

12 V Starting and Charging

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Description and Operation

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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.

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.

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 hours, 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 3.75A load for 20 hours before dropping to 10.5V. (10.5V 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 2.75A load for 20 hours before dropping to 10.5V.

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 7.2V. See battery label for the cold cranking amperage rating of this battery.

Related Part Information

Part Name	Catalog Name	Part Code
Battery	BATTERY,(W/ UPR CVR)	0048A
Battery	BATTERY,	0050A
Battery	BATTERY,(INCOMPLETE)	X0032
Battery	BATTERY PKG,	SS385

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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 3â€™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 3â€™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 13.8â€™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 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 either the negative or positive 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 128â€™Hz with a duty cycle of 0â€™100â€™percent. Normal duty cycle is between 5â€™95â€™percent. Between 0â€™5â€™percent and 95â€™100â€™percent are for diagnostic purposes.

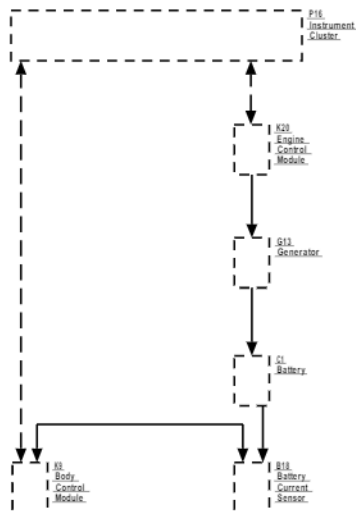
Engine Control Module (ECM)

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 two means of notification, a charge indicator and a driver information center message of SERVICE BATTERY CHARGING SYSTEM if equipped.



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Charging System Operation

The purpose of the charging system is to maintain the battery charge and vehicle loads. There are six 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 to 100 percent. Normal duty cycle is between 5 to 95 percent. Between 0 to 5 percent and 95 to 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
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 to 100 percent.

Normal duty cycle is between 5â€“99â€“percent. Between 0â€“5â€“percent and 100â€“percent are for diagnostic purposes.

Battery Sulfation Mode

The BCM will enter this mode when the interpreted generator output voltage is less than 13.2â€“V for 45 minutes. When this condition exists the BCM will enter Charge Mode for 2â€“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 more 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 0â€“C (32â€“F).
- Battery State of Charge is less than 80 percent.
- Vehicle speed is greater than 145â€“km/h (90â€“mph)
- Current sensor fault exists.
- System voltage was determined to be below 12.56â€“V

When any one of these conditions is met, the system will set targeted generator output voltage to a charging voltage between 13.9â€“15.5â€“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 0â€“C (32â€“F) but less than or equal to 80â€“C (176â€“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 12.5â€“13.1â€“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 13.9â€“14.5â€“V.

Start Up Mode

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

Voltage Reduction Mode

The BCM will enter Voltage Reduction Mode when the calculated ambient air temperature is above 0â€“C (32â€“F). The calculated battery current is less than 1â€“ampere and greater than 7â€“amperes, and the generator field duty cycle is less than 99â€“percent. Its targeted generator output voltage is 12.9â€“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 11â€“V or greater than 16â€“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 11â€“V or greater than 16â€“V for more than 30â€“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 3â€“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.

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Electrical Power Management Description and Operation

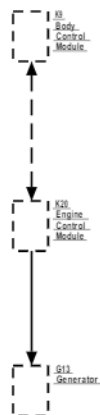
Electrical Power Management

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:



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Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 1 Start	Less Than $\hat{\sim}15^{\circ}\text{C}$ (5°F)	Less Than 13 V	$\hat{\sim}$	First level Idle boost requested
Idle Boost 1 Start	$\hat{\sim}$	$\hat{\sim}$	Battery has a net loss greater than 0.6 Ah	First level Idle boost requested
Idle Boost 1 Start	$\hat{\sim}$	Less Than 10.9 V	$\hat{\sim}$	First level Idle boost requested
Idle Boost 1 End	Greater Than $\hat{\sim}15^{\circ}\text{C}$ (5°F)	Greater Than $\hat{\sim}12$ V	Battery has a net loss less than 0.2 Ah	First level Idle boost request cancelled
Load Shed 1 Start	$\hat{\sim}$	$\hat{\sim}$	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	$\hat{\sim}$	Less Than 10.9 V	$\hat{\sim}$	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 20% of their cycle

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Load Shed 1 End	â€”	Greater Than 12 V	Battery has a net loss of less than 2 Ah	Clear Load Shed 1
Idle Boost 2 Start	â€”	â€”	Battery has a net loss greater than 1.6 Ah	Second level Idle boost requested
Idle Boost 2 Start	â€”	Less Than 10.9 V	â€”	Second level Idle boost requested
Idle Boost 2 End	â€”	Greater Than 12 V	Battery has a net loss less than 0.8 Ah	Second level Idle boost request cancelled
Idle Boost 3 Start	â€”	â€”	Battery has a net loss of 10 Ah	Third level Idle boost requested
Idle Boost 3 Start	â€”	Less Than 10.9 V	â€”	Third level Idle boost requested
Idle Boost 3 End	â€”	Greater Than 12 V	Battery has a net loss of less than 6.0 Ah	Third level Idle boost request cancelled
Load Shed 2 Start	â€”	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	â€”	Less Than 10.9 V	â€”	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	â€”	Greater Than 12.6 V	Battery has a net loss of less than 10.5 Ah	Clear Load Shed 2
Load Shed 3 Start	â€”	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	â€”	Greater Than 12.6 V	Battery has a net loss of less than 15 Ah	Clear Load Shed 3

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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.

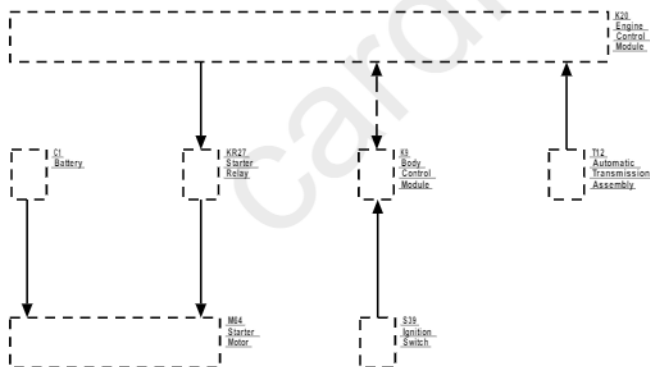
As soon as the solenoid switch contacts close, current stops flowing through the pull-in winding because battery voltage is applied to both ends of the windings. The hold-in winding remains energized. Its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly, and solenoid 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.



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Diagnostic Information and Procedures

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DTC P0560, P0562, or P0563 (LKY)

Diagnostic 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 P0560

System Voltage

DTC P0562

System Voltage Low Voltage

DTC P0563

System Voltage High Voltage

Circuit/System Description

The ECM monitors the battery voltage to ensure that the voltage stays within the proper range. Damage to components and incorrect data may occur if the voltage is out of range.

Conditions for Running the DTC

- The ignition is ON.
- The vehicle speed is greater than 20 km/h (12.4 mph).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0560

The ECM detects that the difference between the battery voltage and the main relay feedback voltage is greater than expected.

P0562

The ECM detects that the battery voltage is less than 7 V.

P0563

The ECM detects that the battery voltage is greater than 16 V.

Action Taken When the DTC Sets

DTC P0560, P0562, and P0563 are Type C DTCs.

Conditions for Clearing the DTC

DTC P0560, P0562, and P0563 are Type C DTCs.

Diagnostic Aids

- A low or high voltage DTC in multiple modules indicates a concern in the charging system.

- A high voltage DTC could be set by overcharging with a battery charger or jump starting.

Reference Information

Schematic Reference

[Starting and Charging Schematics](#)

Connector End View Reference

[Master Electrical Component List](#)

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. Engine running, accessories OFF, verify that the battery voltage at the battery terminals is between 12.6â€“15.0â€‰V.
2.
 - If not within the specified range, refer to [Charging System Test](#).
3. Verify that the scan tool ECM Ignitionâ€‰Signal parameter is between 12.6â€“15.5â€‰V.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K20â€‰ECM.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1â€‰minute. Test for less than 5â€‰â„Ž between the ground circuit terminals listed below and ground:
3.
 - Terminal 1 X1
 - Terminal 3 X1
 - Terminal 5 X1
4.
 - If greater than the specified range, test the ground circuit for an open/high resistance.
5. Ignition ON, verify that a test lamp illuminates between the IGN/B+ circuit terminals listed below and ground:
6.
 - Terminal 2 X1
 - Terminal 4 X1

- Terminal 6 X1

7.

- If the test lamp does not illuminate, test the IGN/B+ circuit for a short to ground or an open/high resistance.

8. If all circuits test normal, replace the K20â€™s ECM.

Repair Instructions

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

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

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DTC 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 P0562

System Voltage Low

DTC P0563

System Voltage High

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0562	P0562, P0563	â€”	â€”
Ground	â€”	P0562, P0563	â€”	â€”

Circuit/System Description

The ECM monitors the battery voltage to ensure that the voltage stays within the proper range. Damage to components and incorrect data may occur if the voltage is out of range.

Conditions for Running the DTC

P0562 (Without FX3)

- The ignition is ON.
- The DTC runs continuously when the above conditions are met.

P0563 (Without FX3)

- The ignition is ON.
- The DTC runs at the end of power latch before switching off the ECM.

P0562 or P0563 (FX3)

- The engine is running.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0562 (Without FX3)

The ECM detects that the system voltage is less than 4.969V or greater than 17.958V for 7.65s.

P0562 (FX3)

The ECM detects that the system voltage is less than 11V.

P0563 (Without FX3)

The ECM detects that the system voltage is greater than 7.9V.

P0563 (FX3)

The ECM detects that the system voltage is greater than 16V.

Action Taken When the DTC Sets

DTC P0562 and P0563 are Type C DTCs.

Conditions for Clearing the DTC

DTC P0562 and P0563 are Type C DTCs.

Diagnostic Aids

- A low or high voltage DTC in multiple modules indicates a concern in the charging system.
- A high voltage DTC could be set by overcharging with a battery charger or jump starting.

Reference Information

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- [Wiring Repairs](#)

DTC Type Reference

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

Scan Tool Reference

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

Circuit/System Verification

1. Engine running, accessories OFF, verify that the battery voltage at the battery terminals is between 12.6V–15.0V.
2.
 - If not within the specified range, refer to [Charging System Test](#).
3. Verify that the scan tool ECM Ignition Signal parameter is between 12.6V–15.5V.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the K20 ECM.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5V between the ground circuit terminals listed below and ground:
- 3.

Without FX3)

- Terminal 24
- Terminal 27
- Terminal 28
- Terminal 33
- Terminal 67

4.

FX3

- Terminal 4
- Terminal 27
- Terminal 28
- Terminal 29
- Terminal 74
- Terminal 75

5.

- If greater than the specified range, test the ground circuit for an open/high resistance.

6. Ignition ON, verify that a test lamp illuminates between the IGN/B+ circuit terminals listed below and ground:

7.

Without FX3

- Terminal 29
- Terminal 30
- Terminal 66

8.

FX3

- Terminal 17
- Terminal 25
- Terminal 47
- Terminal 50

9.

- If the test lamp does not illuminate, test the IGN/B+ circuit for a short to ground or an open/high resistance.

10. If all circuits test normal, replace the K20â€™ECM.

Repair Instructions

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

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

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DTC P0625 or P0626

Diagnostic 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 P0625

Generator F-Terminal Circuit Low Voltage

DTC P0626

Generator F-Terminal Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	â€”	P0625	â€”	â€”
Signal	P0625	P0625	P0626	â€”
Control	P0621	P0621	P0621	â€”

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 5â€”99%.

Conditions for Running the DTC

P0625

- The engine is running.
- The engine speed is less than 3000 RPM.

P0626

- The engine is not running.
- The ignition is in the ON position.

Conditions for Setting the DTC

P0625

The ECM detects a pulse width modulated (PWM) signal less than 5% for 15 s.

P0626

The ECM detects a pulse width modulated (PWM) signal greater than 65% for 15 s.

Action Taken When the DTC Sets

DTC P0625 and P0626 are C type DTCs.

Conditions for Clearing the DTC

DTC P0625 and P0626 are C type DTCs.

Reference Information

Schematic Reference

[Starting and Charging Schematics](#)

Connector End View Reference

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- [Wiring Repairs](#)

DTC Type Reference

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

Scan Tool Reference

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

Circuit/System Verification

1. Engine running.
2. Verify the scan tool Generator F-Terminal Signal Circuit parameter changes between 5 and 99%.
3.
 - If the parameter does not change
 - Refer to Circuit/System Testing.
4.
 - If the parameter changes
5. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal 1 X1 and ground.
2.
 - If the test lamp does not illuminate and the circuit fuse is good
3.
 1. Disconnect the B+ cable at the G13 Generator.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 - 3.

- If 2 $\hat{a}_{,l}$ or greater, repair the open/high resistance in the circuit.
- If less than 2 $\hat{a}_{,l}$, verify the fuse is not open and there is voltage at the fuse.

4.

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

5.

1. Test for infinite resistance between the B+ circuit and ground.

2.

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

3.

- If infinite resistance

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

5.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the G13 Generator.

6.

- **If the test lamp illuminates**

7. Ignition OFF, disconnect the X2 harness connector at the G13 Generator.

8. Verify the scan tool ECM Generator F-Terminal Signal parameter is less than 5%.

9.

- **If 5% or greater**

10.

1. Ignition ON.

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

3.

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

11.

- **If less than 5%**

12. Install a 3 A fused jumper wire between the signal circuit terminal 2 X2 and B+.

13. Verify the scan tool ECM Generator F-Terminal Terminal Signal parameter is greater than 95%.

14.

- **If 95% or less**

15.

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

2. Test for less than 2 $\hat{a}_{,l}$ in the signal circuit end to end.

3.

- If $2 \hat{a}_{\eta}^{\dagger}$ or greater, repair the open/high resistance in the circuit.

4.

- If less than $2 \hat{a}_{\eta}^{\dagger}$

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

6.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the K20 Engine Control Module.

16.

- If greater than 95%.

17. Test or replace the G13 Generator.

Repair Instructions

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

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

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DTC P1668

Diagnostic 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 P1668

Generator L-Terminal Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Generator L- Terminal	P1668	P1668	P1668	â€”

Circuit/System Description

The engine control module (ECM) uses the generator turn ON signal circuit to control the load of the generator on the engine. A high side driver in the ECM applies a voltage to the voltage regulator. This signals the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON signal circuit. The ECM should detect low voltage on generator turn ON signal 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 on the generator turn ON signal circuit. The ECM performs tests to determine the status of the generator turn ON signal circuit.

Conditions for Running the DTC

- No generator, crankshaft position (CKP) sensors, or camshaft position (CMP) sensor DTCs are set.
- The ignition ON, engine OFF for the ignition on test.
- The engine running for the run test.

Conditions for Setting the DTC

- During the ignition ON test, the ECM detects high voltage on the generator turn on signal circuit for at least 5 seconds.
- During the RUN test, the ECM detects low voltage on the generator turn on signal circuit for at least 15 seconds.

Action Taken When the DTC Sets

DTC P1668 is a C type DTC.

Conditions for Clearing the DTC

DTC P1668 is a C type DTC.

Reference Information

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DTC Type Reference

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

Scan Tool Reference

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the generator.
2. Ignition ON, test for less than 1 volt between the generator turn on signal circuit and ground.
3.
 - If greater than the specified value, test the generator turn on signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Engine Running, test for greater than 3.5 volts between the generator turn on signal and ground.
5.
 - If less than the specified value, test the generator turn on signal circuit for a short to ground, an open/ high resistance. If the circuit tests normal, replace the ECM.
6. If the circuit tests normal, test or replace the generator.

Repair Instructions

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

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

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DTC P2500 or P2501

Diagnostic 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 P2500

Generator L-Terminal Circuit Low Voltage

DTC P2501

Generator L-Terminal Circuit High Voltage

For symptom byte information, refer to [Symptom Byte List](#).

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	â€”	P0625	â€”	â€”
Control	P2500	P2500	P2501	â€”
Signal	P0625	P0625	P0626	â€”

Circuit/System Description

The engine control module (ECM) uses the generator turn on control circuit, or L-terminal circuit, to control the load of the generator on the engine. A high side driver in the ECM applies a voltage to the voltage regulator. This 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 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 on the generator turn on control circuit. The ECM performs tests to determine the status of the generator turn on control circuit.

Conditions for Running the DTC

P2500

The engine is running.

P2501

- The ignition is ON.
- The engine is OFF.

Conditions for Setting the DTC

P2500

The ECM detects low voltage on the generator turn on control circuit for 2 s.

P2501

The ECM detects high voltage on the generator turn on control circuit for 2 s.

Action Taken When the DTC Sets

The charge indicator turns ON 15 s after the DTC sets.

Conditions for Clearing the DTC

- The DTC will pass when the conditions for setting the DTC are no longer met for 2 s.
- A history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The charge indicator turns OFF 15 s after the DTC passes.

Reference Information

Schematic Reference

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DTC Type Reference

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

Scan Tool Reference

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

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X1, B X1 or I X1, and ground.
2.
 - **If the test lamp does not illuminate and the circuit fuse is good**
3.
 1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 3.
 - 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.
4.
 - **If the test lamp does not illuminate and the circuit fuse is open**
5.
 1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
 2. Test for infinite resistance between the B+ circuit and ground.
 - 3.

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

6.

- **If the test lamp illuminates**

7. Disconnect the X2 harness connector at the G13 Generator, ignition ON.

8. Test for 1â€‰V or greater between the control circuit terminal 1 X2 and ground.

9.

- **If less than 1 V**

10.

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

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

3.

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

4.

- If infinite resistance

5. Test for less than 2â€‰V in the control circuit end to end.

6.

- If greater than 2â€‰V, repair the open/high resistance in the circuit.
- If less than 2â€‰V, replace the K20 Engine Control Module.

11.

- **If 1V or greater**

12. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module, Ignition ON.

13. Test for less than 1â€‰V between the G13 Generator control circuit terminal 1 X2 and ground.

14.

- **If greater than 1â€‰V**
- Repair the short to voltage on the circuit.

15.

- **If 1V or less**

16. Test or replace the G13 Generator.

Repair Instructions

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

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

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Symptoms - Engine Electrical

Note:

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

- Perform [Diagnostic System Check - Vehicle](#) 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](#)
- [Starter Noise Diagnosis](#)

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Battery Inspection/Test

Battery Load Test

1. Check the battery for obvious damage, such as a cracked or broken case or cover, which could permit the loss of electrolyte. If obvious damage is noted, replace the battery.
2. Connect a voltmeter and a battery load tester across the battery terminals.
3. Apply a 300.ampere load for 15â€œseconds to remove any surface charge from the battery.
4. Remove the load.
5. Wait 15â€œseconds to let the battery recover, and apply a 270.ampere load.
6. If the voltage does not drop below the minimum listed, the battery is good and should be reinstalled. If the voltage is less than the minimum listed, replace the battery.

Voltage	Temperature
9.3 V	20Â°C
9.2 V	16Â°C
9.1 V	10Â°C
9.0 V	4Â°C
8.8 V	1Â°C
8.6 V	7Â°C
8.4 V	12Â°C
8.2 V	18Â°C

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Battery Inspection/Test (LKY)

Diagnostic 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 â€”

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 â€œOut of Vehicleâ€ and then the correct battery type (Flooded, AGM, Spiral AGM or Stop/Start 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 (battery disconnected with test equipment connected directly to the posts) for each battery when testing a vehicle with dual batteries.

Reference Information

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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 must be OFF with the key removed, 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 Battery or C1B Battery “Auxiliary (if equipped) case is not cracked, broken, or damaged, which may be indicated by battery acid leakage.
2.
 - **If there is any apparent damage**
 - Replace the C1 Battery or C1B Battery “Auxiliary.
3.
 - **If there is no damage**
4. Verify that the battery cables are clean and tight. The battery terminal bolts should be torqued as specified in [Fastener Specifications](#).
5.
 - **If the battery cables need to be cleaned or tightened**
 - Clean as required and tighten as specified.
6.
 - **If the battery cables are clean and tight**
7. Disconnect battery from the vehicle. There is no need to remove the battery from the vehicle.
8. Connect the EL-50313 directly to the battery terminal posts.
9. Select “Charging,” “Diagnostic” and “Out of Vehicle” when setting up the test.
10. Select the proper battery type, Flooded, AGM, Spiral AGM or Stop/Start AGM.
11. Enter the CCA as shown on the battery label.
12. Verify the test result is not REPLACE BATTERY or BAD CELL-REPLACE
13. 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 Out of Vehicle test.
14.
 - **If the test result is REPLACE BATTERY or BAD CELL-REPLACE**
 - Replace the C1 Battery or C1B Battery “Auxiliary.
15.
 - **If the test result is not REPLACE BATTERY or BAD CELL-REPLACE**
16. All OK.

Repair Instructions

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

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Battery Charging

Battery State of Charge

Note:

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

For maintenance-free batteries, SOC 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, when checking the voltage the engine must be stopped and all electrical loads turned OFF, including parasitic loads. 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 SOC:

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 12â€‰hours.
3.
 - If the answer is no, the terminal voltage will be stabilized and no action is necessary before reading the voltage.
 - If the answer is yes, terminal voltage will not be stabilized, wait 12â€‰hours since the last time the battery was used/charged before continuing.
4. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12â€‰hours.

5. Note:

The state of charge table is accurate to 10â€‰percent only after the battery has been at rest for 12â€‰hours.

6. Measure the battery voltage at the battery posts. Refer to the following table to determine the SOC according to the estimated battery temperature.

Use the SOC information as follows:

- A battery with a SOC that is below 65â€‰percent must always be recharged before returning it to service or continuing storage.
- A battery with a SOC that is 65â€‰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 charged to at least 90â€‰percent, before returning it to service or continuing storage.

Battery Voltage	% Charge at 0Â°C (32Â°F)	% Charge at 25Â°C (75Â°F)
12.75â€‰V	100%	100%
12.7â€‰V	100%	90%
12.6â€‰V	90%	75%
12.45â€‰V	75%	65%
12.2â€‰V	65%	45%
12.0â€‰V	40%	20%

Charging Time Required

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

- Battery charger capacityâ€”The higher the charger amperage, the less time it will take to charge the battery.
- Battery SOCâ€”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 11â€‰volts, 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 instructions for operating this circuitry.

- Battery temperature – 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 temperature increase the charging current will increase.

Charging Procedure

Warning:

Batteries produce explosive gases. Batteries contain corrosive acid. Batteries supply levels of electrical current high enough to cause burns. Therefore, in order to reduce the risk of personal injury while working near a battery, observe the following guidelines:

- Always shield your eyes.
- Avoid leaning over the battery whenever possible.
- Do not expose the battery to open flames or sparks.
- Do not allow battery acid to contact the eyes or the skin.

Other List: attention-list2

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.

Note:

Flat batteries can be boost charged, avoid high charging current if the battery is more than 50 percent charged. Slow charging is required to fully charge the battery.

1. Remove the battery from the vehicle.
2. Inspect the battery for any physical damage. Do not charge if battery is damaged.
3. Loosen the battery filler caps. Leave the caps resting on top of the filler tubes.
4. Connect the battery charger. Set to the appropriate charge rate.
5. Monitor the electrolyte temperature. If it exceeds 55°C (130°F) turn off the battery charger and allow the battery to cool. After the battery has cooled restart charging at a reduced rate.
6. For slow charging monitor the battery voltage. Specify gravity and temperature every hour. Stop the charging when no change in voltage or specific gravity after 3 consecutive tests.
7. Install the battery filler caps.
8. After charging, test the battery.
9. Install the battery to the vehicle.

Related Part Information

Part Name	Catalog Name	Part Code
Battery	BATTERY,(W/ UPR CVR)	0048A
Battery	BATTERY,	0050A
Battery	BATTERY,(INCOMPLETE)	X0032
Battery	BATTERY PKG,	SS385

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Battery Charging (LKY)

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 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 battery's 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.
3.
 - 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.
4. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12 hours.
5. Note:

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

6. 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 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%
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% must always be recharged before returning it to service or continuing storage.
- A battery with a state of charge that is 65% 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%, 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 15 N-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.
4. 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.
5. 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.
6. Turn ON the charger and set to the highest setting for normal charging.
7. Inspect the battery every half hour after starting the battery charger.
8.
 - 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.
9. After charging, test the battery. Refer to [Battery Inspection/Test](#).

Related Part Information

Part Name	Catalog Name	Part Code
Battery	BATTERY,(W/ UPR CVR)	0048A
Battery	BATTERY,	0050A
Battery	BATTERY,(INCOMPLETE)	X0032
Battery	BATTERY PKG,	SS385

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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 min or longer after turning the ignition off before going to sleep. Other 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 1â€‰%A.
- Digital OnStar generation 6 and later vehicle communication interface module do not “wake up” every 10 min for the first 48 h 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 h 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 remote keyless entry receiver 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 remote keyless entry receiver 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 1â€‰*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% state of charge will last with a constant current draw until it reaches 50% state of charge. Differences in battery reserve capacity and temperature will affect the results.

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

Reference Information

Schematic Reference

[Control Module References](#)

Connector End View Reference

[Master Electrical Component List](#)

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 30â€‰min but it can take up to 2â€‰h 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 1â€‰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
- Headlamps OFF – auto headlamps 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 minutes 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.
3.
 - If greater than the specified range, refer to Circuit/System Testing.

Using the EL 38758 Parasitic Draw Test Switch

1. Warning:

Refer to [Battery Disconnect Warning](#).

2. 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.

3. 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.

4. Ignition OFF, disconnect the battery negative cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
5. Turn the *EL 38758* switch knob to the OFF position.
6. Install the male end of the *EL 38758* switch to the battery ground terminal.
7. Install the battery negative cable to the female end of the *EL 38758* switch.
8. Turn the *EL 38758* switch knob to the ON position.
9. Road test the vehicle and activate all of the accessories such as the radio and air conditioning.
10. Ignition OFF, connect a 10 A fused jumper wire to the test switch tool terminals.
11. Turn the *EL 38758* switch knob to the OFF position. The current now flows through the jumper wire.
12. Check the fuse in the jumper wire. The fuse should be OK.
13.
 - Failed: If the jumper wire fuse is blown, refer to Circuit/System Testing.
14.
 - Passed
15. Turn the *EL 38758* switch knob to the ON position. Remove the fused jumper wire.

16. Connect a DMM set to the 10A DC scale between the test switch tool terminals.
17. Turn the *EL38758* switch knob to the OFF position. The current now flows through the DMM.
18. As the vehicle systems shut down test for less than 30mA of parasitic current drain.
19.
 - 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 10mA, 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

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Charging System Test

Circuit/System Verification

Engine ON, observe the charge indicator on the instrument panel cluster (IPC) or message in the driver information center (DIC). The charge indicator on the IPC should be turned OFF and the DIC should not display any charging system message.

Circuit/System Testing

1. Ignition ON, verify that no generator or battery current sensor DTCs are set that would cause a charging system concern.
2.
 - If DTCs are set, refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
3. Ignition OFF, measure the voltage across the battery terminals. The voltage should read 12.0±%V or greater at room temperature.
4.
 - If not within the specified value, refer to [Battery Inspection/Test](#).
5. Start the engine and increase the engine speed to 2,500±%RPM. Observe the voltage reading on the tester. The voltage should read between 12.615.0±%V.
6.
 - If not within specified range, replace the generator.
7. Adjust the carbon pile tester to the specified load test output value. Refer to [Generator Usage](#).
8.
 - If not within specified value, replace the generator.

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Generator Noise Diagnosis (LKY)

Diagnostic 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.
6.
 - **If any of the pulleys do not spin freely**
 - Replace the affected component.
7.
 - **If all belt driven components spin freely**
8. Start the engine. Operate the engine for no longer than 30-40 seconds.
9. Verify that the noise goes away.
10.
 - **If the noise is still present**
 - The generator is not the cause of the noise. Refer to [Symptoms - Engine Mechanical](#).
11.
 - **If noise is no longer present**
12. 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.

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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

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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.
6.
 - **If any of the pulleys do not spin freely**
 - Replace the affected component.
7.
 - **If all belt driven components spin freely**
8. Start the engine. Operate the engine for no longer than 30â€“40 seconds.
9. Verify that the noise goes away.
10.
 - **If the noise is still present**
 - The generator is not the cause of the noise. Refer to [Symptoms - Engine Mechanical](#).
11.
 - **If the noise is no longer present**
12. 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.

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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	â€”	â€”
Park/Neutral Switch	1	1	2	â€”
Ignition Switch	1	1	2	â€”
1. No crank				
2. Cranks all the time				

Circuit/System Description

When the ignition switch is placed in the START position, a signal is supplied to the starter relay. Providing that the transmission is in Park/Neutral. The engine will crank.

Reference Information

Schematic Reference

- [Starting and Charging Schematics](#)
- [Automatic Transmission Controls Schematics](#)
- [Manual Transmission Schematics](#)

Connector End View Reference

[Master Electrical Component List](#)

Description and Operation

[Starting System Description and Operation](#)

Electrical Information Reference

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

Scan Tool Reference

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

Circuit/System Verification

Transmission range selector in park or neutral, attempt to start the vehicle. The starter solenoid should click and the engine should begin cranking.

- If the starter solenoid does not click or the engine does not crank, refer to Circuit/System Testing.

Circuit/System Testing

Manual Transmission

1. Disconnect the harness connector at the ignition switch.
2. Verify that a test lamp illuminates between the ignition switch B+ circuit terminal 5 and ground.
3.
 - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the F3UA fuse is open, test the ignition switch output terminal 3 for a short to ground.
4. Ensure the parking brake is applied and the transmission is in PARK or Neutral.
5. Momentarily install a 30A fused jumper wire between the ignition switch B+ circuit terminal 5 and the ignition switch output circuit terminal 3. The starter solenoid should engage and the engine should begin cranking.
6.
 - If the solenoid does not engage, test the ignition switch output circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the starter motor.
7. If all circuits test normal, replace the ignition switch.

Automatic Transmission

1. Disconnect the harness connector at the ignition switch.
2. Verify that a test lamp illuminates between the ignition switch B+ circuit terminal 5 and ground.
3.
 - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the F3UA fuse is open, test the ignition switch output terminal 3 for a short to ground.
4. Connect the harness connector at the ignition switch.
5. Connect a test lamp between the ignition switch output terminal 3 and ground.
6. Transmission in park/neutral, cycle the ignition between the OFF and Crank position. The test lamp should turn ON and OFF when changing between the Crank and OFF positions.
7.
 - If the test lamp is always ON, test the ignition switch output circuit for a short to voltage. If the circuit tests normal, replace the ignition switch.
 - If the test lamp is always OFF, test the ignition switch output circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ignition switch.
8. Connect a test lamp between the Park/Neutral Position switch output terminal 6 and ground.
9. Transmission in park/neutral, cycle the ignition between the OFF and Crank position. The test lamp should turn ON and OFF when changing between the Crank and OFF positions.
10.
 - If the test lamp is always ON, test the park/neutral position switch output circuit for a short to voltage. If the circuit tests normal, adjust or replace the park/neutral position switch, refer to [Park/Neutral Position Switch Replacement](#).
 - If the test lamp is always OFF, test the park/neutral position switch output circuit for a short to ground or an open/high resistance. If the circuit tests normal, adjust or replace the park/neutral position switch, refer to [Park/Neutral Position Switch Replacement](#).
11. If all circuits test normal, replace the starter motor.

Repair Instructions

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

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

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Starter Solenoid Does Not Click (LKY)

Diagnostic 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+ (relay terminal 30)	1	1	â€”	â€”
Relay Coil Control (relay terminal 85)	P0615	P0615	2	â€”
Starter Control (relay terminal 87)	1	1	2	â€”
Ground (relay terminal 86)	â€”	P0615	â€”	â€”
1. Starter Solenoid Does Not Click				
2. Cranks All The Time				

Circuit/System Description

When the ignition mode 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 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 solenoid.

Reference Information

Schematic Reference

- [Starting and Charging Schematics](#)
- [Automatic Transmission Controls Schematics](#)

Connector End View Reference

[Master Electrical Component List](#)

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 Verification

1. Ignition ON.

2. Verify that no ignition, starter relay, brake pedal position sensor, immobilizer, or automatic transmission DTCs are set that would cause the ECM to disable engine starting.
3.
 - **If DTCs are set**
 - Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
4.
 - **If no DTCs are set**
5. Verify the scan tool BCM 5 V Ignition Switch parameter is Crank Request when the ignition switch is in the crank position.
6.
 - **If Crank Request not displayed**
 - Refer to [Power Mode Mismatch](#).
7. Verify the scan tool TCM Internal Mode Switch parameter displays Park with the transmission range selector in park.
8.
 - **If the TCM Internal Mode Switch parameter does not indicate Park**
 - Refer to [Transmission Internal Mode Switch Logic](#).
9.
 - **If the TCM Internal Mode Switch parameter indicates Park**
10. Verify the scan tool ECM Crankshaft Position Active Counter parameter is not incrementing.
11.
 - **If the counter increments**
 - Replace the B26 Crankshaft Position Sensor.
12.
 - **If the counter does not increment**
13. Verify the crank relay clicks and the engine begins cranking with the ignition in the Crank position.
14.
 - **If the KR27 Starter Relay does not click**
 - Refer to Circuit/System Testing.
15.
 - **If the KR27 Starter Relay clicks**
16. All OK.

Circuit/System Testing

1. Ignition ON.
2. Verify the scan tool ECM Ignition 1 Signal parameter is greater than 10 V.
3.
 - **If 10 V or less**
4.
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the ignition voltage circuits and ground.
3.
 - If less than infinite resistance, repair the short to ground on the circuit.
4.
 - If infinite resistance
5. Test for less than 2 $\hat{a}_{,q}$ in the control circuit end to end.
6.
 - If 2 $\hat{a}_{,q}$ or greater, repair the open/high resistance in the circuit.
 - If less than 2 $\hat{a}_{,q}$, replace the K20 Engine Control Module.
5.
 - **If greater than 10 V**
6. Ignition OFF, disconnect the KR27 Starter Relay, ignition ON.
7. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.
8.
 - **If the test lamp does not illuminate and the circuit fuse is good**
9.
 1. Ignition OFF.
 2. Test for less than 2 $\hat{a}_{,q}$ in the B+ circuit end to end.
 3.
 - If 2 $\hat{a}_{,q}$ or greater, repair the open/high resistance in the circuit.
 - If less than 2 $\hat{a}_{,q}$, verify the fuse is not open and there is voltage at the fuse.
10.
 - **If the test lamp does not illuminate and the circuit fuse is open**
11.
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 3.
 - If less than infinite resistance, repair the short to ground on the circuit.
 4.
 - If infinite resistance,
 5. Disconnect X1 harness connector at the M64 Starter Motor.
 6. Test for infinite resistance between the control circuit terminal 87 and ground.
 7.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M64 Starter Motor.
12.
 - **If the test lamp illuminates**

12. The test lamp illuminates

13. Ensure the parking brake is applied and the T12 Transmission is in PARK. Momentarily install a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
14. Verify the M64 Starter Motor is activated.
15.
 - **If the M64 Starter Motor does not activate**
16.
 1. Disconnect the X1 harness connector at the M64 Starter Motor.
 2. Test for less than 2 Ω in the control circuit end to end.
 3.
 - If greater the 2 Ω , repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the M64 Starter Motor.
17.
 - **If the M64 Starter Motor activates**
18. Test or replace the KR27 Starter Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR27 Starter Relay.
2. Test for 60 Ω –180 Ω between terminals 85 and 86.
3.
 - **If less than 60 or greater than 180 Ω ,**
 - Replace the relay.
4.
 - **If between 60 Ω –180 Ω ,**
5. Test for infinite resistance between the terminals listed below:
6.
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
7.
 - **If less than infinite resistance**
 - Replace the relay.
8.
 - **If infinite resistance**
9. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
10. Test for less than 2 Ω between terminals 30 and 87.

11.

- If 2 $\hat{a}_{,,|}$ or greater
- Replace the relay.

12.

- If less than 2 $\hat{a}_{,,|}$

13. All OK

Repair Instructions

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

- [Manual Shift Detent Lever with Shaft Position Switch Assembly and Park Pawl Actuator Removal](#)
- [Relay Replacement](#)
- [Crankshaft Position Sensor Replacement](#) for the 2.2L or 2.4L engines
- [Control Module References](#) for ECM replacement, programming, and setup.

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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.

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[Starting and Charging Schematics](#)

Connector End View Reference

[Master Electrical Component List](#)

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[Starting System Description and Operation](#)

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

Scan Tool Reference

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

Circuit/System Verification

1. Verify that battery is sufficiently charged and that the battery cables are clean and tight.
2.
 - If battery not sufficiently charged, refer to [Battery Charging](#).
 - If battery cables are not within specified range, refer to [Fastener Specifications](#).
3. Turn the ignition switch to the start position. The starter solenoid should click.
4.
 - If starter solenoid does not click, Refer to [Starter Solenoid Does Not Click](#).
5. Remove the drive belt. Refer to [Drive Belt Replacement](#).
6. Turn the ignition switch to the START position.
7.
 - If the engine cranks, inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator, etc.
 - If the engine does not crank, refer to [Engine Will Not Crank - Crankshaft Will Not Rotate](#).
8. Using a DMM, measure between the positive battery cable and terminalâ€™B at the solenoid as the ignition switch is turned to the START

position. Voltage should be less than 0.5â€%V.

9.
 - If greater than the specified value, replace the positive battery cable.
10. Using a DMM, measure the negative battery cable to the starter motor case as the ignition switch is turned to the START position. Voltage should be less than 0.5â€%V.
11.
 - If greater than the specified value, replace the negative battery cable.
12. If all circuits test normal, replace the starter motor.

Repair Instructions

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

Refer to [Starter Replacement](#).

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Starter Solenoid Clicks, Engine Does Not Crank (LKY)

Diagnostic 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.

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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 terminals.
2. Verify the measured voltage is between 12V±15 V.
3.
 - If voltage is less than 12 V or greater than 15 V
 - Refer to [Battery Inspection/Test](#).
4.
 - If voltage is between 12V±15V
5. Remove the drive belts. Refer to [Drive Belt Replacement](#) for 2.0L (LTG) or 2.5L (LCV) engines or [Drive Belt Replacement](#) for 2.4L (LUK) engine.
6. Verify the crankshaft rotates rotate the crankshaft by hand using the appropriate tools.
7.
 - If the crankshaft does not rotate
 - Refer to [Engine Will Not Crank - Crankshaft Will Not Rotate](#) for 2.0L (LTG) or 2.5L (LCV) engines or [Engine Will Not Crank - Crankshaft Will Not Rotate](#) for 2.4L (LUK) engine..

8.
 - **If the crankshaft rotates**
9. Verify the engine does not crank when attempting to start the vehicle.
10.
 - **If the engine cranks**
 - Inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator.
11.
 - **If the engine does not crank**
12. Verify that a test lamp illuminates between the M64 Starter Motor B+ terminal 1 X2 or A X2 and ground.
13.
 - **If the test lamp does not illuminate and the circuit fuse is good**
14.
 1. Ignition OFF.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 3.
 - 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.
15.
 - **If the test lamp does not illuminate and the circuit fuse is open**
16.
 1. Ignition OFF.
 2. Test for greater than 100 Ω between the B+ circuit and ground.
 3.
 - If 100 Ω or less, repair the short to ground on the circuit.
 - If greater than 100 Ω , replace the M64 Starter Motor.
17.
 - **If the test lamp illuminates**
18. Test for less than 0.5 V between the positive battery cable and M64 Starter Motor B+ terminal 1 X2 or A X2 with the ignition in the START position.
19.
 - **If 0.5 V or greater**
 - Replace the positive battery cable.
20.
 - **If less than 0.5 V**
21. 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.
22.
 - **If 0.5 V or greater**

- Replace the negative battery cable.

23.

- less than 0.5 V

24. Replace the M64 Starter Motor.

Repair Instructions

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

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

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1. ENGINE/PROPULSION
2. 12 V STARTING AND CHARGING
3. DIAGNOSTIC INFORMATION AND PROCEDURES
- 4.

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

[Master Electrical Component List](#)

Description and Operation

[Starting System Description and Operation](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Wiring Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Connector 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 12V-15 V.
3.
 - If voltage is less than 12 V or greater than 15 V
 - Refer to [Battery Inspection/Test](#).
4.
 - If voltage is between 12V-15 V
5. Remove the water pump and generator belt. Refer to [Water Pump and Generator Belt Replacement](#).
6. Verify the engine cranks slowly when attempting to start the vehicle.
7.
 - If the engine cranks at normal speed
 - Inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator.
- 8.

- **If the engine cranks slowly**

9. Verify that a test lamp illuminates between the M64 starter motor B+ terminal A X1 and ground.

10.

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

11.

1. Ignition OFF.
2. Test for less than 2 Ω in the B+ circuit end to end.
3.
 - 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.

12.

- **If the test lamp illuminates**

13. Test for less than 0.5 V between the positive battery cable and M64 Starter Motor B+ terminal A X1 with the ignition in the START position.

14.

- **If 0.5 V or greater**
- Replace the positive battery cable.

15.

- **If less than 0.5 V**

16. 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.

17.

- **If 0.5 V or greater**
- Replace the negative battery cable.

18.

- **If less than 0.5 V**

19. Replace the M64 starter motor.

Repair Instructions

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

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

1. ENGINE/PROPULSION
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Engine Cranks Slowly (LKY)

Diagnostic 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

[Master Electrical Component List](#)

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 12â€“15 V.
3.
 - If voltage is less than 12 V or greater than 15 V
 - Refer to [Battery Inspection/Test](#).
4.
 - If voltage is between 12â€“15 V
5. Remove the water pump and generator belt. Refer to [Water Pump and Generator Belt Replacement](#).
6. Verify the engine cranks slowly when attempting to start the vehicle.
7.
 - If the engine cranks at normal speed
 - Inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator.
- 8.

- **If the engine cranks slowly**

9. Verify that a test lamp illuminates between the M64 starter motor B+ terminal 1 X2 and ground.

10.

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

11.

1. Ignition OFF.
2. Test for less than 2 Ω in the B+ circuit end to end.
3.
 - 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.

12.

- **If the test lamp illuminates**

13. Test for less than 0.5 V between the positive battery cable and M64 Starter Motor B+ terminal 1 X2 with the ignition in the START position.

14.

- **If 0.5 V or greater**
- Replace the positive battery cable.

15.

- **If less than 0.5 V**

16. 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.

17.

- **If 0.5 V or greater**
- Replace the negative battery cable.

18.

- **If less than 0.5 V**

19. Replace the M64 starter motor.

Repair Instructions

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

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

1. ENGINE/PROPULSION
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Starter Noise Diagnosis

Circuit/System Testing

1. Remove the flywheel inspection cover.
2. Inspect the flywheel for the following:
3.
 - Loose flywheel bolts
 - Chipped gear teeth
 - Missing gear teeth
 - Bent flywheel
4.
 - If not within specifications, secure the flywheel bolts or replace the flywheel.
 - If all inspections were within specification, replace the starter motor.

Repair Instructions

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

- Refer to [Fastener Specifications](#).
- Refer to [Engine Flywheel Replacement](#).
- Refer to [Starter Replacement](#).

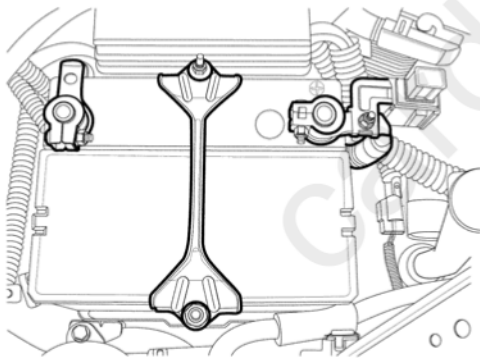
Repair Instructions

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1. ENGINE/PROPULSION
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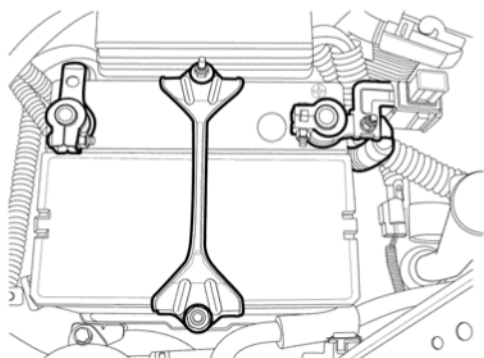
Battery Negative Cable Disconnection and Connection

Disconnection Procedure



1. [Click here for full size](#)
2. Ensure that all lamps and accessories are turned off. Turn the ignition OFF and remove the ignition key.
3. Loosen the negative battery cable nut.
4. Remove the negative battery cable from the battery.

Connect Procedure



1. [Click here for full size](#)
2. Install the negative battery cable to the battery.
3. Caution:
Refer to [Fastener Caution](#).
4. Fasten the negative battery cable nut and tighten to 10â€%N-m (89â€%lbâ€%in).
5. Insert the ignition key and turn the ignition to the ON position.
6. Program all of the customer radio station presets and set the radio clock to the current time.

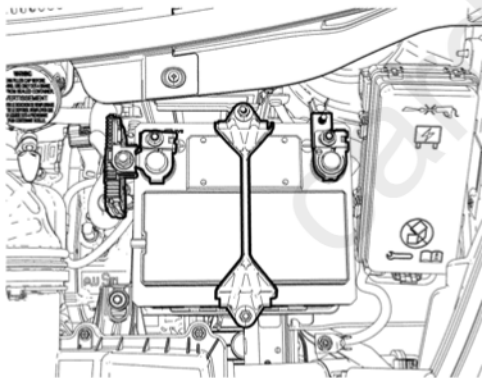
Related Part Information

Part Name	Catalog Name	Part Code
Battery Negative Cable	CABLE,BAT NEG	1700A
Battery Negative Cable	CABLE,BAT NEG	1700B
Battery Negative Cable	CABLE,BAT NEG (36 V)	1703A
Battery Negative Cable	CABLE,BAT NEG (300 V)	4385A

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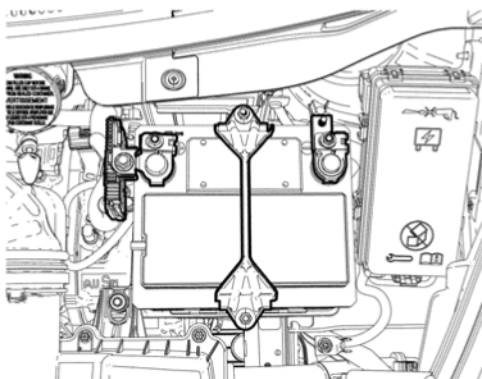
Battery Negative Cable Disconnection and Connection (LKY)

Disconnect Procedure



1. [Click here for full size](#)
2. Ensure that all lamps and accessories are turned off. Turn the ignition OFF and remove the ignition key.
3. Loosen the negative battery cable nut.
4. Remove the negative battery cable from the battery.

Connect Procedure



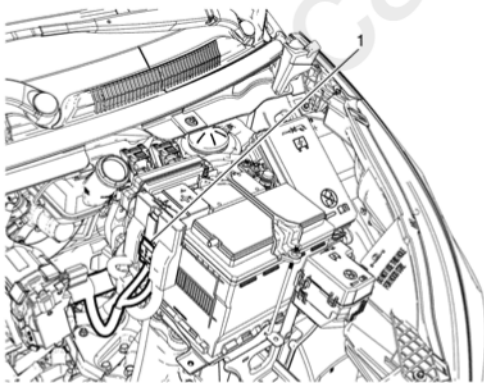
1. [Click here for full size](#)
2. Install the negative battery cable to the battery.
3. Caution:
Refer to [Fastener Caution](#).
4. Fasten the negative battery cable nut and tighten to 12â€%N-m (9â€%lbâ€%ft).
5. Insert the ignition key and turn the ignition to the ON position.
6. Program all of the customer radio station presets and set the radio clock to the current time.

1. ENGINE/PROPULSION
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Battery Positive and Negative Cable Replacement

Removal Procedure

1. Open the hood.
2. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
3. Remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).

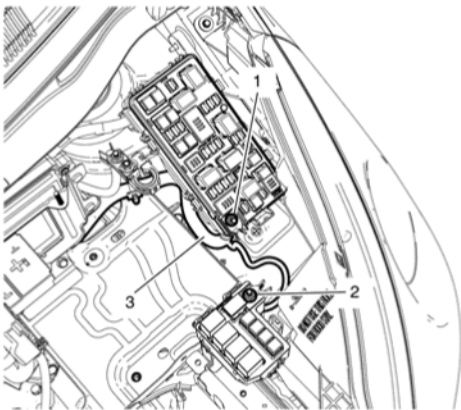


4.

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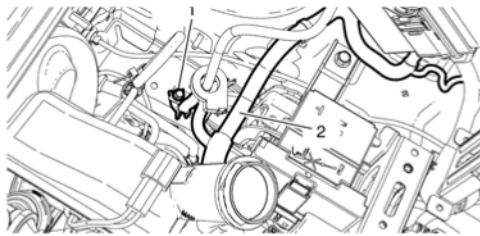
5. Disconnect the body wiring master harness connector (1) from the battery positive cable junction block.

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

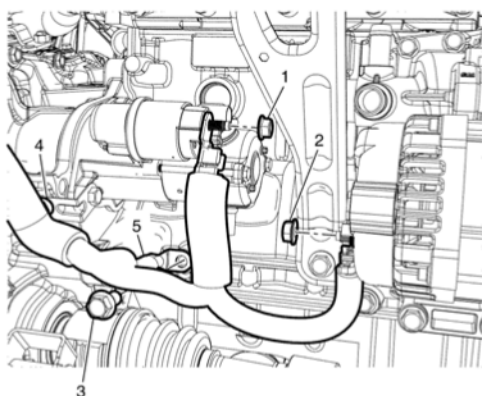


7. [Click here for full size](#)
8. Remove the fuse block cover.
9. Remove the auxiliary fuse block cover.
10. Remove the positive battery cable nut(1) from the fuse block.
11. Remove the positive battery cable nut(2) from the auxiliary fuse block.
12. Remove the positive battery cable(3) from the fuse block and auxiliary fuse block.
13. Remove the battery tray. Refer to [Battery Tray Replacement](#).





14. [Click here for full size](#)
15. Remove the battery negative cable frame ground bolt(1).
16. Remove the battery negative cable(2).
17. Raise the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
18. Remove the exhaust pipe assembly. Refer to [Exhaust Pipe Replacement](#).

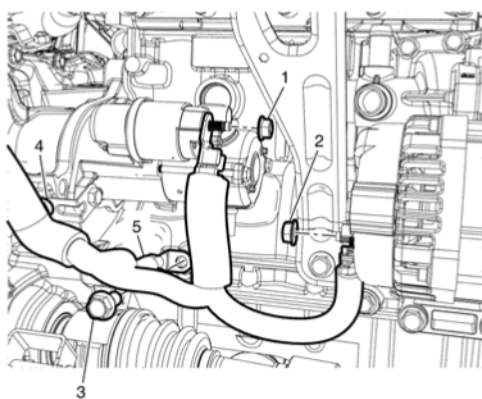


19.

[Click here for full size](#)

20. Remove the starter solenoid (+) nut (1).
21. Remove the generator (+) nut (2).
22. Remove the engine harness and battery cable male ground bolt (3).
23. Remove the retainer (4).
24. Remove the battery positive and negative cable (5) from the vehicle.

Installation Procedure



1. [Click here for full size](#)
2. Install the battery positive and negative cable(5) to the vehicle.
3. Caution:
Refer to [Fastener Caution](#).

4. Install the engine harness and battery cable male ground bolt(3) and tighten to 40â€”N-m (30â€”lbâ€”ft).
5. Install the generator Bâ€”(+) nut(2) and tighten to 11â€”N-m (8â€”lbâ€”ft).
6. Install the starter solenoid Bâ€”(+) nut(1) and tighten to 12â€”N-m (9â€”lbâ€”ft).
7. Install the retainer(4).
8. Install the exhaust pipe assembly. Refer to [Exhaust Pipe Replacement](#).
9. Lower the vehicle.



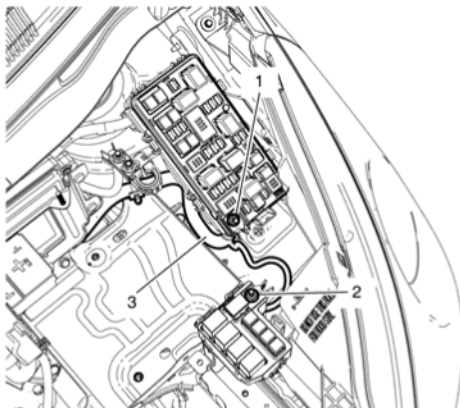
10.

[Click here for full size](#)

11. Install the battery negative cable(2).

12. Install the battery negative cable frame ground bolt(1) and tighten to 9N-m (80lb-in).

13. Remove the battery tray. Refer to [Battery Tray Replacement](#).



14.

[Click here for full size](#)

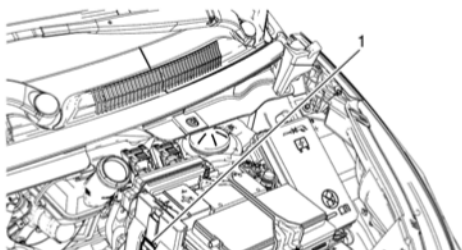
15. Install the positive battery cable(3) to the fuse block and auxiliary fuse block.

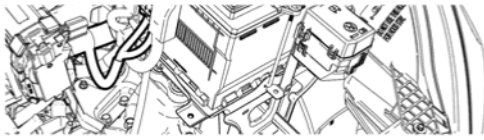
16. Install the positive battery cable nut(1, 2) and tighten to 12N-m (9lb-ft).

17. Install the fuse box cover.

18. Install the auxiliary fuse block cover.

19. Install the battery. Refer to [Battery Replacement](#).





20.

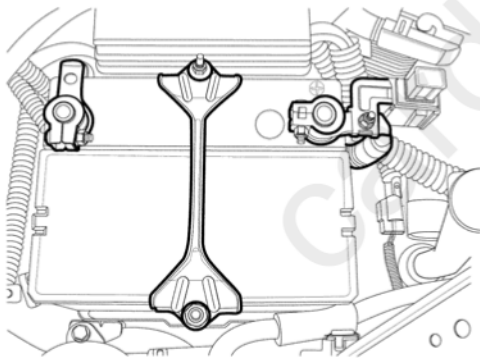
[Click here for full size](#)

21. Connect the body wiring master harness connector(1) to the battery positive cable junction block.
22. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).
23. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
24. Close the hood.

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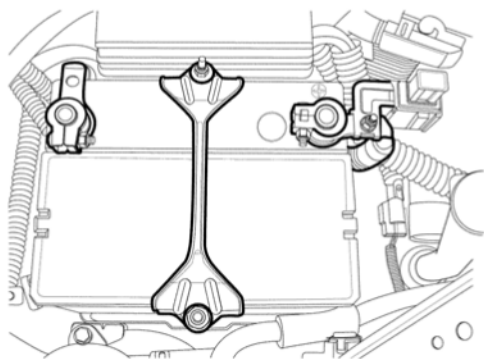
Battery Replacement

Removal Procedure



1. [Click here for full size](#)
2. Disconnect the battery negative cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
3. Disconnect the battery positive cable from the battery.
4. Remove the battery holder mounting nut and the battery holder.
5. Remove the battery.

Installation Procedure



1. [Click here for full size](#)
2. Install the battery.
3. Caution:
Refer to [Fastener Caution](#).
4. Install the battery holder and tighten the retaining nut to 4â€%N-m (35â€%lbâ€%in).
5. Connect the battery cable.

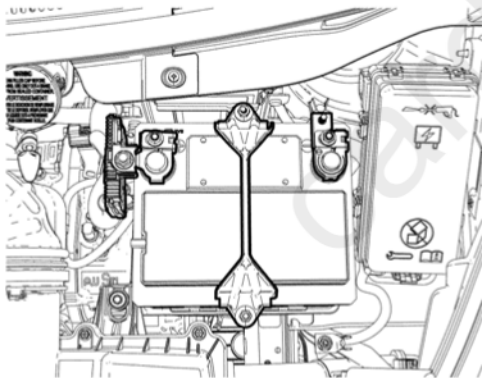
Related Part Information

Part Name	Catalog Name	Part Code
Battery	BATTERY,(W/ UPR CVR)	0048A
Battery	BATTERY,	0050A
Battery	BATTERY,(INCOMPLETE)	X0032
Battery	BATTERY PKG,	SS385

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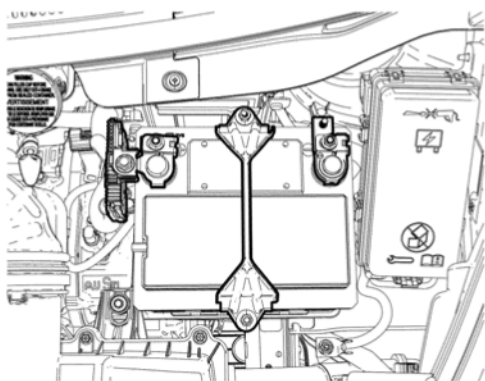
Battery Replacement (LKY)

Removal Procedure



1. [Click here for full size](#)
2. Disconnect the battery negative cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
3. Disconnect the battery positive cable from the battery.
4. Remove the battery holder mounting nut and the battery holder.
5. Remove the battery.

Installation Procedure



1. [Click here for full size](#)

2. Install the battery.

3. Caution:

Refer to [Fastener Caution](#).

4. Install the battery holder and tighten the retaining nut to 6â€%N-m (53â€%lbâ€%in).

5. Connect the battery cable.

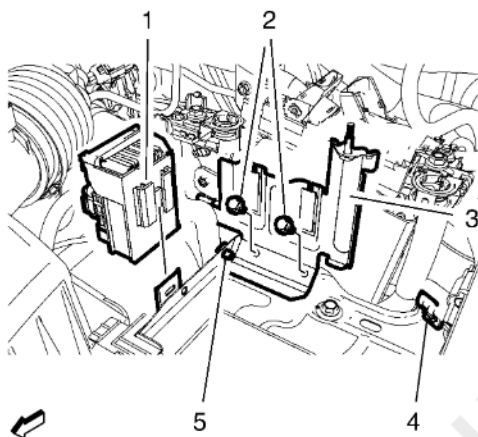
1. ENGINE/PROPULSION
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Battery Tray Replacement

Removal Procedure

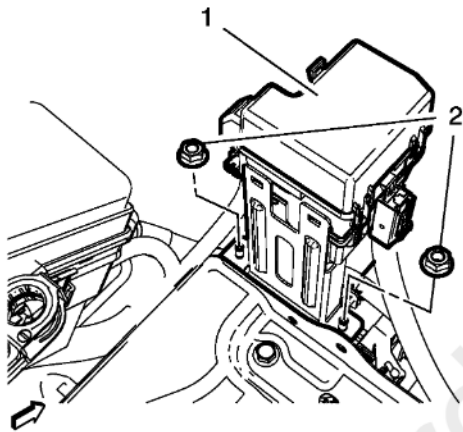
1. Remove the battery. Refer to [Battery Replacement](#).
2. Remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).

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3. [Click here for full size](#)
4. Unclip the glow plug control module in top direction (1) from the battery tray and hang aside.
5. Unclip the 2 battery positive and negative cable clips (4, 5).
6. Remove the 2 engine control module bracket bolts (2) and hang the engine control module bracket (3) along with the engine

control module aside.

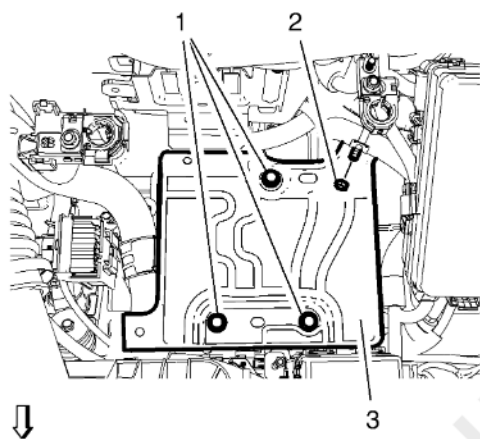


7.

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8. Remove the 2 auxiliary battery relay bracket nuts (2).

9. Hang the auxiliary battery relay bracket along with the auxiliary battery relay housing (1) aside.



10.

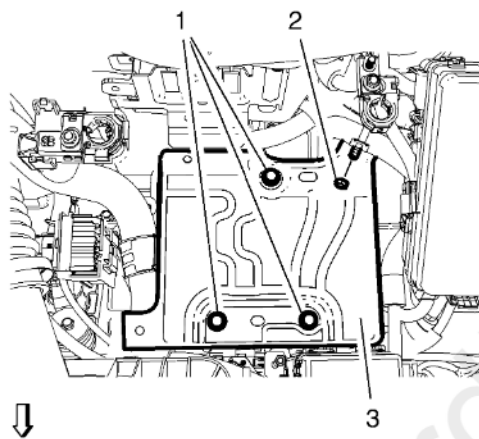
[Click here for full size](#)

11. Remove the battery tray nut(2).

12. Remove the 3 battery tray bolts(1).

13. Remove the battery tray(3).

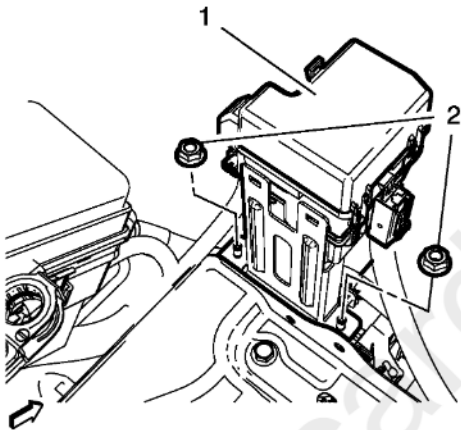
Installation Procedure



1. [Click here for full size](#)
2. Install the battery tray(3).
3. Caution:

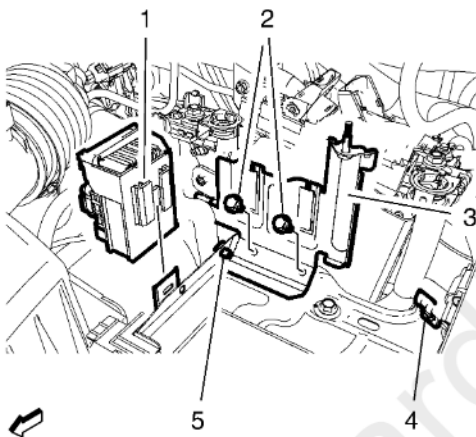
Refer to [Fastener Caution](#).

4. Install the battery tray nut(2) and tighten to 11.5â€%N-mâ€%(102â€%lbâ€%in).
5. Install the battery tray and the 3â€%battery tray boltsâ€%(1) and tighten to 11.5â€%N-mâ€%(102â€%lbâ€%in).



6. [Click here for full size](#)

7. Position the auxiliary battery relay bracket along with the auxiliary battery relay housing(1) to the battery tray.
8. Install the 2auxiliary battery relay bracket nuts(2) and tighten to 10N-m(89lb-in).



9.

[Click here for full size](#)

10. Position the engine control module bracket(3) along with the engine control module.

11. Install the engine control module bracket bolt(2) and tighten to 10N-m(89lb-in).
12. Clip in the 2 battery positive and negative cable clips(4,5).
13. Clip in the glow plug control module(1) to the battery tray.
14. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).
15. Install the battery. Refer to [Battery Replacement](#).

Related Part Information

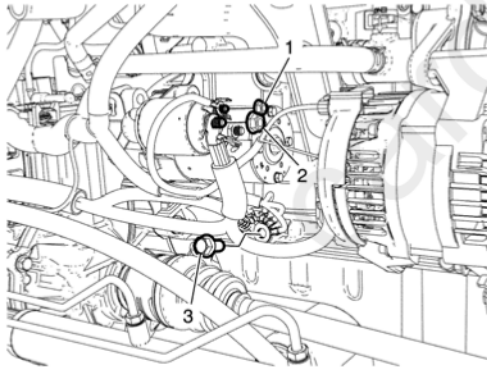
Part Name	Catalog Name	Part Code
Battery Tray	TRAY,BAT (W/SUPT)	0048A
Battery Tray	TRAY,BAT	0050A
Battery Tray	TRAY,BAT	0100A

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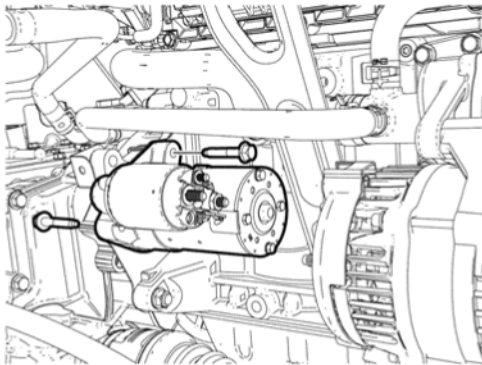
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Starter Replacement

Removal Procedure



1. [Click here for full size](#)
2. Disconnect the battery negative cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).
3. Raise the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
4. Remove the starter solenoid nut(1).
5. Remove the starter solenoid Bâ€‰(+) nut(2).
6. Remove the engine wiring harness ground retaining bolt(3) from the engine block.



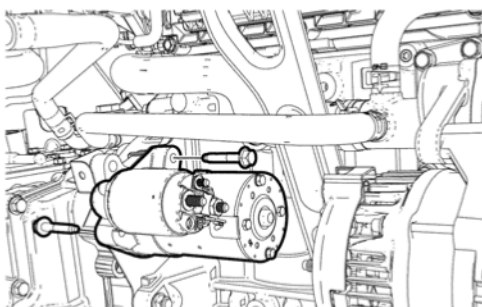
7.

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8. Remove the starter retaining bolt.

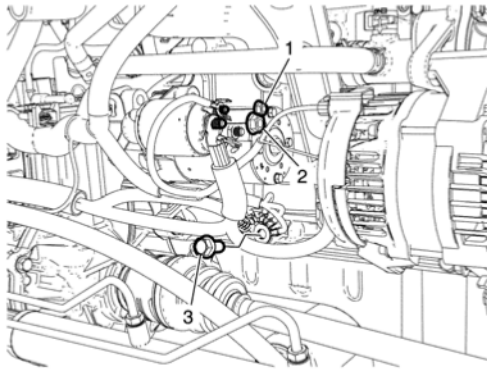
9. Remove the starter.

Installation Procedure





1. [Click here for full size](#)
2. Install the starter.
3. Caution:
Refer to [Fastener Caution](#).
4. Install the starter retaining bolt and tighten to 22â€”N-m (16â€”lbâ€”ft).



5. [Click here for full size](#)
6. Install the engine wiring harness ground retaining bolt to the engine block.
7. Install the starter solenoid Bâ€™%o(+) nutâ€™%o(2).
8. Install the starter solenoid nutâ€™%o(1). Tighten the engine wiring harness ground retaining bolt to 50â€™%oN-m (37â€™%o%lbâ€™%o%ft), the starter solenoid nut to 55â€™%oN-m (49â€™%o%lbâ€™%o%ft), and the starter solenoid Bâ€™%o(+) nut to 10â€™%oN-m (89â€™%o%lbâ€™%o%in).
9. Lower the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
10. Connect the battery negative cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

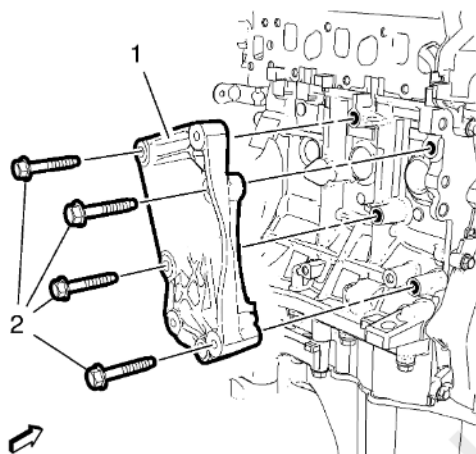
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Generator Bracket Replacement

Removal Procedure

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

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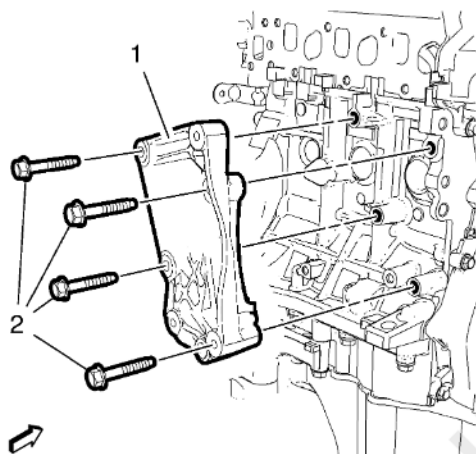
2.

[Click here for full size](#)

3. Remove the 4 generator bracket bolts (2).

4. Remove the generator bracket (1).

Installation Procedure



1. [Click here for full size](#)
2. Install the generator bracket(1).
3. Caution:
Refer to [Fastener Caution](#).

4. Install the 4 generator bracket bolts (2) and tighten to 22 N-m (16 lb-ft).
5. Install the generator. Refer to [Generator Replacement](#).

Related Part Information

Part Name	Catalog Name	Part Code
Generator Bracket	BRACKET,GEN	0175A
Generator Bracket	BRACKET,GEN	0200A
Generator Bracket	BRACKET,GEN (MCHG)	0202A
Generator Bracket	BRACKET,GEN (CSTG)	0203A
Drive Belt Idler Pulley Bracket	BRACKET,DRV BELT IDLER PUL	5610B

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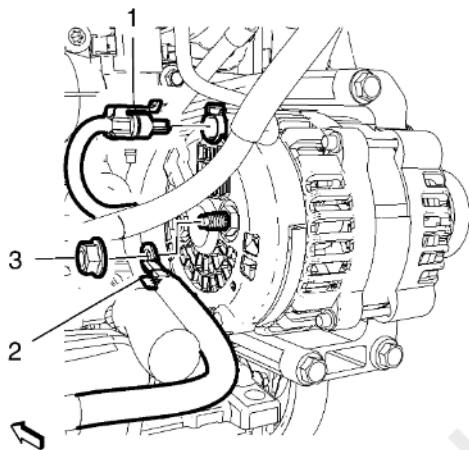
1. ENGINE/PROPULSION
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Generator Replacement

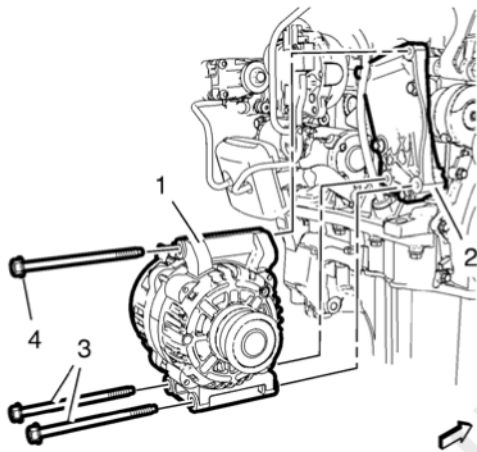
Removal Procedure

1. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the water pump and generator belt. Refer to [Water Pump and Generator Belt Replacement](#).

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3. [Click here for full size](#)
4. Disconnect the generator wiring harness plug(1).
5. Fold the generator positive cable cap aside.
6. Remove the generator positive cable nut(3) and the generator positive cable(2).



7.

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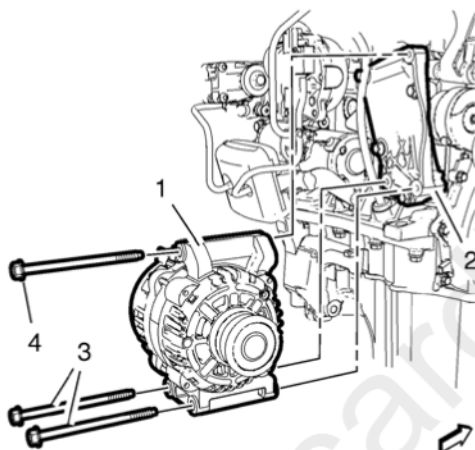
8. Note:

Remove the generator through the wheelhouse.

9. Remove the upper generator bolt (4).

10. Remove the 2 lower generator bolts (3).
11. Remove the generator (1) from the generator bracket (2).

Installation Procedure



2. Note:

Install the generator through the wheelhouse.

3. Note:

Install the upper generator bolt first.

4. Install the generatorâ€“(1) to the generator bracketâ€“(2).

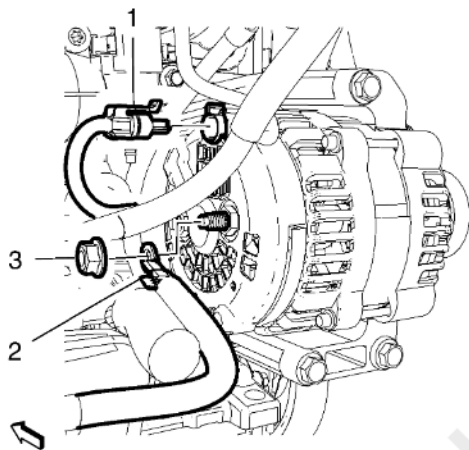
5. Caution:

Refer to [Fastener Caution](#).

6. Install the 2â€“lower generator boltsâ€“(3) and tighten to 22â€“N-mâ€“(16â€“lb-ft).

7. Install the upper generator bolt (4) and tighten to 22â€“N-mâ€“(16â€“lb-ft).

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8. [Click here for full size](#)
9. Install the generator positive cable(2) and the generator positive cable nut(3) and tighten to 12N-m(106lb-in).
10. Fold the generator positive cable cap to the generator positive terminal.
11. Connect the generator wiring harness plug(1).

12. Install the water pump and generator belt. Refer to [Water Pump and Generator Belt Replacement](#).
13. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Related Part Information

Part Name	Catalog Name	Part Code
Starter Generator	GENERATOR,STRTR	0049A
Generator	GENERATOR,	0050A
Generator	GENERATOR,	0050C
Generator	GENERATOR PKG,(W/ BAT POS & NEG CBL)	0050D
Generator	GENERATOR,(W/ DRV MOT)	5510A
Generator	GENERATOR,	SJ177

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Specifications

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Fastener Specifications

Reusable Threaded Fastener Tightening Specifications

Application	Specification
	Metric (English)
Note:	
All fasteners listed in this table can be reused after removal.	
Air Cleaner Assemblyâ€” Battery Tray Retaining Bolt	6>N-m (53 lb in)
Battery Holder Retaining Nut	4>N-m (35 lb in)
Battery Tray Mounting Bolt	11.5N-m (102thinsp;lb in)
Battery Tray Retaining Nut	11.5N-m (102thinsp;lb in)
ECM Bracket Retaining Bolt	10N-m (89 lb in)
Engine Wiring Harness Ground Retaining Bolt	50N-m (37 lb ft)
Generator Bâ€™%o(+) Nut	15N-m (11 lb ft)
Generator Retaining Bolt	22N-m (16 lb ft)
Generator Retaining Nut	12N-m (106thinsp;lb in)
Starter Retaining Bolt	22N-m (16 lb ft)
Starter Solenoid Bâ€™%o(+) Nut	10N-m (89 lb in)
Starter Solenoid Nut	5.5N-m (49 lb in)

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Fastener Specifications (LKY)

Reusable Threaded Fastener Tightening Specifications

Application	Specification
	Metric (English)
Note:	
All fasteners listed in this table can be reused after removal.	
Air Cleaner Assembly â€” Battery Tray Retaining Bolt	6>N-m (53 lb in)
Battery Holder Retaining Nut	6>N-m (53 lb in)
Battery Negative Cable Frame Ground Bolt	12N-m (106thinsp;lb in)
Battery Tray Mounting Bolt	12N-m (106thinsp;lb in)
ECM Bracket Retaining Bolt	10N-m (89 lb in)
Generator Bâ€™%(+) Nut	11N-m (97 lb in)
Generator Under Bolt	12N-m (106thinsp;lb in)
Generator Upper Bolt	22N-m (16 lb ft)
Negative Battery Cable Nut	12N-m (106thinsp;lb in)
Positive Battery Cable Nut	12N-m (106thinsp;lb in)
Starter Retaining Bolt	22N-m (16 lb ft)
Starter Solenoid Bâ€™%(+) Nut	11N-m (97 lb in)
Wiring Harness Clip Retaining Nut	12N-m (106thinsp;lb in)

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Battery Usage (LKY)

Application	Specification
Type	MF (Maintenance Free)
Amp Hours	40 AH (1.0L) / 50 AH (1.2L or 1.19L or Cold Area)
Cold Cranking Amperageâ€‰‰(CCA)	50 AH: 375 EN CCA
RC	40 AH: 52 MIN / 50 AH: 70 MIN

Related Part Information

Part Name	Catalog Name	Part Code
Battery	BATTERY,(W/ UPR CVR)	0048A
Battery	BATTERY,	0050A
Battery	BATTERY,(INCOMPLETE)	X0032
Battery	BATTERY PKG,	SS385

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Battery Usage

Application	Specification
Type	MF(Maintenance Free)
AMP Hours	40AH (1.0L)/50AH (1.2L or 1.19L or Cold Area)
Cold Cranking Amperage(CCA)	40AH:300ENCCA/ 50AH:375ENCCA
RC	40AH:52MIN/ 50AH:70MIN

Related Part Information

Part Name	Catalog Name	Part Code
Battery	BATTERY,(W/ UPR CVR)	0048A
Battery	BATTERY,	0050A
Battery	BATTERY,(INCOMPLETE)	X0032
Battery	BATTERY PKG,	SS385

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Starter Usage (LKY)

Application	Specification
Model	PG260C
Output	1.2â€‰%KW

Related Part Information

Part Name	Catalog Name	Part Code
Starter	STARTER,	0050A
Starter	STARTER,	0050C
Starter	STARTER,	X0070
Starter	STARTER KIT,	X0158
Starter	STARTER,	SJ192
Starter	STARTER,	SJ258

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Starter Usage

Application	Specification
Model	SD80N
Output	0.8â€‰%KW

Related Part Information

Part Name	Catalog Name	Part Code
Starter	STARTER,	0050A
Starter	STARTER,	0050C
Starter	STARTER,	X0070
Starter	STARTER KIT,	X0158
Starter	STARTER,	SJ192
Starter	STARTER,	SJ258

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Generator Usage (LKY)

Application	Specification
Model	NP08
Outputâ€™(Capacity)	12â€™(V)/80â€™(A)

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Generator Usage

Application	Specification
Model	NP08
Outputâ€™(Capacity)	12â€™(V)/80â€™(A)

Related Part Information

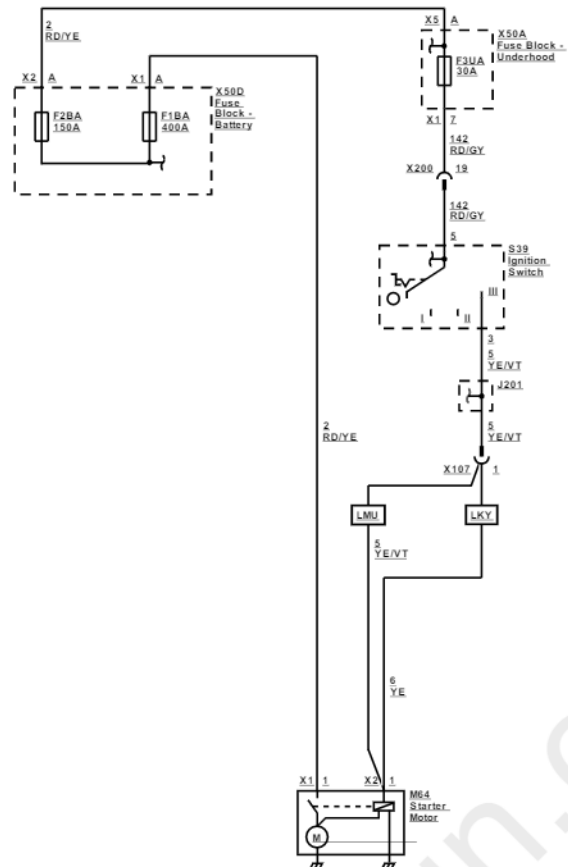
Part Name	Catalog Name	Part Code
Starter Generator	GENERATOR,STRTR	0049A
Generator	GENERATOR,	0050A
Generator	GENERATOR,	0050C
Generator	GENERATOR PKG,(W/ BAT POS & NEG CBL)	0050D
Generator	GENERATOR,(W/ DRV MOT)	5510A
Generator	GENERATOR,	SJ177

Schematic and Routing Diagrams

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Starting and Charging Schematics

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