

Battery Description and Operation

Warning: Batteries produce explosive gases, contain corrosive acid, and supply levels of electrical current high enough to cause burns. Therefore, to reduce the risk of personal injury when working near a battery:

- Always shield your eyes and avoid leaning over the battery whenever possible.
- Do not expose the battery to open flames or sparks.
- Do not allow the battery electrolyte to contact the eyes or the skin. Flush immediately and thoroughly any contacted areas with water and get medical help.
- Follow each step of the jump starting procedure in order.
- Treat both the booster and the discharged batteries carefully when using the jumper cables.

Note: Because of the materials used in the manufacture of automotive lead acid batteries, dealers and service shops that handle them are subject to various regulations issued by OSHA, EPA, DOT, and various state or local agencies. Other regulations may also apply in other locations. Always know and follow these regulations when handling batteries.

Batteries that are no longer wanted must be disposed of by an approved battery recycler and must never be thrown in the trash or sent to a landfill.

Batteries that are not part of the vehicle itself, not the battery under the hood, must only be transported on public streets for business purposes via approved hazardous material transportation procedures.

Battery storage, charging and testing facilities in repair shops must meet various requirements for ventilation, safety equipment, material segregation, etc.

The maintenance free battery is standard. There are no vent plugs in the cover. The battery is completely sealed except for 2 small vent holes in the side. These vent holes allow the small amount of gas that is produced in the battery to escape.

The battery has 3 functions as a major source of energy:

- Engine cranking
- Voltage stabilizer
- Alternate source of energy with generator overload

Battery Low Start Vehicle Message

The body control module (BCM) monitors battery positive voltage to determine battery state of charge. If one or more of the BCM battery positive voltage terminals measure less than approximately 11.6V compared to the BCM ground circuits, this message will display and four chimes may sound. Start the vehicle immediately. If the vehicle is not started and the battery continues to discharge, the climate controls, heated seats, and audio systems will shut off and the vehicle may require a jump start. These systems will function again after the vehicle is started.

Battery Ratings

A battery has 2 ratings:

- Cold cranking amperage
- Amperage hours

When a battery is replaced use a battery with similar ratings. See battery specification label on the original battery.

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Amperage Hours

The amperage hour rating tells you how much amperage is available when discharged evenly over a 20 hour period. The amperage hour rating is cumulative, so in order to know how many constant amperage the battery will output for 20 h, you have to divide the amperage hour rating by 20. Example: If a battery has an amperage hour rating of 74, dividing by 20 = 3.75. Such a battery can carry a 3.75 A load for 20 hours before dropping to 10.5 V. (10.5 V is the fully discharged level, at which point the battery needs to be recharged.) A battery with an amperage hour rating of 55 will carry a 2.75 A load for 20 hours before dropping to 10.5 V.

Cold Cranking Amperage

The cold cranking amperage is an indication of the ability of the battery to crank the engine at cold temperatures. The cold cranking amperage rating is the minimum amperage the battery must maintain for 30 seconds at -18°C (0°F) while maintaining at least 7.2 V. See battery label for the cold cranking amperage rating of this battery.

Auxiliary Battery

Auxiliary batteries are an available option on vehicles where many accessories can be utilized such as TVs, radios, lights, computers, etc. The charging of these batteries is explained in charging system description and operation. Also, the auxiliary battery is only for accessory use and not part of the starting system.

Charging System Description and Operation

Electrical Power Management Overview

The electrical power management system is designed to monitor and control the charging system and send diagnostic messages to alert the driver of possible problems with the battery and generator. This electrical power management system primarily utilizes existing on-board computer capability to maximize the effectiveness of the generator, to manage the load, improve battery state-of-charge and life, and minimize the system's impact on fuel economy. The electrical power management system performs 3 functions:

- It monitors the battery voltage and estimates the battery condition.
- It takes corrective actions by boosting idle speeds, and adjusting the regulated voltage.
- It performs diagnostics and driver notification.

The battery condition is estimated during ignition-off and during ignition-on. During ignition-off the state-of-charge of the battery is determined by measuring the open-circuit voltage. The state-of-charge is a function of the acid concentration and the internal resistance of the battery, and is estimated by reading the battery open circuit voltage when the battery has been at rest for several hours.

The state-of-charge can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout ignition-on, the algorithm continuously estimates state-of-charge based on adjusted net amp hours, battery capacity, initial state-of-charge, and temperature.

While running, the battery degree of discharge is primarily determined by a battery current sensor, which is integrated to obtain net amp hours.

In addition, the electrical power management function is designed to perform regulated voltage control to improve battery state-of-charge, battery life, and fuel economy. This is accomplished by using knowledge of the battery state-of-charge and temperature to set the charging voltage to an optimum battery voltage level for recharging without detriment to battery life.

The Charging System Description and Operation is divided into 3 sections. The first section describes the charging system components and their integration into the electrical power management. The second section describes charging system operation. The third section describes the instrument panel cluster operation of the charge indicator, driver information center messages, and voltmeter operation.

Charging System Components

Generator

The generator is a serviceable component. If there is a diagnosed failure of the generator it must be replaced as an assembly. The engine drive belt drives the generator. When the rotor is spun it induces an alternating current (AC) into the stator windings. The AC voltage is then sent through a series of diodes for rectification. The rectified voltage has been converted into a direct current (DC) for use by the vehicles electrical system to maintain electrical loads and the battery charge. The voltage regulator integral to the generator controls the output of the generator. It is not serviceable. The voltage regulator controls the amount of current provided to the rotor. If the generator has field control circuit failure, the generator defaults to an output voltage of 13.8 V.

Body Control Module (BCM)

The body control module (BCM) is a GMLAN device. It communicates with the engine control module (ECM) and the instrument panel cluster for electrical power management (electrical power management) operation. The BCM determines the output of the generator and sends

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the information to the ECM for control of the generator turn on signal circuit. It monitors the generator field duty cycle signal circuit information sent from the ECM for control of the generator. It monitors a battery current sensor, the battery positive voltage circuit, and estimated battery temperature to determine battery state of charge. The BCM performs idle boost.

Battery Current Sensor

The battery current sensor is a serviceable component that is connected to the negative battery cable at the battery. The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the BCM. It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0–100 percent. Normal duty cycle is between 5–95 percent. Between 0–5 percent and 95–100 percent are for diagnostic purposes.

Engine Control Module (ECM)

When the engine is running, the generator turn-on signal is sent to the generator from the ECM, turning on the regulator. The generator's voltage regulator controls current to the rotor, thereby controlling the output voltage. The rotor current is proportional to the electrical pulse width supplied by the regulator. When the engine is started, the regulator senses generator rotation by detecting AC voltage at the stator through an internal wire. Once the engine is running, the regulator varies the field current by controlling the pulse width. This regulates the generator output voltage for proper battery charging and electrical system operation. The generator field duty terminal is connected internally to the voltage regulator and externally to the ECM. When the voltage regulator detects a charging system problem, it grounds this circuit to signal the ECM that a problem exists. The ECM monitors the generator field duty cycle signal circuit, and receives control decisions based on information from the BCM.

Instrument Panel Cluster

The instrument panel cluster provides the customer notification in case a concern with the charging system. There are 2 means of notification, a charge indicator and a driver information center message of SERVICE BATTERY CHARGING SYSTEM if equipped.

Charging System Operation

The purpose of the charging system is to maintain the battery charge and vehicle loads. There are 6 modes of operation and they include:

- Battery Sulfation Mode
- Charge Mode
- Fuel Economy Mode
- Headlamp Mode
- Start Up Mode
- Voltage Reduction Mode

The engine control module (ECM) controls the generator through the generator turn ON signal circuit. The ECM monitors the generator performance through the generator field duty cycle signal circuit. The signal is a pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0–100 percent. Normal duty cycle is between 5–95 percent. Between 0–5 percent and 95–100 percent are for diagnostic purposes. The following table shows the commanded duty cycle and output voltage of the generator:

Commanded Duty Cycle	Generator Output Voltage
10%	11 V
20%	11.56 V
30%	12.12 V

Commanded Duty Cycle	Generator Output Voltage
40%	12.68 V
50%	13.25 V
60%	13.81 V
70%	14.37 V
80%	14.94 V
90%	15.5 V

The generator provides a feedback signal of the generator voltage output through the generator field duty cycle signal circuit to the ECM. This information is sent to the body control module (BCM). The signal is PWM signal of 128 Hz with a duty cycle of 0–100 percent. Normal duty cycle is between 5–99 percent. Between 0–5 percent and 100 percent are for diagnostic purposes.

Auxiliary Battery Charging

The auxiliary battery is an option and can be used to supply electrical power to additional equipment that the customer may choose to add, without discharging the vehicle's primary battery. The auxiliary battery relay closes when the engine is running, in order to allow the generator to charge the auxiliary battery. The relay opens when the engine is off, so that the accessories are powered only by the auxiliary battery and will not discharge the vehicles primary battery, which is used for engine starting.

Battery Sulfation Mode

The BCM will enter this mode when the interpreted generator output voltage is less than 13.2 V for 45 minutes. When this condition exists the BCM will enter Charge Mode for 2–3 minutes. The BCM will then determine which mode to enter depending on voltage requirements.

Charge Mode

The BCM will enter Charge Mode when ever one of the following conditions are met.

- The wipers are ON for than 3 seconds.
- GMLAN (Climate Control Voltage Boost Mode Request) is true, as sensed by the HVAC control head. High speed cooling fan, rear defogger and HVAC high speed blower operation can cause the BCM to enter the Charge Mode.
- The estimated battery temperature is less than 0°C (32°F).
- Battery State of Charge is less than 80 percent.
- Vehicle speed is greater than 145 km/h (90 mph)
- Current sensor fault exists.
- System voltage was determined to be below 12.56 V

When any one of these conditions is met, the system will set targeted generator output voltage to a charging voltage between 13.9–15.5 V, depending on the battery state of charge and estimated battery temperature.

Fuel Economy Mode

The BCM will enter Fuel Economy Mode when the estimated battery temperature is at least 0° C (32°F) but less than or equal to 80°C (176°F), the calculated battery current is less than 15 amperes and greater than –8 amperes, and the battery state-of-charge is greater than or equal to 80 percent. Its targeted generator output voltage is the open circuit voltage of the

battery and can be between 12.5–13.1 V. The BCM will exit this mode and enter Charge Mode when any of the conditions described above are present.

Headlamp Mode

The BCM will enter Headlamp Mode when ever the headlamps are ON (high or low beams). Voltage will be regulated between 13.9–14.5 V.

Start Up Mode

When the engine is started the BCM sets a targeted generator output voltage of 14.5 V for 30 seconds.

Voltage Reduction Mode

The BCM will enter Voltage Reduction Mode when the calculated ambient air temperature is above 0°C (32°F). The calculated battery current is less than 1 ampere and greater than –7 amperes, and the generator field duty cycle is less than 99 percent. Its targeted generator output voltage is 12.9 V. The BCM will exit this mode once the criteria are met for Charge Mode.

Instrument Panel Cluster Operation

Charge Indicator Operation

The instrument panel cluster illuminates the charge indicator and displays a warning message in the driver information center if equipped, when the one or more of the following occurs:

- The engine control module (ECM) detects that the generator output is less than 11 V or greater than 16 V. The instrument panel cluster receives a GMLAN message from the ECM requesting illumination.
- The instrument panel cluster determines that the system voltage is less than 11 V or greater than 16 V for more than 30 seconds. The instrument panel cluster receives a GMLAN message from the body control module (BCM) indicating there is a system voltage range concern.
- The instrument panel cluster performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.

Display Message: BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM

The BCM and the ECM will send a serial data message to the driver information center for the BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM message to be displayed. It is commanded ON when a charging system DTC is a current DTC. The message is turned OFF when the conditions for clearing the DTC have been met.

Electrical Power Management Description and Operation

Electrical Power Management

The electrical power management is used to monitor and control the charging system and alert the driver of possible problems within the charging system. The electrical power management system makes the most efficient use of the generator output, improves the battery state-of-charge, extends battery life, and manages system electrical loads.

The load shed operation is a means of reducing electrical loads during a low voltage or low battery state-of-charge condition.

The idle boost operation is a means of improving generator performance during a low voltage or low battery state-of-charge condition.

Each electrical power management function, either idle boost or load shed, is discrete. No two functions are active at the same time. Idle boost is activated in incremental steps, idle boost 1 must be active before idle boost 2 can be active. The criteria used by the body control module (BCM) to regulate electrical power management are outlined below:

Electrical Power Management Block Diagram



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Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15°C (5°F)	Less Than 13 V	—	First level Idle boost requested

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 1 Start	—	—	Battery has a net loss greater than 0.6 Ah	First level Idle boost requested
Idle Boost 1 Start	—	Less Than 10.9 V	—	First level Idle boost requested
Idle Boost 1 End	Greater Than -15°C (5°F)	Greater Than -12 V	Battery has a net loss less than 0.2 Ah	First level Idle boost request cancelled
Load Shed 1 Start	—	—	Battery has a net loss of 4 Ah	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 20% of their cycle
Load Shed 1 Start	—	Less Than 10.9 V	—	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 20% of their cycle
Load Shed 1 End	—	Greater Than 12 V	Battery has a net loss of less than 2 Ah	Clear Load Shed 1
Idle Boost 2 Start	—	—	Battery has a net loss greater than 1.6 Ah	Second level Idle boost requested
Idle Boost 2 Start	—	Less Than 10.9 V	—	Second level Idle boost requested
Idle Boost 2 End	—	Greater Than 12 V	Battery has a net loss less than 0.8 Ah	Second level Idle boost request cancelled
Idle Boost 3 Start	—	—	Battery has a net loss of 10 Ah	Third level Idle boost requested
Idle Boost 3 Start	—	Less Than 10.9 V	—	Third level Idle boost requested
Idle Boost 3 End	—	Greater Than 12 V	Battery has a net loss of less than 6.0 Ah	Third level Idle boost request cancelled

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Load Shed 2 Start	—	Less Than 10 V	Battery has a net loss greater than 12 Ah	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 Start	—	Less Than 10.9 V	—	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	—	Greater Than 12.6 V	Battery has a net loss of less than 10.5 Ah	Clear Load Shed 2
Load Shed 3 Start	—	Less Than 11.9 V	Battery has a net loss greater than 20 Ah	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 End	—	Greater Than 12.6 V	Battery has a net loss of less than 15 Ah	Clear Load Shed 3

Starting System Description and Operation

The starter motors are non-repairable starter motors. They have pole pieces that are arranged around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding because battery voltage is applied to both ends of the windings. The hold-in winding remains energized. Its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly, and solenoid switch contacts in place to continue cranking the engine. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened.

When the ignition switch is released from the START position, the START relay opens and battery voltage is removed from the starter solenoid S terminal. Current flows from the motor contacts through both windings to the ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now opposite the direction of the current flow when the winding was first energized.

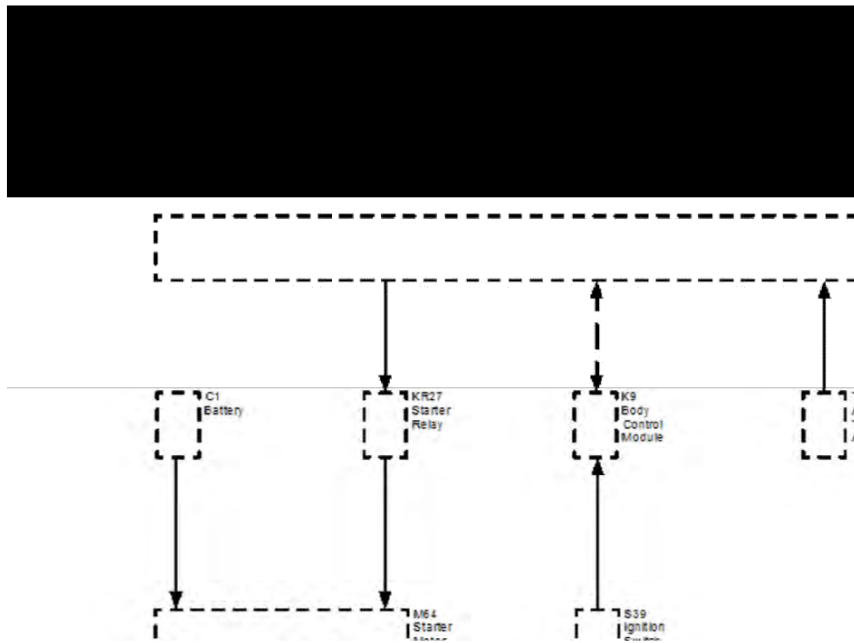
The magnetic fields of the pull-in and hold-in windings now oppose one another. This action of the windings, along with the help of the return spring, causes the starter drive assembly to disengage and the solenoid switch contacts to open simultaneously. As soon as the contacts open, the starter circuit is turned off.

Circuit Description (Key Start)

When the ignition switch is placed in the Start position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the Start position. The BCM then sends a message to the engine control module (ECM) notifying it that CRANK has been requested. The ECM verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 V to the control circuit of the crank relay. When this occurs, battery positive voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid.

Starting System Block Diagram

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DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563

Diagnostic Instructions

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

DTC Descriptors

DTC B1325 03

Device Power Circuit Voltage Below Threshold

DTC B1325 07

Device Power Circuit Voltage Above Threshold

DTC B1330 03

Device Power 2 Circuit Voltage Below Threshold

DTC B1420 00

Device Voltage 1

DTC B1424 00

Device Voltage Low

DTC B1517 03

Battery Voltage Below Threshold

DTC B1517 07

Battery Voltage Above Threshold

DTC B1517 5A

Battery Voltage Plausibility Failure

DTC C0800 03

Device Power 1 Circuit Voltage Below Threshold

DTC C0800 07

Device Power 1 Circuit Voltage Above Threshold

DTC C0800 11

Device Power 1 Circuit High Input

DTC C0800 0D

Device Power 1 Circuit High Resistance

DTC C0895 00

Device Voltage

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DTC C0899 00

Device Voltage Low

DTC C0899 03

Device Voltage Low

DTC C0900 00

Device Voltage High

DTC P0560

System Voltage

DTC P0562

System Voltage Low Voltage

DTC P0563

System Voltage High Voltage

Circuit/System Description

The vehicle control modules or sensors monitor the system voltage to verify the system voltage is within the normal operating range.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The control module or sensor detects a system voltage of less than approximately 9 V for approximately 5 seconds.

Action Taken When the DTC Sets

- A driver information center message and/or warning indicator may be displayed.
- The control module may be temporarily disabled.

Conditions for Clearing the DTC

The system voltage returns to normal operating range.

Diagnostic Aids

- A high or low voltage DTC set or voltage value in multiple modules/sensors indicates a concern in the charging system.
- A possible cause of this DTC could be overcharging with a battery charger or jump starting.

Reference Information**Schematic Reference**[Control Module References](#)**Connector End View Reference**[Component Connector End Views](#)**Description and Operation**[Charging System Description and Operation](#)

Electrical Information Reference

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

DTC Type Reference

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

Scan Tool Reference

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

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the battery terminals.
2. Verify the battery voltage stabilizes between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
 - ⇒ **If battery voltage is less than 12.4 V or more than 12.8 V**
Refer to [Battery Inspection/Test](#).
 - ↓ **If battery voltage is between 12.4 and 12.8 V**
3. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
4. Verify the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.
 - ⇒ **If the voltage is not at least 1 V greater than the voltage measured in step 1 or is greater than 15 V.**
Refer to [Charging System Test](#).
 - ↓ **If the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.**
5. Verify the appropriate control module scan tool B+ and ignition voltage parameters are within 1 V of the battery voltage.
 - ⇒ **If not within 1 V of the battery voltage**
Refer to Circuit/System Testing.
 - ↓ **If within 1 V of the battery voltage**
6. All OK.

Circuit/System Testing

Note: Use the schematic to identify the following:

- Control modules the vehicle is equipped with
- The control module's ground, B+, and Ignition circuit terminal IDs and connectors

Note: Some control module ground circuits may require up to 20 min after the ignition is turned off before achieving a resistance reading of less than 5 Ω . In most cases the readings will drop below 20 Ω within 1 min indicating the control module is going to sleep.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connectors at the appropriate control module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between each ground circuit terminal and ground.
 - ⇒ **If 10 Ω or greater**
 - 2.1. Ignition OFF.

- 2.2. Test for less than 2 Ω in the ground circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , repair the open/high resistance in the ground connection.

↓ **If less than 10 Ω**

- 3. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.

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

- 3.1. Ignition OFF.
- 3.2. Test for less than 2 Ω in the B+ circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.

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

- 3.1. Ignition OFF.
- 3.2. Test for infinite resistance between the B+ circuit and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 - ⇒ If infinite resistance, replace the appropriate control module.

↓ **If the test lamp illuminates**

- 4. Ignition ON.

- 5. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.

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

- 5.1. Ignition OFF.
- 5.2. Test for less than 2 Ω in the ignition circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.

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

- 5.1. Ignition OFF.
- 5.2. Test for infinite resistance between the ignition circuit and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 - ⇒ If infinite resistance, replace the appropriate control module.

↓ **If the test lamp illuminates**

- 6. Replace the control module.

Repair Instructions

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

[Control Module References](#) for control module replacement, setup, and programming

DTC B1516

Diagnostic Instructions

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

DTC Descriptors

DTC B1516 08

Battery Current Sensor Signal Invalid

DTC B1516 66

Battery Current Sensor Wrong Mounting Position

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	B1516 08	B1516 08	—	—
Signal	B1516 08	B1516 08	B1516 08	B1516 08, B1516 66
Low Reference	—	B1516 08	—	—

Typical Scan Tool Data

Battery Current – BCM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, engine OFF. Headlamps, HVAC, and all accessories Off. Parameter Normal Range: –3 amps to –25 amps			
5-Volt Reference	–59.9 amps	–59.9 amps	–6.2 amps
Signal	–59.9 amps	59.9 amps	59.9 amps
Low Reference	—	59.9 amps	—

Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The body control module (BCM) supplies 5 V and ground to the battery current sensor. The battery current sensor measures the amount of current flowing to or from the battery, and supplies a pulse width modulation (PWM) signal to the BCM.

Conditions for Running the DTC

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B1516 08

- The BCM is awake.
- The engine is running.

B1516 66

- The BCM is awake.
- The engine is OFF.

Conditions for Setting the DTC**B1516 08**

The BCM detects the battery current sensor signal is less than 4 percent or greater than 96 percent duty cycle for 2 min.

B1516 66

The BCM detects the battery current sensor polarity is positive for 2 min.

Action Taken When the DTC Sets

- The regulated voltage control (RVC) is disabled.
- The "SERVICE VEHICLE SOON" warning message will be displayed on the driver information centre.

Conditions for Clearing the DTC

The DTC will clear when the battery current sensor signal returns to the normal for greater than 15 seconds.

Reference Information**Schematic Reference**

[Starting and Charging Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Charging System Description and Operation](#)

Electrical Information Reference

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

Scan Tool Reference

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

Circuit/System Verification

Ignition ON, head lamps, HVAC and all accessories OFF, observe the scan tool BCM Battery Current parameter. The reading should be between -3 amps and -25 amps. While observing the scan tool turn the head lamps and accessories ON and OFF, the scan tool parameter should change when head lamps and accessories are operated.

Circuit/System Verification

1. Ignition ON, head lamps, HVAC and all accessories OFF.

2. Verify the scan tool BCM Battery Current parameter reads between -3 a and -25 a.
 ⇒ **If less than or equal to -25 a or equal to or greater than -3 a**
 Refer to Circuit/System Testing.
 ↓ **If between -3 a and -25 a**
3. Verify the scan tool parameter changes when the head lamps and accessories are turned ON and OFF.
 ⇒ **If the parameter does not change**
 Refer to Circuit/System Testing.
 ↓ **If the parameter does change**
4. All OK

Circuit/System Testing

B1516 08

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B18 Battery Current Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal B and ground.
 ⇒ **If 5 Ω or greater**
 - 2.1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module.
 - 2.2. Test for less than 2 Ω in the low reference circuit end to end.
 ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 ⇒ If less than 2 Ω , replace the K9 Body Control Module.
 ↓ **If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8–5.2 V between the 5 V reference circuit terminal A and ground.
 ⇒ **If less than 4.8 V**
 - 4.1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
 - 4.2. Test for infinite resistance between the 5 V reference circuit and ground.
 ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 ↓ If infinite resistance
 - 4.3. Test for less than 2 Ω in the 5V reference circuit end to end.
 ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 ⇒ If less than 2 Ω , replace the K9 Body Control Module.
 ⇒ **If greater than 5.2 V**
 - 4.1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
 - 4.2. Test for less than 1 V between the 5 V reference circuit and ground.
 ⇒ If 1 V or greater, repair the short to voltage on the circuit.
 ⇒ If less than 1 V, replace the K9 Body Control Module.
 ↓ **If between 4.8–5.2 V**
5. Test for 4.8–5.2 V between the signal circuit terminal C and ground.
 ⇒ **If less than 4.8 V**
 - 5.1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
 - 5.2. Test for infinite resistance between the signal circuit and ground.
 ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 ↓ If infinite resistance

- 5.3. Test for less than 2 Ω in the signal circuit end to end.
⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
⇒ If less than 2 Ω , replace the K9 Body Control Module.

⇒ **If greater than 5.2 V**

- 5.1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
5.2. Test for less than 1 V between the signal circuit and ground.
⇒ If 1 V or greater, repair the short to voltage on the circuit.
⇒ If less than 1 V, replace the K9 Body Control Module.

↓ **If between 4.8–5.2 V**

6. Test or replace the B18 Battery Current Sensor.

B1516 66

1. Verify that the B18 Battery Current Sensor is installed securely around the negative battery cable, with the tape tab pointing away from the negative terminal on the C1 Battery.

⇒ **If the B18 Battery Current Sensor is not installed correctly**

Remove and reinstall the B18 Battery Current Sensor properly.

↓ **If the B18 Battery Current Sensor is installed correctly**

2. Replace the B18 Battery Current Sensor.

Repair Instructions

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

- [Battery Negative Cable Replacement](#)
- [Control Module References](#) for BCM replacement, setup, and programming.

DTC B151A

Diagnostic Instructions

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

DTC Descriptor

DTC B151A 58

Low Battery Capacity Detected

Circuit/System Description

The body control module (BCM) monitors the battery voltage level during an engine crank event to detect a low battery voltage condition.

Conditions for Running the DTC

The vehicle is ON

Conditions for Setting the DTC

A minimum crank battery voltage is less than the minimum crank battery voltage threshold for 16 consecutive crank events.

Action Taken When the DTC Sets

A driver information center message is displayed.

Conditions for Clearing the DTC

The DTC will clear if the minimum crank voltage is greater than the minimum crank voltage threshold during a crank event.

Reference Information

Schematic Reference

[Starting and Charging Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Charging System Description and Operation](#)

Electrical Information Reference

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

Scan Tool Reference

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

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Circuit/System Verification

- Refer to the [Battery Inspection/Test](#).
- Refer to the [Charging System Test](#).

DTC B1527

Diagnostic Instructions

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

DTC Descriptor

DTC B1527 00

Parasitic Load

Circuit/System Description

The body control module (BCM) monitors the state of charge of the electrical system.

Conditions for Running the DTC

The ignition is in Accessory or Run mode.

Conditions for Setting the DTC

The state of charge at ignition ON is 30% lower than when the engine was running and battery drain is more than 2 A.

Action Taken When the DTC Sets

There is no battery telltale illuminated or DIC message displayed.

Conditions for Clearing the DTC

- The DTC will clear if the fault does not return after 50 consecutive ignition cycles.
- The DTC will clear when run state of charge is greater than or equal to 80%.

Reference Information

Schematic Reference

[Starting and Charging Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Charging System Description and Operation](#)

Electrical Information Reference

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

Scan Tool Reference

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

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Circuit/System Verification

Refer to [Battery Electrical Drain/Parasitic Load Test](#).

DTC P0615, P0616, or P0617

Diagnostic Instructions

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

DTC Descriptors

DTC P0615

Starter Relay Control Circuit

DTC P0616

Starter Relay Control Circuit Low Voltage

DTC P0617

Starter Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Switch B+ Terminal 30	1	2	—	—
Relay Coil Ignition Terminal 85	P0616	P0615	P0617	—
Relay Switch Control Terminal 87	2	2	3	—
Relay Coil Ground Terminal 86	—	P0615	—	—
1. Opens fuse, Starter Solenoid does not click. 2. Starter Solenoid does not click. 3. Cranks all the time.				

Circuit/System Description

When the ignition is activated to start the vehicle, a discrete signal is supplied to the body control module (BCM). The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch pedal is pressed or the transmission is in park/neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter solenoid.

Conditions for Running the DTC

- The ignition is activated to START.
- The system voltage is between 9.5–18 V.

Conditions for Setting the DTC

The ECM detects improper voltage on the control circuit of the starter relay.

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[Action Taken When the DTC Sets](#)

DTC P0615, P0616, and P0617 are C type DTCs.

[Conditions for Clearing the DTC](#)

DTC P0615, P0616, and P0617 are C type DTCs.

[Reference Information](#)

Schematic Reference

[Starting and Charging Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Starting System Description and Operation](#)

Electrical Information Reference

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

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Testing](#)

1. Ignition OFF and all vehicle systems OFF, disconnect the KR27 Starter Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 86 and ground.
⇒ **If 10 Ω or greater**
 - 2.1. Ignition OFF.
 - 2.2. Test for less than 2 Ω in the ground circuit end to end.
⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
⇒ If less than 2 Ω , repair the open/high resistance in the ground connection.
- ⇓ **If less than 10 Ω**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
⇒ **If the test lamp does not illuminate and the circuit fuse is good**
 - 4.1. Ignition OFF.
 - 4.2. Test for less than 2 Ω in the B+ circuit end to end.
⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
⇒ If less than 2 Ω , verify the fuse is good and there is voltage at the fuse.
- ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
 - 4.1. Ignition OFF.
 - 4.2. Test for infinite resistance between the B+ circuit and ground.

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

⇓ If infinite resistance,

4.3. Test for infinite resistance between the control circuit terminal 87 and ground.

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

⇒ If infinite resistance, replace the M64 Starter Motor.

⇓ **If the test lamp illuminates**

5. Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.

Note: If the Starter Relay command is not available in the scan tool, verify the test lamps turns on and off when cycling the ignition between the OFF and CRANK position with the parking brake set and clutch pedal pressed (manual transmission) or the transmission in park (automatic transmission).

6. Verify the test lamp turns ON and OFF when commanding the Starter Relay ON and OFF with a scan tool.

⇒ **If the test lamp is always OFF**

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

6.2. Test for infinite resistance between the control circuit and ground.

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

⇓ If infinite resistance

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

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω , replace the K20 Engine Control Module.

⇒ **If the test lamp is always ON**

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

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

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

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

⇓ **If the test lamp turns ON and OFF**

7. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.

8. Verify the M64 Starter Motor is activated.

⇒ **If the M64 Starter Motor does not activate**

8.1. Ignition OFF, disconnect the harness connector at the M64 Starter Motor.

8.2. Test for infinite resistance between the control circuit terminal X1 A or X1 1 and ground..

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

⇓ If infinite resistance

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

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

⇒ If less than 2 Ω , replace the M64 Starter Motor.

⇓ **If the M64 Starter Motor activates**

9. Test or replace the KR27 Starter Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR27 Starter Relay.

2. Test for 60–180 Ω between terminals 85 and 86.

⇒ **If less than 60 or greater than 180 Ω**

Replace the relay.

⇓ **If between 60–180 Ω**

3. Test for infinite resistance between the terminals listed below:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87

⇒ **If less than infinite resistance**

Replace the relay.

⇓ **If infinite resistance**

4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.

5. Test for less than 2 Ω between terminals 30 and 87.

⇒ **If 2 Ω or greater**

Replace the relay.

⇓ **If less than 2 Ω**

6. All OK

Repair Instructions

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

- [Relay Replacement](#)
- [Control Module References](#) for ECM replacement, programming, and setup.

DTC P0621

Diagnostic Instructions

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

DTC Descriptor

DTC P0621

Generator L-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	—	P0621	—	—
Control – L Terminal	P0621	P0621	P0621	—
Signal – F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator turn ON control circuit to control the load of the generator on the engine. A high side driver in the ECM applies a duty cycled voltage to the voltage regulator. The duty cycle controls the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON control circuit. The ECM should detect low voltage on the generator turn on control circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage when the duty cycle voltage is commanded high and a low voltage when the duty cycle voltage is commanded low on the generator turn on control circuit.

Conditions for Running the DTC

- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s)
- The engine is running for the run test

Conditions for Setting the DTC

- Ignition ON, engine OFF – The ECM detects greater than 3.5 V on the generator control circuit for 5 s
- Engine running – The ECM detects a low voltage for 15 s on the generator control circuit when the duty cycle voltage is commanded high
- Engine running – The ECM detects a high voltage for 15 s on the generator control circuit when the duty cycle voltage is commanded low

Action Taken When the DTC Sets

DTC P0621 is a C type DTC

Conditions for Clearing the DTC

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- Ignition ON, engine OFF– Low voltage
- Engine running – A control signal duty cycle is detected

Reference Information

Schematic Reference

[Starting and Charging Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Charging System Description and Operation](#)

Electrical Information Reference

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

DTC Type Reference

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

Scan Tool Reference

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

Circuit/System Verification

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

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal X2 1, X2 2 or X2 A and ground.
⇒ **If the test lamp does not illuminate and the circuit fuse is good**
 - 1.1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
 - 1.2. Test for less than 2 Ω in the B+ circuit end to end.
⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
⇒ If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
- ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
 - 1.1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
 - 1.2. Test for infinite resistance between the B+ circuit and ground.
⇒ If less than infinite resistance, repair the short to ground on the circuit.
- ⇓ **If the test lamp illuminates**

2. Disconnect the X1 harness connector at the G13 Generator, ignition ON.
3. Test for 3.0– 5.5 V between the control circuit terminal X1 1 and ground.
 - ⇒ **If less than 3.0 V**
 - 3.1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
 - 3.2. Test for infinite resistance between the control circuit and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 - ⇓ If infinite resistance
 - 3.3. Test for less than 2 Ω in the control circuit end to end.
 - ⇒ If greater the 2 Ω , repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , replace the K20 Engine Control Module.
 - ⇒ **If greater than 5.5 V**
 - 3.1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module, Ignition ON.
 - 3.2. Test for less than 1 V between the control circuit and ground.
 - ⇒ If greater than 1 V, repair the short to voltage on the circuit.
 - ⇒ If less than 1 V, replace the K20 Engine Control Module.
 - ⇓ **If between 3.0–5.5 V**
4. Test or replace the G13 Generator.

Repair Instructions

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

- [Generator Replacement](#)
- [Control Module References](#) for Engine Control Module replacement, programming and setup

DTC P0622

Diagnostic Instructions

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

DTC Descriptor

DTC P0622

Generator F-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	—	P0621	—	—
Control – L Terminal	P0621	P0621	P0621	—
Signal – F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings ON and OFF. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is OFF, the ECM should detect a duty cycle near 0%. When the engine is running, the duty cycle should be between 5–99%.

Conditions for Running the DTC

- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s).
- Engine running at less than 3,000 RPM.

Conditions for Setting the DTC

- DTC P0621 is not set.
- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s), the ECM detects a PWM signal that is greater than 65% for 5 s.
- Engine running at less than 3,000 RPM – The ECM detects a PWM signal that is less than 5% for 30 s.

Action Taken When the DTC Sets

DTC P0622 is a type C DTC.

Conditions for Clearing the DTC

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- Ignition ON, Engine OFF– Low / no PWM signal detected.
- Engine running – A 5–90% duty cycle is detected.

[Reference Information](#)

Schematic Reference

[Starting and Charging Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Charging System Description and Operation](#)

Electrical Information Reference

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

DTC Type Reference

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

Scan Tool Reference

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

[Circuit/System Verification](#)

Note: Do not have a battery charger connected during the generator testing.

1. Engine running.
2. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is between 5–90%.
 - ⇒ **If not between 5–90%**
Refer to Circuit/System Testing.
 - ↓ **If between 5–90%**
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter changes when commanding the headlamps ON and OFF.
 - ⇒ **If the parameter does not change**
Refer to Circuit/System Testing.
 - ↓ **If the parameter changes**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
 - ⇒ **If the DTC sets**
Refer to Circuit/System Testing.
 - ↓ **If the DTC does not set**
6. All OK.

[Circuit/System Testing](#)

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal X2 1, X2 2 or X2 A and ground.

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

- 1.1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
- 1.2. Test for less than 2 Ω in the B+ circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.

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

- 1.1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
- 1.2. Test for infinite resistance between the B+ circuit and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.

↓ **If the test lamp illuminates**

2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is less than 5%.

⇒ **If 5% or greater**

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

↓ **If less than 5%**

4. Install a 3 A fused jumper wire between the signal circuit terminal 2 and B+, engine running.
5. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is greater than 95%.

⇒ **If 95% or less**

- 5.1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
- 5.2. Test for infinite resistance between the signal circuit and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
- ↓ If infinite resistance
- 5.3. Test for less than 2 Ω in the signal circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit
 - ⇒ If less than 2 Ω , replace the K20 Engine Control Module

↓ **If greater than 95%**

6. Test or replace the G13 Generator.

Repair Instructions

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

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

Symptoms - Engine Electrical

Note: The following steps must be completed before using the symptom tables.

- Perform [Control Module References](#) before using the Symptom Tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
- Review the system descriptions and operations in order to familiarize yourself with the system functions. Refer to one of the following system operations:
 - [Battery Description and Operation](#)
 - [Charging System Description and Operation](#)
 - [Electrical Power Management Description and Operation](#)
 - [Starting System Description and Operation](#)

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the starting and charging systems. Refer to [Checking Aftermarket Accessories](#).
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to [Testing for Intermittent Conditions and Poor Connections](#).

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- [Battery Inspection/Test](#)
- [Battery Electrical Drain/Parasitic Load Test](#)
- [Charging System Test](#)
- [Generator Noise Diagnosis](#)
- [Starter Solenoid Does Not Click](#)
- [Starter Solenoid Clicks, Engine Does Not Crank](#)
- [Engine Cranks Slowly](#)

Battery Inspection/Test

Diagnostic Instructions

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

Diagnostic Aids

Note: For Warranty repairs —

You must use regionally required battery test equipment for warranty repairs. For accurate test results the battery must be disconnected from the vehicle and the equipment connected directly to the battery posts. When setting up the equipment, select "Out of Vehicle" and then the correct battery type (Flooded or AGM) and rated CCA (both from the battery label) must be entered.

- Failure to obtain the correct connections during the test may result in a failed test on a good battery.
- Use the Out of Vehicle test (both batteries disconnected with test equipment connected directly to the post) test for each battery when testing a vehicle with dual batteries.

Follow these instructions in order to avoid an incorrect diagnosis because of connections:

- If testing the vehicle with the battery cables still connected, wiggle the battery tester clips on the terminal. This may cut through any coating or through any oxidation that may be present on the terminal.
- If correct connections to the battery terminals in the vehicle are in doubt, perform the following steps:
 1. Disconnect the negative battery cable.
 2. Disconnect the positive battery cable.
 3. Follow the instructions for testing a removed battery.
- If the tester displays a REPLACE BATTERY or BAD CELL-REPLACE result for a battery tested in the vehicle with the battery cables connected, perform the following steps:
 1. Disconnect the negative battery cable.
 2. Disconnect the positive battery cable.

Note: Always write the test code displayed by the tester on the repair order for any warranty purposes. The number is a unique code that describes the test data for a particular battery at a particular time. The test code may occasionally repeat when you retest the same battery. More often, each test will result in a different code. Use the test code from the second, or Out of Vehicle test.

 3. Follow the instructions for testing a removed battery.
 4. Replace the battery only if the second test shows a REPLACE BATTERY or BAD CELL-REPLACE result.

Use the test code from the second test for any warranty purposes.

Reference Information

Schematic Reference

[Starting and Charging Schematics](#)

Connector End View Reference

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[Component Connector End Views](#)**Description and Operation**[Starting System Description and Operation](#)**Electrical Information Reference**

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

Scan Tool Reference

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

Special Tools

EL 50313 Battery Tester

[Circuit/System Testing](#)

Warning: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStar® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar® module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStar® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

1. Verify the C1 or C1B Battery case is not cracked, broken, or damaged, which may be indicated by battery acid leakage.
 - ⇒ **If there is any apparent damage**
Replace the C1 or C1B Battery.
 - ⇓ **If there is no damage**
2. Verify the cold cranking amperage and amperage hour rating of the C1 or C1B Battery. Refer to the manufacturer specifications on the battery label.
 - ⇒ **If the C1 or C1B Battery does not meet specifications**
Replace the C1 or C1B Battery.
 - ⇓ **If the C1 or C1B Battery meets specifications**
3. Verify that the battery cables are clean and tight. The battery terminal bolts should be torqued as specified in [Fastener Tightening Specifications](#).
 - ⇒ **If the battery cables need to be cleaned or tightened**
Clean as required and tighten as specified.
 - ⇓ **If the battery cables are clean and tight**

4. Install the battery tester and follow directions supplied by the tester.

Repair Instructions

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

[Battery Replacement](#)

Battery Charging

Special Tools

EL 50313 Battery Tester

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

Diagnostic Aids

- For best results, use an automatic taper-rate battery charger with a voltage capability of 16 V.
- The charging area should be well ventilated.
- Do not charge a battery that appears to be frozen. Allow the battery to warm to room temperature and test it using the EL 50313 Battery Tester before charging.

Battery State of Charge

Note: Using voltage to determine the batteries state of charge is only accurate after the battery has been at rest for 24 hours. This is enough time for the acid in each cell to equalize. If the battery has been charged or discharged in the past 24 hours, the battery state of charge will only be an estimate.

The maintenance-free batteries state of charge is estimated by reading the voltage of the battery across the battery terminals. Because the voltage is affected by current flow into or out of the battery, the engine must be stopped and all electrical loads turned OFF, including parasitic loads, when checking the voltage. The voltage can also be affected if the battery has just been charged or discharged, so it is important to consider what has happened to the battery in the time just before testing. Use the following procedure to determine the batteries state of charge:

1. Be sure all electrical loads are turned OFF.
2. Determine whether the battery has been used in a vehicle or charged within the past 12 hours.
 - If the answer is no, the terminal voltage will be stabilized and no action is necessary before reading the voltage. Skip to step 3.
 - If the answer is yes, terminal voltage will not be stabilized and you should wait 12 hours since the last time the battery was used.
3. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12 hours.

Note: The table is accurate to 10 percent only after the battery has been at rest for 12 hours.

4. Measure the battery voltage at the battery terminals. Refer to the following table to determine the state of charge according to the estimated battery temperature:

Battery Charging

Battery Voltage	% Charge at 0°C (32°F)	% Charge at 25°C (75°F)
12.75 V	100%	100%
12.7 V	100%	90%
12.6 V	90%	75%
12.45 V	75%	65%

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Battery Voltage	% Charge at 0°C (32°F)	% Charge at 25°C (75°F)
12.2 V	65%	45%
12.0 V	40%	20%

Use the state of charge information as follows:

- A battery with a state of charge that is below 65 percent must always be recharged before returning it to service or continuing storage.
- A battery with a state of charge that is 65 percent or greater is generally considered to be charged enough in order to be returned to normal service or in order to continue storage. However, if the battery is being used in slow traffic or with short drive times, or if the temperature is very hot or very cold, the battery should be fully charged, to at least 90 percent, before returning it to service or continuing storage.

Charging Time Required

The time required to charge a battery will vary depending upon the following factors:

- The battery charger capacity—The higher the charger amperage, the less time it will take to charge the battery.
- The state of charge of the battery—A completely discharged battery requires more than twice as much charging time as a half charged battery. In a discharged battery with a voltage below 11 V, the battery has a very high internal resistance and may only accept a very low current at first. Later, as the charging current causes the acid content to increase in the electrolyte, the charging current will increase. Extremely discharged batteries may not activate the reversed voltage protection in some chargers. Refer to the manufacturer's instructions for operating this circuitry.
- The temperature of the battery—The colder the battery is, the more time it takes to recharge the battery. The charging current accepted by a cold battery is very low at first. As the battery warms, the charging current will increase.

Charging Procedure

Caution: Turn OFF the ignition when connecting or disconnecting the battery cables, the battery charger or the jumper cables. Failure to do so may damage the ECM/PCM or other electronic components.

Caution: Refer to [Fastener Caution](#).

When charging side-terminal batteries with the battery cables connected, connect the charger to the positive cable bolt and to a ground located away from the battery. When charging side-terminal batteries with the battery cables disconnected, install the battery side terminal adapters and connect the charger to the adapters.

Tighten

Tighten the battery side terminal adapters to 15N•m (11 lb ft).

Use the following procedure to charge the battery:

1. Turn OFF the charger.
2. Ensure that all of the battery terminal connections are clean and tight.
3. Connect the charger positive lead to the battery positive terminal on the battery or the remote jumper stud underhood.

Caution: Do not connect the negative charger lead to the housings of other vehicle electrical accessories or equipment. The action of the battery charger may damage such equipment.

4. Connect the negative charger lead to a solid engine ground or to a ground stud in the engine compartment that is connected directly to the battery negative terminal, but away from the battery. If the negative battery cable is disconnected and a terminal adapter is being used, connect directly to the adapter.
5. Turn ON the charger and set to the highest setting for normal charging.
6. Inspect the battery every half hour after starting the battery charger.
 - Charge the battery until the taper-rate charger indicates that the battery is fully charged.
 - Estimate the battery temperature by feeling the side of the battery. If it feels hot to the touch or its temperature is over 45°C (125°F), discontinue charging and allow the battery to cool before resuming charging.
7. After charging, test the battery. Refer to [Battery Inspection/Test](#).

Battery Electrical Drain/Parasitic Load Test

12 V Battery

The following procedure is for the 12 V battery only.

Diagnostic Instructions

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

Circuit/System Description

Components most likely to cause a parasitic draw on the vehicles battery are switches, relays, and control modules. After the ignition is turned OFF the control modules will begin to go to sleep (shut OFF). All control modules do not go to sleep at the same time, some may take up to 30 minutes or longer after turning the ignition off before going to sleep. Others such as the ON Star and keyless entry control modules may periodically wake up then go back to sleep. These are all normal conditions.

Diagnostic Aids

- Rule out any possible aftermarket equipment causing an unacceptable parasitic current drain. Aftermarket accessories installed into the courtesy lamp circuit can cause the inadvertent power timer in the body control module (BCM) to keep resetting. This may cause the BCM to remain awake and cause a current drain on the battery.
- Rule out customer driving habits such as regular short trips that do not allow enough time to properly charge the battery. Refer to [Battery Description and Operation](#).
- Verify that the battery and charging system are in proper working order. Refer to [Battery Charging](#) and [Charging System Test](#).
- A battery discharging for no apparent reason while the vehicle is parked can be caused by an intermittent draw, such as a module waking up, or a continuous draw, such as a dome light or stuck relay.
- Some systems and modules such as OnStar®, and regulated voltage control, if equipped, are designed to wake up, perform a task, and go back asleep at regular intervals. Refer to [Body Control System Description and Operation](#) for the system or modules description and operation.
- An engine off natural vacuum evaporative test can occur if the engine control module (ECM) determines the drive cycle has met the appropriate criteria immediately after key off. The ECM will stay awake and the vent solenoid will stay energized for as long as 45 min. The typical current draw for this is about 1 A.
- Digital OnStar Generation 6 and later vehicle communication interface module do not "wake up" every 10 minutes for the first 48 hours as the Generation 5 and prior. Generation 6 and later vehicle communication interface module current draw is very low, less than 40 mA, so the OnStar system is left in that state for up to the first 48 h. Parasitic draw of up to 40 mA with an occasional spike as high as 80 mA through the vehicle communication interface module for the first 48 hours is normal.
- Some automatic climate control systems can remain in a semi awake state for up to three hours, actual draw amounts vary by vehicle platform but are typically not greater than 50 mA.
- An extremely low mA current level is consumed by the body control module for monitoring purposes, actual system wake up only occurs when the fobs for the vehicle are used. When other devices on the same remote keyless entry operating frequency are activated, such as the 4 tire pressure monitoring sensors and other vehicle Fobs in the vicinity, the body control module will have a 100 mA spike. These spikes are normal and

occur too briefly to have a significant effect on battery drain. Competing signals may cause remote keyless entry performance issues such as jamming but should not cause excessive battery draw.

- If an excessive current draw is not present during initial testing, continue periodic testing over a 1–2 hour period to see if the current draw increases and stays above an unacceptable level.

Note: The battery specification listed below is a generic specification. Refer to the label on the original battery when testing the battery.

- The battery run down time will vary depending on the batteries reserve capacity. If the reserve capacity is higher, then the battery run down time may be longer. If the reserve capacity is lower, then the battery run down time may be shorter. The graph below indicates roughly how many days a 690 cold cranking amperage battery with a 110 min. reserve capacity starting at 80 percent state of charge will last with a constant current draw until it reaches 50 percent state of charge. Differences in battery reserve capacity and temperature will affect the results.

Current Drain	Days
25 mA	33
50 mA	16.5
75 mA	11
100 mA	8.25
250 mA	3.3
500 mA	1.65
750 mA	1
1 A	0.8
2 A	0.4

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Reference Information

Schematic Reference

[Control Module References](#)

Connector End View Reference

[Component Connector End Views](#)

Electrical Information Reference

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

Scan Tool Reference

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

Special Tools

EL 38758 Parasitic Draw Test Switch

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

Circuit/System Verification

Note:

- Most vehicle systems will go to sleep within 30 min, but it can take up to 2 hours before all systems power down allowing the parasitic draw test to pass. An occasional increase in the parasitic draw is normal as long as it returns within 1 s.
- Closing the door latches/ajar switch while leaving the doors open is recommended, this allows the vehicle systems to perform in a "doors closed" mode while allowing vehicle interior access that may be needed to complete the diagnostic steps.
- Locking doors will arm the vehicle content theft deterrent system if equipped. Failure to arm the system may cause a theft system fault to not be present during testing.
- There are many things that can prevent the vehicle from completely going to sleep and passing the parasitic draw test. Make sure all the conditions listed below are met before performing the parasitic current draw test.
 - Ignition OFF
 - Key out of the ignition switch – when not equipped with keyless access and start
 - Retained Accessory Power OFF – open and close the driver door after ignition OFF
 - Scan tool not communicating with a vehicle control module – in some cases it may need to be disconnected from the DLC
 - All access doors closed
 - Head lamps OFF – auto head lamps disabled
 - Any delay lighting OFF
 - If equipped with an under hood lamp disable it
 - HVAC after blow OFF
 - Any accessory that can work with ignition OFF inactive or OFF
 - Wait up to 2 min or longer, after all other listed conditions are met

Using an Inductive Pickup Probe

1. Connect an inductive pickup probe to the negative battery cable that can read down to 1 mA.
 2. Ignition OFF, as the vehicle systems shut down test for less than 30 mA of parasitic current drain.
- ⇒ If greater than the specified range, refer to Circuit/System Testing.

Using the EL 38758 Parasitic Draw Test Switch

Warning: Refer to [Battery Disconnect Warning](#).

Caution: When a fused jumper wire or digital multimeter is connected to the test switch terminals, always turn the test switch ON before opening any access door, turning the ignition on, or turning any accessory on. This is to prevent damaging the jumper wire or digital multimeter fuse.

Note: The switch knob on the EL 38758 switch is marked ON and OFF. When the switch knob is in the ON position, the circuit is closed and electrical current will pass through the switch. When the switch knob is in the OFF position, the circuit is open and electrical current will not pass through the switch.

1. Ignition OFF, disconnect the battery negative cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Turn the EL 38758 switch knob to the OFF position.
3. Install the male end of the EL 38758 switch to the battery ground terminal.
4. Install the battery negative cable to the female end of the EL 38758 switch.

5. Turn the *EL 38758* switch knob to the ON position.
6. Road test the vehicle and activate all of the accessories such as the radio and air conditioning.
7. Ignition OFF, connect a 10 A fused jumper wire to the test switch tool terminals.
8. Turn the *EL 38758* switch knob to the OFF position. The current now flows through the jumper wire.
9. Check the fuse in the jumper wire. The fuse should be OK.
⇒ Failed: If the jumper wire fuse is blown, refer to Circuit/System Testing.
⇓ Passed
10. Turn the *EL 38758* switch knob to the ON position. Remove the fused jumper wire.
11. Connect a DMM set to the 10 A DC scale between the test switch tool terminals.
12. Turn the *EL 38758* switch knob to the OFF position. The current now flows through the DMM.
13. As the vehicle systems shut down test for less than 30 mA of parasitic current drain.
⇒ If greater than the specified range, refer to Circuit/System Testing.

Circuit/System Testing

Note:

- Removing or installing a fuse, relay, or connector, to determine the area causing high parasitic draw may wake up control modules. You must wait for the control modules to go back to sleep before retesting. It is best to install any removed or disconnected components after the diagnosis is completed.
- Fuses for power mode master components such as the BCM should be removed last to avoid misdiagnosis.
- If a scan tool is connected to the DLC, either disconnect it or subtract the scan tool current draw from the DMM reading to get the actual vehicle parasitic current draw.

If the vehicle has an unacceptable amount of parasitic current draw, remove each fuse one at a time until the current draw falls to an acceptable level. A drop of more than 10–20 mA, when disabling a single system or circuit, is an indication of an overly high current draw that could be causing the battery drain. Refer to [Power Distribution Schematics](#) to diagnose exactly which circuit of the suspect system is causing the high parasitic drain. The following is a list of common components that could cause a high current draw:

- Stuck switch
- Stuck relay
- Control module

Repair Instructions

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

[Control Module References](#) for control module replacement, programming and setup

Charging System Test

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	—	P0621	—	—
Control – L Terminal	P0621	P0621	P0621	—
Signal – F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator turn ON control circuit to control the load of the generator on the engine. A high side driver in the ECM applies a duty cycled voltage to the voltage regulator. The duty cycle controls the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON control circuit. The ECM should detect low voltage on the generator turn on control circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage when the duty cycle voltage is commanded high and a low voltage when the duty cycle voltage is commanded low on the generator turn on control circuit.

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings on and off. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is off, the ECM should detect a duty cycle near 0%. When the engine is running, the duty cycle should be between 5–99%.

Reference Information

Schematic Reference

[Starting and Charging Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Charging System Description and Operation](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)

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

[Circuit/System Verification](#)

Note: Do not have a battery charger connected during the generator testing.

1. Ignition ON.
2. Verify that no G13 Generator or B18 Battery Current Sensor DTCs are set that would cause a charging system concern.
 - ⇒ **If DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
 - ↓ **If no DTCs are set**
3. Verify the scan tool Body Control Module Battery Voltage parameter is 12 V or greater.
 - ⇒ **If less than 12 V**
Refer to [Battery Inspection/Test](#).
 - ↓ **If 12 V or greater**
4. Engine running, all accessories OFF.
5. Verify the scan tool Body Control Module Battery Voltage parameter continually increases when controlling the Body Control Module Generator Regulator Setpoint from 10% to 80% with a scan tool. It may take up to 10 s for the battery voltage to stabilize between each setpoint change.
 - ⇒ **If the battery voltage does not continually increase**
Refer to Circuit/System Testing.
 - ↓ **If the battery voltage continually increases**
6. All OK.

[Circuit/System Testing](#)

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

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal 1 X2, 2 X2 or A X2 and ground.
 - ⇒ **If the test lamp does not illuminate and the circuit fuse is good**
 - 1.1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
 - 1.2. Test for less than 2 Ω in the B+ circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
 - 1.1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
 - 1.2. Test for infinite resistance between the B+ circuit and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 - ⇒ If infinite resistance, test or replace the G13 Generator.
 - ↓ **If the test lamp illuminates**
2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is less than 5%.
 - ⇒ **If 5% or greater**
 - 3.1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.

3.2. Test for less than 1 V between the G13 Generator signal circuit terminal 2 X1 and ground.

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

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

↓ **If less than 5%**

4. Install a 3 A fused jumper wire between the signal circuit terminal 1 X1 and B+, engine running.

5. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is greater than 95%.

⇒ **If 95% or less**

5.1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.

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

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

↓ If infinite resistance

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

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit

⇒ If less than 2 Ω , replace the K20 Engine Control Module.

↓ **If greater than 95%**

6. Test or replace the G13 Generator.

Repair Instructions

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

[Generator Replacement](#)

Charge Indicator Always On

Electrical Information Reference

- [Diagnostic System Check - Vehicle](#)
- [Circuit Testing](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)
- [Battery Inspection/Test](#)
- [Battery Electrical Drain/Parasitic Load Test](#)
- [Charging System Test](#)

The driver information center (DIC) may display a "Charging System Failure" message. This message being displayed is the result of a message being sent by the engine control module (ECM), instrument panel module (IPM), dash integration module (DIM) or the instrument panel cluster (IPC) to the DIC. Each module has a different criteria for requesting the message to be displayed.

Warning: Refer to [Safety Glasses Warning](#).

1. Turn off all accessories.
2. With a scan tool, observe the Battery Voltage parameter in the IPM or DIM data list, ECM data list and the IPC) data list.
3. The voltage should be between 11.9 V and 15.9 V. If not within this range carry out charging system test.
4. The voltage should be within 1 V of each other. If not within 1 V carry out circuit testing.
5. If no fault in circuit replace the affected module.

Repair Instructions

[Engine Control Module Replacement](#)

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Charge Indicator Inoperative

Electrical Information Reference

- [Diagnostic System Check - Vehicle.](#)
- [Circuit Testing.](#)
- [Testing for Intermittent Conditions and Poor Connections.](#)

The alternator warning indicator is only illuminated for 6 seconds after the ignition is switched to the ON position with the engine OFF.

Warning: Refer to [Safety Glasses Warning](#).

1. Carry out the Diagnostic System Check.
2. Ignition on alternator warning light should illuminate for 6 second.
 - ⇒ If the alternator warning does not illuminate, connect the scan tool and command the alternator warning light ON.
 - ⇒ If the light does not illuminate replace instrument panel cluster.

Repair Instructions

[Instrument Cluster Replacement.](#)

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Generator Noise Diagnosis

Diagnostic Instructions

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

Diagnostic Aids

Noise from a generator may be due to electrical or mechanical noise. Electrical noise or magnetic whine usually varies with the electrical load placed on the generator and is a normal operating characteristic of all generators. When diagnosing a noisy generator, it is important to remember that loose or misaligned components around the generator may transmit the noise into the passenger compartment and that replacing the generator may not solve the problem.

Circuit/System Testing

1. Start the engine. Verify the noise can be heard. Compare the concern to a similar vehicle.
2. Perform a charging system test. Verify that the generator is charging properly.
3. Inspect the generator, generator mounting, wiring harness, heater hoses, A/C lines, or other accessory equipment that may be misrouted or be the cause of noise being transmitted into the passenger compartment.
4. Ignition OFF, remove the engine drive belt.
5. Verify the generator, A/C compressor, water pump pulley, power steering pump, idler pulley, and tensioner pulley spin freely.
 - ⇒ **If any of the pulleys do not spin freely**
Replace the affected component.
 - ⇓ **If all belt driven components spin freely**
6. Start the engine. Operate the engine for no longer than 30-40 seconds.
7. Verify that the noise goes away.
 - ⇒ **If the noise is still present**
The generator is not the cause of the noise. Refer to [Symptoms - Engine Mechanical](#) for 3.0L (LFW) or 3.6L (LFX LWR) engines or [Symptoms - Engine Mechanical](#) for 6.2L (LS3 LSA) engine.
 - ⇓ **If noise is no longer present**
8. Inspect for worn accessory drive components or abnormalities such as severe cracking, bumps, or missing areas in the accessory drive belt and/or misalignment of system components

Repair Instructions

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

Starter Solenoid Does Not Click

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	—	—
Signal	2	1	—	—
Relay Coil Control Terminal 85	—	1	3	—
Starter Control Terminal 87	1	1	3	—
Ground	—	1	—	—
1. Starter solenoid does not click 2. Cranks in any gear 3. Cranks all the time				

Circuit/System Description

When the ignition is activated, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the crank mode. The BCM then sends a serial data message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch is fully depressed or the automatic transmission is in Park/Neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter motor.

Reference Information

Schematic Reference

- [Starting and Charging Schematics](#)
- [Automatic Transmission Controls Schematics](#) for the Automatic Transmissions - 6L45/6L50/6L80/6L90
- [Manual Transmission Schematics](#) for the Manual Transmission Tremec 6-speed

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Starting System Description and Operation](#)

Electrical Information Reference

- [Circuit Testing](#)

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

Scan Tool Reference

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

Circuit/System Verification

Automatic Transmission

1. Ignition ON.
2. Verify that no ignition, KR27 Starter Relay, brake pedal position sensor, immobilizer, or transmission DTCs are set that would cause the ECM to disable engine starting.
 - ⇒ **If DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
 - ⇓ **If no DTCs are set**
3. Verify the scan tool 5 V Ignition Switch parameter is Crank Request while attempting to start the vehicle.
 - ⇒ **If parameter does not display Crank Request**
Refer to [Vehicle Will Not Change Power Mode](#)
 - ⇓ **If parameter displays Crank Request**
4. Verify the scan tool TCM Internal Mode Switch parameter displays Park when in park.
 - ⇒ **If the TCM Internal Mode Switch parameter does not indicate Park.**
Refer to [Transmission Internal Mode Switch Logic](#)
 - ⇓ **If the TCM Internal Mode Switch parameter displays Park**
5. Verify the scan tool ECM Crankshaft Position Active Counter parameter is not incrementing.
 - ⇒ **If the counter increments**
Replace the B26 Crankshaft Position Sensor.
 - ⇓ **If the counter does not increment**
6. Verify the engine cranks in park or neutral.
 - ⇒ **If the KR27 Starter Relay does not click or the engine does not crank**
Refer to Circuit/System Testing.
 - ⇓ **If the engine cranks**
7. All OK

Manual Transmission

1. Ignition ON.
2. Verify that no ignition, KR27 Starter Relay, clutch pedal position sensor, brake pedal position sensor, or immobilizer DTCs are set that would cause the ECM to disable engine starting.
 - ⇒ **If DTCs are set**
refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
 - ⇓ **If no DTCs are set**
3. Verify the scan tool 5 V Ignition Switch parameter is Crank Request while attempting to start the vehicle.
 - ⇒ **If parameter does not display Crank Request**
Refer to [Power Mode Mismatch](#)
4. Ignition ON.

5. Verify the scan tool Clutch Pedal Starter Inhibit Switch parameter changes between On and Off while depressing and releasing the clutch pedal.
 - ⇒ **If the Clutch Pedal Starter Inhibit parameter does not change**
Refer to [Clutch Pedal Position Sensor Learn](#)
 - ⇓ **If the clutch pedal starter inhibit parameter does change**
6. Fully depress clutch pedal.
7. Attempt to start the vehicle.
8. Verify the scan tool ECM Crankshaft Position Active Counter parameter is not incrementing.
 - ⇒ **If the counter increments**
Replace the B26 Crankshaft Position Sensor.
 - ⇓ **If the counter does not increment**
9. Verify the crank relay does click and the engine begins cranking.
 - ⇒ **If the KR27 Starter Relay does not click or the engine does not begin cranking**
Refer to Circuit/System Testing.
 - ⇓ **If the KR27 Starter Relay does click and the engine does begin cranking**
10. All OK

Circuit/System Testing

1. Ignition ON.
2. Verify the scan tool ECM Ignition 1 Signal parameter is greater than 10 V.
 - ⇒ **If 10 V or less**
 - 2.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 - 2.2. Test for infinite resistance between the ignition voltage circuits and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 - ⇓ If infinite resistance
 - 2.3. Test for less than 2 Ω in the control circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , replace the K20 Engine Control Module.
 - ⇓ **If greater than 10 V**
3. Ignition OFF, disconnect the KR27 Starter Relay, ignition ON.
4. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - ⇒ **If the test lamp does not illuminate and the circuit fuse is good**
 - 4.1. Ignition OFF.
 - 4.2. Test for less than 2 Ω in the B+ circuit end to end.
 - ⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - ⇒ **If the test lamp does not illuminate and the circuit fuse is open**
 - 4.1. Ignition OFF.
 - 4.2. Test for infinite resistance between the B+ circuit and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 - ⇓ If infinite resistance,
 - 4.3. Disconnect X1 harness connector at the M64 Starter Motor.
 - 4.4. Test for infinite resistance between the control circuit terminal 87 and ground.
 - ⇒ If less than infinite resistance, repair the short to ground on the circuit.
 - ⇒ If infinite resistance, replace the M64 Starter Motor.
 - ⇓ **If the test lamp illuminates**

5. Ensure the parking brake is applied and the automatic transmission is in PARK or the manual transmission is in neutral. Momentarily install a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
6. Verify the M64 Starter Motor is activated.
 - ⇒ **If the M64 Starter Motor does not activate**
 - 6.1. Disconnect the X1 harness connector at the M64 Starter Motor.
 - 6.2. Test for less than 2 Ω in the control circuit end to end.
 - ⇒ If greater the 2 Ω , repair the open/high resistance in the circuit.
 - ⇒ If less than 2 Ω , replace the M64 Starter Motor.
 - ⇓ **If the M64 Starter Motor activates**
7. Test or replace the KR27 Starter Relay.

Component Testing

Relay Test

1. Ignition OFF.
2. Disconnect the KR27 Starter Relay.
3. Test for 60–180 Ω between terminals 85 and 86.
 - ⇒ **If not within 60–180 Ω**
Replace the relay.
 - ⇓ **If within 60–180 Ω**
4. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - ⇒ **If not infinite resistance**
Replace the relay.
 - ⇓ **If infinite resistance**
5. Install a 20 A fused jumper wire between relay terminal 85 and B+.
6. Install a jumper wire between relay terminal 86 and ground.
7. Test for less than 2 Ω between terminals 30 and 87.
 - ⇒ **If 2 Ω or greater**
Replace the relay
 - ⇓ **If less than 2 Ω**
8. All OK

Repair Instructions

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

- [Relay Replacement](#)
- [Starter Replacement](#)
- [Crankshaft Position Sensor Replacement](#) for the 2.8L, 3.0L, 3.2L, or 3.6L engine
- [Crankshaft Position Sensor Replacement](#) for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine
- [Control Module References](#) for ECM replacement, programming, and setup

Starter Solenoid Clicks, Engine Does Not Crank

Diagnostic Instructions

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

Reference Information

Schematic Reference

[Starting and Charging Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Starting System Description and Operation](#)

Electrical Information Reference

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

Scan Tool Reference

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

Circuit/System Testing

1. Ignition OFF, measure and record the battery voltage at the C1 Battery terminals.
2. Verify the measured voltage is between 12–15 V.
⇒ **If voltage is less than 12 V or greater than 15 V**
Refer to [Battery Inspection/Test](#).
- ↓ **If voltage is between 12–15 V**
3. Remove the drive belts. Refer to [Drive Belt Replacement](#) for the 3.0L (LFW) or 3.6L (LFX LWR) engines or [Drive Belt Replacement - Accessory](#) for the 6.2L (LS3 LSA) engine.
4. Verify the crankshaft rotates. Rotate the crankshaft by hand using the appropriate tools.
⇒ **If the crankshaft does not rotate**
Refer to [Engine Will Not Crank - Crankshaft Will Not Rotate](#) for the 3.0L (LFW) or 3.6L (LFX LWR) engines or [Engine Will Not Crank - Crankshaft Will Not Rotate](#) for the 6.2L (LS3 LSA) engine.
- ↓ **If the crankshaft rotates**
5. Verify the engine does not crank when attempting to start the vehicle.
⇒ **If the engine cranks**
Inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator.
- ↓ **If the engine does not crank**

6. Verify that a test lamp illuminates between the M64 Starter Motor B+ terminal A X2 and ground.

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

6.1. Ignition OFF.

6.2. Test for less than 2 Ω in the B+ circuit end to end.

⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

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

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

6.1. Ignition OFF.

6.2. Test for greater than 100 Ω between the B+ circuit and ground.

⇒ If 100 Ω or less, repair the short to ground on the circuit.

⇒ If greater than 100 Ω , replace the M64 Starter Motor.

↓ **If the test lamp illuminates**

7. Test for less than 0.5 V between the positive battery post and M64 Starter Motor B+ terminal A X2 with the ignition in the CRANK mode.

⇒ **If 0.5 V or greater**

Replace the positive battery cable.

↓ **If less than 0.5 V**

8. Test for less than 0.5 V between the negative battery post and the M64 Starter Motor case with the ignition in the CRANK mode.

⇒ **If 0.5 V or greater**

Replace the negative battery cable.

↓ **less than 0.5 V**

9. Replace the M64 Starter Motor.

Repair Instructions

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

- [Battery Negative Cable Replacement](#)
- [Starter Replacement](#)

Engine Cranks Slowly

Diagnostic Instructions

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

Reference Information

Schematic Reference

[Starting and Charging Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Starting System Description and Operation](#)

Electrical Information Reference

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

Scan Tool Reference

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

Circuit/System Testing

1. Ignition OFF, measure and record the battery voltage at the C1 Battery terminals.
2. Verify the measured voltage is between 12–15V.
⇒ **If voltage is less than 12 V or greater than 15 V**
Refer to [Battery Inspection/Test](#).
- ↓ **If voltage is between 12 –15 V**
3. Remove the drive belts. Refer to [Drive Belt Replacement](#) for the 2.8L, 3.0L, 3.2L, or 3.6L engines or [Drive Belt Replacement - Accessory](#) for 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engine.
4. Verify the engine cranks slowly when attempting to start the vehicle.
⇒ **If the engine cranks at normal speed**
Inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator.
- ↓ **If the engine cranks slowly**
5. Verify that a test lamp illuminates between the M64 starter motor B+ terminal A X2 and ground.
⇒ **If the test lamp does not illuminate**
 - 5.1. Ignition OFF.
 - 5.2. Test for less than 2 Ω in the B+ circuit end to end.
⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.

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

↓ **If the test lamp illuminates**

6. Test for less than 0.5 V between the positive battery cable and terminal A X2 at the M64 starter motor with the ignition in the START position.

⇒ **If 0.5 V or greater**

Replace the positive battery cable.

↓ **If less than 0.5 V**

7. Test for less than 0.5 V between the negative battery cable and the M64 starter motor case with the ignition in the START position.

⇒ **If 0.5 V or greater**

Replace the negative battery cable.

↓ **If less than 0.5 V**

8. Replace the M64 starter motor.

Repair Instructions

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

- [Battery Positive Cable Replacement](#)
for positive battery cable replacement
- [Battery Negative Cable Replacement](#)
for negative battery cable replacement
- [Starter Replacement](#)

Battery Isolator Malfunction

Diagnostic Instructions

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

Circuit/System Description

The battery isolator is designed to protect the primary battery from excessive discharge while allowing the auxiliary battery to supply non-essential loads. When the Ignition switch is placed in the RUN position ignition voltage is supplied to the battery isolator. If the battery isolator detects the battery voltage drops below 12.2 Volts the battery isolator will open the auxiliary battery B+ circuit, separating the primary battery from the auxiliary battery and auxiliary circuits. If the battery voltage reaches 13.6 Volts the battery isolator will close the auxiliary battery B+ circuit, connecting the auxiliary battery to the primary battery and the charging system.

Reference Information

Schematic Reference

[Auxiliary Battery Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Description and Operation

[Starting System Description and Operation](#)

Electrical Information Reference

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

Circuit/System Testing

1. Verify that auxiliary fuse block and left rear body fuse block fusible links are not open.
⇒ If either fusible link is open, test affected circuit for a short to ground.
2. Ignition OFF, disconnect X2 connector at the battery isolator.
3. Verify a test lamp illuminates between the battery isolator harness side B+ circuit terminal 1 X2 and ground.
⇒ If the test lamp does not illuminate, repair the open/high resistance in the B+ circuit.
4. Verify a test lamp does not illuminate between the battery isolator component side B+ circuit terminal 1 X2 and ground.
⇒ If the test lamp illuminates, test the battery isolator ignition circuit for a short to voltage. If no short to voltage found, replace battery isolator.
5. Ignition OFF, disconnect X1 and X3 connector at the battery isolator.
6. Test for less than 2 Ω from the battery isolator harness side ground circuit 2 X3 and ground.
⇒ If greater than 2 Ω , repair the short to voltage or open/high resistance in the circuit.

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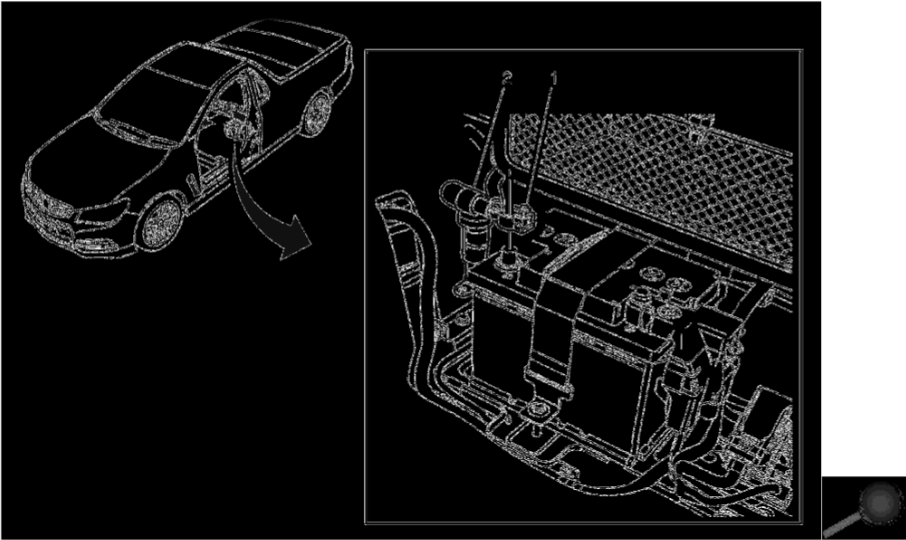
7. Verify a test lamp illuminates between the battery isolator harness side supply B+ circuit terminal 1 X1 and ground.
 - ⇒ If the test lamp does not illuminate, test the battery isolator supply B+ circuit for an open/high resistance.
8. Engine running, verify a test lamp illuminates between the battery isolator harness side ignition circuit terminal 1 X3 and ground.
 - ⇒ If the test lamp does not illuminate, test the battery isolator ignition circuit an short to ground or open/high resistance.
9. Ignition OFF, connect X1 and X3 connector at the battery isolator.
10. Engine running, verify a test lamp illuminates between the battery isolator component side B+ circuit terminal 1 X2 and ground.
 - ⇒ If the test lamp does not illuminate, replace the battery isolator.

Repair Instructions

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

- [Diagnostic Repair Verification](#)
- [Battery Isolator Replacement](#)

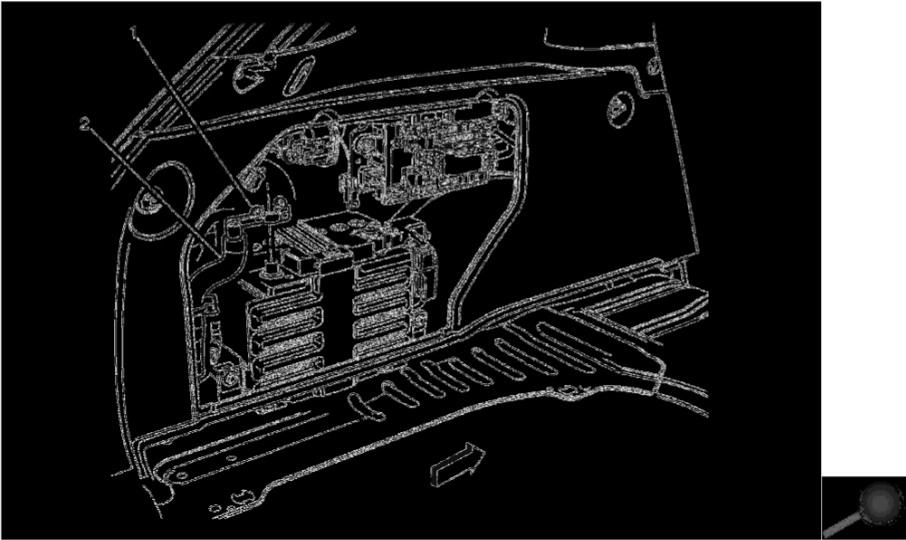
Battery Negative Cable Disconnection and Connection
(Ute)



Battery Negative Cable Disconnection and Connection

Callout	Component Name
Warning: Refer to Battery Disconnect Warning. Preliminary Procedure 1. Slide to driver seat to the forward position. 2. Remove the rear seat back body cushion. Refer to Rear Seat Back Cushion Opening Panel Replacement.	
1	Battery Negative Cable Clamp Fastener Caution: Refer to Fastener Caution . Tighten 5 N•m (44 lb in)
2	Battery Negative Cable

Battery Negative Cable Disconnection and Connection
(Sportwagon)

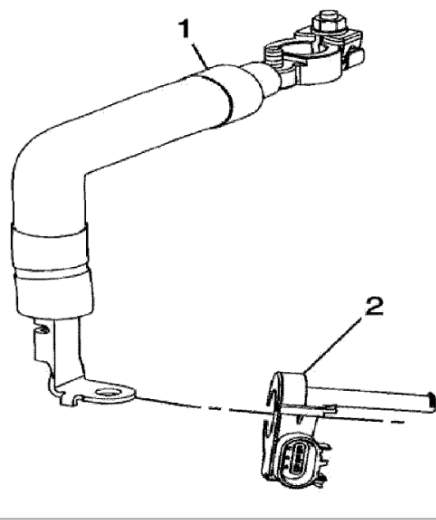


Battery Negative Cable Disconnection and Connection

Callout	Component Name
Warning: Refer to Battery Disconnect Warning . Preliminary Procedure Remove the rear compartment side trim panel access cover. Refer to Rear Compartment Side Trim Panel Access Hole Cover Replacement .	
1	Battery Negative Cable Clamp Fastener Caution: Refer to Fastener Caution . Tighten 5N·m (44 lbin)
2	Battery Negative Cable

cardiagn.com

Battery Current Sensor Replacement



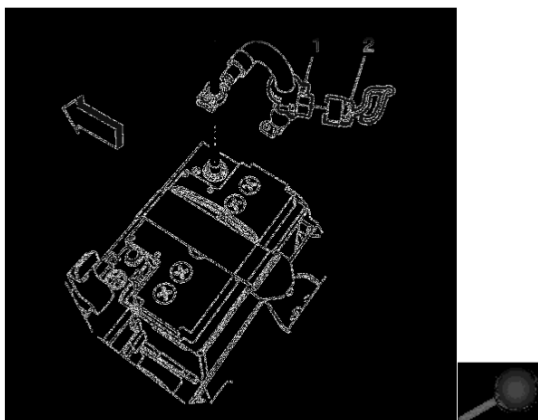
Battery Current Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the battery negative cable. Refer to Battery Negative Cable Replacement .	
1	Battery Negative Cable
2	Battery Current Sensor Note: Note the orientation of the battery current sensor when removing.

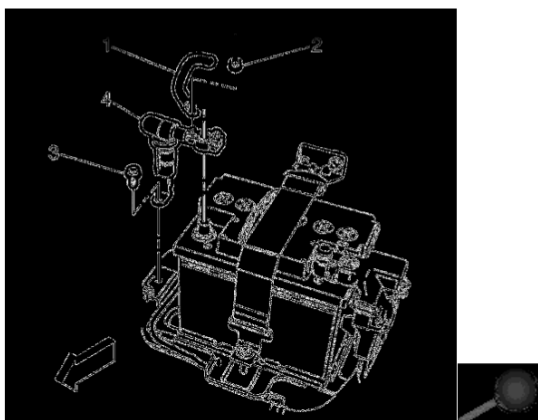
Battery Negative Cable Replacement (Ute)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

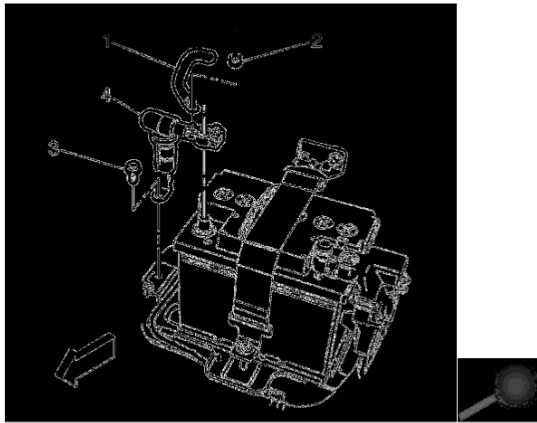


2. Disconnect the body harness connector (2) from the battery current sensor (1).



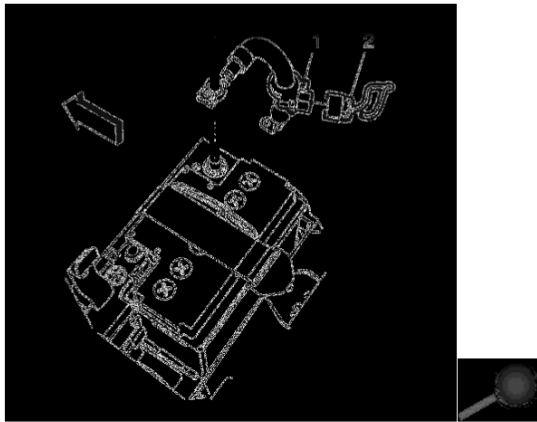
3. Remove the fastener (2) connecting the body harness ground terminal (1) to the battery negative cable (4).
4. Remove the battery negative cable ground fastener (3) and remove the battery negative cable (4) from the vehicle.
5. Transfer the battery current sensor, if necessary.

Installation Procedure



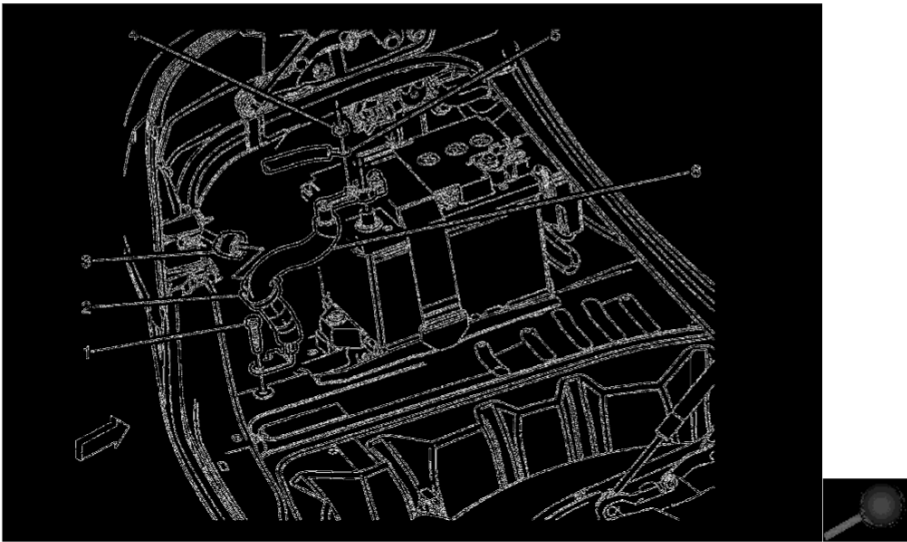
Caution: Refer to [Fastener Caution](#).

1. Install the battery negative cable (4) to the battery tray and tighten the fastener (3) to **22 N•m (16 lb ft)**.
2. Install the body harness ground terminal (1) to the battery negative cable clamp and tighten the fastener (1) to **9 N•m (80 lb in)**.



3. Connect the body harness connector (2) to the battery current sensor (1).
4. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Battery Negative Cable Replacement (Sedan, Sportwagon)



Battery Negative Cable Replacement

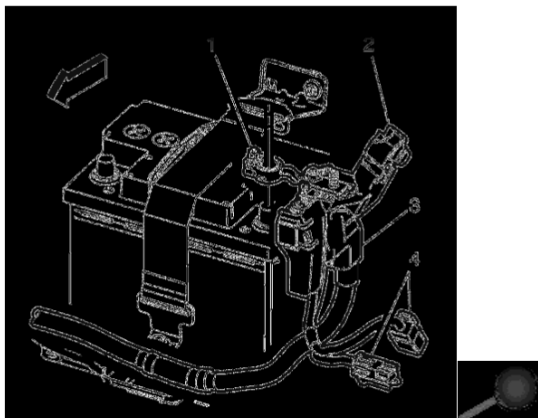
Callout	Component Name
Warning: Refer to Battery Disconnect Warning. Preliminary Procedure Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.	
1	Battery Negative Cable Ground Fastener Caution: Refer to Fastener Caution . Tighten 25 N•m (18 lb ft)
2	Battery Current Sensor
3	Body Harness Connector
4	Body Harness Ground Fastener Tighten 9 N•m (80 lb in)
5	Body Harness Ground Terminal
6	Battery Negative Cable Procedure

Callout	Component Name
	1. Disconnect the body harness connector from the battery current sensor. 2. Remove the body harness ground attached to the battery negative cable clamp. 3. Remove the battery negative cable ground fastener and remove the battery negative cable from the rear compartment. 4. If replacing the battery negative cable, transfer the battery current sensor.

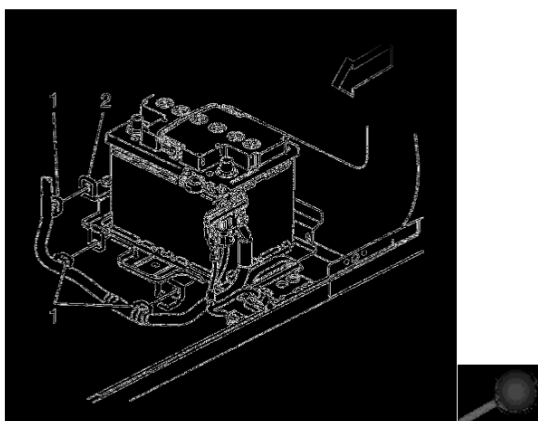
Battery Positive Cable Replacement (Ute)

Removal Procedure

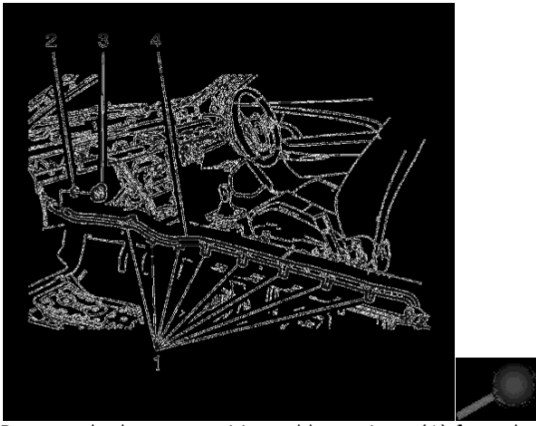
1. Remove the floor panel carpet. Refer to [Floor Panel Carpet Replacement](#).
2. Remove the dash panel inner insulator. Refer to [Dash Panel Inner Insulator Replacement](#).
3. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).



4. Remove the battery positive protective cover (2) from the battery positive cable (3).
5. Loosen the battery positive clamp fastener (1) and remove the battery positive cable (3).
6. Disconnect the connectors (4).

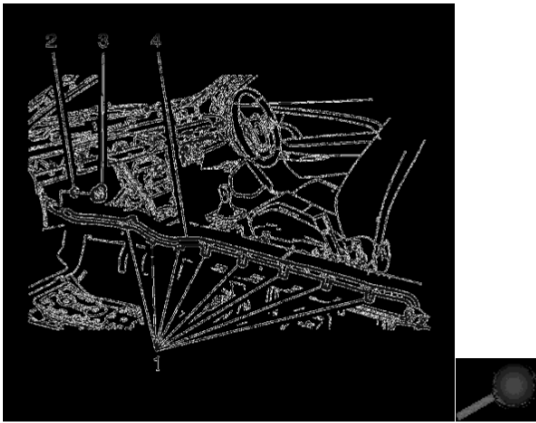


7. Remove the battery positive cable retainers (1) from the battery tray (2).



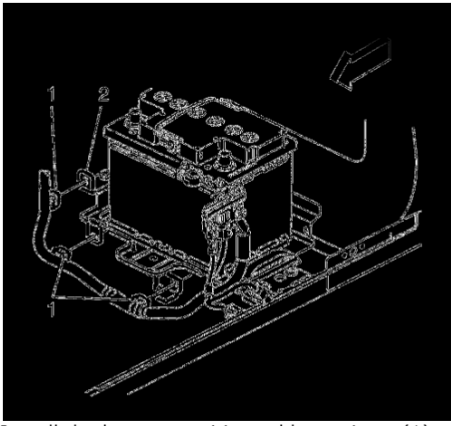
8. Remove the battery positive cable retainers (1) from the floor panel tunnel.
9. Remove the battery positive cable protective cover (3).
10. Remove the battery positive cable fastener (2) and remove the battery positive cable (4) from the passenger compartment.

Installation Procedure

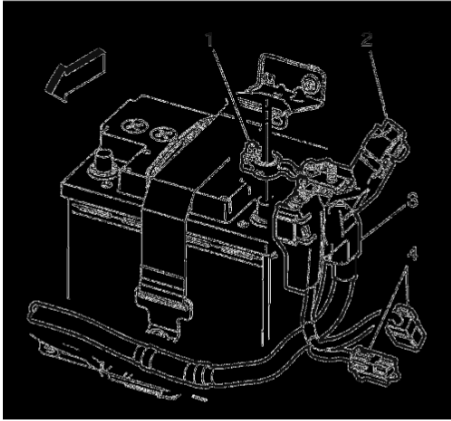


Caution: Refer to [Fastener Caution](#).

1. Install the battery positive cable to the plenum pass through bolt and tighten the fastener (2) to **15N·m (11 lb ft)**.
2. Install the battery positive cable retainers (1) to the floor panel tunnel.



3. Install the battery positive cable retainers (1) to the battery tray (2).

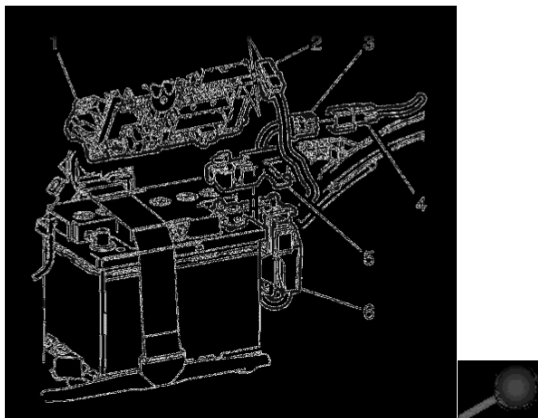


4. Install the battery positive cable (3) to the battery post and tighten the fastener (1) to **5 N·m (44 lb in)**.
5. Install the battery positive cable protective cover (2).
6. Connect the battery positive cable connectors (4).
7. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
8. Install the floor panel carpet. Refer to [Floor Panel Carpet Replacement](#).
9. Install the dash panel inner insulator. Refer to [Dash Panel Inner Insulator Replacement](#).

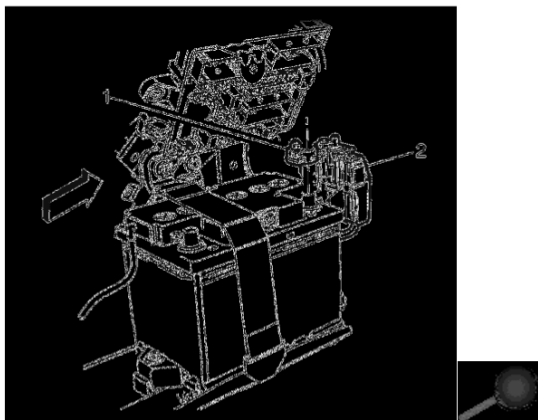
Battery Positive Cable Replacement (Sedan)

Removal Procedure

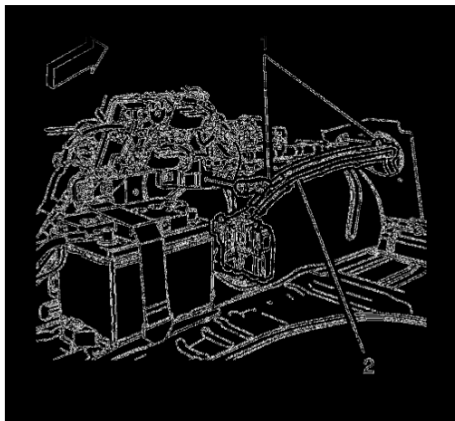
1. Remove the rear compartment side trim panel. Refer to [Rear Compartment Side Trim Panel Replacement](#).
2. Remove the rear compartment floor panel carpet. Refer to [Rear Compartment Floor Panel Carpet Replacement](#).
3. Remove the passenger front seat. Refer to [Driver or Passenger Seat Removal and Installation](#).
4. Remove the rear seat back cushion. Refer to [Rear Seat Back Cushion Removal and Installation](#).
5. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).



6. Remove the battery positive cable cover (5).
7. Disconnect the battery positive cable connector (2) from the accessory relay block (1).
8. Disconnect the battery positive cable connector (3) from the body harness connector (4).

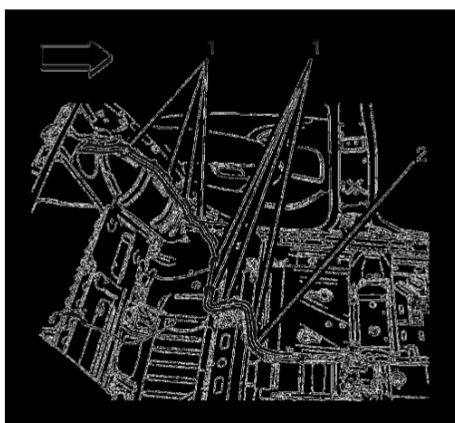


9. Loosen the battery positive cable clamp fastener (1) and remove the battery positive cable (2), from the battery.

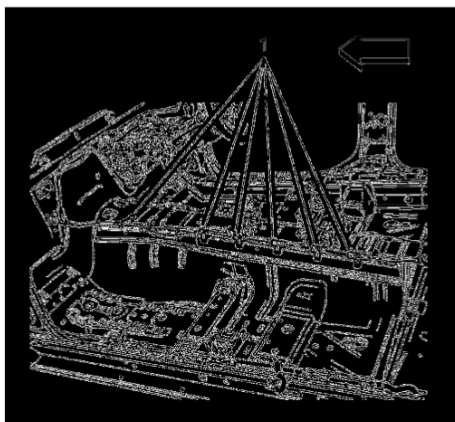


10. Detach the battery positive cable retainers (1) from the body harness conduit.

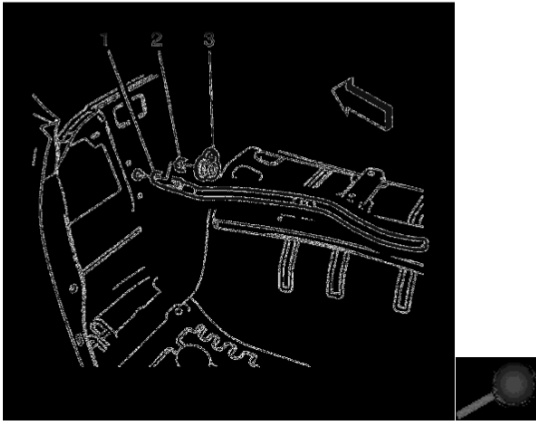
11. Slide the battery positive cable (2) through the back seat opening.



12. Within the rear passenger compartment area, detach the battery positive cable retainers (1) along the body harness conduit.

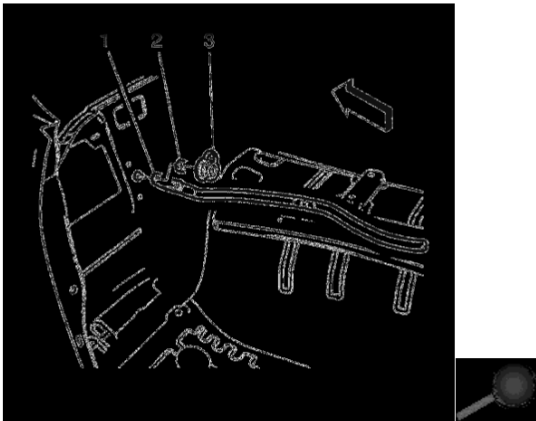


13. Detach the battery positive cable retainers (1) from the floor panel tunnel.



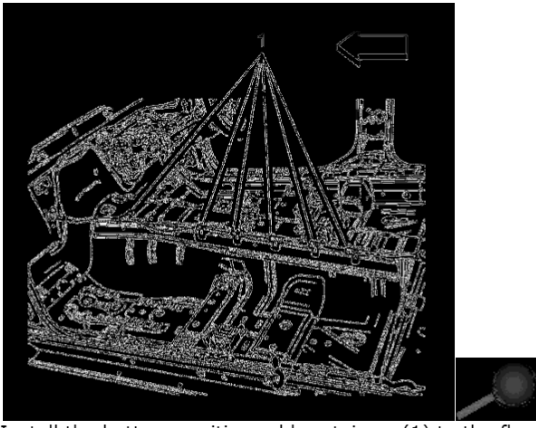
14. Remove the battery positive cable cover (3) and remove the battery positive cable passthrough fastener (2).
15. Remove the battery positive cable (1) from the passenger compartment.

Installation Procedure



Caution: Refer to [Fastener Caution](#).

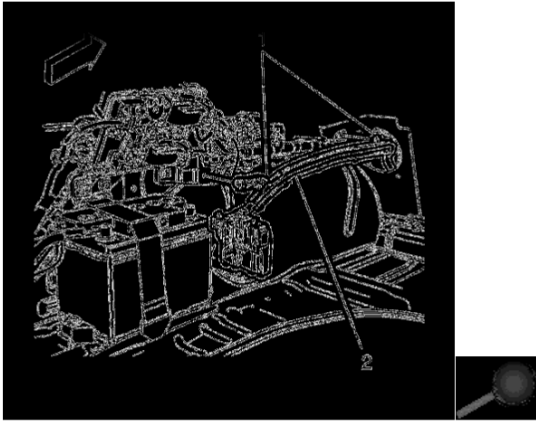
1. Install the battery positive cable (1) to the passthrough stud and tighten the fastener (2) to **15 N·m (11 lb ft)**.
2. Install the protective cover (3).



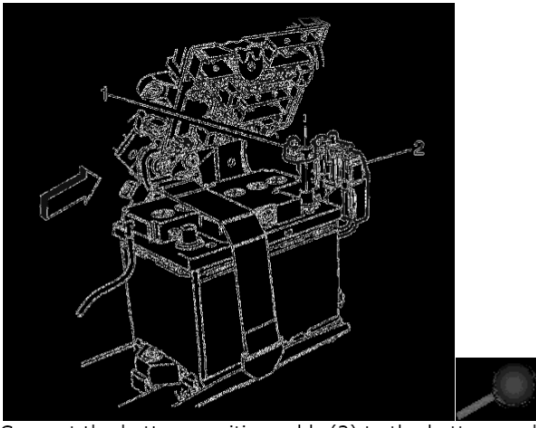
3. Install the battery positive cable retainers (1) to the floor panel tunnel.



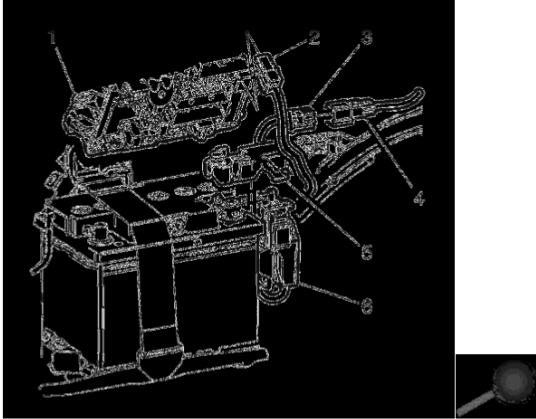
4. Route the battery positive cable (2) along the body harness conduit and attach the battery positive cable retainers (1).



5. Slide the battery positive cable (2) into the rear compartment area and attach the battery positive cable retainers (1) to the body harness conduit.



6. Connect the battery positive cable (2) to the battery and tighten the clamp fastener (1) to **5 N·m (44 lb in)**.

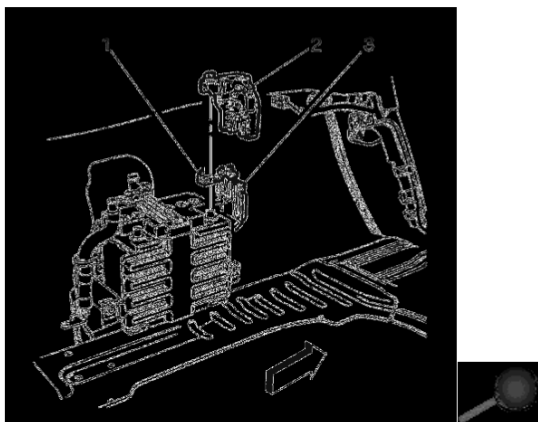


7. Install the battery positive cable cover (5).
8. Connect the battery positive cable connector (3) to the body harness connector (4).
9. Connect the battery positive cable connector (2) to the accessory relay block (1).
10. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
11. Install the rear compartment side trim panel. Refer to [Rear Compartment Side Trim Panel Replacement](#).
12. Install the rear compartment floor panel carpet. Refer to [Rear Compartment Floor Panel Carpet Replacement](#).
13. Install the rear seat cushion. Refer to [Rear Seat Back Cushion Removal and Installation](#).
14. Install the passenger front seat. Refer to [Driver or Passenger Seat Removal and Installation](#).

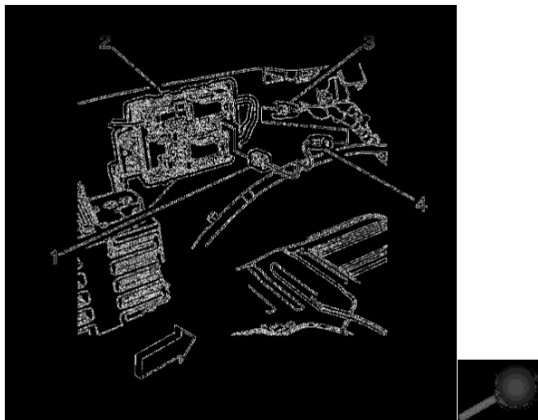
Battery Positive Cable Replacement (Sportwagon)

Removal Procedure

1. Remove the rear compartment side trim panel. Refer to [Rear Compartment Side Trim Panel Replacement](#).
2. Remove the passenger front seat. Refer to [Driver or Passenger Seat Removal and Installation](#).
3. Remove the rear seat cushion. Refer to [Rear Seat Cushion Removal and Installation](#).
4. Remove the rear seat back bolster. Refer to [Rear Seat Back Bolster Replacement](#).
5. Remove the dash panel inner insulator. Refer to [Dash Panel Inner Insulator Replacement](#).
6. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

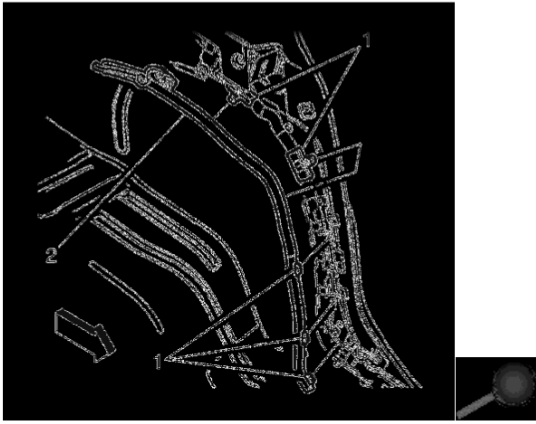


7. Remove the battery positive cable cover (2).
8. Loosen the battery positive cable clamp fastener (1) and remove the battery positive cable (3), from the battery positive post.

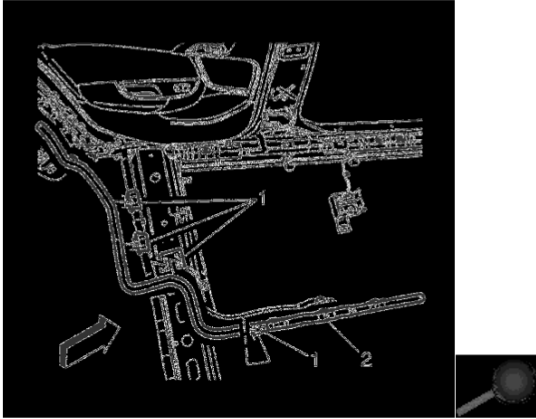


9. Disconnect the battery positive cable connector (1) from the rear fuse block (2).

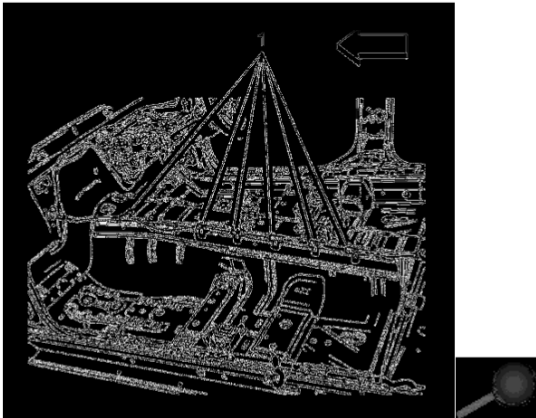
10. Disconnect the battery positive cable connector (4) from the body harness connector (3).



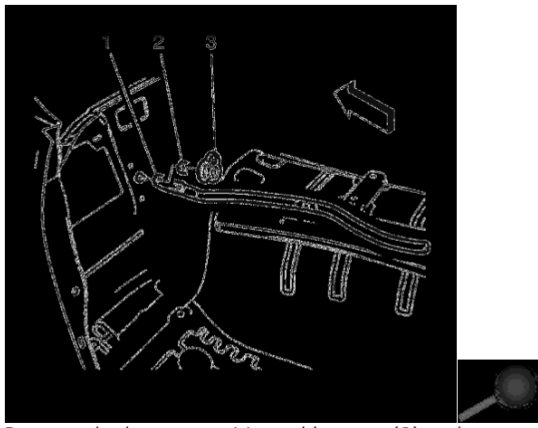
11. Detach the battery positive cable retainers (1) from the body harness conduit.
12. Slide the battery positive cable (2) through the back seat opening.



13. Within the rear passenger compartment area, detach the battery positive cable retainers (1) along the body harness conduit (2).



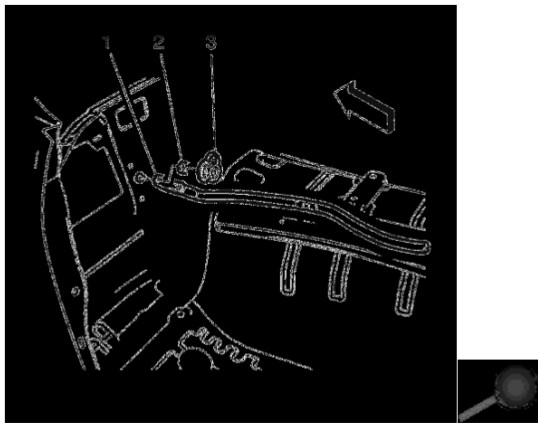
14. Detach the battery positive cable retainers (1) from the floor panel tunnel.



15. Remove the battery positive cable cover (3) and remove the battery positive cable passthrough fastener (2).

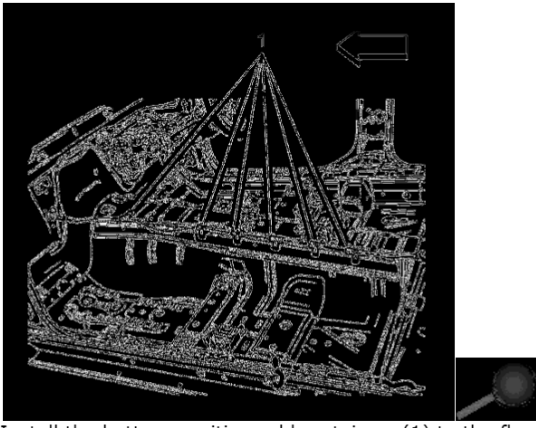
16. Remove the battery positive cable (1) from the passenger compartment.

Installation Procedure

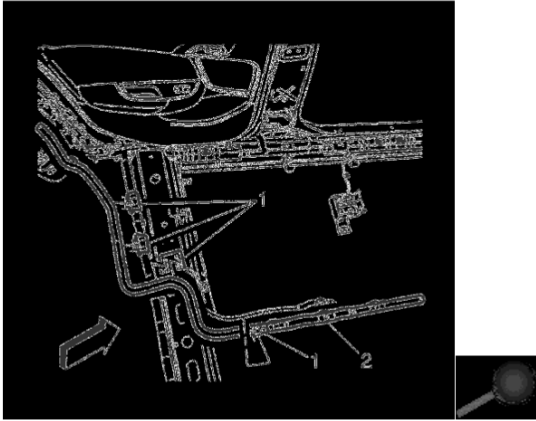


Caution: Refer to [Fastener Caution](#).

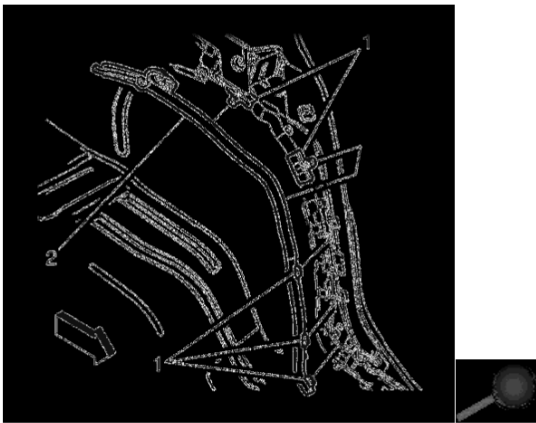
1. Install the battery positive cable (1) to the passthrough stud and tighten the fastener (2) to **15N•m (11 lb ft)**.
2. Install the protective cover (3).



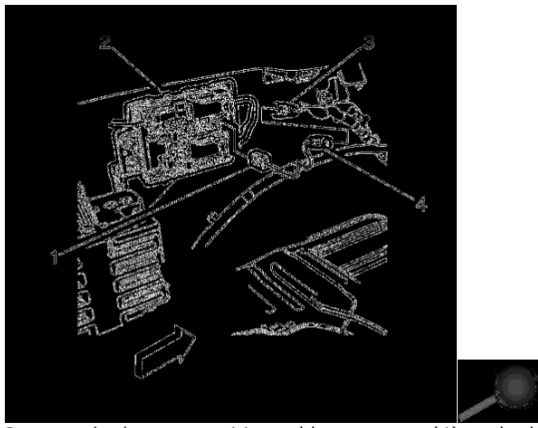
3. Install the battery positive cable retainers (1) to the floor panel tunnel.



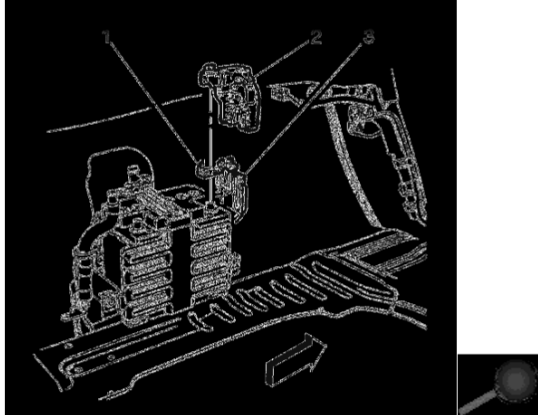
4. Route the battery positive cable (2) along the body harness conduit and attach the battery positive cable retainers (1).



5. Install the battery positive cable (2) into the body harness conduit retainers (1).



6. Connect the battery positive cable connector (4) to the body harness connector (3).
7. Connect the battery positive cable connector (1) to the rear fuse block (2).

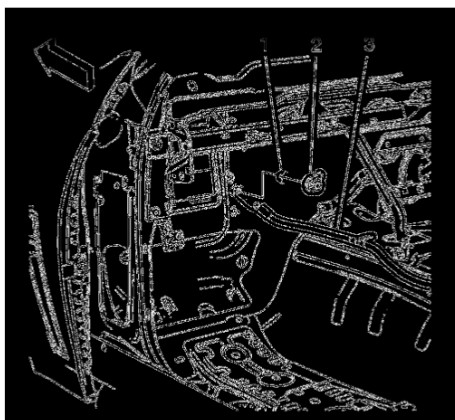


8. Install the battery positive cable (3) to the battery positive post and tighten the clamp fastener (1) to **5 N·m (44 lb in)**.
9. Install the battery positive protective cover (2).
10. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
11. Install the rear compartment side trim panel. Refer to [Rear Compartment Side Trim Panel Replacement](#).
12. Install the rear seat cushion. Refer to [Rear Seat Cushion Removal and Installation](#).
13. Install the rear seat back bolster. Refer to [Rear Seat Back Bolster Replacement](#).
14. Install the dash panel inner insulator. Refer to [Dash Panel Inner Insulator Replacement](#).
15. Install the passenger front seat. Refer to [Driver or Passenger Seat Removal and Installation](#).

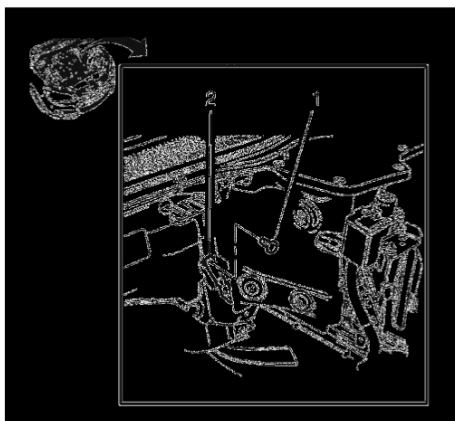
Battery Positive Cable Extension Cable Replacement

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

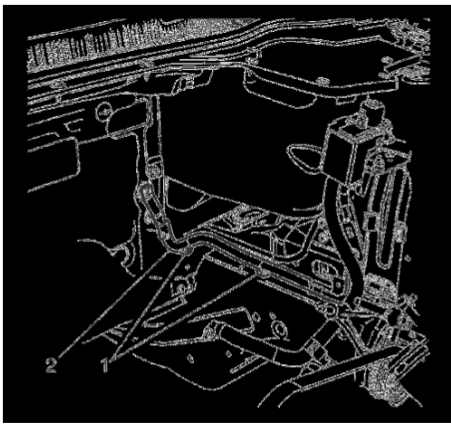


2. Remove the protective cover (2) to the battery positive cable (3).
3. Remove the fastener (1) connecting the battery positive cable (3) to the passthrough stud.

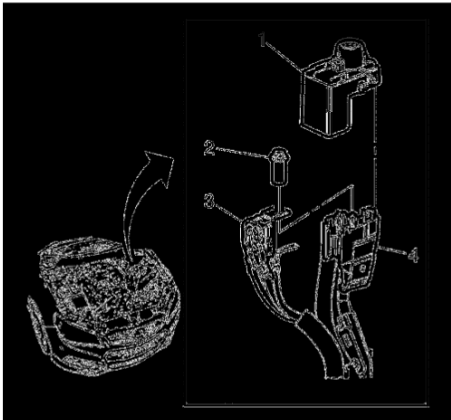


4. Remove the protective sleeve covering the battery positive extension cable (2).
5. Remove the passthrough stud (1) and remove the battery positive extension cable (2).

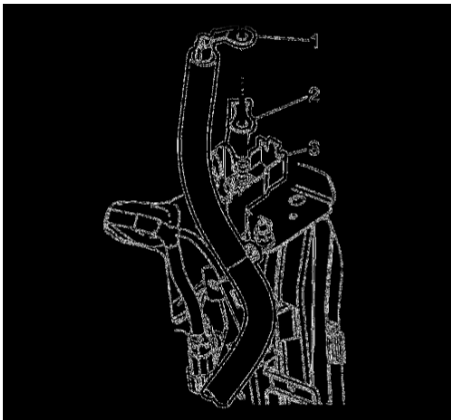
cardiagn.com



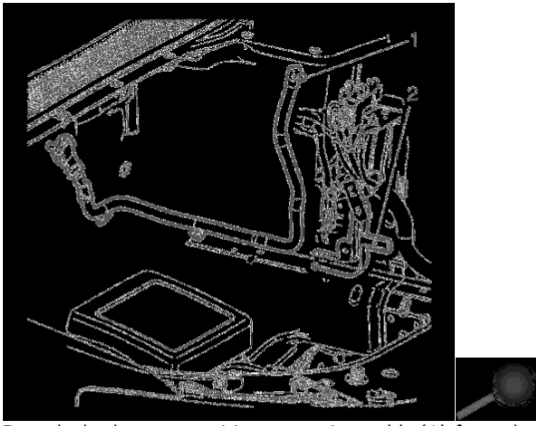
6. Detach the battery positive extension cable retainers (1), from the frame rail.



7. Remove the junction block cover (1) and remove the battery positive cable junction block stud (2).
8. Remove the engine wiring and battery positive cable with the attached mega fuse case (3), from the junction block (4).

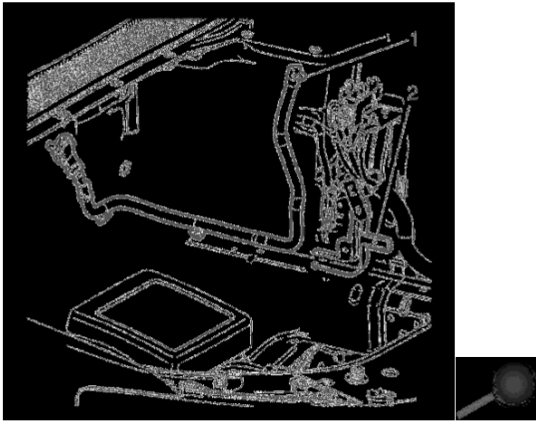


9. Remove the starter solenoid wiring harness (1) and the battery positive extension cable (2), from the junction block (3).

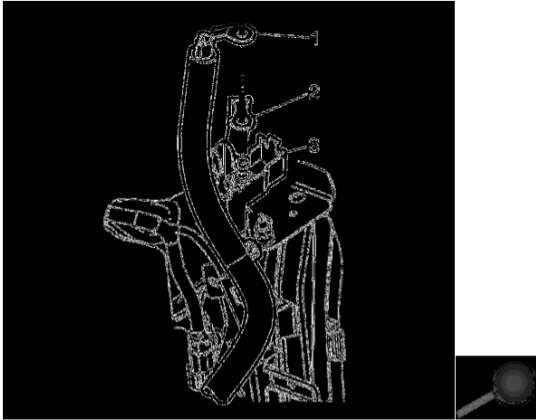


10. Detach the battery positive extension cable (1) from the harness cable conduit (2).
11. Remove the battery positive cable (1) from the engine compartment.

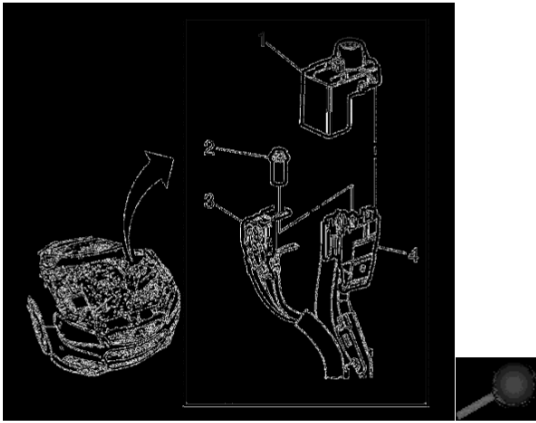
Installation Procedure



1. Install the battery positive extension cable (1) into the harness cable conduit (2).



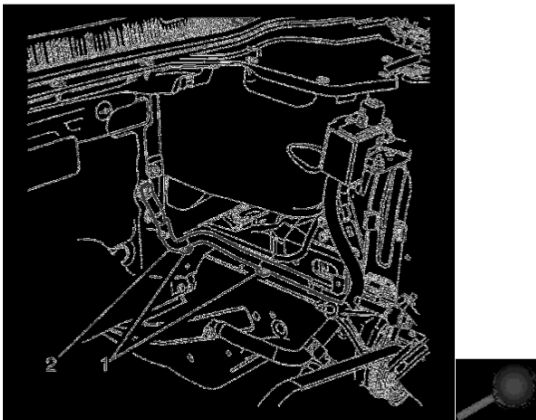
2. Attach the battery positive extension cable terminal (2) to the stud on the junction block (3).
3. Attach the starter solenoid wiring harness cable (1) to the junction block stud.



4. Install the engine wiring and battery positive cable along with the attached mega fuse , to the junction block (4).

Caution: Refer to [Fastener Caution](#).

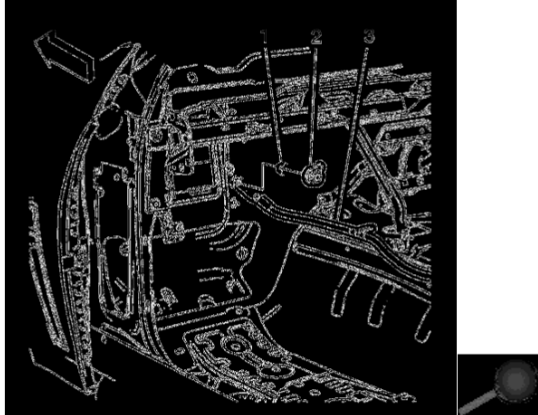
5. Install the battery positive junction block stud (2) and tighten to **15 N·m (11 lb ft)**.
6. Install the junction block cover (1).



7. Install the battery positive extension cable retainers (1) to the frame rail.
8. Position the battery positive extension cable (2) into the plenum passthrough opening.



9. Install the plenum passthrough stud (1) into the battery positive extension cable (2).
10. Install the protective sleeve over the battery positive extension cable.

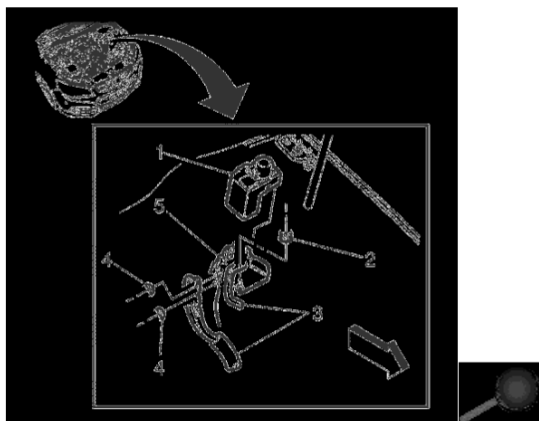


11. Install the battery positive extension cable (3) to the plenum passthrough stud and tighten the fastener (1) to **15 N·m (11 lb ft)**.
12. Install the battery positive cable protective cover (2).
13. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

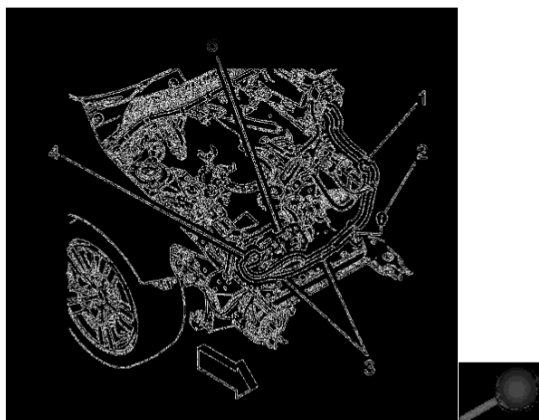
Engine Wiring and Battery Positive Cable Harness Replacement (V6)

Removal Procedure

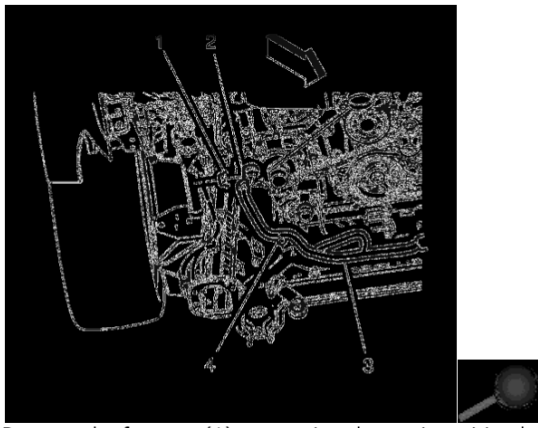
1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).



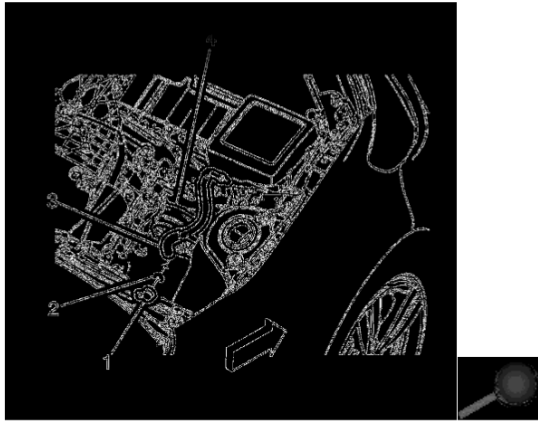
2. Remove the battery positive junction block cover (1).
3. Remove the fasteners (2,4) connecting the engine wiring and battery positive cables (3), to the battery positive junction block (5).



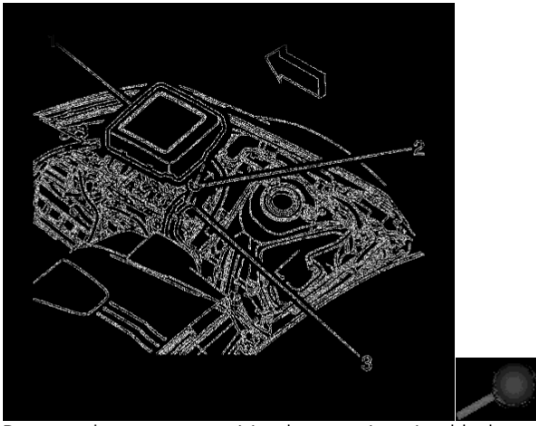
4. Disconnect the connector (4) to the power steering motor (5) and remove the engine wiring and battery positive retainer bracket fastener (2).
5. Unclip the engine harness retainer (1) and detach the engine wiring and battery positive cable retainers (3), from the engine cradle frame.



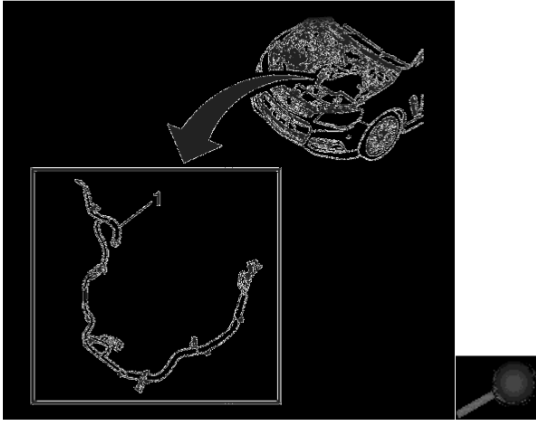
6. Remove the fastener (1) connecting the engine wiring harness and battery positive cable bracket (2) , to the generator mounting stud.
7. Disconnect the engine wiring harness and battery positive cable retainer (4), from the frame rail.



8. Remove the B + protective boot at the back of the generator (4).
9. Remove the battery positive cable fastener (2) and remove the battery positive cable (3), from the generator stud.

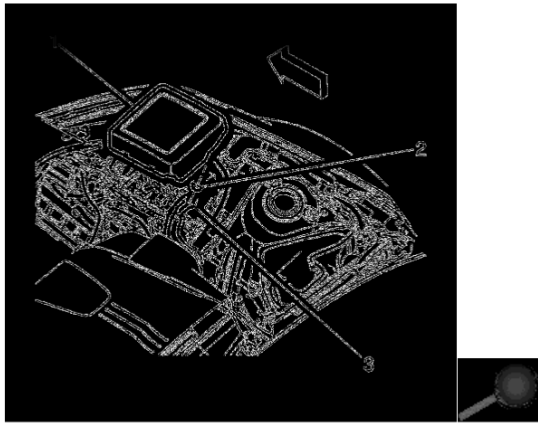


10. Remove the accessory wiring harness junction block cover (1)
11. Remove the battery positive cable fastener (2) and remove the battery positive cable (3), from the accessory wiring harness junction block stud.



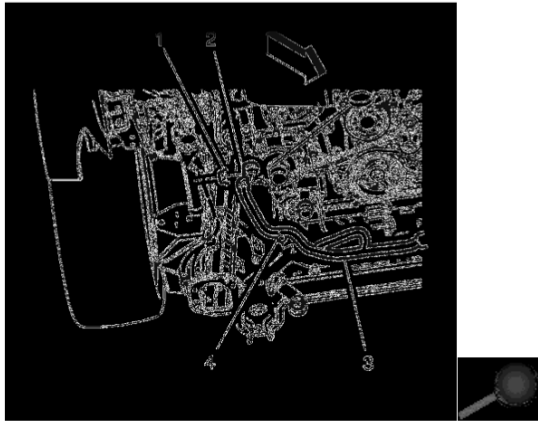
12. Remove the engine wiring harness and battery positive cable (1), from the engine compartment.

[Installation Procedure](#)

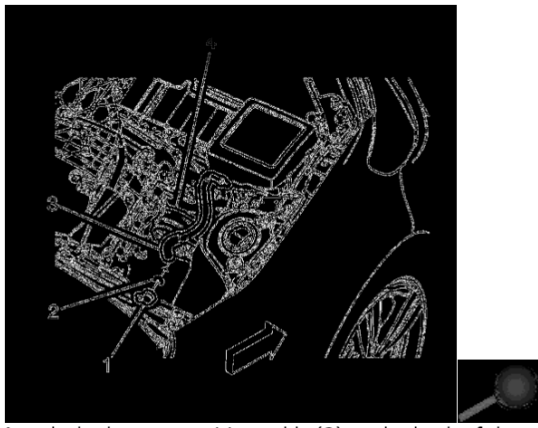


Caution: Refer to [Fastener Caution](#).

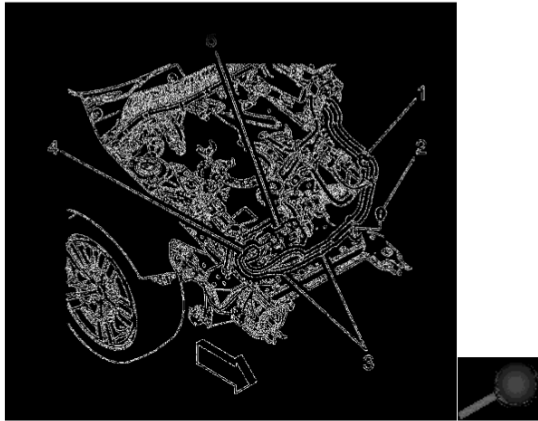
1. Install the battery positive cable (3) to the accessory wiring junction block stud and tighten the fastener (2) to **9 N•m (80 lb in)**.
2. Install the accessory wiring junction block cover (1).



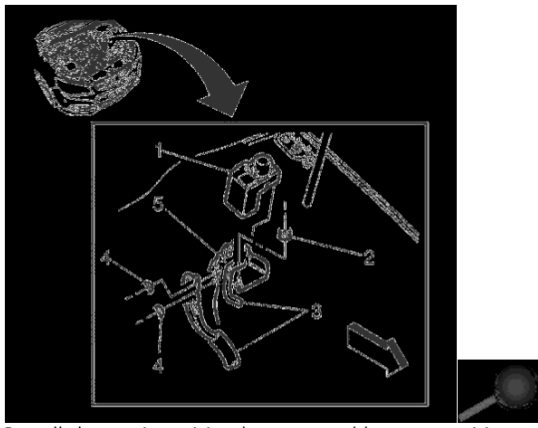
3. Install the engine wiring and battery positive cable bracket (2) to the generator mounting stud and tighten the fastener (1) to **45 N•m (33 lb ft)**.
4. Install the engine wiring harness and battery cable retainer (4).



5. Attach the battery positive cable (3) to the back of the generator (4) and tighten the fastener (2) to **10 N·m (89 lb in)**.
6. Attach the protective boot (1) to the battery positive cable.



7. Install the connector (4) to the steering gear motor (5).
8. Attach the engine wiring harness and battery positive cable retainers (3), to the engine cradle frame.
9. Install the fastener (2), to the engine wiring harness and battery positive cable retainer bracket, and tighten to **10 N·m (89 lb in)**.
10. Attach the engine wiring harness and battery positive cable retainer (1) to the engine harness.

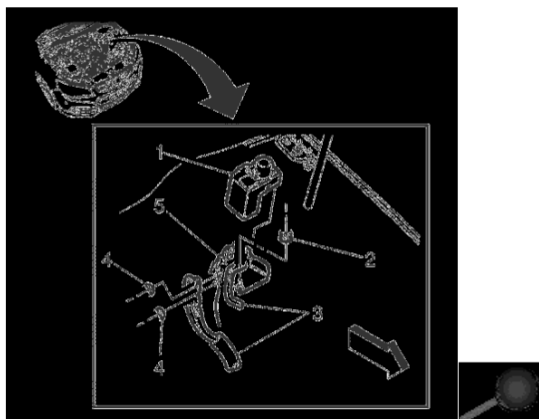


11. Install the engine wiring harness and battery positive cables (3) to the battery positive junction block (5).
12. Install the fasteners (4) and tighten to **9 N·m (80 lb in)**.
13. Install the fastener (2) and tighten to **9 N·m (80 lb in)**.
14. Install the battery positive junction block cover (1).
15. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Engine Wiring and Battery Positive Cable Harness Replacement (V8)

Removal Procedure

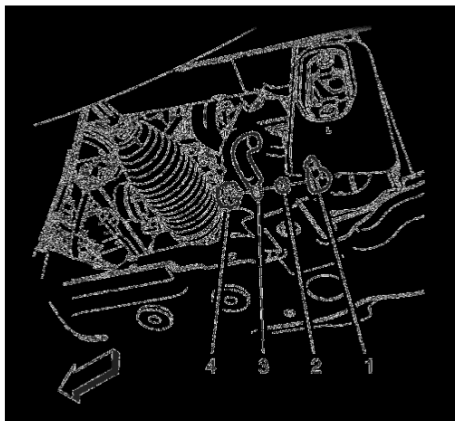
1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).



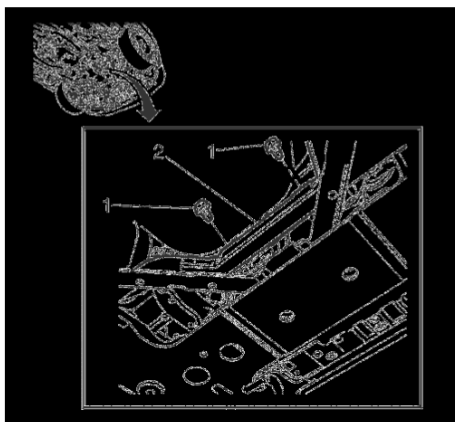
2. Remove the body front wiring harness fuse block cover (1).
3. Remove the fasteners (2,4) connecting the engine wiring and battery positive cables (3), to the body front wiring fuse block (5).



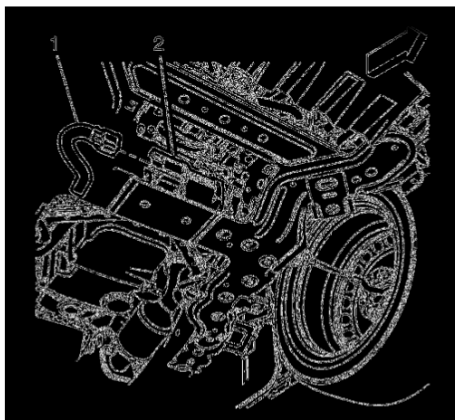
4. Remove the barrel fastener (2) on top of the body front wiring harness fuse block (4).
5. Remove the mega fuse case (4) and the battery positive cable terminal (3).
6. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).



7. Remove the B + stud protective boot (1) at the back of the generator.
8. Remove the battery positive cable fastener (2) and remove the battery positive cable terminal (3) from the generator B + stud (4).

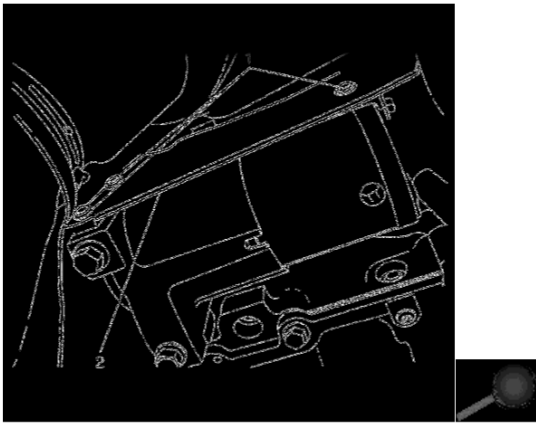


9. Remove the engine wiring and battery positive cable conduit fasteners (1) and slide the conduit (2) out from below the oil pan.

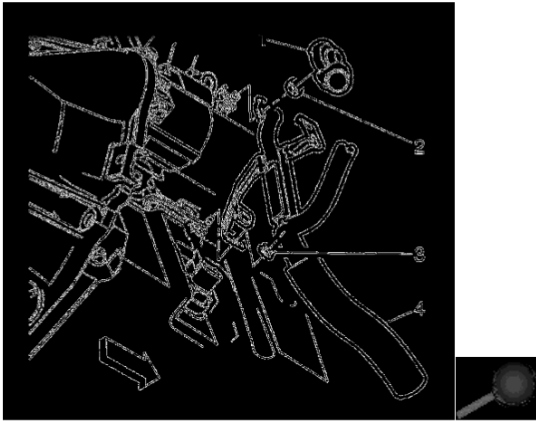


10. Disconnect the connector (1) from the steering motor (2).

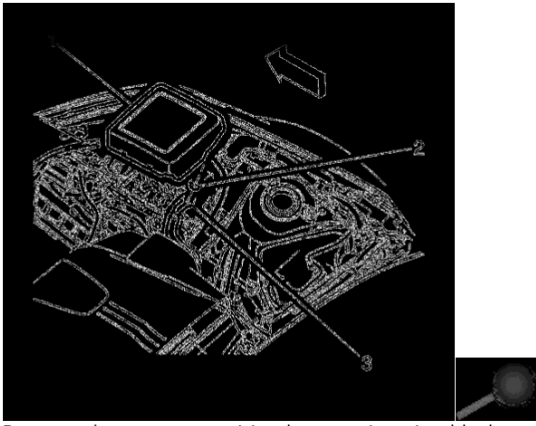
11. Remove the right catalytic converter. Refer to [Catalytic Converter Replacement - Right Side](#).



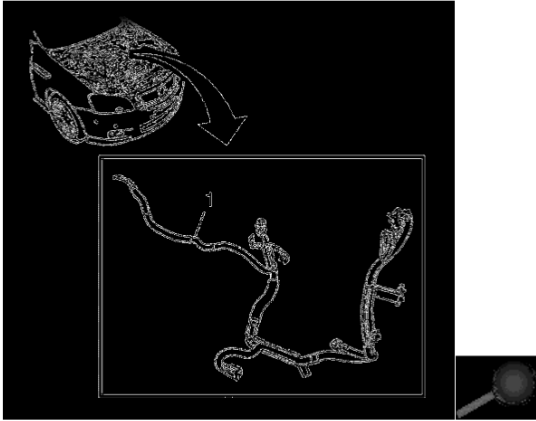
12. Remove the starter heat shield fasteners (1) and remove the starter heat shield (2).



13. Remove the starter B + stud protective boot (1).
14. Remove the battery positive cable fastener (2) and the battery positive cable bracket fastener (3).
15. Remove the battery positive cable (4) from the starter.

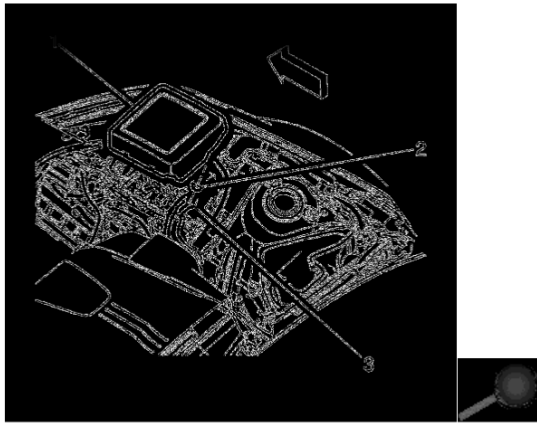


16. Remove the accessory wiring harness junction block cover (1).
17. Remove the battery positive cable fastener (2) and remove the battery positive cable (3), from the accessory wiring harness junction block stud.



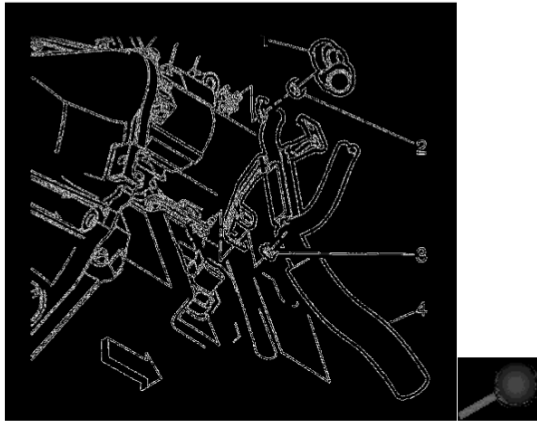
18. Remove the engine wiring harness and battery positive cable (1) from the engine compartment.

[Installation Procedure](#)

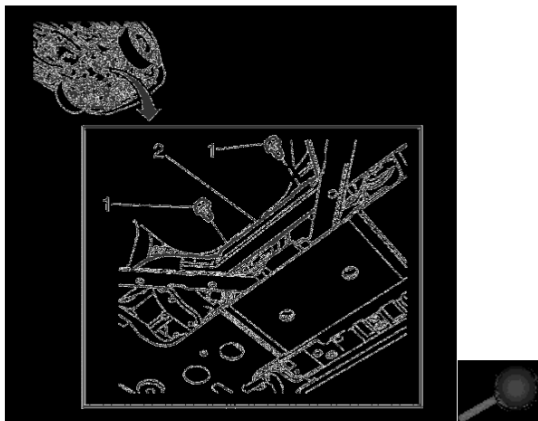


Caution: Refer to [Fastener Caution](#).

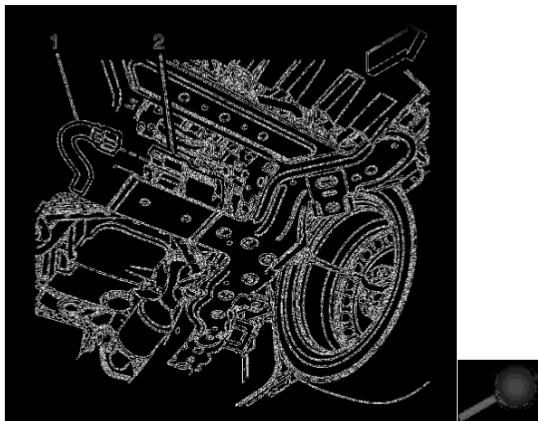
1. Install the battery positive cable (3) to the accessory wiring junction block stud and tighten the fastener (2) to **9 N·m (80 lb in)**.
2. Install the accessory wiring junction block cover (1).



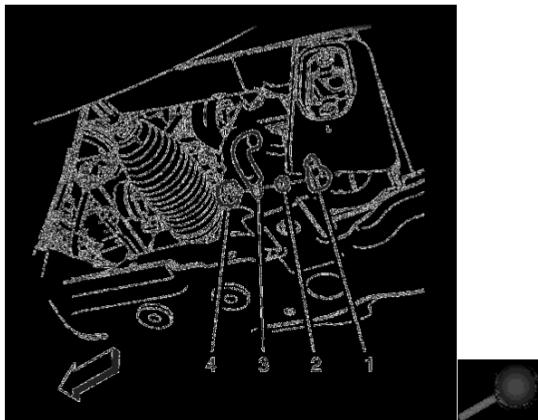
3. Install the battery positive cable bracket to the engine block stud and tighten the fastener (3) to **9 N·m (80 lb in)**.
4. Install the battery positive cable (4) to the starter B + stud and tighten the fastener (2) to **10 N·m (89 lb in)**.
5. Install the protective boot (1).
6. Install the right catalytic converter. Refer to [Catalytic Converter Replacement - Right Side](#).



7. Install the engine wiring and battery positive cable conduit (2) below the oil pan and tighten the fasteners (1) to **9 N·m (80 lb in)**.

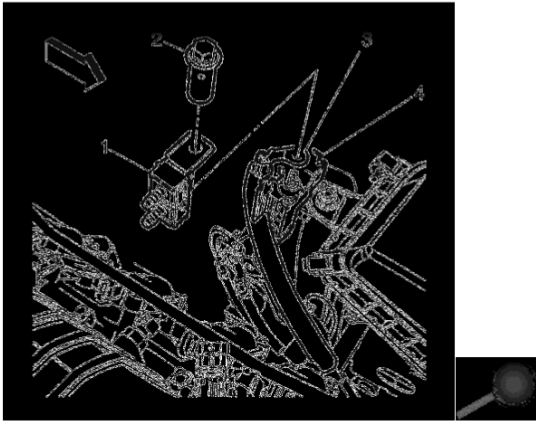


8. Connect the connector (1) to the steering gear motor (2).

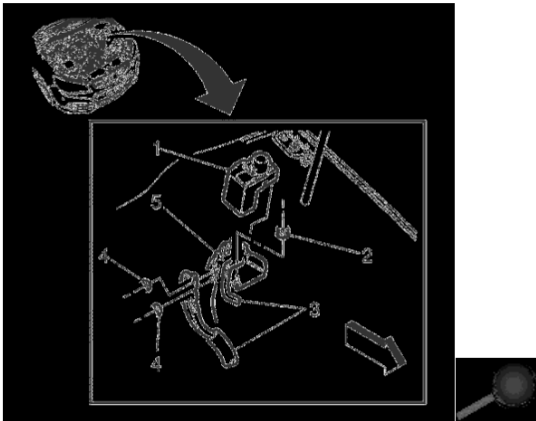


9. Install the battery positive cable terminal (3) to the generator B + stud (4) and tighten the fastener (2) to **10 N·m (89 lb in)**.

10. Install the B + stud protective boot (1).



11. Install the mega fuse case (1) along with the battery positive cable terminal (3) to the body front wiring harness fuse block (4). Tighten the barrel fastener (2) to **9 N·m (80 lb in)**.

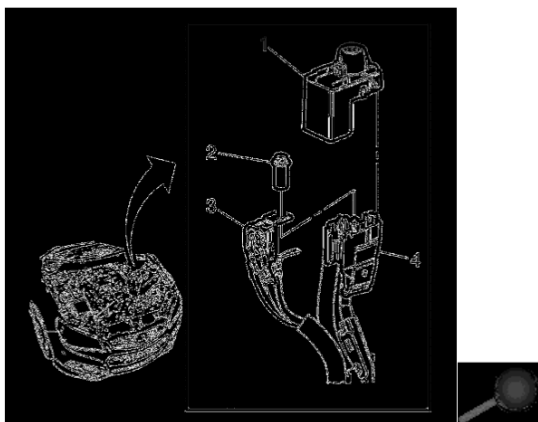


12. Install the engine wiring harness and battery positive cables (3) to the body front wiring harness fuse block (5).
13. Install the fasteners (4) and tighten to **9 N·m (80 lb in)**.
14. Install the fastener (2) and tighten to **9 N·m (80 lb in)**.
15. Install the body front wiring harness fuse block cover (1).
16. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

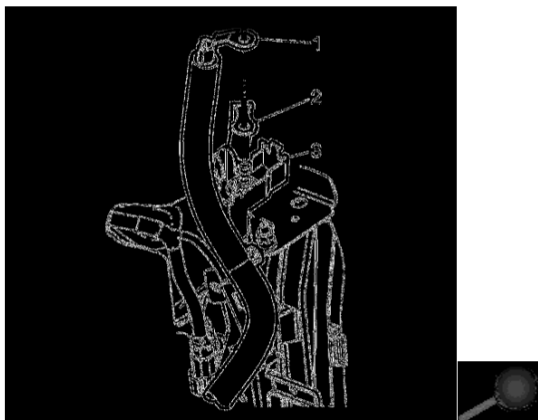
Starter Solenoid Cable Replacement (LFX)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).



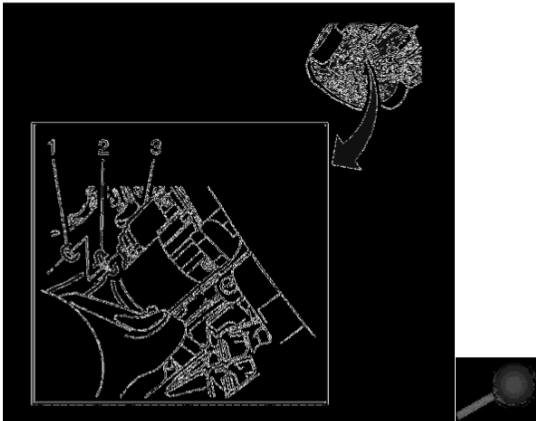
2. Remove the junction block cover (1) and remove the battery positive cable junction block stud (2).
3. Remove the engine wiring and battery positive cable with the attached mega fuse case (3), from the junction block (4).



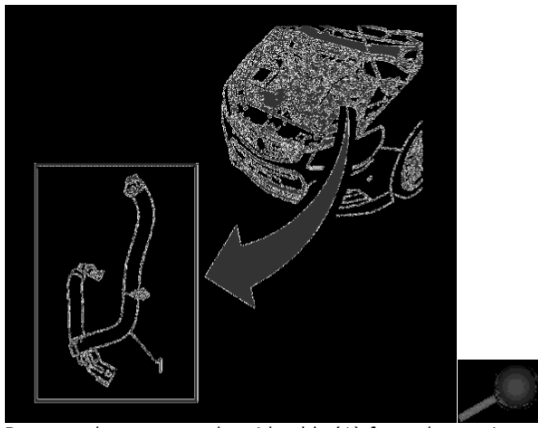
4. Remove the starter solenoid cable (1) from the junction block (3).



5. Remove the starter solenoid cable bracket fastener (3) from the top of the A/C compressor (4).
6. Detach the starter solenoid cable retainer (2) from the junction block bracket.
7. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
8. Remove the oil pan shield. Refer to [Oil Pan Shield Replacement](#).

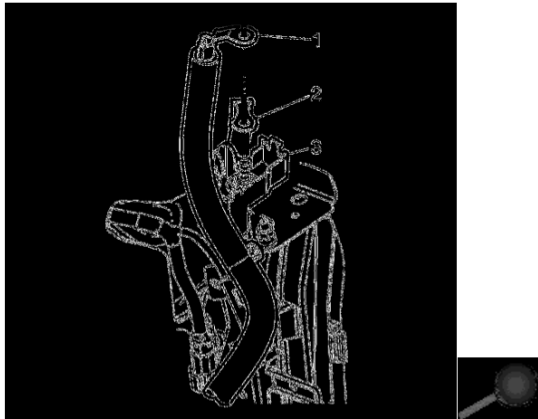


9. Remove the starter solenoid fastener (1) and remove the starter solenoid cable (2) from the starter solenoid (3).
10. Lower the vehicle.

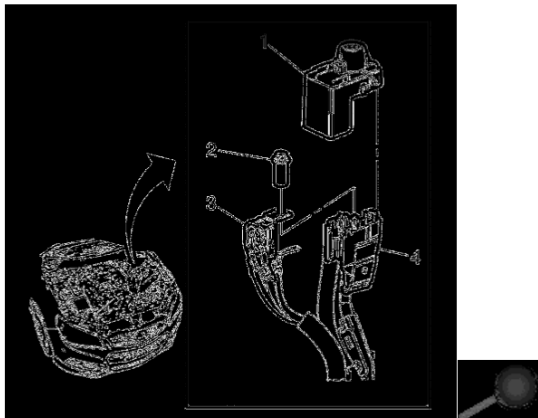


11. Remove the starter solenoid cable (1) from the engine compartment.

Installation Procedure

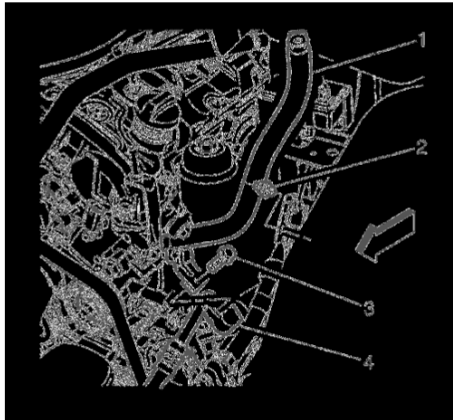


1. Attach the starter solenoid cable (1) to the junction block (3).



Caution: Refer to [Fastener Caution](#).

2. Install the engine wiring and battery positive cable along with the attached mega fuse case, to the junction block (4).
3. Install the battery positive junction block stud (2) and tighten to **15 N·m (11 lb ft)**.
4. Install the junction block cover (1).



5. Install the starter solenoid cable to the top of the A/C compressor (4) and tighten the fastener (3) to **22 N·m (16 lb ft)**.
6. Install the starter solenoid cable retainer (2) to the junction block bracket.
7. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

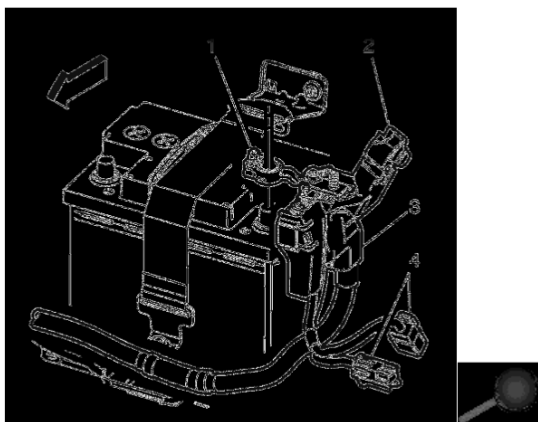


8. Install the starter solenoid cable (2) to the starter solenoid (3) and tighten the fastener (1) to **11 N·m (97 lb in)**.
9. Install the oil pan shield. Refer to [Oil Pan Shield Replacement](#).
10. Lower the vehicle.
11. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

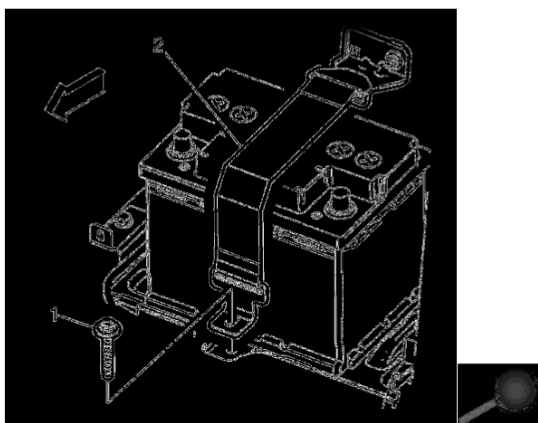
Battery Replacement (Ute)

Removal Procedure

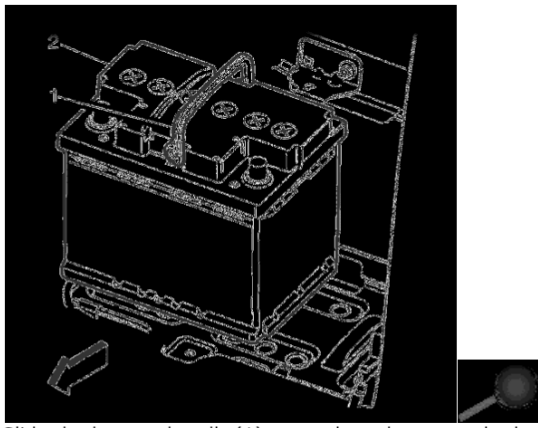
1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).



2. Remove the protective cover (2) from the battery positive cable.
3. Remove the battery positive cable clamp fastener (1) and detach the battery positive cable (3), from the battery post.

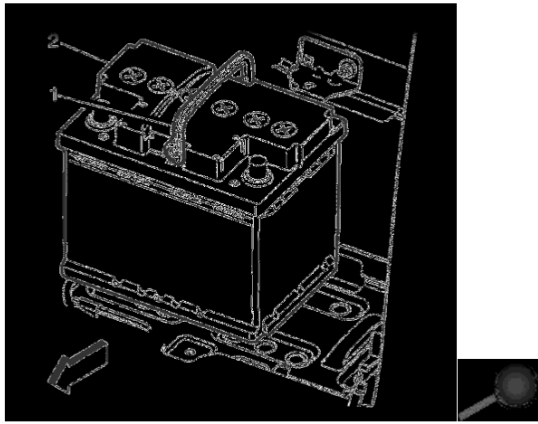


4. Remove the battery strap fastener (1) and remove the battery strap (2), from the top of the battery.

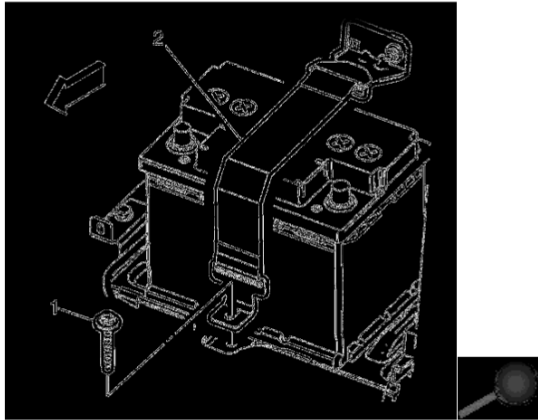


5. Slide the battery handle (1) upwards and remove the battery (2), from the passenger compartment.

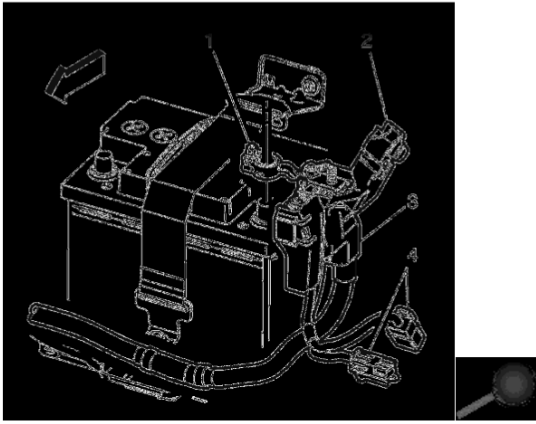
Installation Procedure



1. Using the assist handle (1), position the battery (2) onto the battery tray behind the drivers seat.



2. Install the battery hold down strap (2) and tighten the fastener (1) until it stops rotating.



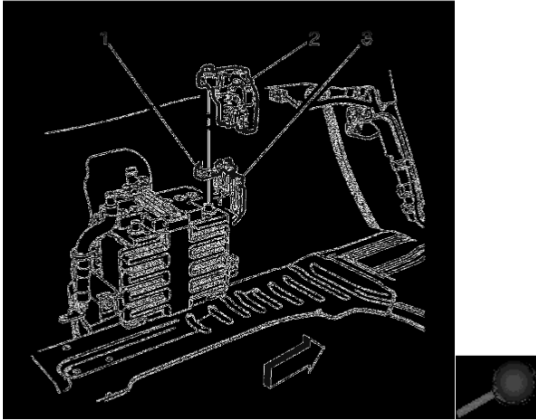
Caution: Refer to [Fastener Caution](#).

3. Install the battery positive cable (3) to the battery post and tighten the fastener (1) to **5 N·m (44 lb in)**.
4. Install the protective cover (2) to the battery positive cable.
5. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

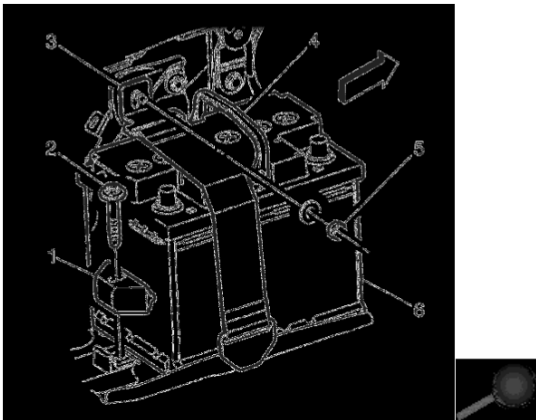
Battery Replacement (Sedan, Sportwagon)

Removal Procedure

1. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the rear compartment side trim panel. Refer to [Rear Compartment Side Trim Panel Replacement](#).

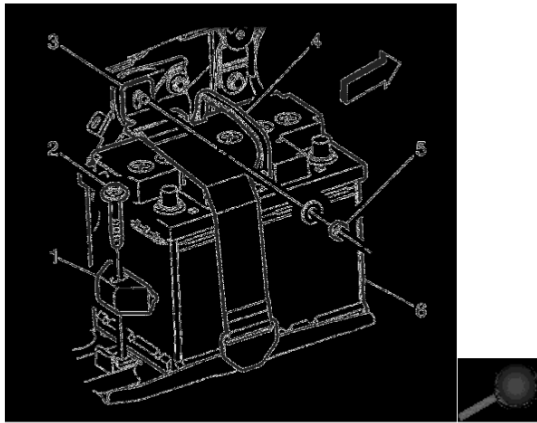


3. Remove the battery positive cable cover (2).
4. Loosen the battery positive cable clamp fastener (1) and remove the battery positive cable (3), from the battery positive post.



5. Remove the battery hold down retainer fastener (2) and the battery hold down retainer (1).
6. Remove the battery strap fastener (5) and remove the battery strap (3).
7. Rotate the battery handle (4) upwards and remove the battery (6) from the rear compartment.

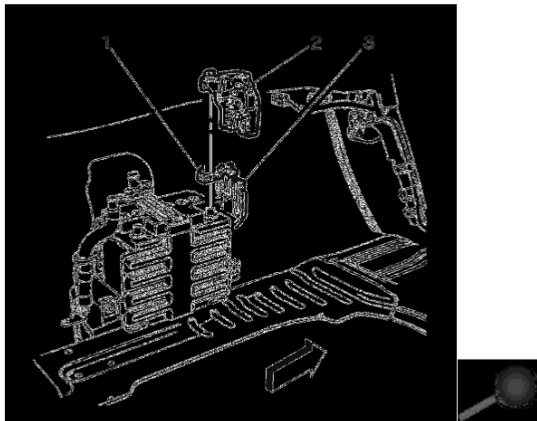
Installation Procedure



1. Install the battery (6) into position.

Caution: Refer to [Fastener Caution](#).

2. Install the battery hold down retainer (1) and tighten the fastener (2) to **17 N•m (13 lb ft)**.
3. Install the battery strap (3) and tighten the fastener (5) to **22 N•m (16 lb ft)**.

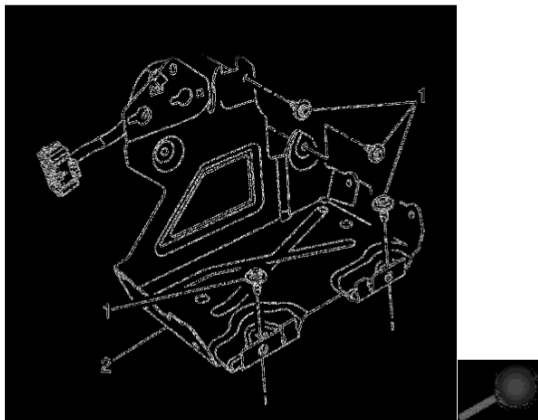


4. Install the battery positive cable (3) to the battery positive post and tighten the fastener (1) to **5 N•m (44 lb in)**.
5. Install the battery positive cable post cover (2).
6. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
7. Install the rear compartment side trim panel. Refer to [Rear Compartment Side Trim Panel Replacement](#).

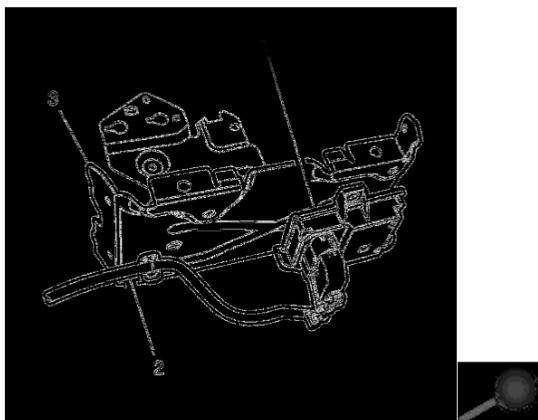
Battery Tray Replacement

Removal Procedure

1. Remove the battery. Refer to [Battery Replacement](#).

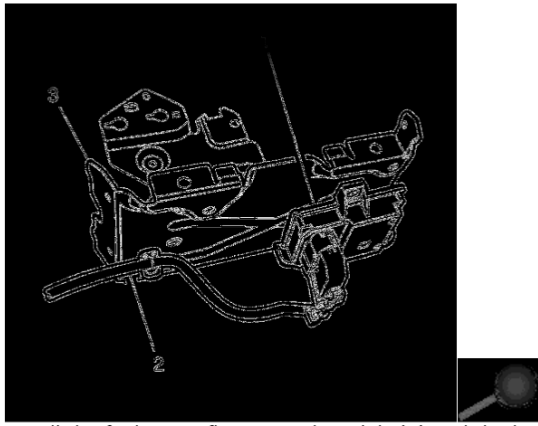


2. Remove the battery tray mounting bolts (1).

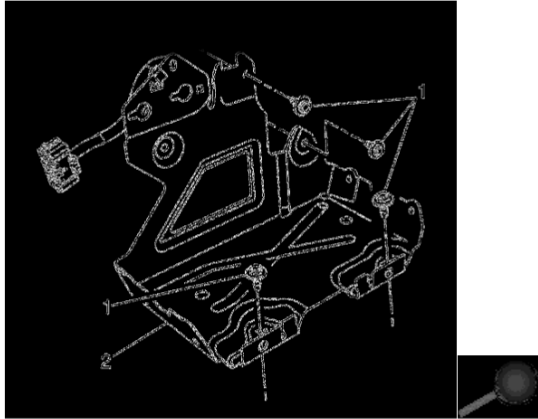


3. Remove the fuel pump flow control module (1) and the harness retainer (2) from the underside of the battery tray (3).
4. Disconnect any harness retainers attached to the battery tray.
5. Remove the battery tray (3) from the rear compartment.

Installation Procedure



1. Install the fuel pump flow control module (1) and the harness retainer (2) to the underside of the battery tray (3).



Caution: Refer to [Fastener Caution](#).

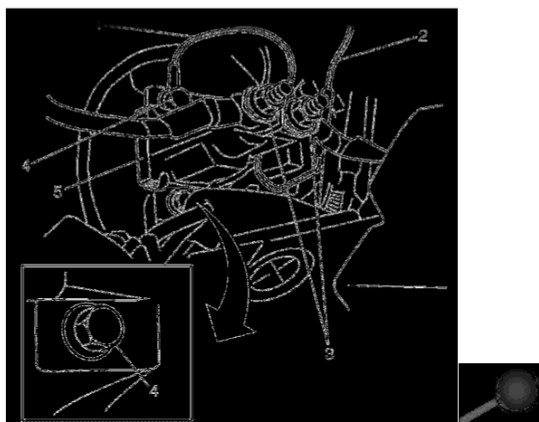
2. Install the battery tray mounting bolts (1) and tighten to **25 N•m (18 lb ft)**.
3. Connect any harness retainers to the battery tray.
4. Install the battery. Refer to [Battery Replacement](#).

Battery Isolator Replacement (Sedan, Sportwagon)

Removal Procedure

Warning: Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery negative cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).



Note: The battery isolator (5) is located in the luggage compartment in the LHS rear quarter panel.

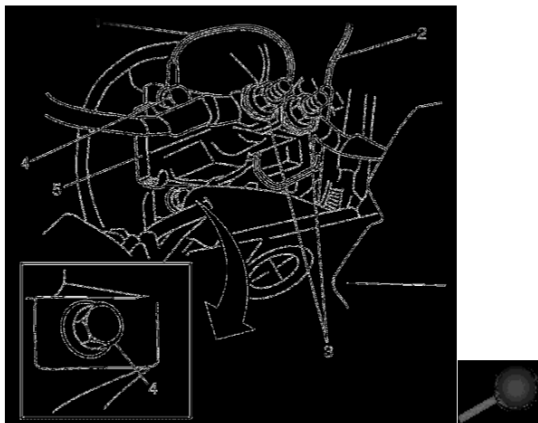
2. Remove the primary and secondary battery cable retaining nuts (3).
3. Disconnect the primary and secondary battery cables from the battery isolator (5).
4. Disconnect the battery isolator (5) input connector (2).

Note: The battery isolator negative cable (1) is secure with the battery isolator retaining bolts, make sure the ground cable is removed when removing the retaining bolts (7).

5. Remove the battery isolator retaining bolts (4).
6. Remove the battery isolator (5).

Installation Procedure

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1. Install the battery isolator (5).

Caution: Refer to [Fastener Caution](#).

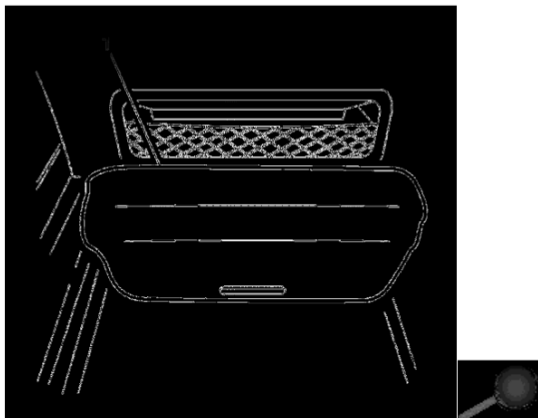
Note: When installing the battery isolator retaining bolts (4), make sure the battery isolator negative cable (1) is installed. Failure to adhere to this may cause incorrect operation of the battery isolator.

2. Install the battery isolator retaining bolts (4) and tighten to **11 N·m (97 lb in)**.
3. Connect the battery isolator input connector (2).
4. Connect the primary and secondary battery cables to the battery isolator (5).
5. Install the primary and secondary battery isolator retaining nuts (3) and tighten to **10 N·m (89 lb in)**.
6. Connect the battery ground cable to the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

Battery Isolator Replacement (UTE)

Removal Procedure

1. Slide and position RHS seat to the full forward position.

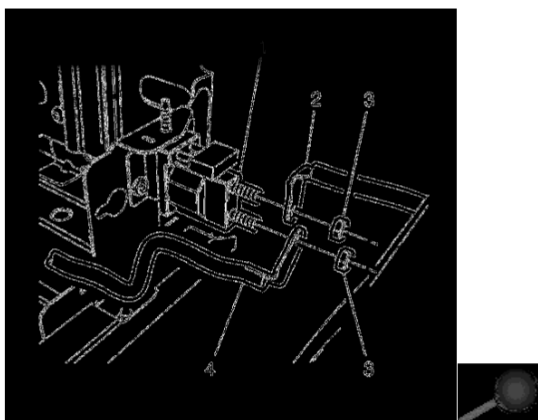


Note: The battery isolator is located on the auxiliary battery tray behind the RHS seat inside the RHS rear window shelf trim panel.

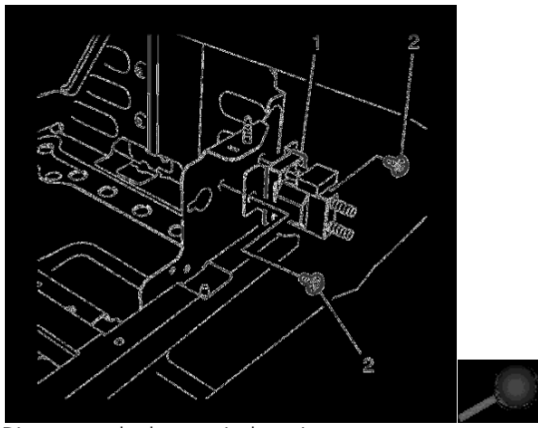
2. Lift the RHS rear window shelf trim battery access panel (1) upwards to gain access to the battery isolator.

Warning: Refer to [Battery Disconnect Warning](#).

3. Disconnect the battery negative cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).



4. Remove the primary and secondary battery cable retaining nuts (3).
5. Disconnect the primary (2) and secondary (4) battery cables from the battery isolator (1).

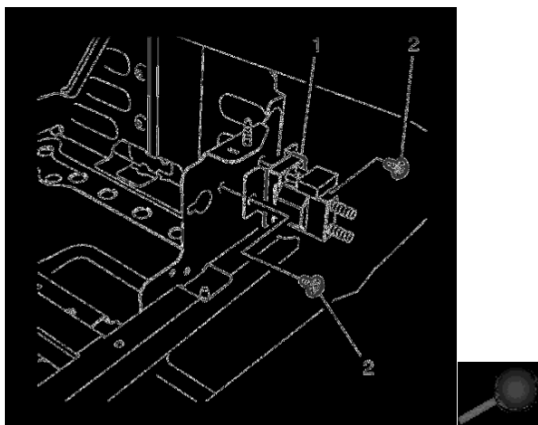


6. Disconnect the battery isolator input connector.

Note: The battery isolator negative cable is secure with the battery isolator retaining bolts, make sure the ground cable is removed when removing the retaining bolts.

7. Remove the battery isolator retaining bolts (2).
8. Remove the battery isolator (1) from the auxiliary battery tray.

Installation Procedure

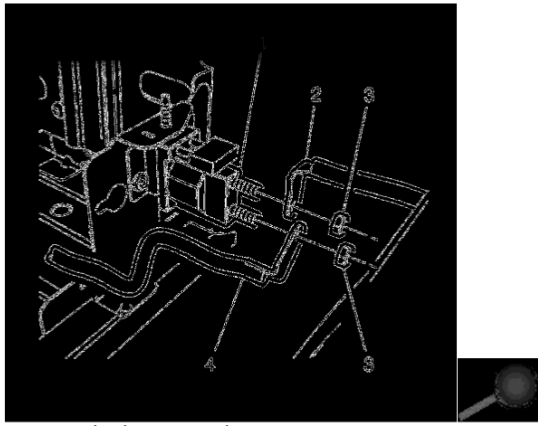


1. Install the battery isolator (1) to the auxiliary battery tray.

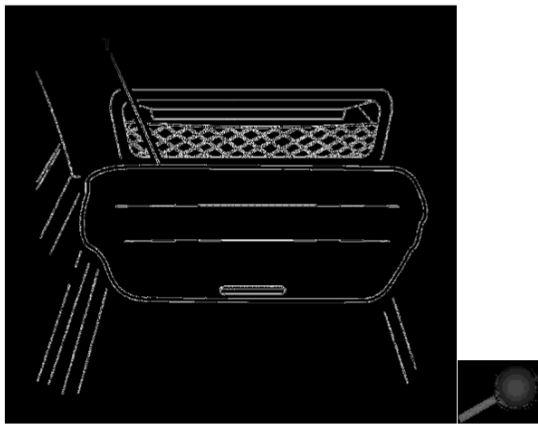
Note: When installing the battery isolator retaining bolts, make sure the battery isolator negative cable is installed, failure to adhere to this may cause incorrect operation of the battery isolator.

Caution: Refer to [Fastener Caution](#).

2. Install the battery isolator retaining bolts (2) and tighten to **11 N•m (97 lb in)**.

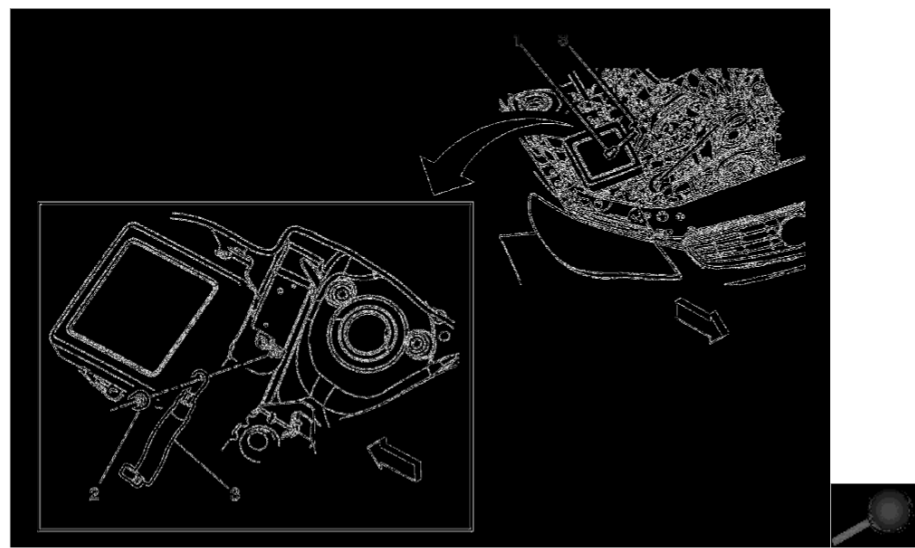


3. Connect the battery isolator input connector.
4. Connect the primary (2) and secondary (2) battery cables to the battery isolator (1).
5. Install the primary and secondary battery isolator retaining nuts (3) and tighten to **10 N·m (89 lb in)**.
6. Connect the battery ground cable to the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).



7. Refit the RHS rear window shelf trim battery access panel (1).
8. Reposition RHS seat.

Engine Ground Cable Replacement (LFX,LFW,LSA,LWR,)



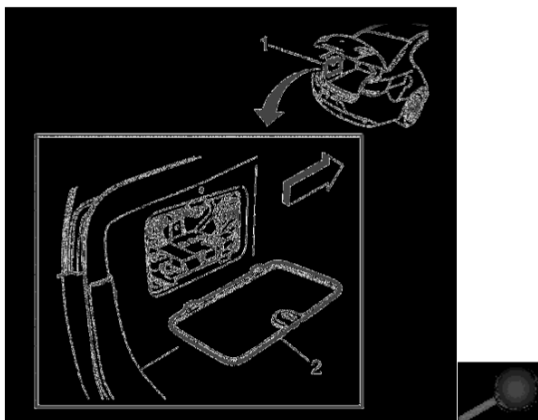
Engine Ground Cable Replacement

Callout	Component Name
1	Engine Block Fastener Caution: Refer to Fastener Caution . Tighten 22 N•m (16 lb ft)
2	Engine Ground Cable Fastener Tighten 25 N•m (18 lb ft)
3	Engine Ground Cable

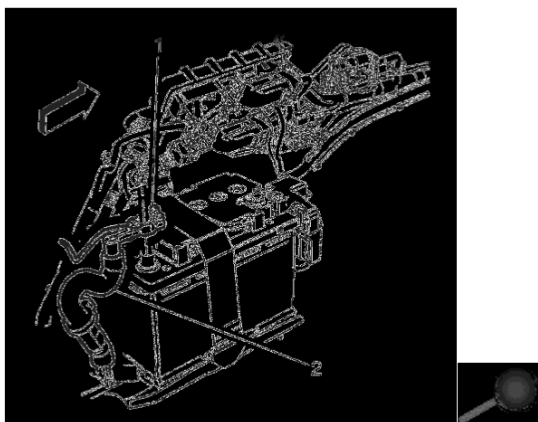
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Battery Negative Cable Disconnection and Connection (Sedan)

[Removal Procedure](#)



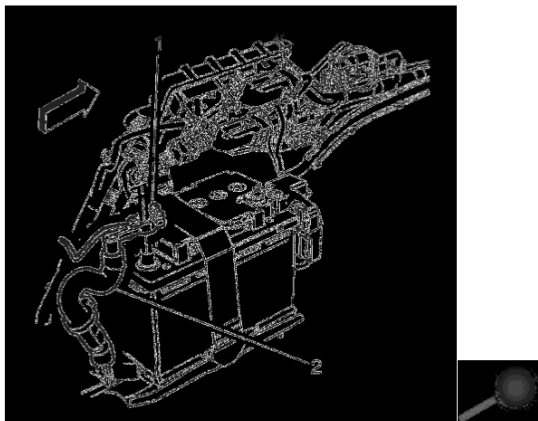
1. Turn the rear compartment side trim panel clip (1) one quarter turn to disengage the access cover (2) from the left rear compartment side trim panel.



Warning: Refer to [Battery Disconnect Warning](#).

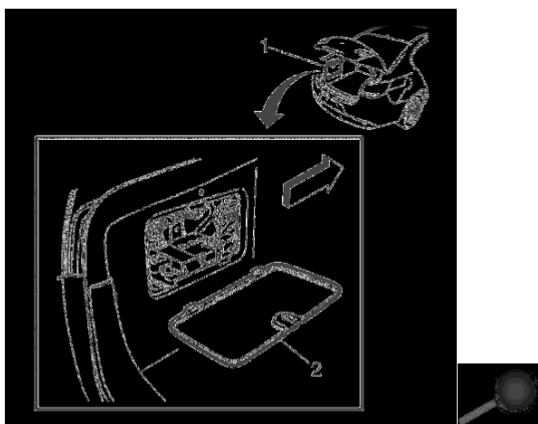
2. Loosen the battery negative cable clamp fastener (1) and remove the battery negative cable (2) from the battery negative post.

[Installation Procedure](#)



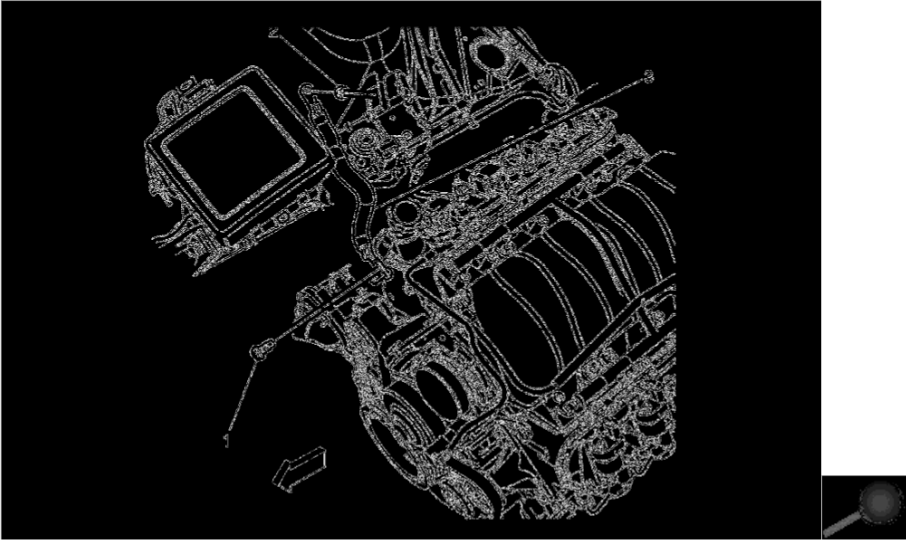
Caution: Refer to [Fastener Caution](#).

1. Install the battery negative cable (2) to the battery negative post and tighten the clamp fastener (1) to **5 N·m (44 lb in)**.



2. Install the access cover (2) to the left rear compartment side trim panel and lock into place with the panel clip (1).

Engine Ground Cable Replacement (L77,LS3)



Engine Ground Cable Replacement

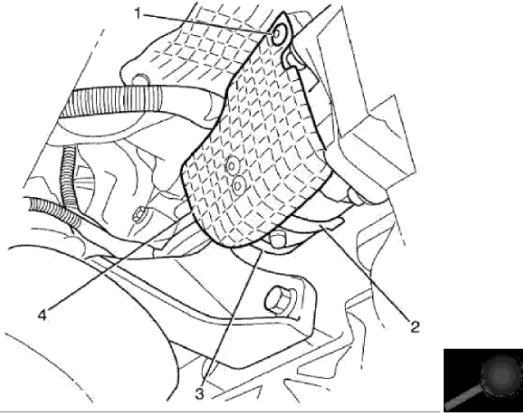
Callout	Component Name
1	Engine Ground Cable Fastener Caution: Refer to Fastener Caution . Tighten 25 N•m (18 lb ft)
2	Engine Ground Cable Fastener Tighten 22 N•m (16 lb ft)
3	Engine Ground Cable

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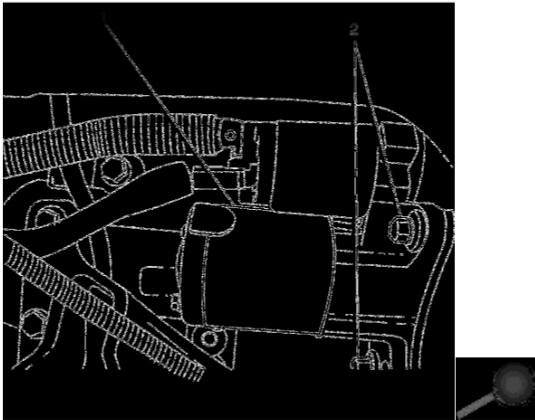
Starter Replacement (LWR)

Removal Procedure

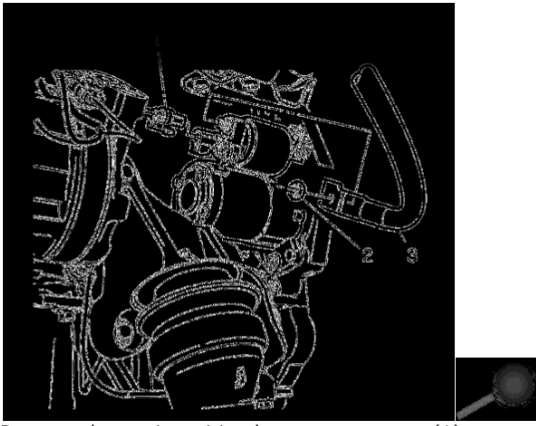
1. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
- Warning:** Refer to [Safety Glasses Warning](#).
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the left catalytic converter from the vehicle. Refer to [Catalytic Converter Replacement - Left Side](#).



4. Remove the starter motor heat shield to starter motor retaining screw (1).
5. Detach the starter motor heat shield to starter motor retaining clip (2) from the starter motor (3).
6. Remove the starter motor heat shield (4).

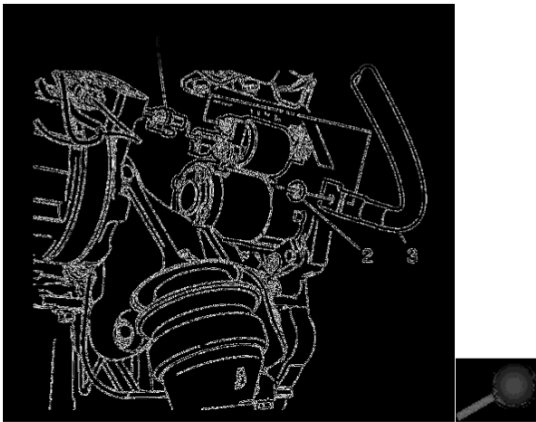


7. Remove the starter motor to bell housing retaining bolts (2).
8. Remove the starter motor (1) from the bell housing.

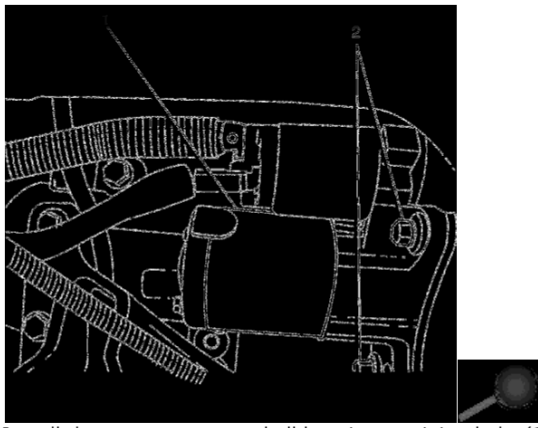


9. Remove the engine wiring harness connector (1).
10. Remove the battery positive cable nut (2) from the starter motor.
11. Remove the battery positive cable (3) from the starter motor.

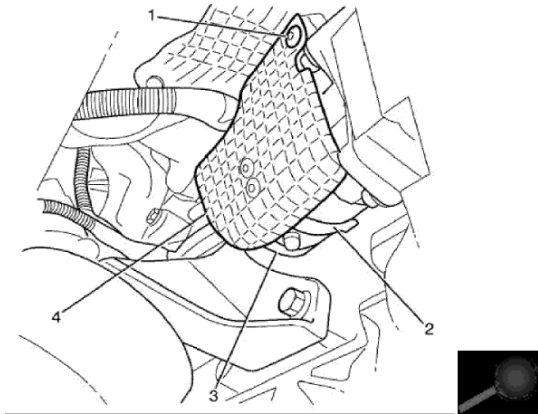
Installation Procedure



1. Install the engine wiring harness connector (1).
- Caution:** Refer to [Fastener Caution](#).
2. Install the battery positive cable (3) to the starter and tighten the nut (2) to **10 N·m (89 lb in)**.
3. Position the starter motor into the correct position on the bell housing.



4. Install the starter motor to bell housing retaining bolts (2) and tighten to **58 N·m (43 lb ft)**.



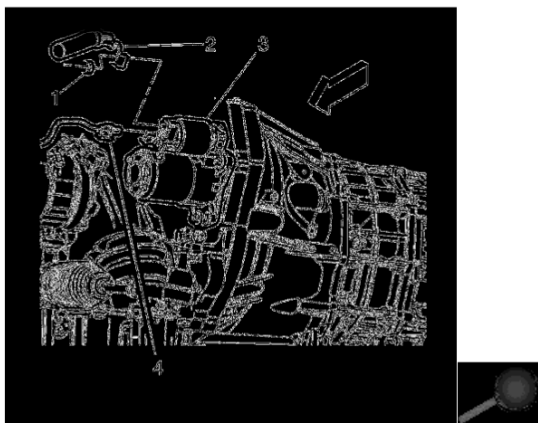
Note: Make sure the heat shield to starter motor retaining clip (2) is correctly attached to the starter motor (3).

5. Attach the heat shield (4) to the starter motor (3).
6. Install the heat shield to starter motor retaining bolt (1) and tighten to **5 N·m (44 lb in)**.
7. Install the left catalytic converter to the vehicle. Refer to [Catalytic Converter Replacement - Left Side](#).
8. Lower the vehicle.
9. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Starter Replacement (LFW,LFX)

Removal Procedure

1. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the left catalytic converter from the vehicle. Refer to [Catalytic Converter Replacement - Left Side](#).

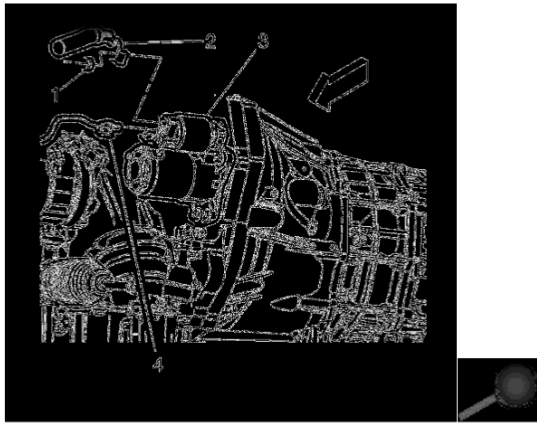


4. Remove the engine wiring harness connector (4).
5. Remove the battery positive fastener (1) and remove the starter cable (2) from the starter solenoid (3).



6. Remove the starter motor to bell housing retaining fasteners (1).
7. Remove the starter motor (2) from the bell housing.

Installation Procedure



1. Position the starter motor (2) into place, locating the correct position on the bell housing.
2. Install the engine wiring harness connector (4) to the starter motor.
- Caution:** Refer to [Fastener Caution](#).
3. Install the starter cable terminal (2) to the starter solenoid (3) and tighten the fastener (1) to **11 N·m (97 lb in)**.

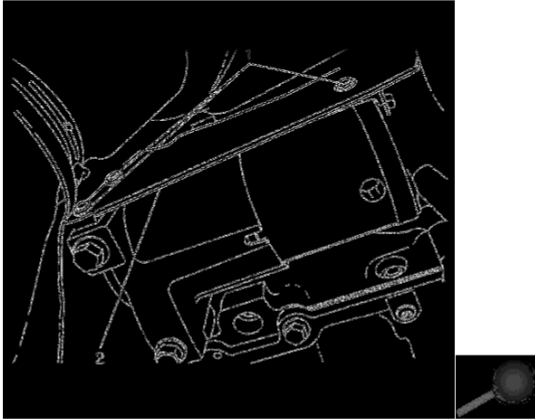


4. Install the starter motor (2) to the bell housing and tighten the fasteners (1) to **58 N·m (43 lb ft)**.
5. Install the left catalytic converter to the vehicle. Refer to [Catalytic Converter Replacement - Left Side](#).
6. Lower the vehicle.
7. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Starter Replacement (V8)

Removal Procedure

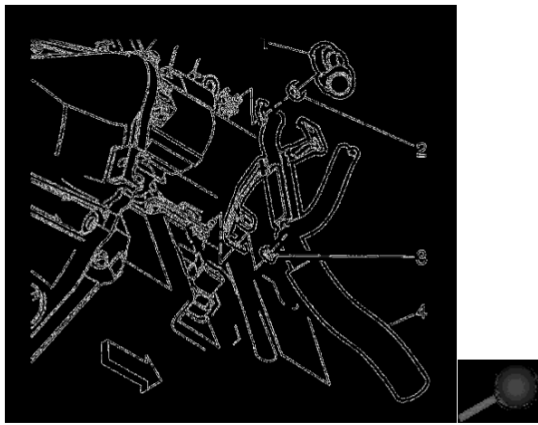
1. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the right catalytic converter from the vehicle. Refer to [Catalytic Converter Replacement - Right Side](#).



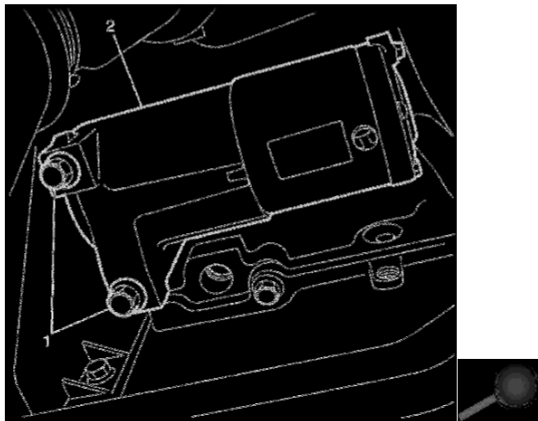
4. Remove the starter motor heat shield retaining fasteners (1).
5. Remove the heat shield (2) from the vehicle.



6. Disconnect the oil level switch connector (1) and the harness retainer (2), to the battery positive cable bracket.
7. Disconnect the knock sensor connector (4) and the electrical connector (3), to the starter solenoid.

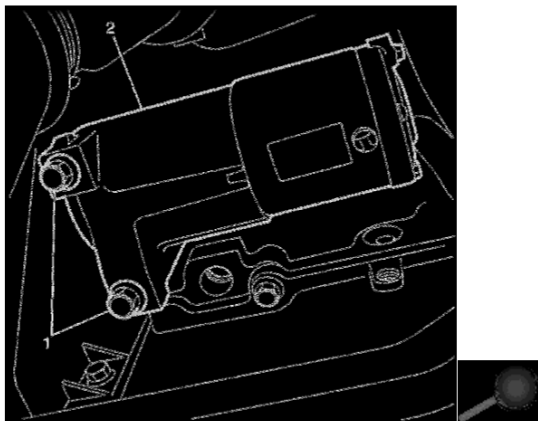


8. Remove the protective boot (1) covering the starter B + stud and remove the battery positive cable fastener (2).
9. Remove the battery positive cable bracket fastener (3) and remove the battery positive cable (4), from the starter.



10. Remove the starter mounting fasteners (1) and remove the starter (2) from the bell housing.

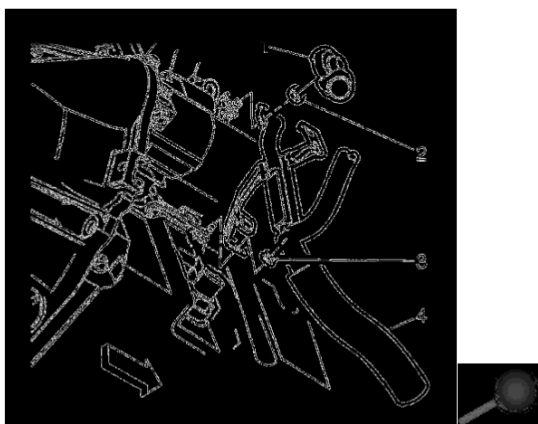
[Installation Procedure](#)



1. Position the starter motor (2) into position on the bell housing.

Caution: Refer to [Fastener Caution](#).

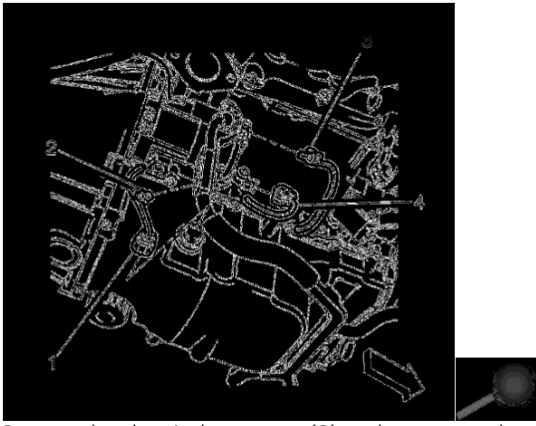
2. Install the starter motor mounting fasteners (1) and tighten to **58 N·m (43 lb ft)**.



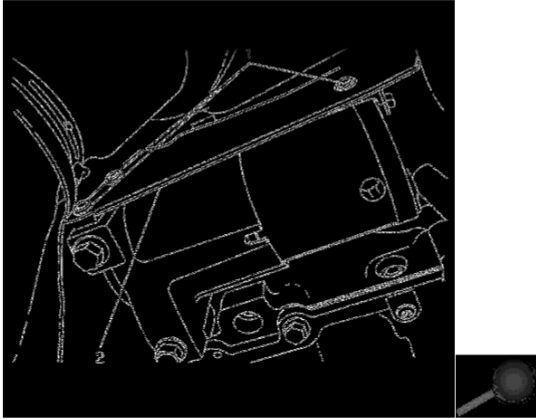
3. Install the battery positive cable bracket to the engine block stud and tighten the fastener (3) to **9 N·m (80 lb in)**.

4. Install the battery positive cable terminal to the starter solenoid and tighten the fastener (2) to **10 N·m (89 lb in)**.

5. Install the protective boot (1) over the starter terminal stud.



6. Connect the electrical connector (3) to the starter solenoid.
7. Connect the knock sensor connector (4) and the oil level switch connector (1).
8. Attach the harness retainer (2) to the battery positive cable bracket.



9. Install the heat shield (2) to the vehicle.
10. Install the heat shield retaining fasteners (1) and tighten to **5 N·m (44 lb in)**.
11. Install the right catalytic converter to the vehicle. Refer to [Catalytic Converter Replacement - Right Side](#).
12. Lower the vehicle.
13. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Starter Shield Replacement (V8)

Removal Procedure

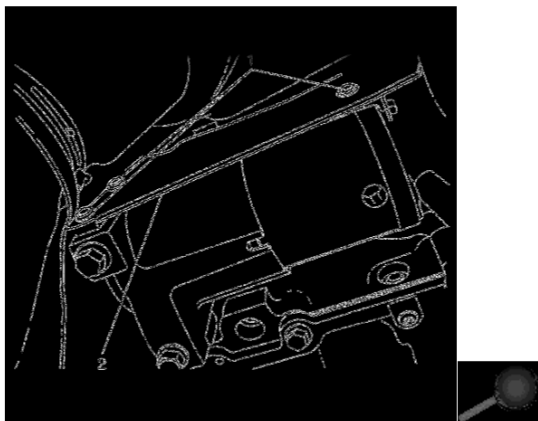
Warning: Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

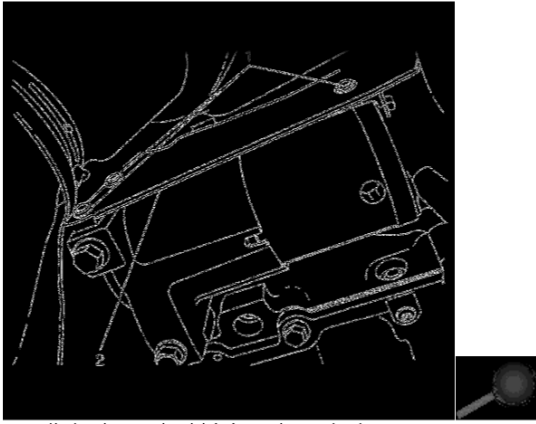
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the right catalytic converter from the vehicle. Refer to [Catalytic Converter Replacement - Right Side](#).



4. Remove the heat shield to starter motor retaining bolts (1).
5. Remove the heat shield (2) from the vehicle.

Installation Procedure

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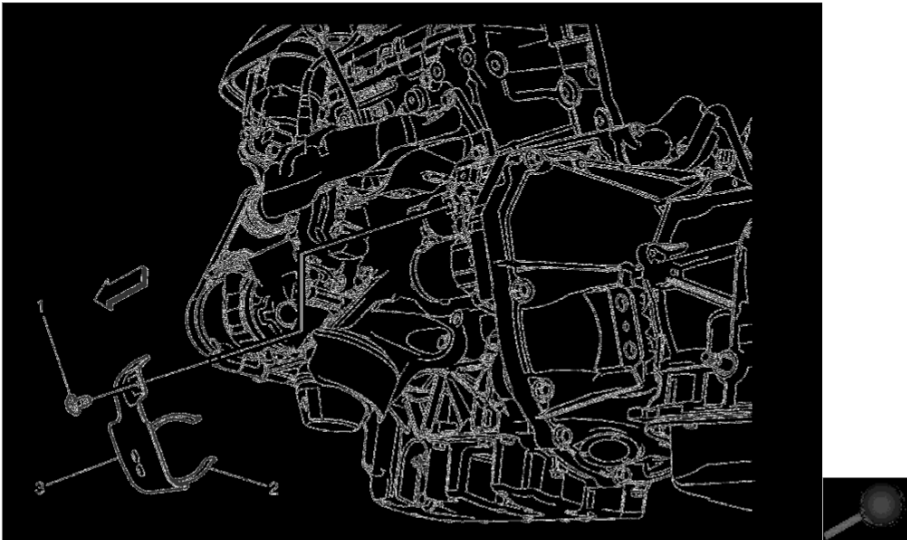


1. Install the heat shield (2) to the vehicle.

Caution: Refer to [Fastener Caution](#).

2. Install the heat shield to starter motor retaining bolts (1) and tighten to **4.7 N•m (42 lb in)**.
3. Install the right catalytic converter to the vehicle. Refer to [Catalytic Converter Replacement - Right Side](#).
4. Connect the battery ground cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

Starter Shield Replacement (LWR)



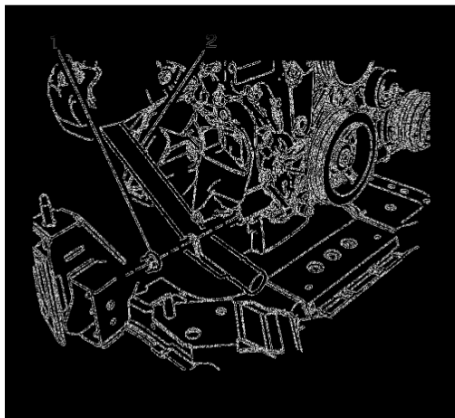
Starter Shield Replacement

Callout	Component Name
Preliminary Procedure 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Remove the left catalytic converter. Refer to Catalytic Converter Replacement - Left Side .	
1	Starter Heat Shield Fastener Caution: Refer to Fastener Caution . Tighten 5N·m (44 lb in)
2	Starter Heat Shield Retaining Clip
3	Starter Heat Shield

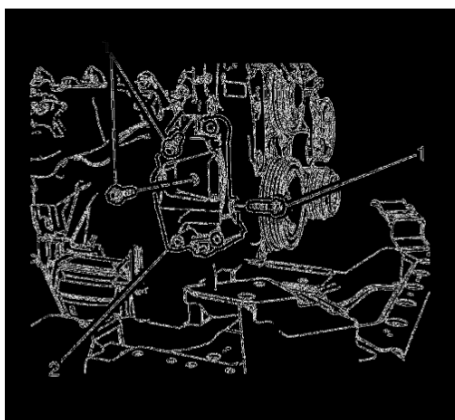
Generator Bracket Replacement (V6)

Removal Procedure

1. Remove the generator. Refer to [Generator Replacement](#).



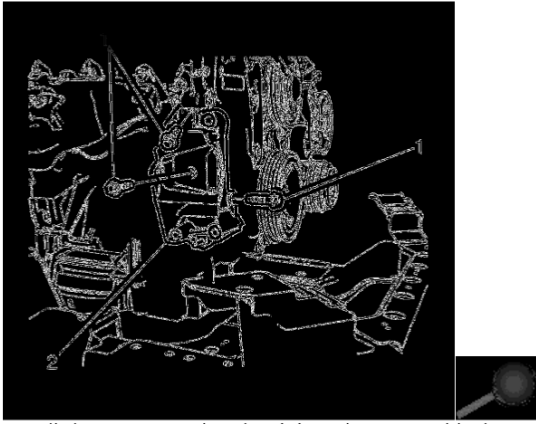
2. Remove the coolant inlet pipe to generator bracket retaining nut (1).
3. Detach the coolant inlet pipe (2) from the generator bracket stud.



4. Remove the generator bracket to engine block retaining bolts (1).
5. Remove the generator bracket (2) from the engine block.

Installation Procedure

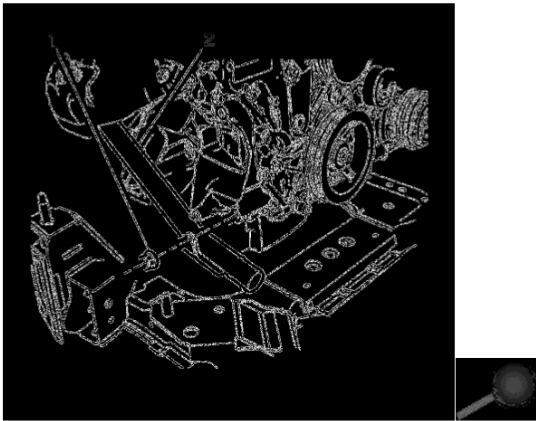
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1. Install the generator bracket (1) to the engine block.

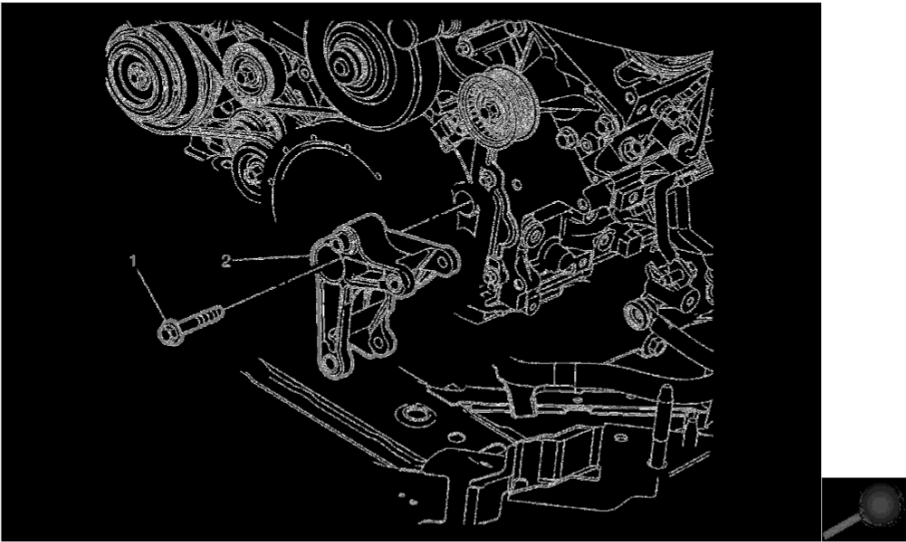
Caution: Refer to [Fastener Caution](#).

2. Install the generator bracket to engine block retaining bolts (1) and tighten to **58 N•m (43 lb ft)**.



3. Install the coolant inlet pipe (2) to generator bracket retaining nut (1) and tighten to **22 N•m (16 lb ft)**.
4. Install the generator. Refer to [Generator Replacement](#).

Generator Bracket Replacement (V8)



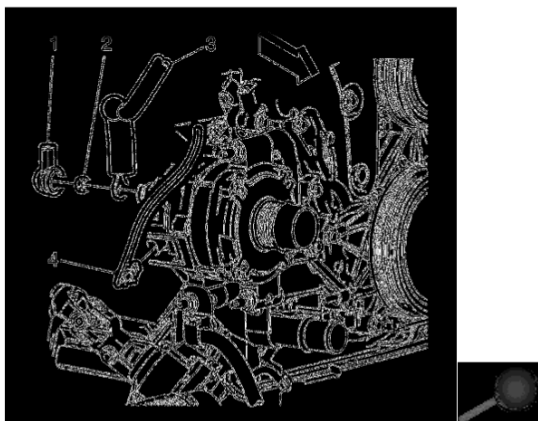
Generator Bracket Replacement

Callout	Component Name
Preliminary Procedure 1. Remove the generator. Refer to Generator Replacement . 2. Remove the lower idler pulley. Refer to Drive Belt Idler Pulley Replacement .	
1	Generator Bracket Fastener Caution: Refer to Fastener Caution . Tighten 58 N·m (43 lb ft)
2	Generator Bracket

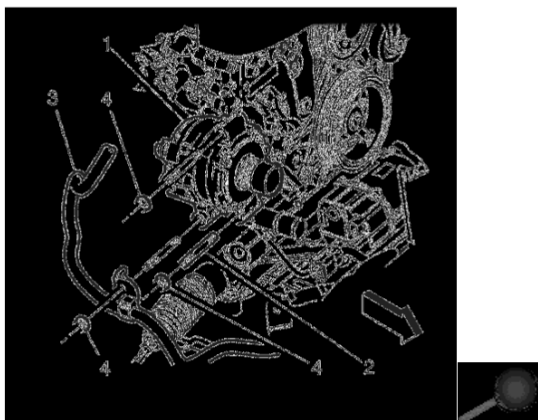
Generator Replacement (V6)

Removal Procedure

1. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
3. Remove the drive belt from the generator. Refer to [Drive Belt Replacement](#).



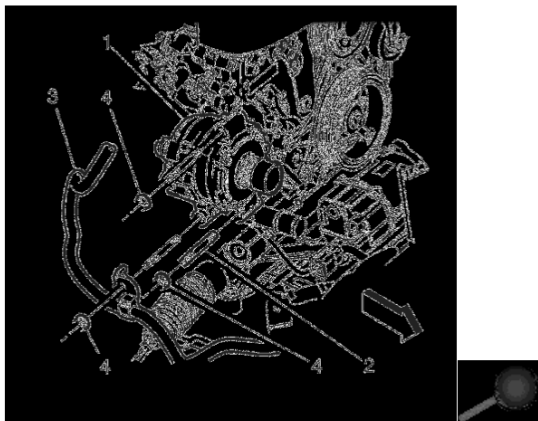
4. Disconnect the electrical connector (4) from the generator.
5. Reposition the protective boot (1) and remove the generator B + fastener (2).
6. Remove the battery positive cable (3) from the generator stud.



7. Remove the generator mounting fasteners (4) and the engine wiring harness and battery positive retainer bracket (3).
8. Remove the generator mounting studs (2) from the generator bracket.
9. Remove the generator (1) from the vehicle.

Installation Procedure

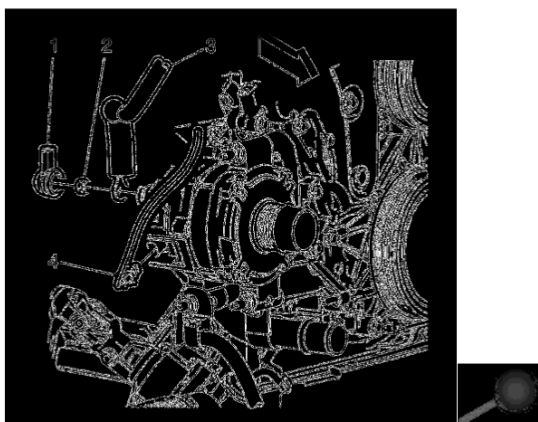
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1. Install the generator (1) to the generator mounting bracket.

Caution: Refer to [Fastener Caution](#).

2. Install the generator mounting studs (2) to the generator bracket and tighten to **18 N•m (13 lb ft)**.
3. Install the engine wiring harness and battery positive cable retaining bracket (3).
4. Install the generator mounting fasteners (4) and tighten to **45 N•m (33 lb ft)**.



5. Install the battery positive cable (3) to the B + stud at the back of the generator and tighten the fastener (2) to **10 N•m (89 lb in)**.
6. Install the terminal boot (1).
7. Connect the electrical connector (4) to the generator.
8. Install the drive belt to the generator. Refer to [Drive Belt Replacement](#).
9. Install the intake manifold sight shield. Refer to [Intake Manifold Sight Shield Replacement](#).
10. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

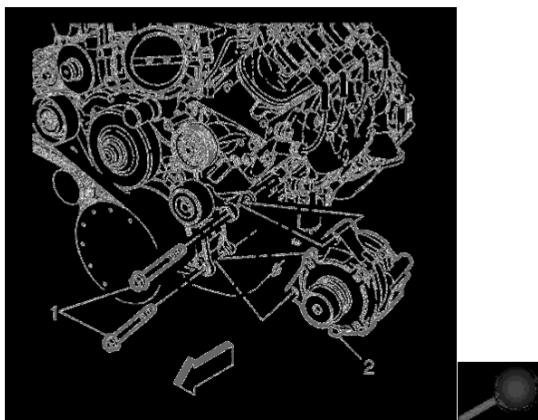
Generator Replacement (V8)

Removal Procedure

1. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).
3. Remove the accessory drive belt from the generator. Refer to [Drive Belt Replacement - Accessory](#).

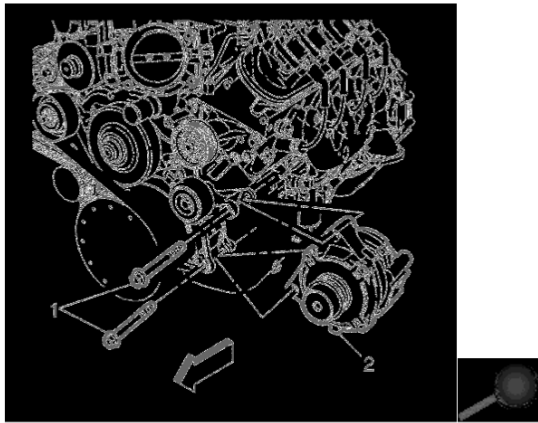


4. Disconnect the electrical connector (3) from the generator.
5. Reposition the protective boot (2) and remove the generator B + fastener (1).
6. Remove the battery positive cable from the generator stud.
7. Remove the fastener (5) securing the generator rear brace (4) to the back of the generator.



8. Remove the generator mounting fasteners (1) and remove the generator (2) from the engine compartment.

Installation Procedure



Caution: Refer to [Fastener Caution](#).

1. Install the generator (2) to the generator mounting bracket and tighten the mounting fasteners (1) to **58 N·m (43 lb ft)**.



2. Install the battery positive cable to the B + stud at the back of the generator and tighten the fastener (1) to **10 N·m (89 lb in)**.
3. Install the terminal boot (2) and connect the electrical connector (3).
4. Install the rear generator brace (4) to the back of the generator and tighten the fastener (5) to **58 N·m (43 lb ft)**.
5. Install the accessory drive belt to the generator. Refer to [Drive Belt Replacement - Accessory](#).
6. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).
7. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Fastener Tightening Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Battery Hold Down Retainer Fastener (Sedan, Wagon)	17 N•m	13 lb ft
Battery Hold Down Strap Retainer (Sedan, Wagon)	22 N•m	16 lb ft
Battery Negative Cable Post Fastener	5 N•m	44 lb in
Battery Negative Cable to Ground Fastener (Pickup)	22 N•m	16 lb ft
Battery Negative Cable to Ground Fastener (Sedan, Wagon)	25 N•m	18 lb ft
Battery Positive Cable Post Fastener	5 N•m	44 lb in
Battery Positive Cable Extension Cable to Junction Block Fastener	15 N•m	11 lb ft
Battery Positive Cable to Accessory Wiring Junction Block Fastener	9 N•m	80 lb in
Battery Positive Cable to Generator Fastener	10 N•m	89 lb in
Battery Positive Cable to Plenum Fastener	15 N•m	11 lb ft
Body Harness Terminal to Negative Battery Cable Fastener	9 N•m	80 lb in
Engine Ground Cable to Engine Block Fastener	25 N•m	18 lb ft
Engine Ground Cable to Body Fastener	22 N•m	16 lb ft
Engine Wiring and Battery Positive Cable Bracket to Engine Block Stud Fastener (V8)	9 N•m	80 lb in
Engine Wiring and Battery Positive Cable Bracket to Generator Mounting Fastener (V6)	45 N•m	33 lb ft
Engine Wiring and Battery Positive Cable Conduit Fastener	9 N•m	80 lb in
Generator Bracket Fastener	58 N•m	43 lb ft
Generator Mounting Fastener (V6)	45 N•m	33 lb ft

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Application	Specification	
	Metric	English
Generator Mounting Fastener (V8)	58 N•m	43 lb ft
Generator Mounting Stud (V6)	18 N•m	13 lb ft
Generator Brace Fastener (V8)	58 N•m	43 lb ft
Starter Heat Shield Fastener	5 N•m	44 lb in
Starter Mounting Fastener	58 N•m	43 lb ft
Starter Mounting Stud (V6)	18 N•m	13 lb ft
Starter Solenoid Cable Bracket Fastener (LFX)	22 N•m	16 lb ft
Starter Solenoid Cable to Starter (LFX)	11 N•m	97 lb in

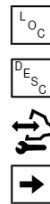
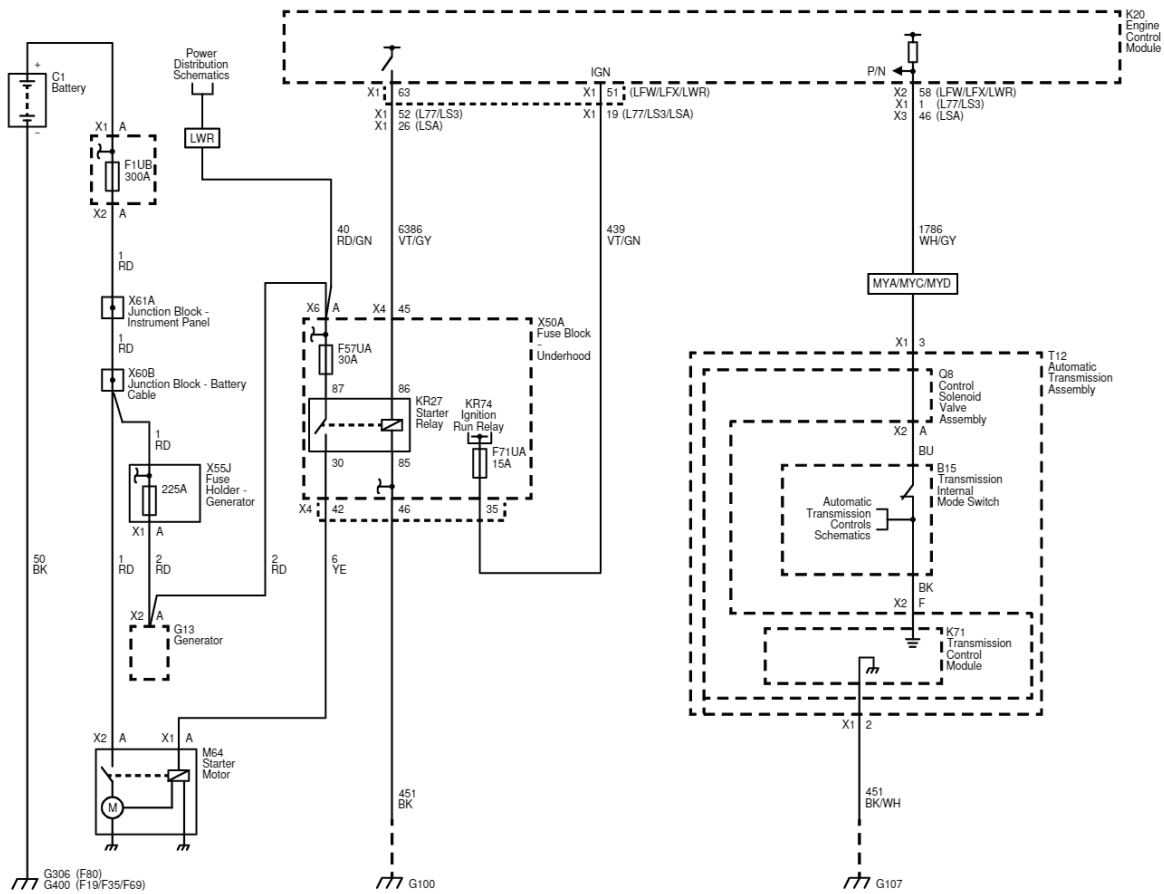
Starting and Charging Schematics

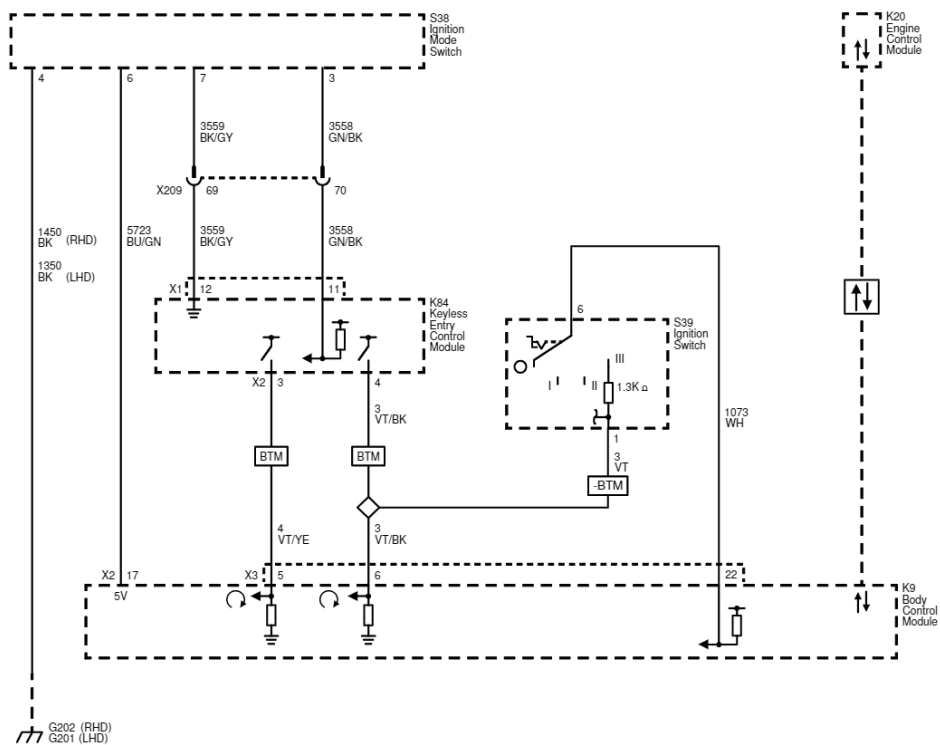
Figure 1: [Starting \(1 of 2\)](#)

Figure 2: [Starting \(2 of 2\)](#)

Figure 3: [Charging](#)

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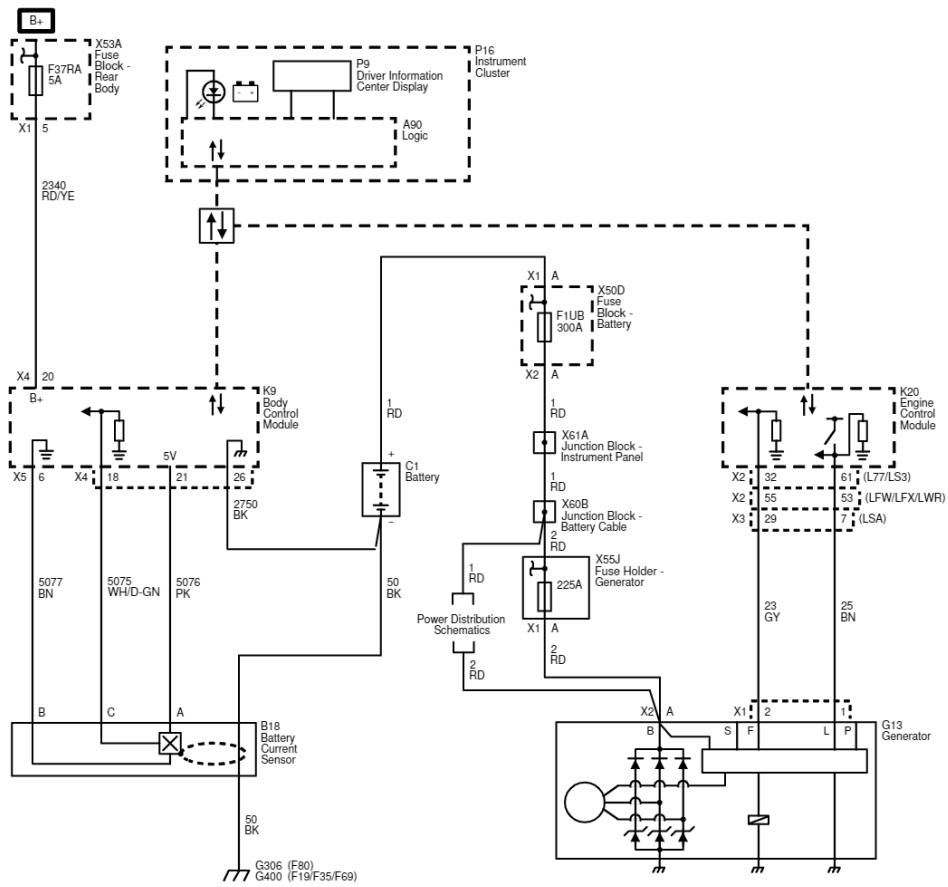


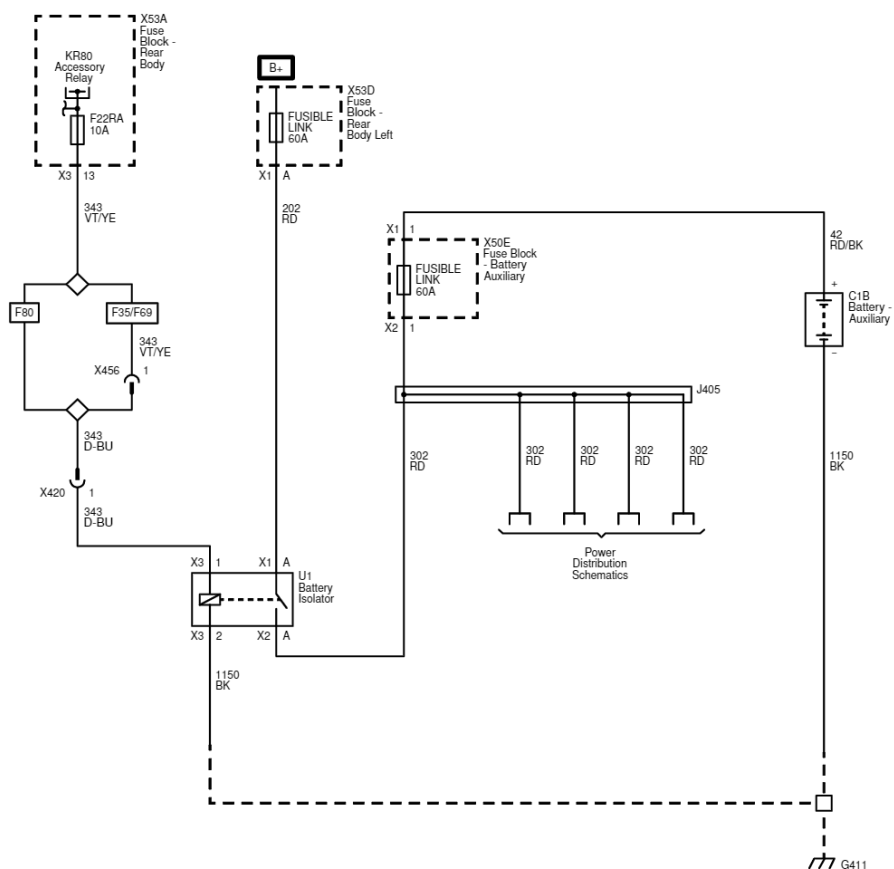


LOG

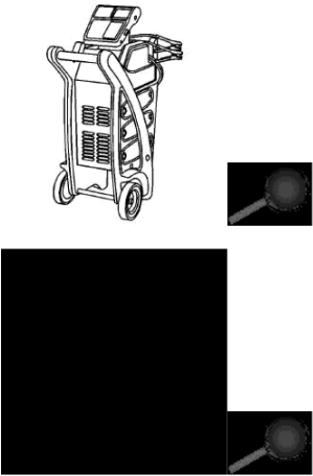
DESIGN







Special Tools

Illustration	Tool Number/Description
	EL 38758 EL 50074 J 38758 Parasitic Draw Test Switch
	EL 50313 EL 42000 EL 50076 J 42000 Battery Tester

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