

2006 Cadillac CTS

2006 ENGINE Engine Electrical - CTS

2006 ENGINE**Engine Electrical - CTS****SPECIFICATIONS****FASTENER TIGHTENING SPECIFICATIONS****Fastener Tightening Specifications**

Application	Specification	
	Metric	English
Battery Cable to Battery Bolt	17 N.m	13 lb ft
Battery Negative Cable to Engine Block Bolt	50 N.m	37 lb ft
Battery Negative Cable to Engine Block Bolt (LS6)	25 N.m	18 lb ft
Battery Negative Cable to Side Rail Bolt	36 N.m	27 lb ft
Battery Positive Cable to Starter Terminal Nut	13 N.m	115 lb in
Battery Positive Cable to Starter Terminal Nut (LS6)	10 N.m	89 lb in
Battery Positive Cable to Underhood Fuse Block Nut	15 N.m	11 lb ft
Battery Retainer Bolt	25 N.m	18 lb ft
Battery Tray Bolt	6 N.m	53 lb in
Engine Mount Lower Nut	80 N.m	59 lb ft
Front Air Inlet Panel Assembly Bolt	6 N.m	53 lb in
Generator Bracket Bolt	50 N.m	37 lb ft
Generator Bracket Bolt (LY7, Rear)	23 N.m	17 lb ft
Generator Bolt	35 N.m	26 lb ft
Generator Output BAT Terminal Nut	13 N.m	115 lb in
Starter Heat Shield Bolt/Nut	8 N.m	71 lb in
Starter Heat Shield Bracket Nut	8 N.m	71 lb in
Starter Motor Bolt	50 N.m	37 lb ft

BATTERY USAGE**Battery Usage**

Application	Specification
Cold Cranking Amperes	690 A
Amp Hour Rating	63 AH
Reserve Capacity Rating	110 min
Replacement Battery Number	101-6YR

GENERATOR USAGE**Generator Usage**

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Application	Specification
3.6L (LY7)	
Generator Model	Denso SC1
Rated Output	135 A
Load Test Output	94 A
5.7L (LS6)	
Generator Model	Denso SC2
Rated Output	155 A
Load Test Output	108 A

SCHEMATIC AND ROUTING DIAGRAMS

STARTING AND CHARGING SCHEMATICS

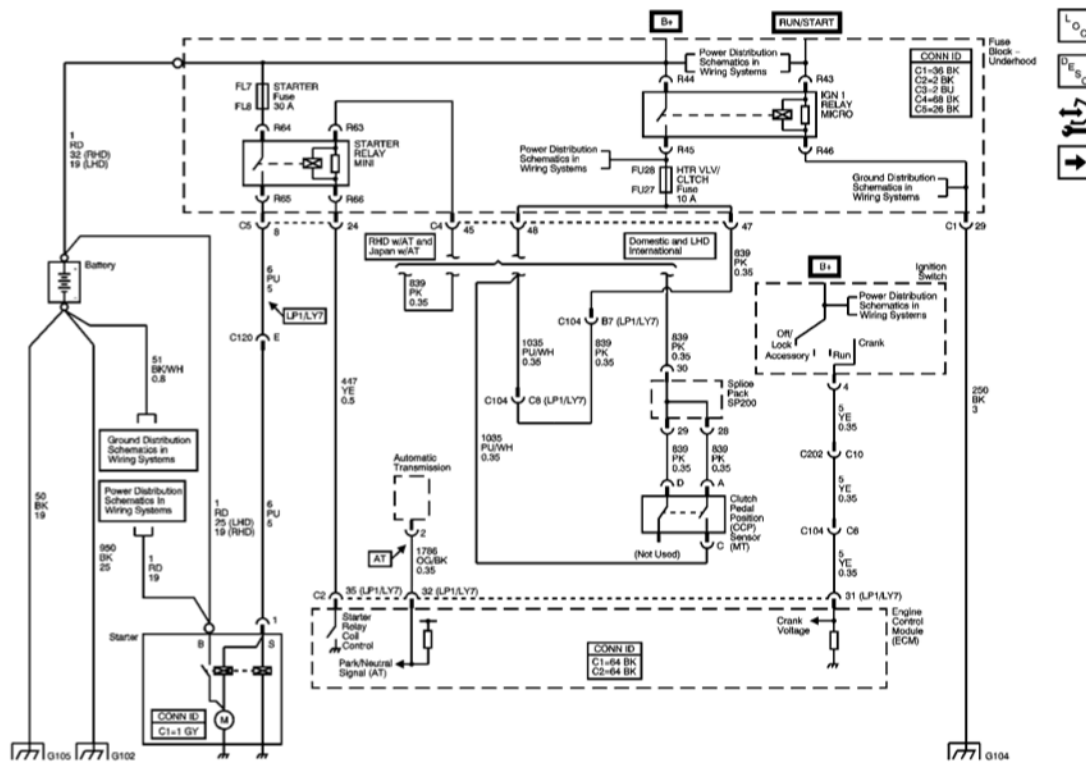


Fig. 1: Starting System - 2.8L/3.6L (LP1/LY7)
Courtesy of GENERAL MOTORS CORP.

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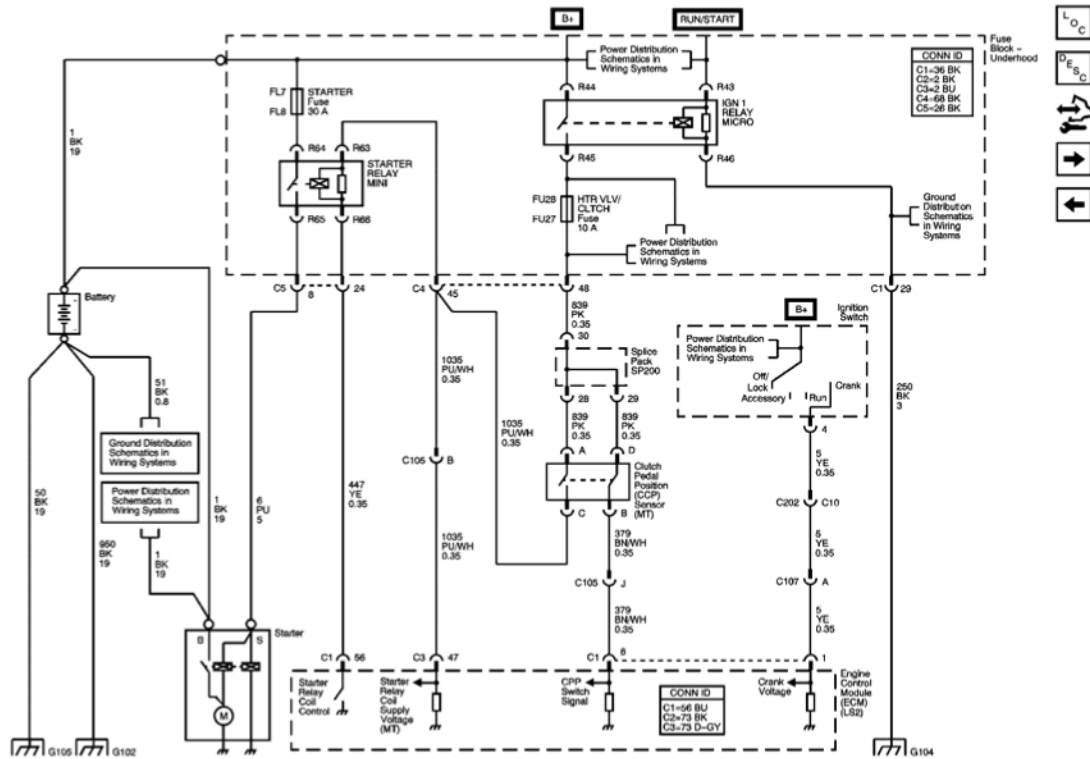


Fig. 2: Starting System - 6.0L (LS2)

Courtesy of GENERAL MOTORS CORP.

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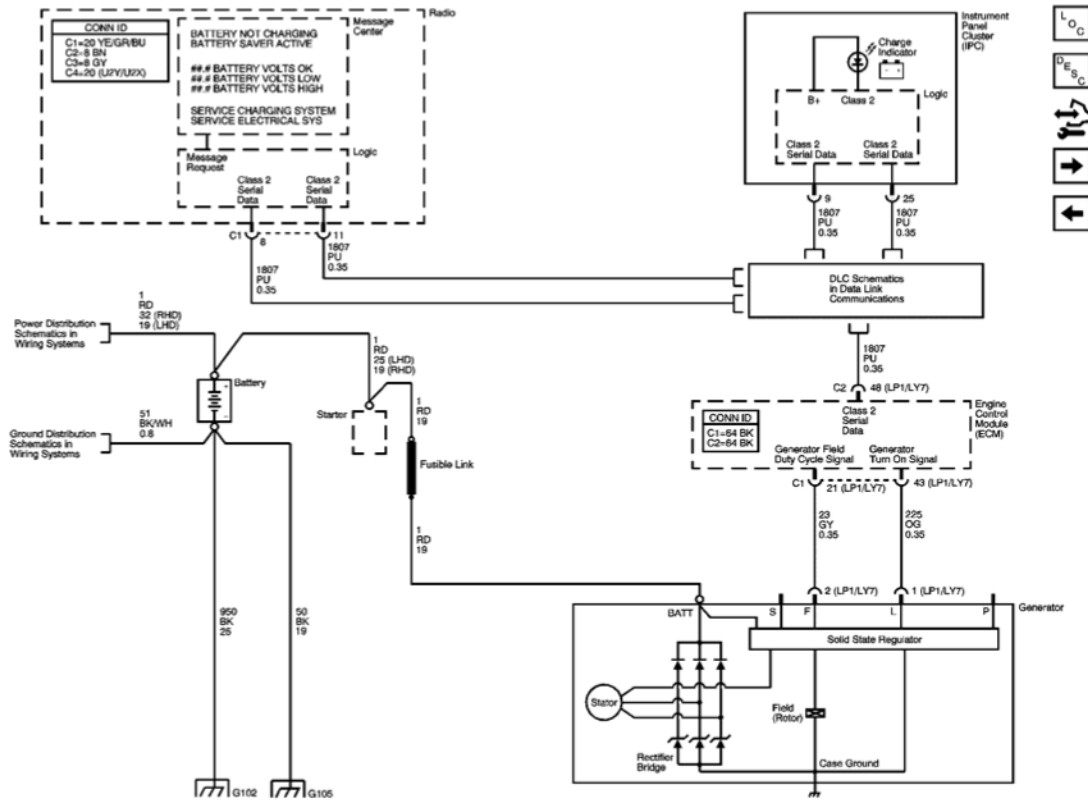


Fig. 3: Charging System - 2.8L/3.6L (LP1/LY7)
 Courtesy of GENERAL MOTORS CORP.

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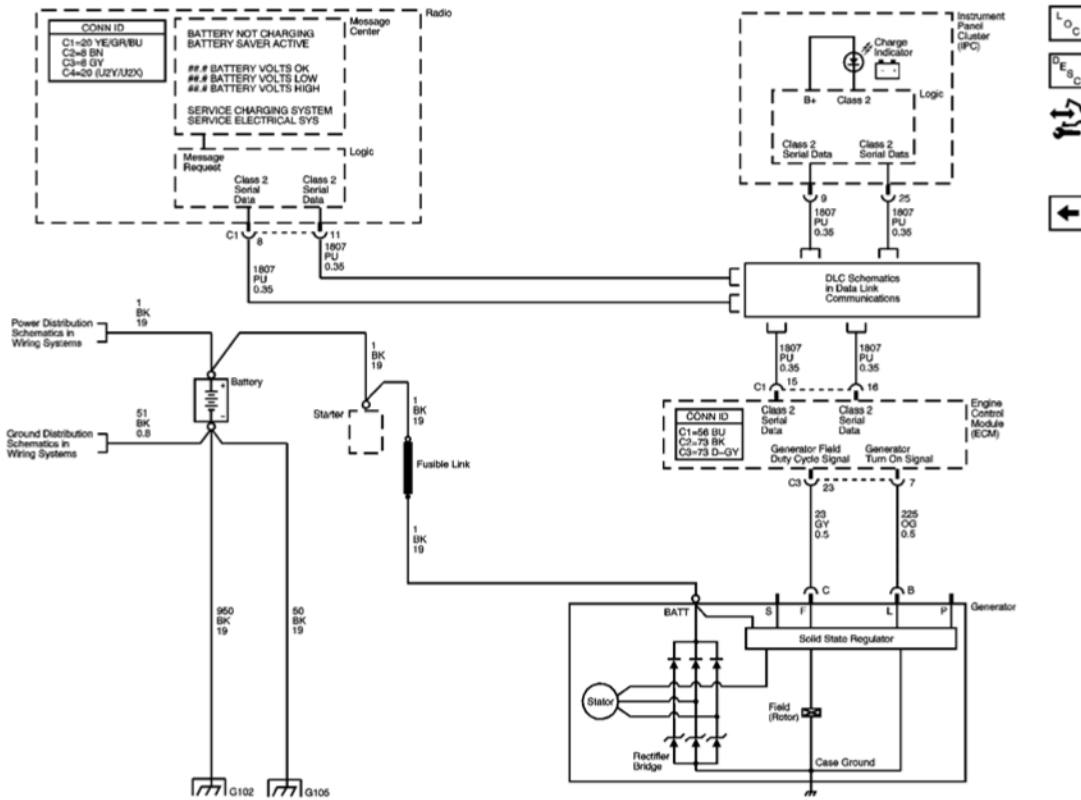


Fig. 4: Charging System -6.0L (LS2)
Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

ENGINE ELECTRICAL COMPONENT VIEWS

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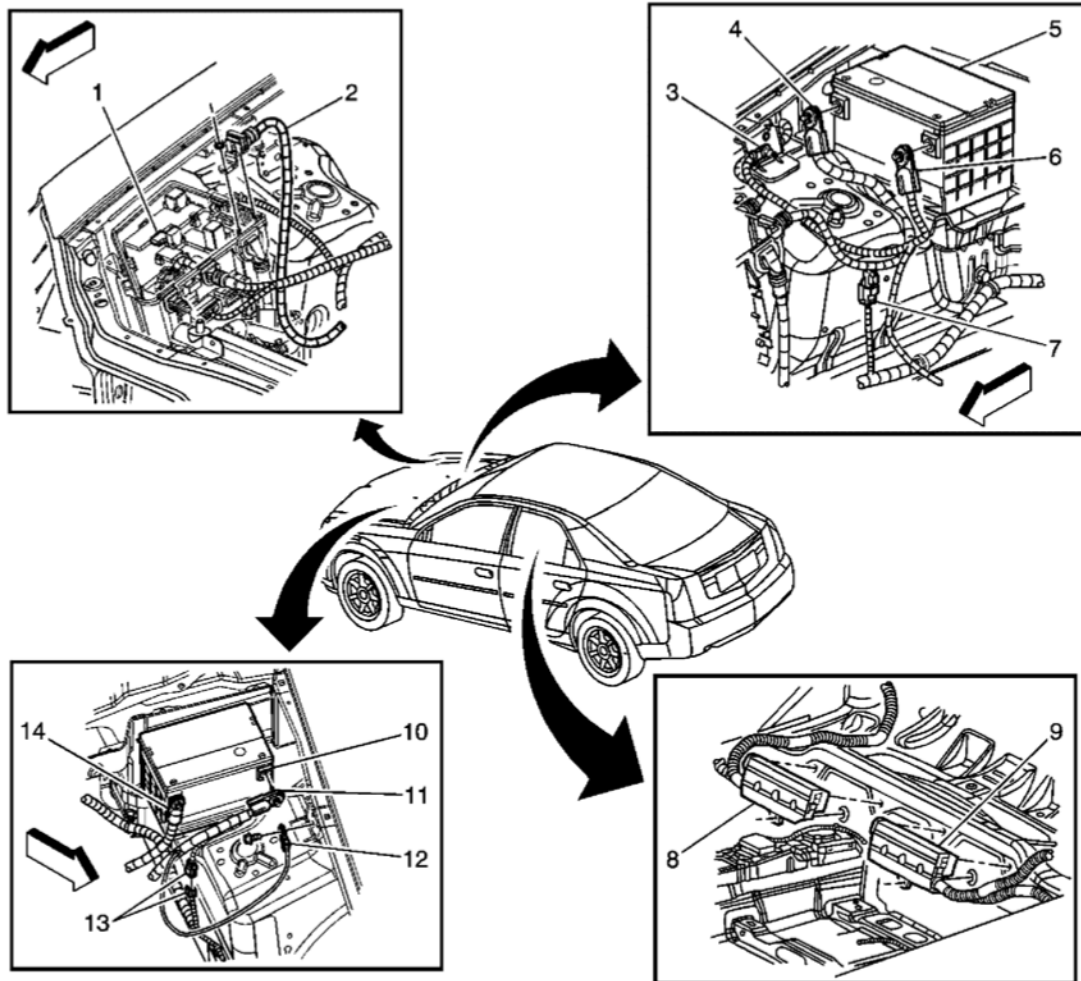


Fig. 5: Battery and Fuse Blocks

Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 5

Callout	Component Name
1	Fuse Block - Underhood
2	Battery Positive Cable Connection to Fuse Block - Underhood
3	Ground G105 (LHD)
4	Battery Positive Cable (LHD)
5	Battery (LHD)
6	Battery Negative Cable (LHD)
7	C103 (LHD)
8	Fuse Block - Right Rear
9	Fuse Block - Left Rear
10	Battery (RHD)
11	Battery Positive Cable Connection to Fuse Block - Right Rear
12	Battery Positive Cable Connection to Fuse Block - Left Rear
13	Battery Positive Cable Connection to Fuse Block - Right Rear
14	Battery Positive Cable Connection to Fuse Block - Left Rear

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11	Battery Negative Cable (RHD)
12	Ground G105 (RHD)
13	C103 (RHD)
14	Battery Positive Cable (RHD)

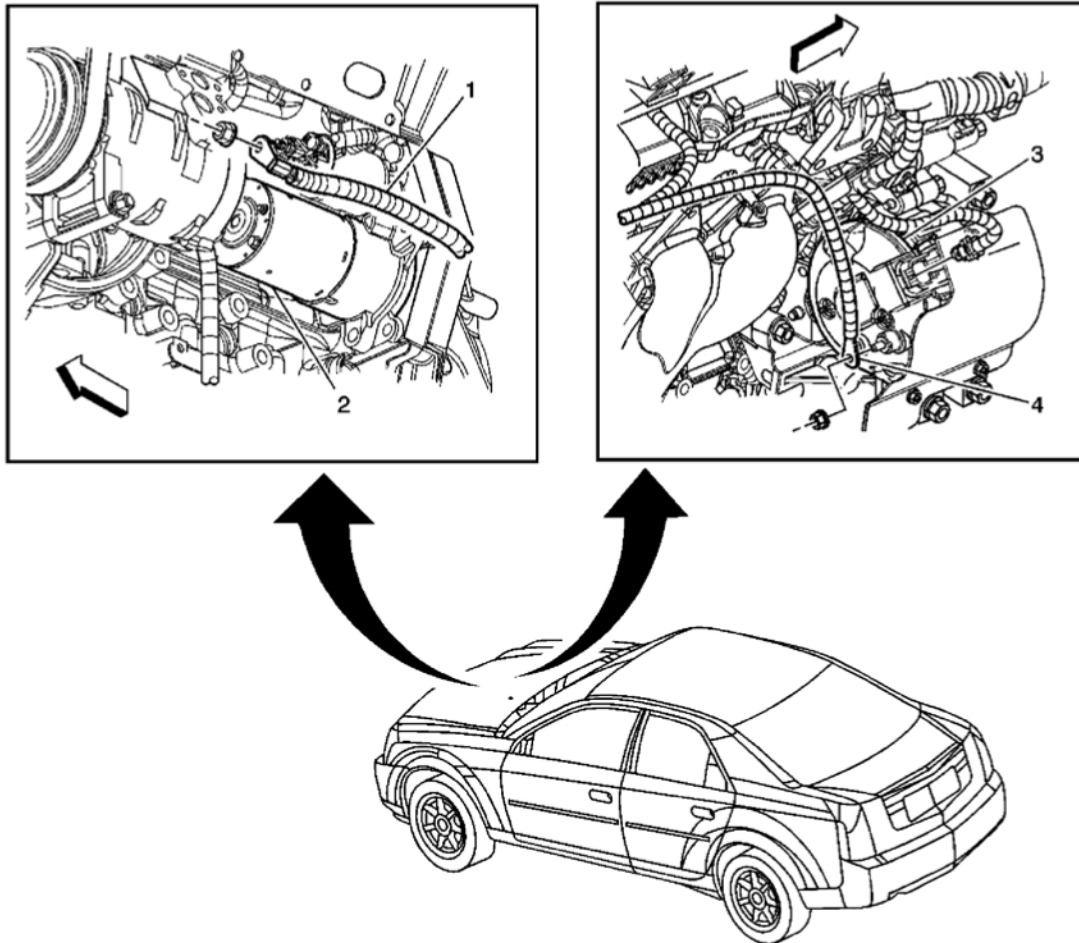


Fig. 6: Engine Electrical Components (LY7) Component View
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 6

Callout	Component Name
1	Battery Positive Cable Connection to Starter
2	Starter
3	Generator
4	Battery Positive Cable Connection to Generator

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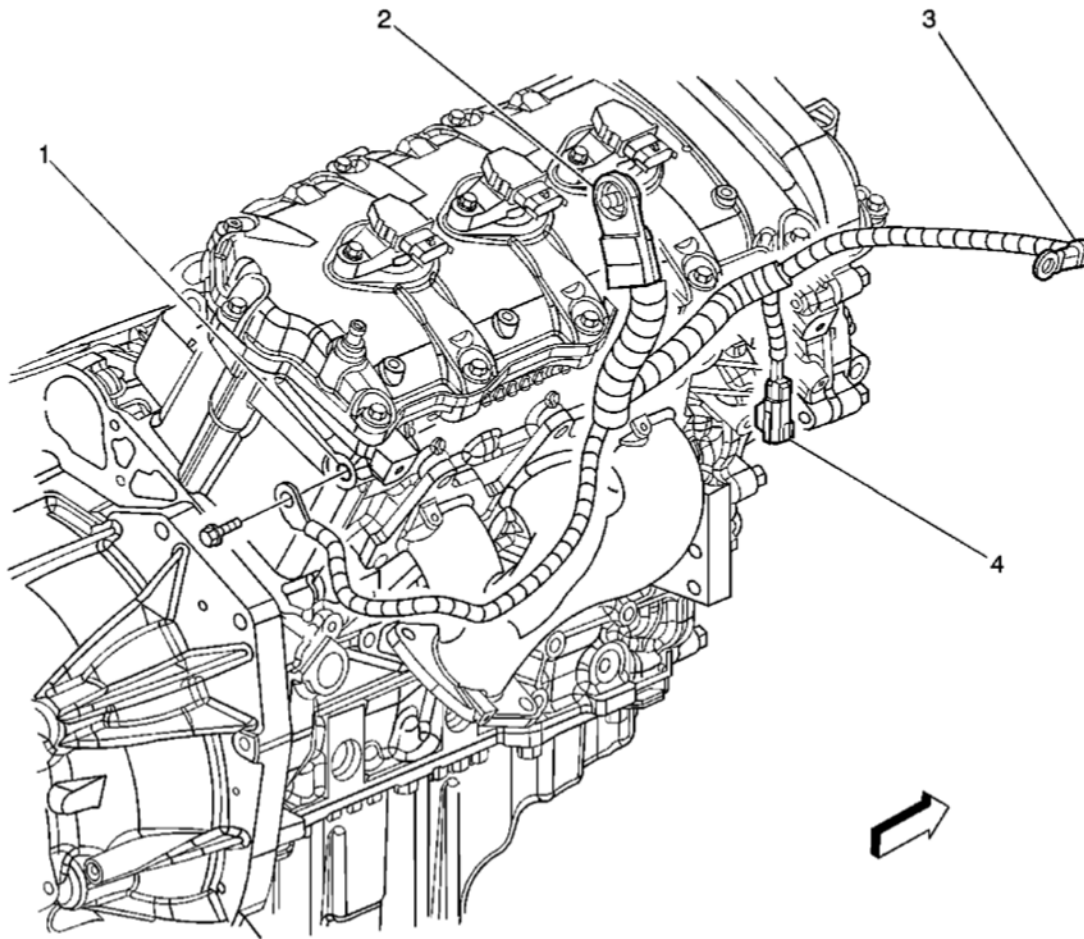


Fig. 7: Battery Negative Cable Component View
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 7

Callout	Component Name
1	Ground G102
2	Battery Negative Cable Connection to Battery
3	Ground G105
4	C103

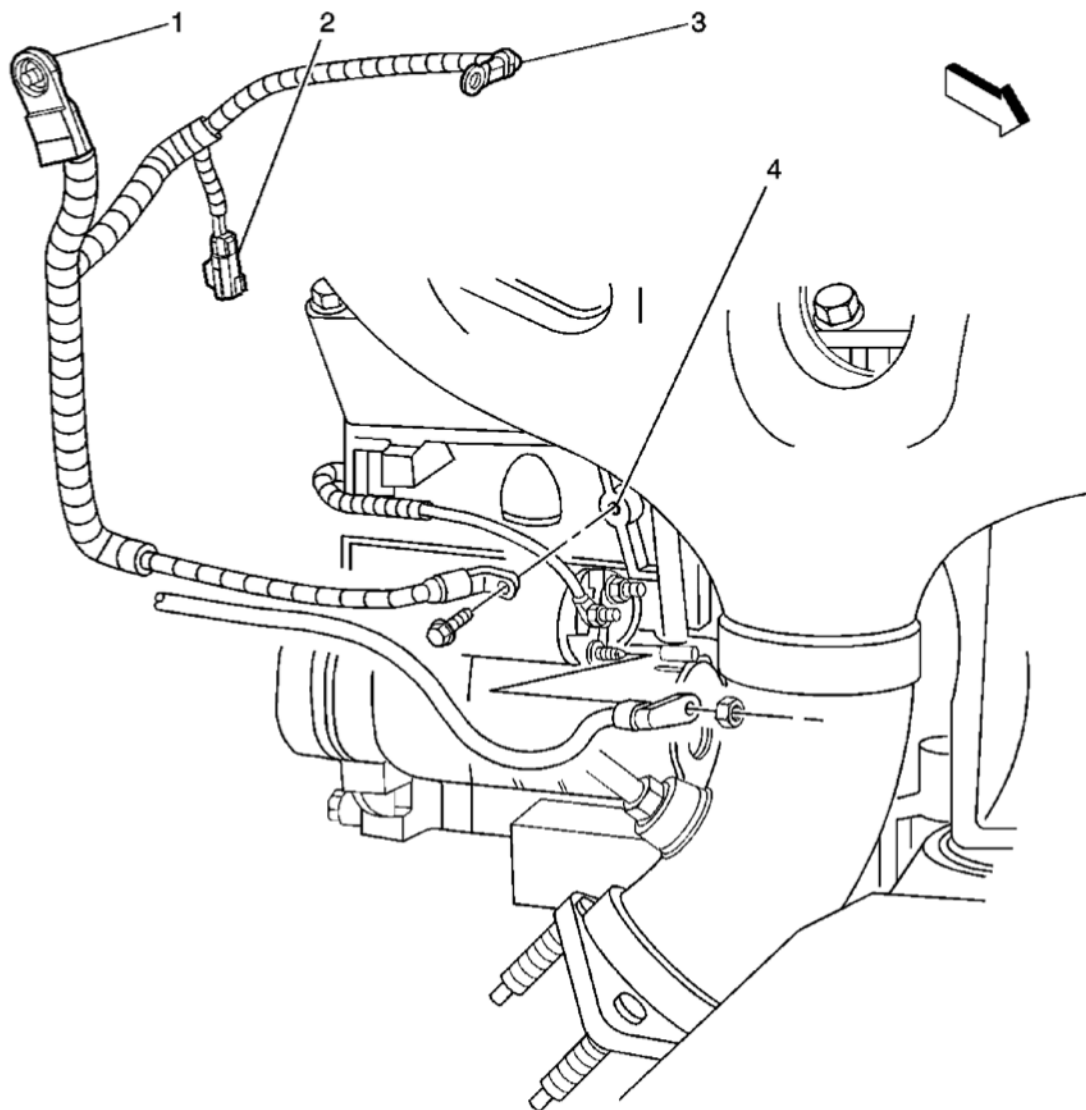


Fig. 8: Battery Negative Cable - 5.7L (LS6)
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 8

Callout	Component Name
1	Battery Negative Cable Connection to Battery
2	C103
3	Ground G105
4	Ground G102

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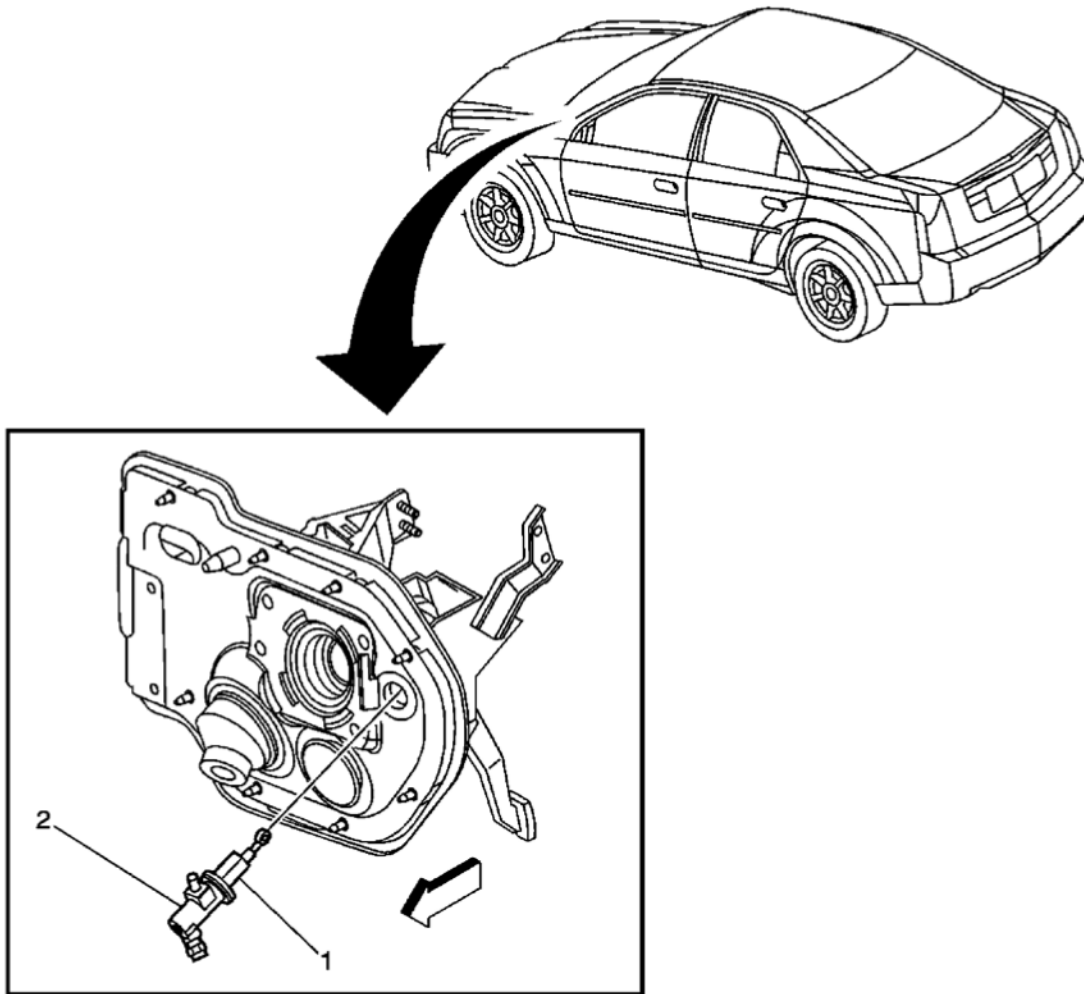


Fig. 9: Clutch Pedal Position (CPP) Sensor Component View (M35/M12/MN6)
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 9

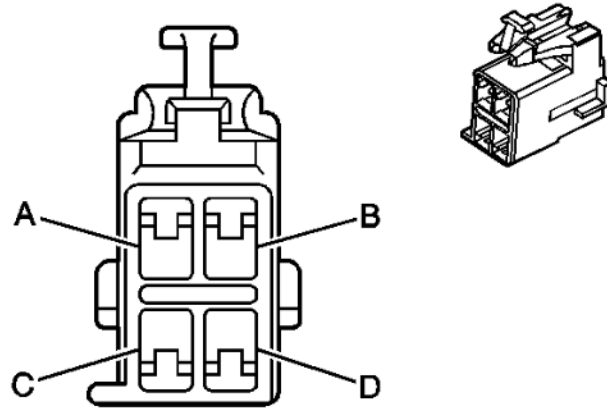
Callout	Component Name
1	Clutch Pedal Position (CPP) Switch
2	Clutch Master Cylinder

ENGINE ELECTRICAL CONNECTOR END VIEWS

Clutch Pedal Position (CPP) Switch (M35/M12-MN6)

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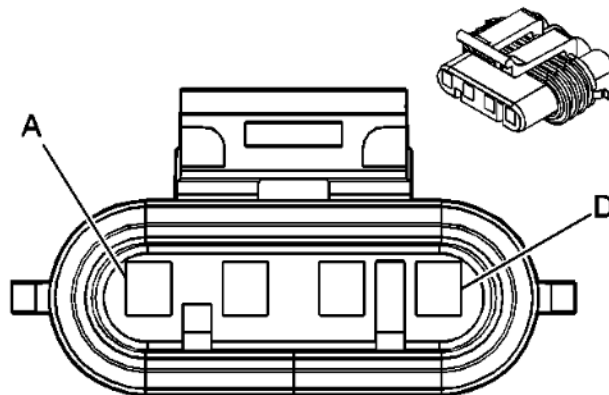


Connector Part Information

- 12129136
- 4-Way F Metri-Pack 280 Series Flex Lock Series (BK)

Pin	Wire Color	Circuit No.	Function
A	PK	839	Ignition 1 Voltage
B	BN/WH	379	CPP Switch Signal
C	PU/WH	1035	Starter Relay Coil Supply Voltage
D	PK	839	Ignition 1 Voltage

Generator (LS2)



Connector Part Information

- 12186568
- 4-Way F Metri-Pack 150 Series (BK)

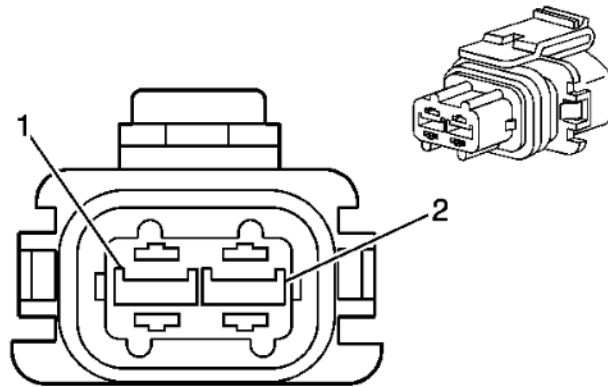
Pin	Wire Color	Circuit No.	Function
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A	-	-	Not Used
B	OG	225	Generator Turn On Signal
C	GY	23	Generator Field Duty Cycle Signal
D	-	-	Not Used

Generator (LP1/LY7)

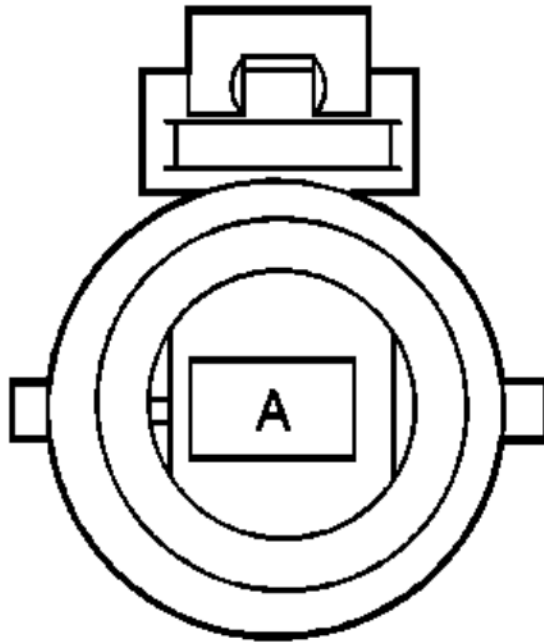


Connector Part Information		• 1928403137 • 2-Way F (BK)	
Pin	Wire Color	Circuit No.	Function
1	OG	225	Generator Turn On Signal
2	GY	23	Generator Field Duty Cycle Signal

Starter Solenoid

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Connector Part Information

- 12089916
- 1-Way F Metri-Pack 280 Series Sealed (MD GY)

Pin

Wire Color

Circuit No.

Function

A

PU

6

Starter Solenoid Crank Voltage

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B1327</u>	Device Power Circuit Low
<u>DTC B1328</u>	Device Power Circuit High
<u>DTC B1513</u>	Charging System Volts Low
<u>DTC B1514</u>	Charging System Volts High
<u>DTC P0560</u>	System Voltage
<u>DTC P0562</u>	System Voltage Low
<u>DTC P0563</u>	System Voltage High

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DTC P0615	Starter Relay Control Circuit
DTC P0616	Starter Relay Control Circuit Low Voltage
DTC P0617	Starter Relay Control Circuit High Voltage
DTC P0621	Generator L-Terminal Circuit
DTC P0622	Generator Field/F Terminal Circuit
DTC P0625	Generator F Terminal Circuit Low Voltage
DTC P0626	Generator F Terminal Circuit High Voltage
DTC P1668	Generator L-Terminal Control Circuit
DTC P2500	Generator L-Terminal Circuit Low Voltage
DTC P2501	Generator L-Terminal Circuit High Voltage

DIAGNOSTIC STARTING POINT - ENGINE ELECTRICAL

Begin the system diagnosis with the **Diagnostic System Check - Vehicle** in Vehicle DTC Information. The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

SCAN TOOL OUTPUT CONTROLS

Scan Tool Output Controls

Scan Tool Output Control	Additional Menu Selection(s)	Description
Engine Output Controls	GEN L-Terminal	The engine control module (ECM) commands the generator OFF by removing the 5-volt reference signal from the L-terminal of the voltage regulator when you select OFF. The generator will then stop generating an output voltage.
Engine Output Controls	Starter Relay Control	The ECM grounds the starter relay control circuit when ON is selected. When OFF is selected, ground is removed from the circuit

SCAN TOOL DATA LIST

Amp

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Engine Running			
Battery Voltage	Data	Volts	13.9 Volts

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Dash Integration Module (DIM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Engine Running/Accessories Off			
Battery Current	RVC Data	amps	35 amps
Battery Voltage Sense	RVC Data	Volts	13.9 Volts
Battery Temperature	RVC Data	°C	65°C
GEN L-Terminal Signal Command	RVC Data	%	72%
Load Shed	RVC Data	Yes/No	No
Running State of Charge	RVC Data	%	90%
Start Up State of Charge	RVC Data	%	80%

Door Modules

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Engine Running			
Battery Voltage	Data	Volts	13.9 Volts

Digital Radio Receiver (DRR)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Engine Running			
Battery Voltage	Data	Volts	13.9 Volts

Engine Control Module (ECM) 2.8L (LP1)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Ignition ON, Engine OFF/Transmission in Park			
Crank Request	Electrical / Theft Data	Yes/No	No
GEN L-Terminal Signal Command	Electrical / Theft Data	%	Varies
Gen F - Terminal Signal	Electrical / Theft Data	%	Varies
Ignition 1 Signal	Electrical / Theft Data	On/Off	On
PNP Switch	Electrical / Theft Data	Park / Neutral / In Gear	Park
Starter Relay Circuit Status	Engine Electrical	Fault / Indeterminate / OK	OK
Starter Relay Command	Electrical / Theft Data	On/Off	Off

Engine Control Module (ECM) 3.6L (LY7)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Ignition ON, Engine OFF/Transmission in Park			

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Crank Request Signal	Electrical / Theft Data	Yes/No	No
GEN L-Terminal Signal Command	Electrical / Theft Data	%	Varies
Gen F - Terminal Signal	Electrical / Theft Data	%	Varies
Ignition 1 Signal	Electrical / Theft Data	On/Off	On
PNP Switch	Electrical / Theft Data	Park / Neutral / In Gear	Park
Starter Relay Circuit Status	Electrical / Theft Data	Fault / Indeterminate / OK	OK
Starter Relay Command	Electrical / Theft Data	On/Off	Off

Engine Control Module (ECM) 6.0L (LS2)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Ignition ON, Engine OFF/Transmission in Park			
Crank Request Signal	Electrical / Theft Data	Yes/No	No
GEN L-Terminal Signal Command	Electrical / Theft Data	%	Varies
GEN L-Terminal Circuit Status	Engine Electrical	Incomplete / Short Gnd / Open / Short to B+ / OK	OK
Gen F - Terminal Signal	Electrical / Theft Data	%	Varies
Ignition 1 Signal	Electrical / Theft Data	Volts	Varies
PNP Switch	Electrical / Theft Data	Park / Neutral / In Gear	Park
Starter Relay Circuit Status	Engine Electrical	Incomplete / Short Gnd / Open / Short to B+ / OK	OK
Starter Relay Command	Electrical / Theft Data	On/Off	Off

Instrument Panel Cluster (IPC)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Engine Running			
Battery Voltage	Data	Volts	13.9 Volts

Memory Seat Module (MSM)

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Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Engine Running			
Battery Voltage	Data	Volts	13.9 Volts

Rear Integration Module (RIM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Engine Running			
Battery Voltage	Data	Volts	13.9 Volts

TV Antenna Module

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Engine Running			
Battery Voltage	Data	Volts	13.9 Volts

Vehicle Theft Deterrent (VTD)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Engine Running			
Battery Voltage	Data	Volts	13.9 Volts
Starter Disabled	Data	Yes/No	No

Vehicle Theft Deterrent (VTD)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Engine Running			
Battery Charger	Data	On/Off	Off
Battery State	Data	Low Voltage/Normal/High Voltage	Normal
Battery Voltage	Data	Volts	13.9 Volts
Start Disabled	Data	Yes/No	No

SCAN TOOL DATA DEFINITIONS**Battery Charger**

The scan tool displays On/Off. The scan tool displays On when the engine is OFF and battery voltage is greater than 13.5 Volts.

Battery Current

The scan tool displays the estimated current draw upon the battery as calculated by the module.

Battery State

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The scan tool displays Low Voltage/Normal/High Voltage. The scan tool displays Low Voltage below 9.0 Volts and returns to Normal when battery voltage returns to above 9.5 Volts. High Voltage is displayed above 16.0 Volts and returns to Normal when battery voltage returns to below 15.5 Volts.

Battery Temperature

The scan tool displays an estimated battery temperature in °C. The module calculates the battery temperature by utilizing either the outside air temperature sensor or the intake air temperature sensor and comparing it against engine run times and ignition cycle times.

Battery Voltage

The scan tool displays a voltage. The scan tool displays the battery voltage as calculated by the module or received as a class 2 message.

Battery Voltage Sense

The scan tool displays the battery voltage as received on a dedicated power and ground circuit. This signal is highly accurate and is sent out as a class 2 message.

Crank Request

The scan tool displays Yes/No. The scan tool displays Yes when the ignition is placed in the Start position and a battery voltage is received by the PCM.

Crank Request Signal

The scan tool displays Yes/No. The scan tool displays No until the ignition is placed into the Start position then Yes is displayed.

Clutch Start Switch

The scan tool displays On/Off. The scan tool displays On when the clutch is depressed.

Fast Idle for Generator

The scan tool displays Yes when Idle boost has been requested due to high system current draw.

GEN L-Terminal Signal

The scan tool displays On/Off. The scan tool displays Off until the engine is running, then the PCM supplies a 5.0 V signal to turn ON the regulator, then On is displayed.

GEN L-Terminal Signal Command

The scan tool displays On/Off. The scan tool displays Off until the engine is running, then the PCM supplies a PWM signal to turn ON the regulator, then On is displayed.

GEN L-Terminal Signal Command (RVC Data)

The scan tool display the PWM signal percentage that the module is requesting the ECM to control the generator L-terminal

GEN F-Terminal Signal

The scan tool displays 0-100%. The scan tool displays the percentage of generator On time, the higher the percentage the greater the generator output.

Ignition 1

The scan tool displays 0-20 Volts. The scan tool displays the voltage as received on the Ignition 1 circuit to the PCM.

Load Shed

The scan tool displays No unless the module has entered one of the load shed states.

PNP Switch

The scan tool displays P-N/R-D-L. The scan tool displays P-N when the transmission is in the Park (P) or Neutral (N) position.

Running State of Charge

The scan tool displays the calculated battery state of charge while the engine is running.

Start Up State of Charge

The scan tool displays the calculated battery state of charge prior to engine start up.

Starter Disabled

The scan tool displays Yes/No. The scan tool displays No unless the VTD receives improper key information, then Yes will be displayed and starting will be disabled.

Starter Motor Status

The scan tool displays Turning/Not Turning. The scan tool displays Turning during cranking until a run flag is received by the PCM.

Starter Relay Circuit Status

The scan tool displays Fault/OK/Invalid State. The scan tool displays Fault until the ignition is placed into the Start position then OK is displayed.

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Starter Relay Command

The scan tool displays On/Off. The scan tool displays On when the PCM has received all of the requirements for starting the engine.

DTC B1327

Circuit Description

The dash integration module (DIM) has an internal voltage sensor with a dedicated circuit that checks the battery positive voltage and battery negative circuit voltage to determine if it is above 9 volts.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1327 Device Power Circuit Low

Conditions for Running the DTC

This DTC shall run only if the DIM has power, ground and the ignition is not in START mode. This DTC shall execute regardless of the battery voltage, except when the DTC B1390 is set current.

Conditions for Setting the DTC

- This DTC shall be set as current when the voltage falls below 9 volts for 1200 milliseconds.
- When the vehicle exits START the DIM shall delay checking the voltage for 2 seconds.

Action Taken When the DTC Sets

A message shall be sent out on the class 2 lines to notify all other modules of low battery voltage.

Conditions for Clearing the MIL/DTC

In order to clear the DTC from a current status the voltage shall be greater than 9.54 volts for 1200 milliseconds.

Test Description

The number below refers to the step number on the diagnostic table.

3: Compares battery voltage with the voltage that the DIM calculates.

DTC B1327

Step	Action	Value(s)	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u>				
Connector End View Reference: <u>Master Electrical Component List</u> in Wiring Systems				

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1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, observe the Battery Voltage parameter in the dash integration module (DIM) data list. Does the scan tool indicate the battery voltage is greater than the specified value?	9.5 V	Go to Step 4	Go to Step 3
3	1. Measure the voltage across the battery terminals. 2. Compare the battery voltage with the Battery Voltage parameter in the DIM data list. Are the voltages within the specified value?	1 V	Go to <u>Battery Inspection/Test</u>	Go to Step 4
4	Inspect for poor connections at the harness connector of the DIM. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	-	Go to Step 6	Go to Step 5
5	Replace the DIM. Refer to <u>Control Module References</u> in Computer/Integrating Systems for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 6	-
6	1. Use the scan tool in order to clear the DTC. 2. Operate the vehicle within the conditions for running the DTC. Does the DTC reset?	-	Go to Step 2	System OK

DTC B1328

Circuit Description

The dash integration module (DIM) has an internal voltage sensor with a dedicated circuit that checks the

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battery positive voltage and battery negative circuit voltage to determine if it is below 15.5 volts.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1328 Device Power Circuit High

Conditions for Running the DTC

This DTC shall run only if the DIM has power, ground and the ignition is not in START mode. This DTC shall execute regardless of the battery voltage, except when the DTC B1390 is set current.

Conditions for Setting the DTC

This DTC shall be set as current when the voltage raises above 16.5 volts for 1200 milliseconds.

Action Taken When the DTC Sets

A message shall be sent out on the class 2 lines to notify the SIR of high battery voltage.

Conditions for Clearing the MIL/DTC

In order to clear the DTC from a current status the voltage shall be less than 15.5 volts for 1200 milliseconds.

Test Description

The number below refers to the step number on the diagnostic table.

3: Compares battery voltage with the voltage that the DIM calculates.

DTC B1328

Step	Action	Value(s)	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u>				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	1. Install a scan tool. 2. Start the engine 3. Increase engine speed to above 1,500 RPM. 4. With a scan tool, observe the Battery Voltage parameter in the dash integration	15.5 V		

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	module (DIM) data list.			
	Does the scan tool indicate the battery voltage is less than the specified value?		Go to Step 4	Go to Step 3
3	1. Measure the voltage across the battery terminals. 2. Compare the battery voltage with the Battery Voltage parameter in the DIM data list. Are the voltages within the specified value?	1 V	Go to <u>Charging System Test</u>	Go to Step 4
4	Inspect for poor connections at the harness connector of the DIM. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	-	Go to Step 6	Go to Step 5
5	Replace the DIM. Refer to <u>Control Module References</u> in Computer/Integrating Systems for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 6	-
6	1. Use the scan tool in order to clear the DTC. 2. Operate the vehicle within the conditions for running the DTC. Does the DTC reset?	-	Go to Step 2	System OK

DTC B1513

Circuit Description

The voltage level is monitored by the engine control module (ECM) or powertrain control module (PCM) and is sent as a class 2 data message to the instrument panel cluster (IPC).

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1513 Charging System Volts Low

Conditions for Running the DTC

- The key is in the ON position.
- The engine is running.

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- Engine speed must be greater than 1,500 RPM.
- DTC B1327 is not current.

Conditions for Setting the DTC

This DTC will be set as current when the voltage falls below 10.5 volts for 30 seconds and the engine is running.

Action Taken When the DTC Sets

The charging system indicator message will be set in the drivers information center (DIC).

Conditions for Clearing the MIL/DTC

The DTC clears as a current status when the voltage is greater than 10.5 volts for 30 seconds with the engine running.

DTC B1513

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	1. Install a scan tool. 2. Start the engine. 3. Allow voltage to stabilize. 4. With a scan tool observe the Volts parameter in the instrument panel cluster (IPC) data list using the scan tool. Does the scan tool indicate that the volts parameter is within the specified range?	10.5-16.2 V	Go to Step 3	Go to <u>Charging System Test</u>
3	Replace the IPC. Refer to <u>Control Module References</u> in Computer/Integrating Systems for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 4	-
4	1. Use the scan tool in order to clear the DTC. 2. Operate the vehicle within the conditions for running the DTC. Does the DTC reset?	-	Go to Step 2	System OK

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DTC B1514

Circuit Description

The voltage level is monitored by the engine control module (ECM) or powertrain control module (PCM) and is sent as a class 2 data message to the instrument panel cluster (IPC).

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1514 Charging System Volts High

Conditions for Running the DTC

- The key is in the ON position.
- The engine is running.
- Engine speed is greater than 1,500 RPM.

Conditions for Setting the DTC

This DTC will be set as current when the voltage is greater than 16 volts for 30 seconds with the engine running.

Action Taken When the DTC Sets

The charge indicator and driver warning message will be set in the driver information center (DIC).

Conditions for Clearing the MIL/DTC

The DTC clears as a current status when the voltage falls below 16.2 volts for 30 seconds with the engine running.

DTC B1514

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	1. Install a scan tool. 2. Start the engine. 3. Allow voltage to stabilize. 4. With a scan tool observe the Volts	10.5-16.2 V		

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	parameter in the instrument panel cluster (IPC) data list using the scan tool.			
	Does the scan tool indicate that the Volts parameter is within the specified range?		Go to Step 3	Go to <u>Charging System Test</u>
3	Replace the IPC. Refer to <u>Control Module References</u> in Computer/Integrating Systems for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 4	-
4	1. Use the scan tool in order to clear the DTC. 2. Operate the vehicle within the conditions for running the DTC.	-		
	Does the DTC reset?		Go to Step 2	System OK

DTC P0560**Circuit Description**

The engine control module (ECM) monitors the ignition 1 voltage to make sure that the voltage stays within the proper range. Damage to components, and incorrect data input can occur when the voltage is out of range. The ECM monitors the system voltage over an extended length of time. If the ECM detects the ignition 1 voltage outside an expected range for the calibrated length of time, DTC P0560 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0560 System Voltage**Conditions for Running the DTC**

- System voltage below 9 volts or above 16 volts.
- Engine speed above 650 RPM.

Conditions for Setting the DTC

The ECM detects ignition 1 voltage out of range for 30 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will command a message to be displayed.
- The ECM will store conditions which were present when the DTC set as Fail Records data only.

Conditions for Clearing the DTC

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- The ECM will command the message OFF after one trip in which the diagnostic test has been run and passed.
- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P0560

Step	Action	Value	Yes	No
Schematic Reference: <u>Engine Controls Schematics</u> for the 2.8L (LP1) engine or <u>Engine Controls Schematics</u> for the 3.6L (LY7) engine Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> for the 2.8L (LP1) engine or <u>Engine Control Module (ECM) Connector End Views</u> for the 3.6L (LY7) engine				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Install a scan tool. 2. Operate the vehicle within the conditions for running the DTC. 3. Using the scan tool, observe the Specific DTC Information for DTC P0560 until the test runs. Does the scan tool indicate that DTC P0560 has passed this ignition cycle?	-	Go to <u>Testing for Intermittent Conditions and Poor Connections</u>	Go to Step 3
3	1. Install a scan tool. 2. Start the engine. 3. With a scan tool, observe the Ignition 1 voltage parameter in the engine control module (ECM) data list. Does the scan tool indicate that the Battery Voltage parameter is within the specified range?	9-16 V	Go to Step 7	Go to Step 4
4	Using a scan tool compare the battery voltage with the Ignition 1 voltage parameter in the ECM data list. Is the battery voltage and ECM Ignition 1 voltage readings different by more than the value specified?	0.5 V	Go to Step 5	Go to <u>Charging System Test</u>
5	Test the ignition 1 voltage circuit of the ECM for a high resistance or open. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	-	Go to Step 8	Go to Step 6
	Inspect for poor connections at the harness connector of the ECM. Refer to <u>Testing for</u>			

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6	<u>Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> . Did you find and correct the condition?	-	Go to Step 8	Go to Step 7
7	Replace the ECM. Refer to <u>Control Module References</u> for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 8	-
8	1. Review and record the scan tool Fail Records data. 2. Use the scan tool in order to clear the DTC. 3. Operate the vehicle within the conditions for running the DTC. 4. Using the scan tool, observe the specific DTC information for DTC P0560 until the test runs. Does the scan tool indicate that DTC P0560 failed this ignition?	-	Go to Step 3	System OK

DTC P0562**Circuit Description**

The engine control module (ECM) checks the system voltage to make sure that the voltage stays within the proper range. Damage to components, and incorrect input can occur when the voltage is out of range. The ECM monitors the system voltage over an extended length of time. If the ECM detects an excessively low system voltage, DTC P0562 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0562 System Voltage Low

Conditions for Running the DTC

- Engine speed is above 1,500 RPM.
- System voltage is between 9.5-18 volts.

Conditions for Setting the DTC

The ECM detects a system voltage below 10 volts for 5 seconds.

Action Taken When the DTC Sets

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- The ECM will command a message to be displayed.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store conditions which were present when the DTC set as Fail Records data only.

Conditions for Clearing the DTC

- The ECM will command the message OFF after one trip in which the diagnostic test has been run and passed.
- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P0562

Step	Action	Value(s)	Yes	No
Schematic Reference: <u>Engine Controls Schematics</u> for the 2.8L (LP1) engine, <u>Engine Controls Schematics</u> for the 3.6L (LY7) engine, or <u>Engine Controls Schematics</u> for the 6.0L engine Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> for the 2.8L (LP1) engine, <u>Engine Control Module (ECM) Connector End Views</u> for the 3.6L (LY7) engine, or <u>Engine Control Module (ECM) Connector End Views</u> for the 6.0L engine				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Install a scan tool. 2. Start the engine. 3. Raise the engine speed above 1,500 RPM. 4. With a scan tool, observe the Ignition 1 Signal parameter in the engine control module (ECM) data list. Does the scan tool indicate that the Ignition 1 Signal parameter is greater than the specified range?	10.5 V	Go to Step 6	Go to Step 3
3	Using a scan tool compare the Battery Voltage Signal parameter in the dash integration module (DIM) data list with the Ignition 1 Signal parameter in the ECM data list. Is the Battery Voltage and Ignition 1 Signal parameter readings different by more than the value specified?	0.5 V	Go to Step 4	Go to <u>Charging System Test</u>
4	Test the battery positive voltage circuit of the ECM for a high resistance. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	-	Go to Step 7	Go to Step 5
	Inspect for poor connections at the harness			

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5	connector of the ECM. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> . Did you find and correct the condition?	-	Go to Step 7	Go to Step 6
6	Replace the ECM or Refer to <u>Control Module References</u> for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 7	-
7	1. Review and record the scan tool Fail Records data. 2. Use the scan tool in order to clear the DTC. 3. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. 4. Using the scan tool, observe the Specific DTC Information for DTC P0562 until the test runs. Does the scan tool indicate that DTC P0562 failed this ignition?	-	Go to Step 2	System OK

DTC P0563**Circuit Description**

The engine control module (ECM) checks the system voltage to make sure that the voltage stays within the proper range. Damage to components, and incorrect input can occur when the voltage is out of range. The ECM monitors the system voltage over an extended length of time. If the ECM detects an excessively high system voltage, DTC P0563 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0563 System Voltage High

Conditions for Running the DTC

- Engine speed above 1,500 RPM.
- System voltage between 9.5-18 volts.

Conditions for Setting the DTC

The ECM detects a system voltage above 16 volts for less than 1 second.

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Action Taken When the DTC Sets

- The ECM will command a message to be displayed.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store conditions which were present when the DTC set as Fail Records data only.

Conditions for Clearing the DTC

- The ECM will command the message OFF after one trip in which the diagnostic test has been run and passed.
- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P0563

Step	Action	Value(s)	Yes	No
Schematic Reference: <u>Engine Controls Schematics</u> for the 2.8L (LP1) engine, <u>Engine Controls Schematics</u> for the 3.6L (LY7) engine, or <u>Engine Controls Schematics</u> for the 6.0L engine Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> for the 2.8L (LP1) engine, <u>Engine Control Module (ECM) Connector End Views</u> for the 3.6L (LY7) engine, or <u>Engine Control Module (ECM) Connector End Views</u> for the 6.0L engine				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Install a scan tool. 2. Start the engine. 3. Raise the engine speed above 1,500 RPM. 4. With a scan tool, observe the Ignition 1 Signal parameter in the engine control module (ECM). Does the scan tool indicate that the Ignition 1 Signal parameter is less than the specified range?	16.0 V	Go to Step 4	Go to Step 3
3	Using a scan tool compare the Battery Voltage parameter in the dash integration module (DIM) data list with the Ignition 1 Signal parameter in the ECM data list. Is the Battery Voltage and Ignition 1 Signal parameter readings different by more than the value specified?	0.8 V	Go to Step 4	Go to <u>Charging System Test</u>
4	Replace the ECM. Refer to <u>Control Module References</u> for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 5	-

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5	1. Review and record the scan tool Fail Records data. 2. Use the scan tool in order to clear the DTC. 3. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. 4. Using the scan tool, observe the Specific DTC Information for DTC P0563 until the test runs. Does the scan tool indicate that DTC P0563 failed this ignition?	-	Go to Step 2	System OK
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DTC P0615

Circuit Description

The engine control module (ECM) supplies a ground path for the STARTER relay when start enable has been requested. The ECM monitors this circuit for conditions that are incorrect for the commanded state. If the ECM detects an improper circuit condition, STARTER relay DTC P0615 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0615 Starter Relay Control Circuit

Conditions for Running the DTC

System voltage is between 9-16 volts.

Conditions for Setting the DTC

- The ECM detects an improper voltage level on the control circuit that controls the STARTER relay.
- The condition exists for at least 2 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Fail Records data only.

Conditions for Clearing the MIL/DTC

- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.

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- The DTC can be cleared by using the scan tool Clear DTC Information function.

Diagnostic Aids

Ignition system DTCs set with the ignition switch in the Crank position if the STARTER relay or the starter is inoperative. When the ECM enables starter operation, the ECM also initiates the diagnostic test routines for DTCs P0335, P0340, and P0385. If a condition exists which prevents the engine from cranking, the ECM will not receive signal input from the crankshaft position (CKP) and camshaft position (CMP) sensors, and the DTCs will set.

Reviewing the Fail Records vehicle mileage since the diagnostic test last failed may assist in diagnosing the condition. The information may help determine how often the condition that set the DTC occurs.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

- 2: Listen for an audible click when the STARTER relay operates. Press the ignition switch back and forth from the ON to Crank positions. Repeat this as necessary.
- 3: Tests for voltage at the coil side of the STARTER relay. The IGN fuse supplies power to the coil side of the STARTER relay.
- 4: Verifies that the ECM is providing ground to the STARTER relay.
- 5: Tests if ground is constantly being applied to the STARTER relay.

DTC P0615

Step	Action	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u> Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> for the 2.8L (LP1) engine or <u>Engine Control Module (ECM) Connector End Views</u> for the 3.6L (LY7) engine			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Press the ignition back and forth from the ON to Crank positions. Does the STARTER relay click with each command?	Go to Step 3	Go to <u>Starter Solenoid Does Not Click</u>
3	1. Turn OFF the ignition. 2. Remove the STARTER relay. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the battery positive voltage of the STARTER relay coil circuit and a		

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	good ground.		
	Does the test lamp illuminate?	Go to Step 4	Go to Step 8
4	1. Connect a test lamp between the battery positive voltage of the STARTER relay coil circuit and the control circuit of the STARTER relay. 2. Turn the ignition back and forth from the ON to Crank positions. Does the test lamp turn ON and OFF with each command?	Go to Step 6	Go to Step 5
5	Test the control circuit of the STARTER relay for a short to voltage or an open. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	Go to Step 11	Go to Step 7
6	Inspect for poor connections at the STARTER relay. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> . Did you find and correct the condition?	Go to Step 11	Go to Step 9
7	Inspect for poor connections at the engine control module (ECM). Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> . Did you find and correct the condition?	Go to Step 11	Go to Step 10
8	Repair the battery positive voltage circuit of the STARTER relay. Refer to <u>Connector Repairs</u> . Did you complete the repair?	Go to Step 11	-
9	Replace the STARTER relay. Did you complete the replacement.	Go to Step 11	-
10	Replace the ECM. Refer to <u>Control Module References</u> for replacement, setup, and programming. Did you complete the replacement?	Go to Step 11	-
11	1. Review and record scan tool Fail Records data. 2. Clear DTCs. 3. Operate vehicle within Fail Records conditions as noted. 4. Using a scan tool, monitor the Specific DTC Information for DTC P0615. Does the scan tool indicate DTC P0615 failed this ignition?	Go to Step 2	System OK

DTC P0616

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Circuit Description

The engine control module (ECM) supplies a ground path for the STARTER relay when start enable has been requested. The ECM monitors this circuit for conditions that are incorrect for the commanded state. If the ECM detects an improper circuit condition, starter relay DTC P0616 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0616 Starter Relay Control Circuit Low Voltage

Conditions for Running the DTC

- System voltage is between 8-16 volts.
- The engine is running.

Conditions for Setting the DTC

- The ECM detects an improper voltage level on the output circuit that controls the STARTER relay.
- The condition exists for at least 2 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Fail Records data only.

Conditions for Clearing the MIL/DTC

- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P0616

Step	Action	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u> Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> for the 2.8L (LP1) engine or <u>Engine Control Module (ECM) Connector End Views</u> for the 3.6L (LY7) engine			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Install a scan tool. 2. Operate the vehicle within the conditions for running the DTC. 3. Using the scan tool, observe the specific DTC information for DTC P0616 until the test runs.	Go to Testing for	

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	Does the scan tool indicate that DTC P0616 has passed this ignition cycle?	<u>Intermittent Conditions and Poor Connections</u>	Go to Step 3
3	Test the control circuit of the STARTER relay for a short to ground. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	Go to Step 6	Go to Step 4
4	Inspect for poor connections at the engine control module (ECM). Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> . Did you find and correct the condition?	Go to Step 6	Go to Step 5
5	Replace the ECM. Refer to <u>Control Module References</u> for replacement, setup, and programming. Did you complete the replacement?	Go to Step 6	-
6	1. Review and record the scan tool Fail Records data. 2. Use the scan tool in order to clear the DTC. 3. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. 4. Using the scan tool, observe the Specific DTC Information for DTC P0616 until the test runs. Does the scan tool indicate that DTC P0616 failed this ignition?	Go to Step 2	System OK

DTC P0617**Circuit Description**

The engine control module (ECM) supplies a ground path for the starter relay when start enable has been requested. The ECM monitors this circuit for conditions that are incorrect for the commanded state. If the ECM detects an improper circuit condition, starter relay DTC P0617 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0617 Starter Relay Control Circuit High Voltage

Conditions for Running the DTC

- System voltage is between 8-16 volts.
- The engine is running.

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Conditions for Setting the DTC

- The ECM detects an improper voltage level on the output circuit that controls the starter relay.
- The condition exists for at least 2 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Fail Records data only.

Conditions for Clearing the MIL/DTC

- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P0617

Step	Action	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u> <u>Engine Controls Schematics</u> for the 2.8L (LP1) engine or <u>Engine Controls Schematics</u> for the 3.6L (LY7) engine Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> for the 2.8L (LP1) engine or <u>Engine Control Module (ECM) Connector End Views</u> for the 3.6L (LY7) engine			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Install a scan tool. 2. Operate the vehicle within the conditions for running the DTC. 3. Using the scan tool, observe the specific DTC information for DTC P0617 until the test runs. Does the scan tool indicate that DTC P0617 has passed this ignition cycle?	Go to <u>Testing for Intermittent Conditions and Poor Connections</u>	Go to Step 3
3	Test the control circuit of the Starter relay for a short to battery. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	Go to Step 6	Go to Step 4
4	Inspect for poor connections at the engine control module (ECM). Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> . Did you find and correct the condition?	Go to Step 6	Go to Step 5
5	Replace the ECM. Refer to <u>Control Module References</u> for replacement, setup, and programming. Did you complete the replacement?	Go to Step 6	-

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6	1. Review and record the scan tool Fail Records data. 2. Use the scan tool in order to clear the DTC. 3. Operate the vehicle within the conditions for running the DTC. 4. Using the scan tool, observe the specific DTC information for DTC P0617 until the test runs.		
	Does the scan tool indicate that DTC P0617 failed this ignition?	Go to Step 2	System OK

DTC P0621

Circuit 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. When the ECM turns ON the high side driver, the voltage regulator turns ON the field circuit. When the ECM turns OFF the high side driver, the voltage regulator turns OFF the field circuit.

The ECM monitors the state of the generator turn on signal circuit. The ECM should detect a low generator turn on signal circuit voltage when the key is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect a high generator turn on signal circuit. The ECM performs key ON and RUN tests to determine the status of the generator turn on signal circuit. During the key ON test, if the ECM detects a high generator turn on signal circuit voltage, DTC P0621 will set. DTC P0621 will also set if, during the RUN test, the ECM detects a low generator turn on signal circuit. When the DTC sets, the PCM will send a class 2 serial data message to the instrument panel cluster (IPC) to illuminate the charge indicator.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0621 Generator L-Terminal Circuit

Conditions for Running the DTC

Key ON Test

- No generator, crankshaft position (CKP) sensors, or camshaft position (CMP) sensor DTCs are set.
- The key is in the RUN position.
- The engine is not running.

Run Test

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- No generator, CKP sensors, or CMP sensor DTCs are set.
- The engine is running.

Conditions for Setting the DTC

- During the key ON test, the ECM detects a high signal voltage on the generator turn on signal circuit for at least 5 seconds.

OR

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

Action Taken When the DTC Sets

- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Failure Records data only.

Conditions for Clearing the MIL/DTC

- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P0621

Step	Action	Value	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u>				
Connector End View Reference: <u>Engine Electrical Connector End Views</u>				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Install a scan tool. 2. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. 3. Using the scan tool, observe the Specific DTC Information for DTC P0621 until the test runs. Does the scan tool indicate that DTC P0621 has passed this ignition cycle?	-	Go to <u>Testing for Intermittent Conditions and Poor Connections</u>	Go to Step 3
	1. Install a scan tool. 2. Start the engine. 3. Turn OFF all accessories, including			

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3	headlamps. 4. With a scan tool, observe the Ignition 1 Signal parameter in the ECM data list. Does the scan tool indicate that the voltage is above the specified value?	13 V	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Disconnect the generator harness connector. 3. Turn the ignition ON, with the engine OFF. 4. Measure and record voltage between the generator turn on signal circuit and a good ground. 5. Start the engine. 6. Measure the voltage between the generator turn on signal circuit and a good ground. Is the voltage less than the first value with the generator OFF and greater than the second value with the generator ON?	0 V 5 V	Go to Step 7	Go to Step 6
5	Test the battery positive voltage circuit of the generator for a high resistance or open. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	-	Go to Step 10	Go to Step 7
6	Test the generator turn on signal circuit for a short or open. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	-	Go to Step 10	Go to Step 8
7	Inspect for poor connections at the harness connector of the generator. Refer to Connector Repairs. Did you find and correct the condition?	-	Go to Step 10	Go to Charging System Test
8	Inspect for poor connections at the harness connector of the engine control module (ECM). Refer to Connector Repairs. Did you find and correct the condition?	-	Go to Step 10	Go to Step 9
9	Replace the ECM. Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 10	-
	1. Review and record the scan tool Failure Records data.			

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10	- Use the scan tool in order to clear the DTC. - Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. - Using the scan tool, observe the Specific DTC Information for DTC P0621 until the test runs.	-		
	Does the scan tool indicate that DTC P0621 failed this ignition?			
			Go to Step 3	System OK

DTC P0622

Circuit Description

The engine control module (ECM) uses the generator field duty cycle signal circuit to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to the high side of the field winding in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field winding 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 state of the generator field duty cycle signal circuit. When the key is in the RUN position and the engine is OFF, the ECM should detect a duty cycle near 0 percent. However, when the engine is running, the duty cycle should be between 5-100 percent. The ECM monitors the PWM signal, if the ECM detects an out of range PWM signal, DTC P0622 will set. When the DTC sets, the ECM will send a class 2 serial data message to the instrument panel cluster (IPC) to illuminate the charge indicator.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0622 Generator Field/F Terminal Circuit

Conditions for Running the DTC

Key ON Test

- No generator, crankshaft position (CKP) sensors, or camshaft position (CMP) sensor DTCs are set.
- The key is in the RUN position.
- The engine is not running.

Run Test

- No generator, CKP sensors, or CMP sensor DTCs are set.

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- The engine speed is less than 3,000 RPM.

Conditions for Setting the DTC

- During the key ON test, the ECM detects a PWM signal greater than 65 percent for at least 5 seconds.

OR

- During the RUN test, the ECM detects a PWM signal less than 5 percent for at least 15 seconds.

Action Taken When the DTC Sets

- The ECM sends a class 2 message to the IPC to illuminate the charge indicator.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Fail Records data only.

Conditions for Clearing the MIL/DTC

- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P0622

Step	Action	Value(s)	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u>				
Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u>				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Install a scan tool. 2. Start the engine. 3. With a scan tool, observe the GEN - F Terminal parameter in the engine control module (ECM) data list. Does the scan tool indicate that the GEN - F Terminal parameter is within the specified range?	5-95%	Go to Step 3	Go to Step 4
3	With the scan tool command the generator OFF. Does the GEN - F Terminal signal parameter change?	-	Go to <u>Testing for Intermittent Conditions and Poor Connections</u>	Go to Step 4

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4	1. Turn OFF the ignition. 2. Disconnect the generator harness connector. 3. Connect test lamp to battery positive voltage. 4. Turn ON the ignition, with the engine OFF. 5. Probe the F-Terminal in the generator connector. 6. Observe the GEN - F Terminal Signal parameter in the ECM data list. Is the GEN - F Terminal Signal parameter near the specified value?	100%	Go to <u>Charging System Test</u>	Go to Step 5
5	Test the generator field duty cycle signal circuit for a short or open. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u>. Did you find and correct the condition?	-	Go to Step 8	Go to Step 6
6	Inspect for poor connections at the harness connector of the ECM. Refer to <u>Connector Repairs</u>. Did you find and correct the condition?	-	Go to Step 8	Go to Step 7
7	Replace the ECM. Refer to <u>Control Module References</u> for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 8	-
8	1. Review and record the scan tool Fail Records data. 2. Clear any DTCs. 3. Operate the vehicle within the Fail Records conditions as noted. 4. Using a scan tool, monitor the Specific DTC info for this DTC. Does the scan tool indicate that this DTC failed this ignition?	-	Go to Step 2	System OK

DTC P0625

Circuit Description

The engine control module (ECM) uses the generator field duty cycle signal circuit to monitor the duty cycle of the generator and fault indication. The generator field duty cycle signal circuit connects to the high side of the field winding in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns

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the field winding 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 state of the generator field duty cycle signal circuit. When the engine is running, the ECM should detect a duty cycle that varies up to 100 percent. The ECM monitors the PWM signal using a key ON test and a RUN test. During the tests, if the ECM detects an out of range PWM signal, a DTC will set. When the DTC sets, the ECM will send a class 2 serial data message to the instrument panel cluster (IPC) and DIC to illuminate the charge indicator or display a charging message.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0625 Generator F Terminal Circuit Low Voltage

Conditions for Running the DTC

- No generator, crankshaft position (CKP) sensors, or camshaft position (CMP) sensor DTCs are set.
- The engine is less than 3,000 RPM.
- The generator has not been commanded OFF by the ECM or scan tool.

Conditions for Setting the DTC

The ECM detects a PWM signal less than 5 percent for at least 15 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Fail Records data only.
- The ECM will send a class 2 serial data message to the IPC and driver information center (DIC) to illuminate the charge indicator or display a charging message.

Conditions for Clearing the MIL/DTC

- The conditions for setting DTC P0625 are not present.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P0625

Step	Action	Values	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u> Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> in Engine Controls - 2.8L (LP1) or <u>Engine Control Module (ECM) Connector End Views</u> in Engine Controls - 3.6L (LY7)				
	Did you perform the Diagnostic System Check - Vehicle?			Go to <u>Diagnostic System Check</u>

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1		-	Go to Step 2	- Vehicle in Vehicle DTC Information
2	1. Install a scan tool. 2. Start the engine. 3. With a scan tool, observe the GEN - F Terminal Signal parameter in the engine control module (ECM) data list. Does the scan tool indicate that the GEN - F Terminal parameter is within the specified range?	5-100%	Go to Testing for Intermittent Conditions and Poor Connections in Wiring Systems	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the generator harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp to battery positive voltage and repeatedly probe the generator field duty cycle signal circuit in the harness connector while monitoring the GEN - F Terminal Signal parameter on the scan tool. Is the GEN - F Terminal Signal parameter affected?	-	Go to Step 5	Go to Step 4
4	Test the generator field duty cycle signal circuit for a short to ground or open. Refer to Circuit Testing and Wiring Repairs in Wiring Systems. Did you find and correct the condition?	-	Go to Step 9	Go to Step 7
5	Test the battery positive voltage cable for an open or high resistance. Refer to Circuit Testing and Wiring Repairs in Wiring Systems. Did you find and correct the condition?	-	Go to Step 9	Go to Step 6
6	Inspect for poor connections at the harness connector of the generator. Refer to Connector Repairs in Wiring Systems. Did you find and correct the condition?	-	Go to Step 9	Go to Charging System Test
7	Inspect for poor connections at the harness connector of the ECM/PCM. Refer to Connector Repairs in Wiring Systems. Did you find and correct the condition?	-	Go to Step 9	Go to Step 8

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8	Replace the ECM. Refer to Control Module References in Computer/Integrating Systems for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 9	-
9	1. Review and record the scan tool Fail Records data. 2. Use the scan tool in order to clear the DTC. 3. Operate the vehicle within the conditions for running DTC P0625. 4. Using the scan tool, observe the specific DTC information for DTC P0625 until the test runs. Does the scan tool indicate that DTC P0625 failed?	-	Go to Step 2	System OK

DTC P0626**Circuit Description**

The engine control module (ECM) uses the generator field duty cycle signal circuit to monitor the duty cycle of the generator and fault indication. The generator field duty cycle signal circuit connects to the high side of the field winding in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field winding 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 state of the generator field duty cycle signal circuit. When the key in the ON position, with the engine OFF, the ECM should detect a duty cycle that is 0 percent.

The ECM monitors the PWM signal using a key ON test and a RUN test. During the tests, if the ECM detects an out of range PWM signal, a DTC will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0626 Generator F Terminal Circuit High Voltage

Conditions for Running the DTC

- No generator, crankshaft position (CKP) sensors, or camshaft position (CMP) sensor DTCs are set.
- The engine is not running.
- The key is in the ON position.

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Conditions for Setting the DTC

The ECM detects a PWM signal greater than 5 percent for at least 15 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Fail Records data only.
- The ECM will send a class 2 serial data message to the instrument panel cluster (IPC) and driver information center (DIC) to illuminate the charge indicator or display a charging message.

Conditions for Clearing the MIL/DTC

- The conditions for setting DTC P0626 are not present.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P0626

Step	Action	Values	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u> Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> in Engine Controls - 2.8L (LP1), or <u>Engine Control Module (ECM) Connector End Views</u> in Engine Controls - 3.6L (LY7)				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF 3. With a scan tool, observe the GEN - F Terminal Signal parameter in the engine control module (ECM) data list. Does the scan tool indicate that the GEN - F Terminal parameter is within the specified range?	0-5%	Go to <u>Testing for Intermittent Conditions and Poor Connections</u> in Wiring Systems	Go to Step 3
	1. Turn OFF the ignition. 2. Disconnect the generator harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp to battery positive			

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3	voltage and repeatedly probe the generator field duty cycle signal circuit in the harness connector while monitoring the GEN - F Terminal Signal parameter on the scan tool. Is the GEN - F Terminal Signal parameter affected?	-	Go to Step 5	Go to Step 4
4	Test the generator field duty cycle signal circuit for a short to battery voltage. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> in Wiring Systems. Did you find and correct the condition?	-	Go to Step 8	Go to Step 6
5	Inspect for poor connections at the harness connector of the generator. Refer to <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	-	Go to Step 8	Go to <u>Charging System Test</u>
6	Inspect for poor connections at the harness connector of the ECM. Refer to <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	-	Go to Step 8	Go to Step 7
7	Replace the ECM. Refer to <u>Control Module References</u> in Computer/Integrating Systems for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 8	-
8	1. Review and record the scan tool Fail Records data. 2. Use the scan tool in order to clear the DTC. 3. Operate the vehicle within the conditions for running DTC. 4. Using the scan tool, observe the specific DTC information for DTC P0626 until the test runs. Does the scan tool indicate that DTC P0626 failed?	-	Go to Step 2	System OK

DTC P1668

Circuit Description

The engine control module (ECM) uses the generator turn-on signal circuit to control the voltage output of the generator. When a different voltage is desired, the ECM will change the pulse width modulation (PWM) signal to the voltage regulator via the generator turn-on signal circuit. This causes the voltage regulator to the voltage output of the generator. The ECM has fault detection circuitry which monitors the state of the generator turn-on

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signal circuit. If the fault detection circuit senses a voltage other than what is expected, this DTC will set. The voltage regulator also contains fault detection circuitry. If the regulator detects a problem, the regulator will ground the generator turn-on signal circuit, pulling the voltage low. This also causes the ECM to set the DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1668 Generator L-Terminal Control Circuit

Conditions for Running the DTC

Key ON Test

- The key is in the ON position for 5 seconds.
- The engine is OFF.

Engine Run Test

- The engine is running.
- The engine speed is less than 3,000 RPM.

Conditions for Setting the DTC

Key ON Test

- The ECM detects a high signal voltage on the generator turn on signal circuit for at least 5 seconds.
- The engine must be started.

During the RUN test, the ECM detects a low signal voltage on the generator turn on signal circuit for at least 5 seconds.

Action Taken When the DTC Sets

- The ECM sends a class 2 message to the IPC to illuminate the charge indicator and/or turn on a message.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Fail Records data only.

Conditions for Clearing the MIL/DTC

- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P1668

Step	Action	Values	Yes	No

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Schematic Reference: Starting and Charging Schematics

Connector End View Reference: Engine Control Module (ECM) Connector End Views for the 2.8L (LP1) engine or Engine Control Module (ECM) Connector End Views for the 3.6L (LY7) engine

1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Wait 5 seconds. 4. Start the engine. 5. With a scan tool, monitor the DTC information for DTC P1668 in Engine Controls. Does the scan tool indicate that DTC P1668 has passed?	-	Go to <u>Testing for Intermittent Conditions and Poor Connections</u>	Go to Step 3
3	1. Turn Off the engine. 2. Disconnect the generator harness connector. 3. Start the engine. 4. With a measure the pulse width modulation (PWM) signal between the generator turn on signal circuit and ground. Is the PWM signal within the specified value?	15-87%	Go to Step 5	Go to Step 4
4	Test the generator turn on signal circuit for a short or open. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	-	Go to Step 10	Go to Step 7
5	Test the generator battery positive voltage output circuit for a high resistance or open. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	-	Go to Step 10	Go to Step 6
6	Inspect for poor connections at the harness connector of the generator. Refer to <u>Connector Repairs</u> . Did you find and correct the condition?	-	Go to Step 10	Go to Step 8
7	Inspect for poor connections at the harness connector of the engine control module (ECM). Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector</u>	-		

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	Repairs . Did you find and correct the condition?		Go to Step 10	Go to Step 9
8	Replace the generator. Refer to <u>Generator Replacement (LP1, LY7)</u> . Did you complete the replacement?	-	Go to Step 10	-
9	Replace the ECM. Refer to <u>Control Module References</u> for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 10	-
10	1. Use the scan tool in order to clear the DTCs. 2. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. Does the DTC reset?	-	Go to Step 3	System OK

DTC P2500**Circuit 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. When the ECM turns ON the high side driver, the voltage regulator turns ON the field circuit. When the ECM turns OFF the high side driver, the voltage regulator turns OFF the field circuit.

The ECM monitors the state of the generator turn on signal circuit. With the engine running, the ECM should detect a high generator turn on signal circuit.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P2500 Generator L-Terminal Circuit Low Voltage

Conditions for Running the DTC

- No generator, crankshaft position (CKP) sensors, or camshaft position (CMP) sensor DTCs are set.
- The engine is running.
- The generator has not been commanded OFF by the ECM or scan tool.

Conditions for Setting the DTC

The ECM detects a low signal voltage on the generator turn on signal circuit for at least 15 seconds.

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Action Taken When the DTC Sets

- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Fail Records data only.
- The ECM will send a class 2 serial data message to the instrument panel cluster (IPC) and driver information center (DIC) to illuminate the charge indicator or display a charging message.

Conditions for Clearing the MIL/DTC

- The conditions for setting DTC P2500 are not present.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P2500

Step	Action	Values	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u> Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> for the 2.8L (LP1) engine or <u>Engine Control Module (ECM) Connector End Views</u> for the 3.6L (LY7) engine				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Install a scan tool. 2. Start the engine. 3. With a scan tool, observe the GEN - F Terminal Signal parameter in the ECM data list. Does the scan tool indicate that the GEN - F Terminal parameter is within the specified range?	5-100%	Go to <u>Testing for Intermittent Conditions and Poor Connections</u>	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the generator harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage between the generator turn on signal circuit of the generator harness connector and a good ground. Is the voltage within the specified range?	4.5-5.5 V	Go to Step 5	Go to Step 4
	Test the generator turn on signal circuit for a short to ground or open. Refer to <u>Circuit</u>			

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4	Testing and Wiring Repairs . Did you find and correct the condition?	-	Go to Step 8	Go to Step 6
5	Inspect for poor connections at the harness connector of the generator. Refer to Connector Repairs . Did you find and correct the condition?	-	Go to Step 8	Go to Charging System Test
6	Inspect for poor connections at the harness connector of the engine control module (ECM). Refer to Connector Repairs . Did you find and correct the condition?	-	Go to Step 8	Go to Step 7
7	IMPORTANT: The replacement ECM must be programmed. Replace the ECM. Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 8	-
8	1. Review and record the scan tool Fail Records data. 2. Use the scan tool in order to clear the DTC. 3. Operate the vehicle within the conditions for running DTC P2500. 4. Using the scan tool, observe the specific DTC information for DTC P2500 until the test runs. Does the scan tool indicate that DTC P2500 failed?	-	Go to Step 2	System OK

DTC P2501

Circuit 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. When the ECM turns ON the high side driver, the voltage regulator turns ON the field circuit. When the ECM turns OFF the high side driver, the voltage regulator turns OFF the field circuit.

The ECM monitors the state of the generator turn on signal circuit. The ECM should detect a low generator turn on signal circuit voltage when the key is ON and the engine is OFF, or when the charging system malfunctions. If the ECM detects a high generator turn on signal circuit voltage, DTC P2501 will set.

DTC Descriptor

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This diagnostic procedure supports the following DTC:

DTC P2501 Generator L-Terminal Circuit High Voltage

Conditions for Running the DTC

- No generator, crankshaft position (CKP) sensors, or camshaft position (CMP) sensor DTCs are set.
- The ignition is in the ON position.
- The engine is not running.

Conditions for Setting the DTC

The ECM detects a high signal voltage on the generator turn on signal circuit for at least 5 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Fail Records data only.
- The ECM will send a class 2 serial data message to the instrument panel cluster (IPC) and driver information center (DIC) to illuminate the charge indicator or display a charging message.

Conditions for Clearing the MIL/DTC

- The conditions for setting DTC P2501 are not present.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P2501

Step	Action	Values	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u> Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> for the 2.8L (LP1) engine or <u>Engine Control Module (ECM) Connector End Views</u> for the 3.6L (LY7) engine				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Turn OFF the ignition. 2. Disconnect the generator harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage between the generator turn on signal circuit of the generator harness connector and a good ground.	3.5-5.5 V		
	Is the voltage within the specified range?		Go to Step 3	Go to Step 4

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3	Test the generator turn on signal circuit for a short to voltage. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	-	Go to Step 7	Go to Step 5
4	Inspect for poor connections at the harness connector of the generator. Refer to <u>Connector Repairs</u> . Did you find and correct the condition?	-	Go to Step 7	Go to <u>Charging System Test</u>
5	Inspect for poor connections at the harness connector of the engine control module (ECM). Refer to <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	-	Go to Step 7	Go to Step 6
6	Replace the ECM. Refer to <u>Control Module References</u> in Computer/Integrating Systems for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 7	-
7	1. Review and record the scan tool Fail Records data. 2. Use the scan tool in order to clear the DTC. 3. Operate the vehicle within the conditions for running DTC. 4. Using the scan tool, observe the specific DTC information for DTC P2501 until the test runs. Does the scan tool indicate that DTC P2501 failed?	-	Go to Step 2	System OK

SYMPTOMS - ENGINE ELECTRICAL

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

- Perform **Diagnostic System Check - Vehicle** in Vehicle DTC Information, 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**
 - **Starting System Description and Operation**
 - **Charging System Description and Operation**

Visual/Physical Inspection

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- Inspect for aftermarket devices which could affect the operation of the Starting and Charging Systems. Refer to **Checking Aftermarket Accessories** in Wiring Systems.
- 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** in Wiring Systems.

Symptom List

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

- **Starter Solenoid Does Not Click**
- **Starter Solenoid Clicks, Engine Does Not Crank**
- **Engine Cranks Slowly**
- **Battery Inspection/Test**
- **Battery Electrical Drain/Parasitic Load Test**
- **Battery Common Causes of Failure**
- **Starter Motor Noise Diagnosis**
- **Charging System Test**
- **Generator Noise Diagnosis**

BATTERY INSPECTION/TEST

Tools Required

J 42000 Battery Tester. See **Special Tools**.

Diagnostic Aids

IMPORTANT:

- Failure to properly understand the battery and its function could lead to a misdiagnosis and unneeded repairs. Refer to **Battery Description and Operation** and **Battery Common Causes of Failure** for more information.
- If testing an AGM battery with the J 42000 , add 100 to the CCA rating of the battery and enter that amount into the tester when prompted for the CCA rating. See **Special Tools**. For instance, if the AGM batteries CCA rating is 500 amps, enter 600 into the J 42000 . See **Special Tools**. Perform this modification only if the J 42000 does not ask if you are testing an AGM battery. See **Special Tools**. If these instructions are not followed when testing an AGM battery, an invalid test result and invalid test code will be obtained on the J 42000 . See **Special Tools**.
- The battery test using the J 42000 requires correct connections to the

battery terminals. See Special Tools. A failure to obtain the correct connections during the test may result in a failed test on a good battery.

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

- If testing the vehicle with the battery cables still connected, wiggle the **J 42000** clips on the terminal bolt. See Special Tools. This may cut through any coating or through any oxidation that may be present on the bolt.

Even new bolts contain a protective coating that may insulate or cause a resistance in the test circuit.

- If correct connections to the battery terminal bolts in the vehicle are in doubt, perform the following steps:
 1. Disconnect the negative battery cable.
 2. Disconnect the positive battery cable.
 3. Install the test adapters on the terminals.
 4. Follow the instructions for an Out-of-Vehicle test.
- If the tester displays a REPLACE BATTERY or BAD CELL-REPLACE result for a battery tested in the vehicle with the battery cables connected, perform the following steps:
 1. Disconnect the negative battery cable.
 2. Disconnect the positive battery cable.
 3. Install the tester adapters.
 4. Follow the instructions for an Out-of-Vehicle test.
 5. Replace the battery only if the Out-of-Vehicle test shows a REPLACE BATTERY or BAD CELL-REPLACE result. This prevents battery replacements that are due only to faulty battery cable connections.
- Use the correct terminal adapters.

Do not use any common bolts or a combination of bolts, nuts, and or washers as adapters when testing the battery.

Use the test adapters that are provided with the **J 42000** or P/N 12303040 terminal adapters. See Special Tools. If the adapters that are provided with the **J 42000** require replacement, use P/N 12303040. See Special Tools. Any other adapter may not contact the correct areas of the battery terminal, causing a resistance that may result in an invalid battery test result.

Battery Inspection/Test

Step	Action	Values	Yes	No
CAUTION: Refer to <u>Battery Disconnect Caution</u> in Cautions and Notices.				
IMPORTANT: Always write the test code displayed by the tester on the repair order for any warranty				

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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. If the battery is replaced due to failing the test, only an Out-of-Vehicle test code is valid for warranty purposes.

1	Inspect the battery for a cracked, broken, or damaged case, which may be indicated by battery acid leakage. Is the battery OK?	-	Go to Step 2	Go to Step 15
2	Compare the cold cranking amperage (CCA), and reserve capacity (RC) and/or amp hour (AH) rating of the battery to the original battery or original equipment (OE) specification. Refer to Battery Usage . Does the battery meet or exceed the specifications?	-	Go to Step 3	Go to Step 15
3	1. Turn OFF the ignition. 2. Attempt to rotate the negative battery cable connector clockwise with light finger pressure. Does the negative connector rotate?	-	Go to Step 4	Go to Step 5
4	Use a torque wrench in order to verify the torque to loosen the negative battery terminal bolt. Is the torque above the specified value?	10 N.m (88 lb in)	Go to Step 9	Go to Step 8
5	Attempt to rotate the positive battery cable connector clockwise with light finger pressure. Does the positive connector rotate?	-	Go to Step 7	Go to Step 6
6	IMPORTANT: Ensure that all of the electrical loads are turned OFF. 1. Install the J 42000 Battery Tester. See Special Tools . 2. Follow the directions supplied with the tester for an In-Vehicle test. 3. Follow any directions displayed on the tester. 4. If the tester calls for charging the battery, refer to Battery Charging . Did the tester pass the battery?	-	Go to Step 14	Go to Step 8
	Use a torque wrench in order to verify the torque to loosen the positive battery terminal	10 N.m (88		

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7	bolt. Is the torque above the specified value?	lb in)	Go to Step 10	Go to Step 8
8	1. Disconnect the negative battery cable. 2. Disconnect the positive battery cable. 3. Clean and wire brush the lead face of both battery terminals and the metal contact rings in both cable connectors. 4. Remove the bolts from the cable connectors in order to provide access to the connector rings as needed. 5. If either of the battery terminals or the cable rings are excessively damaged or corroded, replace as needed. Did you complete the repair?	-	Go to Step 11	-
9	1. Disconnect the negative battery cable. 2. Inspect for the following conditions and repair as needed: • The cable bolt is too long or deformed at the end • There is foreign material present inside the nut in the battery terminal • Damage to the battery terminal face or cable connector ring Did you complete the repair?		Go to Step 10	-
10	1. Disconnect the positive battery cable. 2. Inspect for the following conditions and repair as needed: • The cable bolt is too long or deformed at the end • There is foreign material present inside the nut in the battery terminal • Damage to the battery terminal face or cable connector ring Did you complete the repair?	-	Go to Step 11	-
	IMPORTANT: Ensure that both battery cables are disconnected and proper adapters are			

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11	installed in the battery terminals. 1. Install the J 42000 . See Special Tools. 2. Follow the directions supplied with the tester for an Out-of-Vehicle test. 3. Follow any directions displayed on the tester. 4. If the tester calls for charging the battery, refer to Battery Charging. Did the tester pass the battery?	-	Go to Step 12	Go to Step 15	
12	1. Press the CODE button on the J 42000 . See Special Tools. 2. For warranty purposes, write the displayed code on the repair order. Did you complete this action?	Go to Step 13			-
13	1. Connect the positive battery cable to the batteries positive terminal. NOTE: Refer to Fastener Notice in Cautions and Notices. 2. Tighten the positive battery cable bolt to the specified value. 3. Connect the negative battery cable to the battery negative terminal. 4. Tighten the negative battery cable bolt to the specified value. Are the cable bolts properly tightened?	17 N.m (13 lb ft)	Battery OK	-	
14	1. Press the CODE button on the J 42000 . See Special Tools. 2. For warranty purposes, write the displayed code on the repair order. Did you complete the replacement?	Battery OK			-
15	Replace the battery. Refer to Battery Replacement (LHD) or Battery Replacement (RHD). Did you complete the replacement?	-	Battery OK	-	

BATTERY CHARGING

Tools Required

J 42000 Battery Tester. See **Special Tools**.

- For best results, use an automatic taper-rate battery charger with a voltage capability of 16 volts.
- 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 **J 42000** before charging. See **Special Tools**.

Battery State of Charge

IMPORTANT: Using voltage to determine the batteries state of charge (SOC) 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 SOC will only be an estimate.

The 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, the engine must be stopped and all electrical loads turned OFF, including parasitic loads, when checking the voltage. The voltage can also be affected if the battery has just been charged or discharged, so it is important to consider what has happened to the battery in the time just before testing. Use the following procedure to determine the batteries 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 12 hours.
 - If the answer is no, the terminal voltage will be stabilized and no action is necessary before reading the voltage. Skip to step 3.
 - If the answer is yes, terminal voltage will not be stabilized and you should wait 12 hours since the last time the battery was used.
3. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12 hours.

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

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

Battery Charging

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

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12.45 V	75%	65%
12.2 V	65%	45%
12.0 V	40%	20%

Use the SOC information as follows:

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

Charging Time Required

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

- The battery charger capacity-The higher the charger amperage, the less time it will take to charge the battery.
- The SOC 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 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'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

NOTE: 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 PCM or other electronic components.

NOTE: Refer to Fastener Notice in Cautions and Notices.

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.

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

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

BATTERY ELECTRICAL DRAIN/PARASITIC LOAD TEST

Tools Required

J 38758 Parasitic Draw Test Switch. See **Special Tools**.

Diagnostic Aids

- Be sure to rule out any possible obvious influences, such as customer error or aftermarket equipment.
- Customer driving habits, such as regular short trips. This does 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 (RVC), 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** in Computer/Integrating Systems for the system or modules description and operation.
- Remote keyless entry (RKE) will wake up due to an outside input. Refer to **Keyless Entry System Description and Operation** in Keyless Entry.

IMPORTANT: The battery specification listed below is a generic specification. Refer to

Battery Usage when testing the battery.

- The battery run down time will vary depending on cold cranking amperage (CCA) and reserve capacity (RC). If the CCA and RC are higher, then the battery run down time would be longer. If the CCA and RC are lower, then the battery run down time would be shorter. The graph below indicates roughly how many days a 690 CCA battery with at 110 min. RC (60.5 AH) starting at 80 percent state of charge will last with a constant current draw until it reaches 50 percent state of charge. Differences in battery rating and temperature will affect the results.

Battery Electrical Drain/Parasitic Load Test

Current Drain	Days
25 mA	30.5
50 mA	16.5
75 mA	11
100 mA	8.25
250 mA	3.3
500 mA	1.65
750 mA	1
1 A	0.8
2 A	0.4

CAUTION: Refer to **Battery Disconnect Caution** in Cautions and Notices.

NOTE: Do not turn the parasitic draw test switch to the OFF position with the engine running. Damage will occur to the vehicle's electrical system.

NOTE: The test switch must be in the ON position when removing the fuses in order to maintain continuity in the electrical system. This avoids damaging the digital multimeter due to accidental overloading, such as a door being opened to change a fuse.

IMPORTANT: The switch knob (1) on the J 38758 is marked ON and OFF. See **Special Tools**. When the switch knob is in the ON position, the circuit is closed and electrical current will pass through the switch. When the switch knob is in the OFF position, the circuit is open and electrical current will not pass through the switch.

1. Disconnect the battery negative cable from the battery negative terminal.
2. Install the male end of the **J 38758** to the battery ground terminal. See **Special Tools**.
3. Turn the **J 38758** knob to the OFF position. See **Special Tools**.
4. Install the battery negative cable to the female end of the **J 38758** . See **Special Tools**.

5. Turn the **J 38758** knob to the ON position. See **Special Tools**.
6. Road test the vehicle and activate ALL of the accessories, including the radio and air conditioning. This may take up to 30 minutes.
7. Park the vehicle. Turn the ignition switch to the OFF position and remove the ignition switch key.
8. Connect a 10A fused jumper wire to the test switch tool terminals.
9. Turn the **J 38758** knob to the OFF position. See **Special Tools**. The current now flows through the jumper wire.
10. Wait 1 minute. If the fuse blows, install an inductive ammeter and go to step 20.
11. Remove the fused jumper wire.
12. Set a digital multimeter to the 10A scale.
13. Connect the digital multimeter to the test switch tool terminals.
14. Turn the **J 38758** knob to the OFF position. See **Special Tools**. The current flows now through the digital multimeter.
15. Wait 1 minute. Check and record the current reading.
 1. When there is a current reading on 2A or less, turn the **J 38758** knob to the ON position. See **Special Tools**. The electrical current will now pass through the switch.
 2. Then switch the digital multimeter down to the 2A scale for a more accurate reading when the **J 38758** knob is turned OFF. See **Special Tools**.
16. Turn the **J 38758** knob to the OFF position. See **Special Tools**. Wait 15 minutes for most vehicles.
17. Check and record the current reading.
18. Note the battery reserve capacity, amp hour rating. Refer to **Battery Usage**.
 1. Divide the reserve capacity by 4, amp hour rating by 2.4.
 2. Compare this to the multimeter milliampere reading taken in the previous step. The parasitic current drain should not exceed this number. Example: If a battery has a reserve capacity of 100 minutes, (60 A/H) the current drain should not exceed 25 mA.
19. If excessive current drain is not found at this time and there are no other apparent causes, complete the following:
20. Using the MIN/MAX function of the digital multimeter, monitor the parasitic drain overnight or during the day. This will determine if something has been activated during that time frame.

NOTE: The test switch must be in the ON position when removing the fuses in order to maintain continuity in the electrical system. This avoids damaging the digital multimeter due to accidental overloading, such as a door being opened to change a fuse.

IMPORTANT: Removing fuses, relays, and connectors to determine the failure area may wake up modules. You must wait for these modules to go to sleep or use the sleep function on the scan tool.

21. When the vehicle has an unacceptable amount of parasitic current drain, remove each fuse one at a time until the current drain falls to an acceptable level. This will indicate which circuit is causing the drain.

Refer to **Power Distribution Schematics** in Wiring Systems to diagnose exactly which part of the suspect circuit is causing the parasitic drain. In some cases a non-fused circuit or component, such as a relay, is the cause of excessive parasitic current drain.

22. Repeat the parasitic current drain test procedure after any repair has been completed to make sure that the parasitic current drain is at an acceptable level.
23. When the cause of the excessive current drain has been located and repaired, remove the **J 38758** . See **Special Tools**.
24. Connect the battery negative cable to the battery negative terminal.

BATTERY COMMON CAUSES OF FAILURE

A battery is not designed to last forever. With proper care, however, the battery will provide years of good service. If the battery tests good but still fails to perform well, the following are some of the more common causes:

- A vehicle accessory was left on overnight.
- The driving speeds have been slow with frequent stops, stop-and-go driving, with many electrical accessories in use, particularly air conditioning, headlights, wipers, heated rear window, cellular telephone, etc.
- The electrical load has exceeded the generator output, particularly with the addition of aftermarket equipment.
- Existing conditions in the charging system, including the following possibilities.
 - A slipping belt
 - A bad generator
- The battery has not been properly maintained, including a loose battery hold down or missing battery insulator if used.
- There are mechanical conditions in the electrical system, such as a short or a pinched wire, attributing to power failure. Refer to **General Electrical Diagnosis Procedures** in Wiring Systems.

Electrolyte Freezing

The freezing point of electrolyte depends on its specific gravity. A fully charged battery will not freeze until the ambient temperature gets below -54°C (-65°F). However, a battery with a low state of charge may freeze at temperatures as high as -7°C (20°F). Since freezing may ruin a battery, the battery should be protected against freezing by keeping it properly charged. As long as the green eye is visible in the hydrometer, the freezing point of the battery will be somewhere below -32°C (-25°F).

Battery Protection During Vehicle Storage

Certain devices on the vehicle maintain a small continuous current drain, parasitic load, on the battery. A battery that is not used for an extended period of time will discharge. Eventually permanent damage will result. Discharged batteries will also freeze in cold weather. Refer to **Battery Inspection/Test**.

In order to maintain the battery state of charge while storing the vehicle for more than 30 days:

1. Make sure that the green dot is visible in the built-in hydrometer.

CAUTION: Refer to Battery Disconnect Caution in Cautions and Notices.

2. Disconnect the battery ground cable to protect the battery from discharge by parasitic current drains.

When the battery cannot be disconnected:

1. Maintain a high state of charge.
2. Establish a regular schedule for recharging the battery every 20-45 days.

A battery that has remained in a discharged state for a long period of time is difficult to recharge or may be permanently damaged.

JUMP STARTING IN CASE OF EMERGENCY

CAUTION: 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.
 - Flush any contacted areas with water immediately and thoroughly.
 - Get medical help.

NOTE: This vehicle has a 12 volt, negative ground electrical system. Make sure the vehicle or equipment being used to jump start the engine is also 12 volt, negative ground. Use of any other type of system will damage the vehicle's electrical components.

This vehicle has a 12 volt positive, negative ground electrical system. Do not try to jump start a vehicle if you are unsure of the other vehicle's positive voltage or ground position. The booster battery and the discharged battery should be treated carefully when using jumper cables.

1. Position the vehicle with the booster battery so that the jumper cables will reach.
 - Do not let the two vehicles touch.
 - Make sure that the jumper cables do not have loose ends, or missing insulation.
2. Place an automatic transmission in PARK. If equipped with a manual transmission, place in NEUTRAL

and block the wheels.

3. Turn off all electrical loads on both vehicles that are not needed.
4. Turn OFF the ignition on both vehicles.

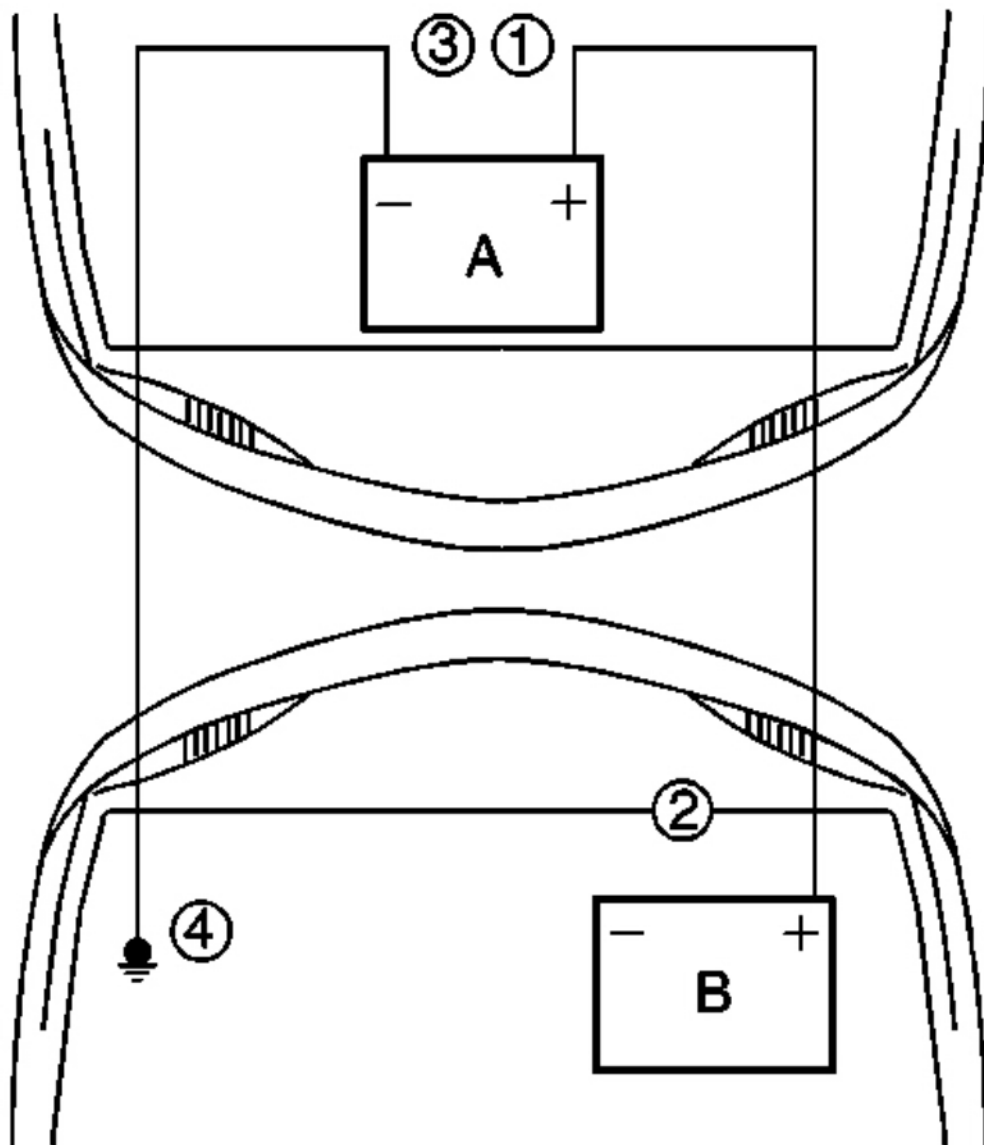


Fig. 10: Identifying Proper Jumper Cable Connection
Courtesy of GENERAL MOTORS CORP.

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5. Connect the red positive (+) cable to the remote positive (+) terminal (1) of the vehicle with the discharged battery.
6. Connect the red positive (+) cable to the positive (+) terminal (2) of the booster battery.

Use a remote positive (+) terminal if the vehicle has one.

7. Connect the black negative (-) cable to the negative (-) terminal (3) of the booster battery.

CAUTION: Do not connect a jumper cable directly to the negative terminal of a discharged battery to prevent sparking and possible explosion of battery gases.

8. The final connection is made to a heavy, unpainted metal engine part (4) of the vehicle with the discharged battery.

This final attachment must be at least 46 cm (18 in) away from the dead battery.

9. Start the engine of the vehicle that is providing the boost.

NOTE: Never operate the starter motor more than 15 seconds at a time without pausing in order to allow it to cool for at least 2 minutes. Overheating will damage the starter motor.

10. Crank the engine of the vehicle with the discharged battery.
11. The black negative (-) cable must be first disconnected from the vehicle that was boosted.
12. Disconnect the black negative (-) cable from the negative (-) terminal of the booster battery.

NOTE: Do not let the cable end touch any metal. Damage to the battery and other components may result.

13. Disconnect the red positive (+) cable from the positive (+) terminal of the booster battery.
14. Disconnect the red positive (+) cable from the remote positive (+) terminal of the vehicle with the discharged battery.

CHARGING SYSTEM TEST

Charging System Test

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information

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2	IMPORTANT: The battery must be above a 70 percent state of charge. Did you perform the Battery Inspection Test?	-	Go to Step 3	Go to Battery Inspection/Test
3	1. Install a scan tool. 2. Start the engine. 3. With a scan tool, command the GEN-L Terminal OFF and ON. 4. Observe the Ignition 1 Signal parameter. Does the voltage change with each command?	-	Go to Step 4	Go to Step 8
4	1. Turn ON the following accessories: • Headlights, high beams • A/C on Max • Blower fan on high • Heated seats, if equipped 2. With a scan tool, observe the ignition 1 signal parameter in the engine data list. 3. Increase engine speed to 2,500 RPM. Is the voltage within the specified value?	12-15.5 V	Go to Step 5	Go to Step 6
5	1. Turn OFF all accessories. 2. Turn OFF the ignition. CAUTION: Make sure that the load is completely turned off before connecting or disconnecting a carbon pile load tester to the battery. Otherwise, sparking could ignite battery gasses which are extremely flammable and may explode violently. 3. Connect a carbon pile tester to the vehicle. IMPORTANT: When measuring generator output current, be sure the inductive probe encircles the generator output wire. 4. Connect an inductive ammeter probe to the output circuit of the generator.	-		

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	- Start the engine. - With a scan tool, command the GEN-L Terminal ON. - Increase engine speed to 2,500 RPM. - Adjust the carbon pile as necessary in order to obtain the maximum current output. Is the generator output greater than or equal to the load test value as specified in <u>Generator Usage ?</u>		System OK	Go to Step 7
6	Is the voltage measured greater than 15.5 volts?	-	Go to Step 12	Go to Step 7
7	- Leave the vehicle accessories ON or maintain load test value. - Maintain engine speed at 2,500 RPM. - Measure the voltage between the generator output terminal and the generator metal housing Is the voltage measured equal to the specified value?	Battery Voltage	Go to Step 14	Go to Step 9
8	- Turn ON the ignition, with the engine OFF. - Disconnect the generator harness connector. - Measure the voltage between the generator turn ON signal circuit and ground. - With a scan tool, command the GEN-L Terminal ON and OFF. Does the voltage measure greater than the first value ON and near the second value OFF?	4.7 V 0 V	Go to Step 14	Go to Step 11
9	- Maintain the engine speed at 2,500 RPM and continue to operate the generator at the load test value. - Measure the voltage drop from the battery negative terminal to the metal housing of the generator. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> in Wiring Systems. Is the voltage measured less than the specified value?	0.5 V	Go to Step 10	Go to Step 15

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10	1. Maintain the engine speed at 2,500 RPM and continue to operate the generator at the load test value. 2. Measure the voltage drop from the output terminal of the generator to the positive terminal on the battery. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> in Wiring Systems. Is the voltage measured less than the specified value?	0.5 V		
			Go to Step 14	Go to Step 16
11	Test the generator turn on signal circuit for a short, or open. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> in Wiring Systems. Did you find and correct the condition?	-	Go to Step 19	Go to Step 13
12	Test the generator battery voltage sense circuit, if equipped, for an open or high resistance. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> in Wiring Systems. Did you find and correct the condition?	-	Go to Step 19	Go to Step 14
13	Inspect for poor connections at the harness connector of the engine control module (ECM) or powertrain control module (PCM). Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	-	Go to Step 19	Go to Step 17
14	Inspect for poor connections at the generator. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	-	Go to Step 19	Go to Step 18
15	Repair the high resistance or open in the ground circuit of the generator. Refer to <u>Wiring Repairs</u> in Wiring Systems. Did you complete the repair?	-	Go to Step 19	-
16	Repair the high resistance or open in the generator output circuit. Refer to <u>Wiring Repairs</u> in Wiring Systems. Did you complete the repair?	-	Go to Step 19	-
17	Replace the PCM or the ECM. Refer to <u>Control Module References</u> in Computer/Integrating Systems for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 19	-

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18	Replace the generator. Refer to <u>Generator Replacement (LP1, LY7)</u> . Did you complete the replacement?	-	Go to Step 19	-
19	Operate the vehicle in order to verify the repair. Did you correct the condition?	-	System OK	Go to Step 2

CHARGE INDICATOR ALWAYS ON

Charge Indicator Always On

Step	Action	Value(s)	Yes	No
Schematic Reference: <u>Body Control System Schematics</u> , <u>Instrument Cluster Schematics</u> , <u>Engine Controls Schematics</u> for the 2.8L (LP1) engine, <u>Engine Controls Schematics</u> for the 3.6L (LY7) engine, or <u>Engine Controls Schematics</u> for the 6.0L engine Connector End View Reference: <u>Computer/Integrating Systems Connector End Views</u> , <u>Engine Control Module (ECM) Connector End Views</u> for the 2.8L (LP1) engine, <u>Engine Control Module (ECM) Connector End Views</u> for the 3.6L (LY7) engine, or <u>Engine Control Module (ECM) Connector End Views</u> for the 6.0L engine				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Install a scan tool. 2. Start the engine. 3. Turn off all accessories. 4. Increase engine speed to 1,500 RPM. 5. With a scan tool, observe the Battery Voltage parameter in the dash integration module (DIM) data list, engine control module (ECM) data list, and the instrument panel cluster (IPC) data list. 6. Compare the voltages. Do all of the voltage measure within the specified range?	11-16 V	Go to <u>Testing for Intermittent Conditions and Poor Connections</u>	Go to Step 3
3	Do all of the voltage measure outside the specified range?	11.5-16 V	Go to <u>Charging System Test</u>	Go to Step 4
4	Test the battery positive voltage circuit of the affected module for a high resistance or an open. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?		Go to Step 7	Go to Step 5
5	Inspect for poor connections at the harness connector of the affected module. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> .	-		

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	Did you find and correct the condition?		Go to Step 7	Go to Step 6
6	Replace the affected module. Refer to <u>Control Module References</u> for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 7	-
7	Operate the system in order to verify the repair. Did you correct the condition?	-	System OK	Go to Step 2

CHARGE INDICATOR INOPERATIVE

Charge Indicator Inoperative

Step	Action	Yes	No
Schematic Reference: <u>Body Control System Schematics</u> , <u>Instrument Cluster Schematics</u> , <u>Engine Controls Schematics</u> for the 2.8L (LP1) engine, <u>Engine Controls Schematics</u> for the 3.6L (LY7) engine, or <u>Engine Controls Schematics</u> for the 6.0L engine Connector End View Reference: <u>Computer/Integrating Systems Connector End Views</u> , <u>Engine Control Module (ECM) Connector End Views</u> for the 2.8L (LP1) engine, <u>Engine Control Module (ECM) Connector End Views</u> for the 3.6L (LY7) engine, or <u>Engine Control Module (ECM) Connector End Views</u> for the 6.0L engine			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	Turn ON the ignition, with the engine OFF. Does the battery charge indicator illuminate?	Go to <u>Testing for Intermittent Conditions and Poor Connections</u>	Go to Step 3
3	1. Turn OFF the engine. 2. Disconnect the generator harness connector. 3. Connect a test lamp between the generator turn-on signal circuit and ground. 4. Start the engine. Does the charge indicator illuminate?	Go to <u>Charging System Test</u>	Go to Step 4
4	1. Install a scan tool. 2. Operate the vehicle within the conditions for running the DTC. 3. Using the scan tool, observe the specific DTC information for the DTCs until the test runs. Does the scan tool indicate that the generator L-terminal DTC has failed this ignition cycle?	Go to Step 8	Go to Step 5
5	Test the generator turn on signal circuit for an open. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	Go to Step 9	Go to Step 6

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6	Inspect for poor connections at the harness connector of the engine control module (ECM). Refer to Connector Repairs . Did you find and correct the condition?	Go to Step 9	Go to Step 7
7	Replace the ECM. Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	Go to Step 9	-
8	Replace the instrument panel cluster (IPC). Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	Go to Step 9	-
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2

GENERATOR NOISE DIAGNOSIS

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.

Generator Noise Diagnosis

Step	Action	Yes	No
1	Test the generator for proper operation using the Generator Tester. Refer to Charging System Test and Charging System Description and Operation . Is the generator operating properly?	Go to Step 2	Go to Step 11
2	1. Start the engine. Verify that the noise can be heard. 2. Turn OFF all accessories. 3. Turn OFF the ignition. CAUTION: Make sure that the load is completely turned off before connecting or disconnecting a carbon pile load tester to the battery. Otherwise, sparking could ignite battery gasses which are extremely flammable and may explode violently. 4. Connect a carbon pile tester to the vehicle. 5. Connect an inductive ammeter probe to the		

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	output circuit of the generator. - Start the engine. - Increase engine speed to 1,500 RPM. - Increase and decrease the amount of load placed upon the generator. - Listen for the noise. Does the noise increase and decrease with the amount of load placed upon the generator by the carbon pile tester?	Go to Step 11	Go to Step 3
3	- Turn OFF the engine. - Remove the drive belt. Refer to <u>Drive Belt Replacement - Generator and Water Pump</u> for the 2.8L (LP1) engine, <u>Drive Belt Replacement - Generator and Water Pump</u> for the 3.6L (LY7) engine. - Spin the generator pulley by hand. Does the generator shaft spin smoothly and without any roughness or grinding noise?	Go to Step 4	Go to Step 11
4	Inspect the generator for a loose pulley and/or pulley nut. Is the generator pulley or pulley nut loose?	Go to Step 11	Go to Step 5
5	- Loosen all of the generator mounting bolts. - Tighten the generator mounting bolts to specifications and in the proper sequence, if necessary. Refer to <u>Generator Replacement (LP1, LY7)</u>. - Install the drive belt. Refer to <u>Drive Belt Replacement - Generator and Water Pump</u> for the 2.8L (LP1) engine or <u>Drive Belt Replacement - Generator and Water Pump</u> for the 3.6L (LY7) engine. - Start the engine. Has the noise decreased or stopped?	System OK	Go to Step 6
6	Inspect the generator for the following conditions: - Strained or stretched electrical connections - Hoses or other vehicle equipment resting on the generator, which may cause the noise to be transmitted into the passenger compartment		

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	Are any electrical connections pulling on the generator or are any hoses, etc. resting on the generator?	Go to Step 7	Go to Step 8
7	1. Reroute the electrical connections to relieve the tension. 2. Reroute the hoses, etc. away from the generator. 3. Start the engine. Has the noise decreased or stopped?	System OK	Go to Step 8
8	Inspect the drive belt for proper tension. Refer to <u>Drive Belt Tensioner Diagnosis</u> for the 2.8L (LP1) engine, or <u>Drive Belt Tensioner Diagnosis</u> for the 3.6L (LY7) engine. Is the drive belt loose?	Go to Step 9	Go to Step 10
9	1. Replace the drive belt tensioner. Refer to <u>Drive Belt Tensioner Replacement - Generator and Water Pump</u> for the 2.8L (LP1) engine or <u>Drive Belt Tensioner Replacement - Generator and Water Pump</u> for the 3.6L (LY7) engine. 2. Start the engine. Has the noise decreased or stopped?	System OK	Go to Step 11
10	Compare the vehicle with a known good vehicle. Do both vehicles make the same noise?	System OK	Go to Step 11
11	IMPORTANT: If no definite generator problems were found, be sure that all other possible sources of objectionable noise are eliminated before replacing the generator. Replacing the generator may not change the noise level if the noise is a normal characteristic of the generator or the generator mounting. Replace the generator. Refer to <u>Generator Replacement (LP1, LY7)</u>. Has the noise decreased or stopped?	Go to Step 12	-
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2

STARTER SOLENOID DOES NOT CLICK

Starter Solenoid Does Not Click

Step	Action	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u> Connector End View Reference: <u>Master Electrical Component List</u> in Wiring Systems			

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1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	Turn the ignition to the START position. Does the starter solenoid click?	Go to <u>Testing for Intermittent Conditions and Poor Connections</u> in Wiring Systems	Go to Step 3
3	1. Install a scan tool. 2. With a scan tool, observe the Starter Relay Command parameter in the ECM/PCM data list. 3. Turn the ignition switch to the Crank position. Does the scan tool display ON?	Go to Step 4	Go to Step 5
4	Turn the ignition back and forth from the ON to Crank position a few times. Does the Starter Relay click each time the ignition is turned to the Crank position?	Go to Step 15	Go to Step 9
5	1. Turn ON the ignition, with the engine OFF. 2. With a scan tool, observe the Crank Request parameter in the engine control module (ECM) or powertrain control module (PCM) data list. 3. Turn the ignition switch to the START position. Does the scan tool display Yes?	Go to Step 6	Go to Step 8
6	1. Turn ON the ignition, with the engine OFF. 2. With a scan tool, observe the Start Disabled parameter in the VTD data list. Does the scan tool display Yes?	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information	Go to Step 7
7	1. Turn ON the ignition, with the engine OFF. 2. Verify that the transmission is in Park or Neutral. 3. With a scan tool, observe the IMS Range parameter in the Transmission data list. Does the scan tool display Park or Neutral?	Go to Step 24	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
8	1. Turn OFF the ignition. 2. Disconnect the ECM/PCM. 3. Connect a test lamp between the Start Command circuit of the ECM/PCM and a good ground. 4. Turn the ignition to the Start position.		

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	Does the test lamp illuminate?	Go to Step 24	Go to Step 17
9	1. Turn OFF the ignition. 2. Disconnect the Run/Crank Relay. 3. Connect a test lamp between the battery positive voltage circuit of the Run/Crank Relay coil circuit and a good ground. 4. Turn On the ignition, with the engine OFF.		
	Does the test lamp illuminate?	Go to Step 10	Go to Step 25
10	1. Turn OFF the ignition. 2. Connect a test lamp between the ignition 1 voltage circuit of the Run/Crank Relay coil and the ground circuit of the Run/Crank Relay coil. 3. Turn On the ignition, with the engine OFF.		
	Does the test lamp illuminate?	Go to Step 11	Go to Step 26
11	1. Connect a 10-amp fused jumper between the battery positive voltage circuit of the Run/Crank Relay switch and the Starter Relay Ignition 1 circuit of the Run Crank Relay switch. 2. Turn the ignition switch to the START position.		
	Does the starter solenoid click?	Go to Step 20	Go to Step 12
12	IMPORTANT: Leave the fused jumper in place. 1. Disconnect the Starter Relay. 2. Connect a test lamp between the ignition 1 voltage circuit of the Starter Relay coil and a good ground.		
	Does the test lamp illuminate?	Go to Step 13	Go to Step 27
13	1. Connect a test lamp between the ignition 1 voltage circuit of the Starter Relay coil and the control circuit of the Starter Relay coil. 2. Turn the ignition to the Start position.		
	Does the test lamp illuminate?	Go to Step 21	Go to Step 14
14	1. Turn OFF the ignition. 2. Disconnect the ECM/PCM. 3. Install the Starter Relay. 4. Connect a test lamp between the control circuit of		

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	the Starter Relay and a good ground.		
	Does the test lamp illuminate?	Go to Step 24	Go to Step 28
15	IMPORTANT: The engine may crank when the fused jumper is put into place. Connect a 30-amp fused jumper between the battery positive voltage circuit of the Starter relay switch circuit and the supply voltage circuit of the starter solenoid. Does the engine crank?	Go to Step 21	Go to Step 16
16	Does the fuse in the jumper open?	Go to Step 18	Go to Step 19
17	Test the Start Command circuit of the ECM/PCM for a high resistance or open. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> in Wiring Systems. Did you find and correct the condition?	Go to Step 34	Go to Step 23
18	Test the supply voltage circuit of the starter solenoid for a short to ground. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> in Wiring Systems. Did you find and correct the condition?	Go to Step 34	Go to Step 22
19	Test the supply voltage circuit of the starter solenoid for a high resistance or open. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> in Wiring Systems. Did you find and correct the condition?	Go to Step 34	Go to Step 22
20	Inspect for poor connection at the Run/Crank Relay. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	Go to Step 34	Go to Step 29
21	Inspect for poor connection at the Starter Relay. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	Go to Step 34	Go to Step 30
22	Inspect for poor connection at the starter solenoid. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	Go to Step 34	Go to Step 31
23	Inspect for poor connection at the ignition switch. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	Go to Step 34	Go to Step 32
24	Inspect for poor connection at the ECM/PCM. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	Go to Step 34	Go to Step 33
	Repair the high resistance or open in the ignition 1		

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25	voltage circuit of the Run/Crank Relay coil. Refer to <u>Wiring Repairs</u> in Wiring Systems. Did you complete the repair?	Go to Step 34	-
26	Repair the high resistance or open in the ground circuit of the Run/Crank Relay coil. Refer to <u>Wiring Repairs</u> in Wiring Systems. Did you complete the repair?	Go to Step 34	-
27	Repair the high resistance or open in the ignition 1 voltage circuit of the Starter relay coil. Refer to <u>Wiring Repairs</u> in Wiring Systems. Did you complete the repair?	Go to Step 34	-
28	Repair the high resistance or open in the control circuit of the Starter relay. Refer to <u>Wiring Repairs</u> in Wiring Systems. Did you complete the repair?	Go to Step 34	-
29	Replace the Run/Crank relay. Did you complete the replacement?	Go to Step 34	-
30	Replace the Starter relay. Did you complete the replacement?	Go to Step 34	-
31	Replace the starter. Refer to <u>Starter Motor Replacement (LP1, LY7)</u> . Did you complete the replacement?	Go to Step 34	-
32	Replace the ignition switch. Refer to <u>Ignition Switch Replacement</u> in Steering Wheel and Column. Did you complete the replacement?	Go to Step 34	-
33	Replace the ECM/PCM. Refer to <u>Control Module References</u> in Computer/Integrating Systems for replacement, setup, and programming. Did you complete the replacement?	Go to Step 34	-
34	Operate the system for which the symptom occurred. Did you correct the condition?	System OK	Go to Step 2

STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK

Starter Solenoid Clicks, Engine Does Not Crank

Step	Action	Yes	No
Schematic Reference: <u>Starting and Charging Schematics</u> Connector End View Reference: <u>Engine Electrical Connector End Views</u>			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	Turn the ignition to the START position. Did the starter solenoid click?	Go to Step 3	Go to <u>Starter Solenoid Does Not Click</u>
	Inspect the engine and belt drive system for		Go to <u>Engine Will</u>

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3	mechanical binding, seized engine, seized generator. Does the engine move freely?	Go to Step 4	<u>Not Crank - Crankshaft Will Not Rotate</u> for the 2.8L (LP1) engine, <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u> for the 3.6L (LY7) engine, or <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u> for the 6.0L (LS2) engine
4	Test the battery positive cable between the battery and the starter solenoid for high resistance. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	Go to Step 8	Go to Step 5
5	Test the ground circuit between the battery and the starter motor for a high resistance. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	Go to Step 8	Go to Step 6
6	Inspect for poor connections at the starter. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> . Did you find and correct the condition?	Go to Step 8	Go to Step 7
7	Replace the starter. Refer to <u>Starter Motor Replacement (LP1, LY7)</u> . Did you complete the replacement?	Go to Step 8	-
8	Operate the system for which the symptom occurred. Did you correct the condition?	System OK	Go to Step 2

ENGINE CRANKS SLOWLY

Inspect the following items:

- Battery - Perform the Battery Inspection/Test. Refer to **Battery Inspection/Test**.
- Wiring - Inspect the wiring for damage. Inspect all connections to the starter motor, the solenoid, the battery, and all ground connections. Refer to **Circuit Testing** , **Wiring Repairs** , **Testing for Intermittent Conditions and Poor Connections** , and **Connector Repairs** in Wiring Systems.
- Engine - Verify that the engine is not seized.

If the battery, the wiring, and the engine are functioning properly, and the engine continues to crank slowly, replace the starter motor. Refer to **Starter Motor Replacement (LP1, LY7)**.

STARTER MOTOR NOISE DIAGNOSIS

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Diagnostic Aids

Inspect the flywheel ring gear for damage or unusual wear.

Test Description

The number below refers to the step number on the diagnostic table.

5: A starter motor that remains engaged after engine start up can be caused by a starter relay that hangs up or a low current short to B+ on the starter solenoid crank voltage circuit. Verify the integrity of the starter solenoid crank voltage circuit before replacing the starter motor.

Starter Motor Noise Diagnosis

Step	Action	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	Start the engine. Does the starter operate normally?	Go to <u>Testing for Intermittent Conditions and Poor Connections</u>	Go to Step 3
3	Start the engine while listening to the starter motor turn. Is there a loud "whoop", that may sound like a siren if the engine is revved while the starter is engaged, after the engine starts, but while the starter is still held in the engaged position?	Go to Step 6	Go to Step 4
4	Do you hear a "rumble", a "growl", or, in some cases, a "knock" as the starter is coasting down to a stop after starting the engine?	Go to Step 7	Go to Step 5
5	IMPORTANT: This is often diagnosed as a starter drive gear hang-in or a weak solenoid. When the engine is cranked, do you hear a high-pitched whine after the engine cranks and starts normally?	Go to Step 8	Go to Step 7
6	Inspect the flywheel ring gear for the following: • Chipped gear teeth • Missing gear teeth • Milled teeth Is the flywheel bent, or does it have damaged teeth?	Go to Step 8	Go to Step 7

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7	1. Remove the starter motor. Refer to <u>Starter Motor Replacement (LP1, LY7)</u>. 2. Inspect the starter motor bushings and clutch gear. Does the clutch gear have chipped or milled teeth or worn bushings?	Go to Step 9	Go to Step 10
8	Replace the flywheel. Refer to <u>Engine Flywheel Replacement</u> for the 2.8L (LP1) engine, or <u>Engine Flywheel Replacement</u> for the 3.6L (LY7) engine. Did you complete the replacement?	Go to Step 10	-
9	Replace the starter motor. Refer to <u>Starter Motor Replacement (LP1, LY7)</u>. Did you complete the replacement?	Go to Step 10	-
10	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

REPAIR INSTRUCTIONS

BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE

Removal Procedure

CAUTION: Refer to **Battery Disconnect Caution** in Cautions and Notices.

1. Turn off all the lamps and accessories.
2. Turn the ignition OFF.

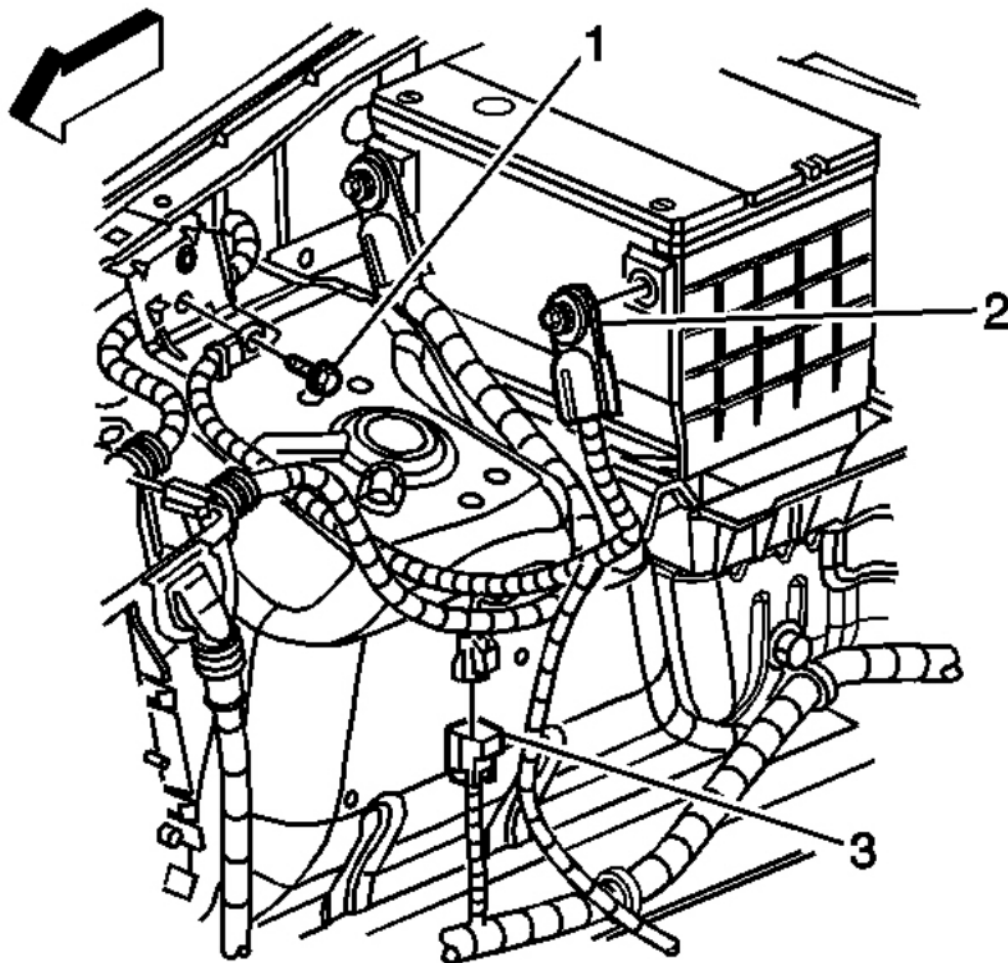


Fig. 11: View Of Battery Area Mounts And Connectors
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the battery negative cable (2) from the battery.

Installation Procedure

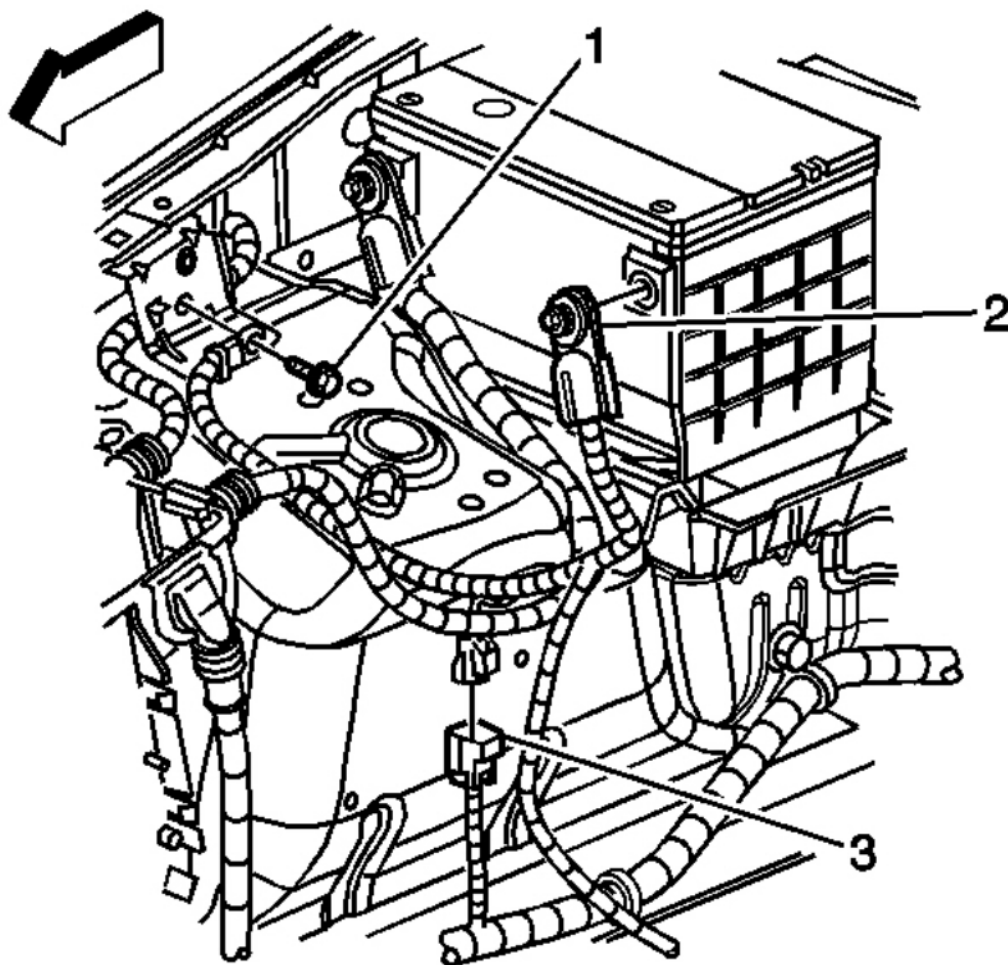


Fig. 12: View Of Battery Area Mounts And Connectors
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Clean any existing corrosion from the battery terminal, the battery cable bolt and the battery cable.

NOTE: Refer to Fastener Notice in Cautions and Notices.

1. Connect the battery negative (2) cable to the battery.

Tighten: Tighten the battery cable bolt to 17 N.m (13 lb ft).

2. Power Windows calibration:

1. Repeat these steps for each window.
2. Turn the ignition switch to the RUN position.
3. Press the power window switch to the down position. After the window is in the full down position, press and hold the switch in the down position for 3 seconds.
4. Press the power window switch to the up position. After the window is in the full up position, press and hold the switch in the up position for 3 seconds.

BATTERY NEGATIVE CABLE REPLACEMENT (LP1, LY7)**Removal Procedure****IMPORTANT:**

- Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.
- Always route the replacement cable the same as the original cable.

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.

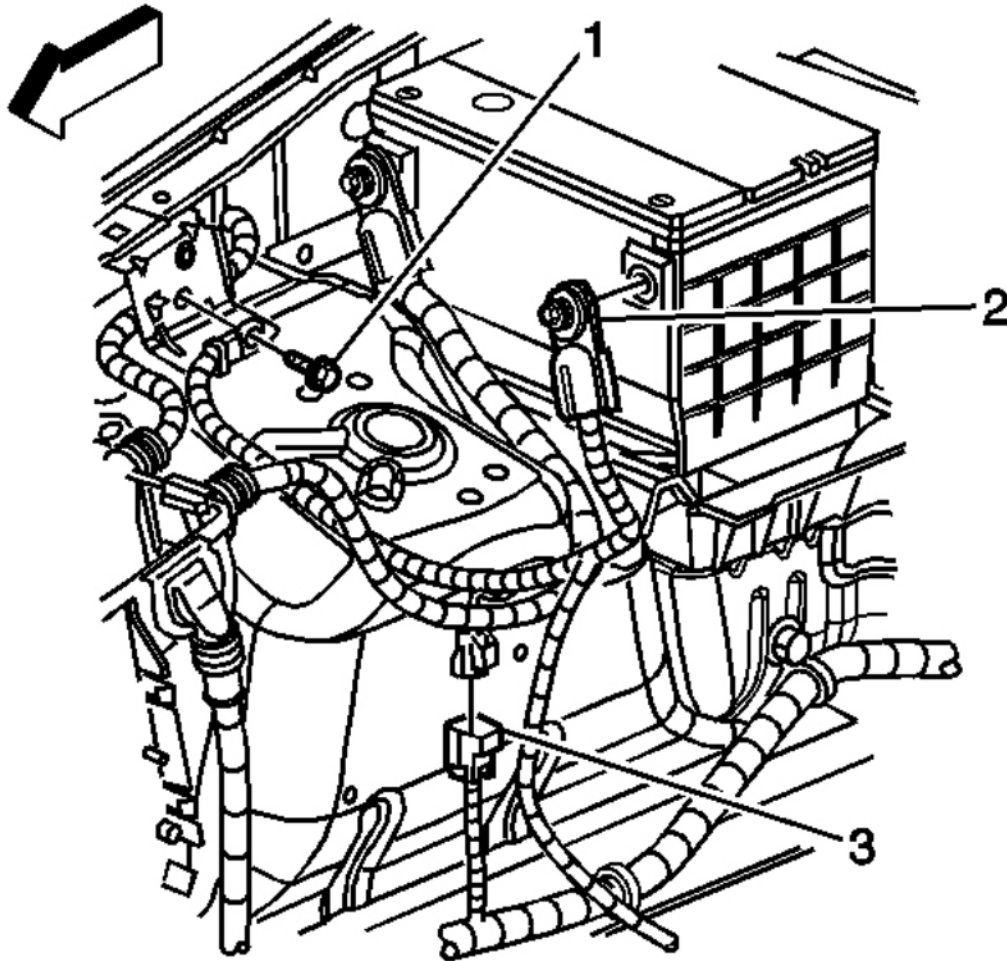


Fig. 13: View Of Battery Area Mounts And Connectors
Courtesy of GENERAL MOTORS CORP.

2. Remove the bolt (1) securing the battery negative cable to the side rail.
3. Disconnect the body harness connector (3) from the battery negative cable.

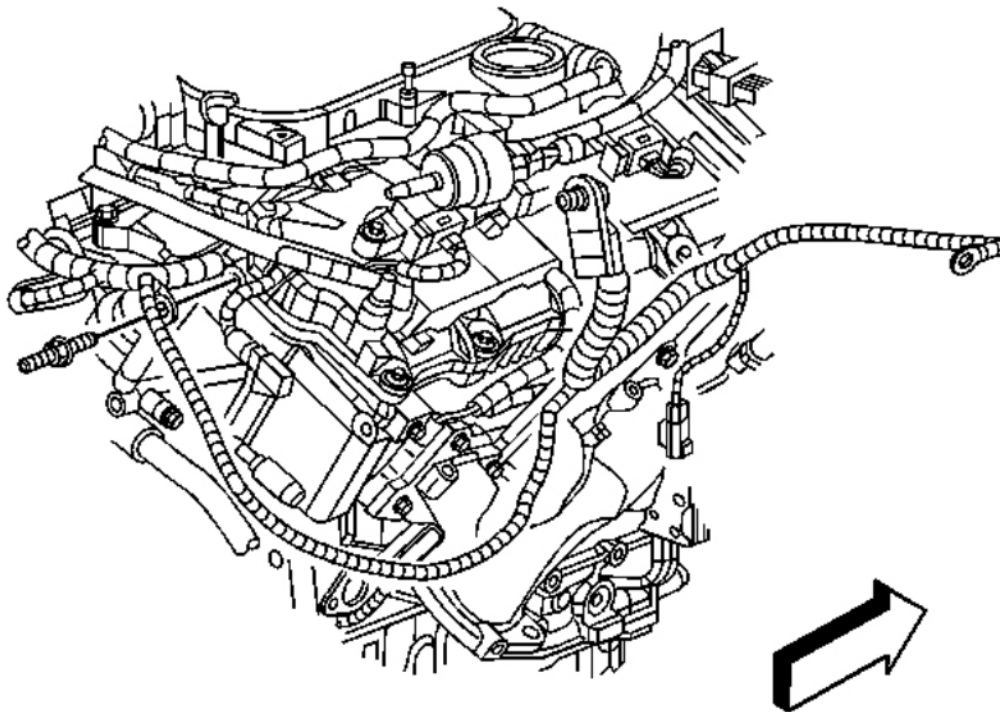


Fig. 14: Identifying Stud Securing Battery Negative Cable To Engine Block
Courtesy of GENERAL MOTORS CORP.

4. Remove the stud securing the battery negative cable to the engine block.
5. Lower the vehicle.
6. Remove the battery negative cable from the engine.

Installation Procedure

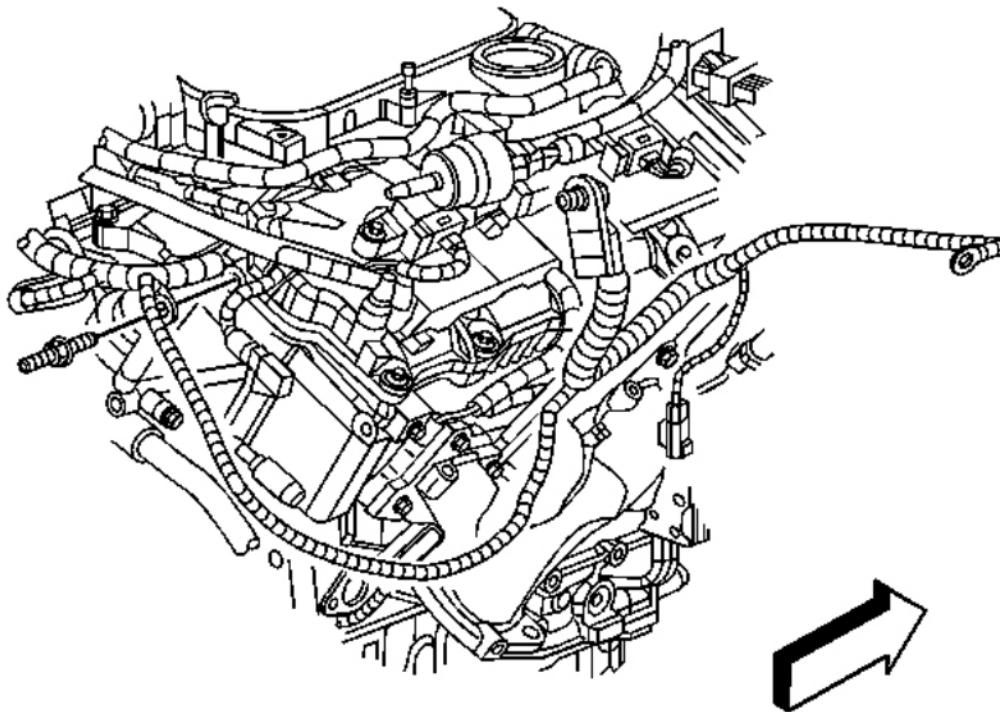


Fig. 15: Identifying Stud Securing Battery Negative Cable To Engine Block
Courtesy of GENERAL MOTORS CORP.

1. Position the battery negative cable to the engine.

NOTE: Refer to Fastener Notice in Cautions and Notices.

2. Install the battery negative cable to engine stud.

Tighten: Tighten the stud to 50 N.m (37 lb ft).

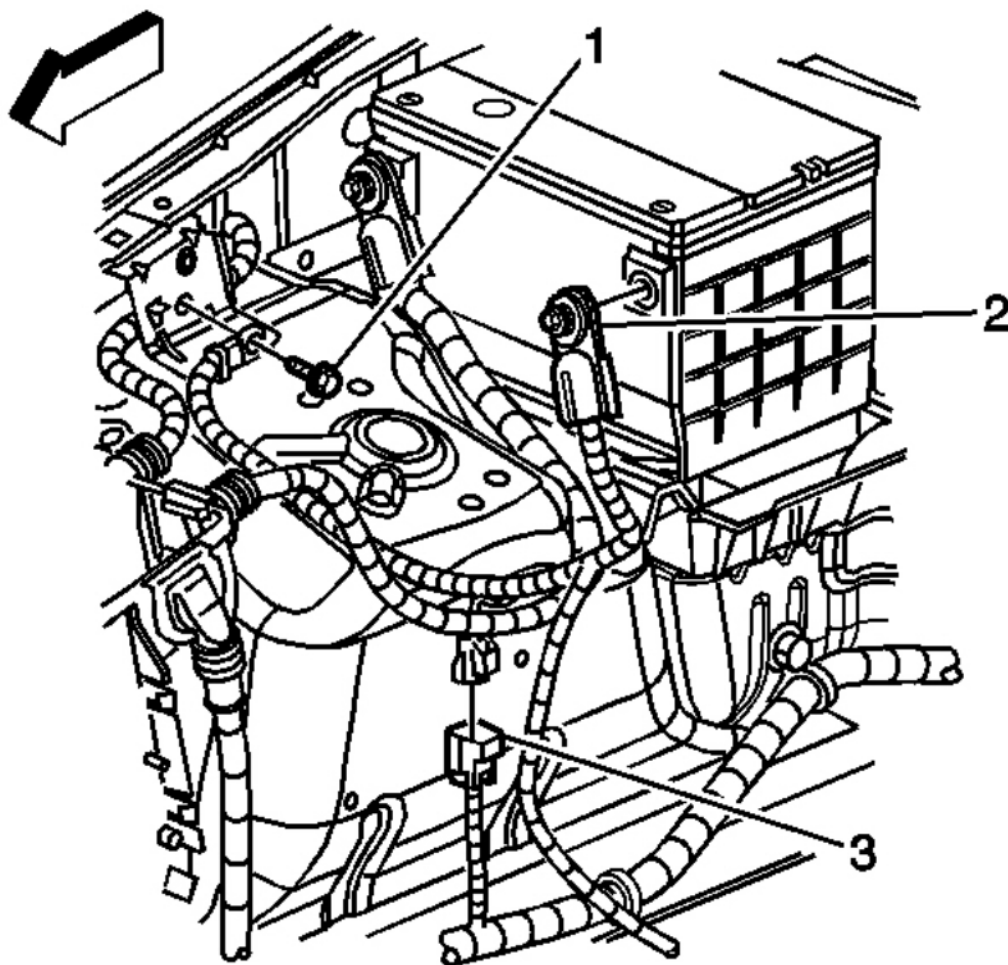


Fig. 16: View Of Battery Area Mounts And Connectors
Courtesy of GENERAL MOTORS CORP.

3. Install the bolt (1) securing the battery negative cable to the side rail.

Tighten: Tighten the battery negative cable to side rail bolt to 36 N.m (27 lb ft).

4. Connect the body harness connector (3) to the battery negative cable.
5. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.

BATTERY NEGATIVE CABLE REPLACEMENT (RHD)

Removal Procedure

IMPORTANT:

- Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.
- Always route the replacement cable the same way as the original cable.

1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnect/Connect Procedure.

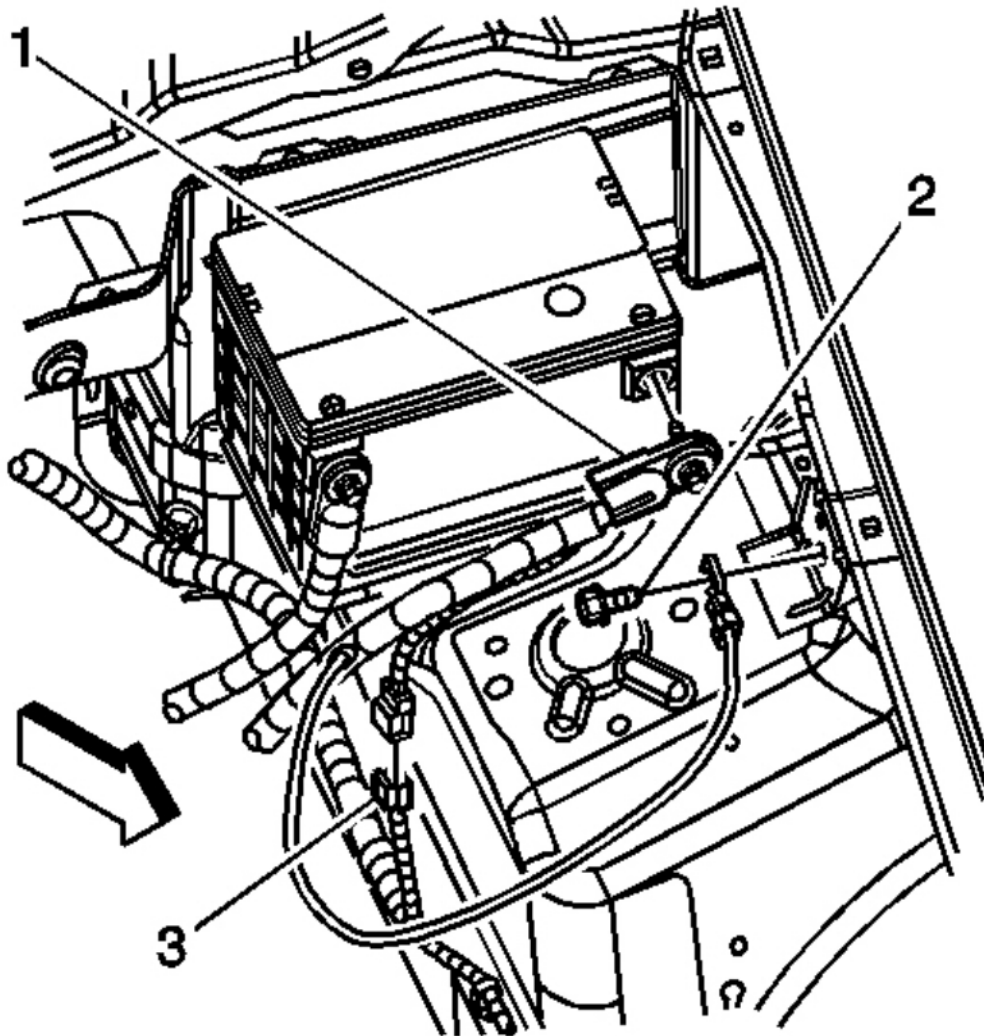


Fig. 17: View Of Battery Negative Cable To Side Rail & Body Harness Connector
Courtesy of GENERAL MOTORS CORP.

2. Remove the bolt (2) securing the battery negative cable to the side rail.
3. Disconnect the body harness connector (3) from the battery negative cable.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

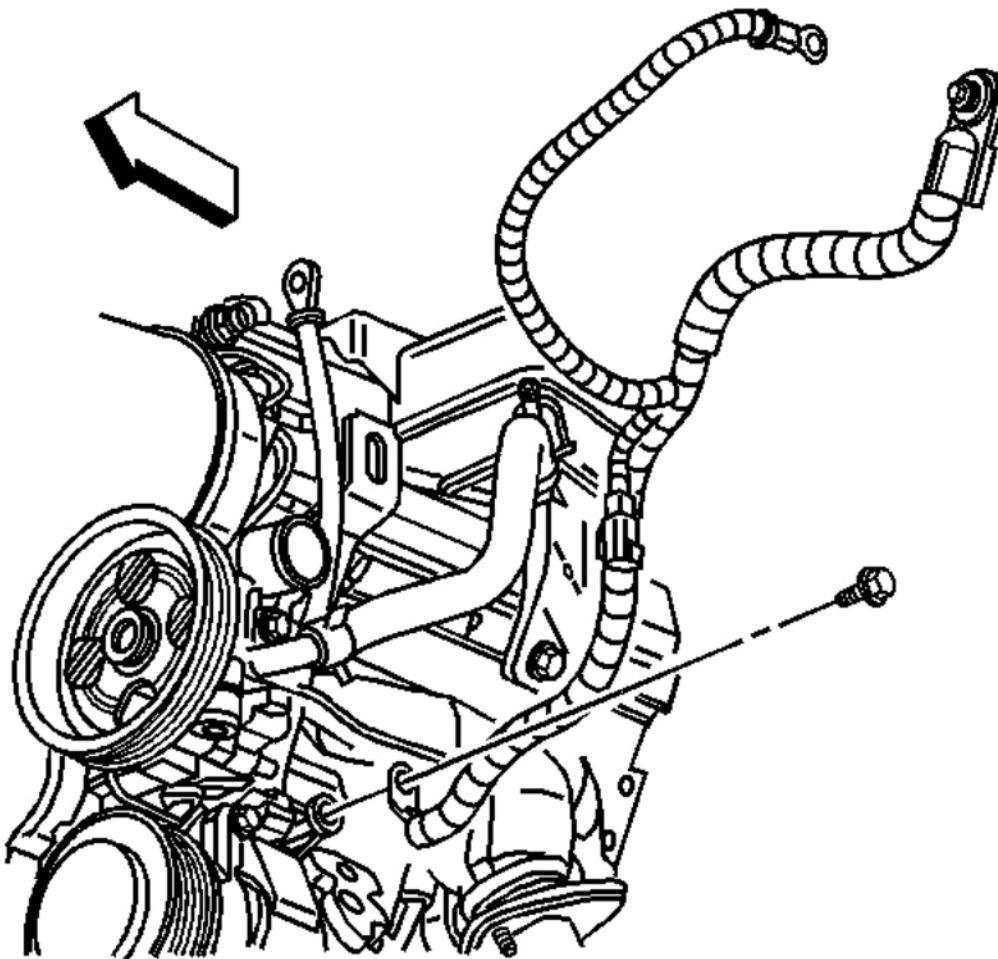


Fig. 18: View Of Battery Negative Cable To Engine Block Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the bolt securing the battery negative cable to the engine block.
6. Remove the battery negative cable from the engine.

1. Position the battery negative cable to the engine.

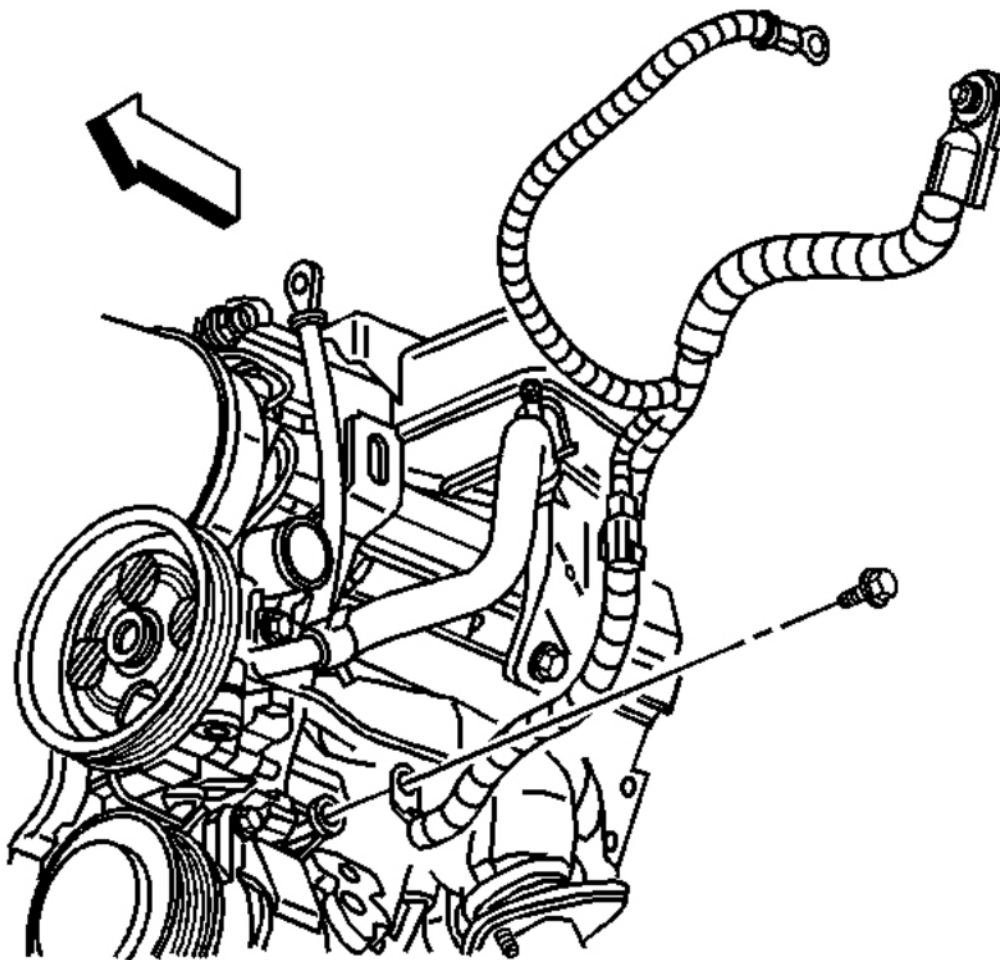


Fig. 19: View Of Battery Negative Cable To Engine Block Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

2. Install the bolt securing the battery negative cable to the engine block.

Tighten: Tighten the battery negative cable to engine block bolt to 50 N.m (37 lb ft).

3. Lower the vehicle.

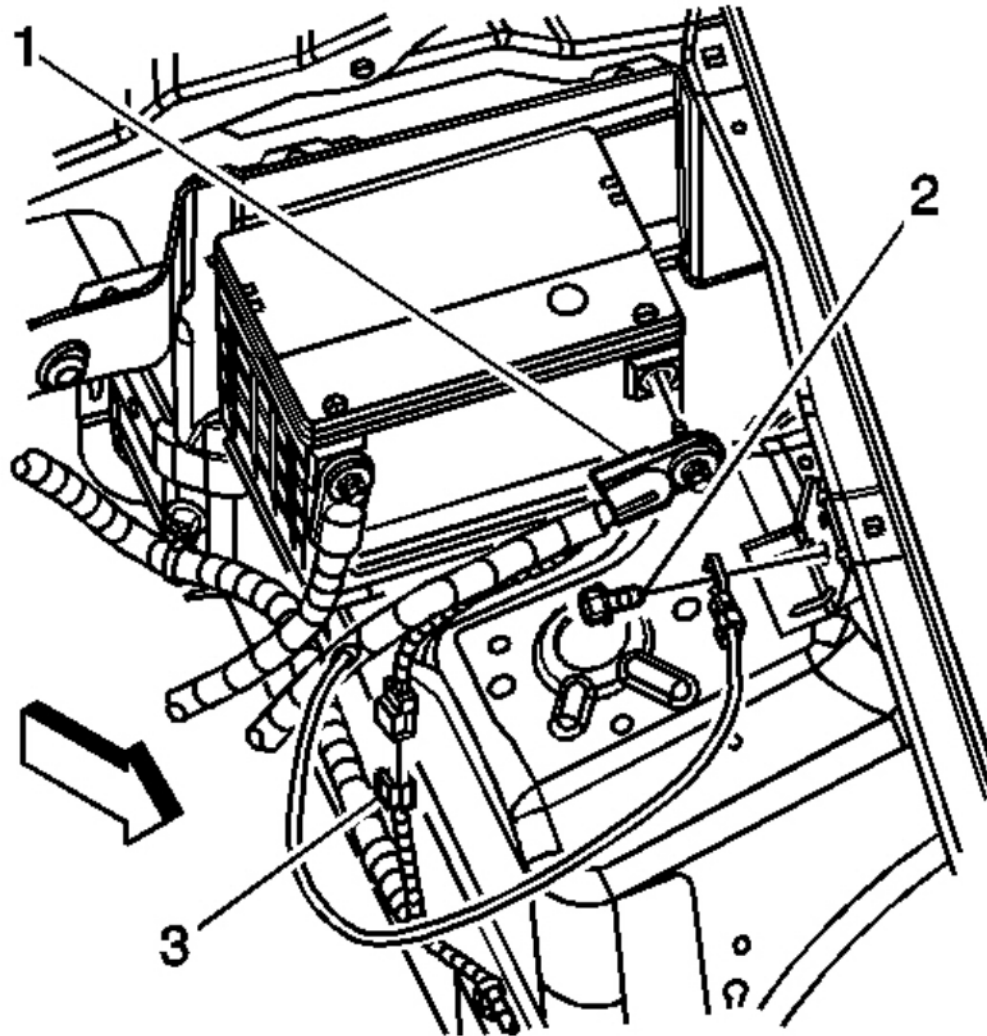


Fig. 20: View Of Battery Negative Cable To Side Rail & Body Harness Connector
 Courtesy of GENERAL MOTORS CORP.

4. Install the bolt (2) securing the battery negative cable to the side rail.

Tighten: Tighten the battery negative cable to side rail bolt to 36 N.m (27 lb ft).

5. Connect the body harness connector (3) to the battery negative cable.
6. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.

BATTERY POSITIVE CABLE REPLACEMENT (LP1, LY7)

Removal Procedure

IMPORTANT:

- Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.
- Always route the replacement cable the same as the original cable.

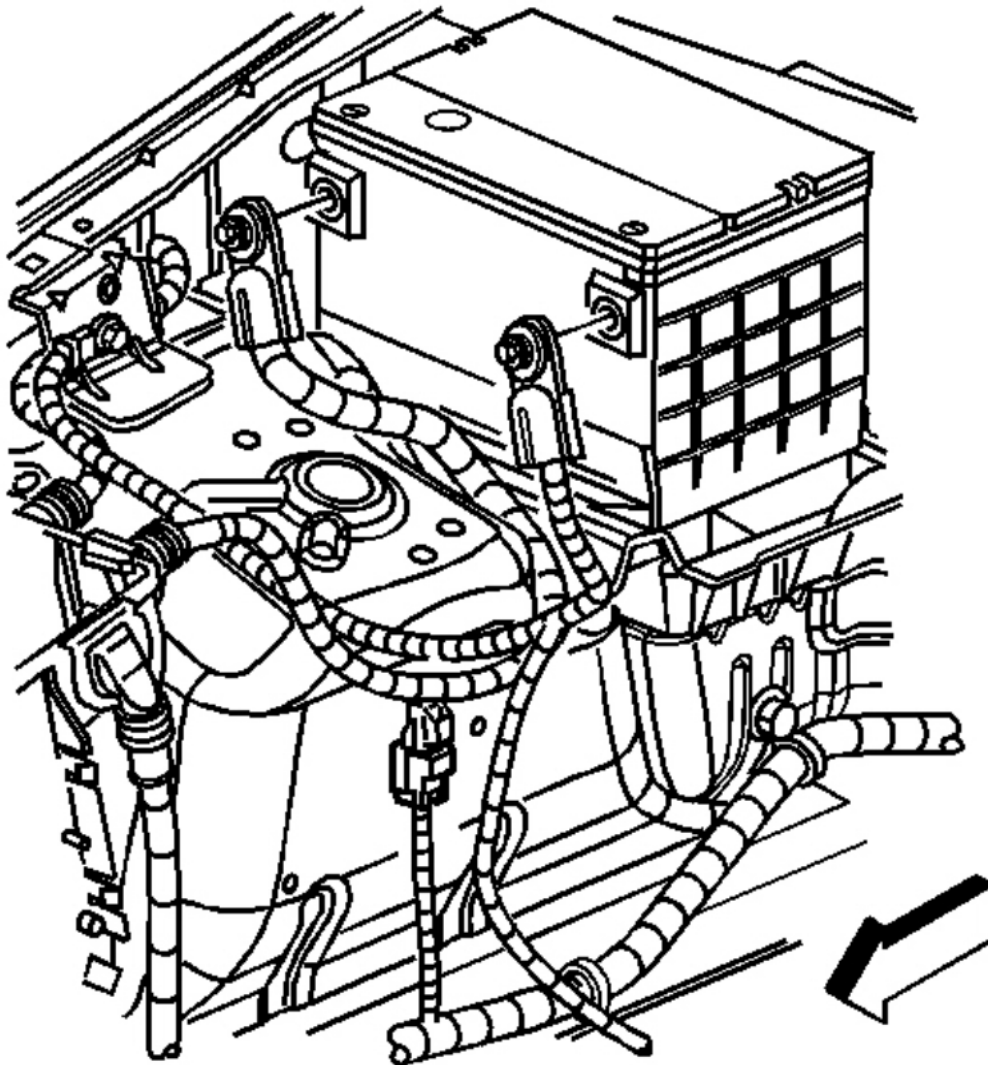


Fig. 21: View Of Battery Positive & Negative Cables

Courtesy of GENERAL MOTORS CORP.

1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnect/Connect Procedure.
2. Remove the transmission. Refer to Transmission Replacement or Transmission Replacement (LP1, LY7).
3. Disconnect the battery positive cable from the battery.

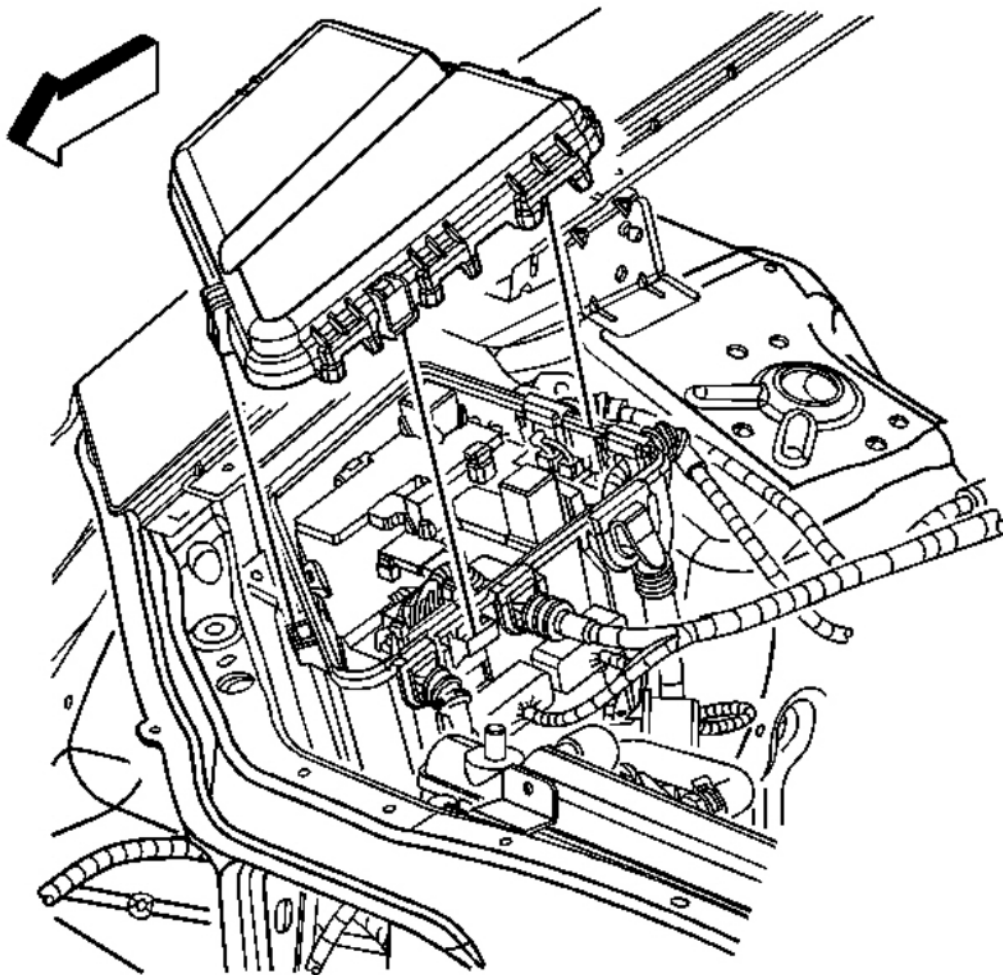


Fig. 22: View Of Underhood Fuse Box
Courtesy of GENERAL MOTORS CORP.

4. Depress the tabs in order to remove the cover from the electrical center.

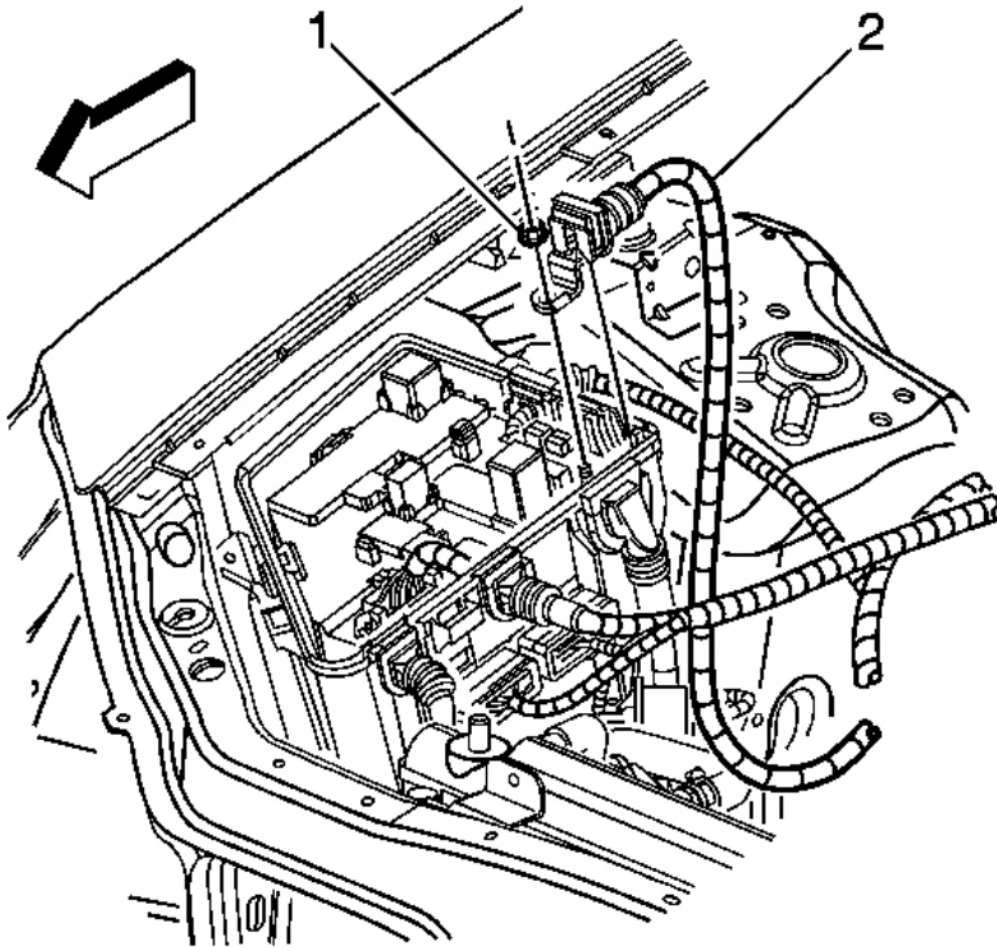


Fig. 23: Identifying Battery Positive Cable To Underhood Fuse Block
Courtesy of GENERAL MOTORS CORP.

5. Remove the nut (1) securing the battery positive cable (2) to the underhood fuse block.

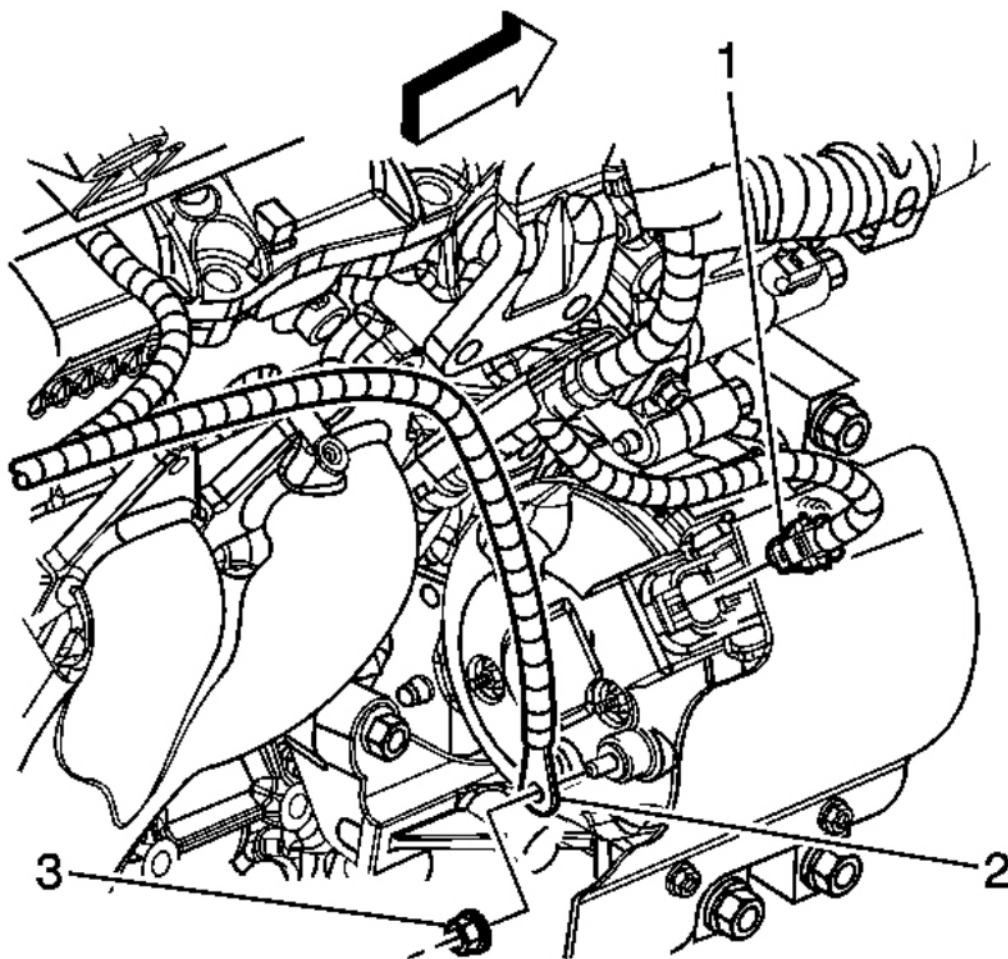


Fig. 24: View Of Battery Positive Lead & Generator BAT Terminal Nut
Courtesy of GENERAL MOTORS CORP.

6. Reposition the protective boot from the generator output BAT terminal for access.
7. Remove the generator output BAT terminal nut (3) and disconnect the battery positive lead (2) from the generator.

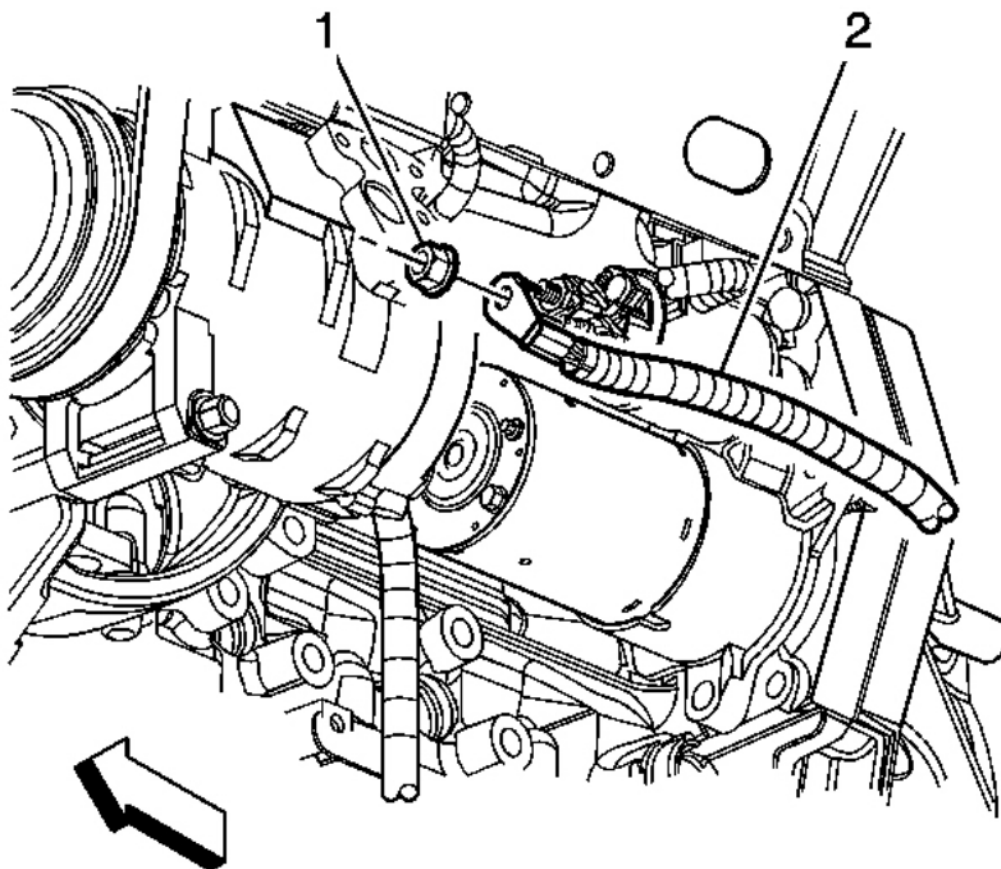


Fig. 25: View Of Starter Terminal Nut & Battery Positive Cable
Courtesy of GENERAL MOTORS CORP.

8. Remove the starter terminal nut (1) and disconnect the battery positive cable (2) from the starter.
9. Lower the vehicle.
10. Remove the battery positive cable from the engine.

Installation Procedure

1. Position the battery positive cable to the engine.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

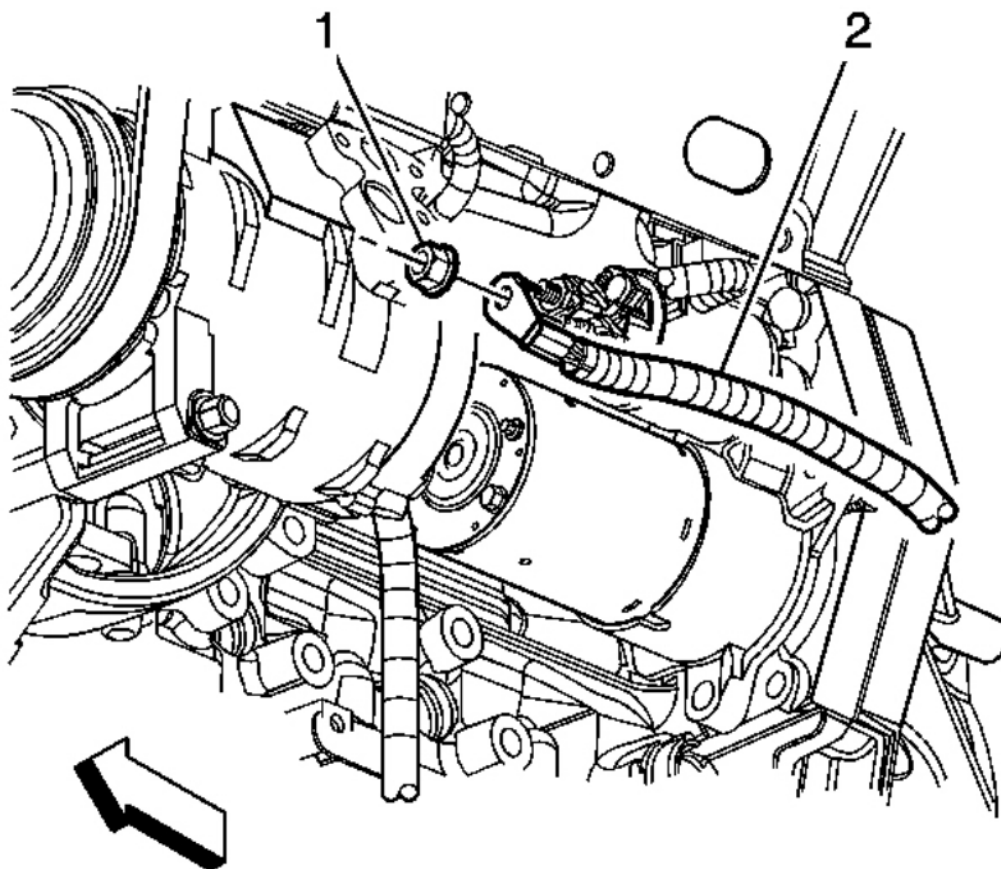


Fig. 26: View Of Starter Terminal Nut & Battery Positive Cable
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Connect the battery positive cable (2) to the starter and install the starter terminal nut (1).

Tighten: Tighten the nut to 13 N.m (115 lb in).

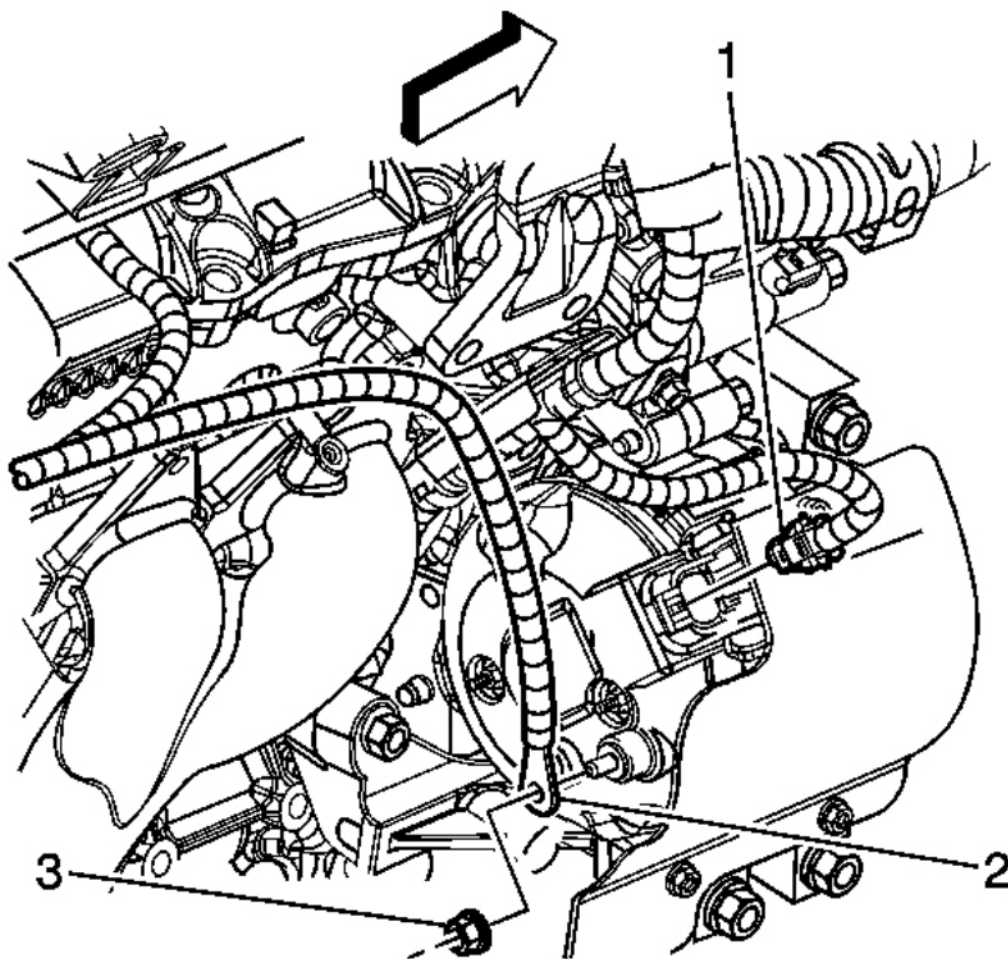


Fig. 27: View Of Battery Positive Lead & Generator BAT Terminal Nut
Courtesy of GENERAL MOTORS CORP.

4. Connect the battery positive lead (2) to the generator and install the generator BAT terminal nut (3).

Tighten: Tighten the nut to 13 N.m (115 lb in).

5. Install the protective boot to the generator output BAT terminal.
6. Lower the vehicle.

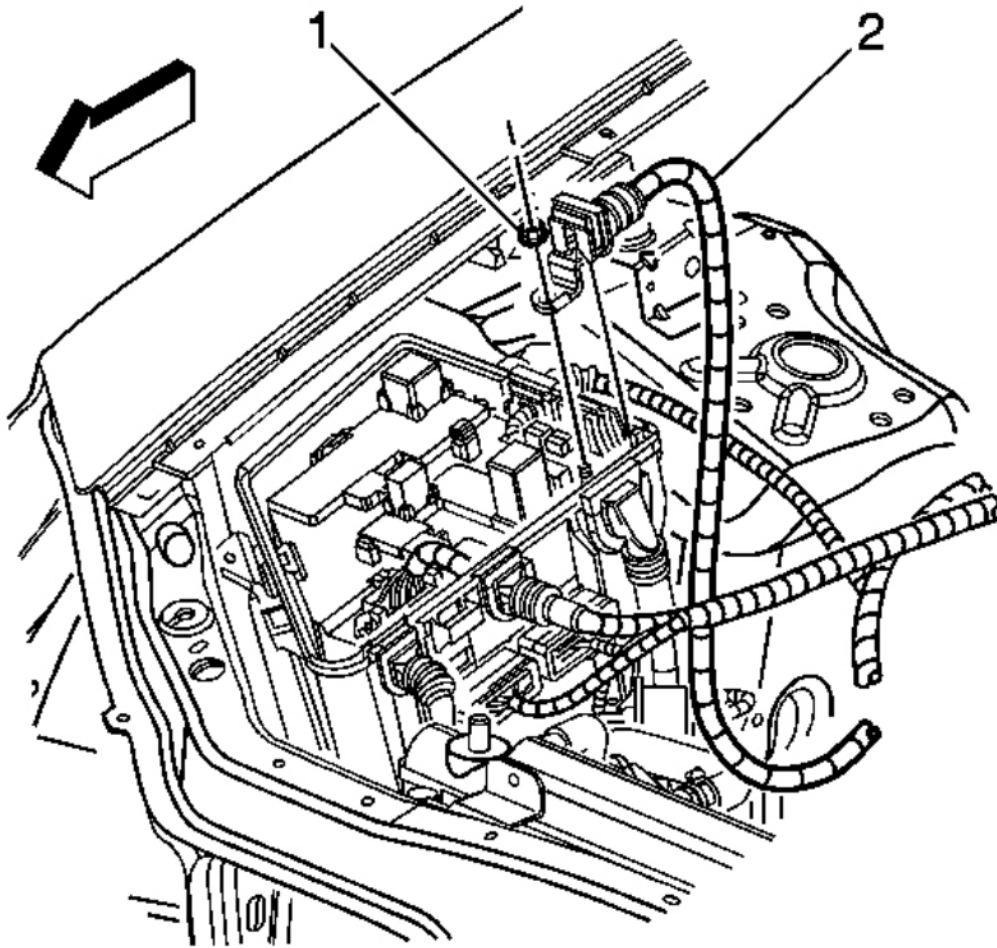


Fig. 28: Identifying Battery Positive Cable To Underhood Fuse Block
Courtesy of GENERAL MOTORS CORP.

7. Install the nut (1) securing the battery positive cable (2) to the underhood fuse block.

Tighten: Tighten the nut to 15 N.m (11 lb ft).

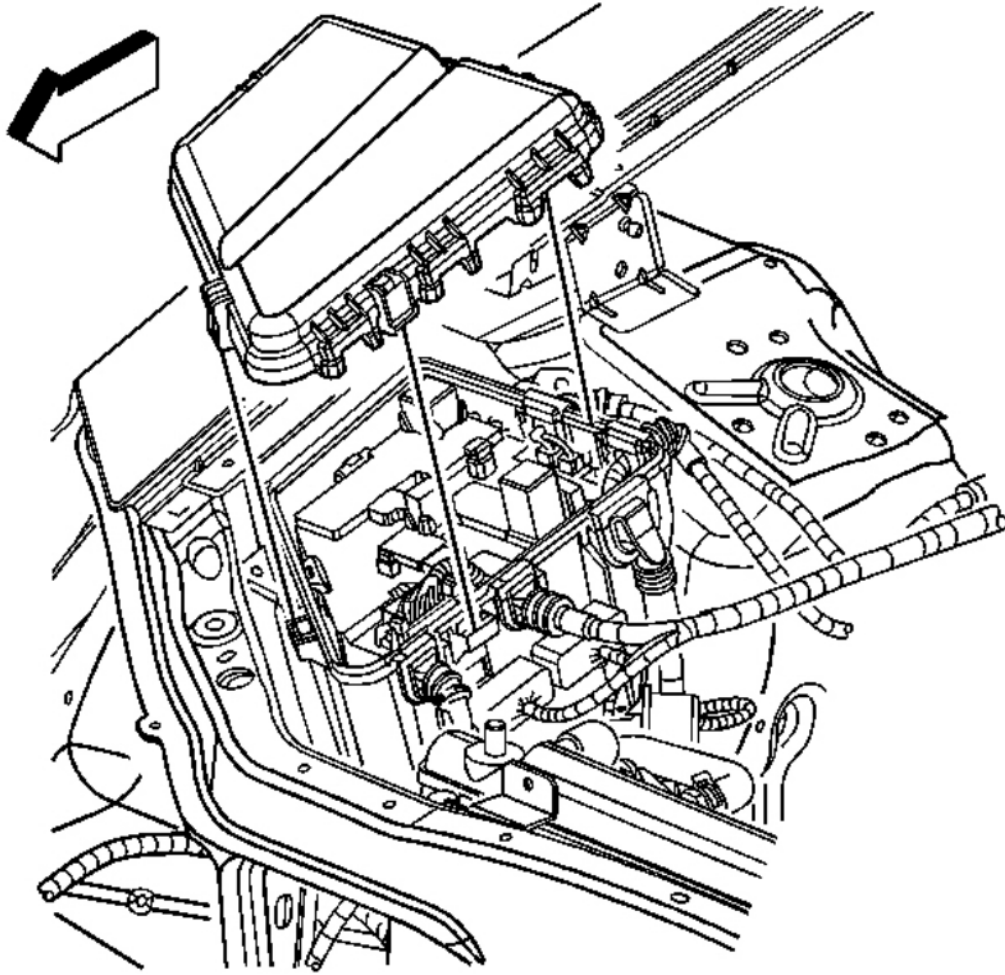


Fig. 29: View Of Underhood Fuse Box
Courtesy of GENERAL MOTORS CORP.

8. Install the electrical center cover.

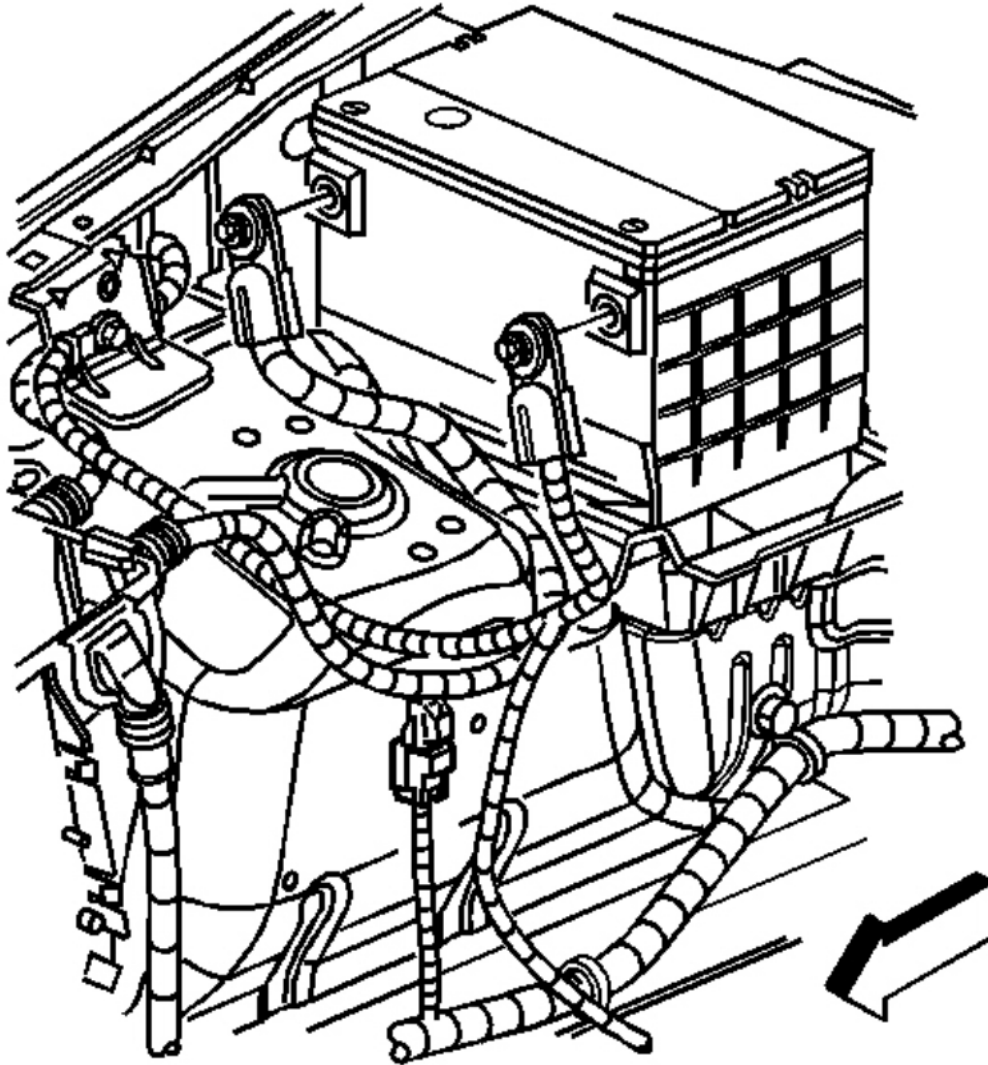


Fig. 30: View Of Battery Positive & Negative Cables
Courtesy of GENERAL MOTORS CORP.

9. Connect the battery positive cable to the battery.

Tighten: Tighten the battery cable to 17 N.m (13 lb ft).

10. Install the transmission. Refer to [Transmission Replacement](#) or [Transmission Replacement \(LP1, LY7\)](#).

11. Connect the battery negative cable. Refer to Battery Negative Cable Disconnect/Connect Procedure.

BATTERY REPLACEMENT (LHD)

Removal Procedure

1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnect/Connect Procedure.

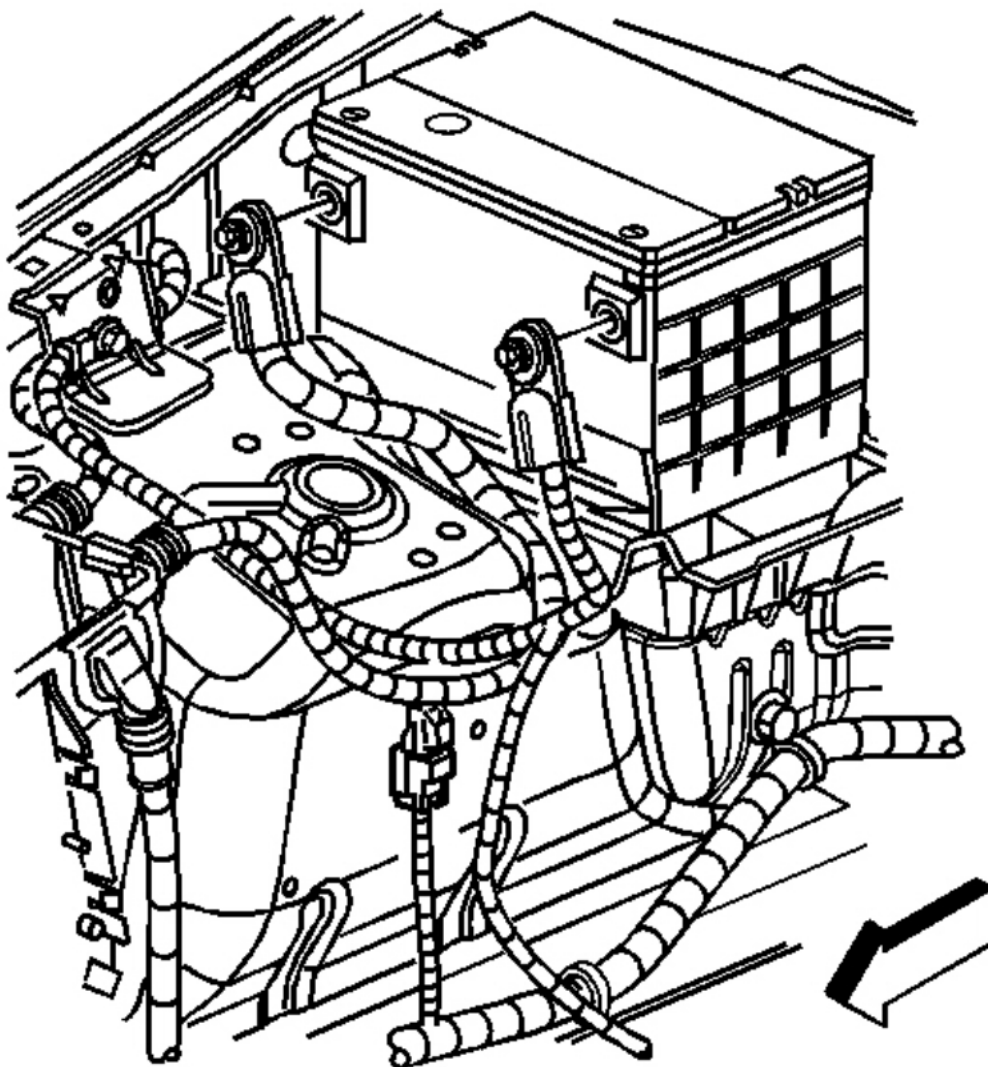


Fig. 31: View Of Battery Positive & Negative Cables
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the battery positive cable from the battery.

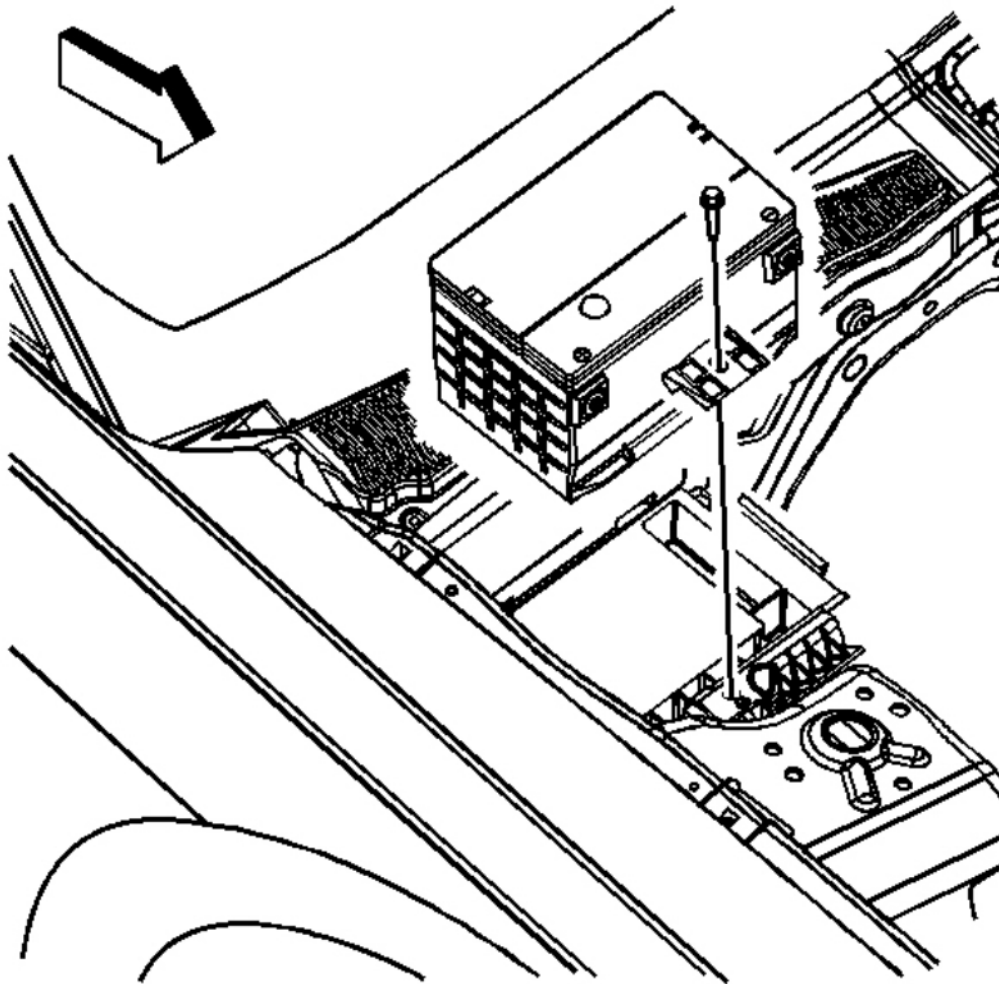


Fig. 32: Identifying Battery Tray & Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the battery retainer bolt and battery retainer.
4. Remove the battery from the vehicle.
5. Remove the battery heat shield. Refer to **Battery Heat Shield Replacement**.

Installation Procedure

1. Install the battery heat shield. Refer to Battery Heat Shield Replacement.

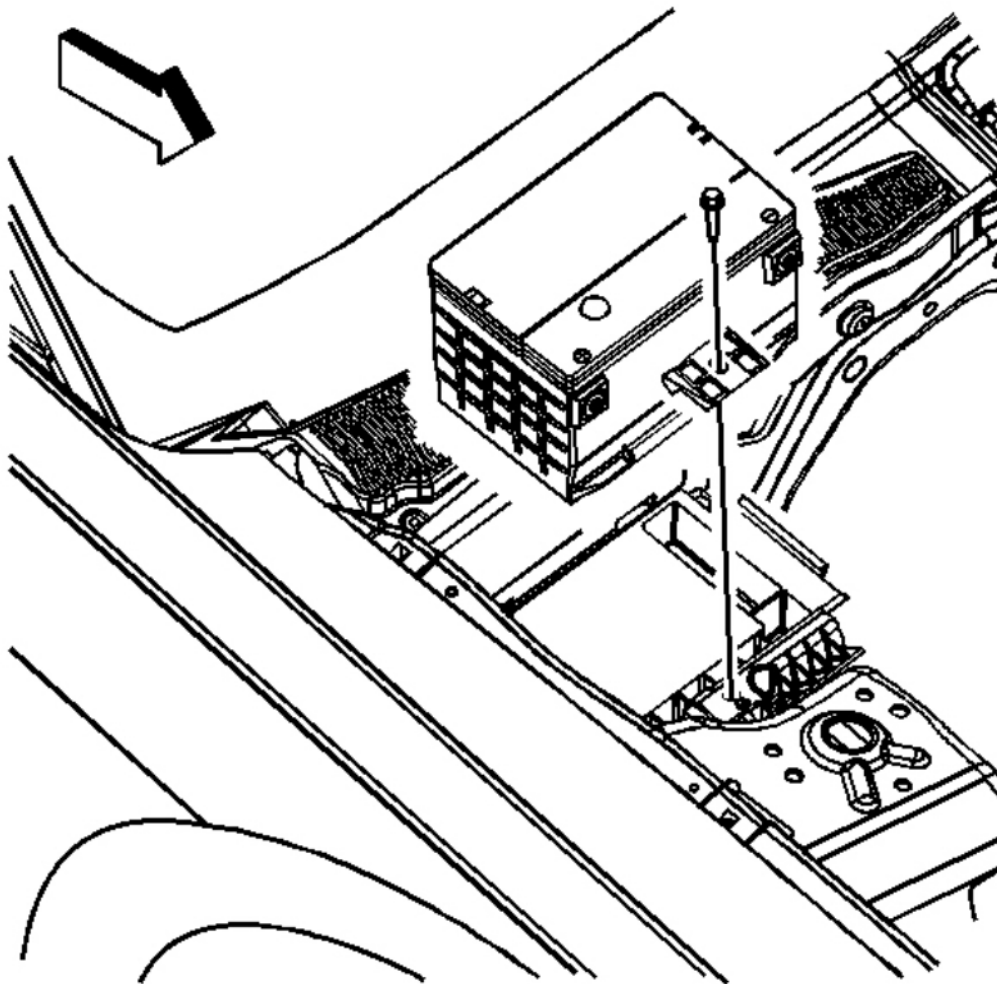


Fig. 33: Identifying Battery Tray & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Install the battery into the vehicle.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Install the battery retainer and bolt.

Tighten: Tighten the battery retainer bolt to 25 N.m (18 lb ft).

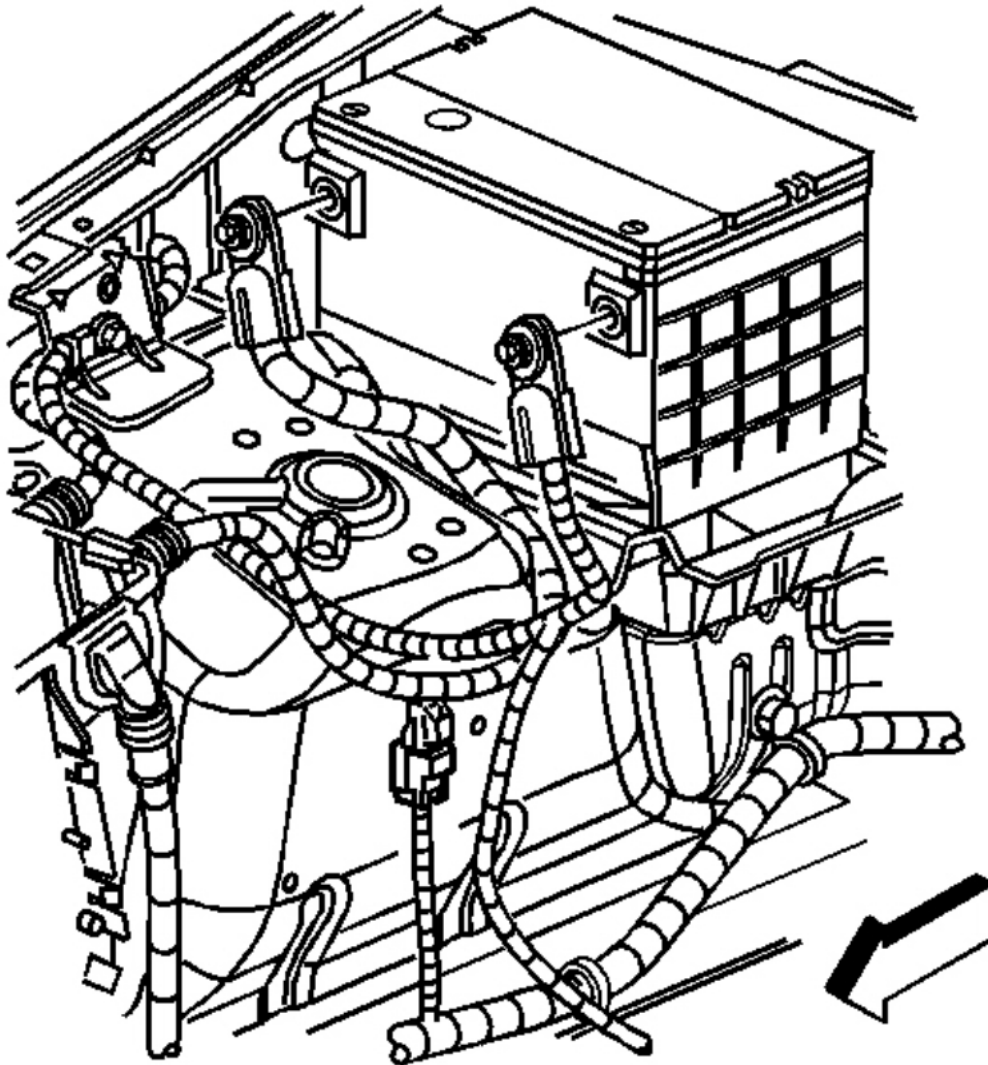


Fig. 34: View Of Battery Positive & Negative Cables
Courtesy of GENERAL MOTORS CORP.

4. Connect the battery positive cable to the battery.

Tighten: Tighten the battery cable bolt to 17 N.m (13 lb ft).

5. Connect the battery negative cable. Refer to Battery Negative Cable Disconnect/Connect Procedure.

BATTERY REPLACEMENT (RHD)

Removal Procedure

1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnect/Connect Procedure.

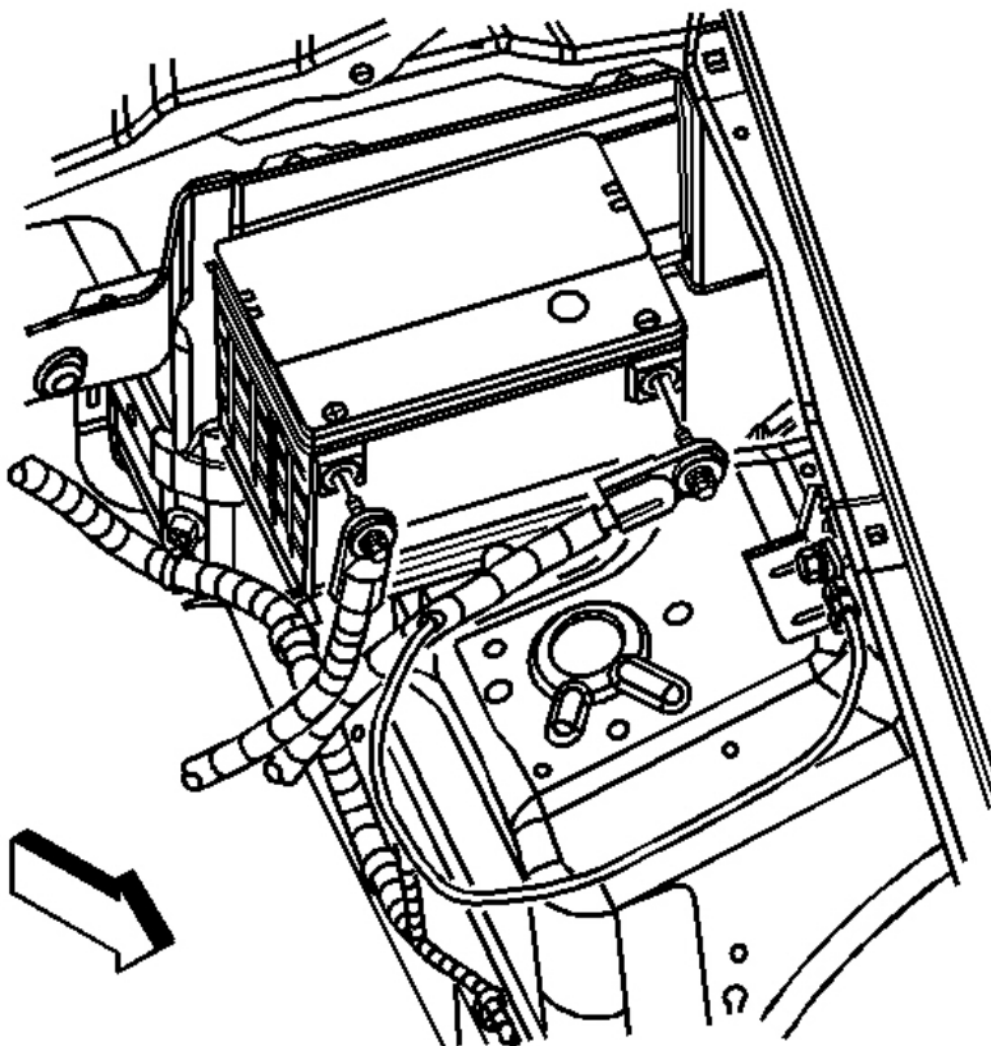


Fig. 35: View Of Battery Positive & Negative Cables

Courtesy of GENERAL MOTORS CORP.

2. Disconnect the battery positive cable from the battery.

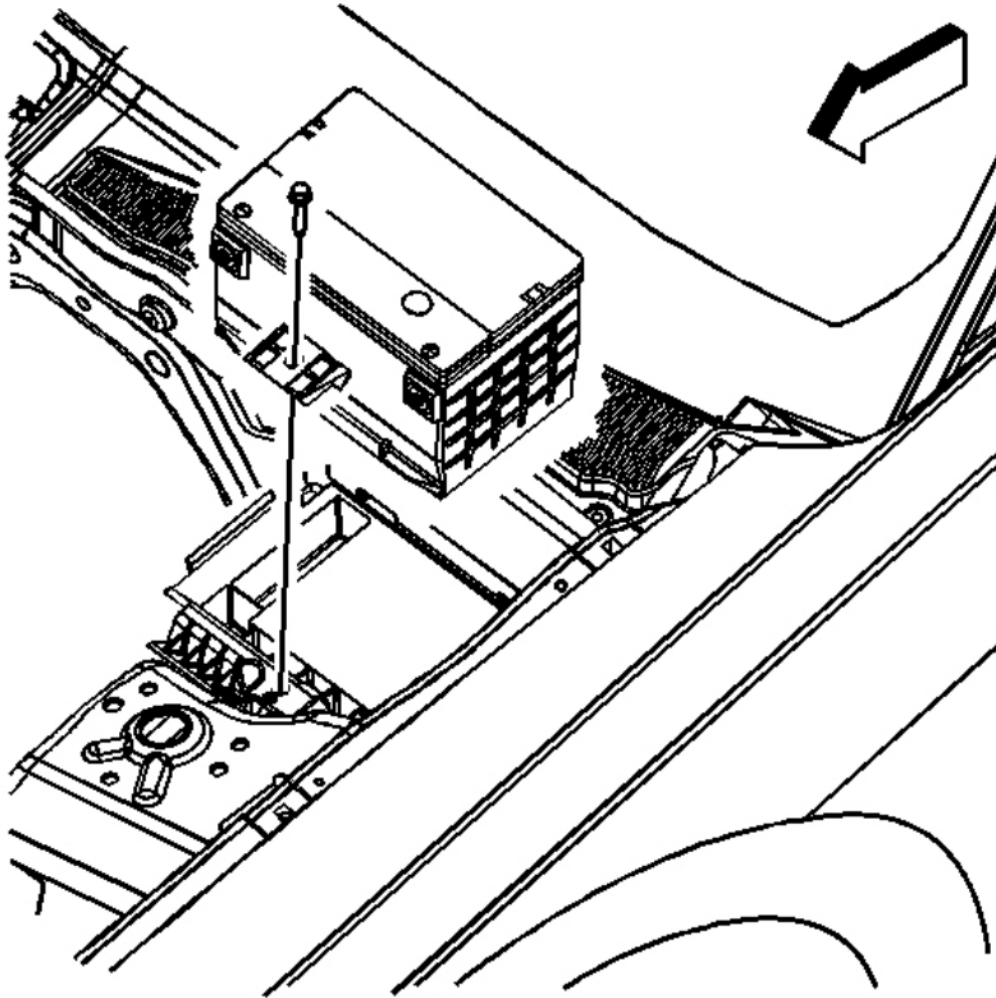


Fig. 36: Locating Battery Retainer & Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the battery retainer bolt and battery retainer.
4. Remove the battery from the vehicle.
5. Remove the battery heat shield. Refer to **Battery Heat Shield Replacement**.

Installation Procedure

1. Install the battery heat shield. Refer to Battery Heat Shield Replacement.

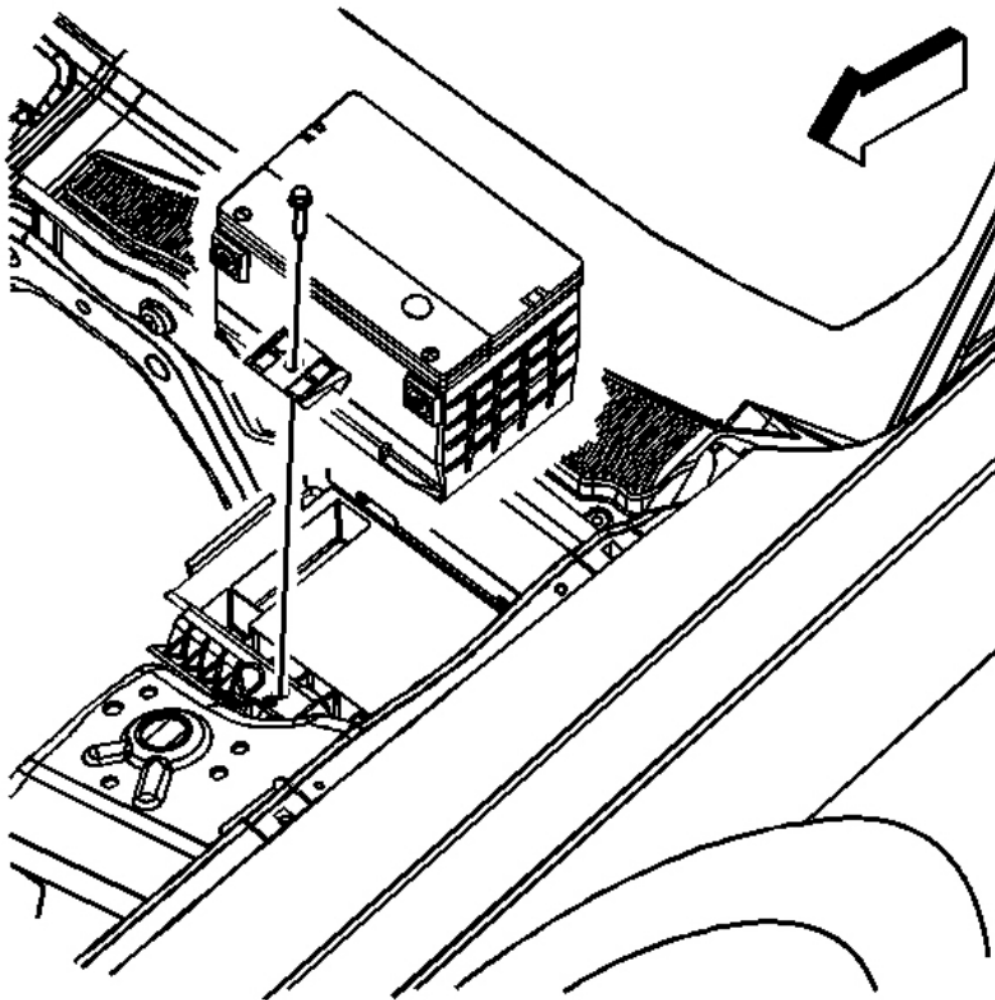


Fig. 37: Locating Battery Retainer & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Install the battery into the vehicle.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Install the battery retainer and bolt

Tighten: Tighten the battery retainer bolt to 25 N.m (18 lb ft).

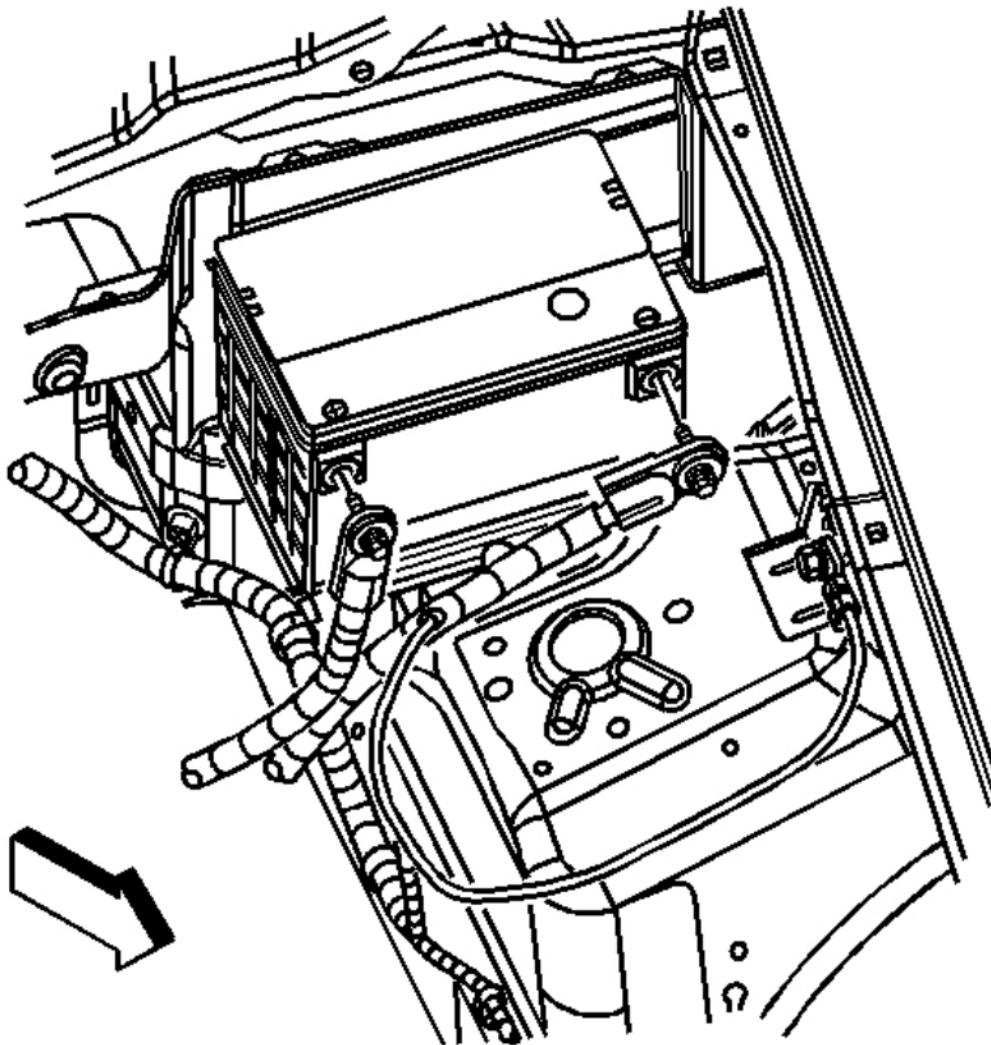


Fig. 38: View Of Battery Positive & Negative Cables
Courtesy of GENERAL MOTORS CORP.

4. Connect the battery positive cable to the battery.

Tighten: Tighten the battery cable bolt to 17 N.m (13 lb ft).

5. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.

BATTERY TRAY REPLACEMENT (LHD)**Removal Procedure**

1. Remove the battery. Refer to Battery Replacement (LHD) or Battery Replacement (RHD).
2. Remove the right air inlet grill panel only. Refer to Air Inlet Grille Panel Replacement (LHD) or Air Inlet Grille Panel Replacement (RHD) in Body Front End.

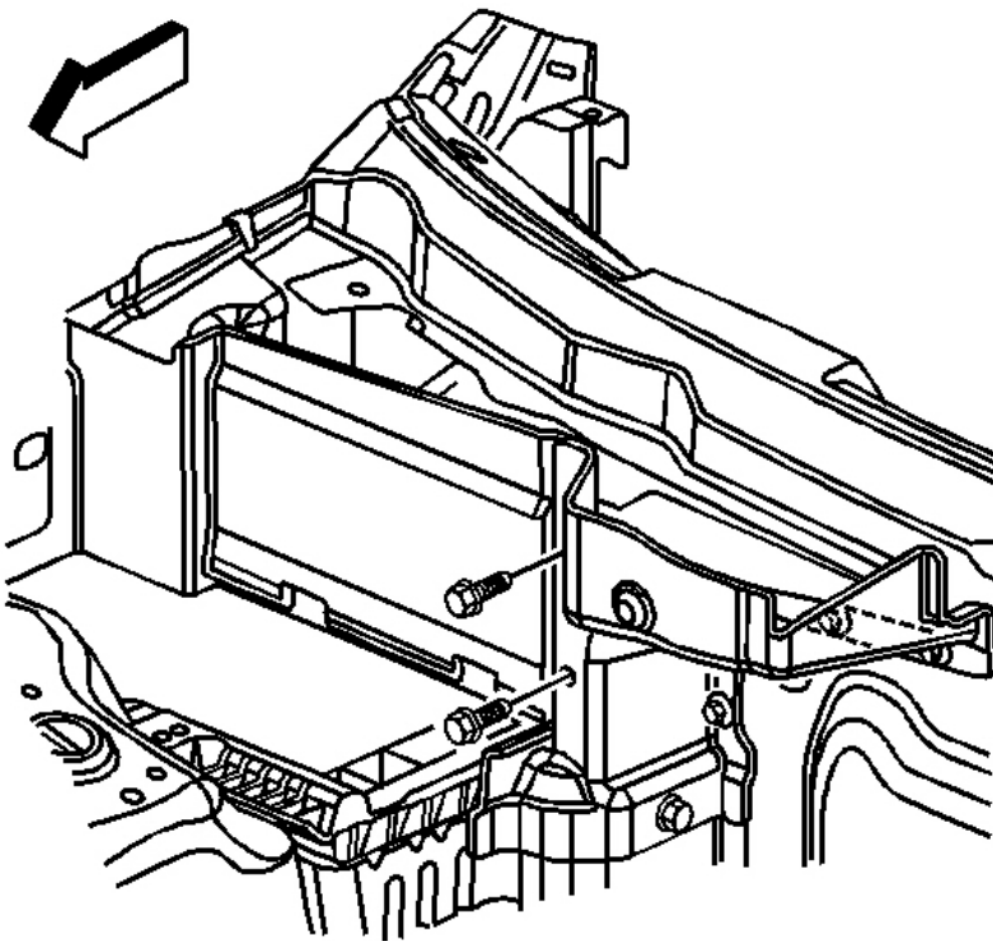


Fig. 39: Identifying Bolts To Front Air Inlet Panel Assembly To Battery Tray
Courtesy of GENERAL MOTORS CORP.

3. Remove the 2 bolts securing the front air inlet panel assembly to the battery tray.

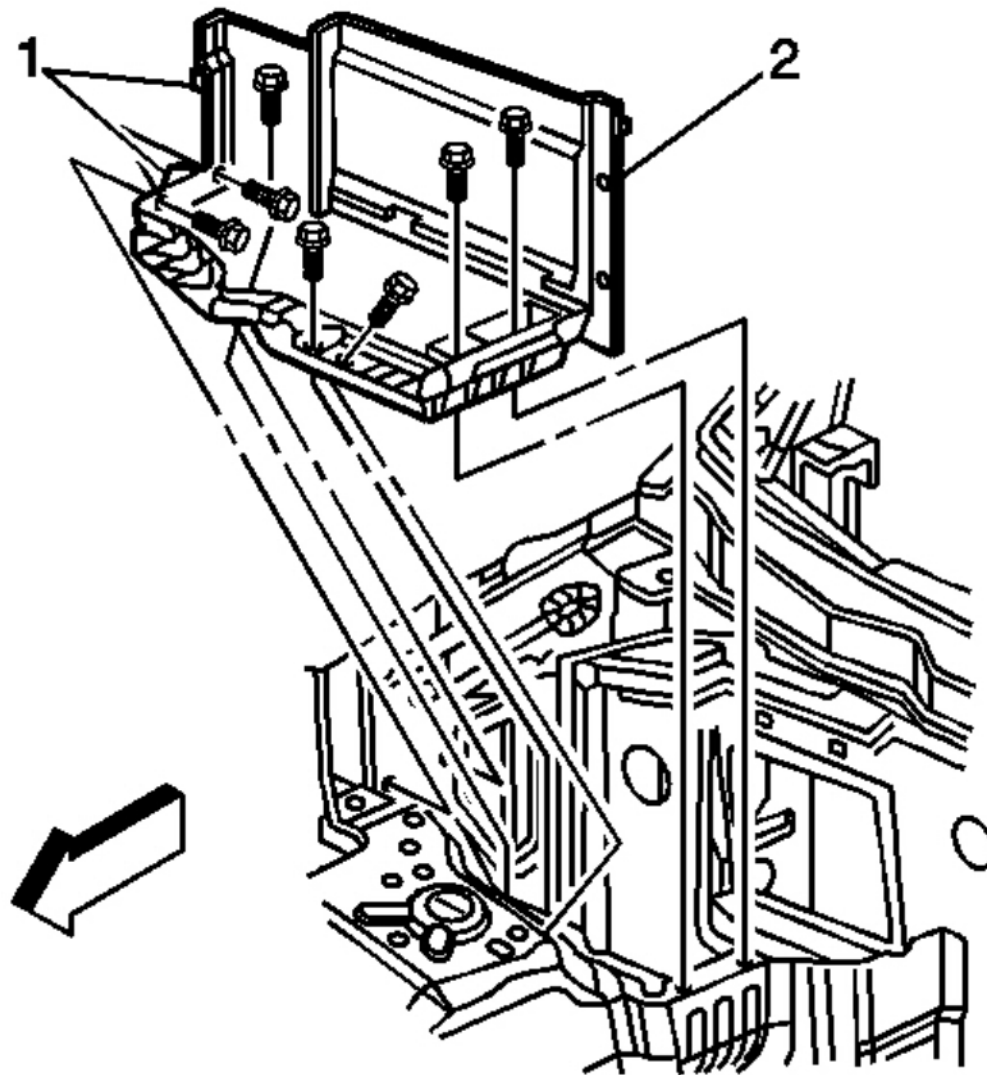


Fig. 40: View Of Battery Tray & Mounting Bolts
 Courtesy of GENERAL MOTORS CORP.

4. Remove the battery tray bolts from the following:
 - The inner fender panel
 - The shock tower
 - The lower air inlet panel assembly
5. Remove the battery tray (2) from the vehicle.

Installation Procedure

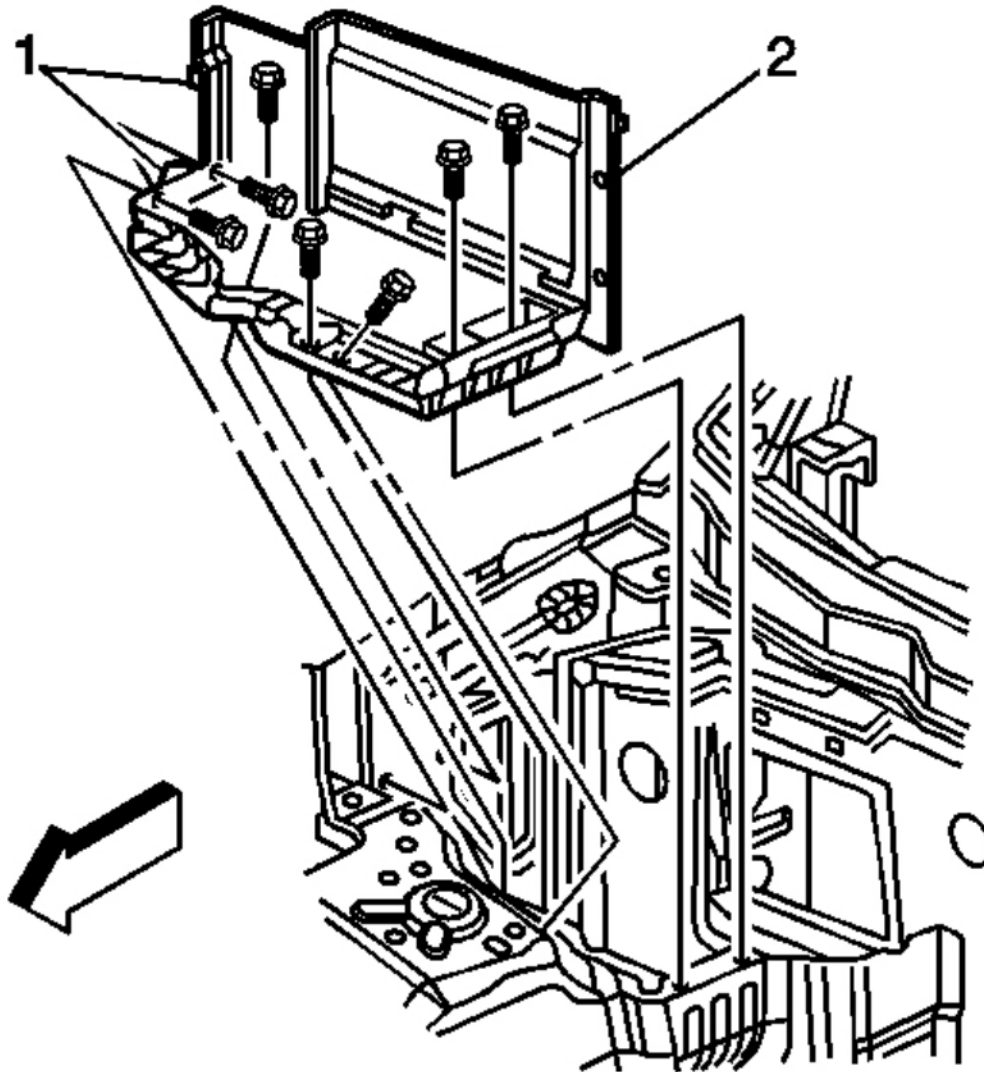


Fig. 41: View Of Battery Tray & Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices

1. Position the battery tray (2) to the vehicle, locating the alignment datums (1) with the holes in the inner fender.

2. Install the battery tray bolts to the following:

- The inner fender panel
- The shock tower
- The lower air inlet panel assembly

Tighten: Tighten the battery tray bolts to 6 N.m (53 lb in).

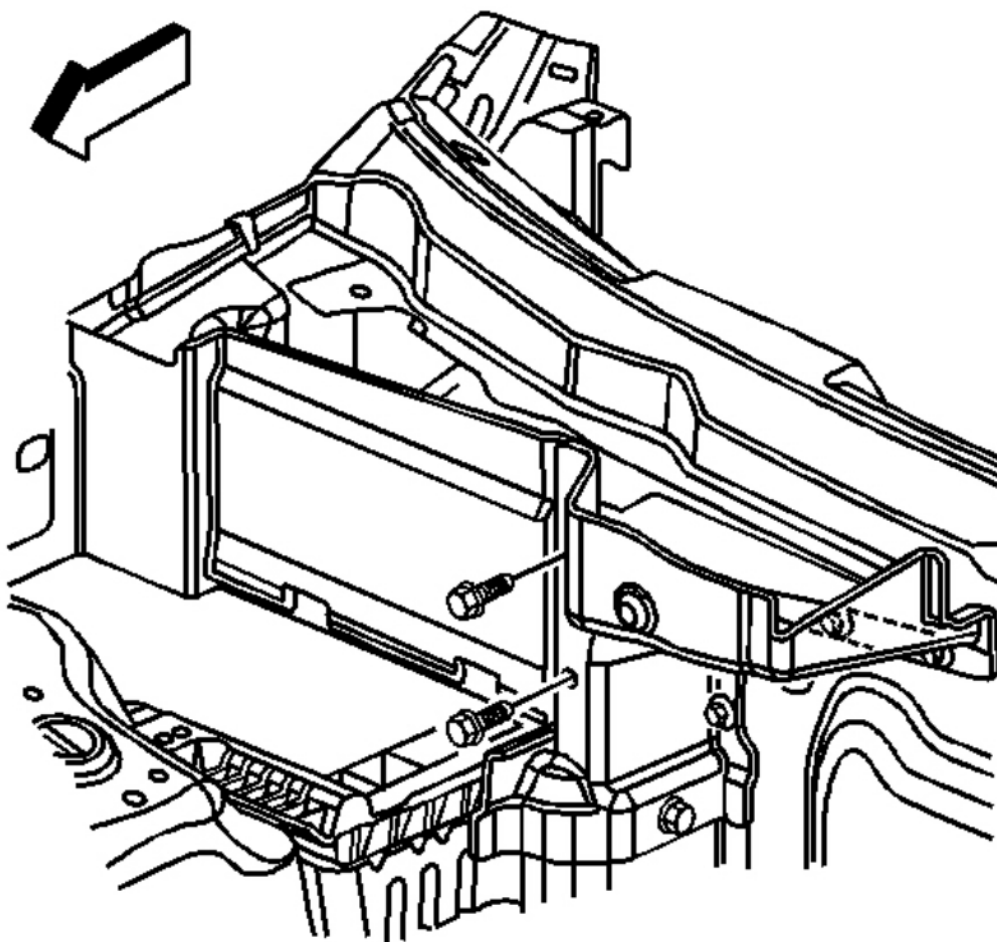


Fig. 42: Identifying Bolts To Front Air Inlet Panel Assembly To Battery Tray
Courtesy of GENERAL MOTORS CORP.

3. Install the 2 bolts securing the front air inlet panel assembly to the battery tray.

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Tighten: Tighten the front air inlet panel assembly bolts to 6 N.m (53 lb in).

4. Install the right air inlet grill panel. Refer to [Air Inlet Grille Panel Replacement \(LHD\)](#) or [Air Inlet Grille Panel Replacement \(RHD\)](#) in Body Front End.
5. Install the battery. Refer to [Battery Replacement \(LHD\)](#) or [Battery Replacement \(RHD\)](#).

BATTERY TRAY REPLACEMENT (RHD)

Removal Procedure

1. Remove the battery. Refer to [Battery Replacement \(LHD\)](#) or [Battery Replacement \(RHD\)](#).
2. Remove the left air inlet grill panel only. Refer to [Air Inlet Grille Panel Replacement \(LHD\)](#) or [Air Inlet Grille Panel Replacement \(RHD\)](#) in Body Front End.

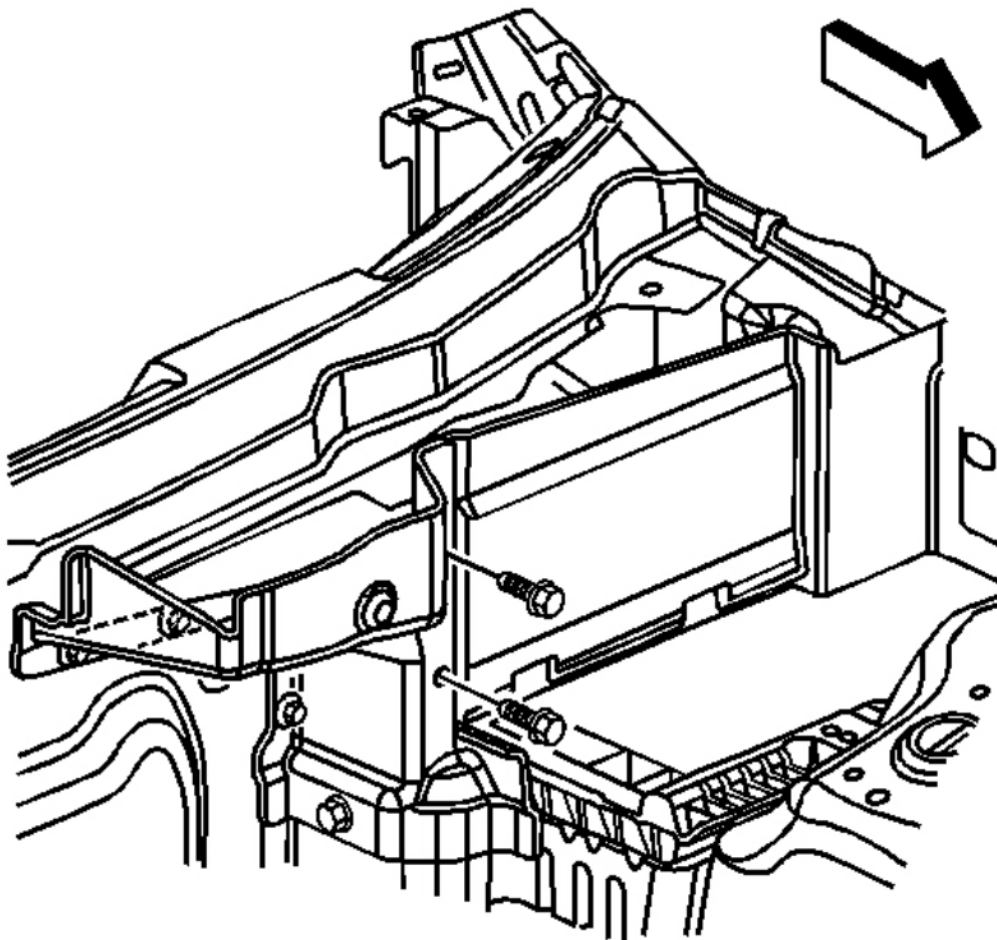


Fig. 43: Identifying Front Air Inlet Panel Assembly To Battery Tray Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the 2 bolts securing the front air inlet panel assembly to the battery tray.

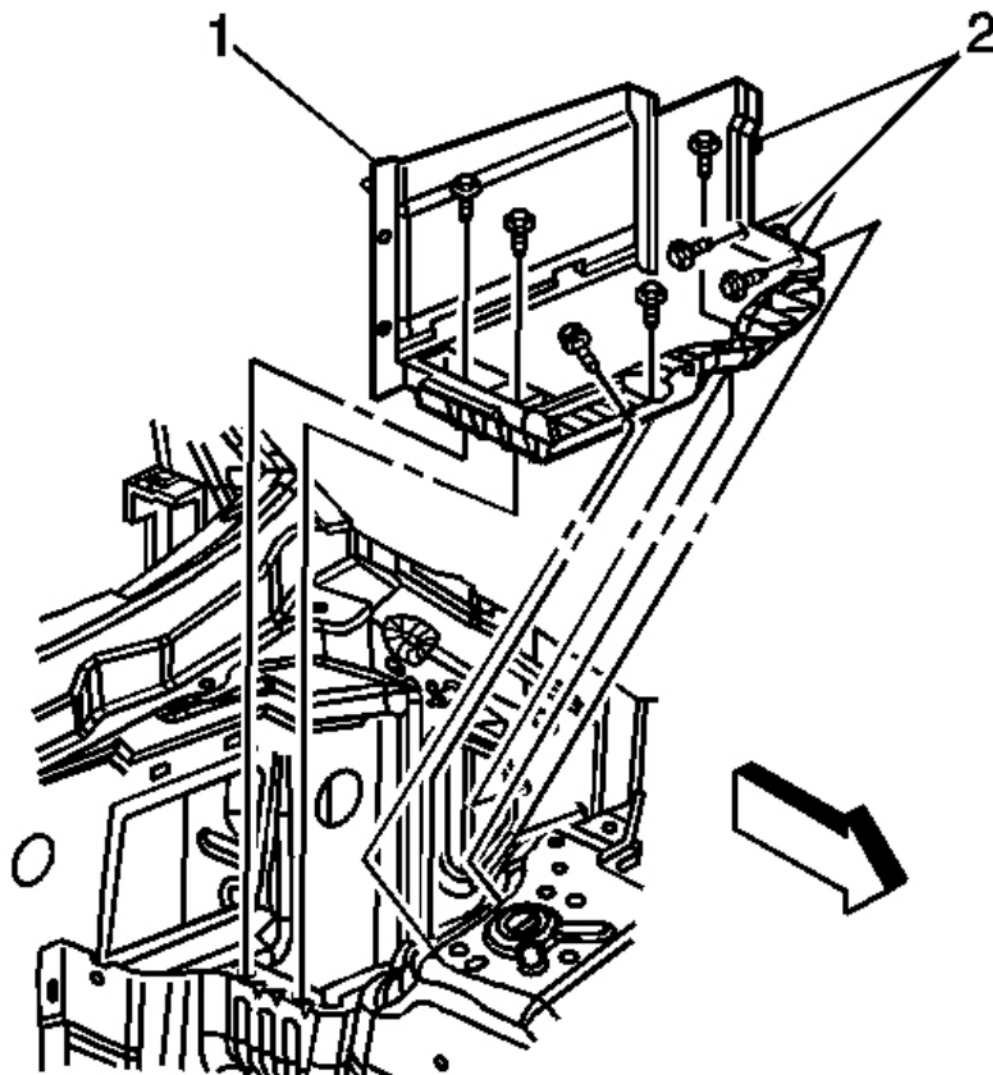


Fig. 44: View Of Battery Tray & Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the battery tray bolts from the following:
 - The inner fender panel
 - The shock tower
 - The lower air inlet panel assembly
5. Remove the battery tray (1) from the vehicle.

Installation Procedure

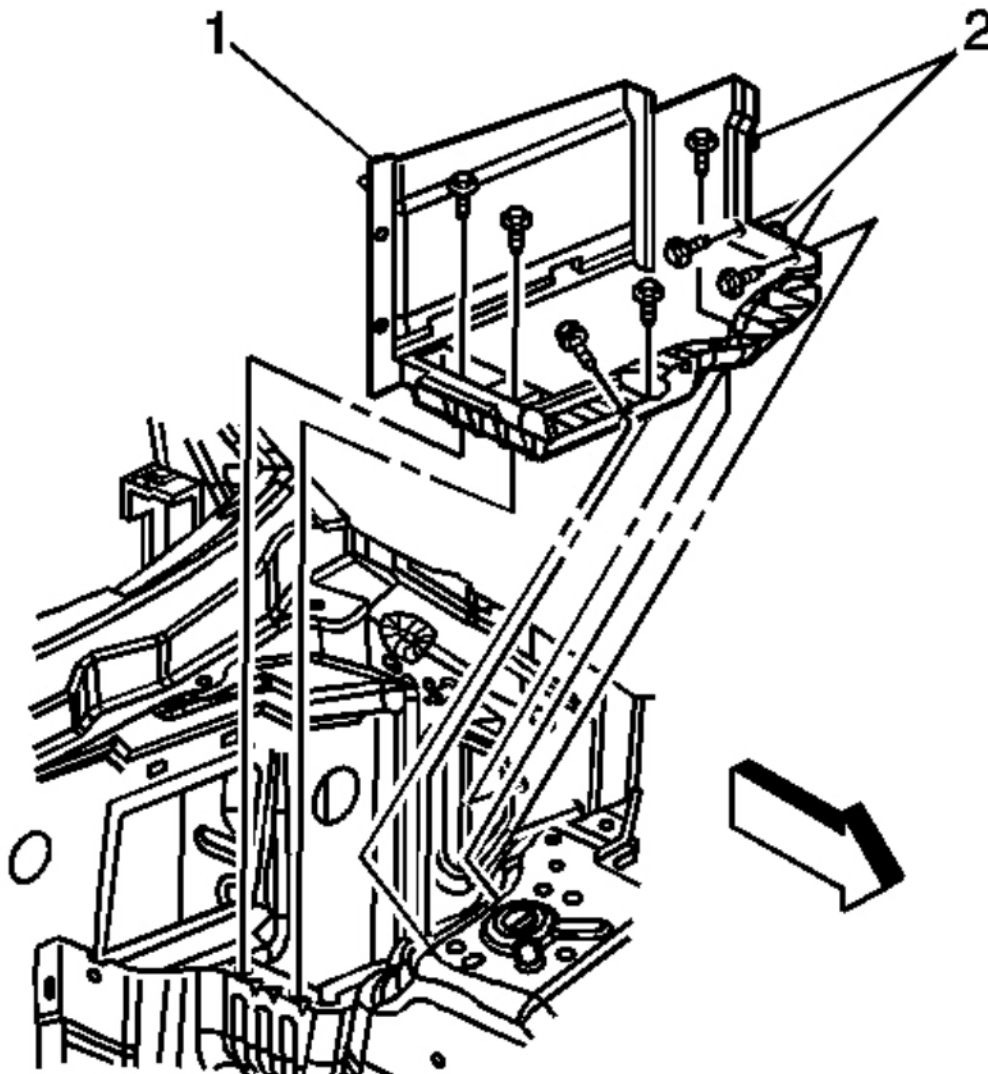


Fig. 45: View Of Battery Tray & Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice in Cautions and Notices

1. Position the battery tray (1) to the vehicle, locating the alignment datums (2) with the holes in the inner fender.

2. Install the battery tray bolts to the following:

- The inner fender panel
- The shock tower
- The lower air inlet panel assembly

Tighten: Tighten the battery tray bolts to 6 N.m (53 lb in).

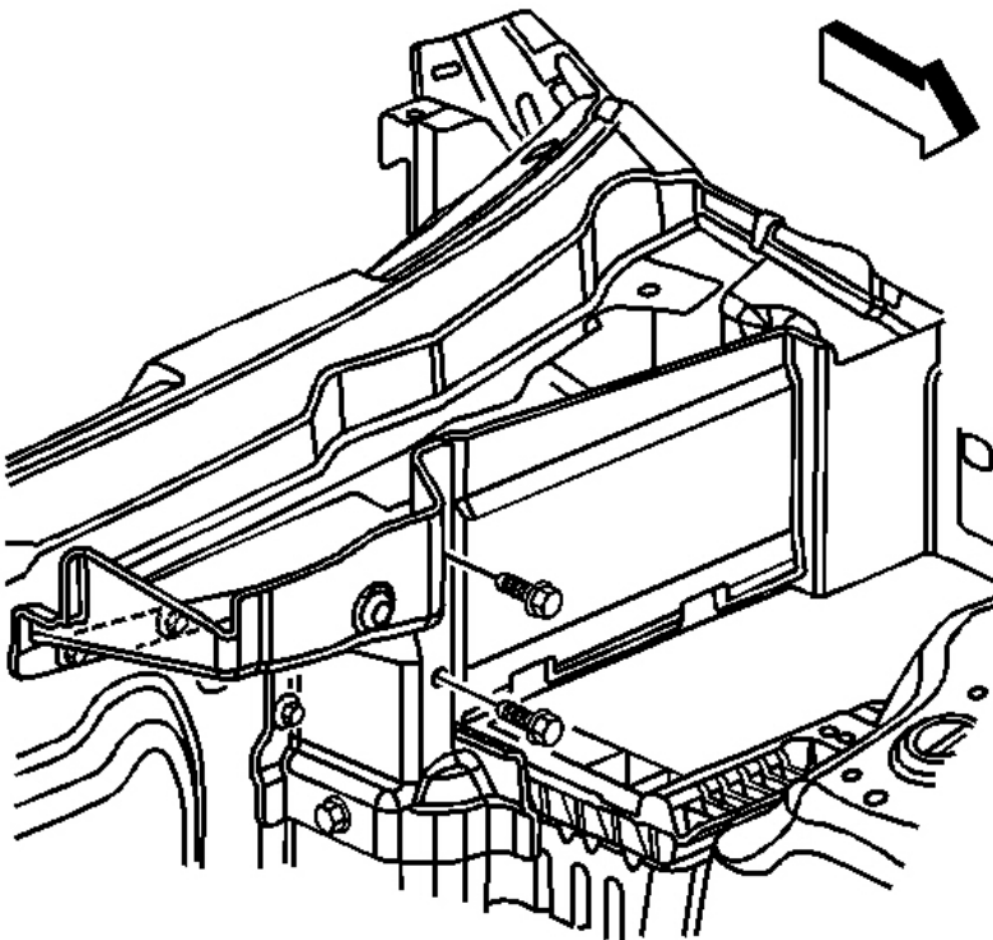


Fig. 46: Identifying Front Air Inlet Panel Assembly To Battery Tray Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the 2 bolts securing the front air inlet panel assembly to the battery tray.

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Tighten: Tighten the front air inlet panel assembly bolts to 6 N.m (53 lb in).

4. Install the left air inlet grill panel. Refer to **Air Inlet Grille Panel Replacement (LHD)** or **Air Inlet Grille Panel Replacement (RHD)** in Body Front End.
5. Install the battery. Refer to **Battery Replacement (LHD)** or **Battery Replacement (RHD)**.

BATTERY HEAT SHIELD REPLACEMENT

Removal Procedure

1. Remove the battery. Refer to **Battery Replacement (LHD)** or **Battery Replacement (RHD)**.

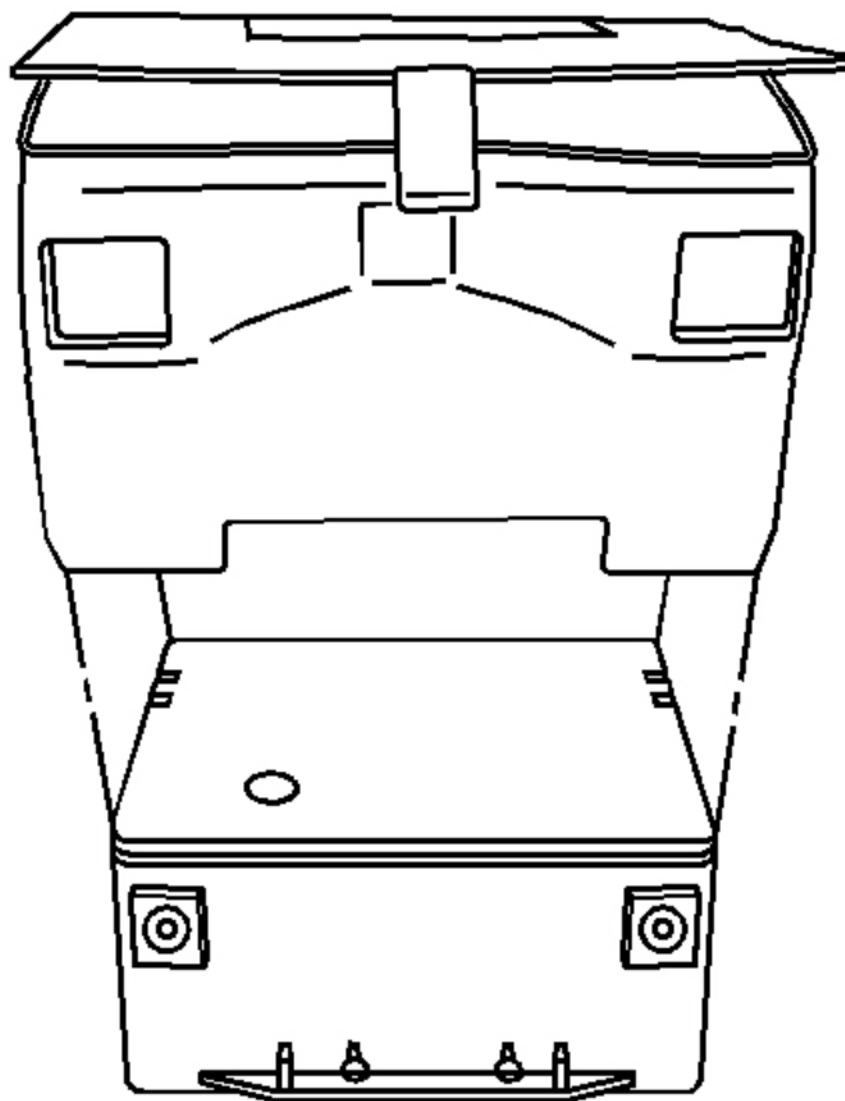


Fig. 47: Aligning Battery Heat Shield Downward
Courtesy of GENERAL MOTORS CORP.

2. Lift the battery heat shield upward from the battery.

Installation Procedure

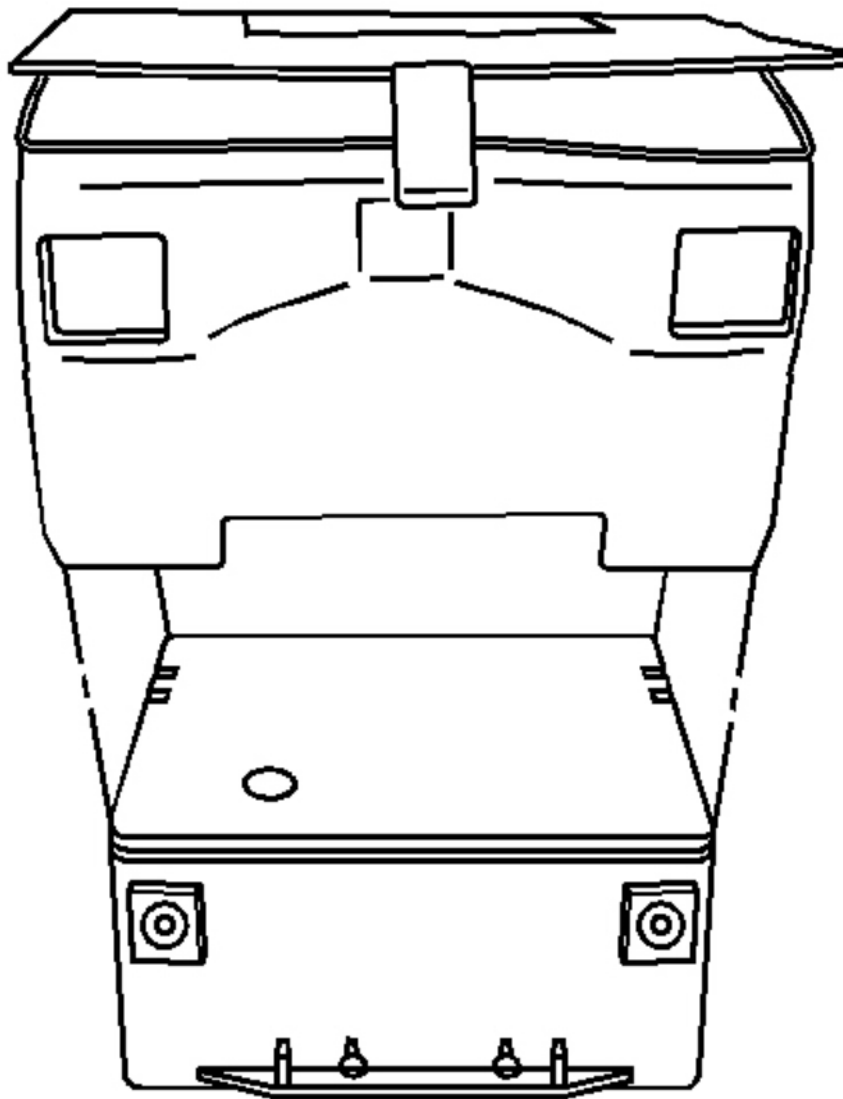


Fig. 48: Aligning Battery Heat Shield Downward
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure the openings in the heat shield are aligned with the battery terminal bosses.

1. Position the battery heat shield downward over the battery.

2. Install the battery. Refer to Battery Replacement (LHD) or Battery Replacement (RHD).

STARTER MOTOR REPLACEMENT (LP1, LY7)

Removal Procedure

1. Turn the ignition OFF.
2. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnect/Connect Procedure.
3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle in General Information.

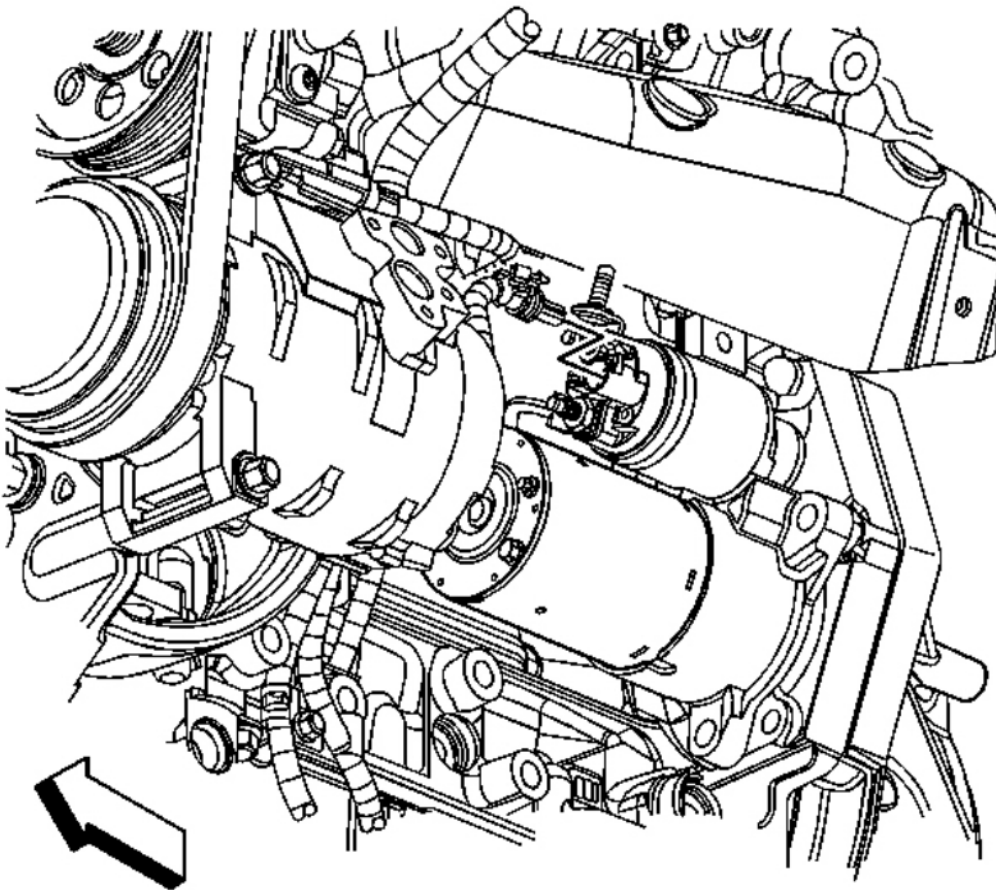


Fig. 49: View Of Starter Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the starter solenoid electrical connector from the starter.

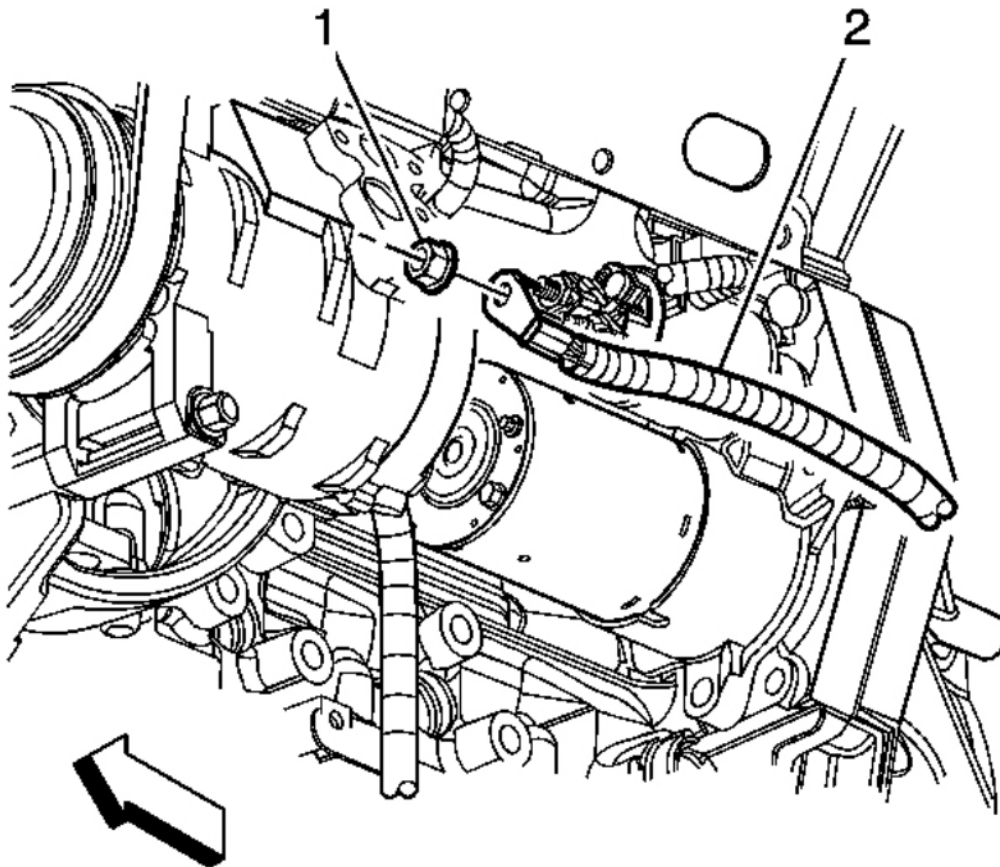


Fig. 50: View Of Starter Terminal Nut & Battery Positive Cable
Courtesy of GENERAL MOTORS CORP.

5. Remove the starter terminal nut (1) and the battery positive cable (2) from the starter.

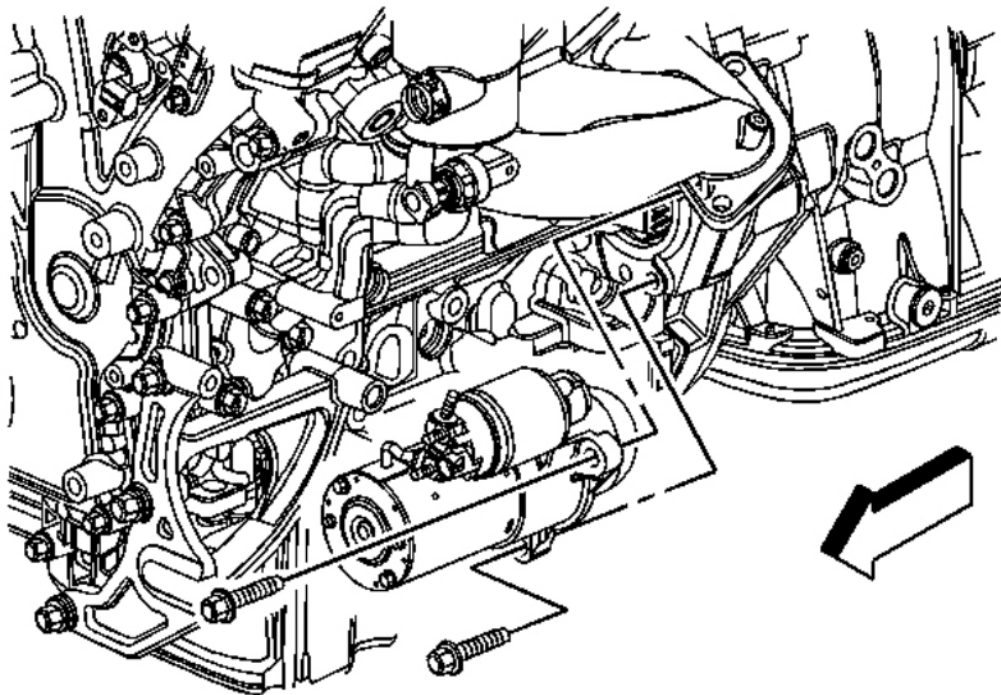


Fig. 51: View Of Starter Motor - LY7
Courtesy of GENERAL MOTORS CORP.

6. Remove the starter motor bolts.
7. Remove the starter motor.

Installation Procedure

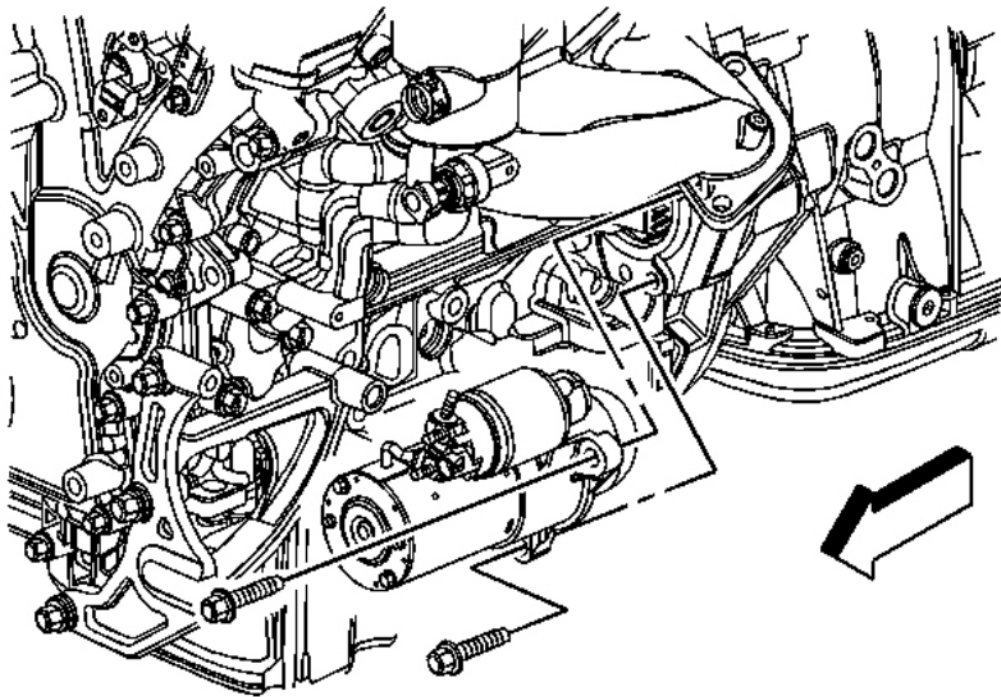


Fig. 52: View Of Starter Motor - LY7
Courtesy of GENERAL MOTORS CORP.

1. Install the starter motor.

NOTE: Refer to Fastener Notice in Cautions and Notices.

2. Install the starter motor bolts

Tighten: Tighten the bolts to 50 N.m (37 lb ft).

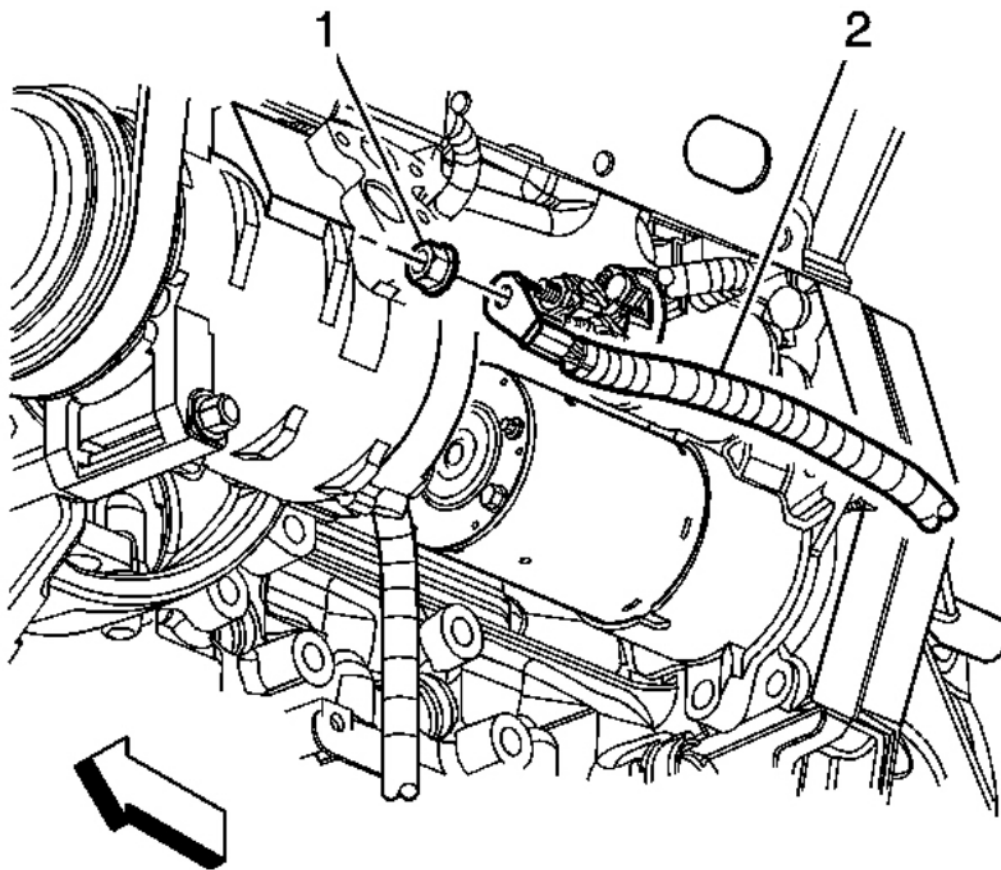


Fig. 53: View Of Starter Terminal Nut & Battery Positive Cable
Courtesy of GENERAL MOTORS CORP.

3. Install the battery positive cable (2) to the starter and install the starter terminal nut (1).

Tighten: Tighten the nut to 13 N.m (115 lb in).

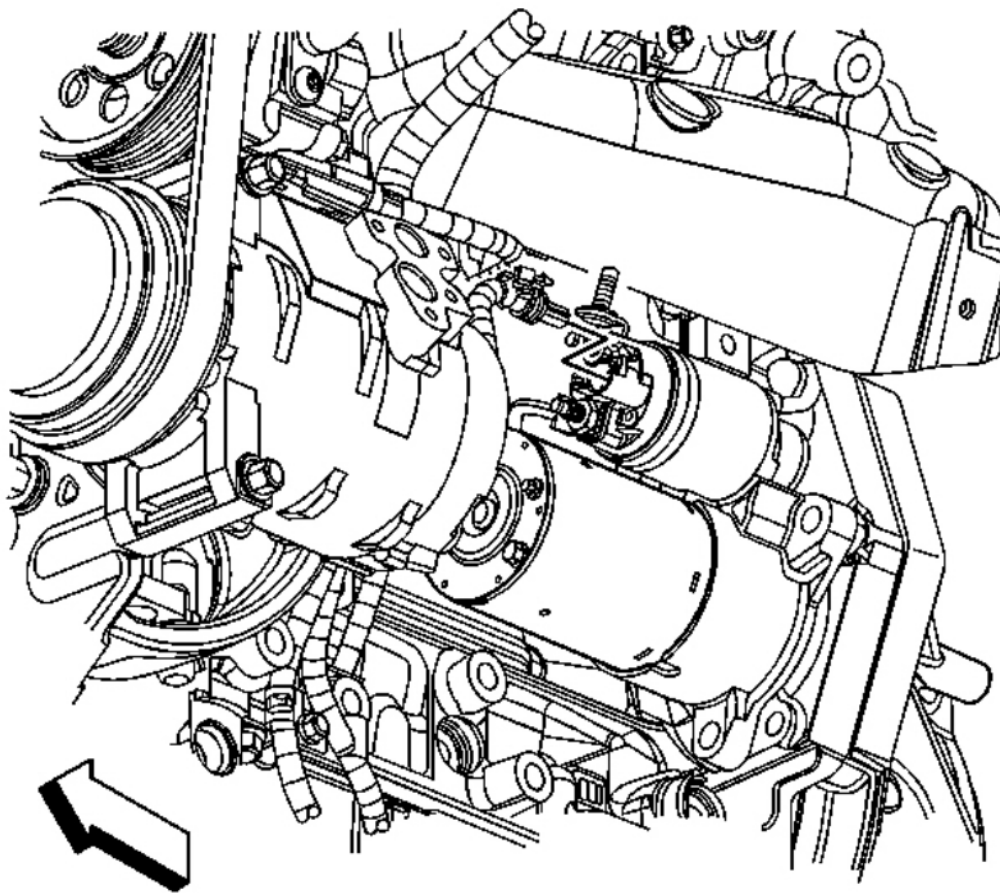


Fig. 54: View Of Starter Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Connect the electrical connector to the starter solenoid.
5. Lower the vehicle.

STARTER SHIELD REPLACEMENT (LP1, LY7)

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
2. Remove the right catalytic converter. Refer to **Catalytic Converter Replacement - Right (LP1, LY7)** in Engine Exhaust.

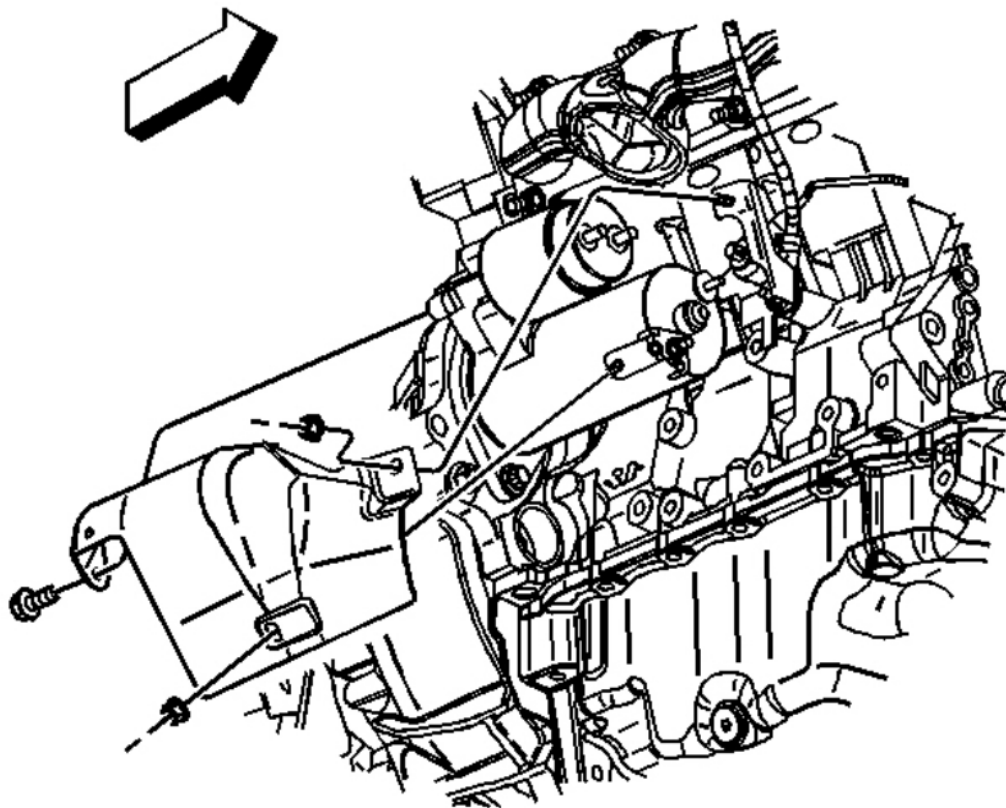


Fig. 55: Aligning Starter Heat Shield To Starter Motor & Brackets
Courtesy of GENERAL MOTORS CORP.

3. Remove the fasteners securing the starter heat shield to the starter.
4. Remove the starter heat shield.

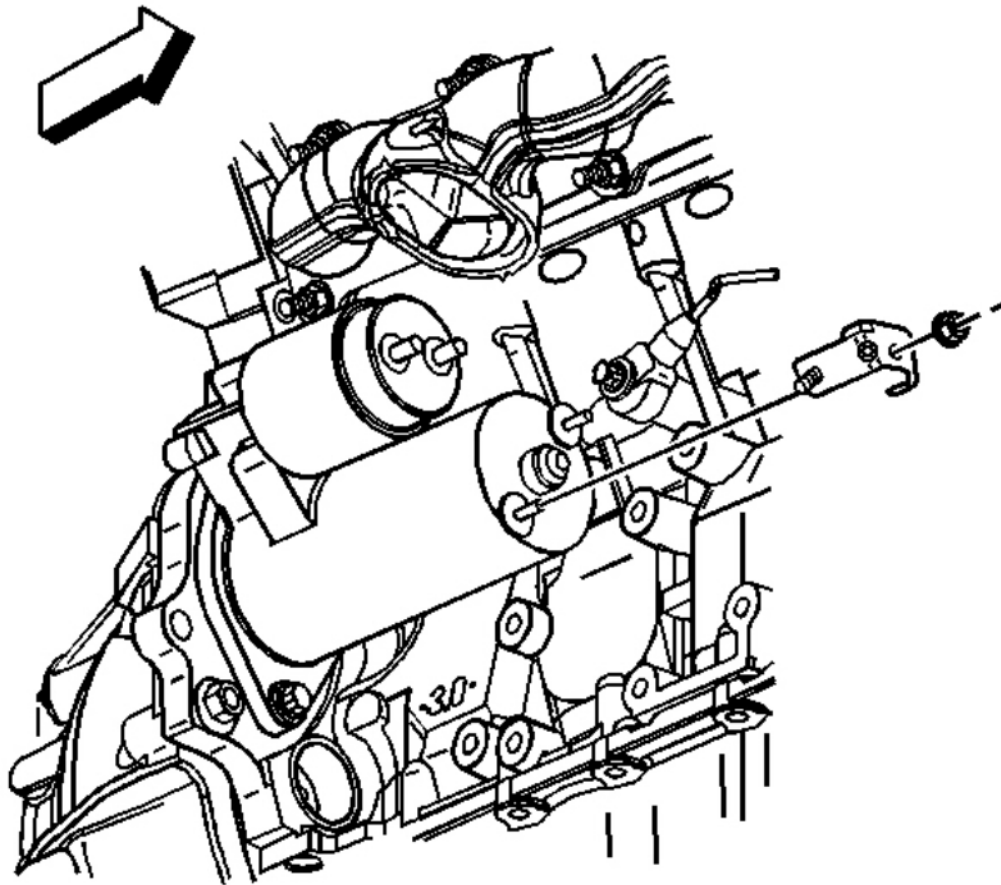


Fig. 56: View Of Starter Heat Shield Mounting Bracket Retaining Nut
Courtesy of GENERAL MOTORS CORP.

5. Remove the nut securing the starter heat shield bracket to the starter.
6. Remove the starter heat shield bracket.

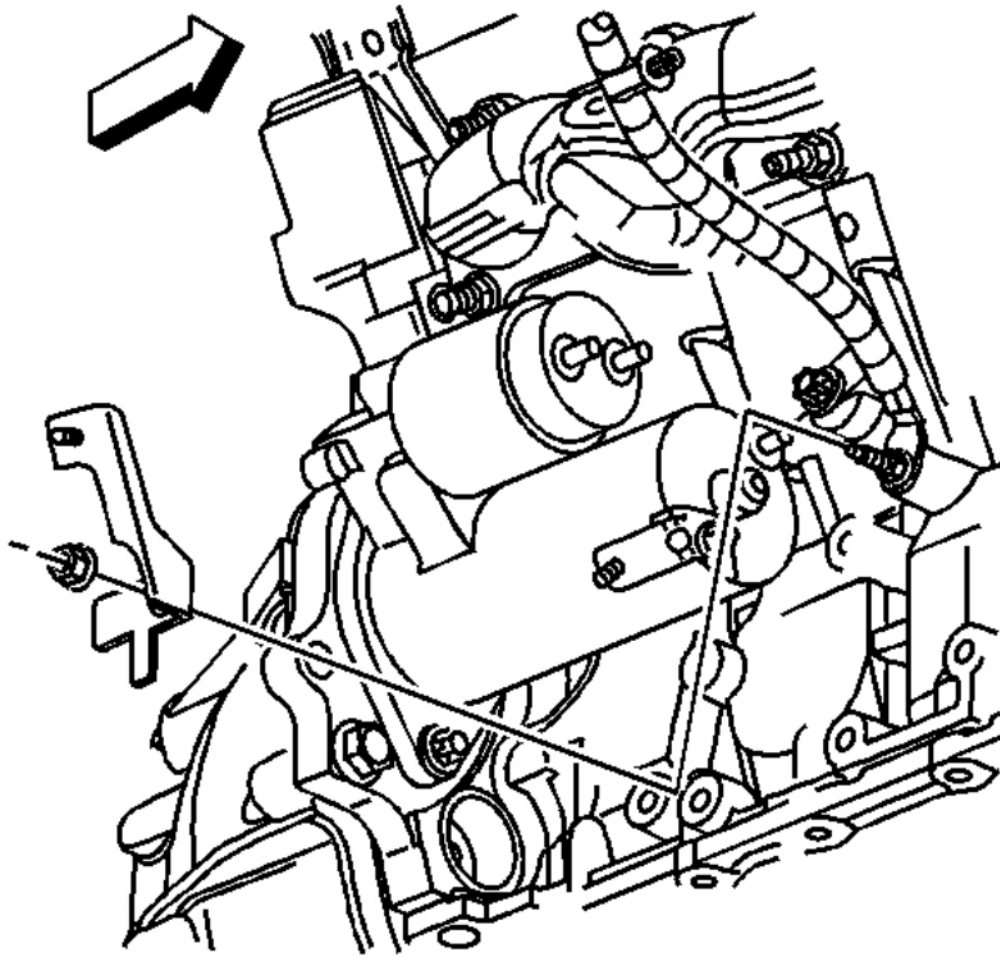


Fig. 57: Locating Starter Heat Shield Mounting Bracket To Engine Block Retaining Nut
Courtesy of GENERAL MOTORS CORP.

7. Remove the nut securing the starter heat shield bracket to the engine block.
8. Remove the starter heat shield bracket.

Installation Procedure

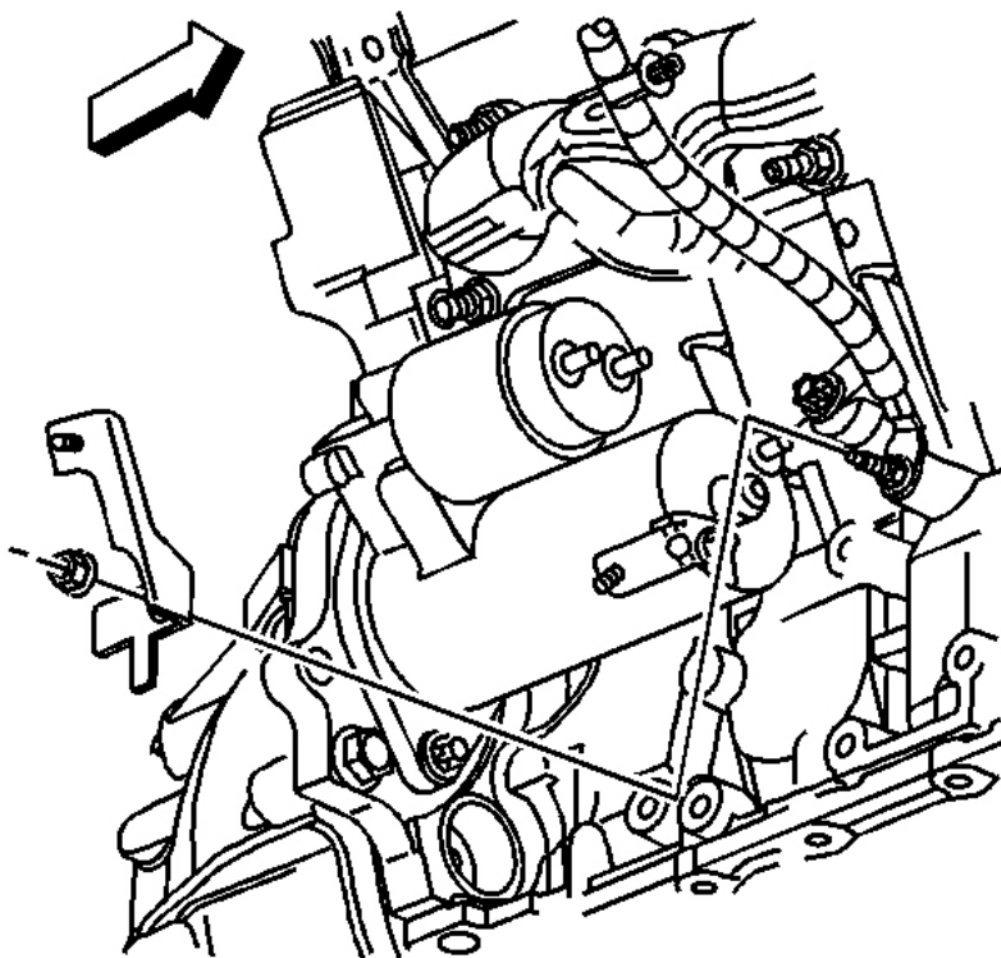


Fig. 58: Locating Starter Heat Shield Mounting Bracket To Engine Block Retaining Nut
Courtesy of GENERAL MOTORS CORP.

1. Install the starter heat shield bracket to the stud located at the engine block.

NOTE: Refer to Fastener Notice in Cautions and Notices.

2. Install the nut securing the starter heat shield bracket to the engine block.

Tighten: Tighten the nut to 8 N.m (71 lb in).

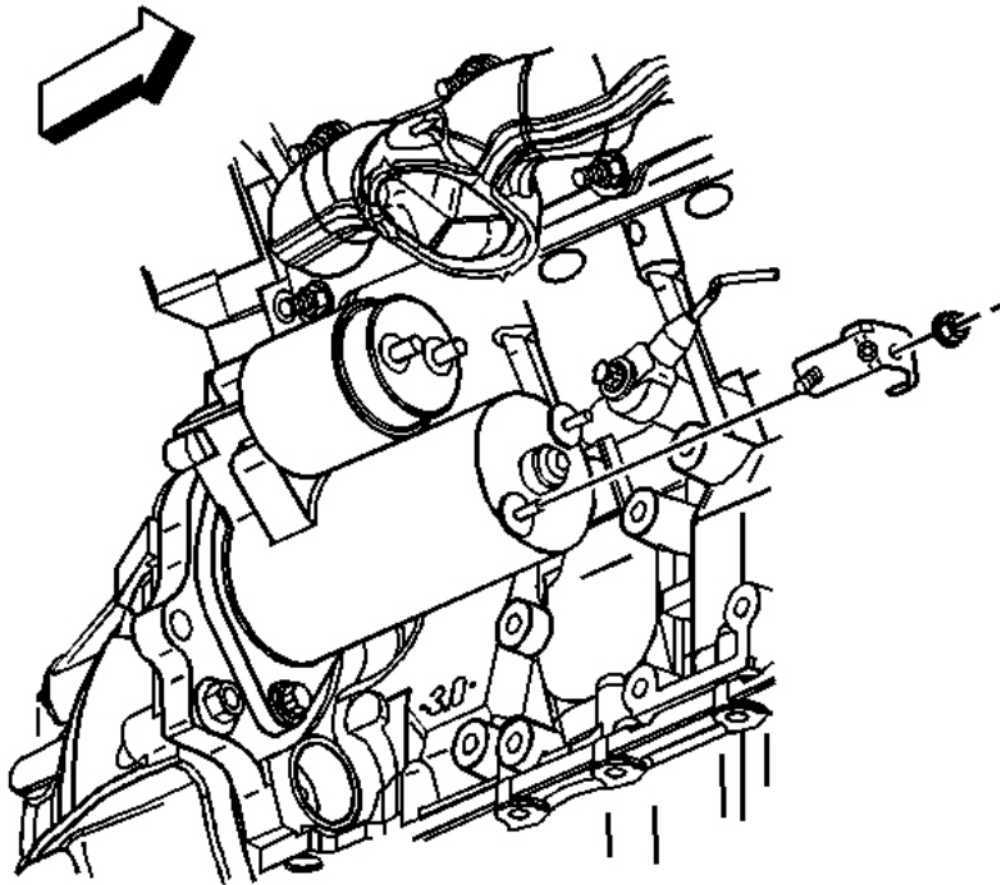


Fig. 59: View Of Starter Heat Shield Mounting Bracket Retaining Nut
Courtesy of GENERAL MOTORS CORP.

3. Install the starter heat shield bracket to the stud located at the rear of the starter motor.
4. Install the nut securing the starter heat shield bracket to the starter.

Tighten: Tighten the nut to 8 N.m (71 lb in).

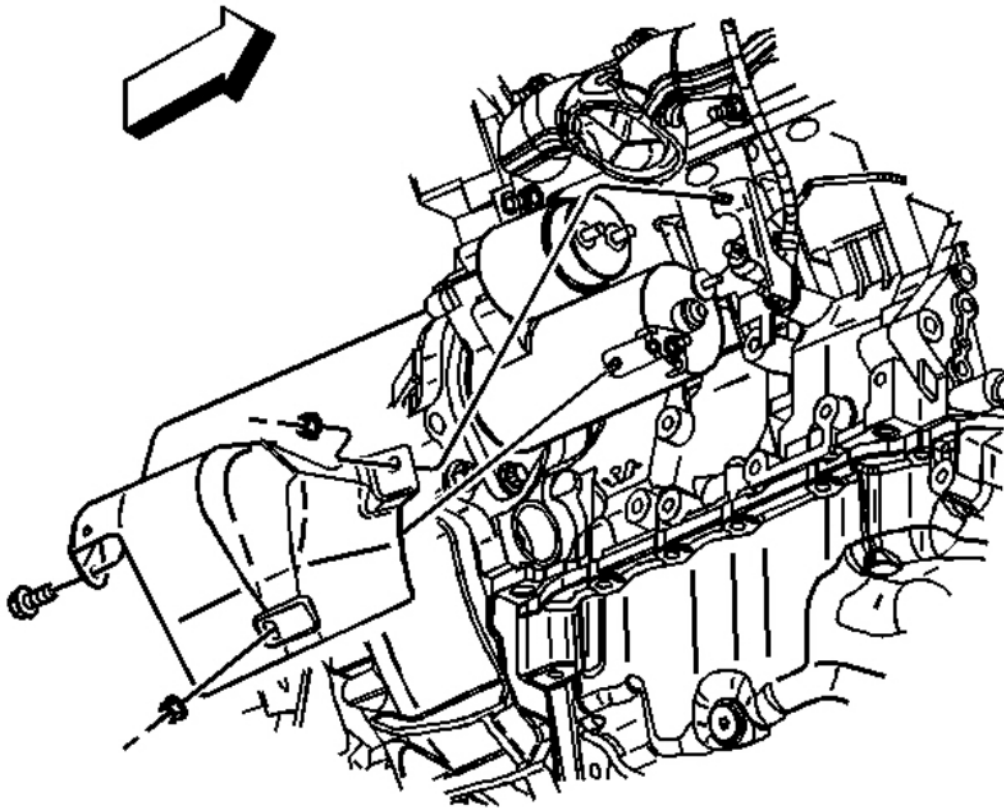


Fig. 60: Aligning Starter Heat Shield To Starter Motor & Brackets
 Courtesy of GENERAL MOTORS CORP.

5. Position the starter heat shield to the starter motor and brackets.
6. Install the bolt/nuts securing the starter heat shield to the starter motor and brackets.

Tighten: Tighten the bolt/nuts to 8 N.m (71 lb in).

7. Install the right catalytic converter. Refer to **Catalytic Converter Replacement - Right (LP1, LY7)** in Engine Exhaust.
8. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.

GENERATOR BRACKET REPLACEMENT (LP1, LY7)

Removal Procedure

1. Turn the ignition OFF.

2. Remove the generator. Refer to **Generator Replacement (LP1, LY7)**.
3. Remove the coolant inlet pipe lower bolt from the generator bracket.
4. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement - Generator and Water Pump** in Engine Mechanical - 2.8L1 (LP1), or **Drive Belt Tensioner Replacement - Generator and Water Pump** in Engine Mechanical - 3.6L (LY7).

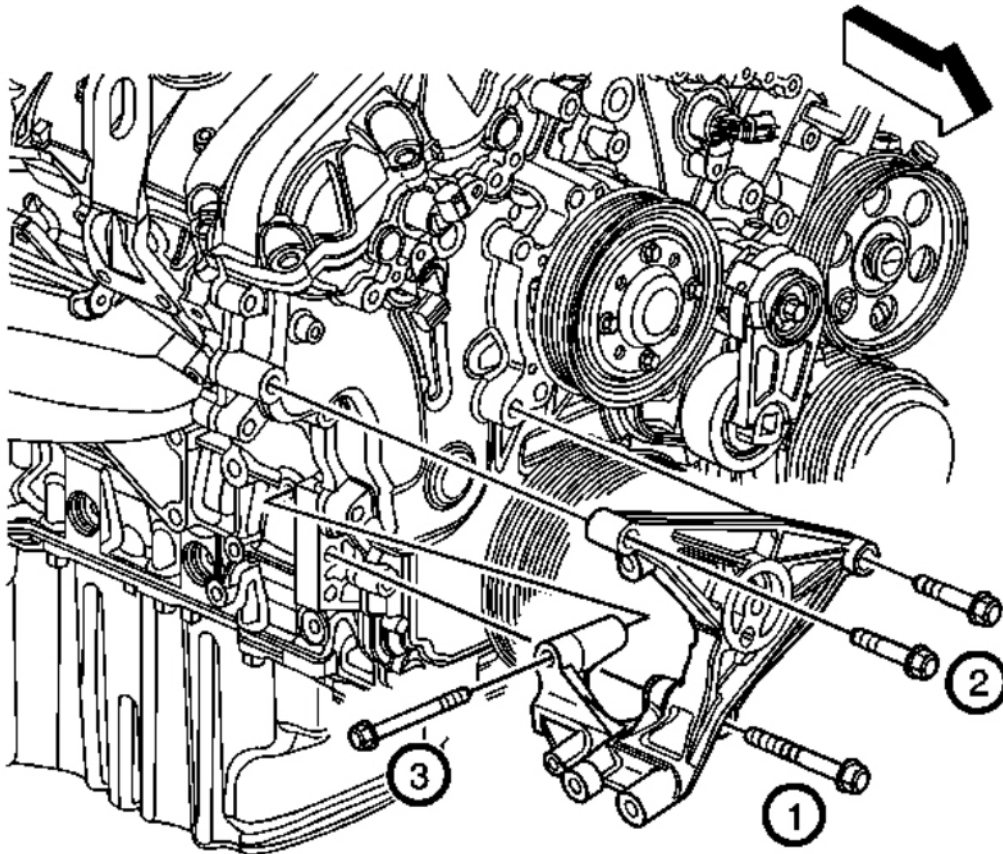


Fig. 61: View Of Generator Bracket Bolts - LY7
Courtesy of GENERAL MOTORS CORP.

5. Remove the generator bracket bolts.
6. Remove the generator bracket.

Installation Procedure

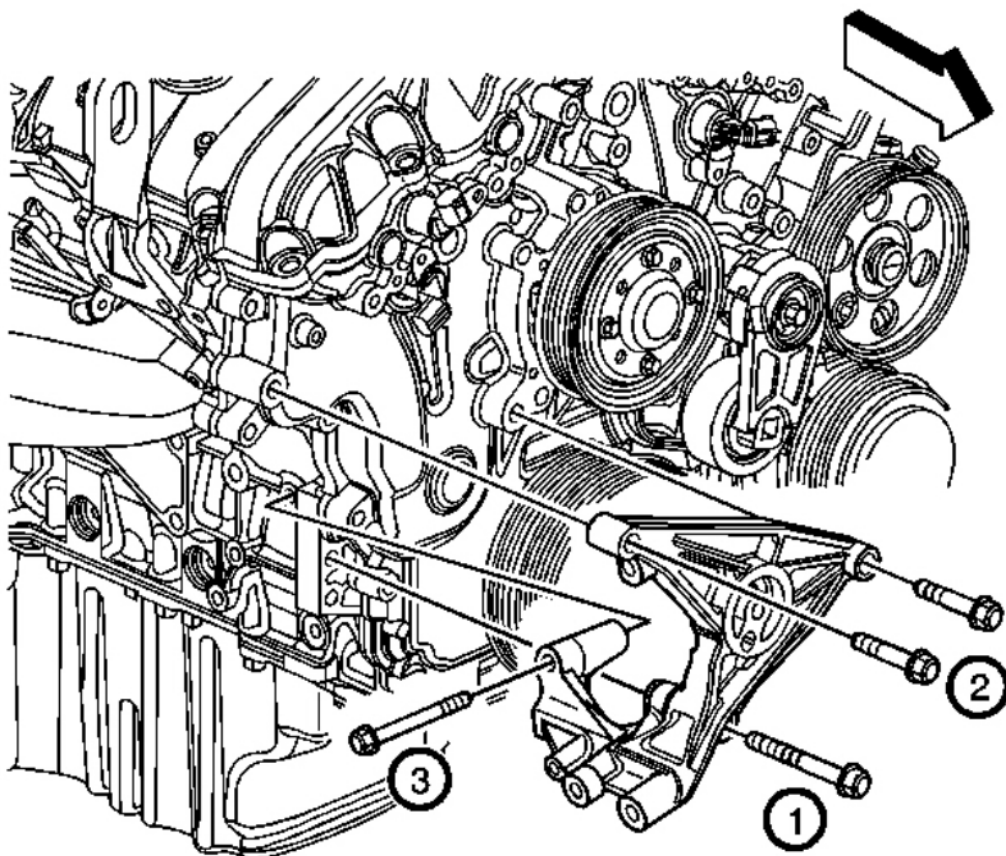


Fig. 62: View Of Generator Bracket Bolts - LY7
Courtesy of GENERAL MOTORS CORP.

1. Install the generator bracket.

NOTE: Refer to Fastener Notice in Cautions and Notices.

2. Install the generator bracket bolts.

Tighten: Tighten the generator bracket bolts in the sequence shown.

1. Tighten the generator bracket bolts (1) to 50 N.m (37 lb in).
 2. Tighten the generator bracket bolts (2) to 50 N.m (37 lb in).
 3. Tighten the generator bracket bolt (3) to 23 N.m (17 lb in).
3. Install the belt tensioner. Refer to Drive Belt Tensioner Replacement - Generator and Water Pump in

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Engine Mechanical - 2.8L (LP1), or **Drive Belt Tensioner Replacement - Generator and Water Pump** in Engine Mechanical - 3.6L (LY7).

4. Install the coolant inlet pipe lower bolt from the generator bracket.
5. Install the generator. Refer to **Generator Replacement (LP1, LY7)**.

GENERATOR REPLACEMENT (LP1, LY7)

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
2. Remove the drive belt from the generator. Refer to **Drive Belt Replacement - Generator and Water Pump** in Engine Mechanical - 2.8L (LP1), or **Drive Belt Replacement - Generator and Water Pump** in Engine Mechanical - 3.6L (LY7).
3. Install the engine support fixture. Refer to **Engine Support Fixture** in Engine Mechanical - 2.8L (LP1), or **Engine Support Fixture** in Engine Mechanical - 3.6L (LY7).
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

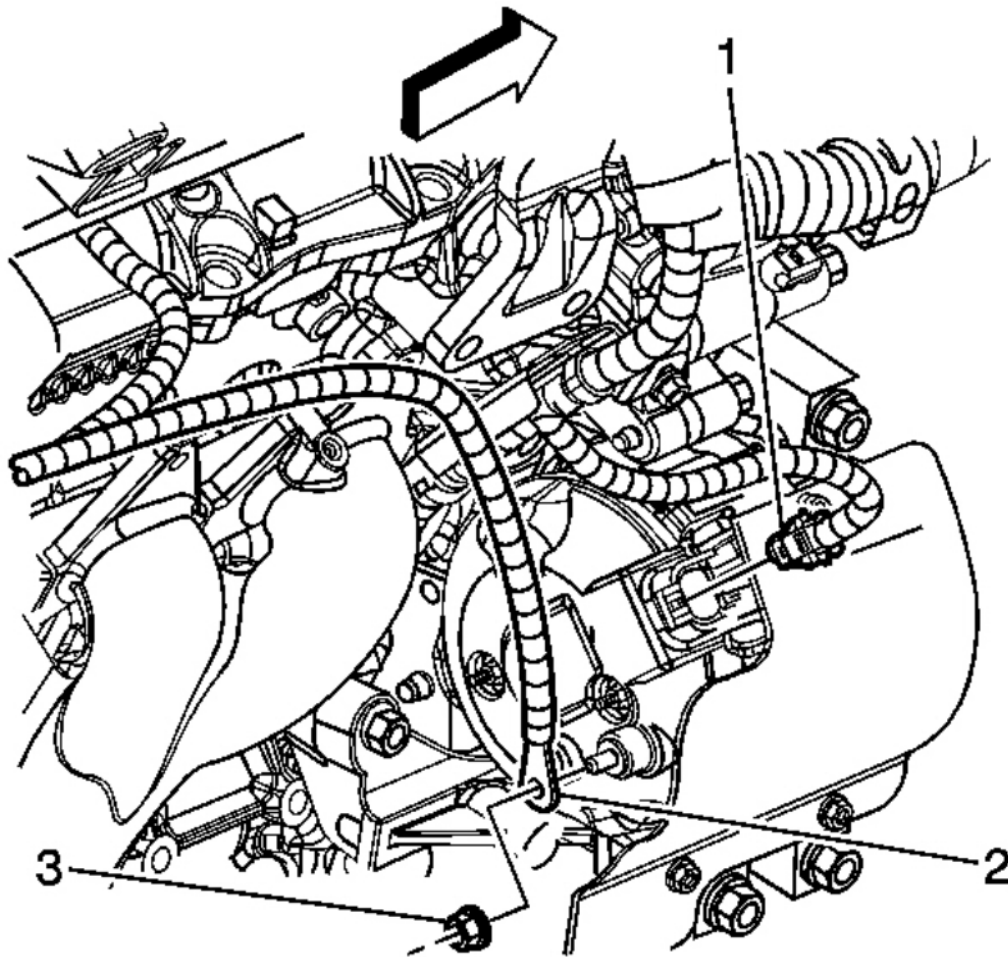


Fig. 63: View Of Battery Positive Lead & Generator BAT Terminal Nut
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the electrical connector (1) from the generator.
6. Reposition the protective boot from the generator output BAT terminal for access.
7. Remove the generator output BAT terminal nut (3) and remove the battery positive lead (2) from the generator.
8. Disconnect the electronic brake control module (EBCM) electrical connector.

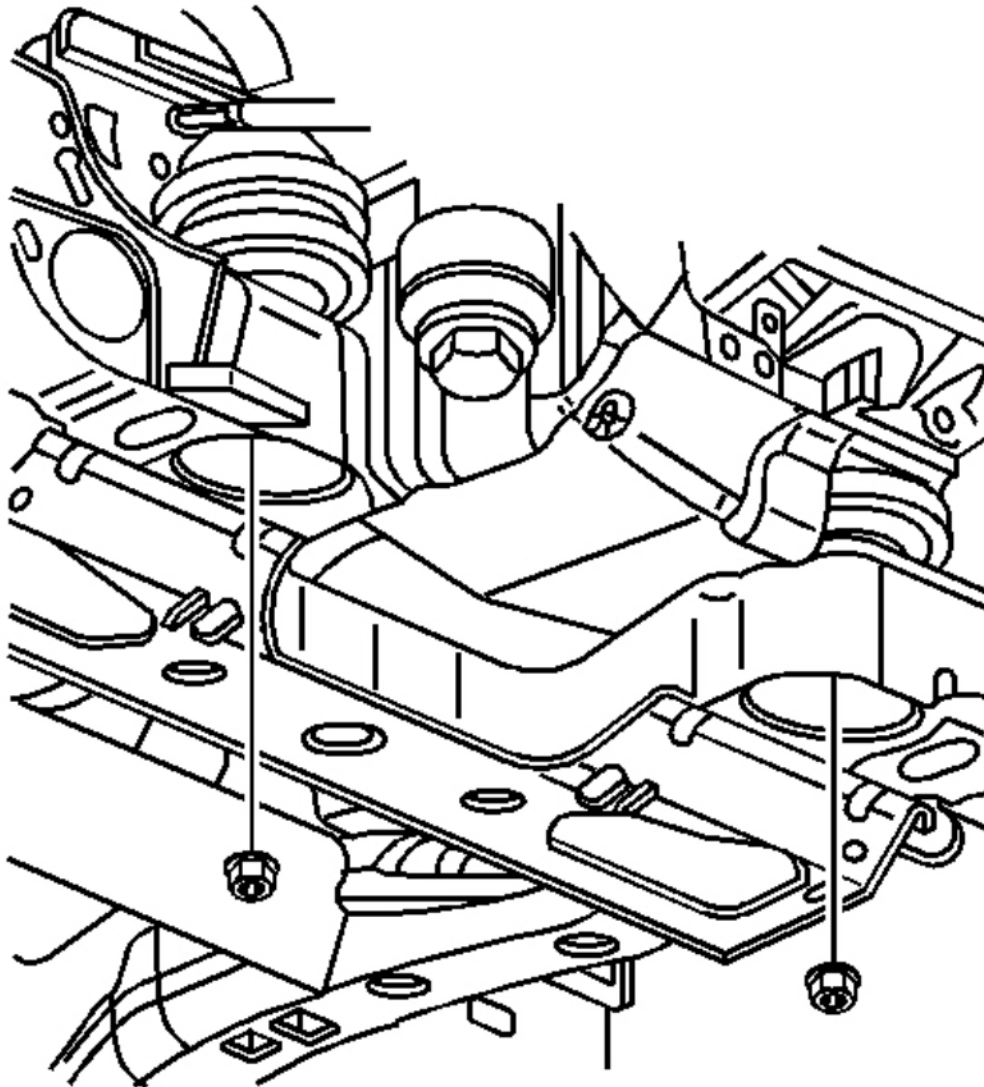


Fig. 64: Identifying Frame Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

9. Remove the engine mount lower nuts.

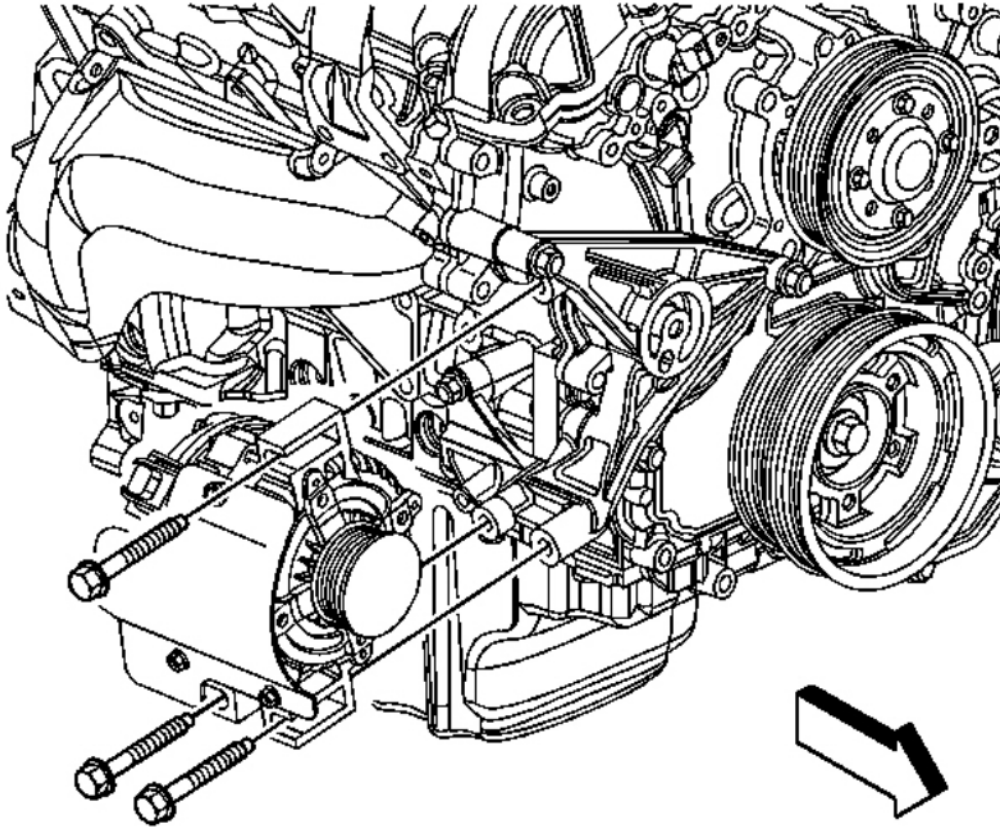


Fig. 65: View Of Generator

Courtesy of GENERAL MOTORS CORP.

10. Remove the generator lower bolts.
11. Lower the vehicle.
12. Raise the engine using the support fixture.
13. Remove the generator upper bolt.
14. Remove the generator from the engine.
15. If necessary, remove the generator shield bolts and shield.

Installation Procedure

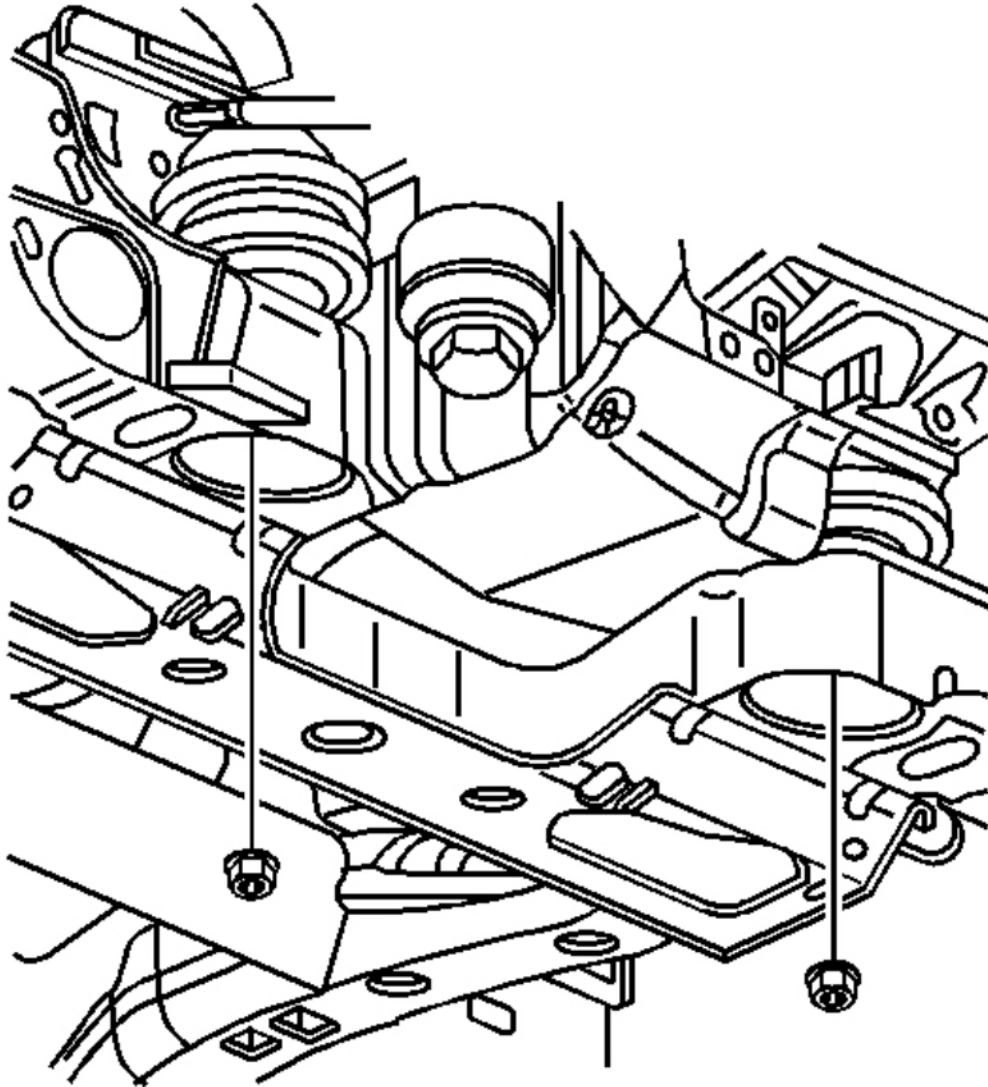


Fig. 66: Identifying Frame Mounting Nuts

Courtesy of GENERAL MOTORS CORP.

1. If necessary, install the generator shield and bolts.
2. Install the generator to the engine.
3. Lower the engine using the support fixture.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.

NOTE: Refer to Fastener Notice in Cautions and Notices.

5. Install the engine mount lower nuts.

Tighten: Tighten the nuts to 80 N.m (59 lb ft).

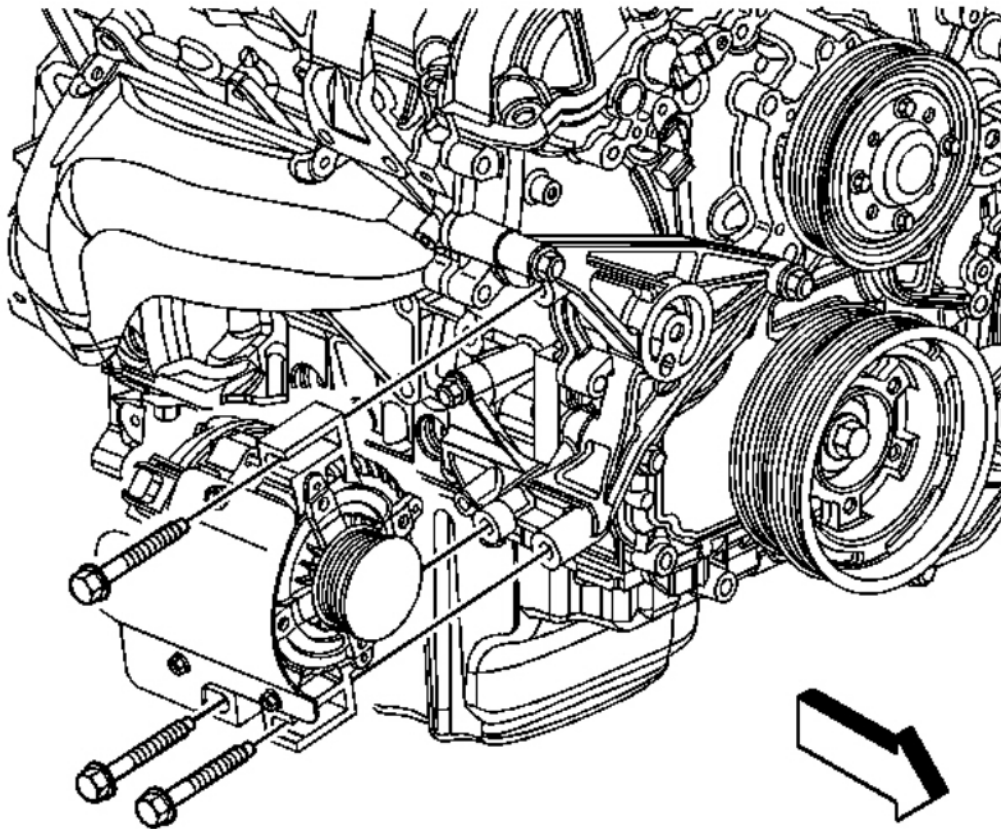


Fig. 67: View Of Generator
Courtesy of GENERAL MOTORS CORP.

6. Install the generator lower bolts.

Tighten: Tighten the generator bolts to 50 N.m (37 lb ft).

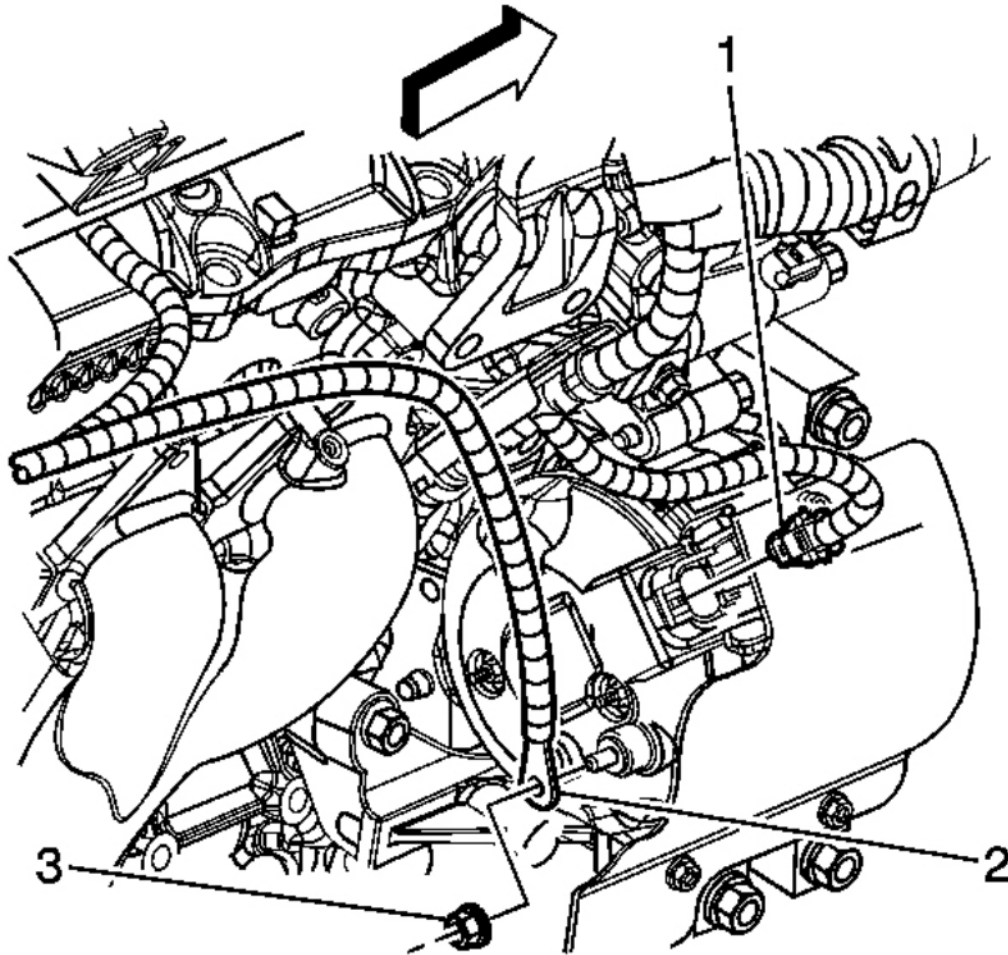


Fig. 68: View Of Battery Positive Lead & Generator BAT Terminal Nut
Courtesy of GENERAL MOTORS CORP.

7. Install the battery positive lead (2) and the generator BAT terminal nut (3) to the generator.

Tighten: Tighten the nut to 13 N.m (115 lb in).

8. Install the BAT terminal boot.
9. Connect the electrical connector (1) to the generator.
10. Lower the vehicle.
11. Install the generator upper bolt.

Tighten: Tighten the generator bolt to 50 N.m (37 lb ft).

12. Remove the engine support fixture. Refer to **Engine Support Fixture** in Engine Mechanical - 2.8L (LP1), or **Engine Support Fixture** in Engine Mechanical - 3.6L (LY7).
13. Install the drive belt to the generator. Refer to **Drive Belt Replacement - Generator and Water Pump** in Engine Mechanical - 2.8L (LP1), or **Drive Belt Replacement - Generator and Water Pump** in Engine Mechanical - 3.6L (LY7).
14. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.

DESCRIPTION AND OPERATION

BATTERY DESCRIPTION AND OPERATION

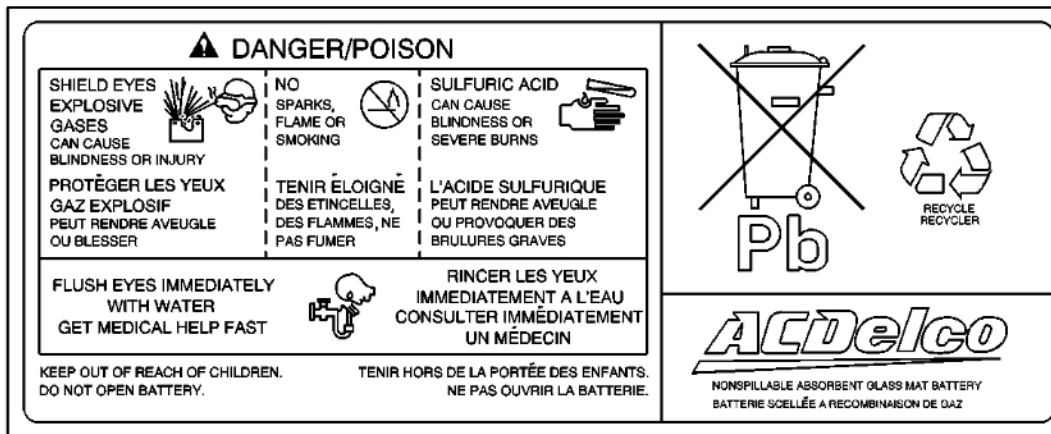


Fig. 69: Battery Warning Label

Courtesy of GENERAL MOTORS CORP.

CAUTION: 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.

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

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

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

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

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

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

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

The battery specification label, example below, contains information about the following:

- The test ratings
- The original equipment catalog number
- The recommended replacement model number

CATALOG NO.

1819

CCA 770	LOAD TEST 380
REPLACEMENT MODEL 100 – 6YR	

Fig. 70: View Of Battery Specification Label
Courtesy of GENERAL MOTORS CORP.

Battery Ratings

A battery may have 3 ratings:

- Amp hour
- Reserve capacity
- Cold cranking amperage

When a battery is replaced, use a battery with similar ratings. Refer to the battery specification label on the original battery or refer to **Battery Usage**.

Amp Hour

The amp hour rating of a battery is the amount of time it takes a fully charged battery, being discharged at a

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constant rate of 1 amperes and a constant temperature of 27°C (80°F), to reach a terminal voltage of 10.5 volts. Refer to **Battery Usage** for the amp hour rating of the original equipment battery.

Reserve Capacity

Reserve capacity is the amount of time in minutes it takes a fully charged battery, being discharged at a constant rate of 25 amperes and a constant temperature of 27°C (80°F), to reach a terminal voltage of 10.5 volts. Refer to **Battery Usage** for the reserve capacity rating of the original equipment battery.

Cold Cranking Amperage

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

CHARGING SYSTEM DESCRIPTION AND OPERATION

Generator

The generator features the following major components:

- The delta stator
- The rectifier bridge
- The rotor with slip rings and brushes
- A conventional pulley
- Dual internal fans
- The regulator

The pulley and the fan cool the slip ring and the frame.

The generator features permanently lubricated bearings. Service should only include tightening of mount components. Otherwise, replace the generator as a complete unit.

Regulator

The voltage regulator controls the rotor field current in order to limit the system voltage. When the field current is on, the regulator switches the current on and off at a rate of 400 cycles per second in order to perform the following functions:

- Radio noise control
- Obtain the correct average current needed for proper system voltage control

At high speeds, the on-time may be 10 percent with the off-time at 90 percent. At low speeds, the on-time may be 90 percent and the off-time 10 percent.

Circuit Description (LS6) / (LS2)

The generator provides voltage to operate the vehicle electrical system and to charge its battery. A magnetic field is created when current flows through the rotor. This field rotates as the rotor is driven by the engine, creating an AC voltage in the stator windings. The AC voltage is converted to DC by the rectifier bridge and is supplied to the electrical system at the battery terminal.

When the engine is running, the generator turn-on signal is sent to the generator from the powertrain control module (PCM)/engine control module (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 F terminal is connected internally to the voltage regulator and externally to the PCM/ECM. When the voltage regulator detects a charging system problem, it grounds the generator L-terminal circuit to signal the PCM/ECM that a problem exists. The PCM/ECM also monitors the generator field duty cycle signal circuit for failures. The system voltage sense circuit receives battery positive voltage that is Hot At All Times through the DIM fuse in the rear fuse block. This voltage is used by the regulator as the reference for system voltage control.

Regulated Voltage Control (RVC)

The LY7 engine comes equipped with GEN II regulated voltage control (RVC). RVC is used to more accurately control the amount of voltage put into the battery based upon the battery state of charge (SOC) and battery temperature.

The main components of the RVC system is a new voltage regulator, dash integration module (DIM), and the engine control module (ECM).

- Voltage regulator-Uses a pulse width modulation (PWM) signal on the generator L-terminal circuit instead of a 5-volt reference signal from the ECM to determine voltage output of the generator.
- ECM-Controls the PWM signal to the regulator and provides diagnostics for the generator L-terminal and generator F-terminal. It also provides feedback of the generator F-terminal to the DIM for its calculations.
- DIM-Calculates an estimate of the battery SOC and battery temperature based upon, battery voltage and internal calibrations. When the DIM has determined what voltage the battery should receive, a message is sent to the ECM. This message tells the ECM what percentage to set the PWM signal at.

With RVC in closed loop control of the generator, it can vary the voltage at the battery from 13.4 volts, battery temperature above 70°C (158°F) and battery SOC 95 percent or higher, to 14.9 volts, battery temperature below -30°C (-22°F) and battery SOC 65 percent or lower. If RVC loses control of the generator because of a failure the voltage regulator will default to 13.9 volts at the battery and function as a normal generator.

Circuit Description (LY7)

The generator provides voltage to operate the vehicle electrical system and to charge its battery. A magnetic field is created when current flows through the rotor. This field rotates as the rotor is driven by the engine, creating an AC voltage in the stator windings. The AC voltage is converted to DC by the rectifier bridge and is

supplied to the electrical system at the battery terminal.

When the engine is running, the engine control module (ECM) sends a pulse width modulation (PWM) signal to the voltage regulator. The generator's voltage regulator then controls the current to the rotor according to the PWM signal received, thereby controlling the output voltage. The rotor current is proportional to the electrical pulse width supplied by the regulator. The PWM signal may vary between 12-88 percent. The lower the PWM signal percentage the lower the generator voltage output will be. Below 12 percent and above 88 percent the voltage regulator defaults to 13.9 volts. This generator is self starting and does not require voltage on the L-terminal circuit to initiate battery charging. This also means that the generator cannot be commanded OFF with the scan tool. When the voltage regulator detects a charging system problem, it grounds the generator L-terminal circuit to signal the ECM that a problem exists. The ECM also monitors the generator field duty cycle signal circuit for failures.

Charging System Indicators

The instrument panel cluster (IPC) illuminates the charge indicator when the following occurs:

- The engine control module (ECM)/powertrain control module (PCM) detects that the generator output is less than 11 volts or greater than 16 volts. The IPC receives a class 2 message from the ECM/PCM requesting illumination.
- The IPC determines that the system voltage is less than 11 volts or greater than 16 volts. The IPC receives a class 2 message from the dash integration module (DIM) indicating the system voltage.
- The IPC performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.

BATTERY NOT CHARGING - 7

The IPC illuminates the BATTERY NOT CHARGING - 7 indicator in the driver information center (DIC) when the ECM/PCM detects a malfunction with the generator output. The IPC receives a class 2 message from the ECM/PCM requesting illumination.

BATTERY SAVER ACTIVE - 27

The IPC illuminates the BATTERY SAVER ACTIVE - 27 indicator in the DIC when the DIM reduces or disables the performance of some vehicle systems in order to reduce the load on the charging system. The IPC receives a class 2 message from the DIM requesting illumination.

BATTERY VOLTAGE HIGH - 8

The IPC illuminates the BATTERY VOLTAGE HIGH - 8 indicator in the DIC when the IPC determines that the system voltage is greater than 16 volts. The IPC receives a class 2 message from the DIM indicating the system voltage.

BATTERY VOLTAGE LOW - 6

The IPC illuminates the BATTERY VOLTAGE LOW - 6 indicator in the DIC when the IPC determines that the system voltage is less than 11 volts. The IPC receives a class 2 message from the DIM indicating the system

voltage.

SERVICE CHARGING SYS - 102

The IPC illuminates the SERVICE CHARGING SYS - 102 indicator in the DIC when the PCM/ECM detects a malfunction with the generator output. The IPC receives a class 2 message from the PCM/ECM requesting illumination.

STARTING SYSTEM DESCRIPTION AND OPERATION

The starter motors on this vehicle are non repairable starter motors. They have pole pieces that are arranged around the armature within the starter housing. When the solenoid windings are energized, the pull-in winding circuit is completed to ground through the starter motor. The hold-in winding circuit is completed to ground through the solenoid. The windings work together magnetically to pull in 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. At the same time, the plunger closes the solenoid switch contacts in the starter solenoid. Full battery voltage is then applied directly to the starter motor and it cranks the engine.

As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding as battery voltage is now 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, the pinion gear overrun protects the armature from excessive speed until the switch is opened.

When the ignition switch is released from the START position, crank voltage is removed from the starter solenoid C1 terminal. Current flows from the motor contacts through both windings to ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now in the opposite 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, cause the starter drive assembly to disengage and the solenoid switch contacts to open simultaneously. As soon as the contacts open, the starter motor is turned off.

Circuit Description

Moving the ignition switch to the START position sends a 12-volt signal to the engine control module (ECM) to command starting. Battery voltage also travels through the switch side of the Run/Crank relay then through the clutch switch, if equipped with manual transmission, and on through the coil side of the Starter relay and then to the ECM. The ECM receives class 2 information from the vehicle theft deterrent (VTD) and transmission control module (TCM) to verify that all parameters are met for starting. When all parameters are met the ECM grounds the control circuit of the Starter relay closing the switch providing battery voltage to the starter solenoid through a 30 A Maxi-Fuse.

LOAD SHED SYSTEM DESCRIPTION AND OPERATION

Electrical Power Management

Electrical power management (EPM) is used to monitor and control the charging system and alert the driver of possible problems within the charging system. The EPM system makes the most efficient use of the generator output, improves the battery state-of-charge (SOC), refer to **Battery Description and Operation**, extends battery life, and manages system electrical loads. EPM has also been know as "load management" or "load-shed" in the past.

EPM performs the following 3 functions:

- Monitors battery voltage and estimates battery SOC
- Takes corrective actions by boosting idle speed, reducing system electrical loads, and/or adjusting the generator regulated voltage control (RVC).
- Perform diagnostics and informs the driver of charging system malfunctions

The EPM algorithm is run any time the dash integration module (DIM) is awake, which includes engine running, key on, accessory mode, and retained accessory power (RAP). During this time the DIM continuously estimates the battery SOC based on battery voltage, estimated net amp hours, refer to **Battery Description and Operation**, battery capacity, initial SOC, and estimated battery temperature. Estimated battery temperature is a calculation based on key off time, engine run time, and the temperature reading provided by the engine control modules (ECM) air intake temperature or HVACs outside air temperature.

When the EPM algorithm is running, the DIM calculates the net charge rate on the electrical system by making constant voltage measurements. It uses the measurements to calculate the charge rate in amp/hours. If the DIM detects a negative charge rate, equal to a discharge from the battery, EPM can request up to 3 levels of idle boost from the ECM, when the vehicle is in park or neutral, as well as up to 2 levels of load shedding for a total of 5 levels of corrective action to maintain proper vehicle electrical system operation.

The DIM sends a serial data request to the PCM/ECM to increase the idle speed. The PCM/ECM then adjusts the idle speed by using a special program and idle speed ramp calculations in order to prevent driveability and safety concerns. The idle speed boost and cancel function will vary from vehicle to vehicle and from one moment to another on the same vehicle. This happens because the PCM/ECM responds to changes in the inputs from the sensors used to control the powertrain. In order to maintain Idle quality the ECM may not enter idle boost for up to 120 seconds, unless there is a manual change in throttle position. There is no set time limit for the idle decrease when the criteria has been met to exit idle boost, unless there is a manual change in throttle position.

IMPORTANT: The DIM also has responsibility for requesting up to 3 levels of idle boost from the ECM for the HVAC system based upon head pressure, vehicle speed, and engine running. EPM has priority over the HVAC system when requesting idle boost. However, idle boost will be maintained at the level the HVAC system requires, even though the exit criteria has been met for EPM.

Each EPM function, either idle boost or load-shed, is discrete. No 2 functions are active at the same time. However, the set flags may be set 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 DIM to regulate EPM are outlined below:

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Load Shed System Description and Operation

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15°C (5°F)	Less Than 13 V	-	First level Idle boost requested
Idle Boost 1 Start	-	-	Battery has a net loss greater than 0.6 AH	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 10.9 V	-	First level Idle boost requested
Idle Boost 1 End	Greater Than -15°C (5°F)	Greater Than 12.0 V	Battery has a net loss less than 0.2 AH	First level Idle boost request cancelled
Load Shed 1 Start	-	-	Battery has a net loss of 1.6 AH	Controlled outputs cycled OFF for 20% of their cycle
Load Shed 1 Start	-	Less Than 10.9 V	-	Controlled outputs cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12.0 V	Battery has a net loss of less than 0.8 AH	Clear Load Shed 1
Idle Boost 2 Start	-	-	Battery has a net loss greater than 5.0 AH	Second level Idle boost requested
Idle Boost 2 Start	-	Less Than 10.9 V	-	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12.0 V	Battery has a net loss less than 2.0 AH	Second level Idle boost request cancelled
Idle Boost 3 Start	-	-	Battery has a net loss of 10.0 AH	Third level Idle boost requested
Idle Boost 3 Start	-	Less Than 10.9 V	-	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12.0 V	Battery has a net loss of less than 6.0 AH	Third level Idle boost request cancelled
Load Shed 2 Start	-	Less Than 11.9 V	Battery has a net loss greater than 20.0 AH -	Controlled outputs cycled OFF for 100% of their cycle, Battery Indicator or Battery Saver Indicator ON request sent

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Load Shed 2 Start	-	Less Than 10.9 V	-	Controlled outputs cycled OFF for 100% of their cycle, Battery Indicator or Battery Saver Indicator ON request sent
Load Shed 2 End	-	Greater Than 12.6 V	Battery has a net loss of less than 15.0 AH	Clear Load Shed 2

During each load management function, the DIM checks the battery temperature, battery voltage and amp-hour calculations and determines if the DIM should implement a different power management function.

The highest loads on the electrical system are the resistance load of heating elements. The DIM controls the heating elements in the outside rear view mirrors, the rear window and the heated seats, either directly or by sending messages to any module controlling power to these devices.

The second highest load on the electrical system are the blowers used in the HVAC system. The DIM will send messages to the HVAC system controller that will result in reducing the blower operation on vehicles equipped with automatic HVAC systems.

Load-Shed

This vehicle uses the following load-shed actions:

Load Shed System Description and Operation

Load Shed Level	Affected Systems	Action Taken
Load-Shed Level 0	No systems affected	Normal operation
Load-Shed Level 1	Heated Outside Rear View Mirrors, Heated Rear Window / Rear Window Defrost, Heated Seats	Cycled at 80% duty cycle, OFF for 4 of every 20 second cycle. Indicator and timer not affected.
	Message Center, Instrument Cluster	No messages or indicators are displayed. Data (DPID) indicating that the Load-Shed 1 was entered is stored and may be accessed with a scan tool. DPID will reset after 40 ignition switch cycles with no repeated load-shed 1 action or with a battery disconnection.
	Heated Outside Rear View Mirrors, Heated Rear Window / Rear Window Defrost, Heated Seats	Turned OFF. Indicator and timer are not affected. The indicators and timers are controlled by the RIM. The operator must turn ON system when load-shed level is

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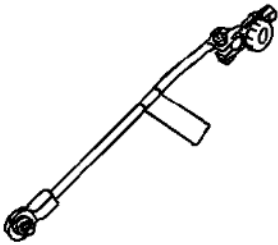
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Load-Shed Level 2		exited. System will not respond to operator input until current load-shed level is exited. This system will respond to only one Load-Shed Level 2 command per ignition switch cycle.
	Message Center, Instrument Cluster	"Battery Saver Action" message is displayed. Charge indicator is illuminated. Data (DPID) indicating that the Load-Shed Level 2 was entered is stored and may be accessed with a scan tool. DPID will reset after 40 ignition switch cycles with no repeated Load-Shed 2 actions or with a battery disconnection.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Special Tools

Illustration	Tool Number/Description
	J 38758 Parasitic Draw Test Switch
	J 42000 Battery Tester

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