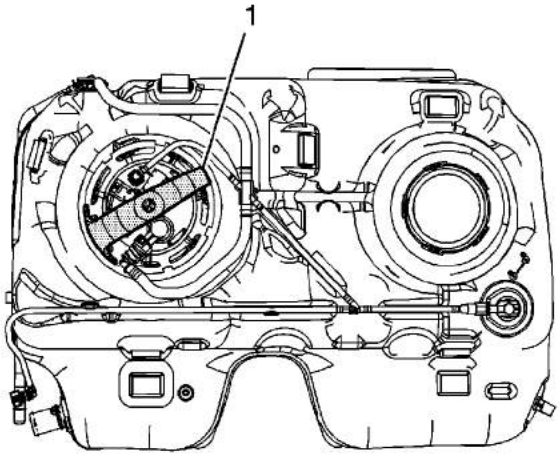


4. Disconnect the engine wiring harness electrical connectors (2) from the fuel tank fuel pump primary module and the fuel tank pressure sensor.
5. Disconnect the vapor line quick connect fittings (1) from the fuel tank fuel pump module. Refer to Plastic Collar Quick Connect Fitting Service.



6. Install the J 45722 (1) to the fuel tank fuel pump module lock ring.

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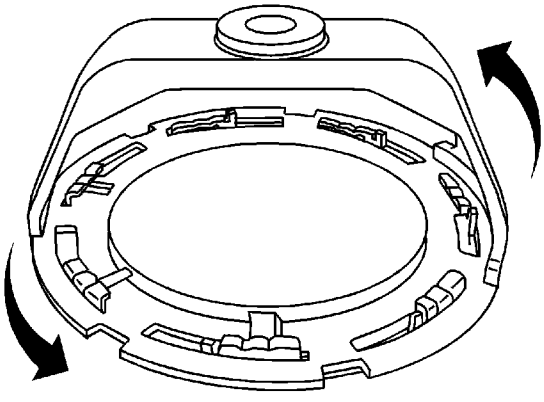
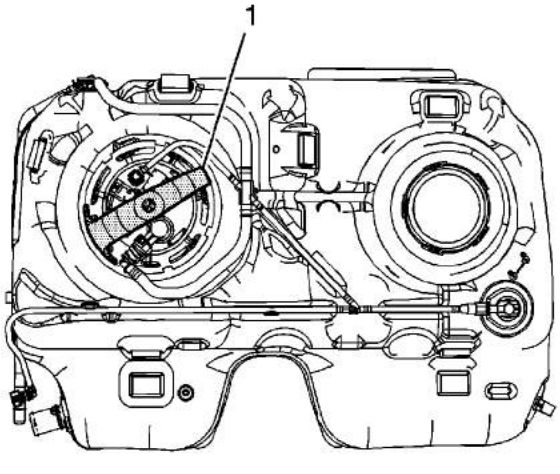


Caution: Avoid damaging the lock ring. Use only J-45722 to prevent damage to the lock ring.

Note: Do NOT use impact tools. Significant force will be required to release the lock ring. The use of a hammer and screwdriver is not recommended. Secure the fuel tank in order to prevent fuel tank rotation.

7. Using the J 45722 and a long breaker bar, rotate the lock ring counterclockwise unlocking the fuel tank fuel pump module lock ring.



8. Remove the J 45722 (1).

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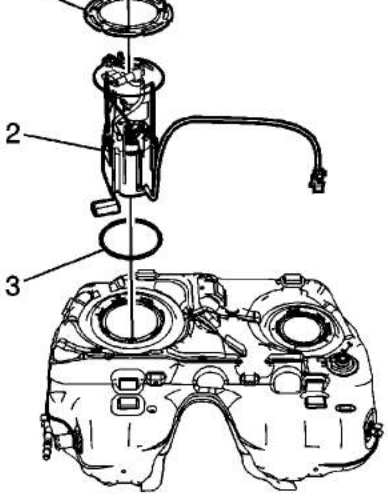

9. Remove the fuel tank fuel pump module lock ring (1).

Caution: Do Not handle the fuel sender assembly by the fuel pipes. The amount of leverage generated by handling the fuel pipes could damage the joints.

10. Slowly raise the module (2) until the fuel level sensor float arm is just visible.

Note: When removing the module from the fuel tank, be aware that the module reservoir bucket is full of fuel. The module must be tipped slightly during removal to avoid bending the fuel level sensor float arm.

11. Tilt the module toward the rear of the fuel tank to allow the level sensor float arm to clear the tank opening. Remove the module from the tank.
12. Carefully discard the fuel in the module reservoir bucket into an approved fuel container.

Note: DO NOT reuse the old fuel tank module O-ring seal.

13. Remove and discard the fuel tank fuel pump module O-ring seal (3).
14. If replacing the fuel tank fuel pump module, remove the fuel level sensor, if required. Refer to Fuel Level Sensor Replacement.

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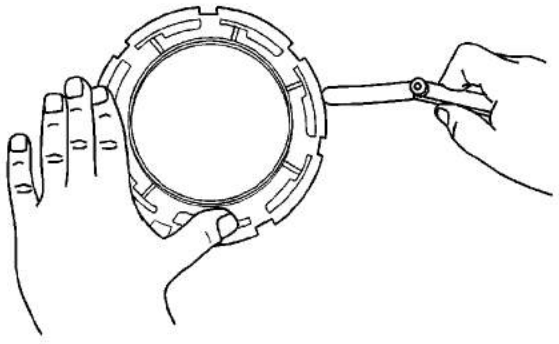

Note:

- Some lock rings were manufactured with "DO NOT REUSE" stamped into them. These lock rings may be reused if they are not damaged or warped.
- Inspect the lock ring for damage due to improper removal or installation procedures. If damage is found, install a NEW lock ring.
- Check the lock ring for flatness.

15. Place the lock ring on a flat surface. Measure the clearance between the lock ring and the flat surface using a feeler gage at 7 points.
16. If warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
17. If warpage is greater than 0.41 mm (0.016 in), the lock ring must be replaced.

Installation Procedure

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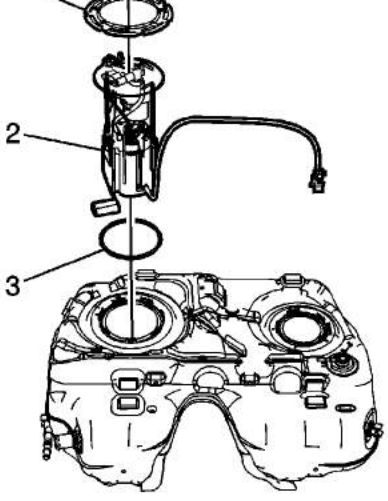
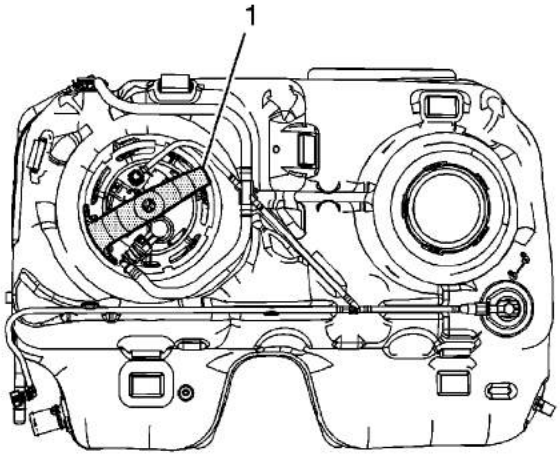


1. If the fuel tank fuel pump module was replaced, install the fuel level sensor, if required. Refer to Fuel Level Sensor Replacement.
2. Install a NEW fuel tank module O-ring seal (3) onto the fuel tank.
3. Tilt the module toward the rear of the fuel tank to allow the fuel level sensor float arm to clear the tank opening. Install the module into the fuel tank.
4. Lower the module assembly (2) into the tank.
5. Position and install the fuel tank module lock ring (1).



6. Install the J 45722 (1) to the fuel tank fuel pump module lock ring.

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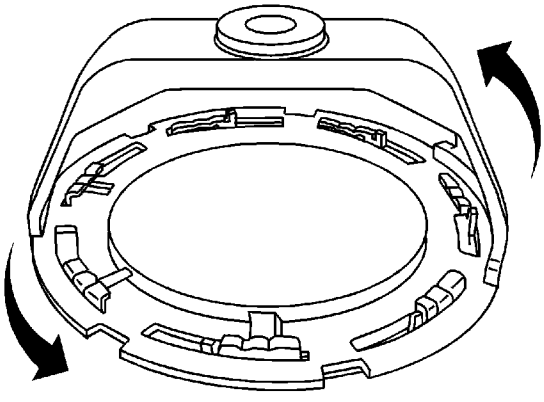
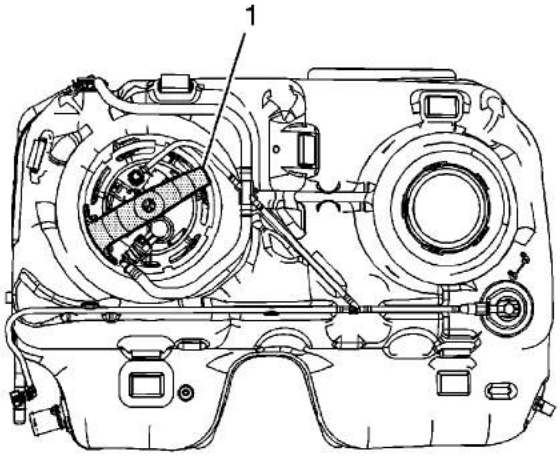


Note: Always replace the fuel tank module seal when installing the fuel tank module. Replace the lock ring if necessary. DO NOT apply any type of lubrication in the seal groove.

Ensure the lock ring is installed with the correct side facing upward. A correctly installed lock ring will only turn in a clockwise direction.

7. Use the J 45722 and a long breaker bar, rotate the lock ring clockwise locking the fuel tank module lock ring.



8. Remove the J 45722 (1) from the fuel tank fuel pump module lock ring.

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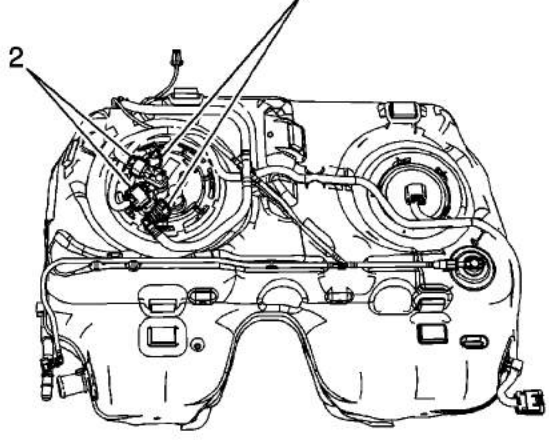
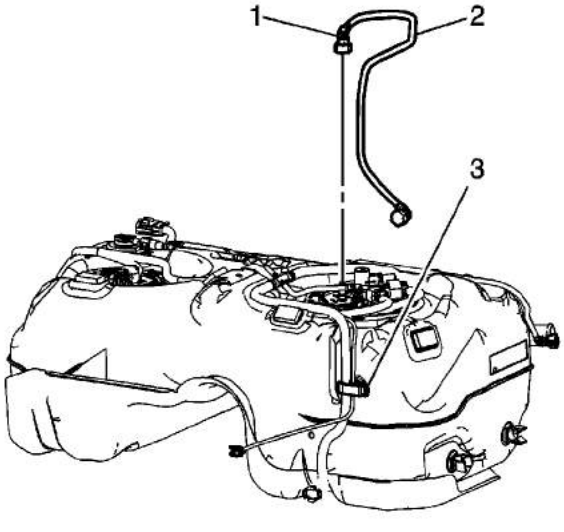


9. Connect the vapor line quick connect fittings (2) to the fuel tank fuel pump module. Refer to Plastic Collar Quick Connect Fitting Service.
10. Connect the engine wiring harness electrical connectors (1) to the fuel tank fuel pump primary module and the fuel tank pressure sensor.



11. Lay the fuel feed line (2) into position and connect the fuel feed line quick connect fitting (1) to the fuel tank fuel pump module. Refer to Plastic Collar Quick Connect Fitting Service.
12. Close the retaining clip (3) on the fuel tank.
13. Install the secondary fuel tank fuel pump module. Refer to Fuel Tank Fuel Pump Module Replacement - Secondary.

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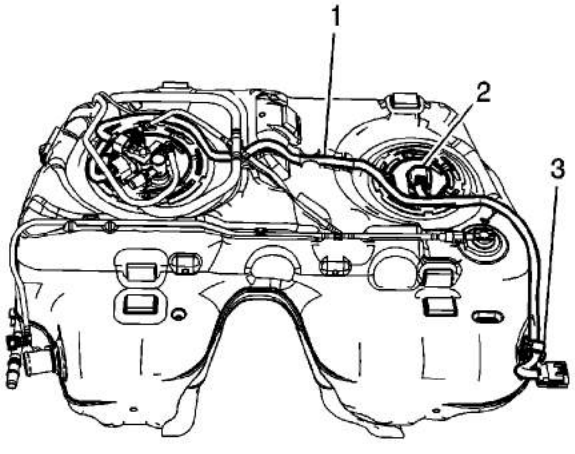
Fuel Tank Fuel Pump Module Replacement - Secondary

Special Tools

CH-48482 Fuel Sender Lock Ring Wrench

Removal Procedure



1. Remove the fuel tank. Refer to Fuel Tank Replacement .
2. Disconnect the fuel tank wiring harness electrical connector (2) from the secondary fuel tank fuel pump module.
3. Remove the fuel tank wiring harness from the retaining clip (3).
4. Reposition the fuel tank wiring harness (1) out of the way.
5. Install the CH-48482 to the fuel tank fuel pump module lock ring.
6. Using the CH-48482 and a long breaker bar, rotate the lock ring counterclockwise unlocking the fuel tank fuel pump module lock ring.
7. Remove the CH-48482 .

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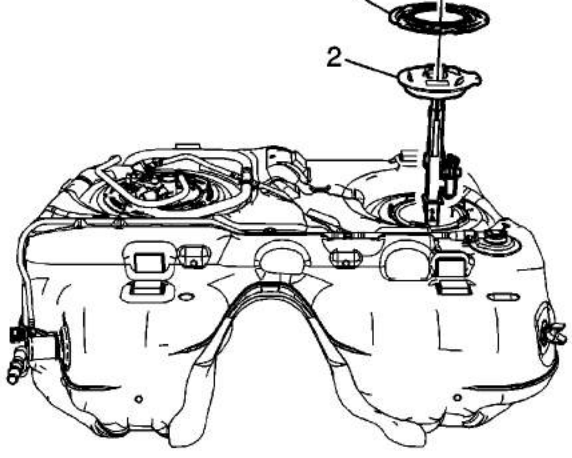
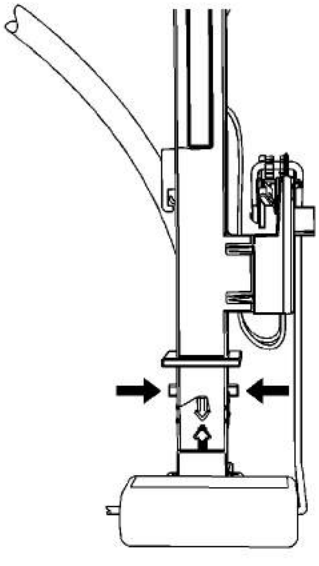


8. Remove the fuel tank module lock ring (1).
9. Slowly raise the fuel tank fuel pump module (2) until the fuel level sensor float arm and primary fuel tank fuel pump module suction port are just visible.



10. Squeeze in the primary fuel tank fuel pump module suction port tabs on either side of the port in order to disengage the primary fuel tank fuel pump module suction port from the secondary fuel tank fuel pump module.

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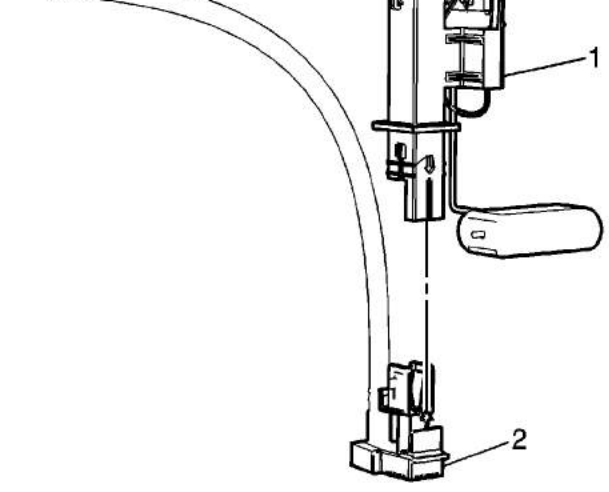
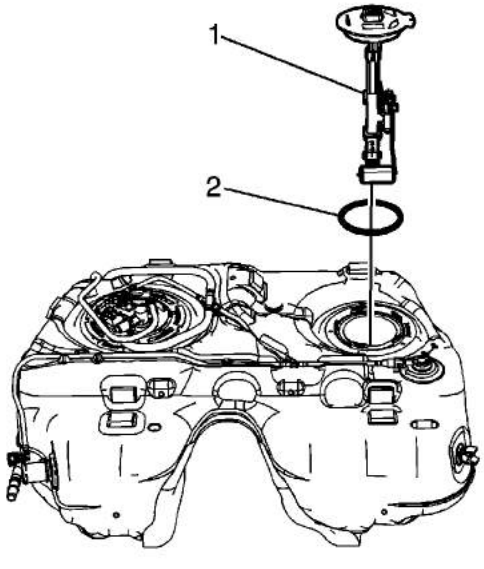


11. Remove the primary fuel tank fuel pump module suction port (2) from the secondary fuel tank fuel pump module (1).



12. Tilt the module toward the rear of the fuel tank to allow the level sensor float arm to clear the tank opening. Remove the module (1) from the tank.
13. Remove and discard the fuel tank module O-ring seal (2).
14. If the secondary fuel tank fuel pump module is being replaced, remove the secondary fuel level sensor, if required. Refer to Secondary Fuel Level Sensor Replacement .

Installation Procedure

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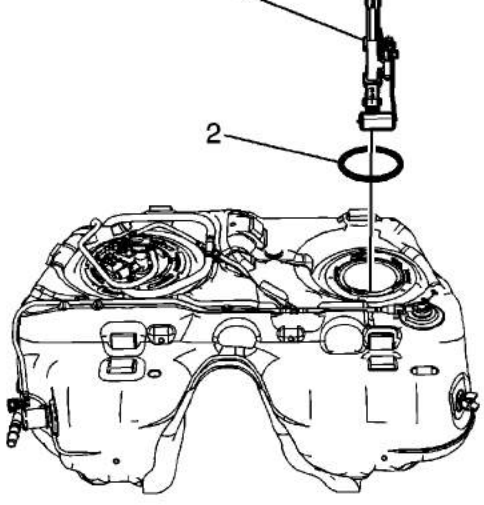
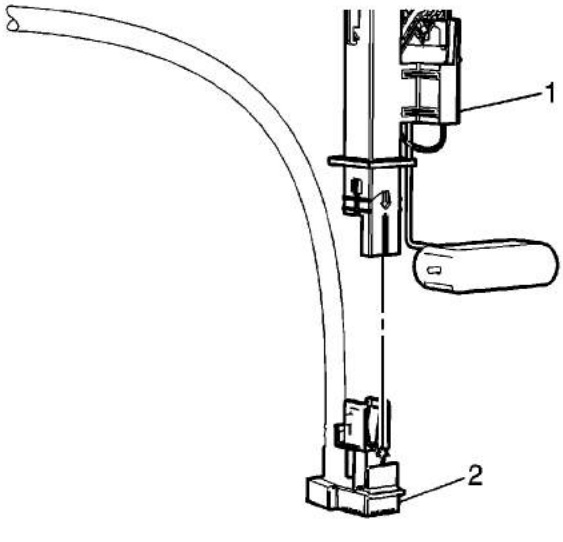


1. If the secondary fuel tank fuel pump module was replaced, install the secondary fuel level sensor, if required. Refer to Secondary Fuel Level Sensor Replacement .
2. Install a NEW fuel tank module O-ring seal (2) onto the fuel tank.
3. Tilt the module toward the rear of the fuel tank to allow the fuel level sensor float arm to clear the tank opening. Install the module (1) into the fuel tank.



4. Align the arrow (2) on the primary fuel tank fuel pump module suction port to the arrow (1) on the secondary fuel tank fuel pump module. Install the primary fuel tank fuel pump module suction port to the secondary fuel tank fuel pump module.

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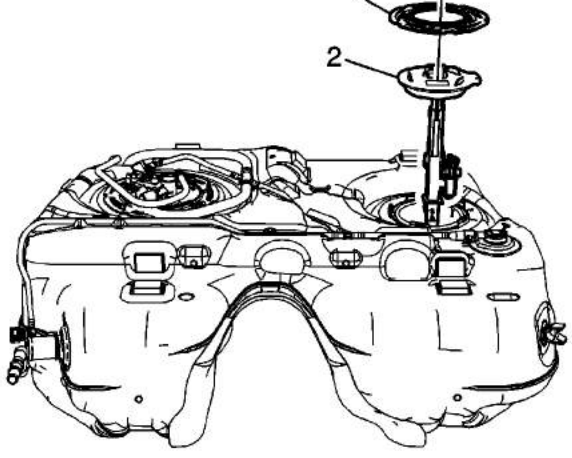
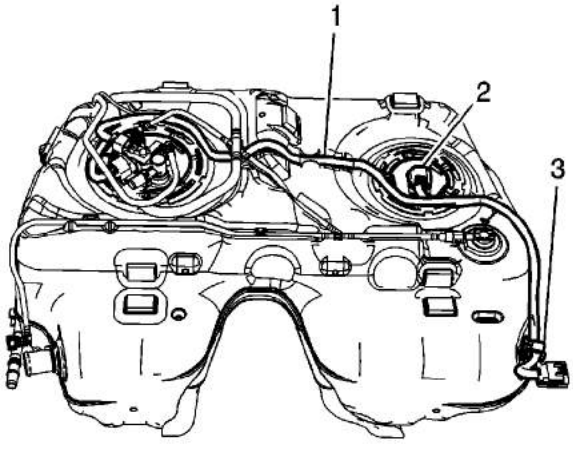


5. Lower the fuel tank fuel pump module (2) into the fuel tank.
6. Install the fuel tank module lock ring (1).



7. Install the CH-48482 to the fuel tank fuel pump module lock ring.
8. Using the CH-48482 and a long breaker bar, rotate the lock ring clockwise locking the fuel tank fuel pump module lock ring.
9. Remove the CH-48482 from the fuel tank fuel pump module lock ring.
10. Position the fuel tank wiring harness (1) to the module.
11. Connect the fuel tank wiring harness electrical connector (2) to the secondary fuel tank fuel pump module.
12. Install the fuel tank wiring harness to the retaining clip (3).
13. Install the fuel tank. Refer to Fuel Tank Replacement .

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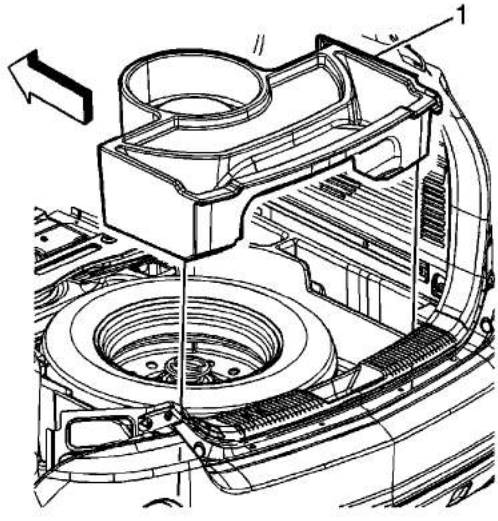
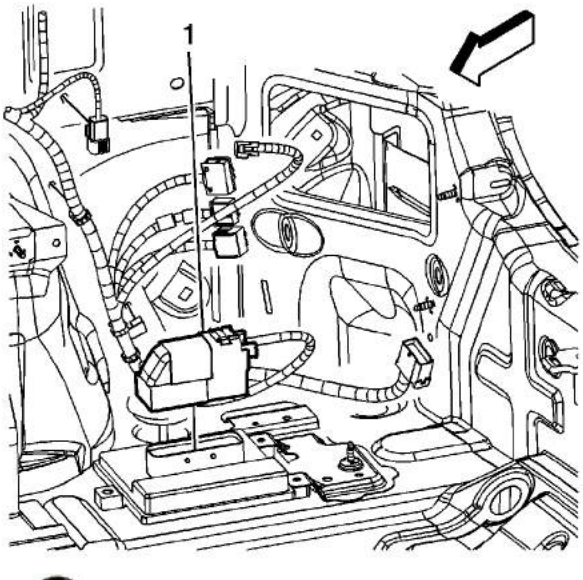
Fuel Pump Flow Control Module Replacement

Removal Procedure



1. Open the rear compartment floor stowage compartment cover.
2. Remove the spare tire spacer (1).
3. Remove the rear compartment floor stowage compartment. Refer to Rear Compartment Floor Stowage Compartment Replacement.



4. Disconnect the body wiring harness electrical connector (1) from the fuel pump flow control

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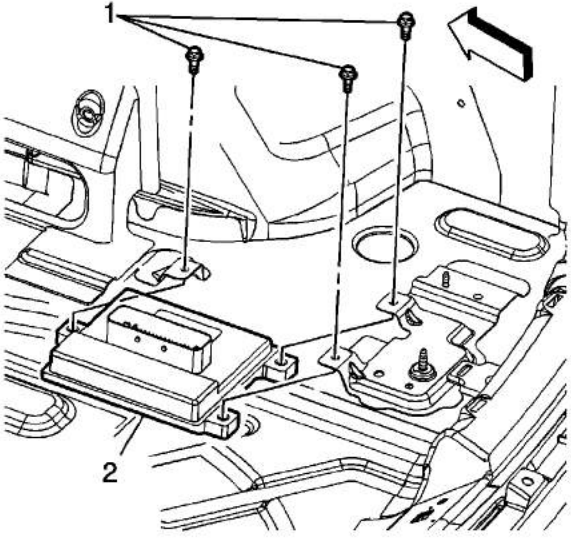
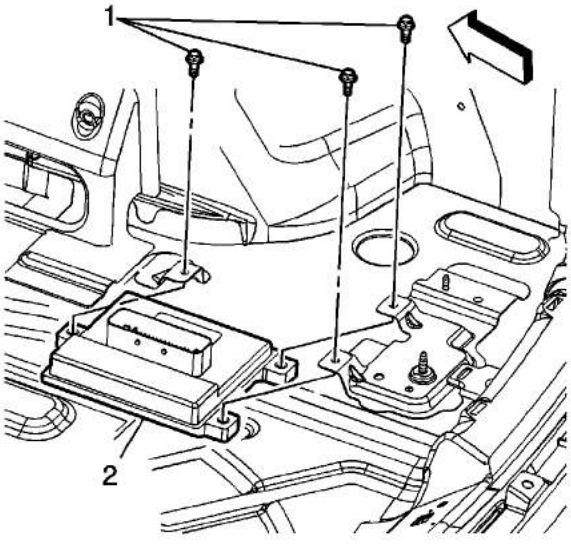


5. Remove the fuel pump flow control module bolts (1).
6. Slide the fuel pump flow control module towards the driver side of the vehicle.
7. Remove the fuel pump flow control module (2) from the vehicle.

Installation Procedure



1. Install the fuel pump flow control module (2) to the vehicle.
2. Slide the fuel pump flow control module towards the passenger side of the vehicle.

Caution: Refer to Fastener Caution in the Preface section.

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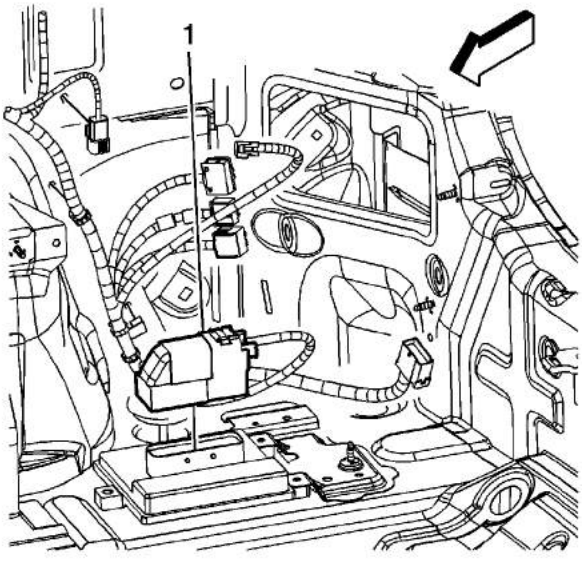
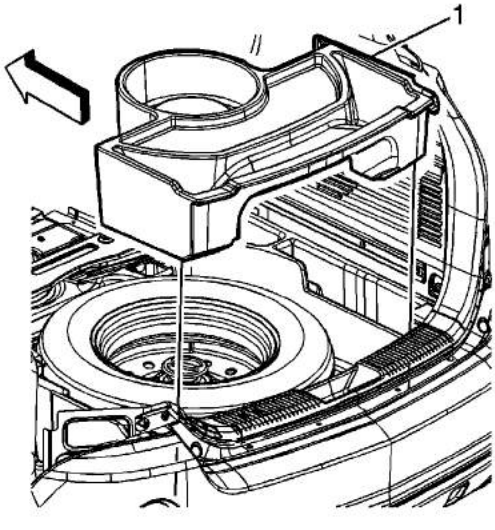
Tighten
Tighten the bolts to 10 N·m (89 lb in).



4. Connect the body wiring harness electrical connector (1) to the fuel pump flow control module.



5. Install the rear compartment floor stowage compartment. Refer to Rear Compartment Floor Stowage Compartment Replacement.
6. Install the spare tire spacer (1).
7. Close the rear compartment floor stowage compartment cover.
8. Program the fuel pump flow control module. Refer to Control Module References.

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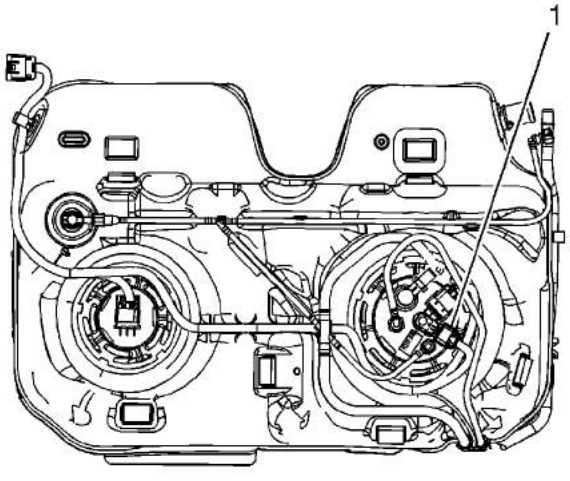
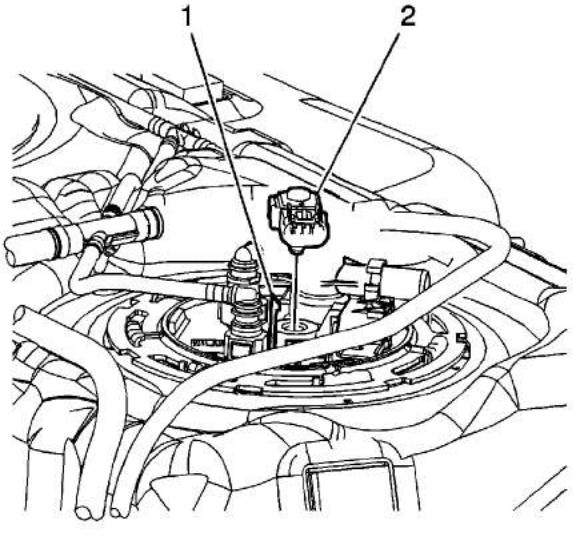
Fuel Tank Pressure Sensor Replacement

Removal Procedure



1. Remove the fuel tank. Refer to Fuel Tank Replacement.
2. Disconnect the fuel tank wiring harness electrical connector (1) from the fuel tank pressure sensor.



3. Disengage the retaining tab (1) securing the fuel tank pressure sensor.
4. Carefully lift and remove the fuel tank pressure sensor (2) from the fuel pump module.

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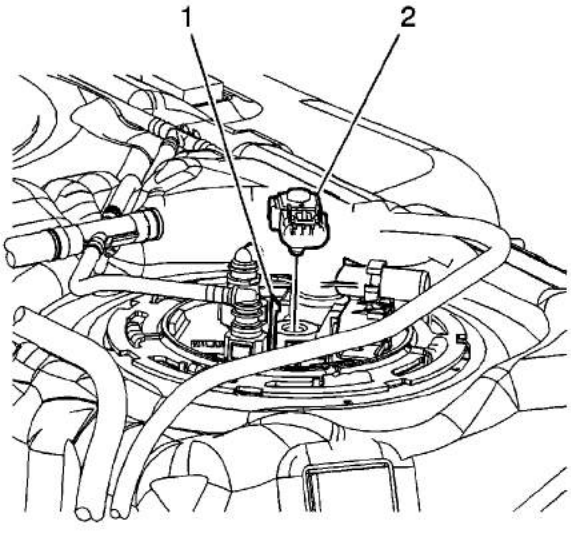
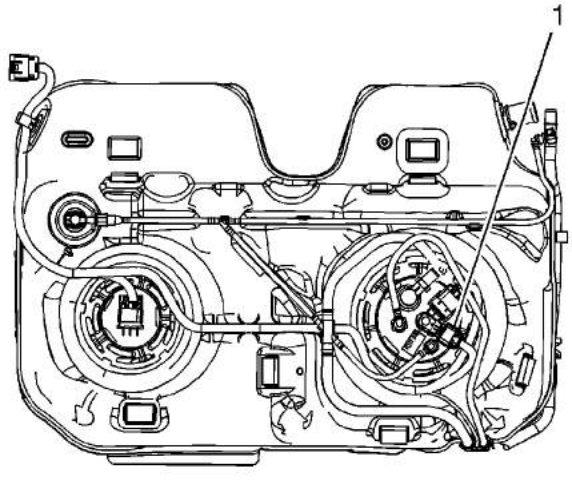


1. Install the fuel tank pressure sensor (2) to the fuel pump module assembly until the sensor engages the retaining tab (1).



2. Connect the fuel tank wiring harness electrical connector (1) to the fuel tank pressure sensor.
3. Install the fuel tank. Refer to Fuel Tank Replacement.

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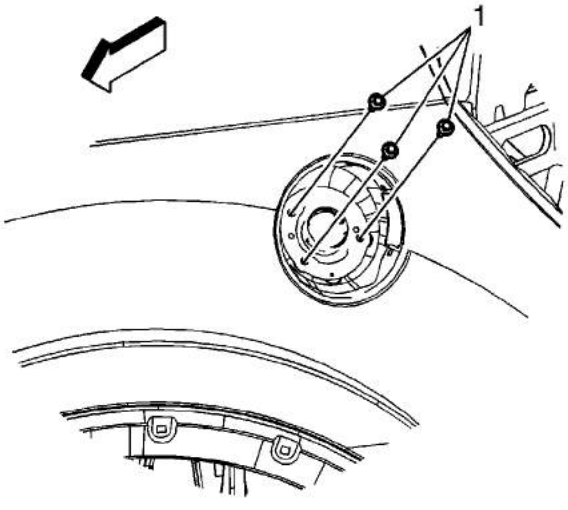
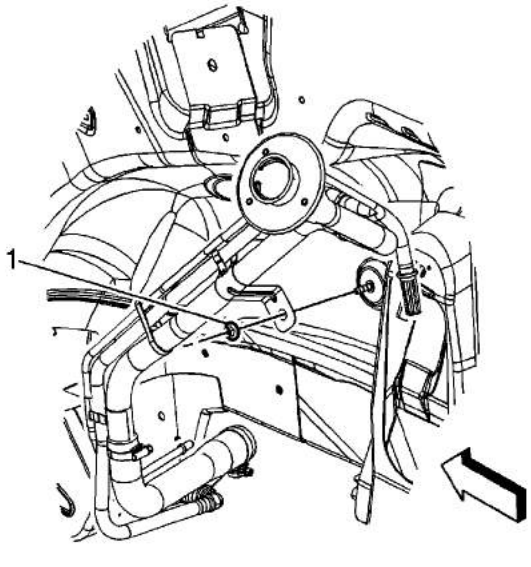
Filler Tube Replacement

Removal Procedure



1. Drain the fuel tank until the level in the tank is less than 1/4 full. Refer to Fuel Tank Draining.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Remove the fuel fill cap.
4. Remove the fuel tank fill pipe housing to fuel tank fill pipe screws (1).



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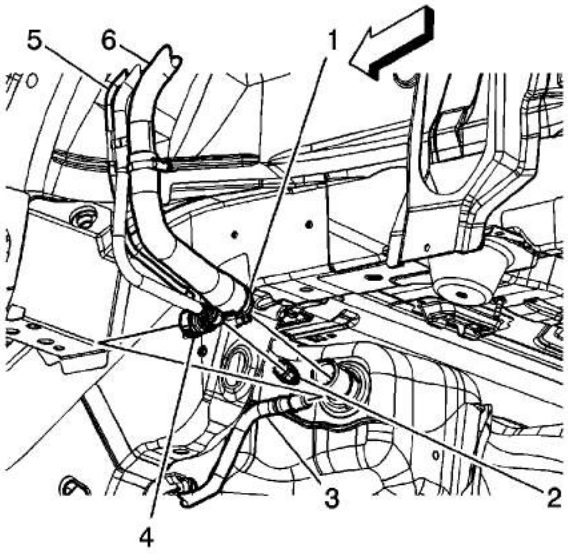
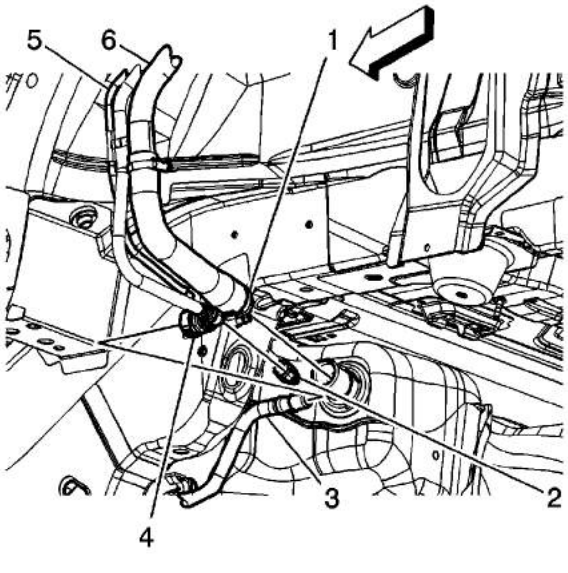


7. Disconnect the fill pipe vent line quick connect fitting (4) from the fuel tank fresh air line (3). Refer to Plastic Collar Quick Connect Fitting Service.
8. Disconnect the fuel tank vapor line quick connect fitting (2) from the fill pipe recirculation line (5). Refer to Plastic Collar Quick Connect Fitting Service.
9. Loosen the fuel fill pipe hose clamp (1) at the fuel tank.
10. Remove the fuel fill pipe (6) from the fuel tank.

Installation Procedure



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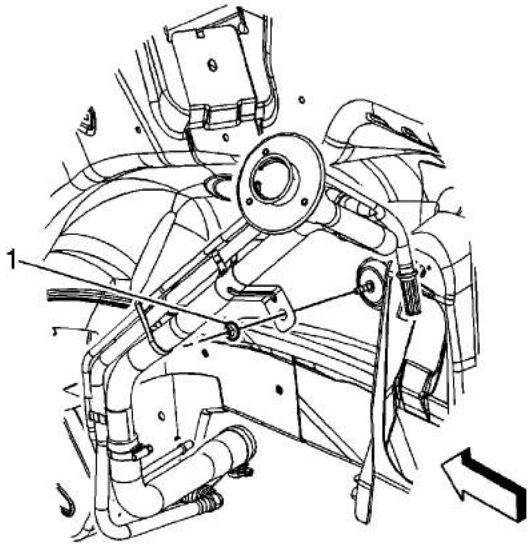
1. Install the fuel fill pipe (6) to the fuel tank.
2. Tighten the fuel fill pipe hose clamp (1) at the fuel tank.

   Tighten
   Tighten the clamp to 5 N·m (44 lb in).

3. Connect the fuel tank vapor line quick connect fitting (2) to the fill pipe recirculation line (5). Refer to Plastic Collar Quick Connect Fitting Service.
4. Connect the fill pipe vent line quick connect fitting (4) to the fuel tank fresh air line (3). Refer to Plastic Collar Quick Connect Fitting Service.



5. Install the fuel fill pipe upper bracket nut (1).

   Tighten
   Tighten the nut to 4 N·m (35 lb in).

6. Install the right rear wheelhouse liner. Refer to Rear Wheelhouse Panel Liner Replacement.

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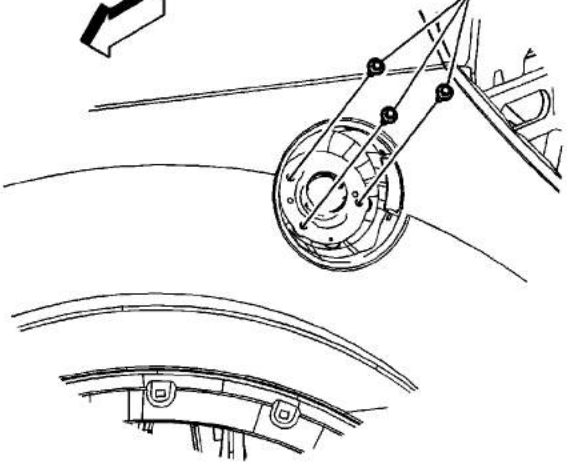

7. Install the fuel tank fill pipe housing to fuel tank fill pipe screws (1).

   Tighten
   Tighten the screws to 10 N·m (89 lb in).

8. Install the fuel fill cap.
9. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

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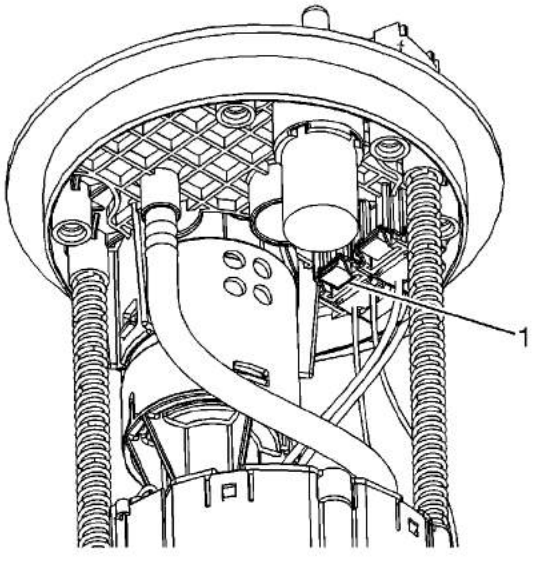
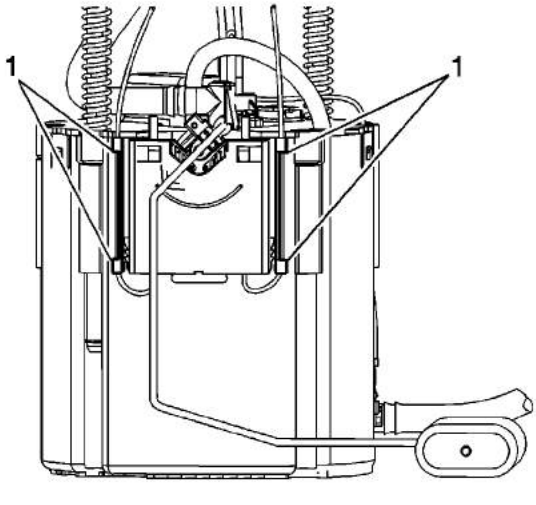
Fuel Level Sensor Replacement

Removal Procedure

Important: There are 2 fuel level sensor assemblies in the fuel tank. There is one located on each fuel pump module. The fuel level sensors are NOT the same for each of the fuel pump modules.



1. Remove the fuel pump module. Refer to Fuel Tank Fuel Pump Module Replacement.
2. Disconnect the fuel level sensor electrical connector (1) from the fuel tank fuel pump module cover.



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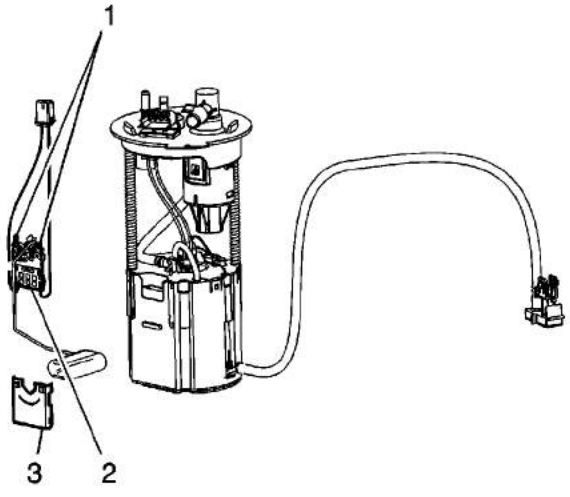
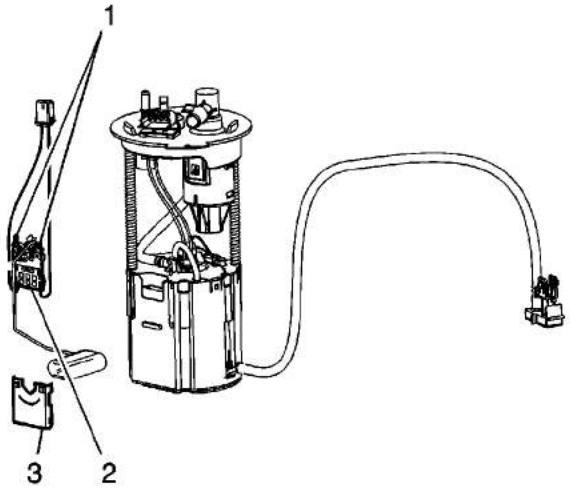
3. Remove the fuel level sensor wiring from behind the retaining features (1) molded into the fuel tank fuel pump module reservoir.



4. Slide the fuel level sensor up and remove the sensor from the fuel tank fuel pump module.
5. Place the fuel level sensor on a clean work surface.
6. Push in the fuel level sensor retainers (1), in order to remove the sensor from the cover.
7. Remove the fuel level sensor (2) from the cover (3).

Installation Procedure



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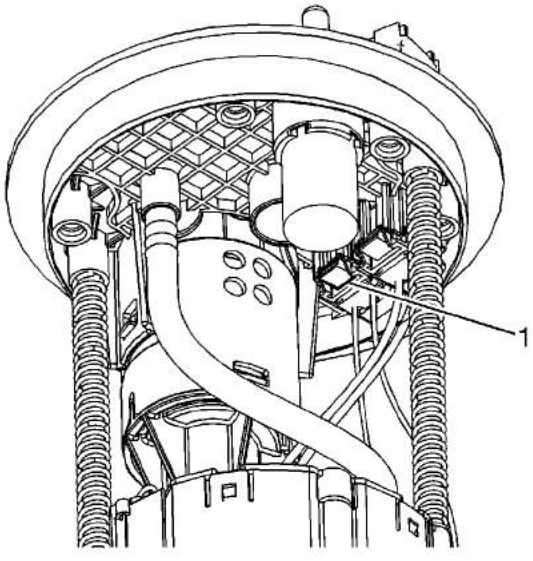
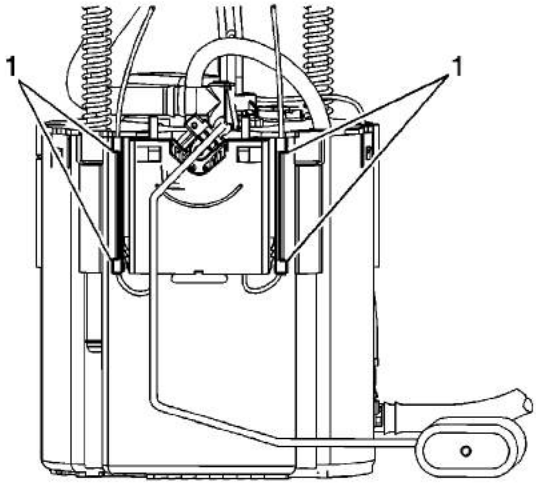
3. Position the fuel level sensor to the fuel tank fuel pump module and slide the sensor down into position.



4. Connect the fuel level sensor electrical connector (1) to the fuel tank fuel pump module cover.



5. Install the fuel level sensor wiring behind the retaining features (1) molded into the fuel tank fuel pump module reservoir.
6. Install the fuel pump module. Refer to Fuel Tank Fuel Pump Module Replacement.

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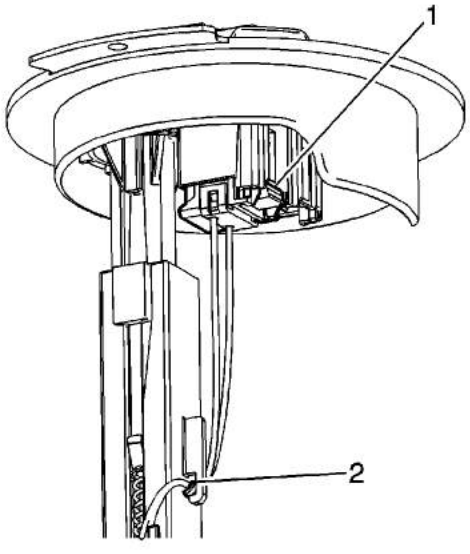
Secondary Fuel Level Sensor Replacement

Removal Procedure

Important: There are 2 fuel level sensor assemblies in the fuel tank. There is one located on each fuel pump module. The fuel level sensors are NOT the same for each of the fuel pump modules.



1. Remove the fuel pump module. Refer to Fuel Tank Fuel Pump Module Replacement - Secondary.
2. Disconnect the fuel level sender electrical connector (1) from the fuel tank fuel pump module cover.
3. Remove the fuel level sensor wiring from the retaining feature (2) on the fuel tank fuel pump module.

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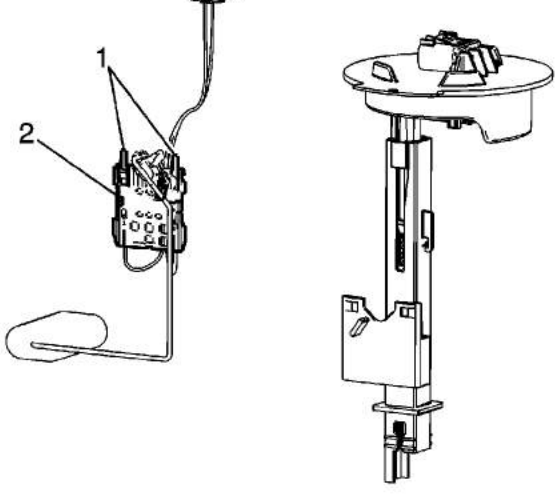
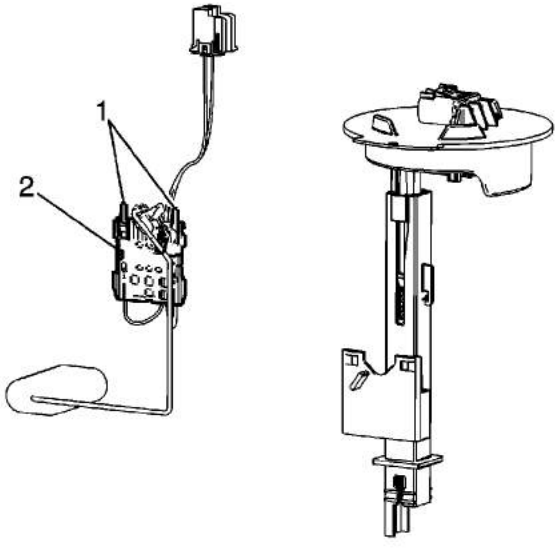


4. Push in the fuel level sensor retainers (1), in order to disengage the retainers from the module.
5. Slide the fuel level sensor (2) up, out of the fuel tank fuel pump module.

Installation Procedure



1. Position the fuel level sensor (2) to the fuel tank fuel pump module.
2. Push the fuel level sensor down until the retainers (1) engage the fuel tank fuel pump module.

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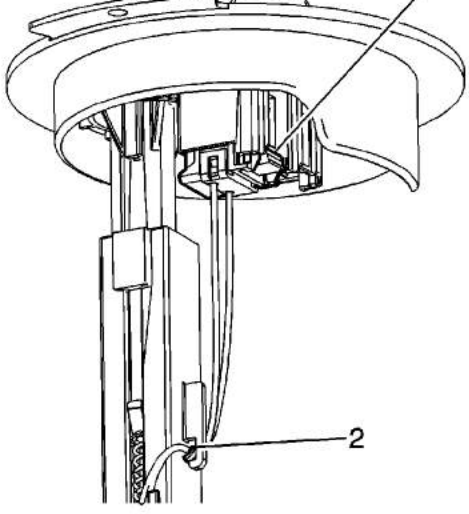

3. Connect the fuel level sender electrical connector (1) to the fuel tank fuel pump module cover.
4. Install the fuel level sensor wiring to the retaining feature (2) on the fuel tank fuel pump module.
5. Install the fuel pump module. Refer to Fuel Tank Fuel Pump Module Replacement - Secondary.

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Fuel Hose / Pipes Replacement - Chassis

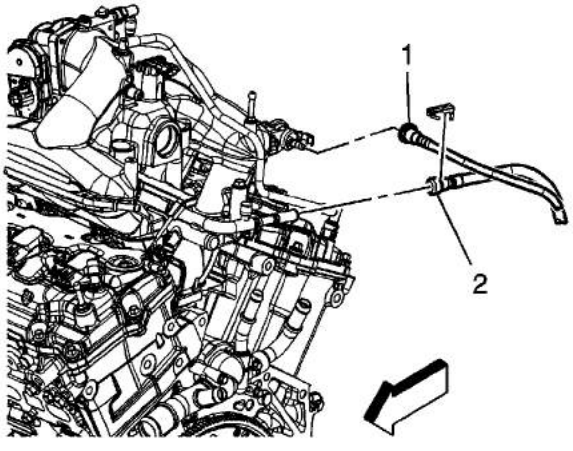
Removal Procedure

Warning: Ensure that the vehicle is properly supported and squarely positioned. To help avoid personal injury when a vehicle is on a hoist, provide additional support for the vehicle on the opposite end from which the components are being removed.

Warning: Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

Warning: Whenever fuel lines are removed, catch fuel in an approved container. Container opening must be a minimum of 300 mm (12 in) diameter to adequately catch the fluid.

Caution: Fuel/Vapor lines cannot be spliced or repaired. The line must be replaced (if damaged) with the same type of line.



1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Disconnect the chassis fuel feed line quick connect fitting (2) from the fuel rail. Refer to Metal Collar Quick Connect Fitting Service.
4. Disconnect the chassis evaporative emission (EVAP) line quick connect fitting (1) from the EVAP canister purge solenoid valve. Refer to Plastic Collar Quick Connect Fitting Service.

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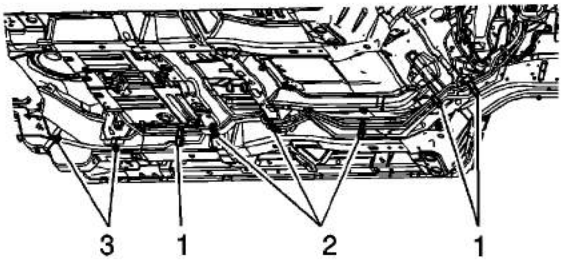
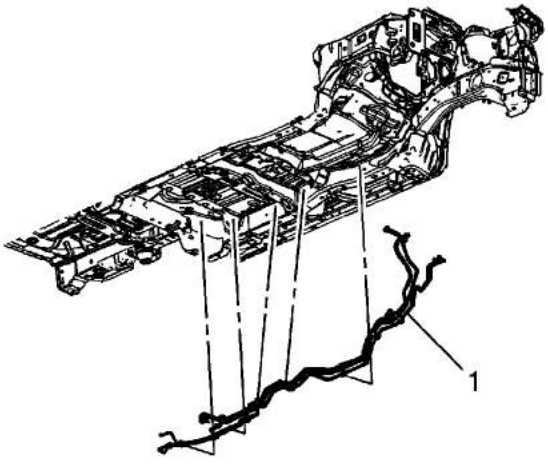


5. Remove the brake, fuel and EVAP line retainers (1) from the underbody and side rail.
6. Remove the brake, fuel and EVAP line retainers (2) from the underbody studs.
7. Remove the brake line retainers (3) from the underbody side rail.



8. Remove the brake, fuel and EVAP line bundle (1) from the vehicle.

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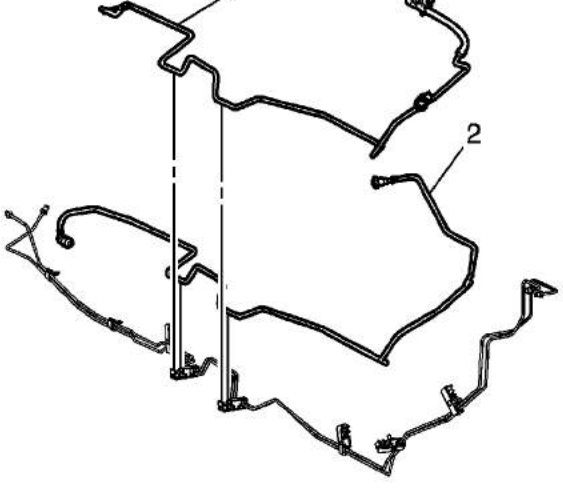
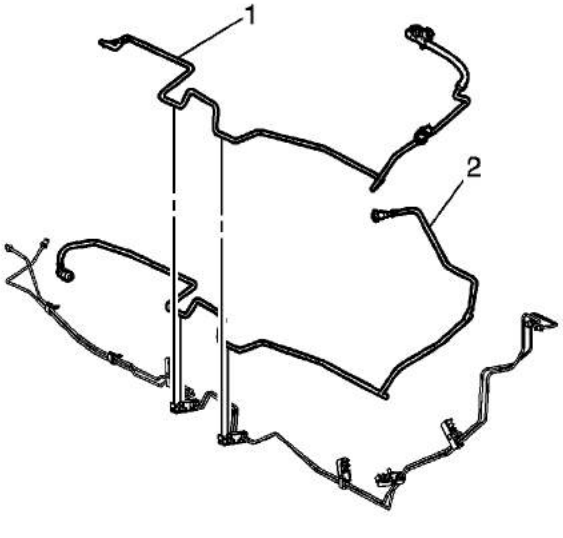


9. Remove the chassis fuel feed line (1) from the retainers.

Installation Procedure



1. Install the chassis fuel feed line (1) to the retainers.

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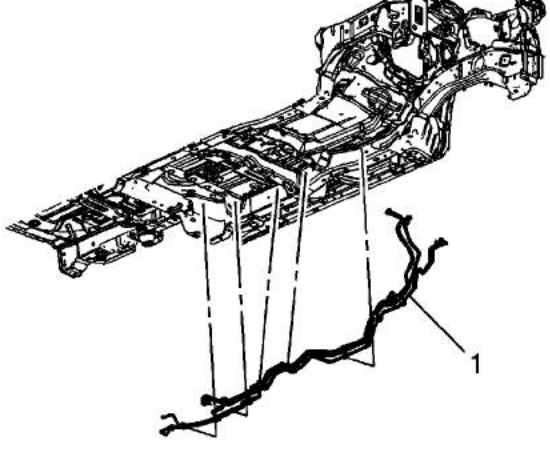
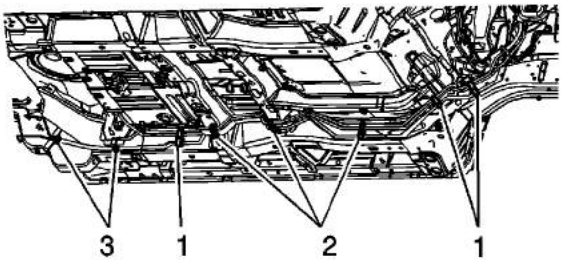


2. Install the brake, fuel and EVAP line bundle (1) to the vehicle.



3. Install the brake, fuel and EVAP line retainers (1) to the underbody and side rail.
4. Install the brake, fuel and EVAP line retainers (2) to the underbody studs.
5. Install the brake line retainers (3) to the underbody side rail.

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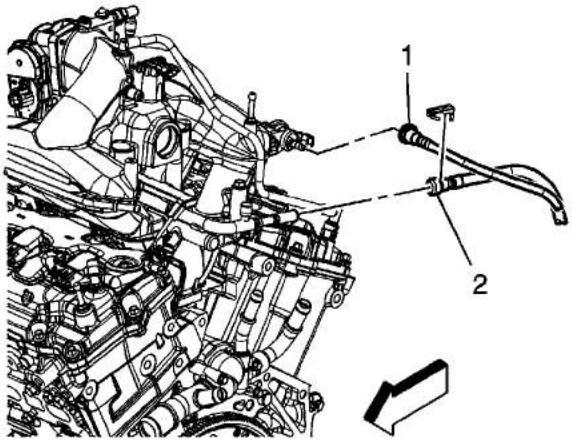

6. Connect the chassis fuel feed line quick connect fitting (2) to the fuel rail. Refer to Metal Collar Quick Connect Fitting Service.
7. Connect the chassis EVAP line quick connect fitting (1) to the EVAP canister purge solenoid valve. Refer to Plastic Collar Quick Connect Fitting Service.
8. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
9. Use the following procedure in order to inspect for leaks:
   9.1. Turn the ignition ON, with the engine OFF, for 2 seconds.
   9.2. Turn the ignition OFF for 10 seconds.
   9.3. Turn the ignition ON, with the engine OFF.
   9.4. Inspect for fuel leaks.
10. Install the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.

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Fuel System Cleaning

Important: Only use oil free compressed air to blow out fuel pipes. If the fuel filter is plugged, the fuel tank should be inspected internally and cleaned if necessary.

1. Remove the fuel tank module.
2. Inspect the fuel sender strainer. Replace a contaminated strainer and inspect the fuel pump.
3. Inspect the fuel pump inlet for dirt and debris. Replace the fuel pump if you find dirt or debris in the fuel pump inlet.

   Important: When flushing the fuel tank, handle the fuel and water mixture as a hazardous material. Handle the fuel and water in accordance with all applicable local, state, and federal laws and regulations.

4. Flush the fuel tank with hot water.
5. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to be sure that the removal of the water from the fuel tank is complete.
6. Install the fuel tank module.

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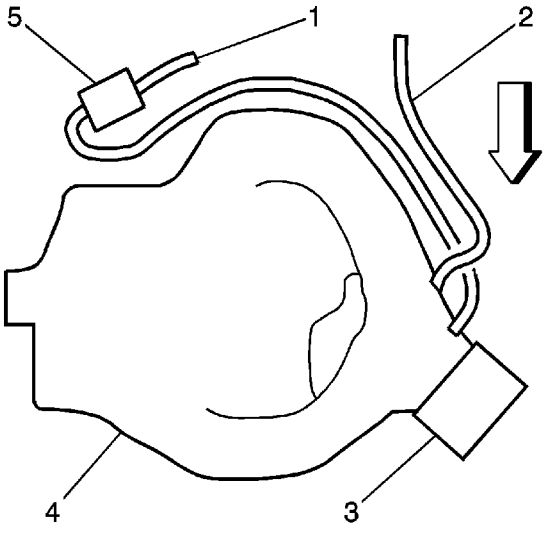
Emission Hose Routing Diagram



(1) Emissions Hose to Evaporative Emissions (EVAP) Canister
(2) Positive Crankcase Ventilation (PCV) Hose to Cam Cover
(3) Throttle Body Assembly
(4) Upper Intake Manifold
(5) EVAP Canister Purge Solenoid

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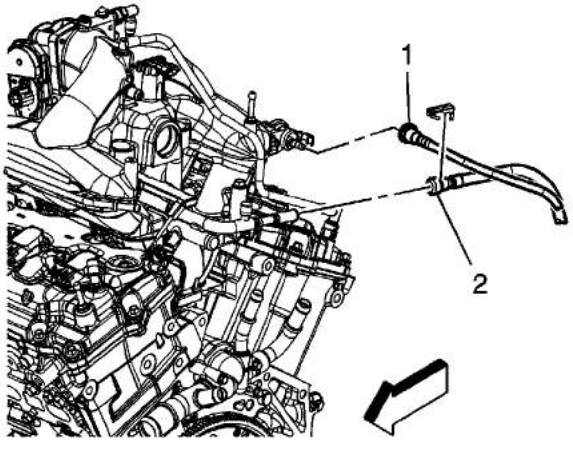
Fuel Injector and Fuel Rail Replacement

Removal Procedure

Warning: Refer to Gasoline/Gasoline Vapors Warning in the Preface section.



1. Remove the upper intake manifold. Refer to Upper Intake Manifold Replacement.
2. Disconnect the fuel feed line quick connect fitting (2) from the fuel rail. Refer to Metal Collar Quick Connect Fitting Service.

   Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

3. Use compressed air in order to remove any debris from the around the area where the fuel injectors enter the lower intake manifold.

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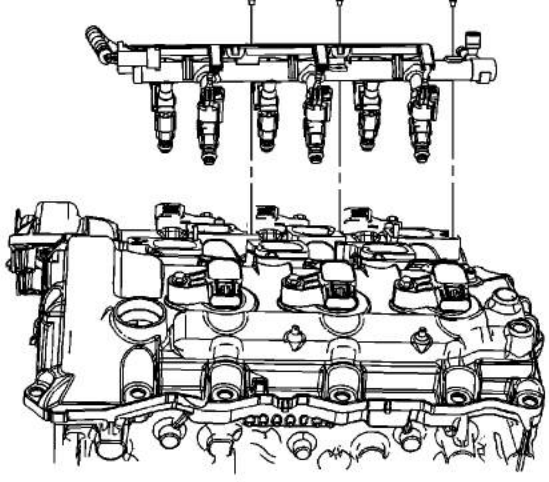
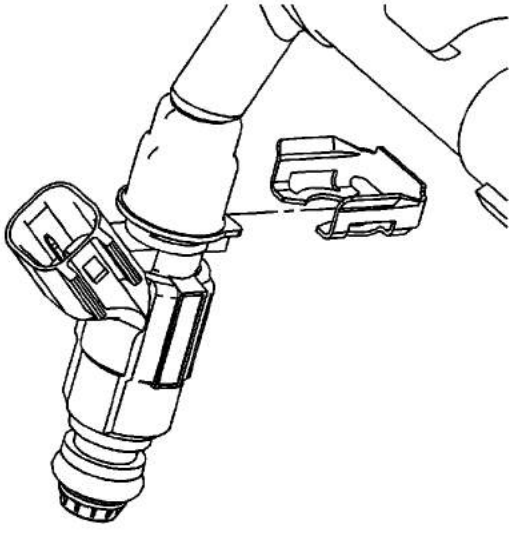


4. Remove the fuel rail bolts.

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.

5. Remove the fuel rail with fuel injectors from the lower intake manifold.
6. Disengage the fuel injector electrical connector lock.
7. Disconnect the fuel injector electrical connector.



8. Remove the fuel injector retainer clip.

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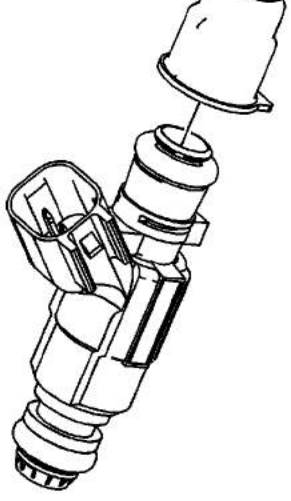
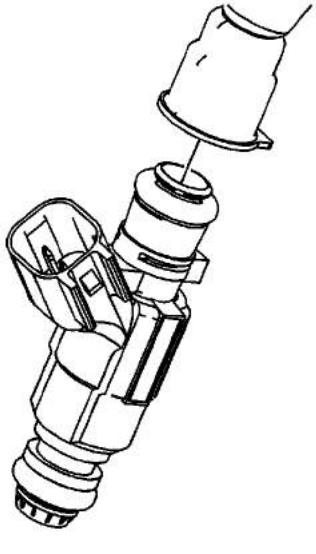


9. Remove the fuel injector.
10. Remove and discard the fuel injector seals.

Installation Procedure



1. Install NEW fuel injector seals.
2. Install the fuel injector.

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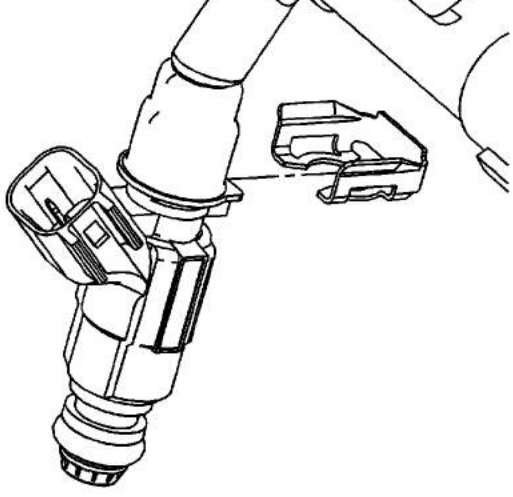
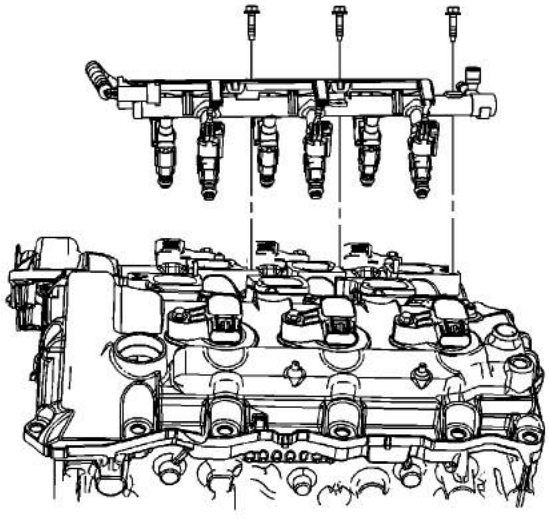


3. Install the fuel injector retainer clip.
4. Install the fuel injector electrical connector.
5. Engage the fuel injector electrical connector lock.



6. Install the fuel rail with fuel injectors to the lower intake manifold.

   Caution: Refer to Fastener Caution in the Preface section.

7. Install the fuel rail bolts. Tighten the bolts to **10 N·m (89 lb in).**

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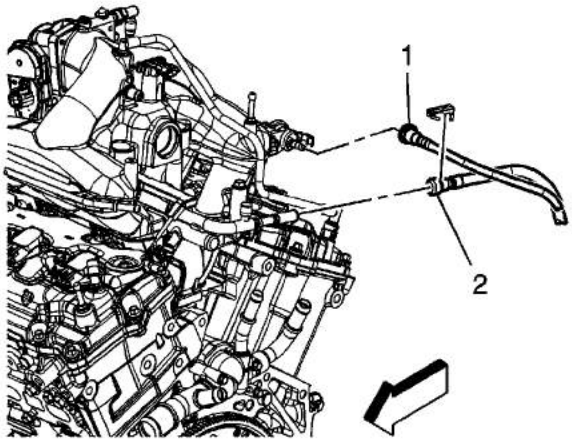

8. Connect the fuel feed line quick connect fitting (2) to the fuel rail. Refer to Metal Collar Quick Connect Fitting Service.
9. Install the upper intake manifold. Refer to Upper Intake Manifold Replacement.

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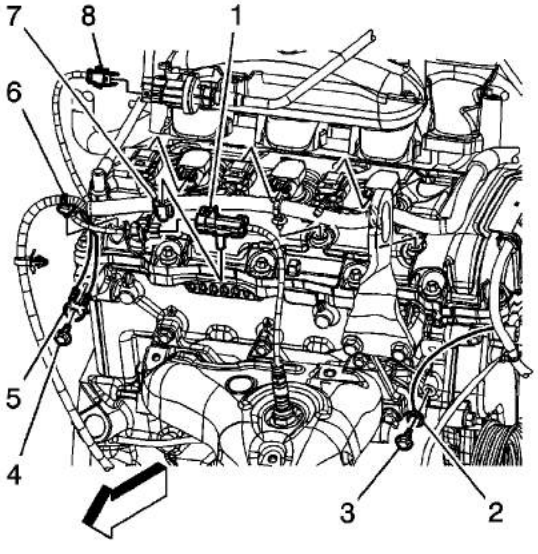
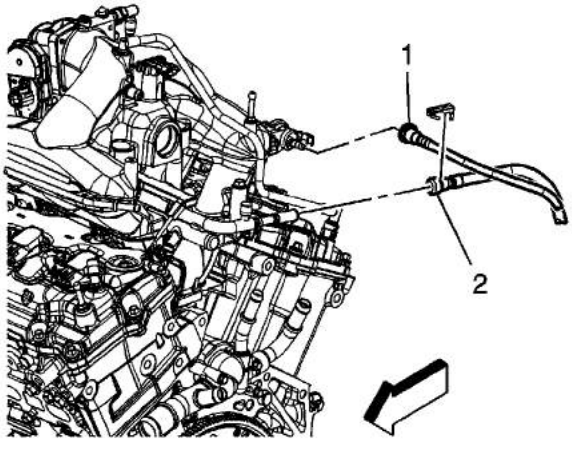
Evaporative Emission Canister Purge Solenoid Valve Replacement

Removal Procedure



1. Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.
2. Disconnect the engine wiring harness electrical connector (8) from the evaporative emission (EVAP) purge solenoid.



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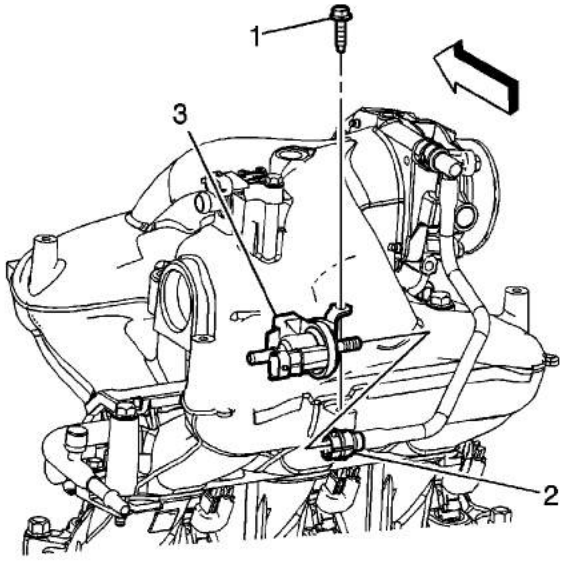
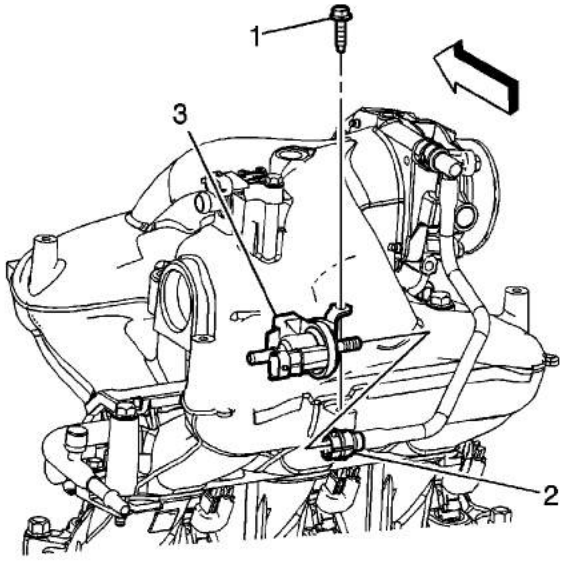


4. Disconnect the EVAP line quick connect fitting (1) from the EVAP canister purge solenoid valve. Refer to Plastic Collar Quick Connect Fitting Service.
5. Remove the EVAP purge solenoid bracket bolt (1).
6. Remove the EVAP purge solenoid (3).

Installation Procedure



1. Position the EVAP purge solenoid (3) to the upper intake manifold.

Caution: Refer to Fastener Caution in the Preface section.

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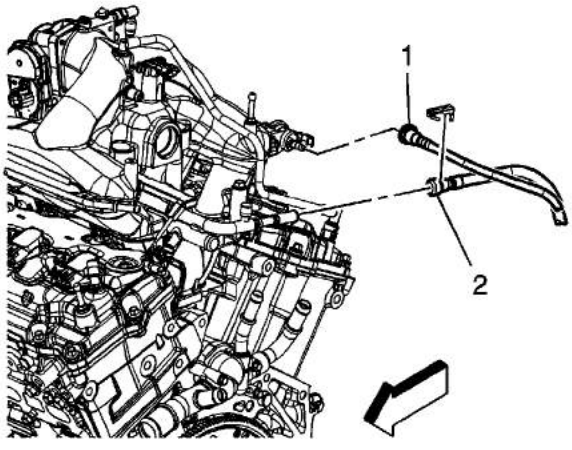
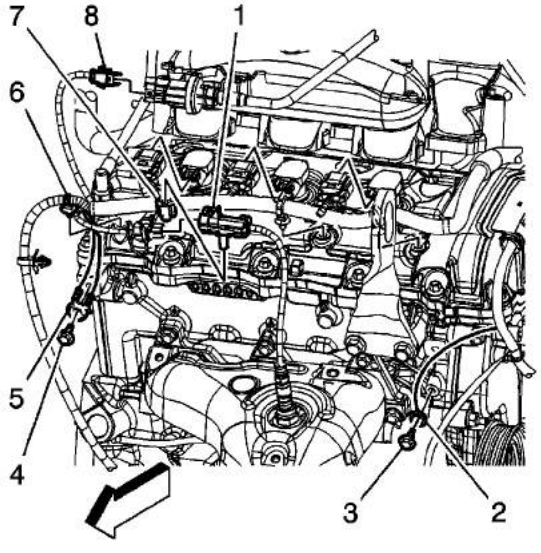
Refer to Plastic Collar Quick Connect Fitting Service.



4. Connect the chassis EVAP line quick connect fitting (1) to the EVAP canister purge solenoid valve. Refer to Plastic Collar Quick Connect Fitting Service.



5. Connect the engine wiring harness electrical connector (4) to the EVAP purge solenoid.
6. Install the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.

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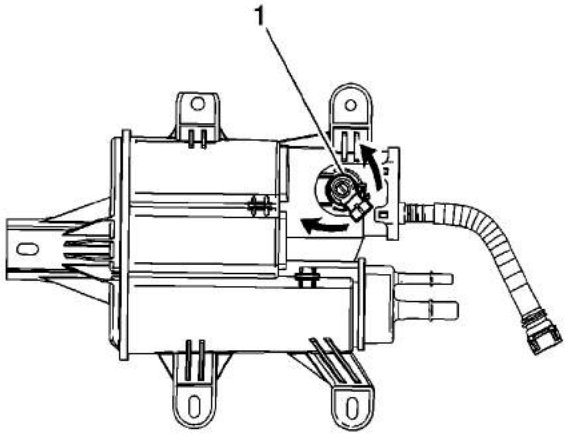
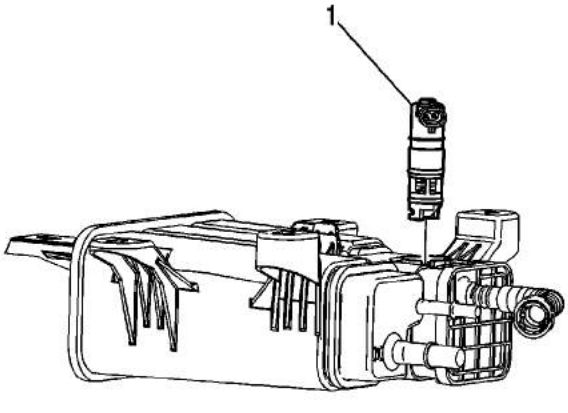
Evaporative Emission Canister Vent Solenoid Valve Replacement

Removal Procedure



1. Remove the evaporative emission (EVAP) canister. Refer to Evaporative Emission Canister Replacement.
2. Rotate the EVAP canister vent solenoid valve (1) clockwise.



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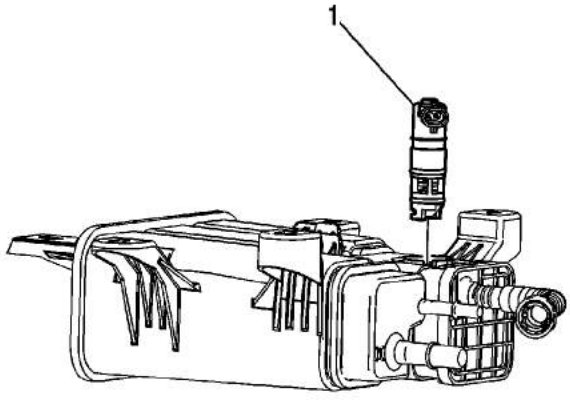
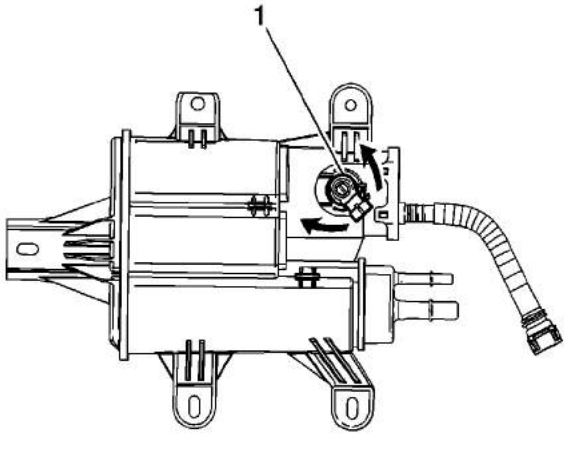
Installation Procedure



1. Install the EVAP canister vent solenoid valve (1) to the EVAP canister.



2. Rotate the EVAP canister vent solenoid valve counterclockwise until it reaches the positive stop.
3. Install the EVAP canister. Refer to Evaporative Emission Canister Replacement.

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Evaporative Emission Pipe Replacement

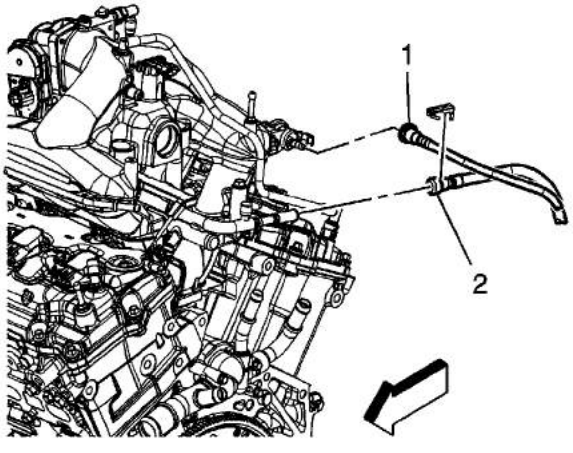
Removal Procedure

Warning: Ensure that the vehicle is properly supported and squarely positioned. To help avoid personal injury when a vehicle is on a hoist, provide additional support for the vehicle on the opposite end from which the components are being removed.

Warning: Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

Warning: Whenever fuel lines are removed, catch fuel in an approved container. Container opening must be a minimum of 300 mm (12 in) diameter to adequately catch the fluid.

Caution: Fuel/Vapor lines cannot be spliced or repaired. The line must be replaced (if damaged) with the same type of line.



1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
3. Disconnect the chassis fuel feed line quick connect fitting (2) from the fuel rail. Refer to Metal Collar Quick Connect Fitting Service.
4. Disconnect the chassis evaporative emission (EVAP) line quick connect fitting (1) from the EVAP canister purge solenoid valve. Refer to Plastic Collar Quick Connect Fitting Service.

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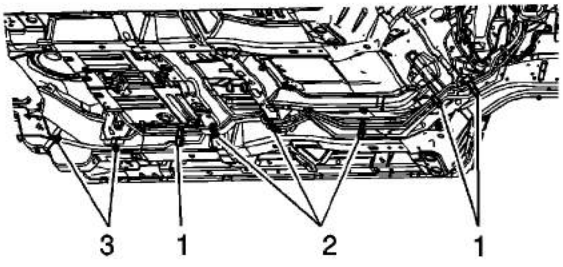
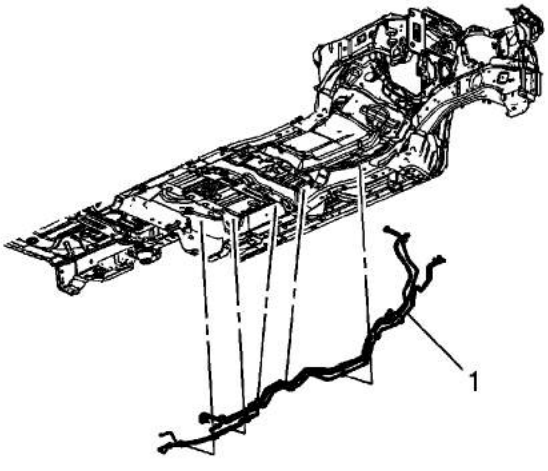


5. Remove the brake, fuel and EVAP line retainers (1) from the underbody and side rail.
6. Remove the brake, fuel and EVAP line retainers (2) from the underbody studs.
7. Remove the brake line retainers (3) from the underbody side rail.



8. Remove the brake, fuel and EVAP line bundle (1) from the vehicle.

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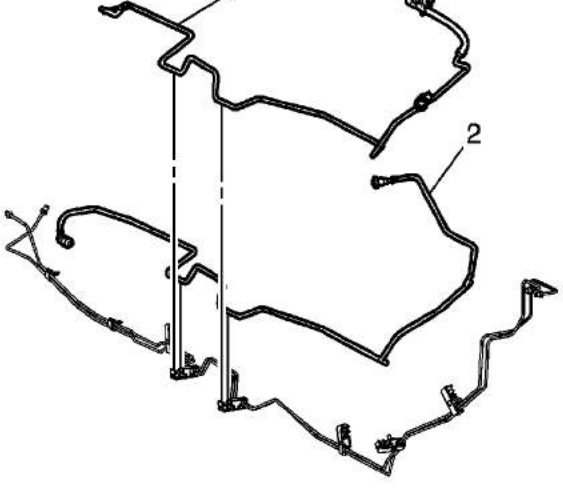
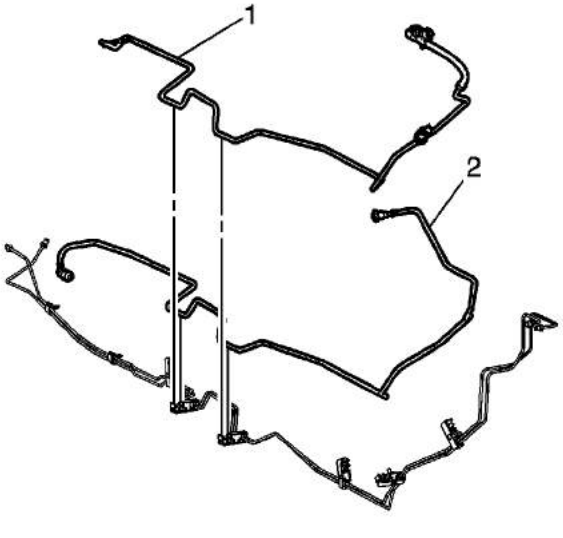


9. Remove the chassis EVAP line (2) from the retainers.

Installation Procedure



1. Install the chassis EVAP line (2) to the retainers.

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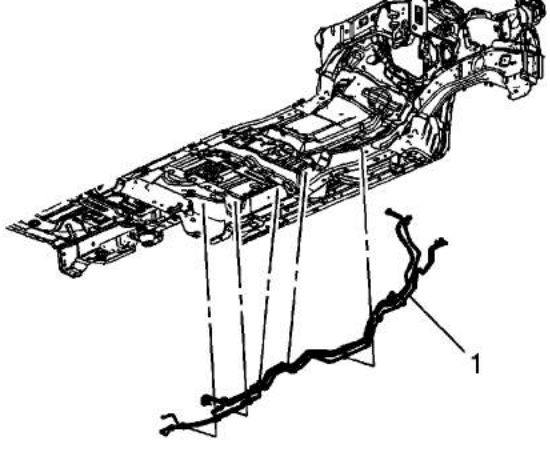
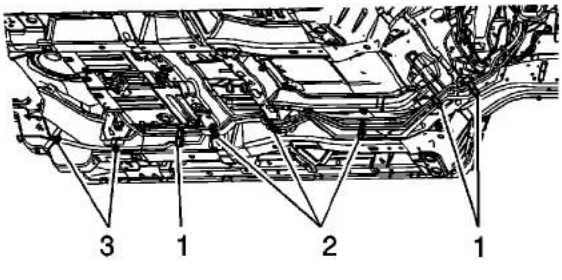


2. Install the brake, fuel and EVAP line bundle (1) to the vehicle.



3. Install the brake, fuel and EVAP line retainers (1) to the underbody and side rail.
4. Install the brake, fuel and EVAP line retainers (2) to the underbody studs.
5. Install the brake line retainers (3) to the underbody side rail.

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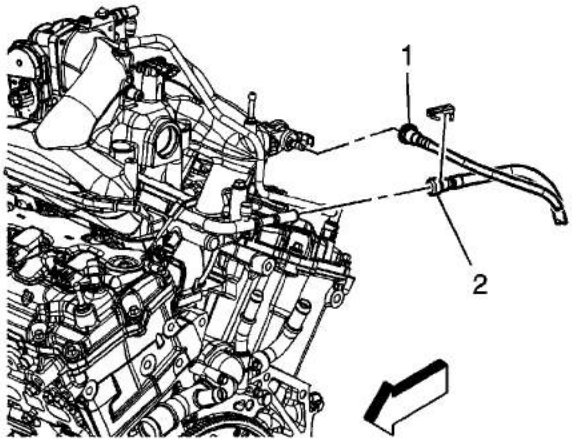

6. Connect the chassis fuel feed line quick connect fitting (2) to the fuel rail. Refer to Metal Collar Quick Connect Fitting Service.
7. Connect the chassis EVAP line quick connect fitting (1) to the EVAP canister purge solenoid valve. Refer to Plastic Collar Quick Connect Fitting Service.
8. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.
9. Use the following procedure in order to inspect for leaks:
   9.1. Turn the ignition ON, with the engine OFF, for 2 seconds.
   9.2. Turn the ignition OFF for 10 seconds.
   9.3. Turn the ignition ON, with the engine OFF.
   9.4. Inspect for fuel leaks.
10. Install the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.

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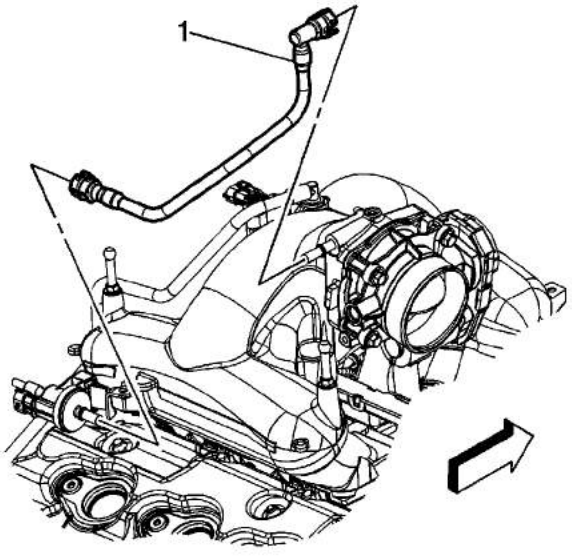
Evaporative Emission Canister Purge Tube Replacement

Removal Procedure



1. Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.
2. Disconnect the evaporative emission (EVAP) canister purge line quick connect fitting from the intake manifold. Refer to Plastic Collar Quick Connect Fitting Service.
3. Disconnect the EVAP canister purge line quick connect fitting from the EVAP canister purge solenoid valve. Refer to Plastic Collar Quick Connect Fitting Service.
4. Remove the EVAP canister purge line (1) from the vehicle.

Installation Procedure

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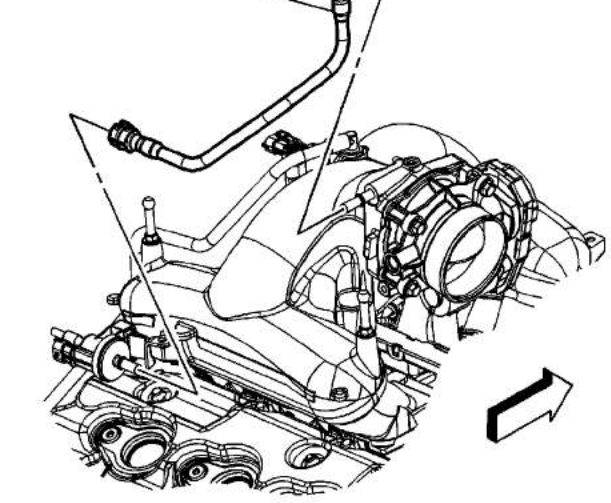

1. Install the EVAP canister purge line (1) to the vehicle.
2. Connect the EVAP canister purge line quick connect fitting to the EVAP canister purge solenoid valve. Refer to Plastic Collar Quick Connect Fitting Service.
3. Connect the EVAP canister purge line quick connect fitting to the intake manifold. Refer to Plastic Collar Quick Connect Fitting Service.
4. Install the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.

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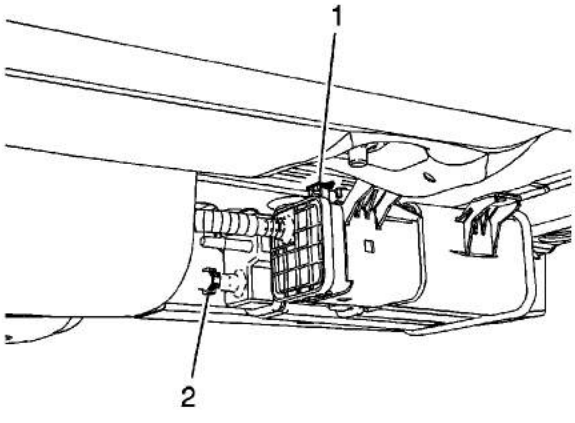
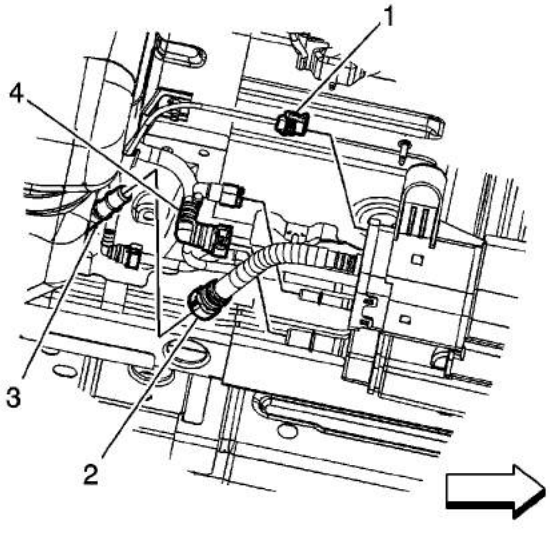
Evaporative Emission Canister Replacement

Removal Procedure

Warning: Ensure that the vehicle is properly supported and squarely positioned. To help avoid personal injury when a vehicle is on a hoist, provide additional support for the vehicle on the opposite end from which the components are being removed.



1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Disconnect the fuel tank wiring harness electrical connector (1) from the evaporative emission (EVAP) canister vent solenoid valve.



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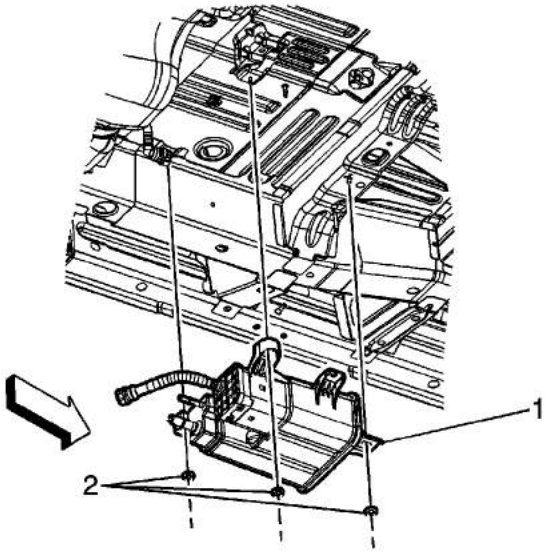
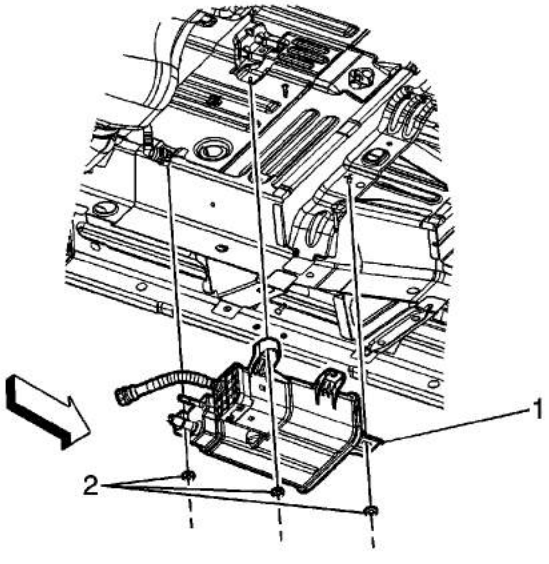
3. Disconnect the fuel tank vapor line quick connect fitting (4) from the EVAP canister. Refer to Plastic Collar Quick Connect Fitting Service.
4. Disconnect the chassis EVAP line quick connect fitting (1) from the EVAP canister. Refer to Plastic Collar Quick Connect Fitting Service.
5. Disconnect the EVAP canister line quick connect fitting (2) from the fuel tank fresh air line (3). Refer to Plastic Collar Quick Connect Fitting Service.



6. Remove the EVAP canisters nuts.
7. Remove the canister from the vehicle underbody.

Installation Procedure



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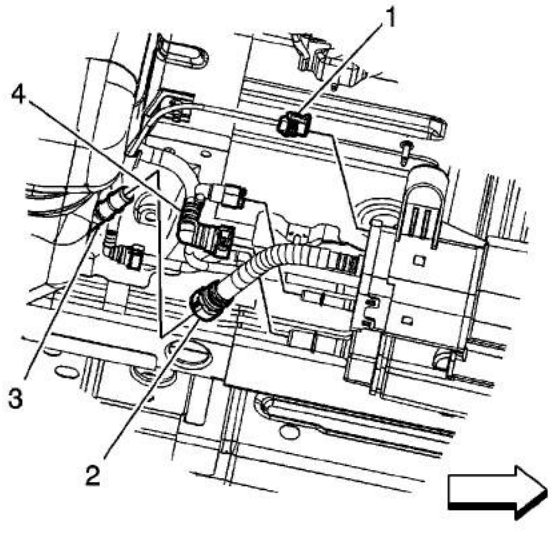
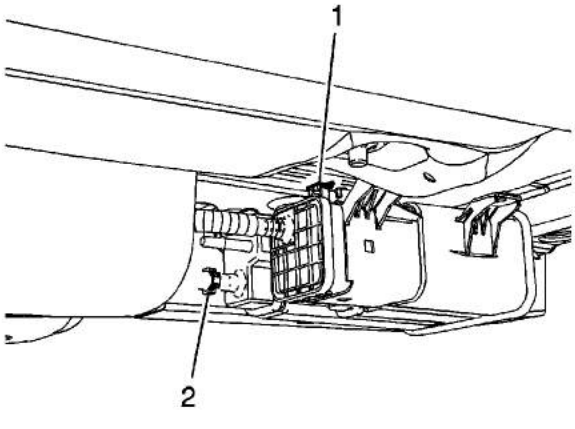
1. Position the EVAP canister to the underbody studs.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the EVAP canister nuts. Tighten the nuts to **8 N·m (71 lb in).**



3. Connect the EVAP canister line quick connect fitting (2) to the fuel tank fresh air line (3). Refer to Plastic Collar Quick Connect Fitting Service.
4. Connect the fuel tank vapor line quick connect fitting (4) to the EVAP canister. Refer to Plastic Collar Quick Connect Fitting Service.
5. Connect the chassis EVAP line quick connect fitting (1) to the EVAP canister. Refer to Plastic Collar Quick Connect Fitting Service.



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7. Lower the vehicle.

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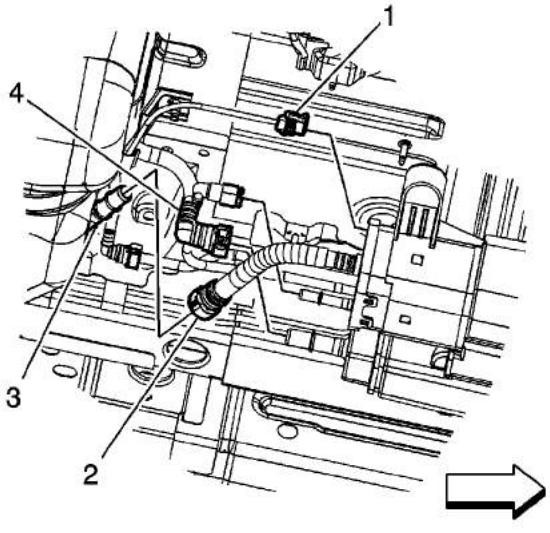
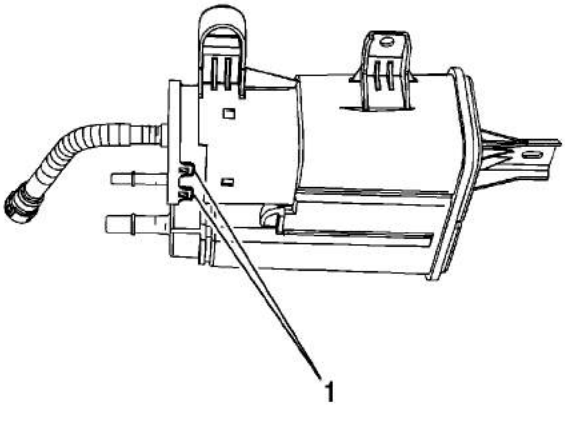
Evaporative Emission Canister Filter Replacement

Removal Procedure



1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Disconnect the evaporative emission (EVAP) canister line quick connect fitting (2) from the fuel tank fresh air line (3). Refer to Plastic Collar Quick Connect Fitting Service.



3. Clean away any debris that may be present around the EVAP canister filter cover.
4. Using a small flat bladed tool, carefully release the EVAP canister filter cover lower retaining

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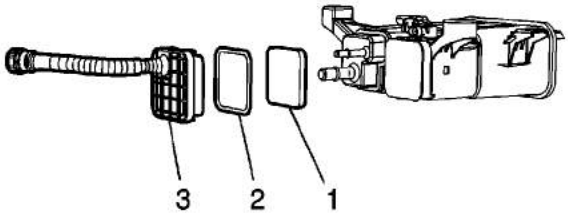
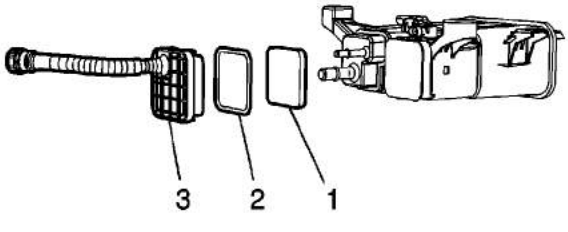


6. Remove the EVAP canister filter cover (3) from the EVAP canister.
7. Remove and discard the EVAP canister filter (1).
8. Remove and discard the filter cover seal (2).
9. Clean the inside of the EVAP canister filter housing with a clean shop towel.

Installation Procedure



1. Install a NEW filter cover seal (2) to the filter cover.
2. Install a NEW EVAP canister filter (1) to the EVAP canister.
3. Install the EVAP canister filter cover (3) to the EVAP canister.

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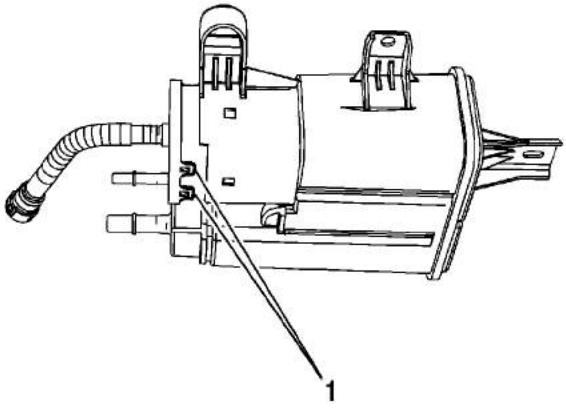
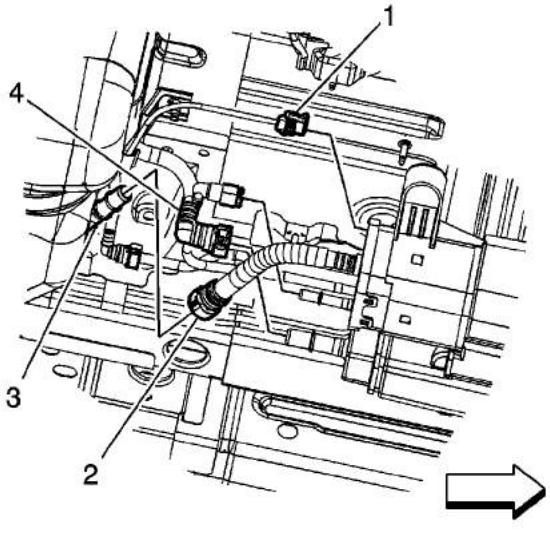


4. Ensure that the EVAP canister filter cover upper and lower retaining tabs (1) are fully engaged with the EVAP canister tabs.



5. Connect the EVAP canister line quick connect fitting (2) to the fuel tank fresh air line (3). Refer to Plastic Collar Quick Connect Fitting Service.
6. Lower the vehicle.

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Evaporative Emission System Cleaning

Tools Required

J 41413-200 Evaporative Emission System Tested

Inspection Procedure

Notice: Use the EVAP Pressure/Purge Diagnostic Station J 41413 in order to provide a clean, dry, low pressure gas source. Do not substitute any other pressurized gas source. Damage may result to the EVAP system.

> **Important:** 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 J 41413-200 .
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.

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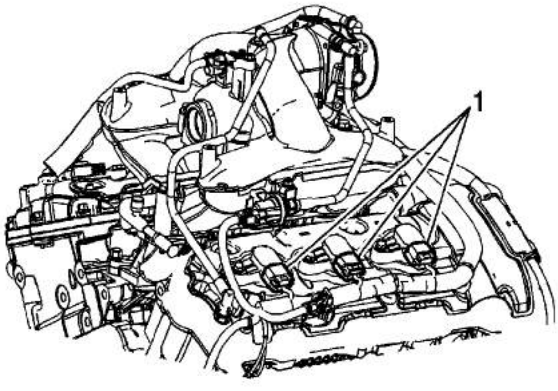
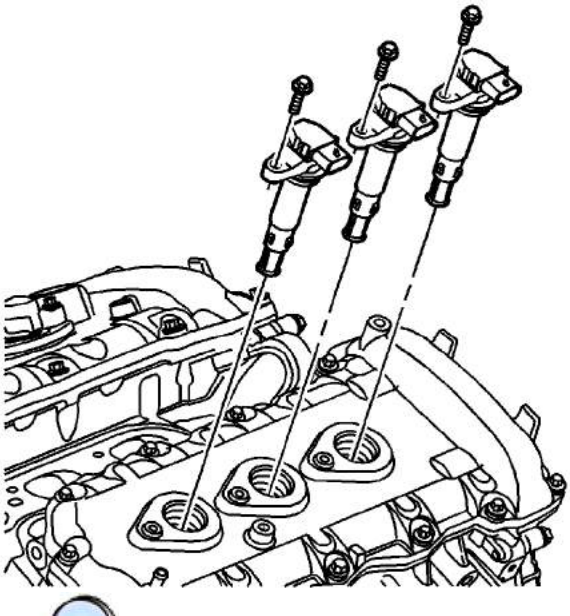
Ignition Coil Replacement - Bank 1

Removal Procedure



1. Remove the injector sight shield. Refer to Fuel Injector Sight Shield Replacement.
2. Disconnect the engine wiring harness electrical connectors (1) from the ignition coils.



3. Remove the ignition coil bolts.
4. Remove the ignition coils.

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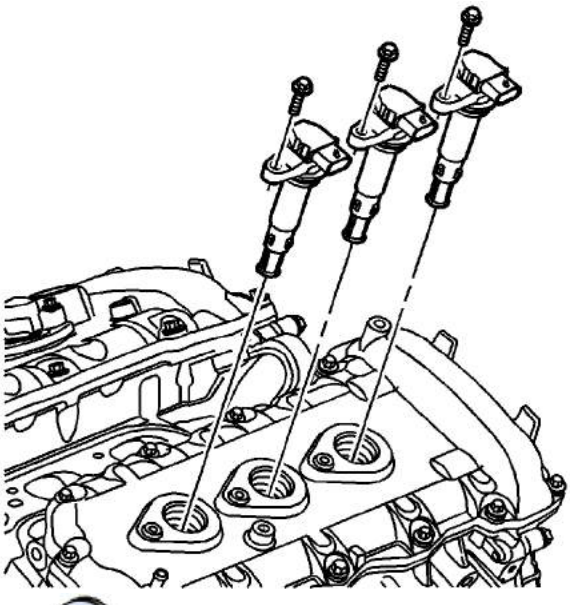
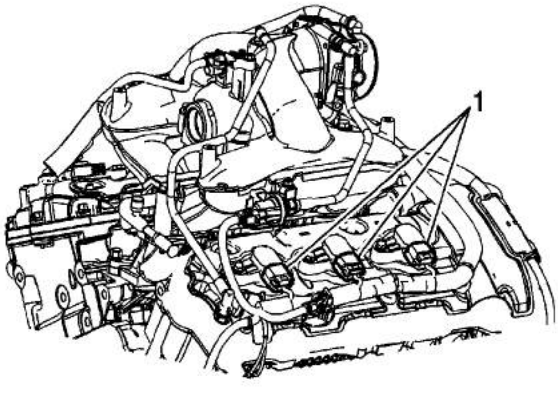


1. Install the ignition coils.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the ignition coil bolts. Tighten the bolts to **10 N·m (89 lb in).**



3. Connect the engine wiring harness electrical connectors (1) to the ignition coils.
4. Install the injector sight shield. Refer to Fuel Injector Sight Shield Replacement.

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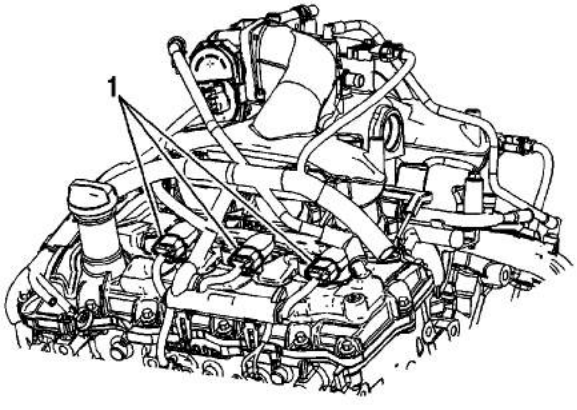
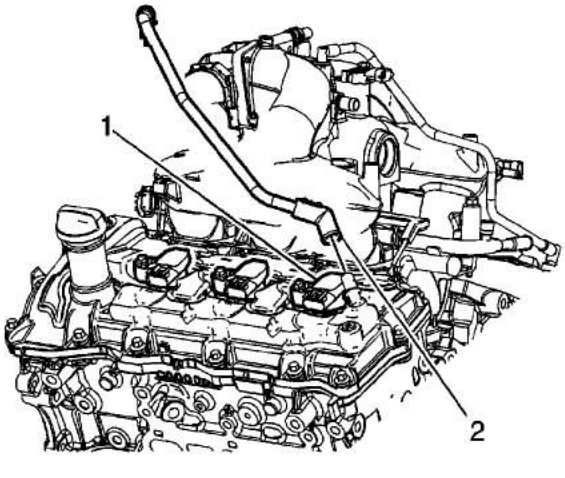
Ignition Coil Replacement - Bank 2

Removal Procedure



1. Remove the air fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.
2. Disconnect the engine wiring harness electrical connectors (1) from the ignition coils.



3. If removing the #6 ignition coil (1), disconnect the positive crankcase ventilation (PCV) fresh air line (2) from the camshaft cover.

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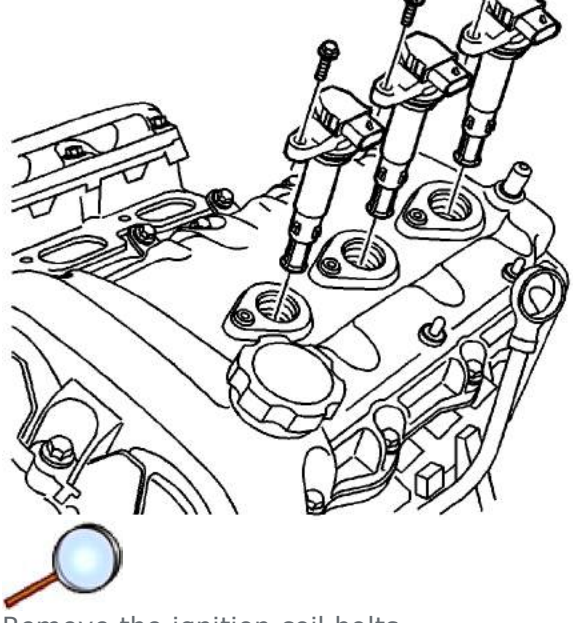
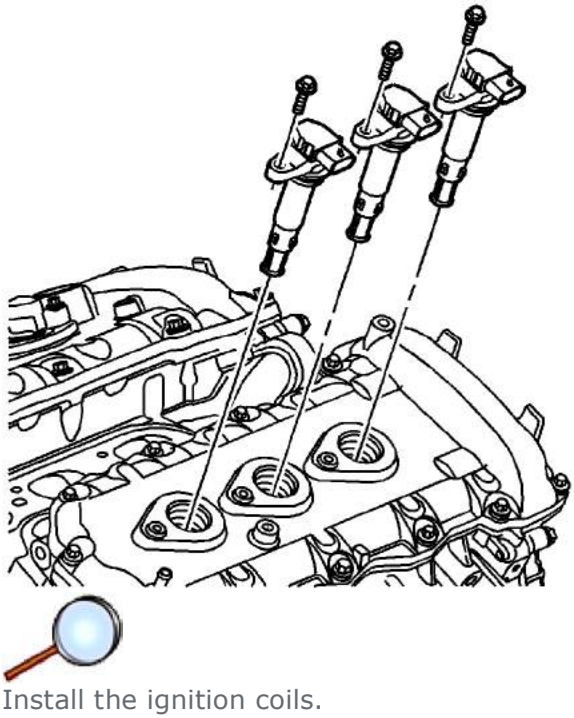


4. Remove the ignition coil bolts.
5. Remove the ignition coils.

Installation Procedure



1. Install the ignition coils.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the ignition coil bolts. Tighten the bolts to **10 N·m (89 lb in).**

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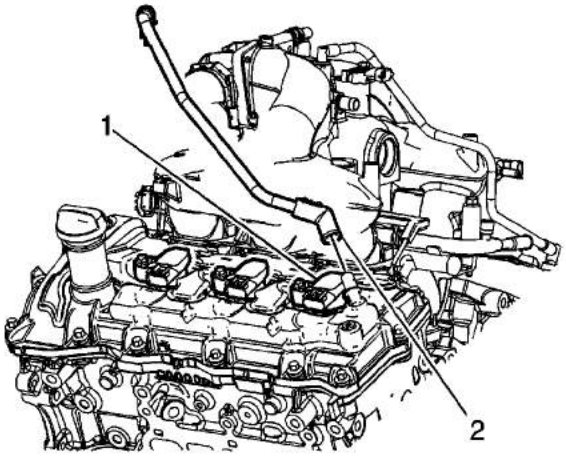
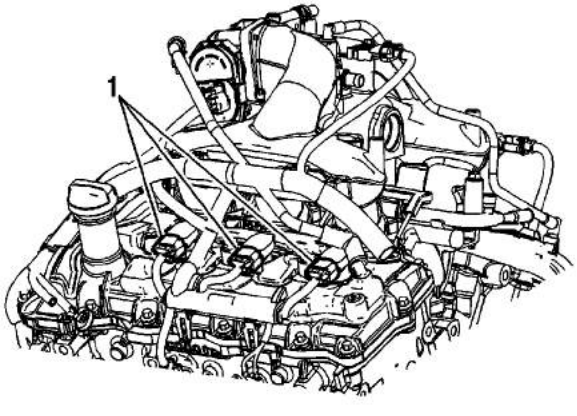


3. If the #6 ignition coil (1) was removed, connect the PCV fresh air line (2) to the camshaft cover.



4. Connect the engine wiring harness electrical connectors (1) to the ignition coils.
5. Install the air fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.

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Spark Plug Inspection

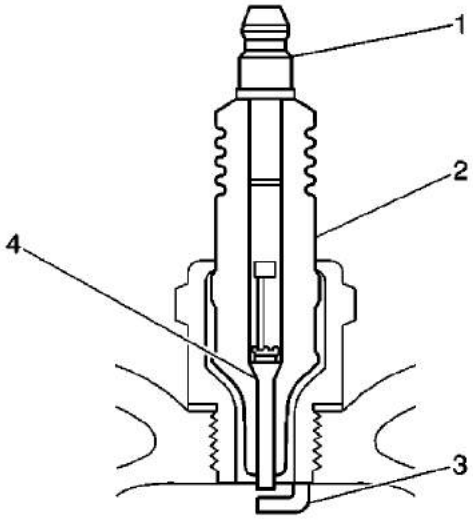
Spark Plug Usage

- ı Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to Ignition System Specifications for the correct spark plug.
- ı Ensure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:

- Spark plug fouling--Colder plug
- Pre-ignition causing spark plug and/or engine damage--Hotter plug

Spark Plug Inspection

-



ı Inspect the terminal post (1) for damage.

- Inspect for a bent or broken terminal post (1).
- Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.

-

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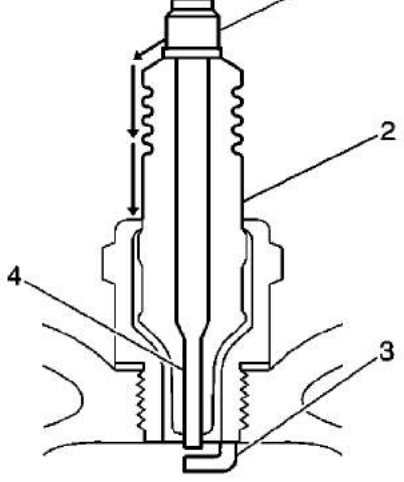
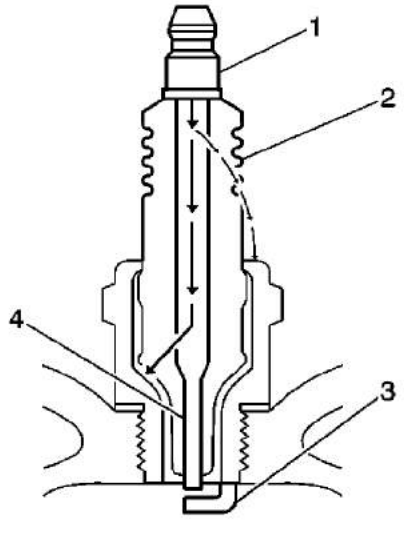


l Inspect the insulator (2) for flashover or carbon tracking, soot. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:

- Inspect the spark plug boot for damage.
- Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant, or water. A spark plug boot that is saturated causes arcing to ground.



l Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).

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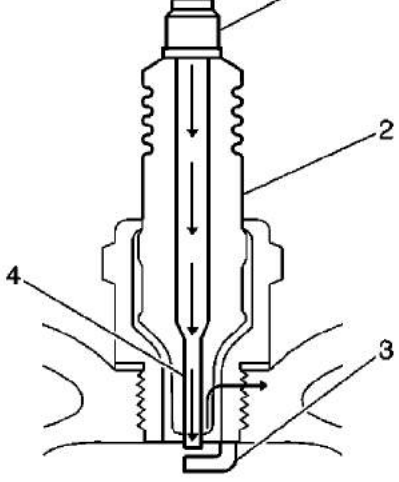

- Inspect for evidence of improper arcing.

- Measure the gap between the center electrode (4) and the side electrode (3) terminals. Refer to Ignition System Specifications . An excessively wide electrode gap can prevent correct spark plug operation.
- Inspect for the correct spark plug torque. 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.
- Carbon fouled--Dry, fluffy, black carbon or soot caused by the following conditions:
- Rich fuel mixtures
- Leaking fuel injectors

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- Restricted air filter element
- Incorrect combustion
- Reduced ignition system voltage output
- Weak coils
- Worn ignition wires
- Incorrect spark plug gap
- Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
- Deposit fouling--Oil, coolant, or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

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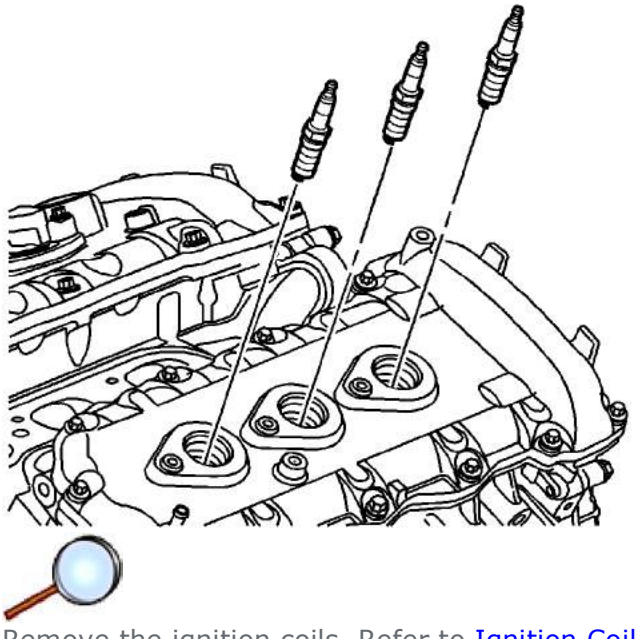
Spark Plug Replacement

Removal Procedure



1. Remove the ignition coils. Refer to Ignition Coil Replacement - Bank 1 and/or Ignition Coil Replacement - Bank 2.

   Warning: Refer to Safety Glasses and Compressed Air Warning in the Preface section.

   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.

2. Use compressed air in order to remove debris from the spark plug cavity.

   Caution: Allow the engine to cool before removing the spark plugs. Attempting to remove the spark plugs from a hot engine may cause the plug threads to seize, causing damage to cylinder head threads.

3. Remove the spark plug.

Installation Procedure

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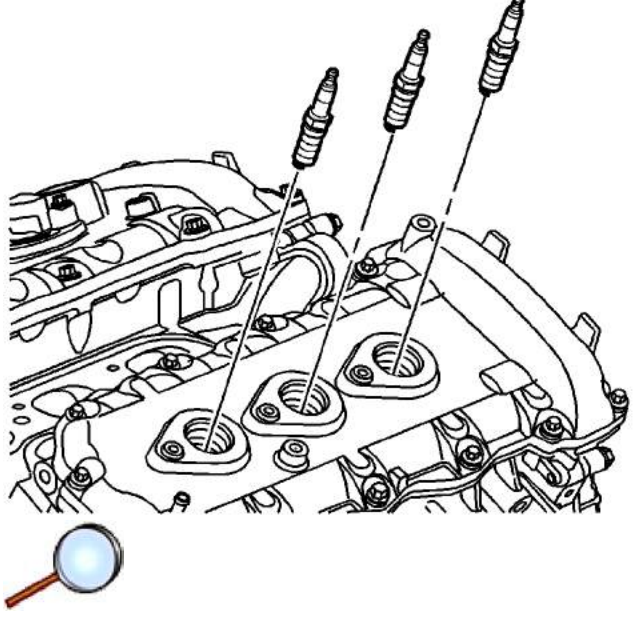

Caution: Use only the spark plugs specified for use in the vehicle. Do not install spark plugs that are either hotter or colder than those specified for the vehicle. Installing spark plugs of another type can severely damage the engine.

Caution: Check the gap of all new and reconditioned spark plugs before installation. The pre-set gaps may have changed during handling. Use a round feeler gage to ensure an accurate check. Installing the spark plugs with the wrong gap can cause poor engine performance and may even damage the engine.

1. Ensure that the spark plug gap is equivalent to the spark plug gap specification. Refer to Ignition System Specifications.

   Caution: Refer to Fastener Caution in the Preface section.

   Caution: Be sure that the spark plug threads smoothly into the cylinder head and the spark plug is fully seated. Use a thread chaser, if necessary, to clean threads in the cylinder head. Cross-threading or failing to fully seat the spark plug can cause overheating of the plug, exhaust blow-by, or thread damage.

2. Install the spark plug. Tighten the spark plug to **20 N·m (15 lb ft).**
3. Install the ignition coils. Refer to Ignition Coil Replacement - Bank 1 and/or Ignition Coil Replacement - Bank 2.

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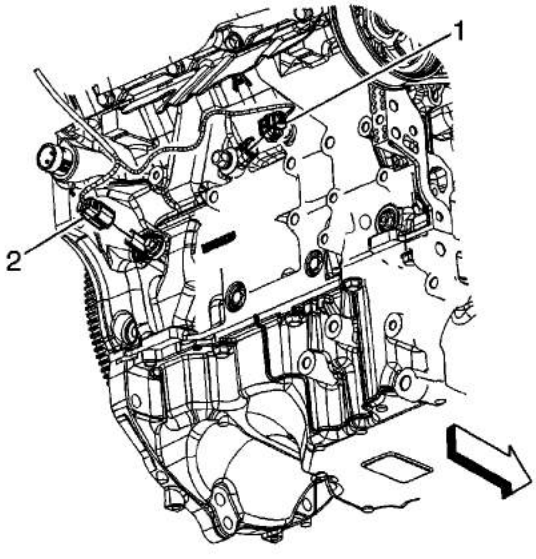
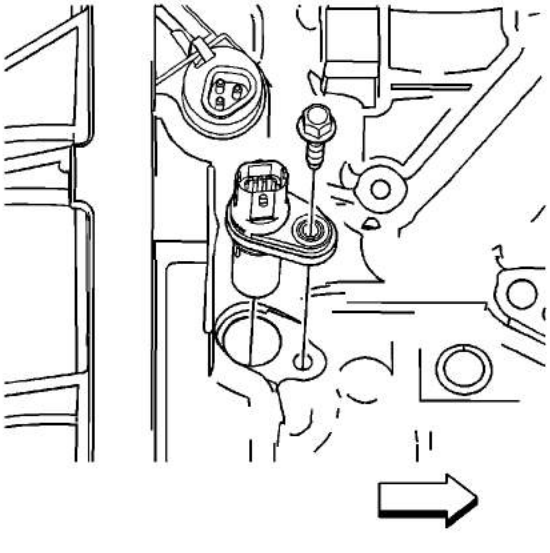
Crankshaft Position Sensor Replacement

Removal Procedure



1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. If equipped with all wheel drive (AWD), remove the transfer case. Refer to Transfer Case Assembly Replacement.
3. Disconnect the engine wiring harness electrical connector (2) from the crankshaft position (CKP) sensor.



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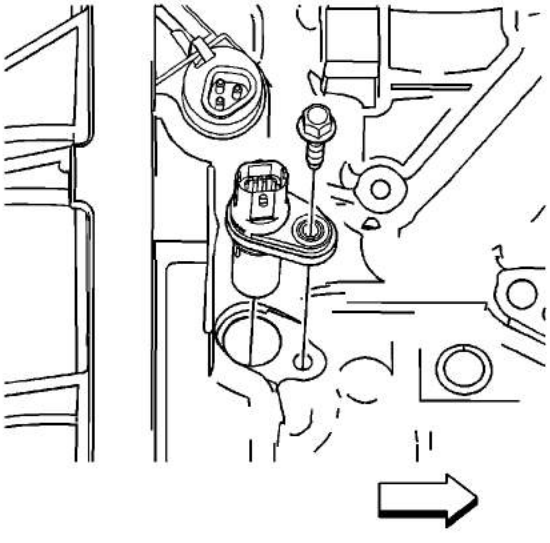
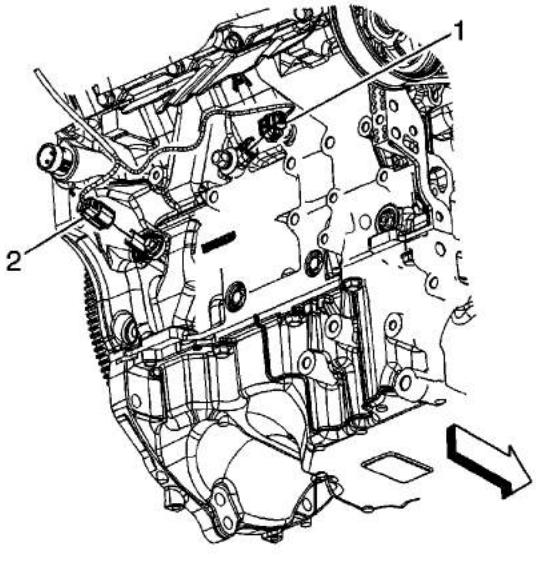
Installation Procedure



1. Install the crankshaft position sensor.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the crankshaft position sensor bolt. Tighten the bolt to **10 N·m (89 lb in).**



3. Connect the engine wiring harness electrical connector to the CKP sensor.

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5. Lower the vehicle.
6. Perform the Crankshaft Position System Variation Learn procedure. Refer to Crankshaft Position System Variation Learn.

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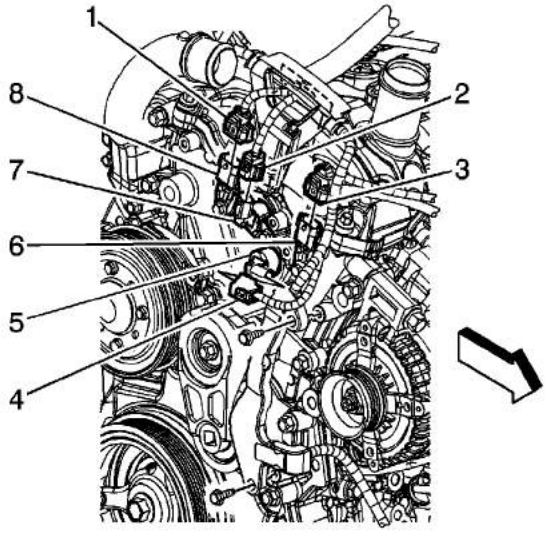
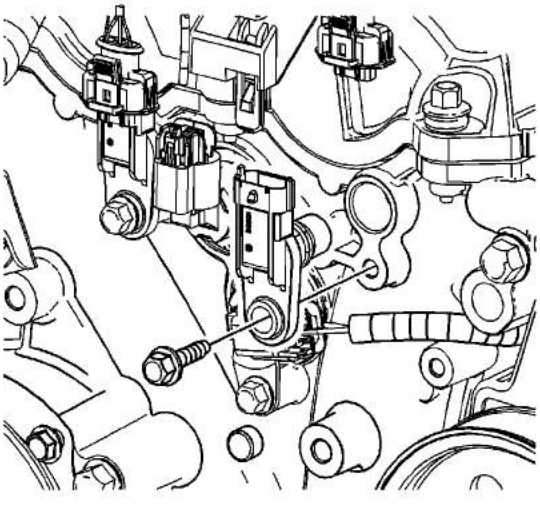
Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust

Removal Procedure



1. Remove the engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side.
2. Disconnect the engine wiring harness electrical connector (3) from the bank 2 exhaust camshaft position (CMP) sensor (6).



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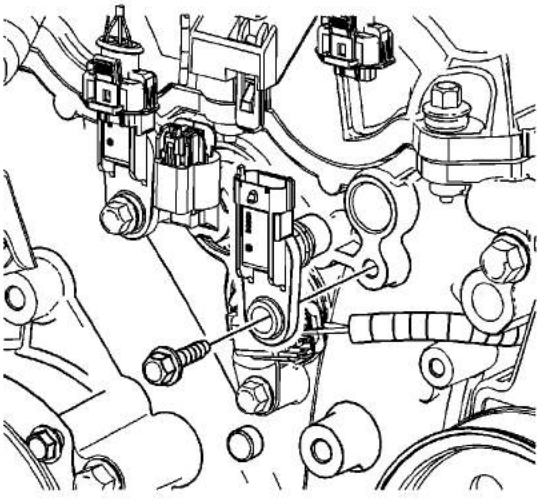
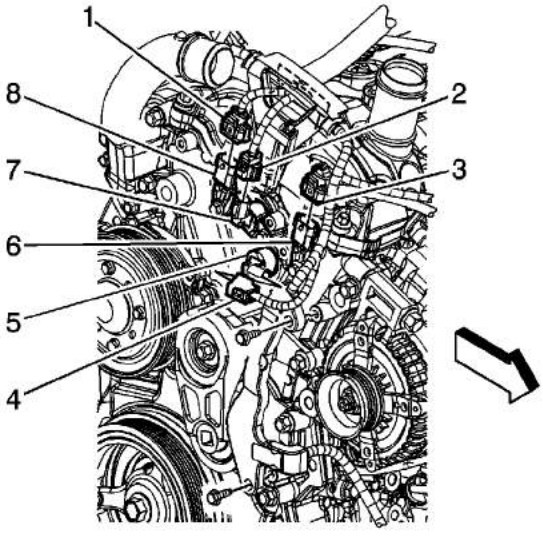
Installation Procedure



1. Install the CMP sensor.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the CMP sensor bolt. Tighten the bolt to **10 N·m (89 lb in).**



3. Connect the engine wiring harness electrical connector (3) to the bank 2 exhaust CMP

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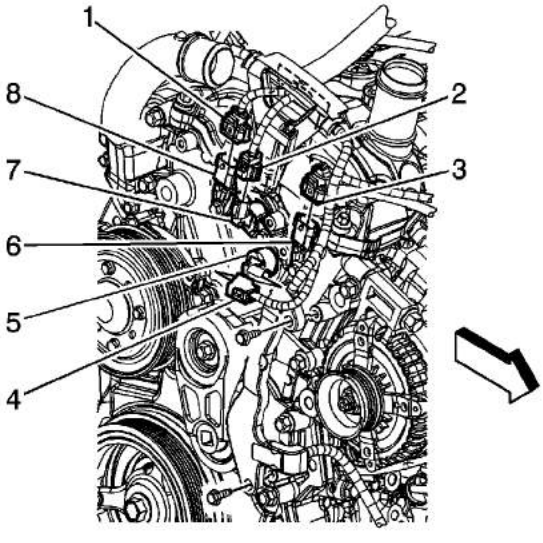
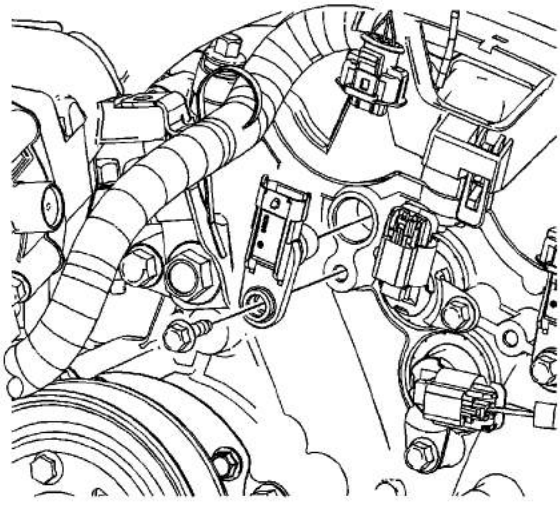
Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake

Removal Procedure



1. Remove the engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side.
2. Disconnect the engine wiring harness electrical connector (1) from the bank 2 intake camshaft position (CMP) sensor (8).



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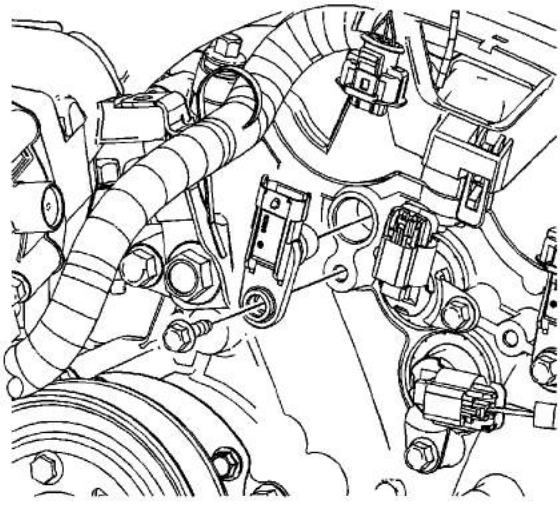
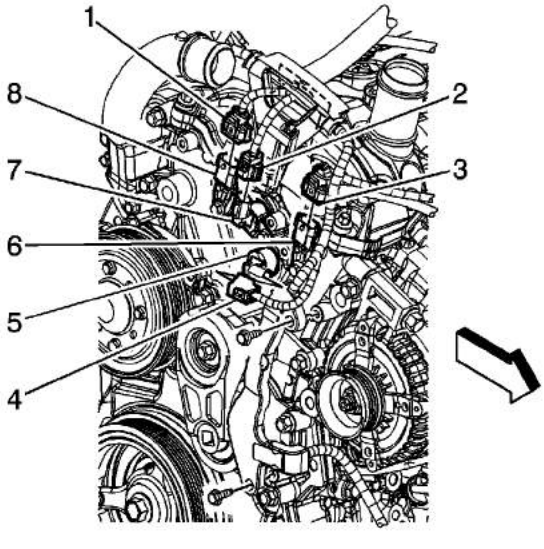
Installation Procedure



1. Install the CMP sensor.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the CMP sensor bolt. Tighten the bolt to **10 N·m (89 lb in).**



3. Connect the engine wiring harness electrical connector (1) to the bank 2 intake CMP

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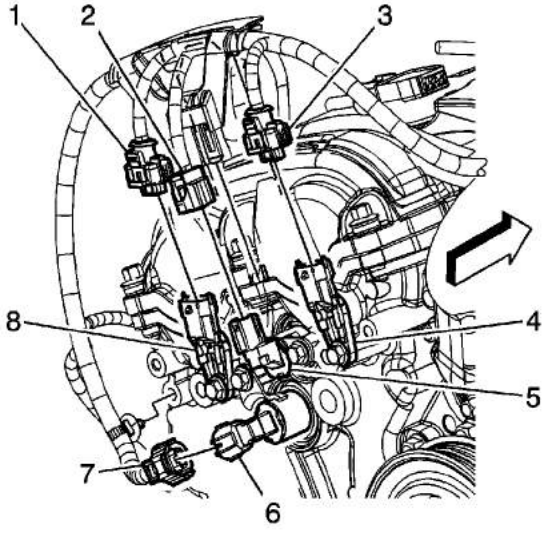
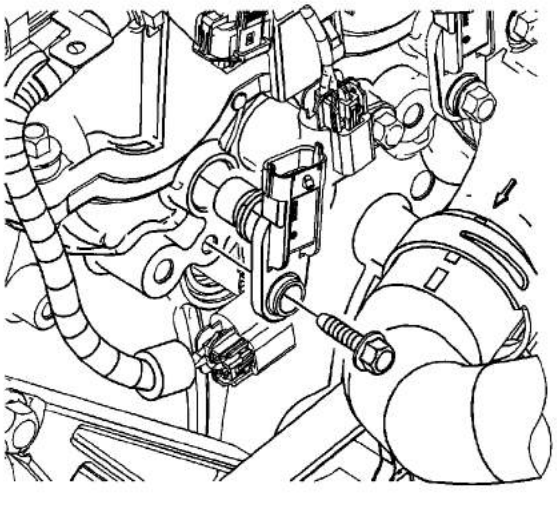
Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust

Removal Procedure



1. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement.
2. Disconnect the engine wiring harness electrical connector (1) from the bank 1 exhaust camshaft position (CMP) sensor (8).



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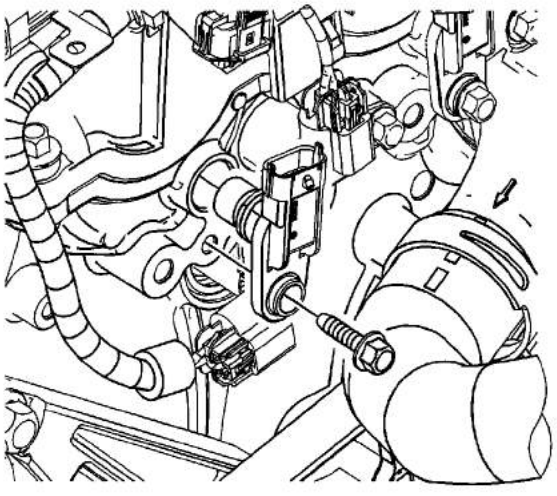
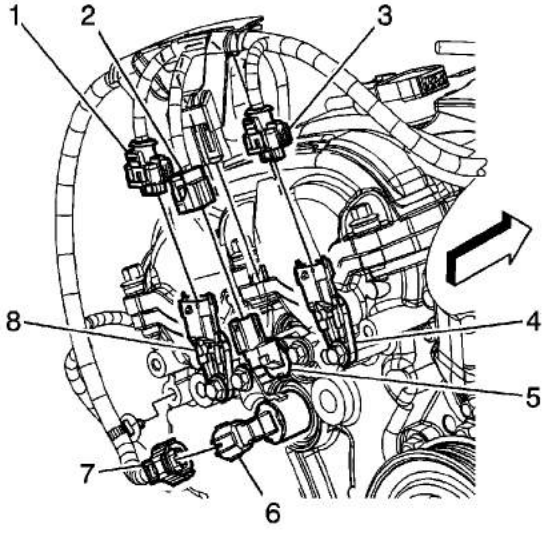
Installation Procedure



1. Install the CMP sensor.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the CMP sensor bolt. Tighten the bolt to **10 N·m (89 lb in).**



3. Connect the engine wiring harness electrical connector (1) to the bank 1 exhaust CMP

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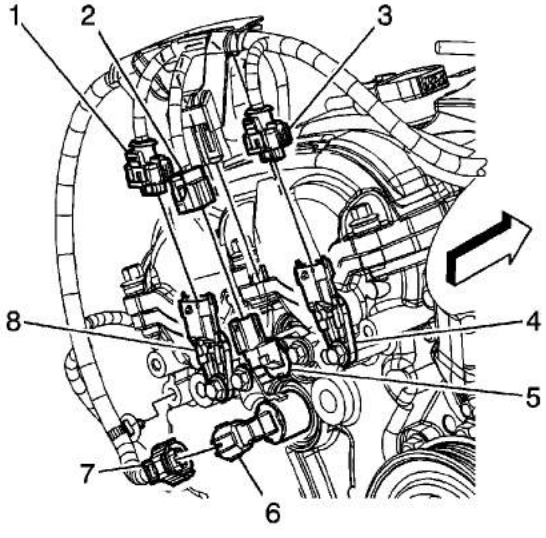
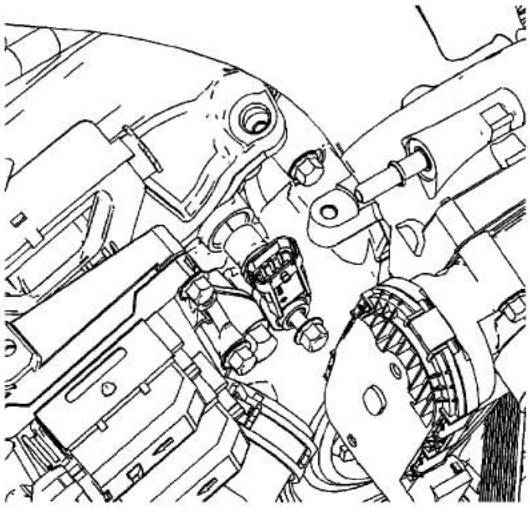
Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake

Removal Procedure



1. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement.
2. Disconnect the engine wiring harness electrical connector (3) from the bank 1 intake camshaft position (CMP) sensor (4).



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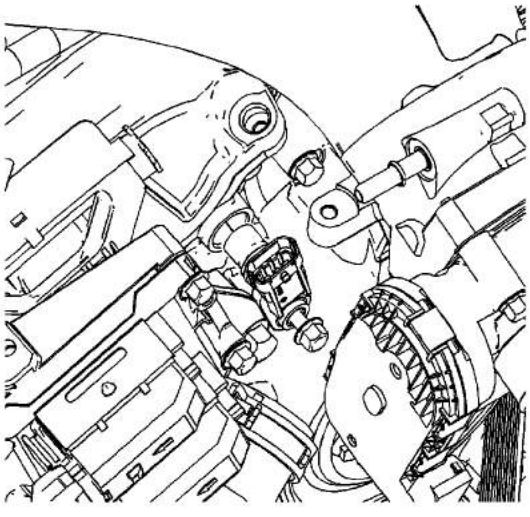
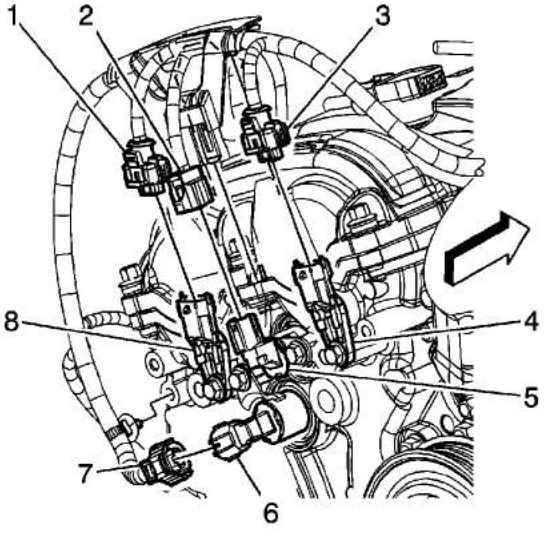
Installation Procedure



1. Install the CMP sensor.

   Caution: Refer to Fastener Caution in the Preface section.

2. Install the CMP sensor bolt. Tighten the bolt to **10 N·m (89 lb in).**



3. Connect the engine wiring harness electrical connector (2) to the bank 1 intake CMP

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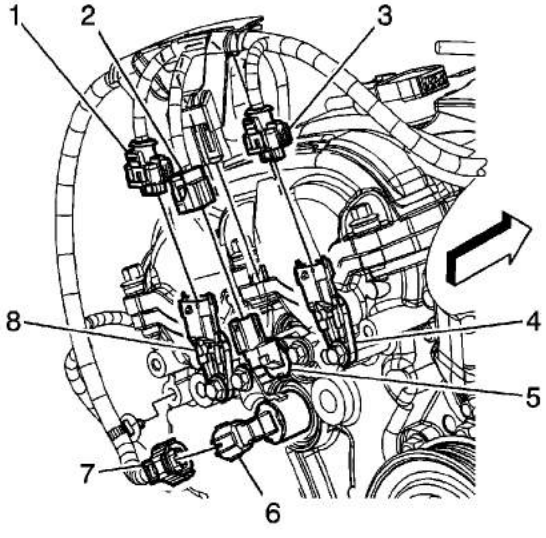
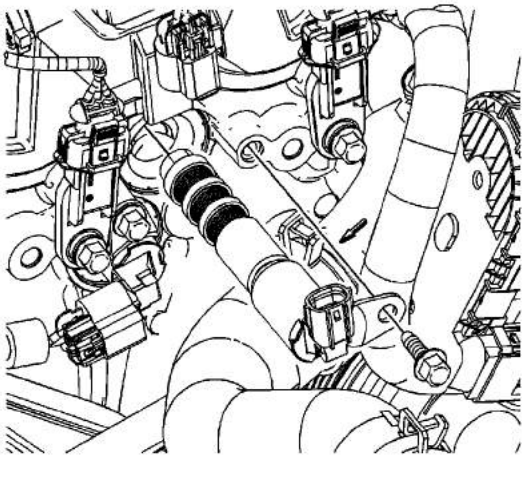
Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake

Removal Procedure



1. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement.
2. Disconnect the engine wiring harness electrical connector (2) from the bank 1 intake camshaft position (CMP) actuator solenoid valve (5).



[redacted]

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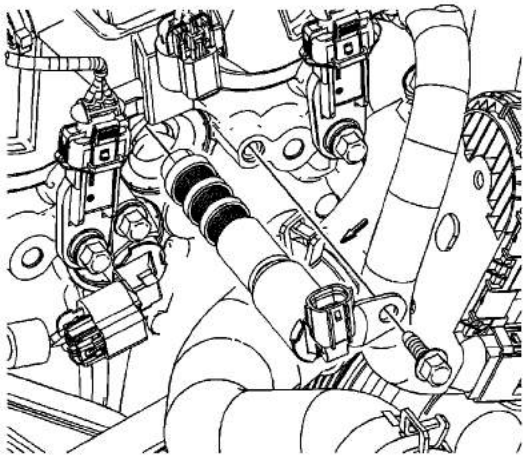
5. Inspect the CMP actuator solenoid valve seal and replace as necessary.

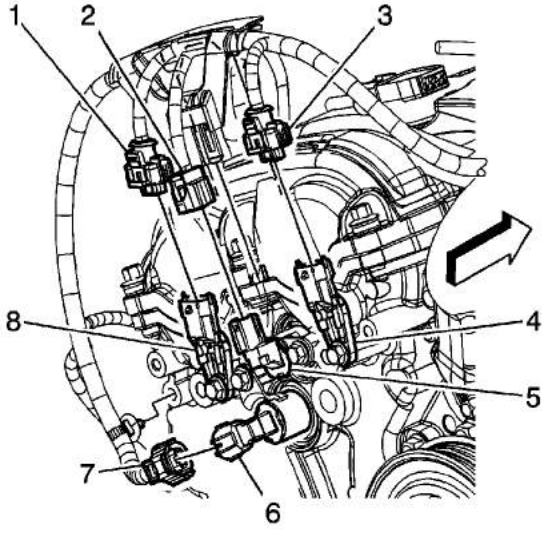
Installation Procedure



1. Inspect the CMP actuator solenoid valve seal for damage. Replace the seal if necessary.
2. Install the CMP actuator solenoid valve.

   Caution: Refer to Fastener Caution in the Preface section.

3. Install the CMP actuator solenoid valve bolt. Tighten the bolt to **10 N·m (89 lb in).**



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4. Connect the engine wiring harness electrical connector (2) to the bank 1 intake CMP actuator solenoid valve (5).
5. Install the air cleaner assembly. Refer to Air Cleaner Assembly Replacement.

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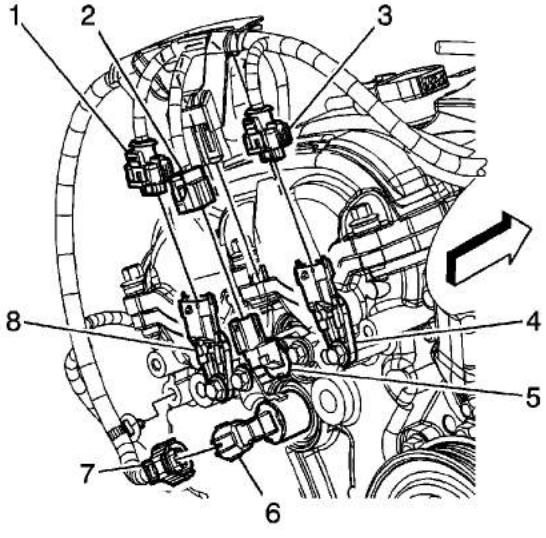
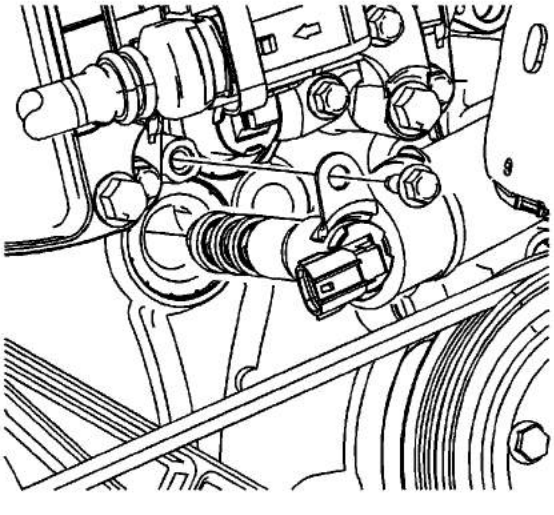
Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust

Removal Procedure



1. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement.
2. Disconnect the engine wiring harness electrical connector (7) from the bank 1 exhaust camshaft position (CMP) actuator solenoid valve (6).



[redacted]

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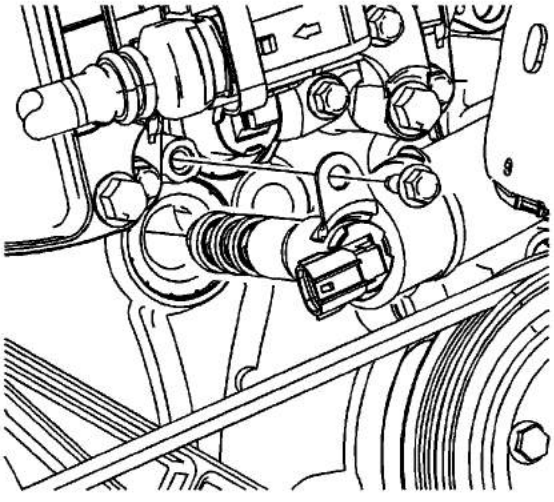
5. Inspect the CMP actuator solenoid valve seal and replace as necessary.

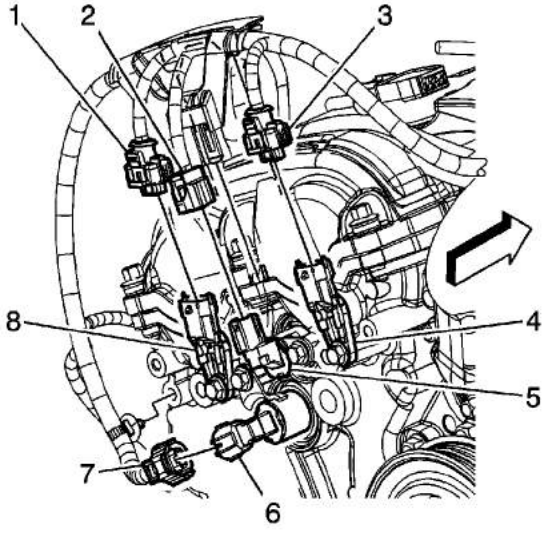
Installation Procedure



1. Inspect the CMP actuator solenoid valve seal for damage. Replace the seal if necessary.
2. Install the CMP actuator solenoid valve.

   Caution: Refer to Fastener Caution in the Preface section.

3. Install the CMP actuator solenoid valve bolt. Tighten the bolt to **10 N·m (89 lb in).**



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4. Connect the engine wiring harness electrical connector (7) to the bank 1 exhaust CMP actuator solenoid valve (6).
5. Install the air cleaner assembly. Refer to Air Cleaner Assembly Replacement.

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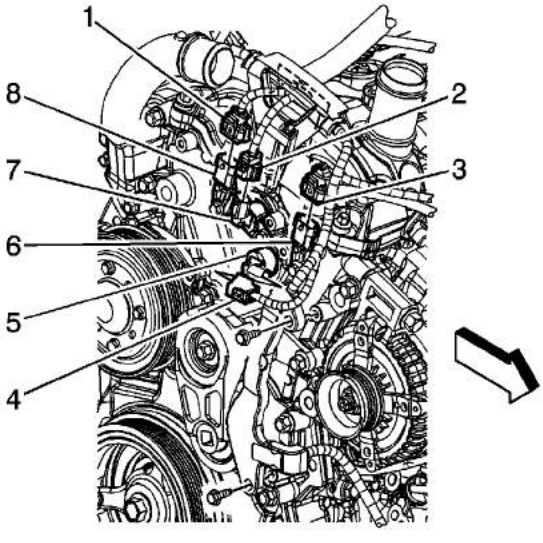
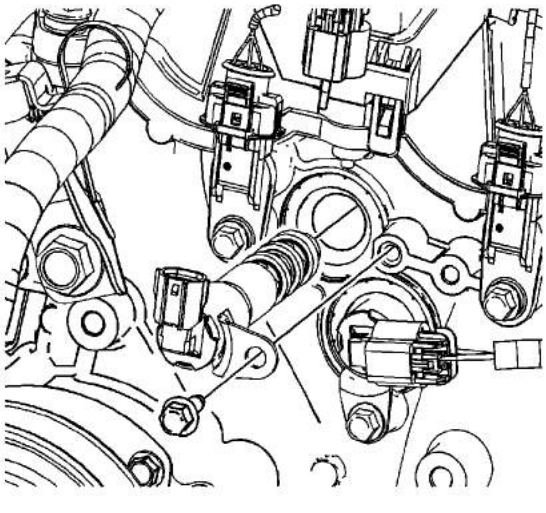
Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake

Removal Procedure



1. Remove the engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side.
2. Disconnect the engine wiring harness electrical connector (2) from the bank 2 intake camshaft position (CMP) actuator solenoid valve (7).



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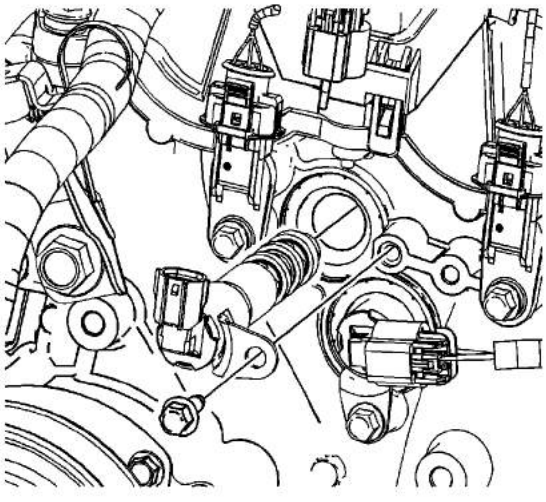
5. Inspect the CMP actuator solenoid valve seal for damage and replace as necessary.

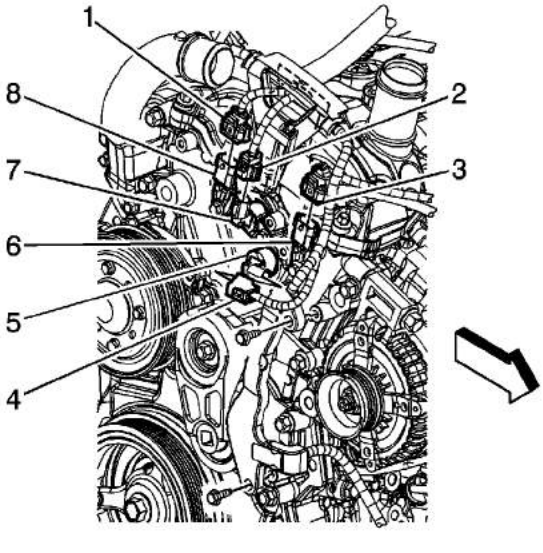
Installation Procedure



1. Inspect the CMP actuator solenoid valve seal for damage. Replace the seal if necessary.
2. Install the CMP actuator solenoid valve.

   Caution: Refer to Fastener Caution in the Preface section.

3. Install the CMP actuator solenoid valve bolt. Tighten the bolt to **10 N·m (89 lb in).**



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4. Connect the engine wiring harness electrical connector (2) to the bank 2 intake CMP actuator solenoid valve (7).
5. Install the engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side.

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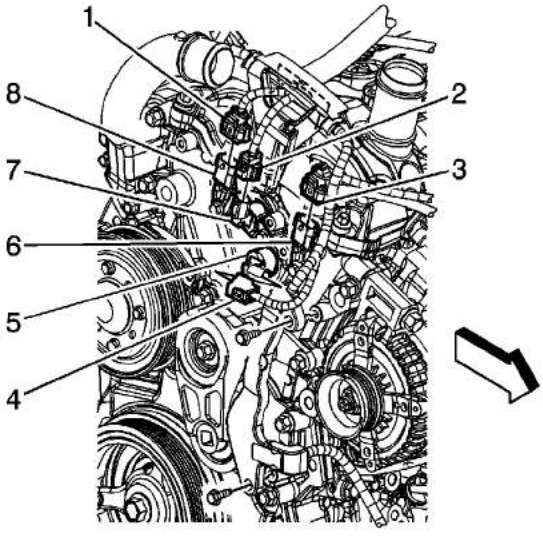
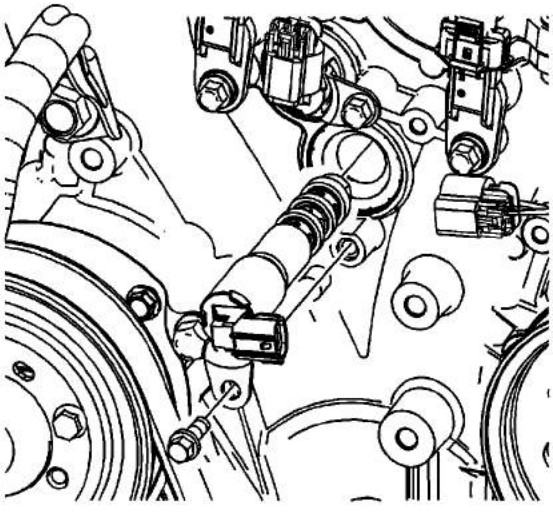
Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust

Removal Procedure



1. Remove the engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side.
2. Disconnect the engine wiring harness electrical connector (4) from the bank 2 exhaust camshaft position (CMP) actuator solenoid valve (5).



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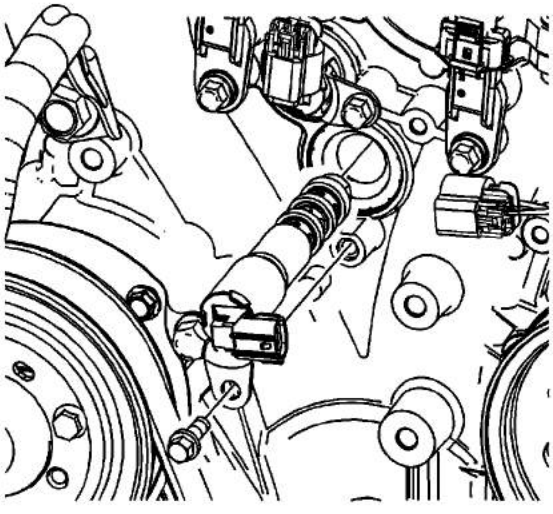
5. Inspect the CMP actuator solenoid valve seal for damage and replace as necessary.

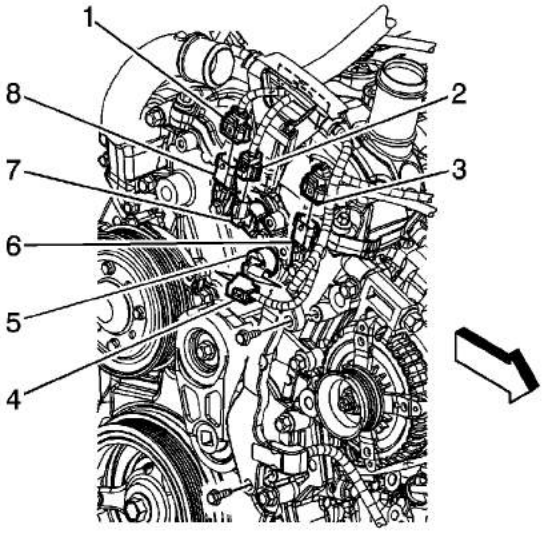
Installation Procedure



1. Inspect the CMP actuator solenoid valve seal for damage. Replace the seal if necessary.
2. Install the CMP actuator solenoid valve.

   Caution: Refer to Fastener Caution in the Preface section.

3. Install the CMP actuator solenoid valve bolt. Tighten the bolt to **10 N·m (89 lb in).**



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4. Connect the engine wiring harness electrical connector (4) to the bank 2 exhaust CMP actuator solenoid valve (5).
5. Install the engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side.

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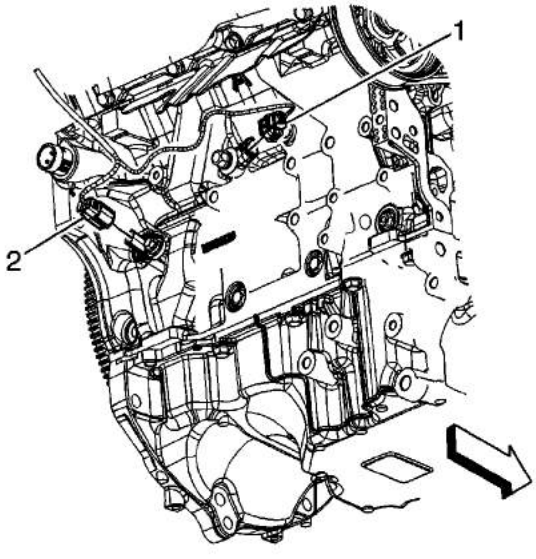
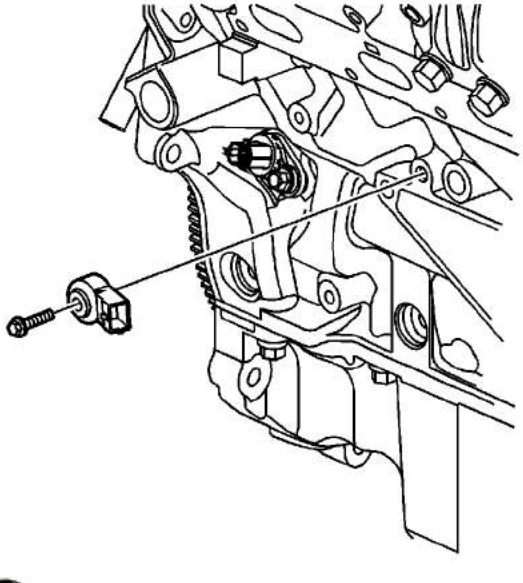
Knock Sensor Replacement - Bank 1

Removal Procedure



1. Remove the right catalytic converter. Refer to Catalytic Converter Replacement - Right Side.
2. Remove the exhaust manifold heat shield. Refer to Exhaust Manifold Heat Shield Replacement.
3. Disconnect the engine wiring harness electrical connector (1) from the bank 1 knock sensor.



4. Loosen the knock sensor bolt and remove the knock sensor.

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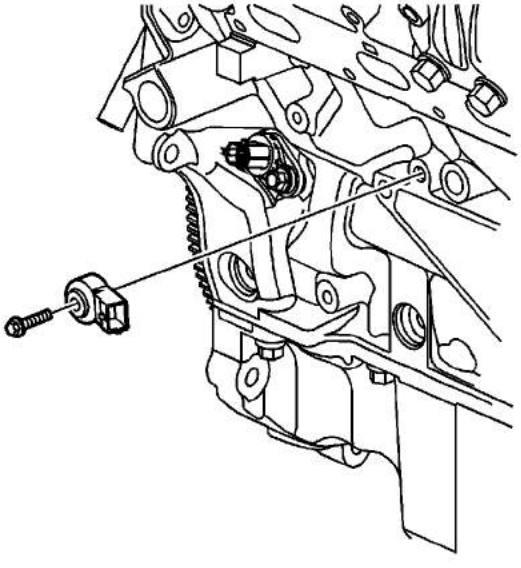
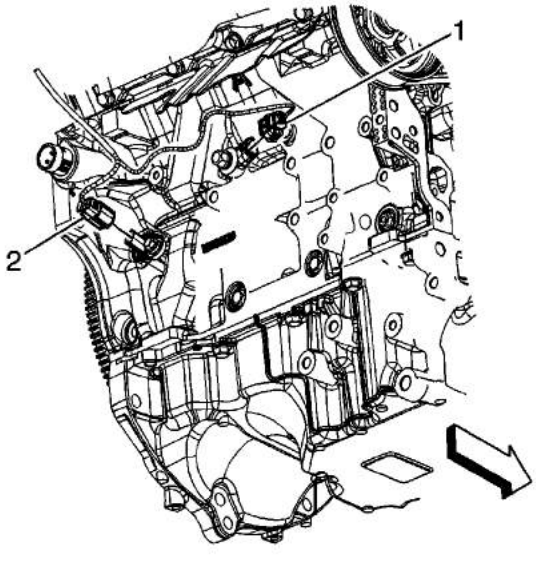
Caution: Refer to Fastener Caution in the Preface section.



1. Position the knock sensor and tighten the knock sensor bolt.

Tighten
Tighten the bolt to 23 N·m (17 lb ft).



2. Connect the engine wiring harness electrical connector (1) to the bank 1 knock sensor.

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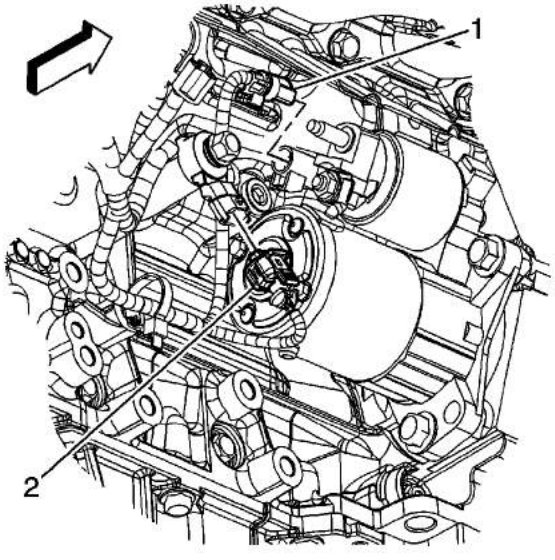
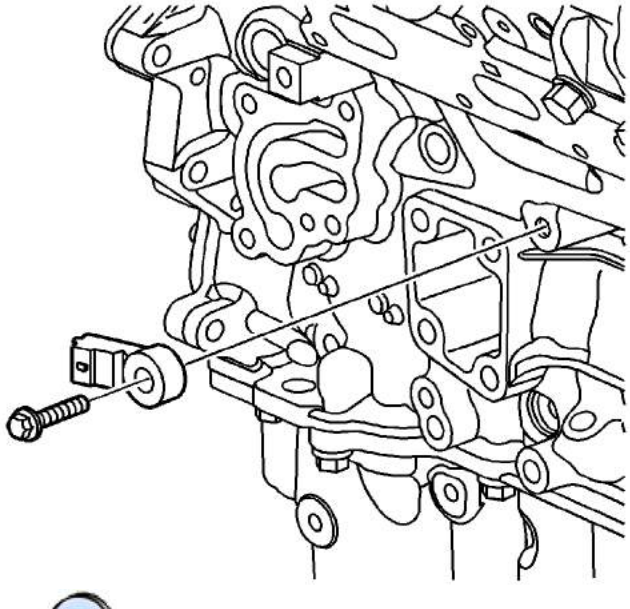
Knock Sensor Replacement - Bank 2

Removal Procedure



1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Disconnect the engine wiring harness electrical connector (2) from the bank 2 knock sensor.



3. Loosen the knock sensor bolt and remove the knock sensor.

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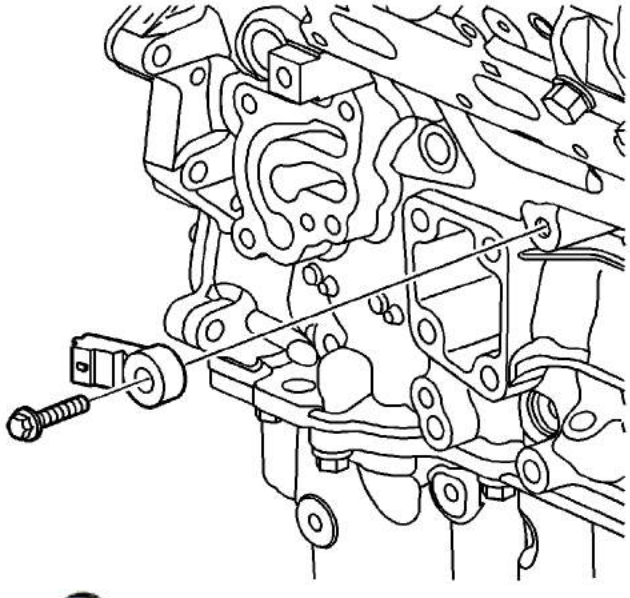
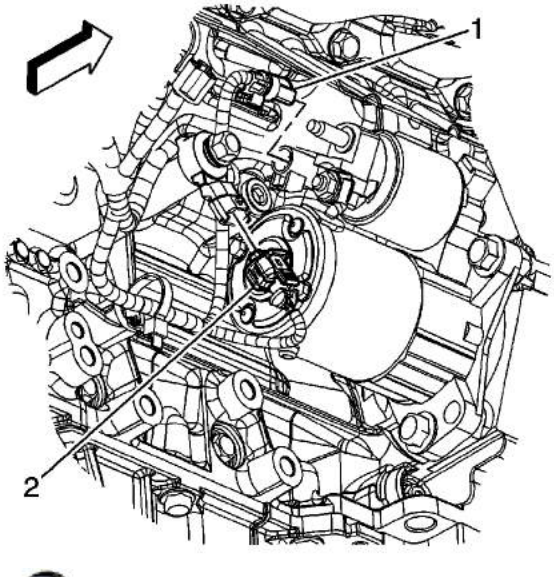
Caution: Refer to Fastener Caution in the Preface section.



1. Position the knock sensor and tighten the knock sensor bolt. Tighten the bolt to **23 N·m (17 lb ft).**



2. Connect the engine wiring harness electrical connector (2) to the bank 2 knock sensor.
3. Lower the vehicle.

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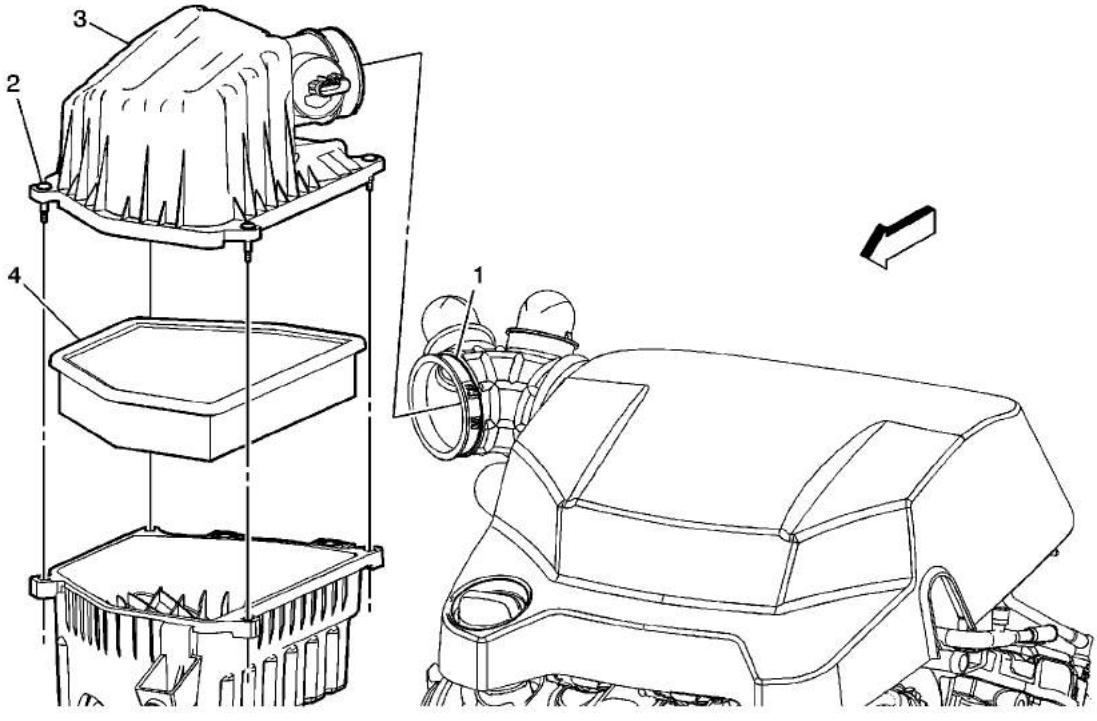
Air Cleaner Element Replacement



Callout	Component Name
1	Air Cleaner Outlet Duct Clamp **Caution:** Refer to Fastener Caution in the Preface section. **Tighten** 3 N·m (27 lb in)
2	Air Cleaner Assembly Upper Housing Screw (Qty: 4) **Tighten** 3 N·m (27 lb in)
3	Air Cleaner Assembly Upper Housing **Procedure** Disconnect the MAF/IAT Sensor Electrical Connector.
4	Air Cleaner Element

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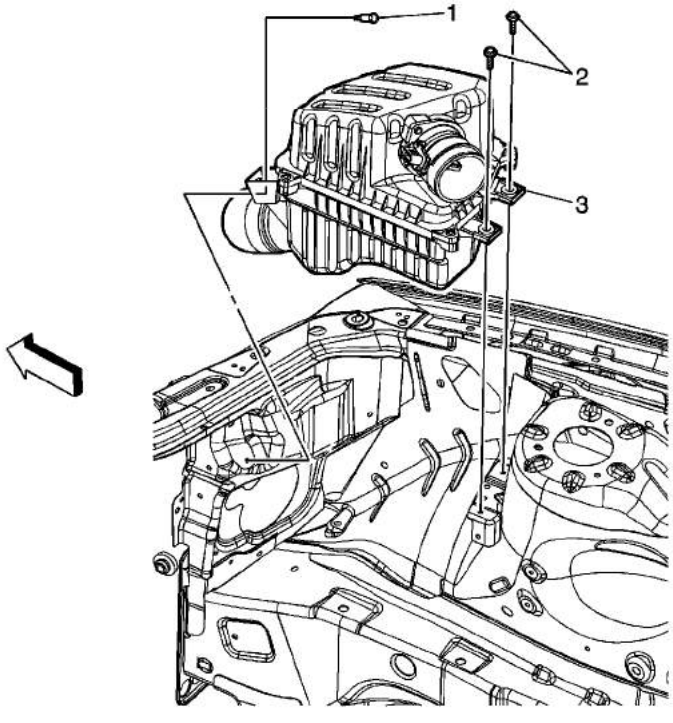
Air Cleaner Assembly Replacement



Callout	Component Name
Preliminary Procedure Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.	
1	Air Cleaner Assembly Bolt (Qty: 1) **Caution:** Refer to Fastener Caution in the Preface section. **Tighten** 8 N·m (71 lb in)
2	Air Cleaner Assembly Bolt (Qty: 2) **Tighten** 6 N·m (53 lb in)
3	Air Cleaner Assembly **Procedure** 1. Disconnect any electrical connectors as needed.

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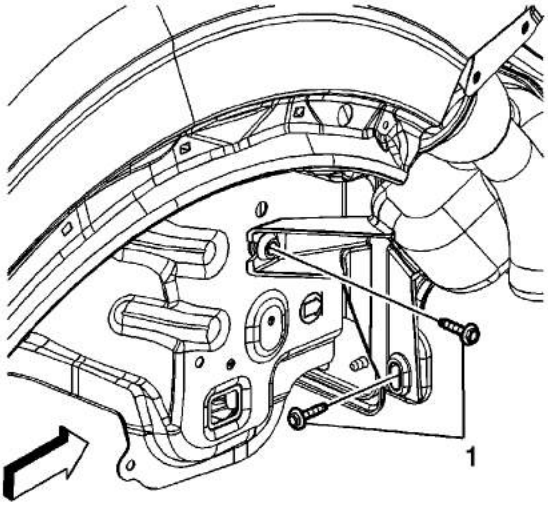
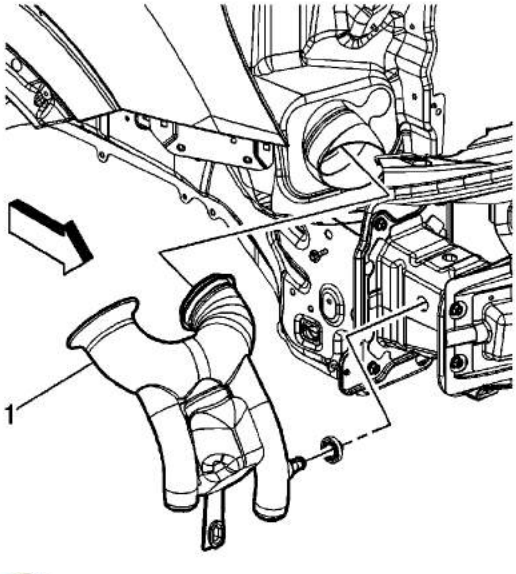
Air Cleaner Inlet Duct Replacement

Removal Procedure

1. Remove the front bumper fascia. Refer to Front Bumper Fascia Replacement.



2. Remove the air cleaner inlet duct bolts (1).



3. Pull on and dislocate the air cleaner inlet duct (1) from the air cleaner assembly and vehicle body grommet.

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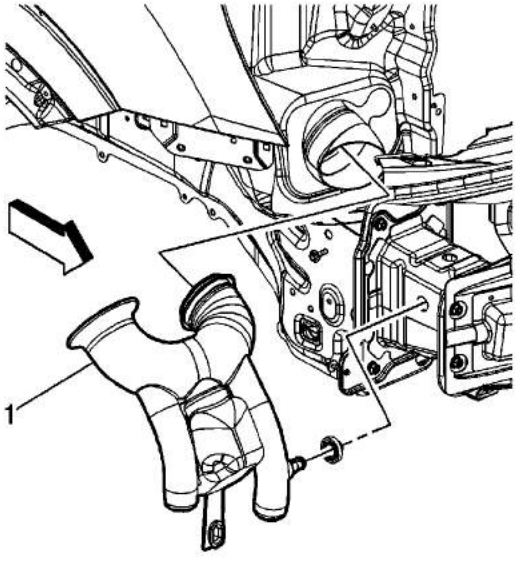
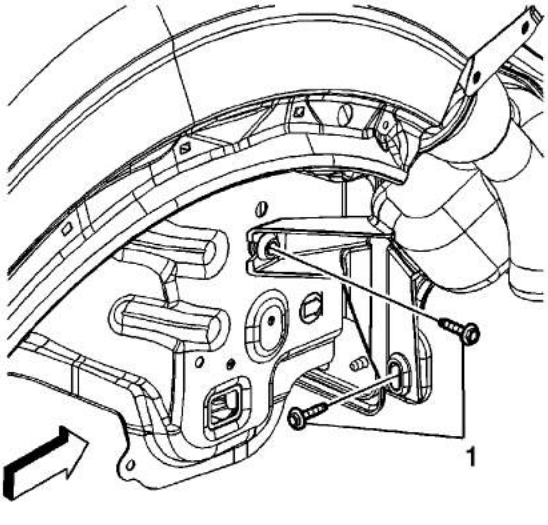


1. Position the air cleaner inlet duct (1) in the vehicle body grommet and air cleaner assembly.

   Caution: Refer to Fastener Caution in the Preface section.



2. Install the air cleaner inlet duct bolts (1).

   Tighten
   Tighten the bolts to 6 N·m (53 lb in).

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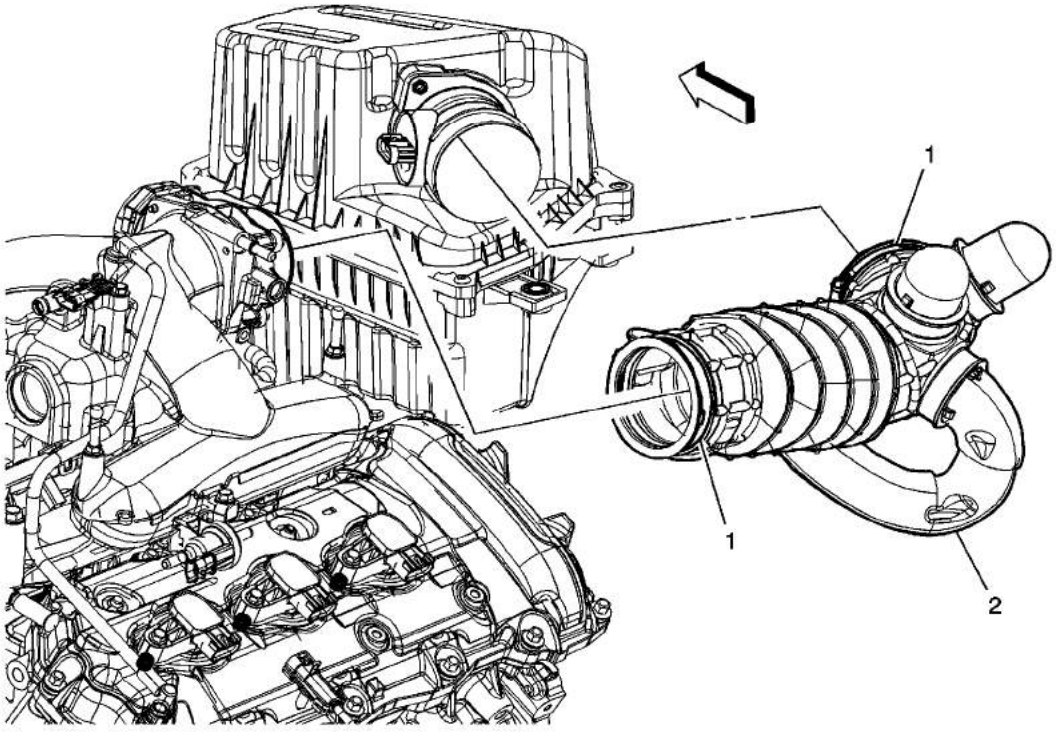
Air Cleaner Outlet Duct Replacement



Callout	Component Name
Preliminary Procedure Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.	
1	Air Cleaner Outlet Duct Clamp (Qty: 2) **Caution:** Refer to Fastener Caution in the Preface section. **Tighten** 3 N·m (27 lb in)
2	Air Cleaner Outlet Duct

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