2007 ENGINE

Engine Electrical - H3

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Air Conditioning Compressor Bolt	50 N.m	37 lb ft
Battery Cable to Battery Nut	9 N.m	80 lb in
Battery Retainer Nut	15 N.m	11 lb ft
Generator Mounting Bolt	50 N.m	37 lb ft
Generator Output BAT Terminal Nut	20 N.m	15 lb ft
Generator Positive Cable to Underhood Fuse Block Nut	10 N.m	89 lb in
Negative Battery Cable to Battery Tray Bolt	9 N.m	80 lb in
Negative Battery Cable to Engine Block Bolt	35 N.m	26 lb ft
Positive Battery Cable to Starter Terminal Nut	9 N.m	80 lb in
Positive Battery Cable to Underhood Fuse Block Nut	10 N.m	89 lb in
Starter Motor Bolt/Nut	50 N.m	37 lb ft
Starter Solenoid S Terminal Nut	3.5 N.m	31 lb in

BATTERY USAGE

Battery Usage (Early 2007)

Early 2007	
Cold Cranking Amperage (CCA)	690 A
Reserve Capacity Rating	110 Minutes
Replacement Battery Number	86-7YR

Battery Usage (Late 2007)

Late 2007	
Cold Cranking Amperage (CCA)	590 A
Reserve Capacity Rating	110 Minutes

Replacement Battery Number	86-7YR

GENERATOR USAGE

Generator Usage

Generator Model	TG13 Valeo
Rated Output	125 A
Load Test Output	70 A

SCHEMATIC AND ROUTING DIAGRAMS

STARTING AND CHARGING SCHEMATICS

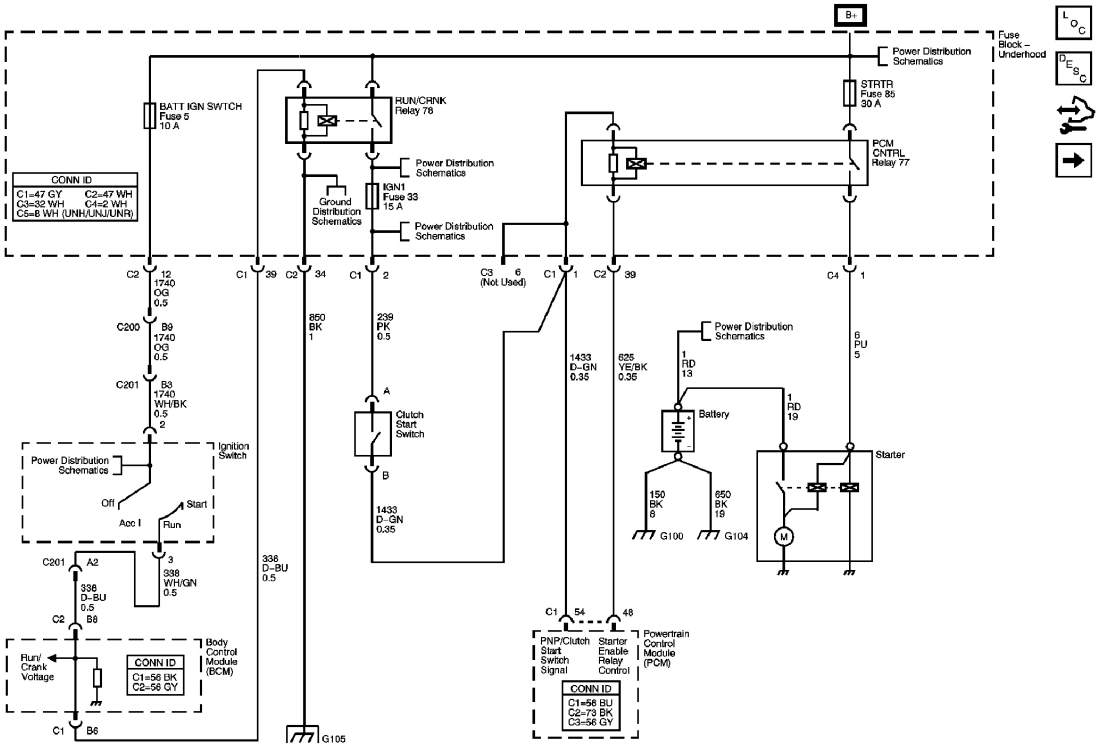


Fig. 1: Starting System Schematic - MA5
Courtesy of GENERAL MOTORS CORP.

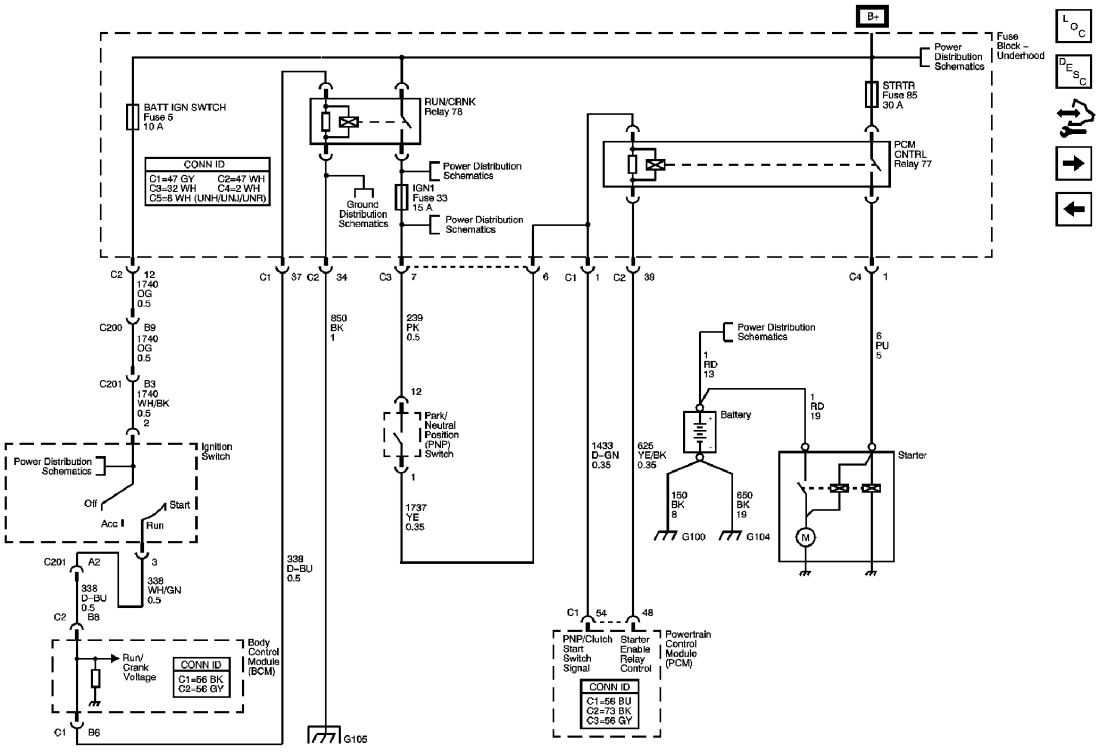


Fig. 2: Starting System Schematic - M30
Courtesy of GENERAL MOTORS CORP.

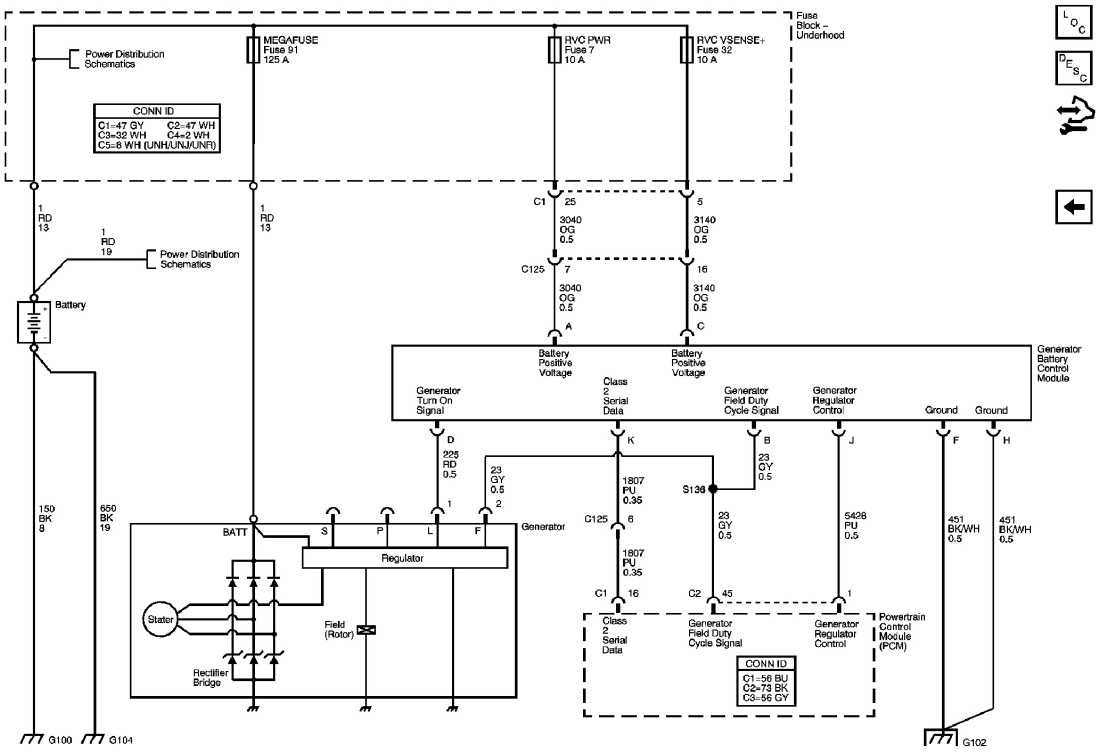


Fig. 3: Charging System Schematic
Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

ENGINE ELECTRICAL COMPONENT VIEWS

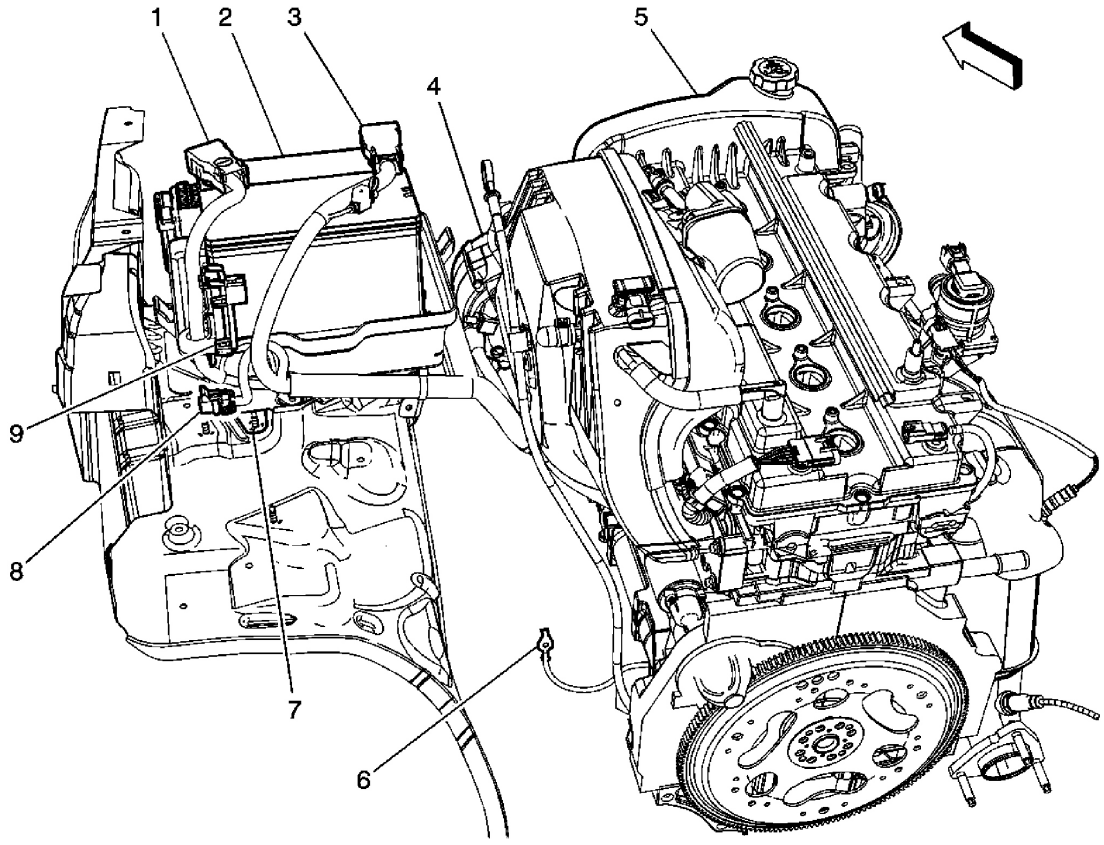


Fig. 4: Identifying Engine Electrical Components
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 4

Callout	Component Name
1	Negative Battery Cable
2	Battery
3	Positive Battery Cable
4	Generator
5	Engine-LRR
6	G120
7	G100
8	C130 (UE1)
9	Generator Control Module

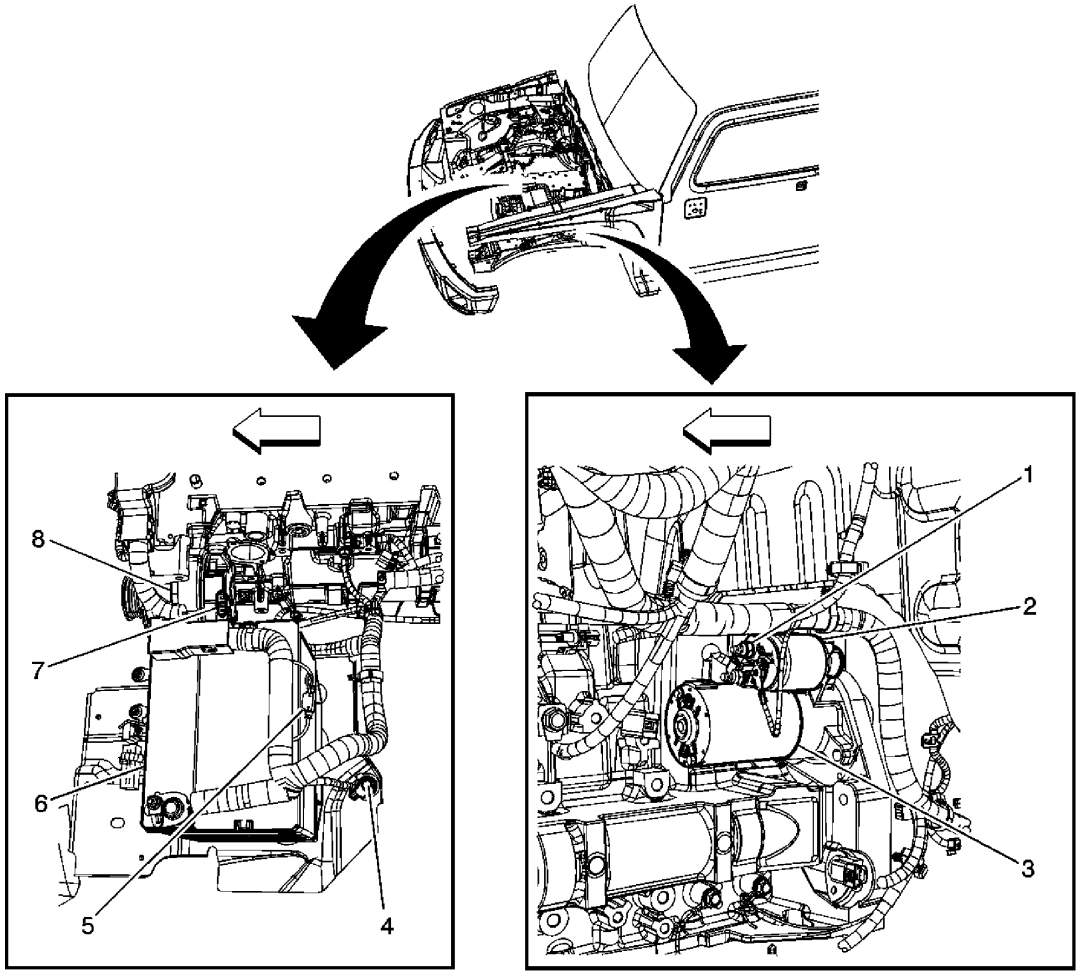


Fig. 5: Identifying Engine Electrical Components (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 5

Callout	Component Name
1	Battery Positive Cable
2	Starter Solenoid
3	Starter Motor
4	G100
5	OnStar Fuse
6	Battery
7	Generator Connector
8	Generator

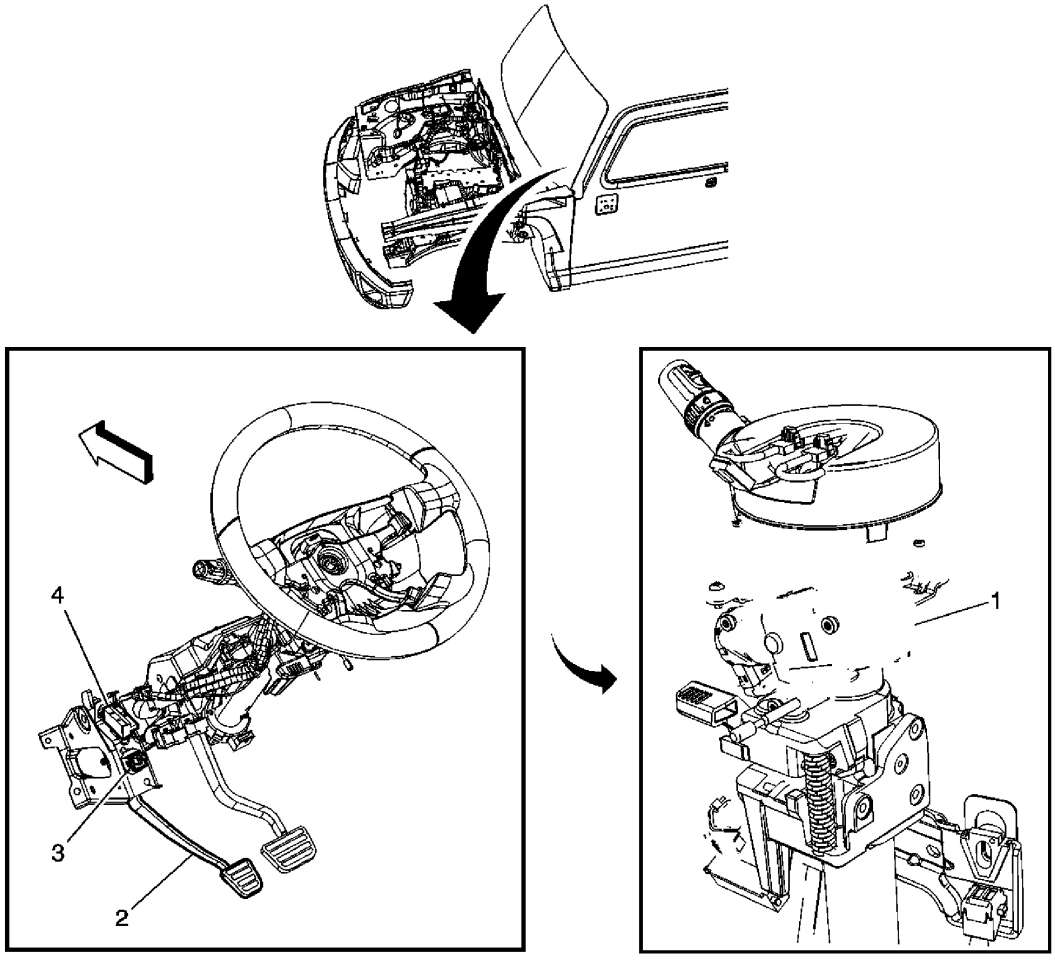


Fig. 6: Identifying Engine Electrical Components (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 6

Callout	Component Name
1	Ignition Switch
2	Clutch Pedal (MA5)
3	Clutch Release Switch (MA5)
4	Clutch Start Switch (MA5)

ENGINE ELECTRICAL CONNECTOR END VIEWS

Clutch Start Switch

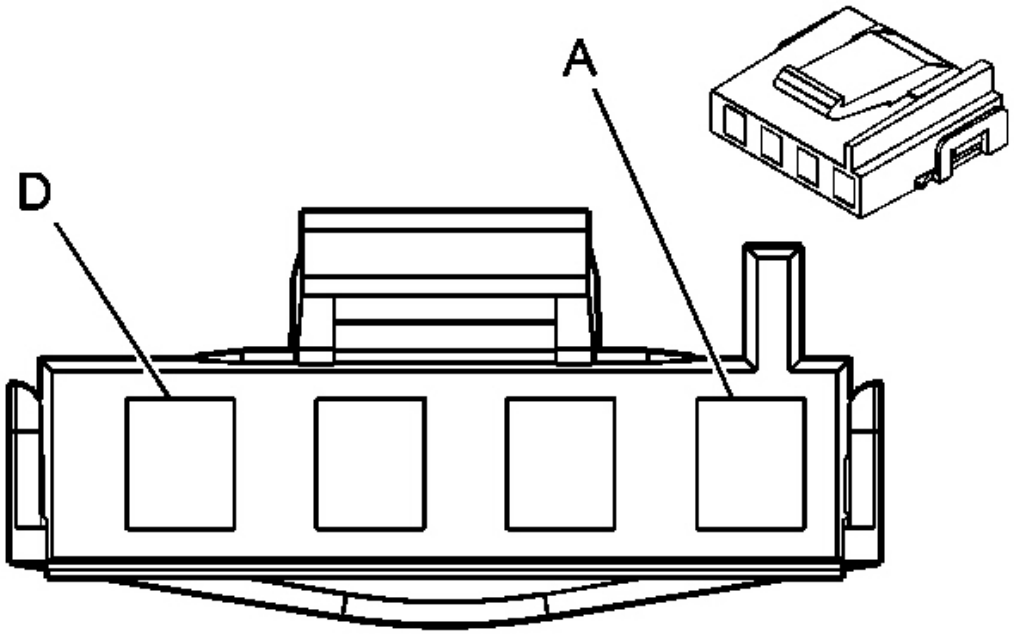


Fig. 7: Clutch Start Switch Connector End Views
Courtesy of GENERAL MOTORS CORP.

Clutch Start Switch Connector Parts Information

Connector Part Information

- OEM: 12033706
- Service: 15306359
- Description: 4-Way F Metri-Pack 280 Series (BU)

Terminal Part Information

- Terminal/Tray: 12034046/2
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-4A (PU)

Clutch Start Switch Connector Terminal Identification

Pin	Wire Color	Circuit No.	Function
A	PK	239	Run/Crank Ignition 1 Voltage

B	D-GN	1433	Clutch Start Switch Signal
C-D	-	-	Not Used

Generator

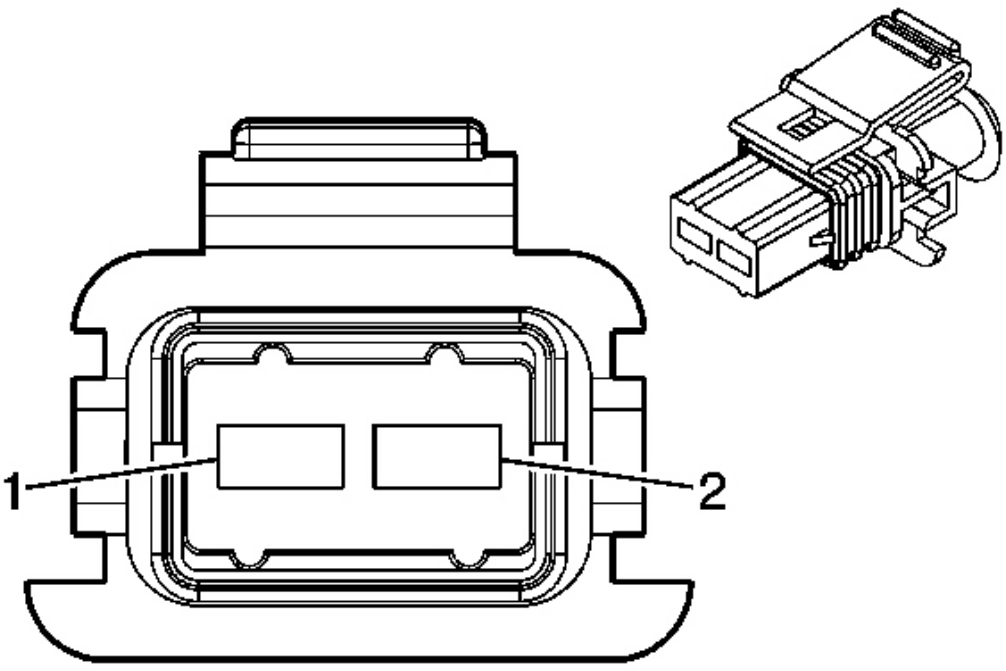


Fig. 8: Generator Connector End View
Courtesy of GENERAL MOTORS CORP.

Generator Connector Parts Information

Connector Part Information

- OEM: 1-928-403-137
- Service: See Catalog
- Description: 2-Way F Timer Junior Power Timer Series Sealed (BK)

Terminal Part Information

- Terminal/Tray: 4-964286-1/16

- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-4A (PU)

Generator Connector Terminal Identification

Pin	Wire Color	Circuit No.	Function
1	RD	225	Generator Turn On Signal
2	GY	23	Generator Field Duty Cycle Signal

Generator Battery Control Module

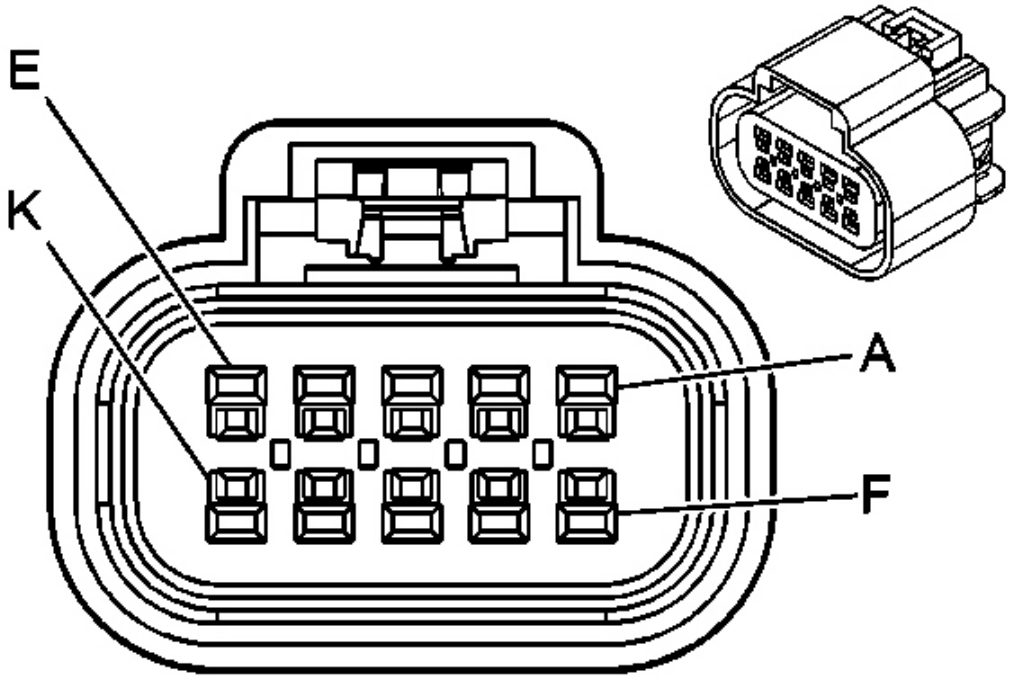


Fig. 9: Generator Battery Control Module Connector End View
Courtesy of GENERAL MOTORS CORP.

Generator Battery Control Module Connector Parts Information

Connector Part Information

- OEM: 15326842

- Service: 15326843
- Description: 10-Way F GT 150 Series Sealed (BK)

Terminal Part Information

- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: Pins A, C, G, H, K - E/A
- Core/Insulation Crimp: Pins B, D, F - 2/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Generator Battery Control Module Connector Terminal Identification

Pin	Wire Color	Circuit No.	Function
A	OG	3040	Battery Positive Voltage
B	GY	23	Generator Field Duty Cycle Signal
C	OG	3140	Battery Positive Voltage
D	RD	225	Generator Turn On Signal
E	-	-	Not Used
F	BK/WH	451	Ground
G	-	-	Not Used
H	BK/WH	451	Ground
J	PU	5428	Generator Regulator Control
K	PU	1807	Class 2 Serial Data

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC B1327	Device Power 1 Circuit Low
DTC B1390	Device Voltage Reference Input 1 Circuit
DTC B1487	Generator L-Terminal Circuit Low
DTC B1488	Generator L-Terminal Circuit High
DTC B1492	Generator F-Terminal Circuit Low
DTC B1516	Battery Current Sensor Performance
DTC B1566	Current Sensor Polarity Check
DTC C0899	Device Voltage Low

DTC C0901	Device 2 Voltage Low
DTC P0562	System Voltage Low
DTC P0563	System Voltage High

DIAGNOSTIC STARTING POINT - ENGINE ELECTRICAL

Begin the system diagnosis with the **Diagnostic System Check - Vehicle** . 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 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

Generator Battery Control Module (GBCM)

Scan Tool Output Control	Additional Menu Selection(s)	Description
GEN L Terminal	Body, Generator Battery Control Module, Special Functions	The GBCM commands the generator On and Off.

SCAN TOOL DATA LIST

Generator Battery Control Module (GBCM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine OFF			
Battery Voltage Signal	Body, Generator Battery Control Module	Volts	12.3 V
Generator L Terminal Signal Command	Body, Generator Battery Control Module	Percent	0 Percent
Regulated Voltage Control	Body, Generator Battery Control	Amps	1 Amp

Current Sensor	Module		
Running State of Charge	Body, Generator Battery Control Module	Percent	90 Percent

Powertrain Control Module (PCM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Operating Conditions: Ignition ON/Engine OFF			
Crank Request Signal	PCM, Data Display, Engine Data Display, Electrical/Theft Data	Yes/No	No
Generator L Terminal Signal Command	PCM, Data Display, Engine Data Display, Electrical/Theft Data	Off/On	Off
Generator F Terminal Signal	PCM, Data Display, Engine Data Display, Electrical/Theft Data	%	10-90%
Ignition 1 Signal	PCM, Data Display, Engine Data Display, Electrical/Theft Data	Volts	9.6-14.4 V
Starter Relay Circuit Status	PCM, Data Display, Engine Data Display, Electrical/Theft Data	Fault, Indeterminate, OK	OK
Starter Relay Command	PCM, Data Display, Engine Data Display, Electrical/Theft	Off/On	Off

	Data		
TR Sw.	PCM, Transmission Data	Park, Reverse, Neutral, Drive 5, Drive 4, Drive 3, Drive 2, Drive 1	Park

SCAN TOOL DATA DEFINITIONS

Battery Voltage Signal

The scan tool displays 0-20 volts. The scan tool displays the voltage as received by the module.

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.

Generator L Terminal Signal Command

The scan tool displays On/Off. The scan tool displays Off until the engine is running, at which time it will display On.

Generator F Terminal Signal

The scan tool displays 0-100 percent. The scan tool displays 0-5 percent until the engine is running, then the percentage value varies depending on electrical loads.

Ignition 1 Signal

The scan tool displays system voltage received by the module.

Starter Relay Circuit Status

The scan tool displays Fault, Indeterminate and OK. The scan tool displays the status of the starter relay circuit.

Starter Relay Command

The scan tool displays Off/On. The scan tool displays Off until engine start has been requested, then it displays On.

TR Sw

The scan tool displays Park, Reverse, Neutral, Drive 5, Drive 4, Drive 3, Drive and Drive 1. The scan tool displays the position of the transmission range switch.

DTC B1327

Circuit Description

The control modules on this vehicle monitor system voltage through the battery positive voltage circuits. Damage to components and incorrect data can occur when the voltage is out of range. This vehicle has multiple modules that will set this DTC. For more information on which modules refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1327 Device Power 1 Circuit Low

Conditions for Running the DTC

This DTC shall run only if the module has power, ground and the ignition is not in START mode. This DTC shall execute regardless of the battery voltage.

Conditions for Setting the DTC

- This DTC shall be set as current when the voltage falls below 9 volts for 1.2 seconds.
- When the vehicle exits START, the module shall delay checking the voltage for 2 seconds.

Action Taken When the DTC Sets

- A message shall be sent out to notify all other modules of low battery voltage.
- The modules disable the setting of U codes and other DTCs.

Conditions for Clearing the DTC

- The DTC will clear current status when the voltage is greater than 9.5 volts for 1.2 seconds.
- A history DTC will clear after 50 consecutive ignition cycles, if the condition for the malfunction is no longer present.
- Use a scan tool.

DTC B1327

Step	Action	Values	Yes	No
Schematic Reference: Control Module References				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	1. Install a scan tool. 2. Operate the vehicle within the Conditions for Running DTC B1327. Does the scan tool indicate that DTC B1327 is current in more than one module?	-	Go to **Step 6**	Go to **Step 3**
3	1. Turn ON the ignition, with the engine OFF. 2. With a scan tool, observe the Battery Voltage Signal parameter in the body control module (BCM) data list. Does the voltage measure greater than the specified value?	9.4 V	Go to **Step 11**	Go to **Step 4**
4	1. Turn OFF the ignition. 2. Disconnect the BCM. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage between the battery positive voltage circuit of the BCM and the ground circuit of the BCM. Does the voltage measure greater than the specified value?	9.4 V	Go to **Step 5**	Go to **Battery Inspection/Test (Non-HP2)**
5	Measure the voltage between the battery positive voltage circuit of the BCM and a good ground.	9.4 V		

	Does the voltage measure greater than the specified value?		Go to **Step 9**	Go to **Step 8**
6	1. Turn OFF the ignition. 2. Disconnect the harness connector of the module setting the DTC B1327. 3. Measure the voltage between the battery positive voltage circuit of the module setting the DTC B1327 and the ground circuit of the module setting the DTC B1327. Does the voltage measure greater than the specified value?	9.4 V	Go to **Step 10**	Go to **Step 7**
7	Measure the voltage between the battery positive voltage circuit of the BCM or module setting DTC B1327 and a good ground. Does the voltage measure greater than the specified value?	9.4 V	Go to **Step 9**	Go to **Step 8**
8	Test the battery positive voltage circuit of the BCM or module setting DTC B1327 for a high resistance or an open. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 12**	Go to **Step 10**
9	Test the ground circuit of the BCM or module setting DTC B1327 for a high resistance or an open. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 12**	Go to **Step 10**
	Inspect for poor connections at the harness connector of the BCM or module setting DTC B1327. Refer to			

10	**Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	-	Go to **Step 12**	Go to **Step 11**
11	Replace the affected module setting DTC B1327. Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	-	Go to **Step 12**	-
12	1. Use the scan tool in order to clear the DTCs. 2. Operate the vehicle within the Conditions for Running the DTC. Does the DTC reset?	-	Go to **Step 3**	System OK

DTC B1390

Circuit Description

The generator battery control module monitors the battery voltage for precision electrical power management. The generator battery control module monitors both the battery sense positive voltage circuit and the battery sense negative, ground, circuit to precisely determine system voltage. If there is a difference between the less precise battery voltage, battery positive voltage circuit and ground circuit and the more precise battery sense voltage of 1 volt or more for 10 seconds, then DTC B1390 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1390 Device Voltage Reference Input 1 Circuit

Conditions for Running the DTC

- Vehicle in RUN mode and Engine Run Flag is False or True.
- This diagnostic shall be run every 100 ms.

Conditions for Setting the DTC

The difference between the low precision battery voltage circuit reading and the high precision battery voltage sense circuit reading is greater than or equal to 1 volt for 10 seconds.

Action Taken When the DTC Sets

The generator battery control module will request the driver information center (DIC) message of the Service Charging System. The battery tell-tale is not turned ON.

The generator battery control module uses the less accurate battery positive voltage circuit for voltage readings.

Conditions for Clearing the DTC

- During the current ignition cycle, the difference between the less precision battery positive voltage circuit reading and the high precision battery voltage sense circuit reading is less than 1 volt.
- Clear the DTC with a scan tool.

Diagnostic Aids

IMPORTANT: You must cycle the ignition after clearing the DTC to turn OFF the DIC message of Service Charging System.

Recommended action:

- Check the Batt + voltage and Batt + sense voltage wires for an open or short low condition.
- Check the Batt - ground and Batt - sense ground wires for an open or short high condition.
- Clear the codes.
- Cycle the ignition.

IMPORTANT: You must cycle the ignition after clearing the DTC to turn OFF the DIC message of Service Charging System.

If a fault condition persists, replace the module.

DTC B1390

Step	Action	Values	Yes	No
Schematic Reference: Starting and Charging Schematics				

Connector End View Reference: Engine Electrical Connector End Views				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	With a DMM, measure the voltage between both the battery positive voltage circuits of the generator battery control module and a good ground. Compare the reading between circuits. Is the DMM reading above the specified value?	1 V	Go to **Step 4**	Go to **Step 3**
3	With a DMM connected to a good battery positive source, test both the ground circuits of the generator battery control module. Compare the reading between circuits. Is the DMM reading above the specified value?	1 V	Go to **Step 6**	Go to **Step 4**
4	Inspect for poor connections at the harness connector of the generator battery control module. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	-	Go to **Step 8**	Go to **Step 5**
5	Repair the open or high resistance in the affected battery positive voltage circuit. Did you find and correct the condition?	-	Go to **Step 8**	Go to **Step 7**
6	Repair the open or high resistance in the affected generator battery control module ground circuit. Did you find and correct the condition?	-	Go to **Step 8**	Go to **Step 7**

7	Replace the generator battery control module. Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	-	Go to **Step 8**	-
8	1. Use the scan tool in order to clear the DTC. 2. Operate the vehicle within the Conditions for Running the DTC, as specified in the supporting text. Does the DTC reset?	-	Go to **Step 2**	System OK

DTC B1487

Circuit Description

The generator battery control module controls the generator through the generator turn on signal circuit. The signal is a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. If the generator turn on signal circuit is in the 0-5 percent range, pulled low to ground or open then DTC B1487 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1487 Generator L-Terminal Circuit Low

Conditions for Running the DTC

- The engine speed is greater than 450 RPM.
- This diagnostic shall be run every 100 ms.

Conditions for Setting the DTC

The generator turn on signal circuit is less than or equal to 5 percent duty cycle for more than 120 seconds.

Action Taken When the DTC Sets

The generator battery control module will request the driver information center (DIC) message of

Charging System Failure and commands ON the Battery indicator.

Conditions for Clearing the DTC

- The generator turn on signal circuit input is from 1-99 percent duty cycle, greater than 0 volts.
- Clear the DTC with a scan tool.

Diagnostic Aids

IMPORTANT: You must cycle the ignition after clearing the DTC to turn OFF the DIC message of Service Charging System.

Recommended Action:

- Correct L-Term short low condition
- Clear the codes.
- Cycle the ignition.

IMPORTANT: You must cycle the ignition after clearing the DTC to turn OFF the DIC message of Charging System Failure and turn OFF the battery indicator.

If a fault condition persists, replace the module.

DTC B1487

Step	Action	Values	Yes	No
Schematic Reference: Starting and Charging Schematics **Connector End View Reference: Engine Electrical Connector End Views**				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	1. Turn ON the engine. 2. With a DMM test the generator turn on signal circuit of the generator battery control module.	0 V		

	Is the DMM reading equal to the specified value?		Go to **Step 4**	Go to **Step 3**
3	Inspect for poor connections at the harness connector of the generator battery control module. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	-	Go to **Step 6**	Go to **Step 5**
4	Repair the short to ground of the generator turn on signal circuit. Did you find and correct the condition?	-	Go to **Step 6**	Go to **Step 5**
5	Replace the generator battery control module. Refer to **Control Module References** 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, as specified in the supporting text. Does the DTC reset?	-	Go to **Step 2**	System OK

DTC B1488

Circuit Description

The generator battery control module controls the generator through the generator turn on signal circuit. The signal is a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. If the generator turn on signal circuit is 65 percent or greater duty cycle or pulled high to battery positive voltage, 5 volts, then DTC B1488 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1488 Generator L-Terminal Circuit High

Conditions for Running the DTC

- Vehicle in RUN mode and Engine Run Flag is False.
- The engine RPM is less than or equal to 0 RPM.
- This diagnostic shall be run every 100 ms.

Conditions for Setting the DTC

The generator turn on signal circuit is 65 percent or greater and shorted high to battery voltage, 5 volts, for greater than 5 seconds.

Action Taken When the DTC Sets

The generator battery control module will request the driver information center (DIC) message of Service Charging System and commands ON the Battery indicator.

Conditions for Clearing the DTC

The generator battery control module determines the fault has cleared.

Diagnostic Aids

IMPORTANT: You must cycle the ignition after clearing the DTC to turn OFF the DIC message of Service Charging System.

Recommended Action:

- Correct L-Term short high condition.
- Clear the codes.
- Cycle the ignition.

IMPORTANT: You must cycle the ignition after clearing the DTC to turn OFF the DIC message of Service Charging System and turn OFF the battery indicator.

If a fault condition persists, replace the module.

DTC B1488

Step	Action	Values	Yes	No
Schematic Reference: Starting and Charging Schematics **Connector End View Reference: Engine Electrical Connector End Views**				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	1. Ignition ON, engine OFF. 2. With a DMM, test the generator turn on signal circuit of the generator battery control module. Is the DMM reading equal to or above the specified value?	4.8 - 5.2 V	Go to **Step 4**	Go to **Step 3**
3	Inspect for poor connections at the harness connector of the generator battery control module. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	-	Go to **Step 6**	Go to **Step 5**
4	Repair the short to battery of the generator turn on signal circuit. Did you find and correct the condition?	-	Go to **Step 6**	Go to **Step 5**
5	Replace the generator battery control module. Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	-	Go to **Step 6**	-
	1. Use the scan tool in order to clear the DTC. 2. Operate the vehicle within the Conditions for Running the			

6	DTC, as specified in the supporting text. Does the DTC reset?	-	Go to **Step 2**	System OK

DTC B1492

Circuit Description

The generator battery control module monitors the generator through the generator field duty cycle signal circuit. The signal is a pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. If the generator field duty cycle signal circuit is in the 0-5 percent range or pulled low to ground, then DTC B1492 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1492 Generator F-Terminal Circuit Low

Conditions for Running the DTC

- Vehicle in RUN mode and Engine Run Flag is True.
- The engine speed is less that 1,000 RPM.
- DTC B1487 or B1488 is not set as a current DTC.
- This diagnostic shall be run every 100 ms.

Conditions for Setting the DTC

The generator field duty cycle signal circuit is less than or equal to 5 percent duty cycle for more than 120 seconds.

Action Taken When the DTC Sets

The generator battery control module will request the driver information center (DIC) message of Service Charging System and commands ON the Battery indicator.

Conditions for Clearing the DTC

- The generator field duty cycle signal circuit input is greater than 5 percent duty cycle.
- Clear the DTC with a scan tool.

Diagnostic Aids

IMPORTANT: You must cycle the ignition after clearing the DTC to turn OFF the DIC message of Service Charging System.

Recommended Action:

- Correct F-Term short low condition.
- Clear the codes.
- Cycle the ignition.

IMPORTANT: You must cycle the ignition after clearing the DTC to turn OFF the DIC message of Service Charging System and turn OFF the battery indicator.

If a fault condition persists, replace the module.

DTC B1492

Step	Action	Values	Yes	No
Schematic Reference: Starting and Charging Schematics **Connector End View Reference: Engine Electrical Connector End Views**				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	1. Start engine and idle. 2. With a scan tool, observe the Generator F-Terminal Signal parameter in the powertrain control module (PCM) data display. Is the Generator F-Terminal Signal data less than the specified value?	5%	Go to **Step 3**	**Testing for Intermittent Conditions and Poor Connections**
3	Disconnect the generator battery control module harness connector Is the Generator F-Terminal Signal parameter still less than the	5%		

	specified value?		Go to **Step 5**	Go to **Step 4**
4	Inspect for poor connections at the harness connector of the generator battery control module. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	-	Go to **Step 7**	Go to **Step 6**
5	Repair the short to ground of the generator field duty cycle control circuit. Did you find and correct the condition?	-	Go to **Step 7**	Go to **Step 6**
6	Replace the generator battery control module. Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	-	Go to **Step 7**	-
7	1. Use the scan tool in order to clear the DTC. 2. Operate the vehicle within the Conditions for Running the DTC, as specified in the supporting text. Does the DTC reset?	-	Go to **Step 2**	System OK

DTC B1516

Circuit Description

The generator battery control module monitors its internal battery current sensor for many charging system operations. When the values of the battery current sensor go out of range, DTC B1516 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1516 Battery Current Sensor Performance

Conditions for Running the DTC

- Vehicle in RUN mode and Engine Run Flag is True.
- This diagnostic shall be run every 50 ms.

Conditions for Setting the DTC

The duty cycle of the internal battery current sensor is less than 2 percent duty cycle or greater than 98 percent duty cycle for greater than 240 seconds.

Action Taken When the DTC Sets

- The filtered battery current is set to 0.1 amp.
- The generator field control circuit duty cycle is set to 100 percent, battery voltage defaults to 13.8 volts.
- The generator battery control module will request the driver information center (DIC) message of Service Charging System. The battery indicator remains OFF.

Conditions for Clearing the DTC

The duty cycle of the internal battery current sensor is greater than 2 percent duty cycle or less than 98 percent duty cycle.

Diagnostic Aids

IMPORTANT: You must cycle the ignition after clearing the DTC to turn OFF the DIC message of Service Charging System.

Recommended Action:

- Clear the codes.
- Cycle the ignition.

DTC B1516

Step	Action	Yes	No
Schematic Reference: Starting and Charging Schematics **Connector End View Reference: Engine Electrical Connector End Views**			
	Did you perform the Diagnostic System Check - Vehicle?		Go to **Diagnostic**

1		Go to **Step 2**	**System Check - Vehicle**
2	1. Install a scan tool. 2. Clear DTC. 3. Cycle ignition. Does DTC B1516 reset?	Go to **Step 3**	Go to **Testing for Intermittent Conditions and Poor Connections**
3	Replace the generator battery control module. Refer to **Control Module References** 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, as specified in the supporting text. Does the DTC reset?	Go to **Step 2**	System OK

DTC B1566

Circuit Description

The generator battery control module monitors its internal battery current sensor for many charging system operations. When the polarity of the battery current is sensed, DTC B1566 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1566 Current Sensor Polarity Check

Conditions for Running the DTC

- Vehicle in RUN mode and Engine Run Flag is True.
- This diagnostic shall be run every 50 ms.

Conditions for Setting the DTC

The duty cycle of the internal battery current sensor is less than 2 percent duty cycle or greater than 98 percent duty cycle for greater than 240 seconds.

Action Taken When the DTC Sets

- The filtered battery current is set to 0.1 amp.
- The generator field control circuit duty cycle is set to 100 percent, battery voltage defaults to 13.8 volts.
- The generator battery control module will request the driver information center (DIC) message of Service Charging System. The battery indicator remains OFF.

Conditions for Clearing the DTC

- The duty cycle of the internal battery current sensor is greater than 2 percent duty cycle or less than 98 percent duty cycle.
- Clear the DTC with a scan tool.

Diagnostic Aids

IMPORTANT: You must cycle the ignition after clearing the DTC to turn OFF the DIC message of Service Charging System.

Recommended Action:

- Clear the codes.
- Cycle the ignition.

DTC B1566

Step	Action	Yes	No
Schematic Reference: Starting and Charging Schematics **Connector End View Reference: Engine Electrical Connector End Views**			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	1. Install a scan tool. 2. Clear DTC. 3. Cycle ignition.		Go to **Testing for Intermittent Conditions and Poor**

	Does DTC B1566 reset?	Go to **Step 3**	**Connections**
3	Replace the generator battery control module. Refer to **Control Module References** 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, as specified in the supporting text. Does the DTC reset?	Go to **Step 2**	System OK

DTC C0899

Diagnostic Instructions

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

DTC Descriptor

DTC C0899

Device Voltage Low

Circuit/System Description

The electronic brake control module (EBCM) monitors the ignition voltage level available for system operation. A low voltage condition prevents the system from operating properly.

Conditions for Running the DTC

Ignition is ON.

Conditions for Setting the DTC

This fault will be set if the ignition voltage to EBCM is less than 9 volts for 100 msec.

Action Taken When the DTC Sets

- Traction Control System (TCS) and Vehicle Stability Enhancement System (VSES) for the duration of the ignition cycle.
- The TCS indicator turns ON.
- The driver information center (DIC) displays the Service Stability System message.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Antilock Brake System Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

- **Scan Tool Data List**
- **Scan Tool Data Definitions**

Circuit/System Testing

1. Measure and record the voltage at the battery terminals. With scan tool, observe the battery voltage signal parameter. Verify that battery terminal voltage and battery voltage signal readings do not differ more than 1 volt.

- If more than 1 volt, test the battery positive voltage and ground circuits of the EBCM for an open/high resistance or replace the EBCM.

2. Refer to **Charging System Test**.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for EBCM replacement, setup and programming

DTC C0901

Diagnostic Information

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

DTC Descriptor

DTC C0901

Device 2 Voltage Low

Circuit/System Description

The electronic brake control module (EBCM) monitors the ignition 1 voltage (IGN1) level available for system operation. A low voltage condition prevents the system from operating properly.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

- Ignition 1 (IGN1) voltage to EBCM is less than 6.5 volts for 7 seconds.
- Vehicle speed is greater than 3 km/h (2 mph).

Action Taken When the DTC Sets

Brake Warning indicator turns ON.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present and the DTC is cleared with a scan tool.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Antilock Brake System Connector End Views

Electrical Information Reference

- **Charging System Test**
- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Scan Tool Data List for EBCM

Diagnostic Aids

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

Circuit/System Verification

1. If the DTC is history, refer to **Charging System Test**.
2. Start the engine. Record the voltage at the battery terminals. Observe the battery voltage signal parameter in the EBCM data list. Voltages should not differ by more than 1 volt.
    - If more than 1 volt, replace the EBCM.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for EBCM replacement, setup and programming

DTC P0562

Circuit Description

The powertrain control module (PCM) monitors the system voltage to make sure that the voltage stays within the proper range. If the PCM detects an excessively low system voltage, DTC P0562 will set.

When the charging system detects a fault, the instrument panel cluster (IPC) displays a message or the charge indicator will light.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0562 System Voltage Low

Conditions for Running the DTC

- Engine run time is more than 20 seconds and above 1,200 RPM.
- Vehicle speed is above 8 km/h (5 mph).

Conditions for Setting the DTC

The PCM detects an improper voltage below 11 volts for 5 seconds.

Action Taken When the DTC Sets

- The PCM stores the DTC information into memory when the diagnostic runs and fails.
- The PCM will store conditions which were present when the DTC set as Failure Records data only.
- The PCM disables most outputs.
- The transmission defaults to a predetermined gear.
- The torque converter clutch (TCC) operation is inhibited.
- The IPC displays a message.
- The malfunction indicator lamp (MIL) will not illuminate.

Conditions for Clearing the DTC

- The Conditions for Setting the DTC are no longer present.
- A history DTC will clear after 40 malfunction-free ignition cycles.
- The PCM receives the clear code command from the scan tool.

DTC P0562

Step	Action	Values	Yes	No
Schematic Reference: Starting and Charging Schematics **Connector End View Reference: Engine Electrical Connector End Views**				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	With the scan tool monitor the ignition 1 signal voltage in the powertrain control module (PCM) data list. Does the scan tool display ignition 1 voltage greater than the specified value?	11 V	Go to **Step 4**	Go to **Step 3**
3	Test the ignition feed circuit to the PCM for high resistance or open. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 7**	Go to **Step 5**
4	1. Inspect for poor connections at the PCM. Refer to **Testing for Intermittent Conditions and Poor Connections** . 2. If you find a poor connection, repair the condition as necessary. Refer to **Wiring Repairs** . Did you find and correct the condition?	-	Go to **Step 7**	Go to **Step 6**
	Repair the ignition feed circuit to the			

5	PCM for an open or a short to ground. Refer to **Wiring Repairs** . Is the action complete?	-	Go to **Step 7**	-
6	Replace the PCM. Refer to **Control Module References** for replacement, setup and programming. Did you compete the replacement?	-	Go to **Step 7**	-
7	1. Select the DTC option and the Clear DTC Information option using the scan tool. 2. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text, if applicable. Does the DTC reset?	-	Go to **Step 2**	System OK

DTC P0563

Circuit Description

The powertrain control module (PCM) continuously monitors that the system voltage stays within the proper range. If the PCM detects an excessively high system voltage, DTC P0563 will set. A high voltage condition may cause a stalling condition or other driveability concerns.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0563 System Voltage High

Conditions for Running the DTC

- The engine run time is more than 20 seconds.
- The engine is running above 1,200 RPM.
- Vehicle speed is above 8 km/h (5 mph).

Conditions for Setting the DTC

- The PCM senses the system voltage is above 19 volts.
- All of the conditions are present for 5 seconds.

Action Taken When the DTC Sets

- The PCM stores DTC P0563 in the PCM memory when the diagnostic runs and fails.
- The PCM will record the operating conditions at the time the diagnostic fails. The PCM stores this information in Failure Records.
- The PCM disables most outputs.
- The transmission defaults to a predetermined gear.
- The torque converter clutch (TCC) operation is inhibited.
- The instrument panel cluster (IPC) displays a message.
- The malfunction indicator lamp (MIL) will not illuminate.

Conditions for Clearing the DTC

- The Conditions for Setting the DTC are no longer present.
- A history DTC will clear after 40 malfunction-free ignition cycles.
- The PCM receives the clear code command from the scan tool.

DTC P0563

Step	Action	Values	Yes	No
Schematic Reference: Starting and Charging Schematics **Connector End View Reference: Engine Electrical Connector End Views**				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	1. Turn OFF all the accessories. 2. Measure the battery voltage at the battery using the DMM. 3. Operate the engine speed above 2,000 RPM. Is the battery voltage less than the specified value?	19 V	Go to **Step 4**	Go to **Step 3**
3	Replace the generator. Refer to **Generator Replacement**. Is the action complete?	-	Go to **Step 5**	-

4	Replace the powertrain control module (PCM). Refer to **Control Module References** for replacement, setup and programming. Did you compete the replacement?	-	Go to **Step 5**	-
5	1. Select the DTC option and the Clear DTC Information option using the scan tool. 2. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text, if applicable. Does the DTC reset?	-	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** before using the Symptom Tables in order to verify that all of the following are true:
  - There are no DTCs set.
  - The control modules can communicate via the serial data link.
- Review the system descriptions and operations in order to familiarize yourself with the system functions. Refer to one of the following system operations:
  - **Battery Description and Operation**
  - **Charging System Description and Operation**
  - **Electrical Power Management Description and Operation**
  - **Starting System Description and Operation**

Visual/Physical Inspection

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

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

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

- **Battery Inspection/Test (Non-HP2)**
- **Battery Electrical Drain/Parasitic Load Test**
- **Battery Common Causes of Malfunction**
- **Charging System Test**
- **Charge Indicator Always On**
- **Charge Indicator Inoperative**
- **Generator Noise Diagnosis**
- **Starter Solenoid Does Not Click**
- **Starter Solenoid Clicks, Engine Does Not Crank**
- **Engine Cranks Slowly**
- **Starter Motor Noise Diagnosis**

BATTERY INSPECTION/TEST (NON-HP2)

Diagnostic Aids

CAUTION: Refer to Battery Disconnect Caution .

IMPORTANT:

- **The battery test using the J 42000 Battery Tester 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.**
- **Use the Out of Vehicle test for each battery when testing a vehicle with dual batteries.**

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

- If testing the vehicle with the battery cables still connected, wiggle the **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 testing a removed battery.
- If the tester displays a REPLACE BATTERY or BAD CELL-REPLACE result for a battery tested in the vehicle with the battery cables connected, perform the following steps:
  1. Disconnect the negative battery cable.
  2. Disconnect the positive battery cable.
  3. Install the tester adapters.

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

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

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

- Use the correct terminal adapters.

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

Use the test adapters that are provided with the **J 42000** or GM P/N 12303040 terminal adapters. See **Special Tools**. If the adapters that are provided with the **J 42000** require replacement, use GM 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 (Non-HP2)

Step	Action	Value(s)	Yes	No
CAUTION: Refer to **Battery Disconnect Caution** .				
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 19**
2	Compare the cold cranking amperage (CCA) and reserve capacity (RC) 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 19**
3	Does the hydrometer display a yellow dot?	-	Go to **Step 4**	Go to **Step 5**
4	Tap the hydrometer lightly on top with the handle of a small screwdriver in order to dislodge any air bubbles inside the battery. Does the hydrometer still display a yellow dot?	-	Go to **Step 19**	Go to **Step 5**
5	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 6**	Go to **Step 7**
	Use a torque wrench in order to			

6	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 8**	Go to **Step 7**
7	Disconnect the negative battery cable. Is the cable disconnected?	-	Go to **Step 9**	-
8	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. Is the repair complete?	-	Go to **Step 9**	-
9	Rotate the positive battery cable connector clockwise with light finger pressure. Does the positive connector rotate?	-	Go to **Step 10**	Go to **Step 11**
10	Use a torque wrench in order to verify the torque to loosen the positive battery terminal bolt. Is the torque above the specified value?	10 N.m (88 lb in)	Go to **Step 12**	Go to **Step 11**
11	Disconnect the positive battery cable. Is the cable disconnected?	-	Go to **Step 13**	-
	1. Disconnect the positive battery cable. 2. Inspect for the following conditions and repair as			

12	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. Is the repair complete?	-	Go to **Step 13**	-
13	1. Clean and wire brush the lead face of both battery terminals and the metal contact rings in both cable connectors. 2. Remove the bolts from the cable connectors in order to provide access to the connector rings as needed. 3. If either of the battery terminals or the cable rings are excessively damaged or corroded, replace as needed. Are the metal connecting parts clean and in good condition?	-	Go to **Step 14**	-
14	1. Connect the positive battery cable to the battery positive terminal. 2. Tighten the cable bolt to the specified value. Is the cable bolt properly tightened?	15 N.m (11 lb ft)	Go to **Step 15**	-
15	1. Connect the negative battery cable to the battery negative terminal. 2. Tighten the cable bolt to the	15 N.m (11 lb ft)		

	specified value. Is the cable bolt properly tightened?		Go to **Step 16**	-
16	**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. 3. Follow any direction displayed on the tester. Did the tester pass the battery?	-	Go to **Step 17**	Go to **Step 18**
17	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?	-	Battery OK	-
18	1. Press the CODE button on the **J 42000** . See **Special Tools**. 2. For warranty purposes, write the displayed code on the repair order. 3. Replace the battery. Refer to **Battery Replacement**. Did you complete the replacement?	-	Battery OK	-
19	Replace the battery. Refer to **Battery Replacement**. 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%
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 ECM/PCM or other electronic components.

NOTE: Refer to FASTENER NOTICE .

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 (Non-HP2)**.

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** 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** .

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

Load Test

CAUTION: Refer to Battery Disconnect Caution .

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 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. Refer to **Battery Negative Cable Disconnection and Connection**.
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 19** .
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 of 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 up to 45 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:
    1. 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.

2. 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** 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.
3. 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.
4. When the cause of the excessive current drain has been located and repaired, remove the **J 38758** . See **Special Tools**.

20. Connect the battery negative cable to the battery negative terminal.

BATTERY COMMON CAUSES OF MALFUNCTION

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 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** .

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 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 (Non-HP2)**.

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

IMPORTANT: If a green dot is not visible in the hydrometer, charge the battery. Refer to Battery Charging.

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

CAUTION: Refer to BATTERY DISCONNECT CAUTION .

2. Disconnect the battery ground 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 (NON HP2)

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 comfortably reach the battery of the other vehicle.
   - Do not let the 2 vehicles touch.
   - Make sure that the jumper cables do not have loose clamps or missing insulation.
2. Perform the following steps on both vehicles:
   1. Place the automatic transmission in PARK.
   2. Block the wheels.
   3. Set the parking brake.
   4. Turn off all electrical loads that are not needed. Leave the hazard flashers ON.
   5. Turn OFF the ignition switch.

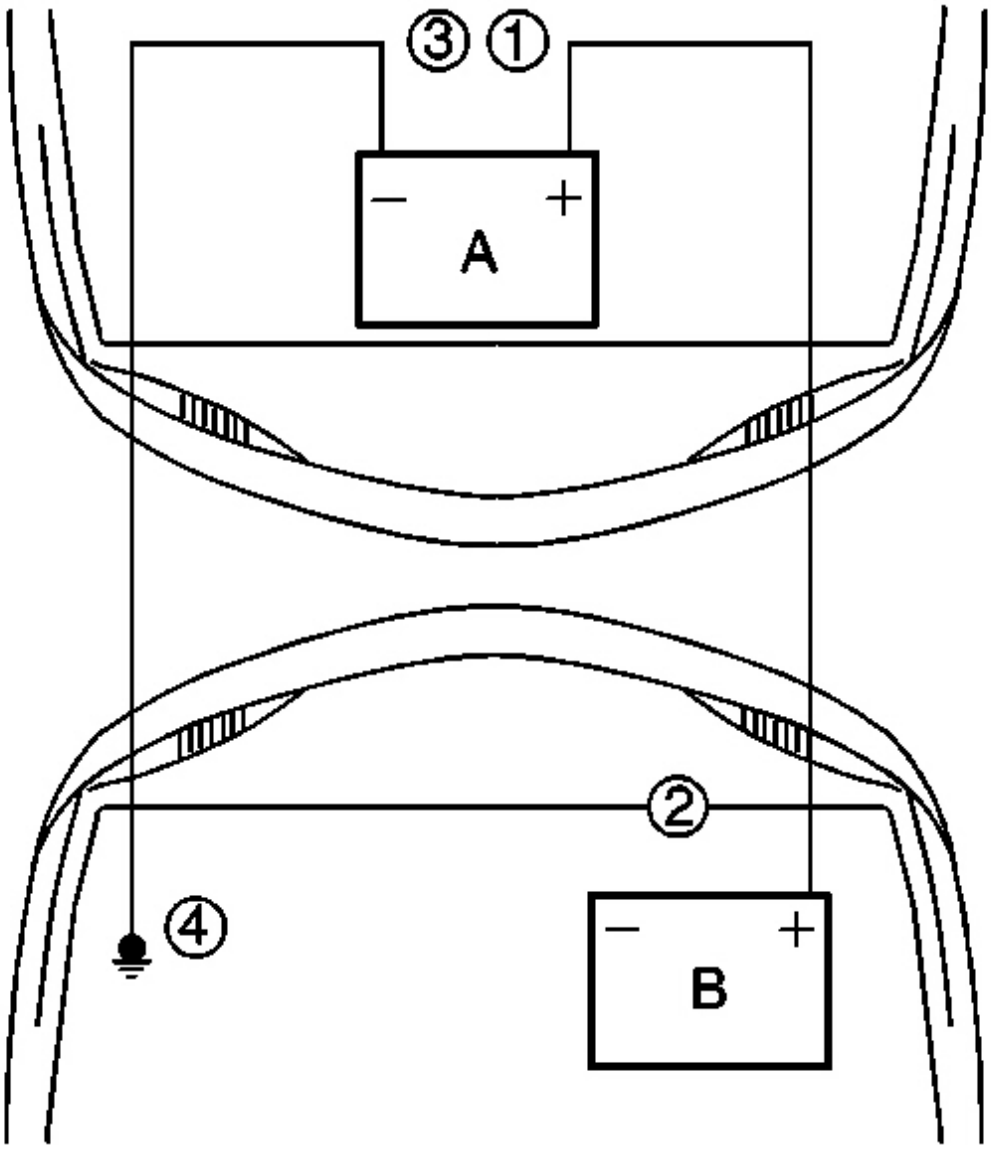


Fig. 10: Identifying Proper Jumper Cable Connection
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Some vehicles have a battery remote positive stud. ALWAYS use the battery remote positive stud in order to give or to receive a jump start. Consult the vehicle's owner's manual

for proper connections.

3. Attach the end of one jumper cable to the positive terminal of the discharged battery.
4. Attach the other end of the first cable to the positive terminal of the booster battery.
5. Attach one end of the remaining jumper cable to the negative terminal of the booster battery.

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.

6. Make the final connection of the negative jumper cable to the block or suitable bracket connected directly to the block, away from the battery.
7. Start the engine of the vehicle that is providing the jump start and turn off all electrical accessories. Raise the engine RPM to approximately 1,500 RPM.
8. Crank the engine of the vehicle with the weak battery.

   If the engine does not crank or cranks too slowly, perform the following steps:

   1. Turn the ignition OFF.
   2. Allow the booster vehicle engine to run at approximately 1,500 RPM for 5 minutes.
   3. Attempt to start the engine of the vehicle with the discharged battery.
9. Reverse the steps exactly when removing the jumper cables. The negative battery cable must first be disconnected from the engine that was jump started.

CHARGING SYSTEM TEST

Charging System Test

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
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 (Non-HP2)**

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**
	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**			

5	**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. 5. Start the engine. 6. With a scan tool, command the GEN-L Terminal ON. 7. Increase engine speed to 2,500 RPM. 8. 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 **Generator Usage** ?	-	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	1. Leave the vehicle accessories ON or maintain load test value. 2. Maintain engine speed at 2,500 RPM. 3. Measure the voltage between the generator output terminal and the generator metal housing.	B+		

	Is the voltage measured equal to the specified value?		Go to **Step 14**	Go to **Step 9**
8	1. Turn ON the ignition, with the engine OFF. 2. Disconnect the generator harness connector. 3. Measure the voltage between the generator turn ON signal circuit and ground. 4. Start the engine. 5. 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	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 battery negative terminal to the metal housing of the generator. Refer to **Circuit Testing** and **Wiring Repairs** . Is the voltage measured less than the specified value?	0.5 V	Go to **Step 10**	Go to **Step 15**
	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			

10	the generator to the positive terminal on the battery. Refer to **Circuit Testing** and **Wiring Repairs** . 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 **Circuit Testing** and **Wiring Repairs** . 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 **Circuit Testing** and **Wiring Repairs** . 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 powertrain control module (PCM). Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . 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 **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . 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 **Wiring**	-		-

	Repairs . Did you complete the repair?		Go to **Step 19**	
16	Repair the high resistance or open in the generator output circuit. Refer to **Wiring Repairs** . Did you complete the repair?	-	Go to **Step 19**	-
17	Replace the PCM. Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	-	Go to **Step 19**	-
18	Replace the generator. Refer to **Generator Replacement**. 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: Starting and Charging Schematics or **Instrument Cluster Schematics**				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	Start the engine. Does the battery charge indicator remain illuminated?	-	Go to **Step 3**	Go to **Testing for Intermittent Conditions and Poor Connections**
	1. Install a scan tool			

3	2. With a scan tool, observe the Battery Voltage parameter in the instrument panel cluster (IPC) data list. Does the voltage measure within the normal operating range?	12.5-15.5 V	Go to **Step 4**	Go to **Charging System Test**
4	Replace the IPC. Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	-	Go to **Step 5**	-
5	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
1	Did you perform the Diagnostic System Check - Vehicle?	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	Turn ON the ignition, with the engine OFF observe the charge indicator on the instrument panel cluster (IPC). Is the charge indicator illuminated?	Go to **Testing for Intermittent Conditions and Poor Connections**	Go to **Step 3**
3	Replace the IPC. Refer to **Control Module References** for replacement, setup and programming. Did you complete the replacement?	Go to **Step 4**	-
4	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, 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**. 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 the engine. 3. Disconnect the 4-way connector from the generator. 4. Start the engine. 5. Listen for the noise. Has the noise stopped?	Go to **Step 11**	Go to **Step 3**
3	1. Turn OFF the engine. 2. Remove the drive belt. Refer to **Drive Belt Replacement (Without A/C)** or **Drive Belt Replacement (With A/C)** . 3. 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**
	1. Loosen all of the generator mounting		

5	bolts. 2. Tighten the generator mounting bolts to specifications and in the proper sequence, if necessary. Refer to **Generator Replacement**. 3. Install the drive belt. Refer to **Drive Belt Replacement (Without A/C)** or **Drive Belt Replacement (With A/C)** . 4. 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 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 **Drive Belt Tensioner Diagnosis** . Is the drive belt loose?	Go to **Step 9**	Go to **Step 10**
	1. Replace the drive belt tensioner.		

9	Refer to **Drive Belt Tensioner Replacement** . 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 **Generator Replacement**.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: Starting and Charging Schematics			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	Turn the ignition switch to the START position. Does the engine crank?	Go to **Testing for Intermittent Conditions and Poor Connections**	Go to **Step 3**
	Is the security indicator flashing?	Go to **Diagnostic**	

3		**System Check - Vehicle**	Go to **Step 4**
4	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, observe the Crank Request Signal parameter in the powertrain control module (PCM) data list. 4. Turn the ignition switch to the START position. Does the scan tool display Yes?	Go to **Step 5**	Go to **Power Mode Mismatch**
5	1. Turn ON the ignition, with the engine OFF. 2. With a scan tool, observe the Starter Relay Command parameter in the PCM data list. 3. Turn the ignition switch to the START position. Does the scan tool display Yes?	Go to **Step 7**	Go to **Step 6**
6	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 TR Sw. parameter in the PCM data list. Does the scan tool display Park or Neutral?	Go to **Step 7**	Go to **Range Selector Displays Incorrect Range**
7	Turn the ignition switch to the START position. Do you hear the PCM CNTRL relay click?	Go to **Step 10**	Go to **Step 8**
	1. Turn OFF the ignition. 2. Disconnect the PCM CNTRL relay.		

8	3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the battery positive voltage circuit of the PCM CNTRL relay coil and a good ground. Does the test lamp illuminate?	Go to **Step 9**	Go to **Step 18**
9	1. Connect a test lamp between the battery positive voltage circuit of the PCM CNTRL relay coil and the control circuit of the PCM CNTRL relay. 2. Turn the ignition to the START position. Does the test lamp illuminate?	Go to **Step 15**	Go to **Step 14**
10	1. Turn OFF the ignition. 2. Disconnect the PCM CNTRL relay. 3. Connect a test lamp between the battery positive voltage circuit of the PCM CNTRL relay switch and a good ground. Does the test lamp illuminate?	Go to **Step 11**	Go to **Step 19**
11	**IMPORTANT:** **Ensure the parking brake is applied and the transmission is in park if equipped with an automatic transmission or neutral on a manual transmission.** Connect a 30-amp fused jumper between the battery positive voltage circuit of the PCM CNTRL relay switch and the starter solenoid crank voltage circuit.Does the engine crank?	Go to **Step 16**	Go to **Step 12**
12	Does the fuse in the jumper open?	Go to **Step 20**	Go to **Step 13**
	Test the starter solenoid crank voltage		

13	circuit for a high resistance or open. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	Go to **Step 24**	Go to **Step 16**
14	Test the control circuit of the PCM CNTRL relay for an open or short to battery voltage. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	Go to **Step 24**	Go to **Step 17**
15	Inspect for poor connections at the PCM CNTRL relay. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 24**	Go to **Step 21**
16	Inspect for poor connections at the starter solenoid. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 24**	Go to **Step 22**
17	Inspect for poor connections at the harness connector of the PCM. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 24**	Go to **Step 23**
18	Repair an open or high resistance in the battery positive voltage circuit of the PCM CNTRL relay coil. Refer to **Wiring Repairs** . Did you complete the repair?	Go to **Step 24**	-
19	Repair the open or high resistance in the battery positive voltage circuit of the PCM CNTRL relay switch. Refer to **Wiring Repairs** . Did you complete the repair?	Go to **Step 24**	-
20	Repair the short to ground in the starter solenoid crank voltage circuit. Refer to **Wiring Repairs** . Did you complete the repair?	Go to **Step 24**	-
	Replace the PCM CNTRL relay. Refer to		

21	**Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)** . Did you complete the replacement?	Go to **Step 24**	-
22	Replace the starter motor. Refer to **Starter Motor Replacement**. Did you complete the replacement?	Go to **Step 24**	-
23	Replace the PCM. Refer to **Control Module References** for replacement, setup and programming. Did you compete the replacement?	Go to **Step 24**	-
24	Operate the system in order to verify the repair. 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: Starting and Charging Schematics			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	Turn the ignition to the START position. Did the starter solenoid click?	Go to **Step 3**	Go to **Starter Solenoid Does Not Click**
3	Inspect the engine and belt drive system for mechanical binding, e.g. seized engine, seized generator. Does the engine move freely?	Go to **Step 4**	Go to **Engine Will Not Crank - Crankshaft Will Not Rotate**
4	Test the battery positive cable between the battery and the starter solenoid for high resistance. Refer to **Circuit Testing** and **Wiring Repairs** . Did you find and correct the condition?	Go to **Step 8**	Go to **Step 5**
	Test the ground circuit between the battery and the starter motor for a high resistance.		

5	Refer to **Circuit Testing** and **Wiring Repairs** . 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 **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** . Did you find and correct the condition?	Go to **Step 8**	Go to **Step 7**
7	Replace the starter. Refer to **Starter Motor Replacement**. 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

Perform the following checks:

- Battery-Battery Inspection/Test. Refer to **Battery Inspection/Test (Non-HP2)**.
- Wiring-Inspect the wiring for damage. Inspect all connections to the starter motor, solenoid, battery and all ground connections. Refer to **Circuit Testing** , **Wiring Repairs** , **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** .
- Engine-Make sure 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**.

STARTER MOTOR NOISE DIAGNOSIS

Diagnostic Aids

Inspect the flywheel ring gear for damage or unusual wear.

Starter Motor Noise Diagnosis

Step	Action	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to **Diagnostic System Check -**

		Go to **Step 2**	**Vehicle**
2	Start the engine. Does the starter operate normally?	Go to **Testing for Intermittent Conditions and Poor Connections**	Go to **Step 3**
3	Start the engine while listening to the starter motor turn. Is there a loud "whoop", it 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	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 6**	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 9**
7	1. Remove the starter motor. Refer to **Starter Motor Replacement**. 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 8**
8	Replace the flywheel. Refer to **Engine Flywheel Replacement (w/Automatic Transmission)** . Did you complete the replacement?	Go to **Step 10**	-
9	Replace the starter motor. Refer to **Starter Motor Replacement**. 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 DISCONNECTION AND CONNECTION

Disconnecting Procedure

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.**

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

result in personal injury and/or damage to the vehicle or its components.

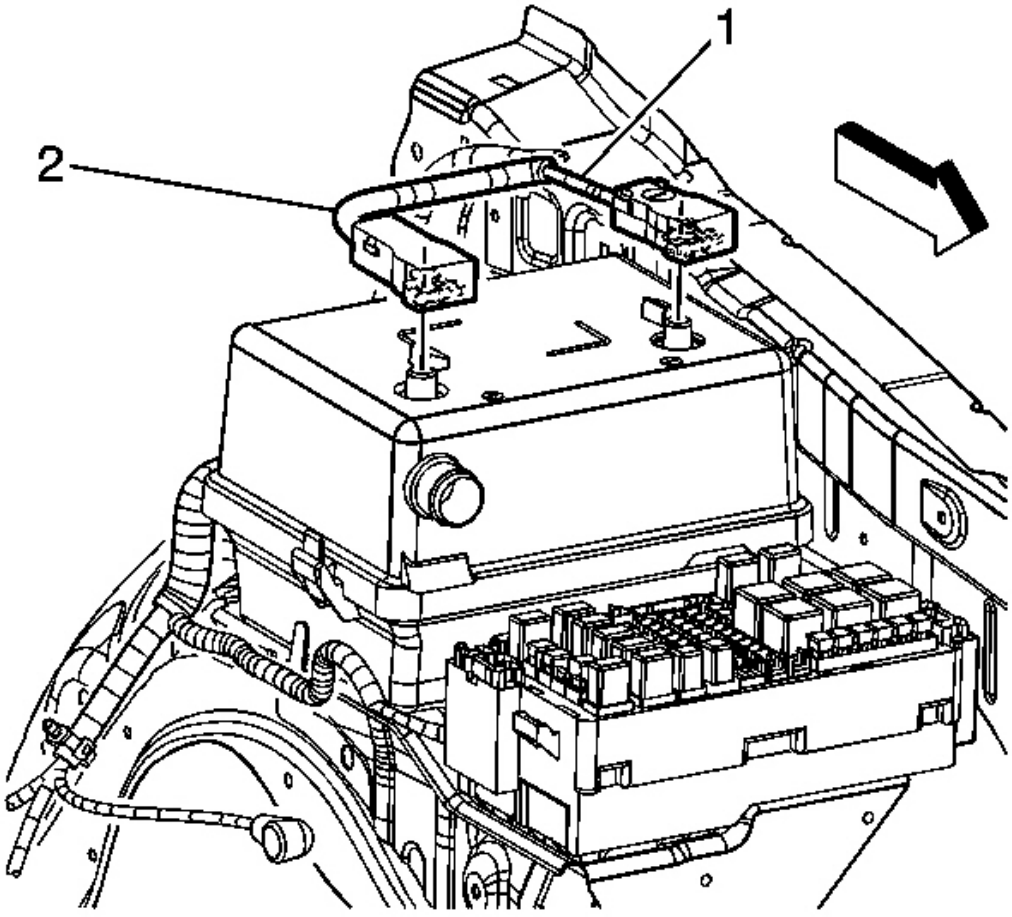


Fig. 11: Identifying Battery Cables
Courtesy of GENERAL MOTORS CORP.

1. Record all preset and theft codes from the radio.
2. Turn off all lamps and accessories.
3. Turn the ignition switch to the LOCK position.
4. Open the negative battery cable cover.
5. Loosen the negative battery cable nut.

6. Remove the negative battery cable (1) from the battery.

Connecting Procedure

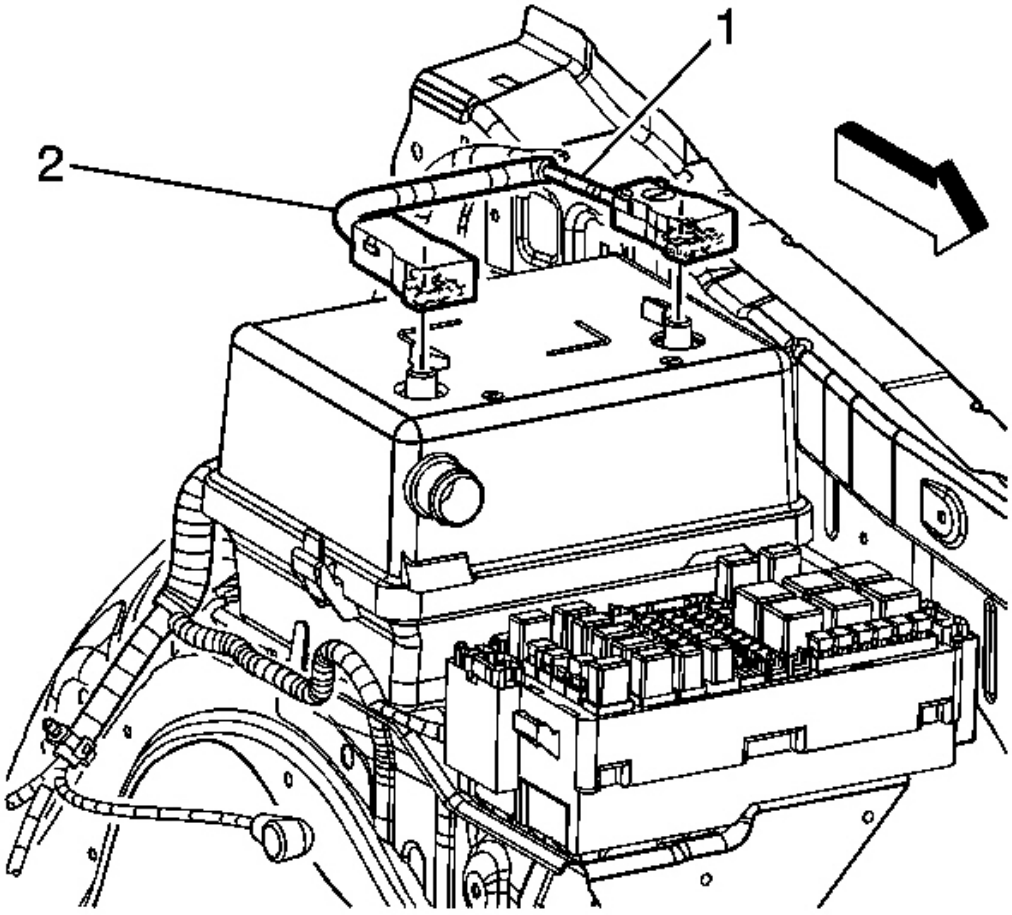


Fig. 12: Identifying Battery Cables
Courtesy of GENERAL MOTORS CORP.

1. Clean any existing corrosion from the battery terminal and battery cable (1) using a wire brush.
2. Install the negative battery cable (1) to the battery.

NOTE: Refer to Fastener Notice .

3. Tighten the negative battery cable nut.

   Tighten: Tighten the nut to 9 N.m (80 lb in).

4. Close the negative battery cable cover.
5. Reset all preset and theft codes previously recorded to the radio.

BATTERY POSITIVE AND NEGATIVE CABLE REPLACEMENT

IMPORTANT:

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

Removal Procedure

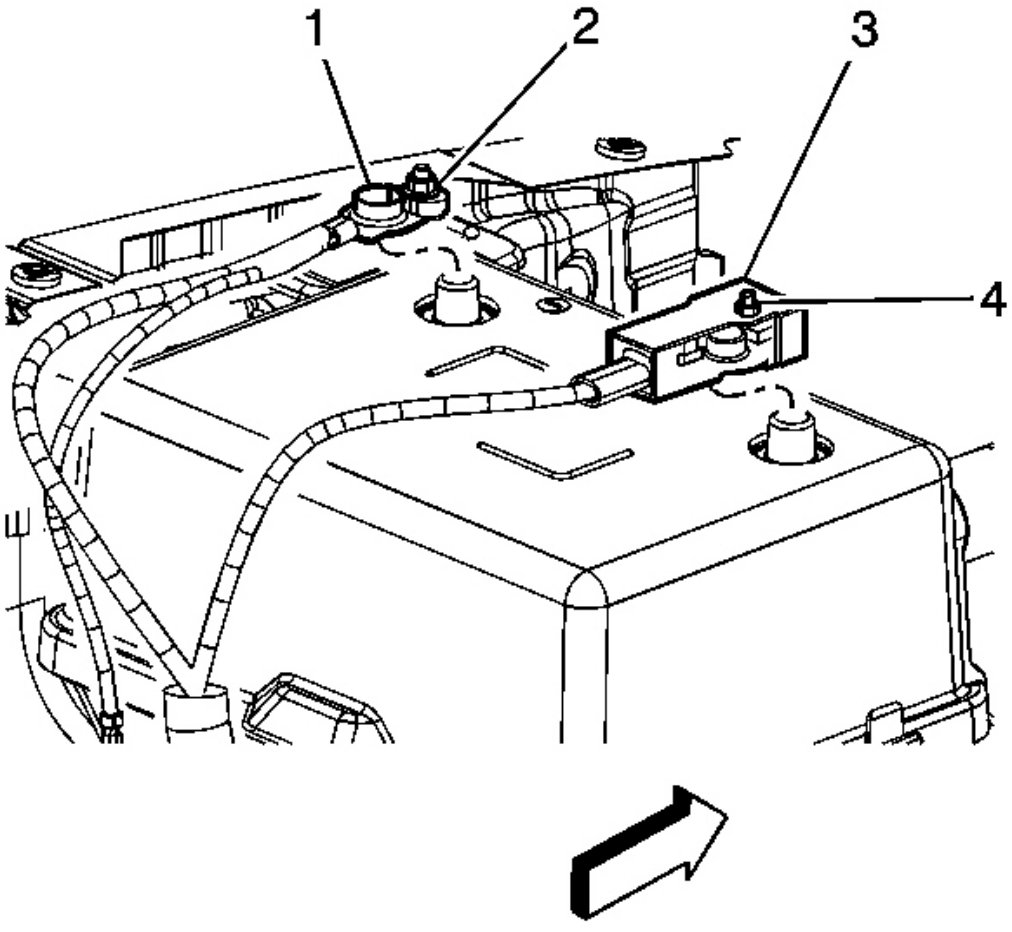


Fig. 13: View Of Battery Cables
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Open the protective cover to access the positive battery cable terminal.
3. Loosen the positive battery cable nut (3).
4. Remove the positive battery cable (4) from the battery.

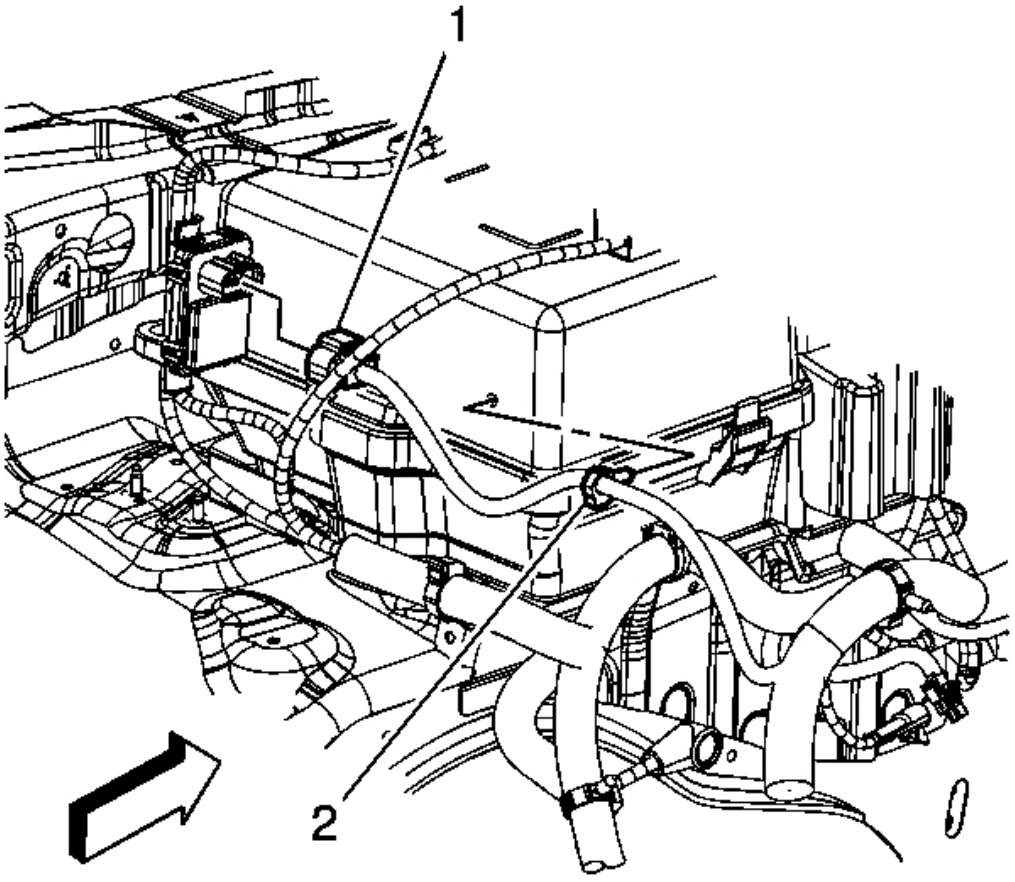


Fig. 14: Identifying Engine Wiring Harness Connector & Retaining Clips
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the engine wiring harness electrical connector (1) from the generator battery control module.
6. Remove the engine wiring harness clip (2) from the upper battery box.

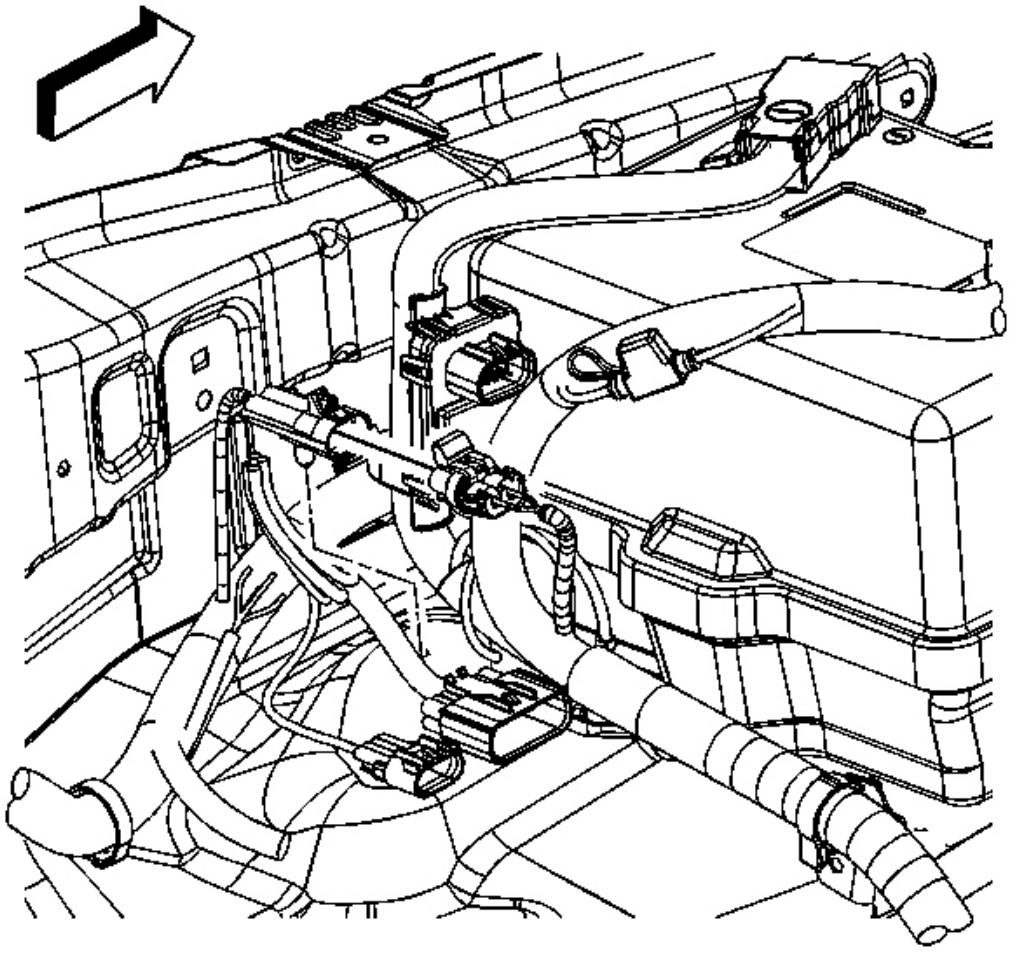


Fig. 15: Identifying Battery Cable Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the battery cable wiring harness electrical connector from the body wiring harness electrical connector.

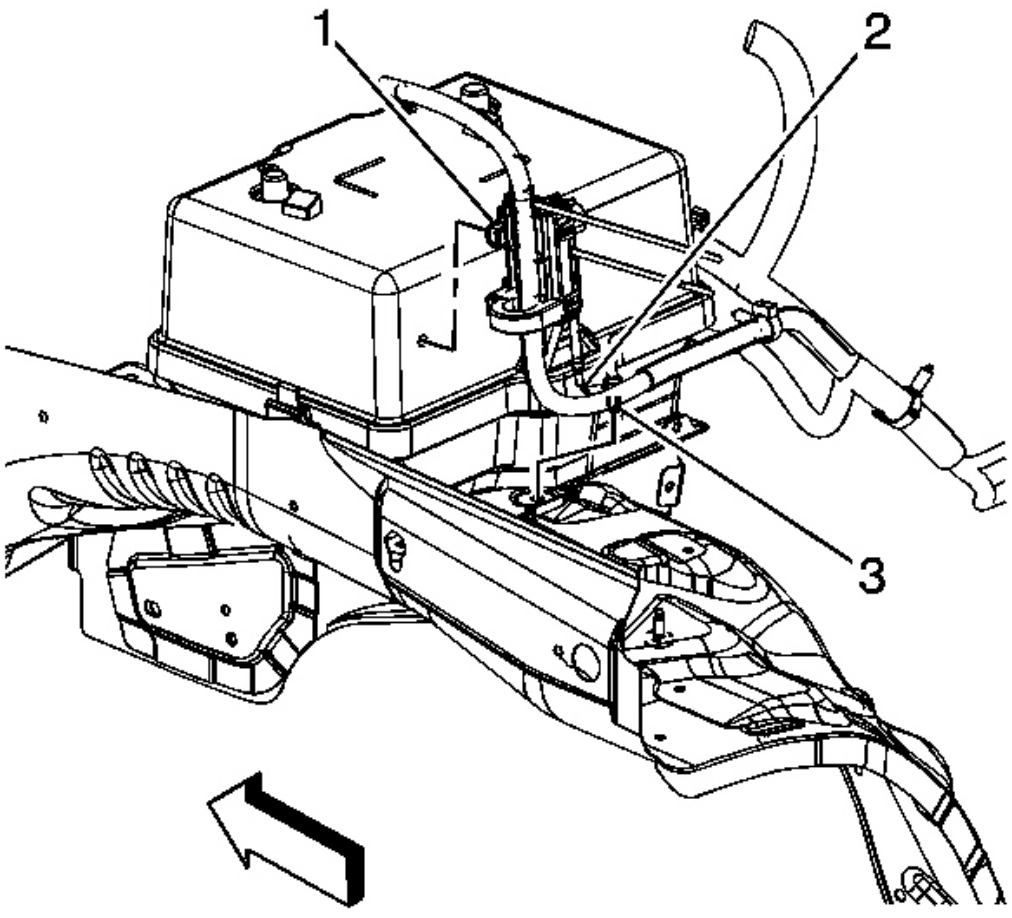


Fig. 16: Locating Negative Battery Cable Ground Bolt & Control Module Clip
Courtesy of GENERAL MOTORS CORP.

8. Remove the bolt (3) securing the negative battery cable ground (2) to the battery tray.
9. Remove the generator battery control module clip (1) from the upper battery box.

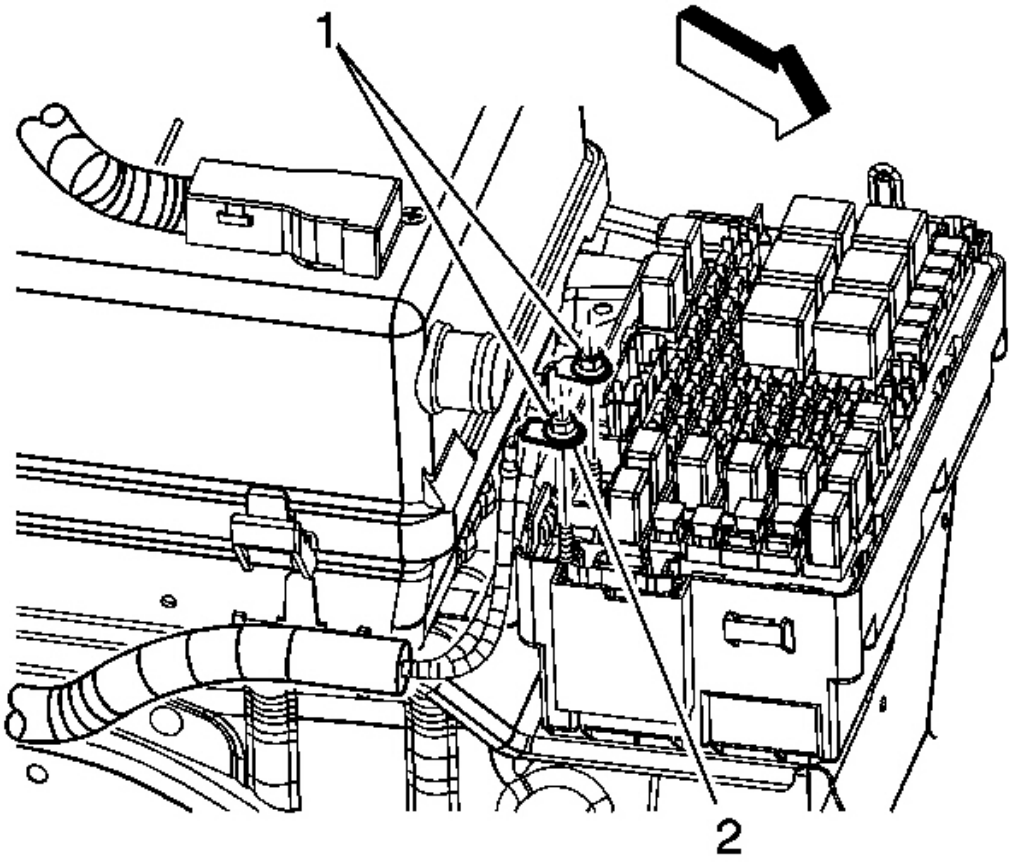


Fig. 17: Locating Nuts Securing The Battery Cables To Underhood Fuse Block
Courtesy of GENERAL MOTORS CORP.

10. Press the locking tabs inward in order the remove the underhood fuse block cover from the underhood fuse block.
11. Remove the nuts (1) securing the battery cables to the underhood fuse block.

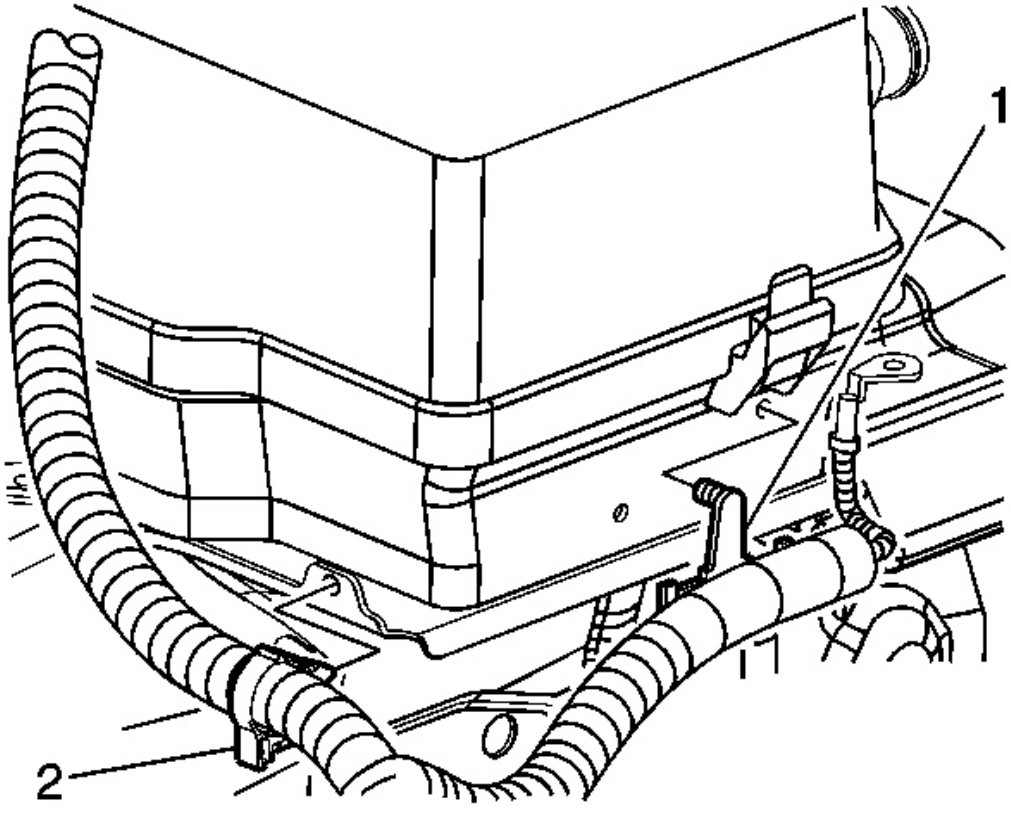


Fig. 18: Identifying Battery Cable Harness Clips
Courtesy of GENERAL MOTORS CORP.

12. Remove the battery cable harness clips (1, 2) from the battery tray.
13. Remove the left wheelhouse liner. Refer to **Wheelhouse Panel Replacement (Front)** or **Wheelhouse Panel Replacement (Rear)** .

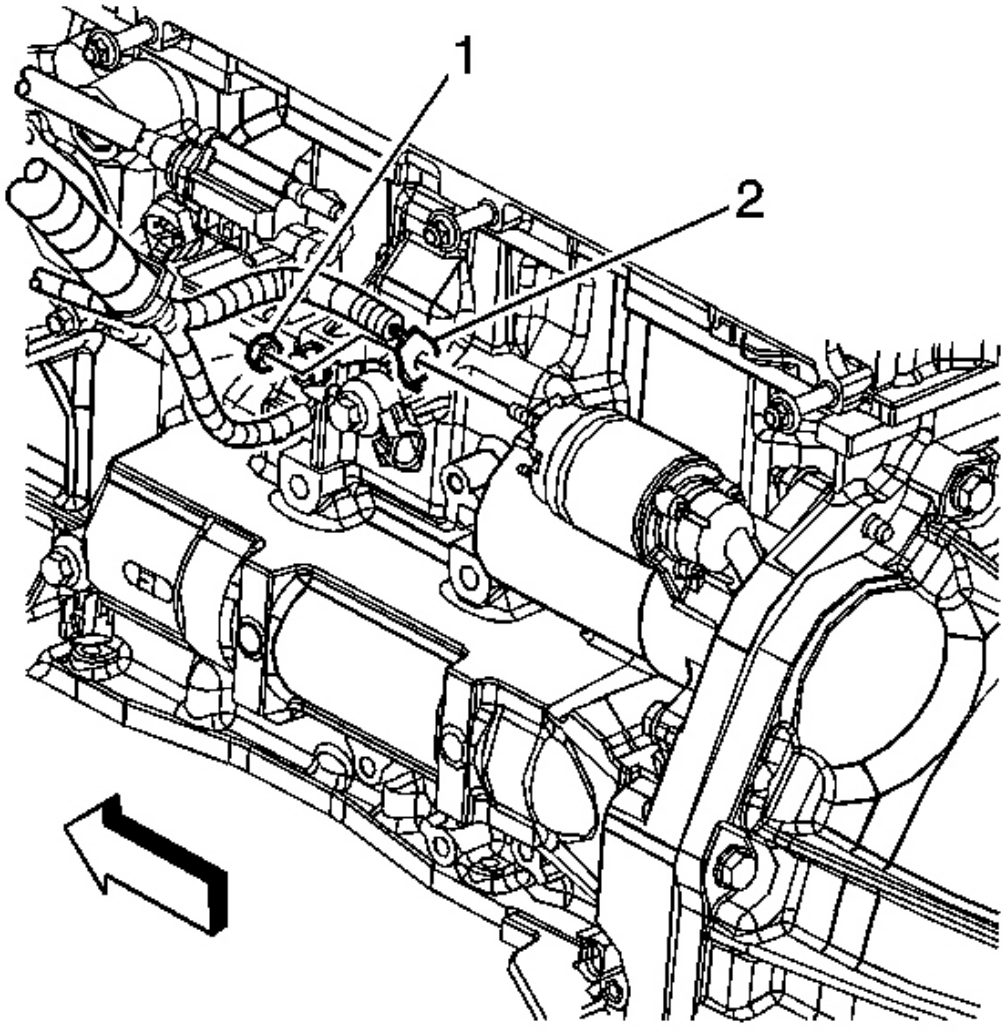


Fig. 19: View Of Starter Wiring
Courtesy of GENERAL MOTORS CORP.

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

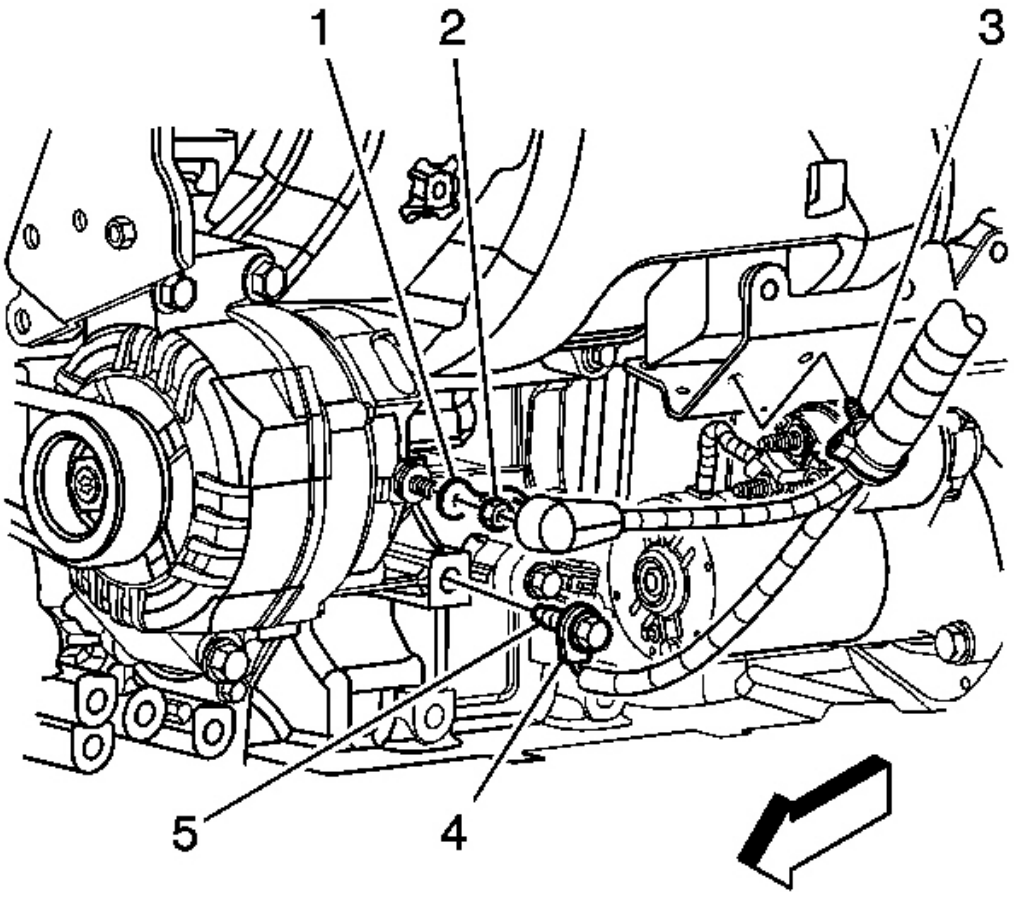


Fig. 20: Identifying Generator/Starter Wiring
Courtesy of GENERAL MOTORS CORP.

15. Remove the bolt (5) securing the negative battery cable ground terminal (4) to the engine block.
16. Remove the battery cable clip (3) from the engine wiring harness bracket.
17. Remove the battery cables from the vehicle.

Installation Procedure

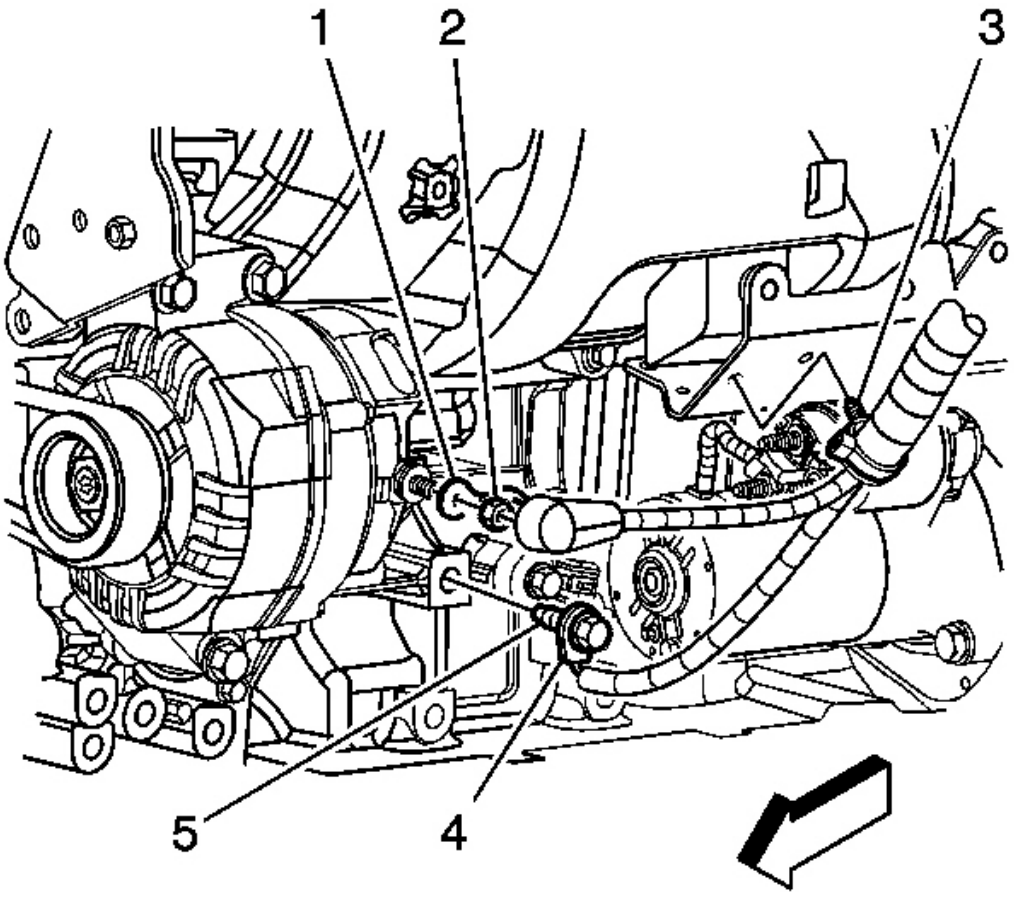


Fig. 21: Identifying Generator/Starter Wiring
Courtesy of GENERAL MOTORS CORP.

1. Insert the battery cables to the vehicle.
2. Install the battery cable clip (3) to the engine wiring harness bracket.

NOTE: Refer to Fastener Notice .

3. Install the bolt (5) securing the negative battery cable ground terminal (4) to the engine block.

Tighten: Tighten the bolt to 35 N.m (26 lb ft).

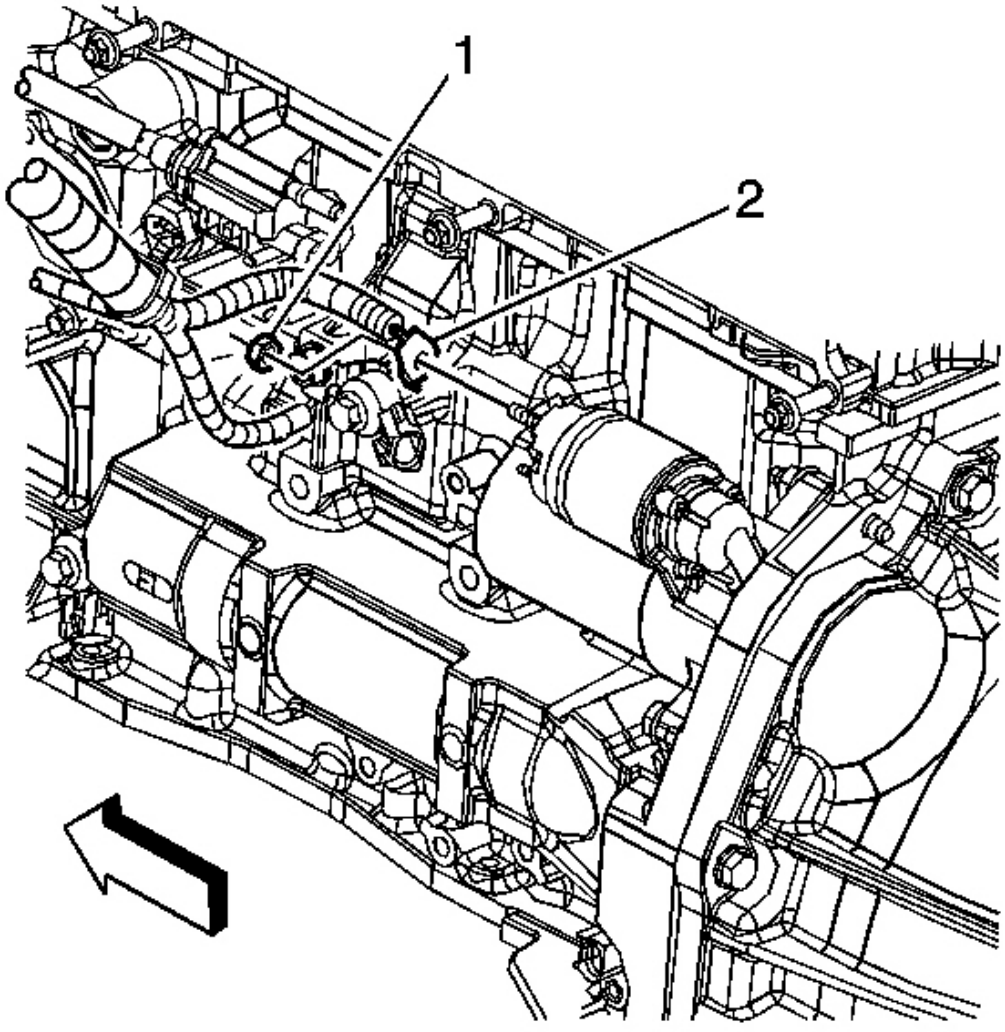


Fig. 22: View Of Starter Wiring
Courtesy of GENERAL MOTORS CORP.

4. Install the positive battery cable terminal (2) to the starter and the starter terminal nut (1).
5. Install the left wheelhouse liner. Refer to **Wheelhouse Panel Replacement (Front)** or **Wheelhouse Panel Replacement (Rear)** .

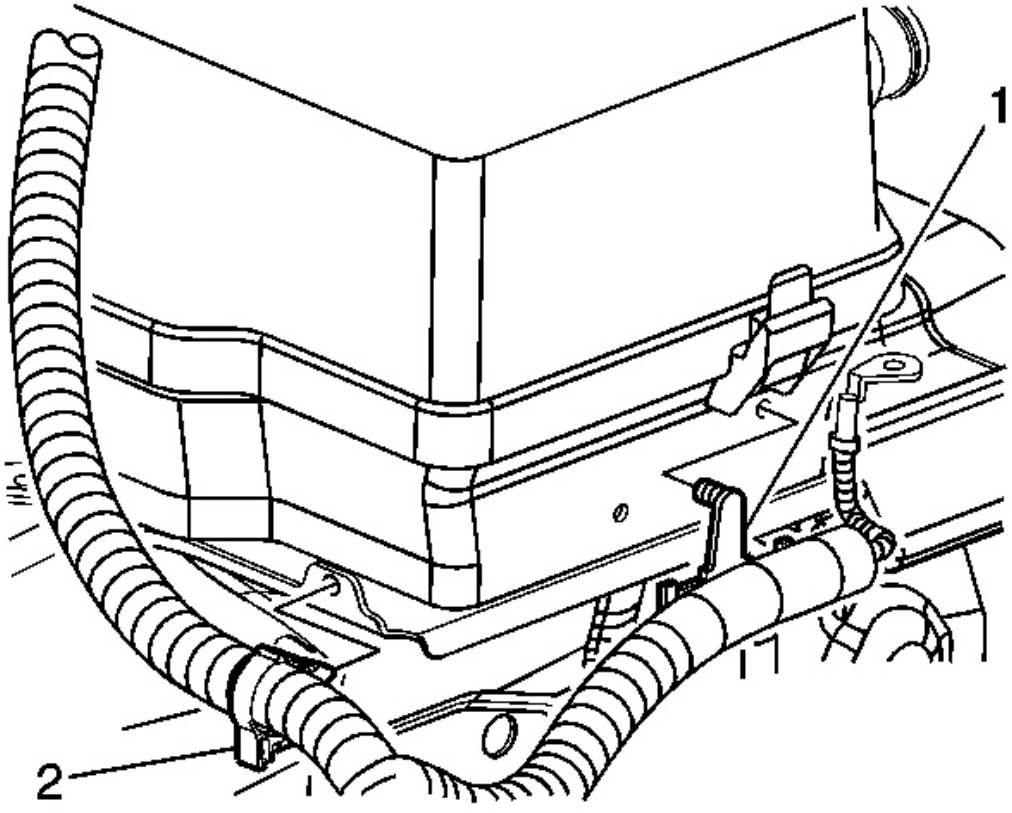


Fig. 23: Identifying Battery Cable Harness Clips
Courtesy of GENERAL MOTORS CORP.

6. Install the battery cable harness clips (1, 2) to the battery tray.

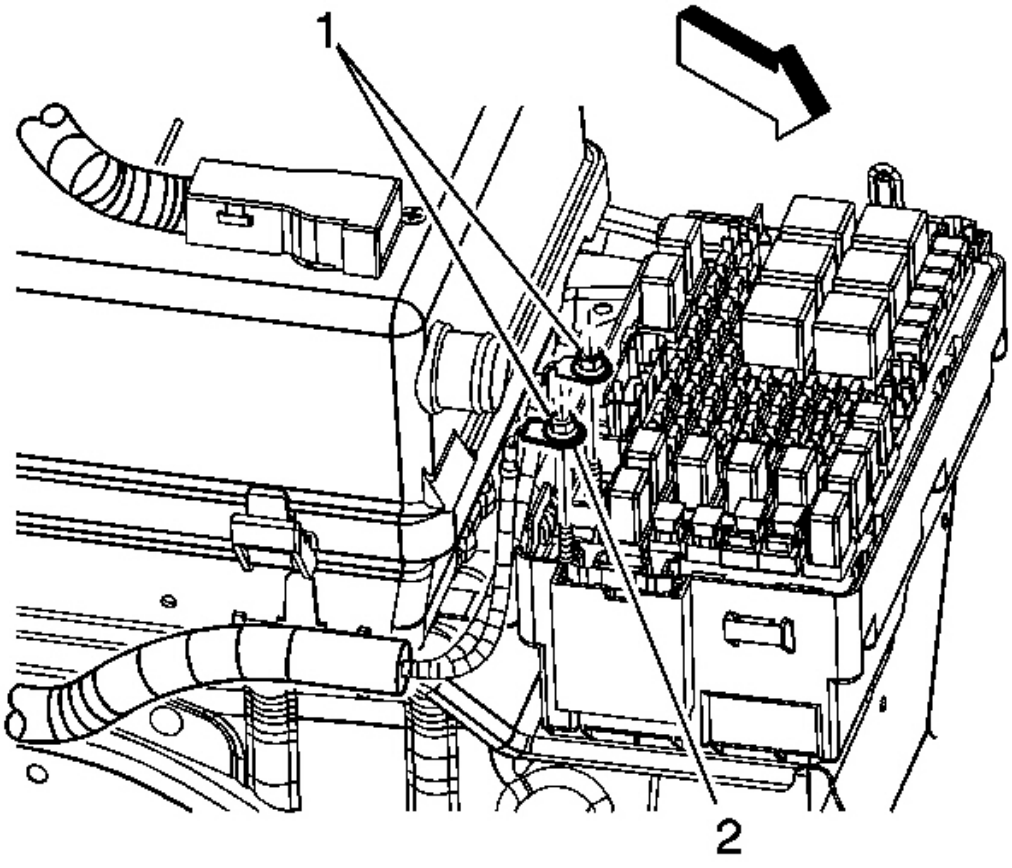


Fig. 24: Locating Nuts Securing The Battery Cables To Underhood Fuse Block
Courtesy of GENERAL MOTORS CORP.

7. Tighten the nuts (1) securing the battery cables to the underhood fuse block.

   Tighten: Tighten the nuts to 10 N.m (89 lb in).

8. Install the underhood fuse block cover to the underhood fuse block, engaging the locking tabs.

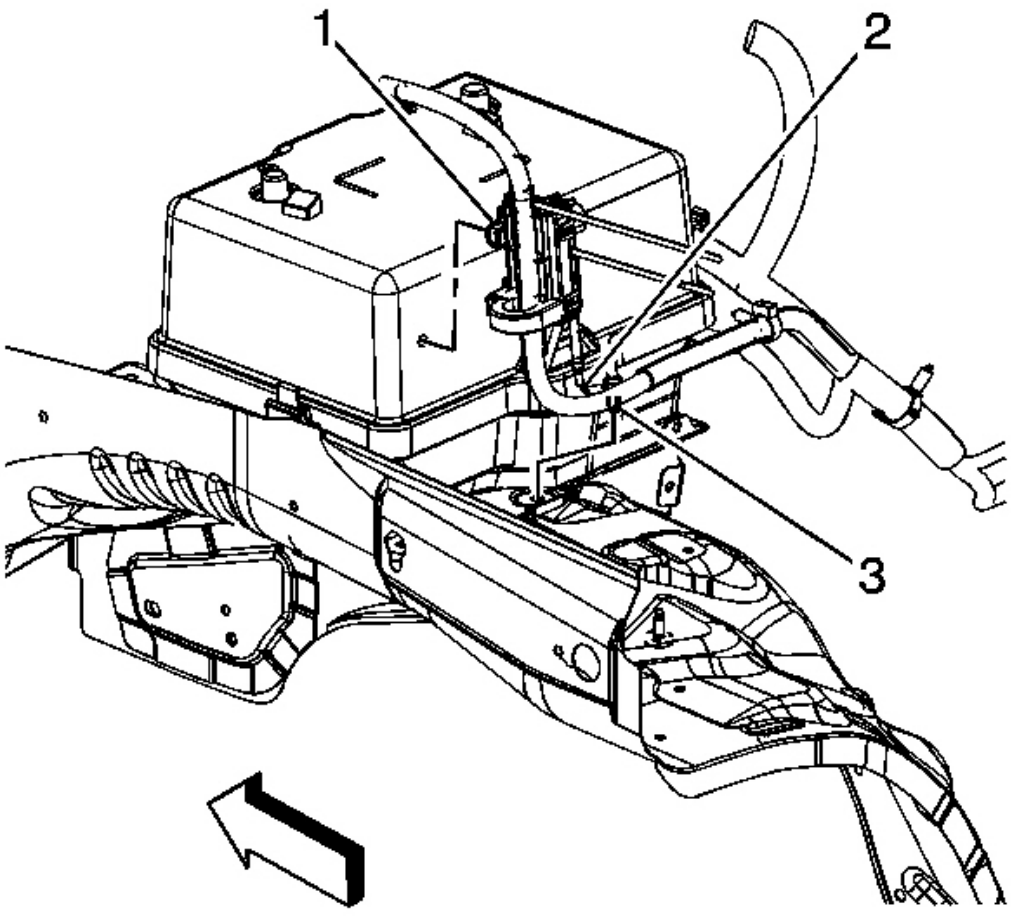


Fig. 25: Locating Negative Battery Cable Ground Bolt & Control Module Clip
Courtesy of GENERAL MOTORS CORP.

9. Install the generator battery control module clip (1) to the upper battery box.
10. Install the bolt (3) securing the negative battery cable ground (2) to the battery tray.

Tighten: Tighten the bolt to 9 N.m (80 lb in).

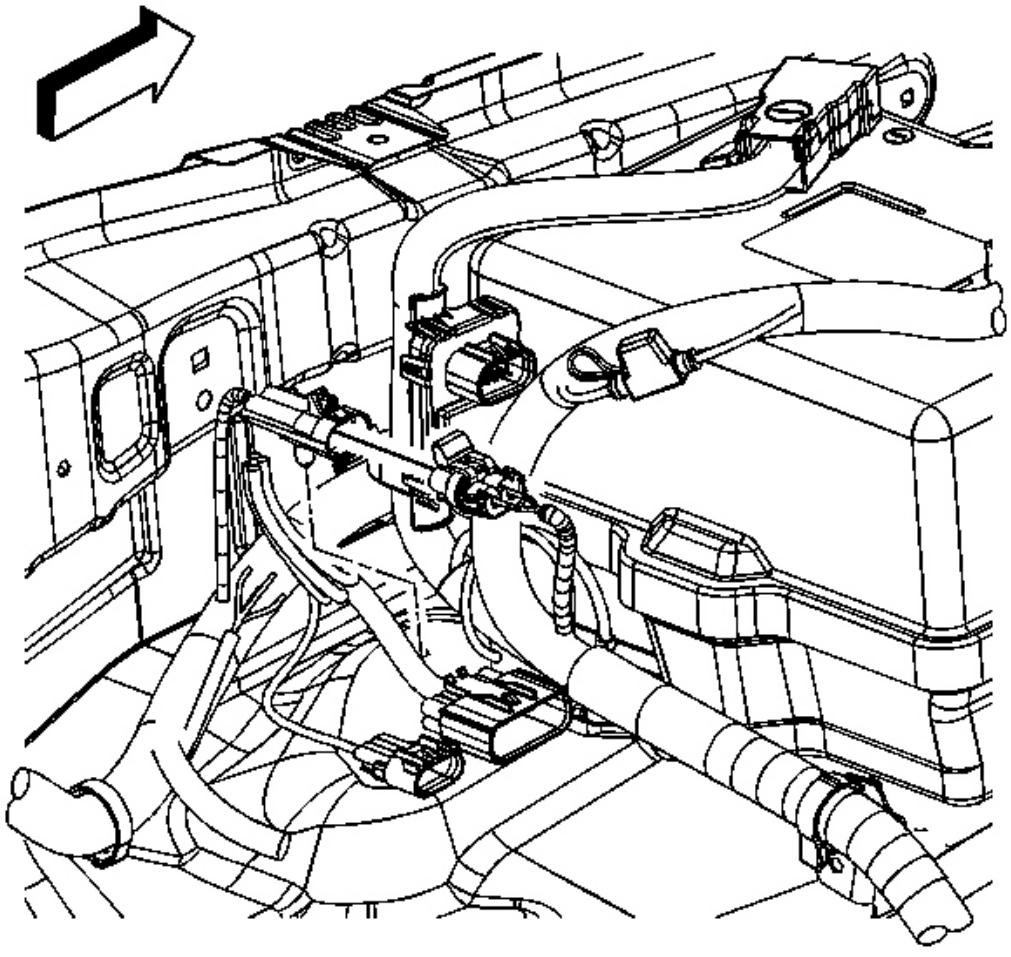


Fig. 26: Identifying Battery Cable Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

11. Connect the battery cable wiring harness electrical connector to the body wiring harness electrical connector.

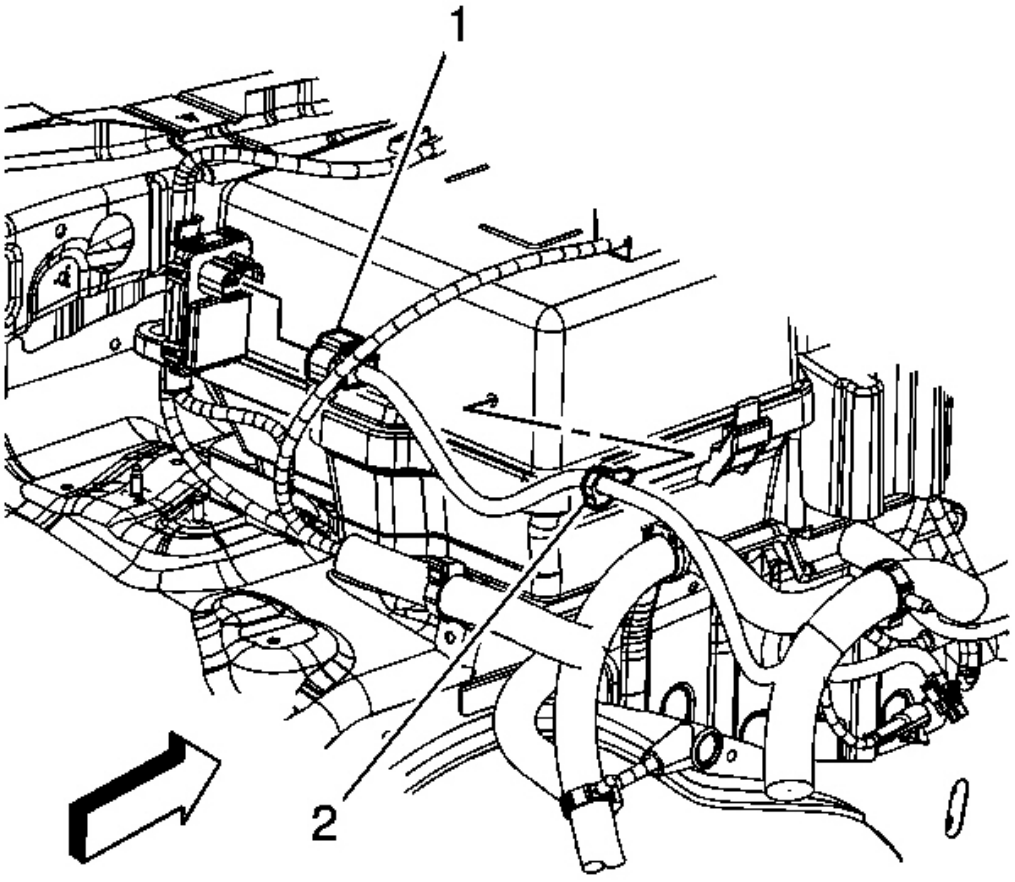


Fig. 27: Identifying Engine Wiring Harness Connector & Retaining Clips
Courtesy of GENERAL MOTORS CORP.

12. Connect the engine wiring harness electrical connector (1) to the generator battery control module.
13. Install the engine wiring harness clip (2) to the upper battery box.

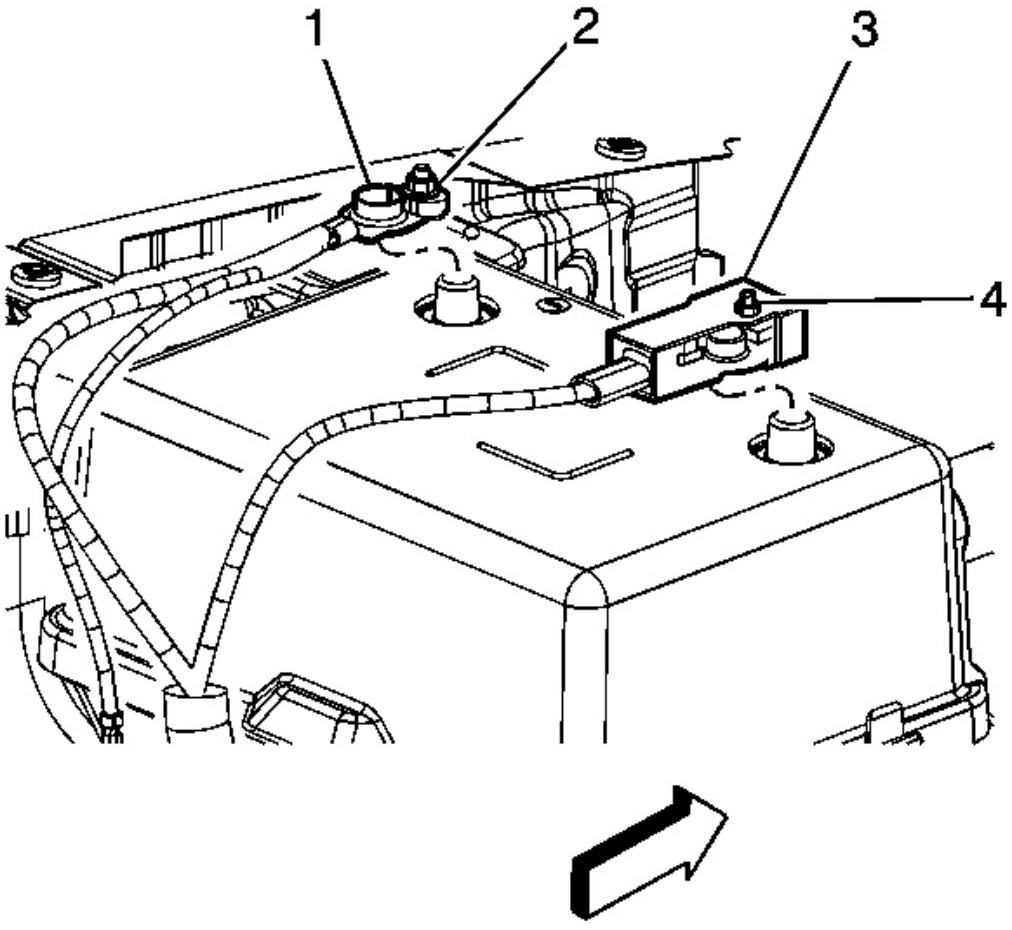


Fig. 28: View Of Battery Cables
Courtesy of GENERAL MOTORS CORP.

14. Install the positive battery cable (4) to the battery.
15. Tighten the positive battery cable nut (3).

    Tighten: Tighten the nut to 9 N.m (80 lb in).

16. Close the protective cover to access the positive battery cable terminal.
17. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

GENERATOR CABLE REPLACEMENT

IMPORTANT:

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

Removal Procedure

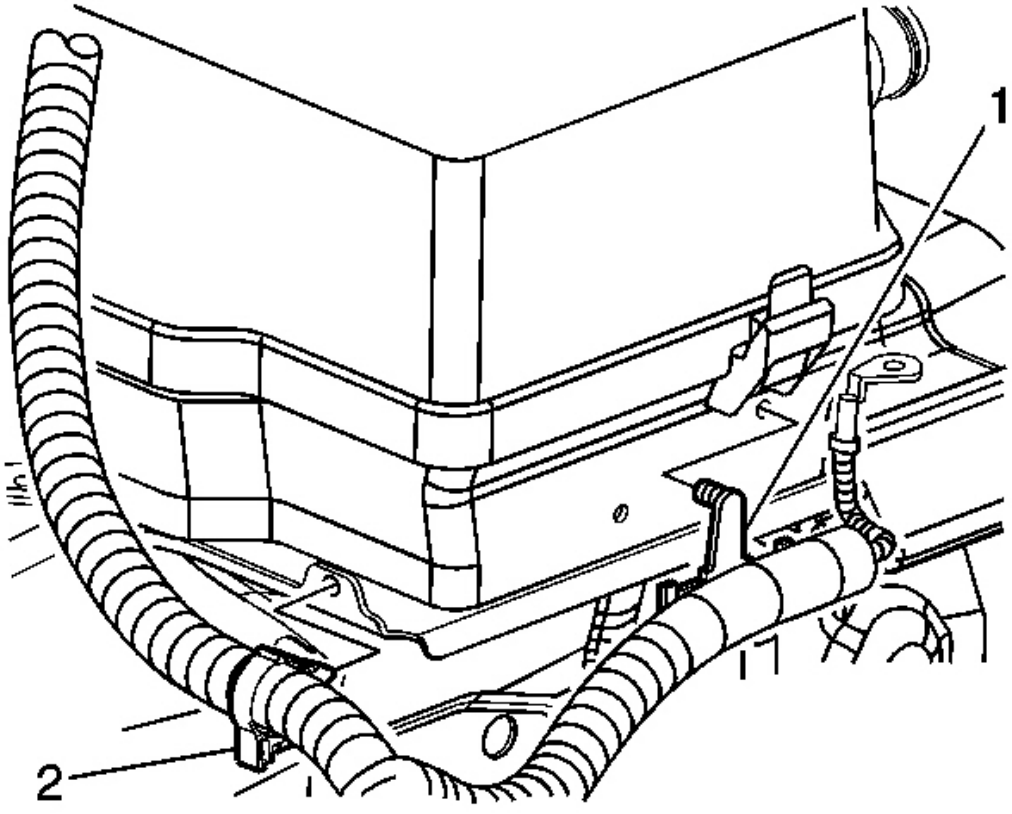


Fig. 29: Identifying Battery Cable Harness Clips
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**.

2. Remove the battery cable harness clips (1, 2) from the battery tray.

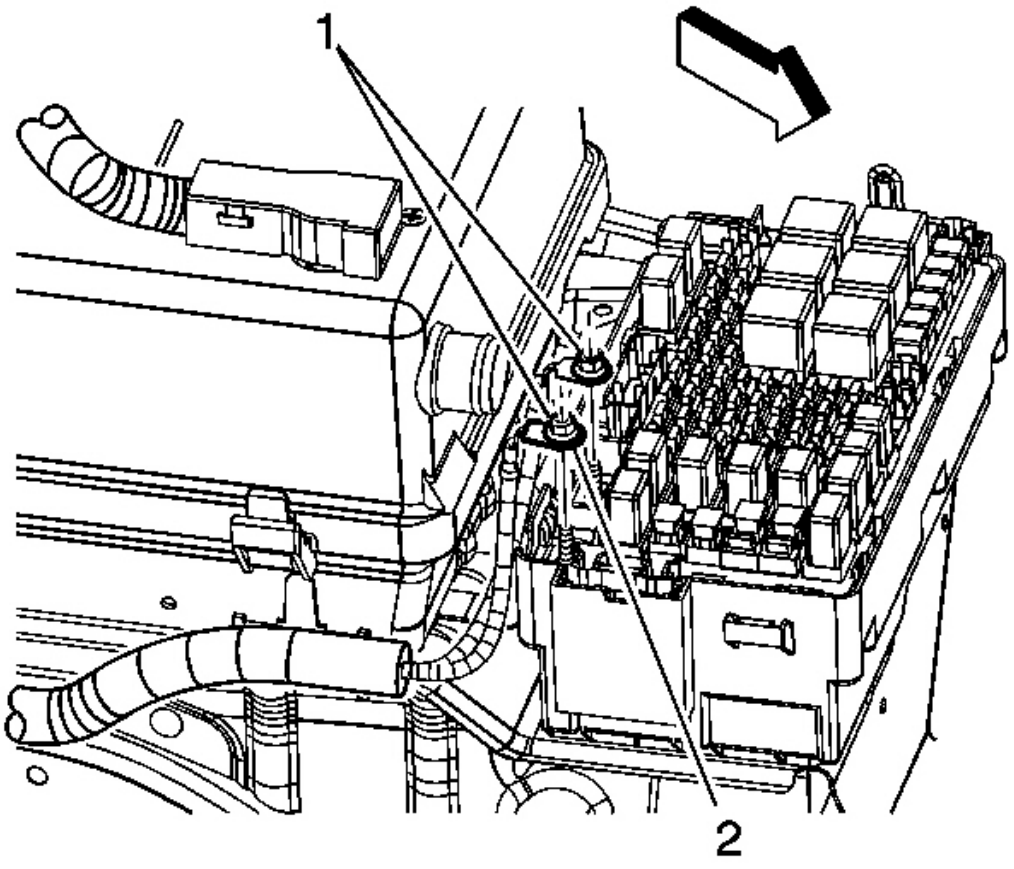


Fig. 30: Locating Nuts Securing The Battery Cables To Underhood Fuse Block
Courtesy of GENERAL MOTORS CORP.

3. Press the locking tabs inward in order to remove the underhood fuse block cover from the underhood fuse block.
4. Remove the nut (1) securing the generator positive cable inner terminal to the underhood fuse block.

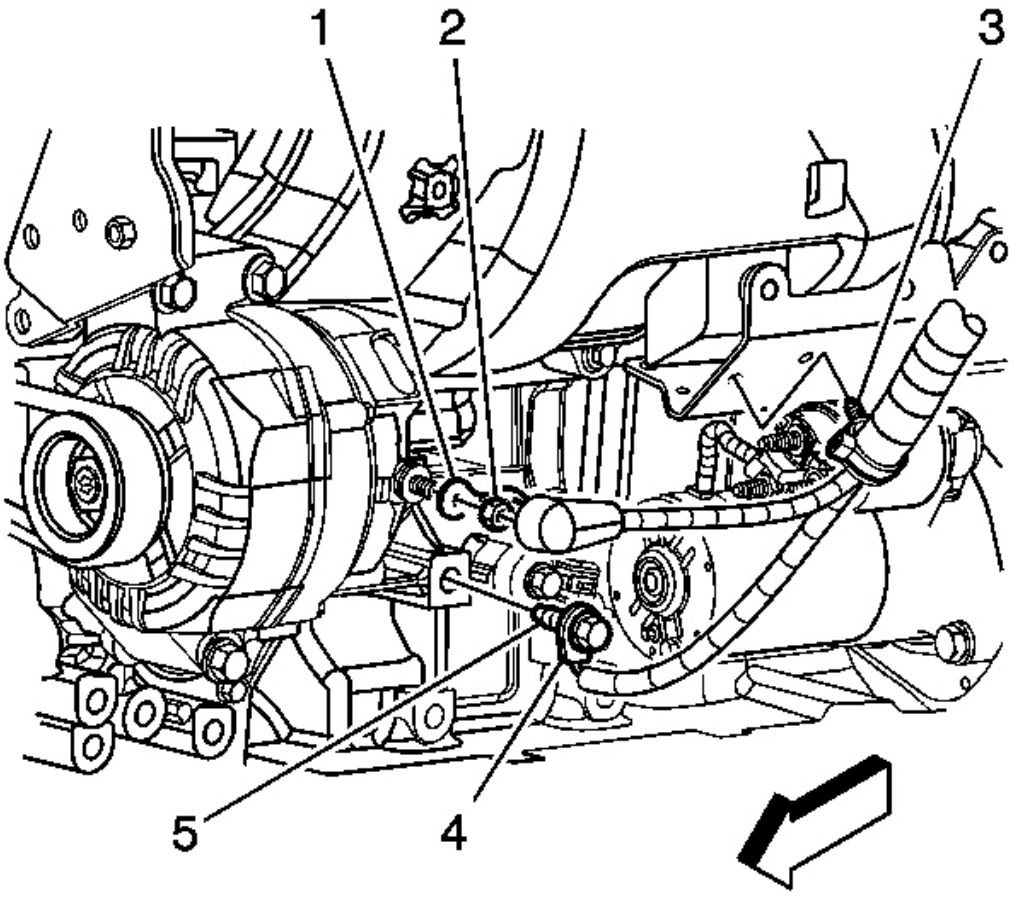


Fig. 31: Identifying Generator/Starter Wiring
Courtesy of GENERAL MOTORS CORP.

5. Remove the left front wheelhouse liner. Refer to **Wheelhouse Panel Replacement (Front)** or **Wheelhouse Panel Replacement (Rear)** .
6. Reposition the protective boot from the generator output BAT terminal for access.
7. Remove the generator output BAT terminal nut (2) and disconnect the generator positive lead (1) from the generator.
8. Remove the positive cable clip (3) from the engine wiring harness bracket.
9. Remove the generator positive cable from the battery cables harness conduit.

Installation Procedure

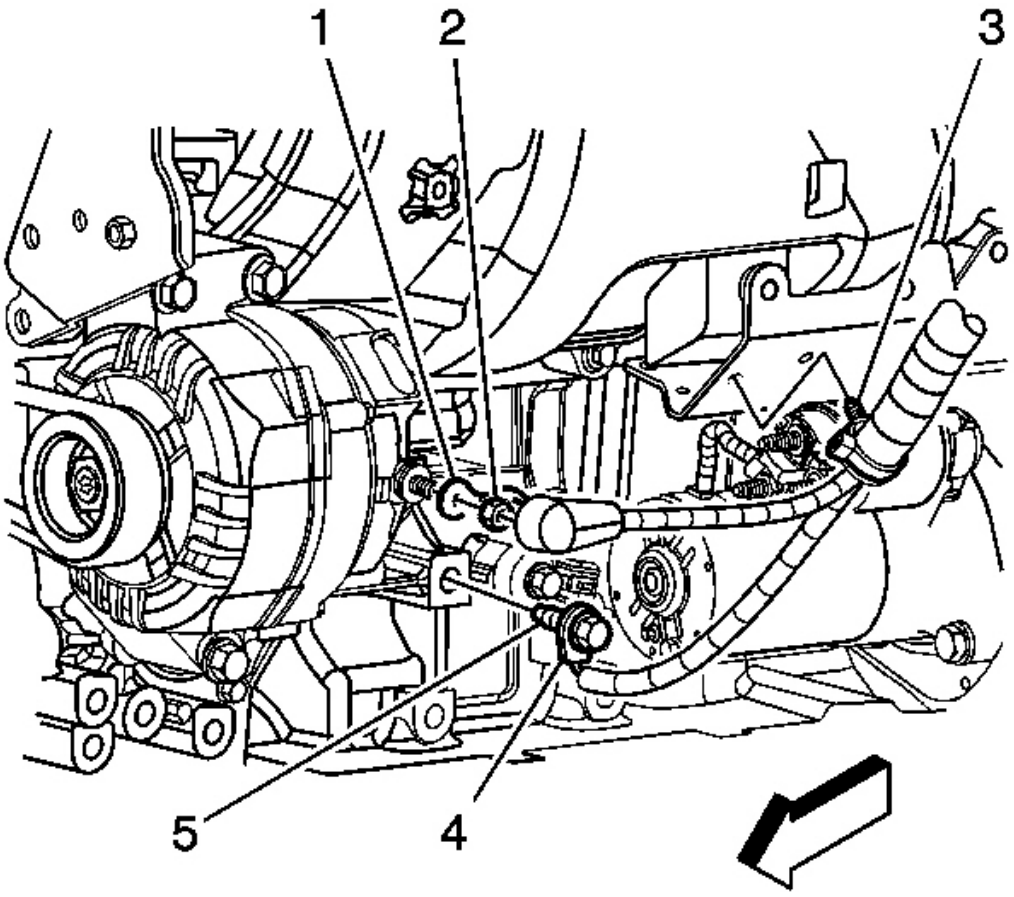


Fig. 32: Identifying Generator/Starter Wiring
Courtesy of GENERAL MOTORS CORP.

1. Insert the generator positive cable into the battery cables harness conduit.
2. Install the positive cable clip (3) to the engine wiring harness bracket.

NOTE: Refer to Fastener Notice .

3. Connect the generator positive lead (2) to the generator and install the generator output BAT terminal nut (1).

Tighten: Tighten the nut to 20 N.m (15 lb ft).

4. Position the protective boot onto the generator output BAT terminal.

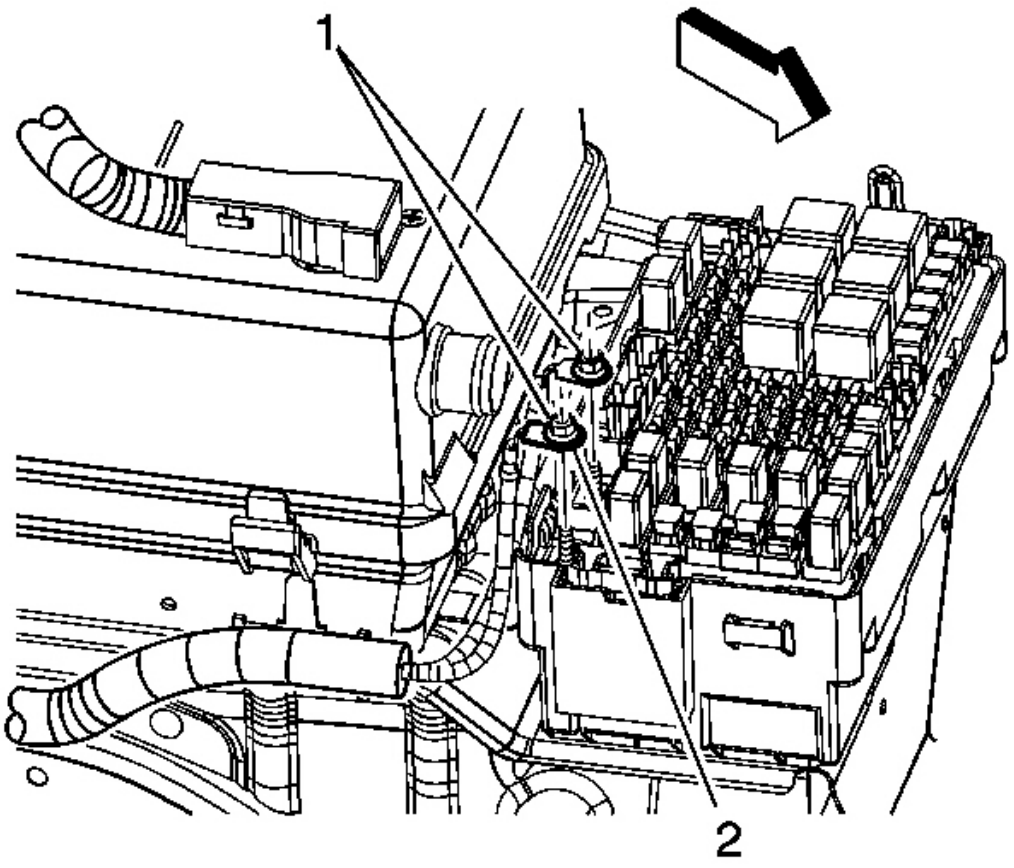


Fig. 33: Locating Nuts Securing The Battery Cables To Underhood Fuse Block
Courtesy of GENERAL MOTORS CORP.

5. Install the nut (1) securing the generator positive cable inner terminal to the underhood fuse block.

   Tighten: Tighten the nut to 10 N.m (89 lb in).

6. Install the left front wheelhouse liner. Refer to **Wheelhouse Panel Replacement (Front)** or **Wheelhouse Panel Replacement (Rear)** .
7. Install the underhood fuse block cover to the underhood fuse block, engaging the locking tabs.

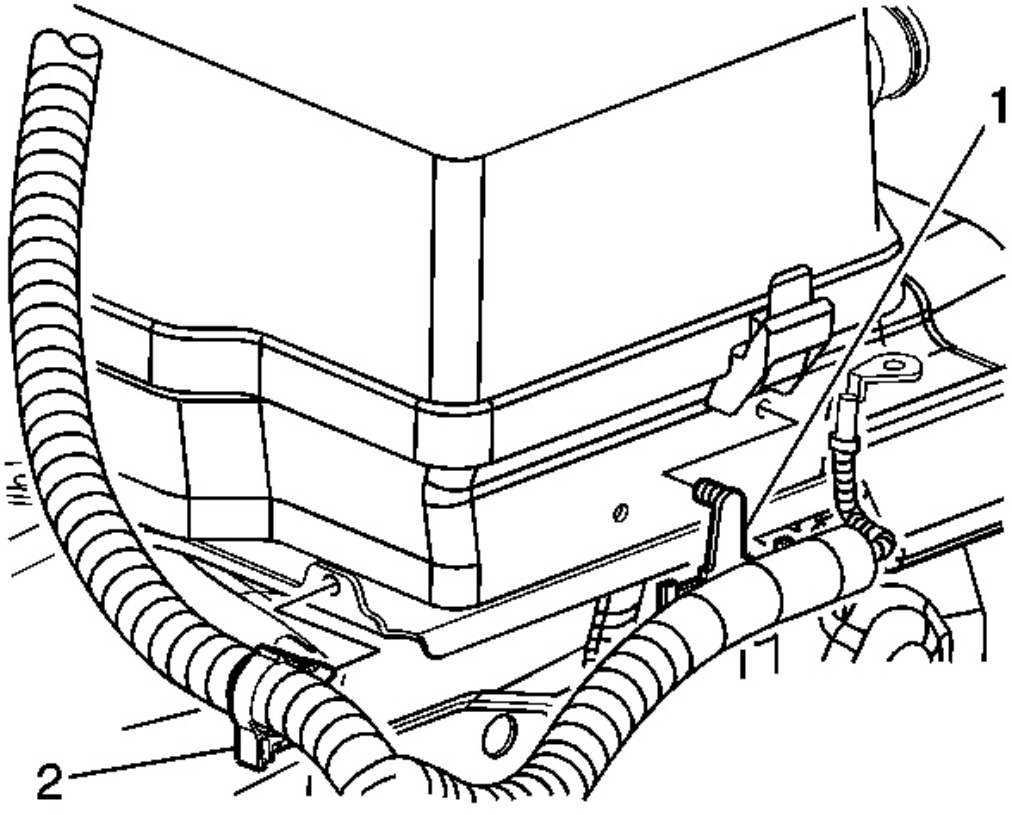


Fig. 34: Identifying Battery Cable Harness Clips
Courtesy of GENERAL MOTORS CORP.

8. Install the battery cable harness clips (1, 2) to the battery tray.
9. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY REPLACEMENT

Removal Procedure

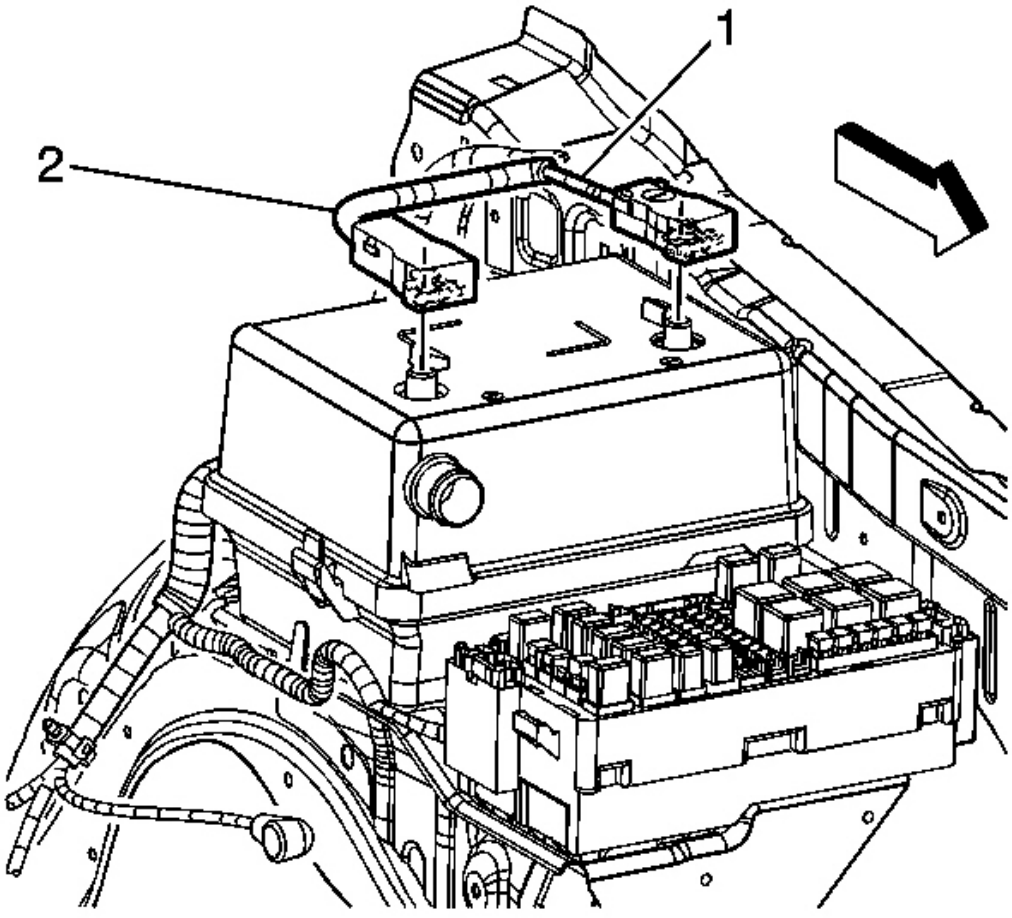


Fig. 35: Identifying Battery Cables
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Open the protective cover to access the positive battery cable terminal.
3. Loosen the positive battery cable nut.
4. Remove the positive battery cable (2) from the battery.

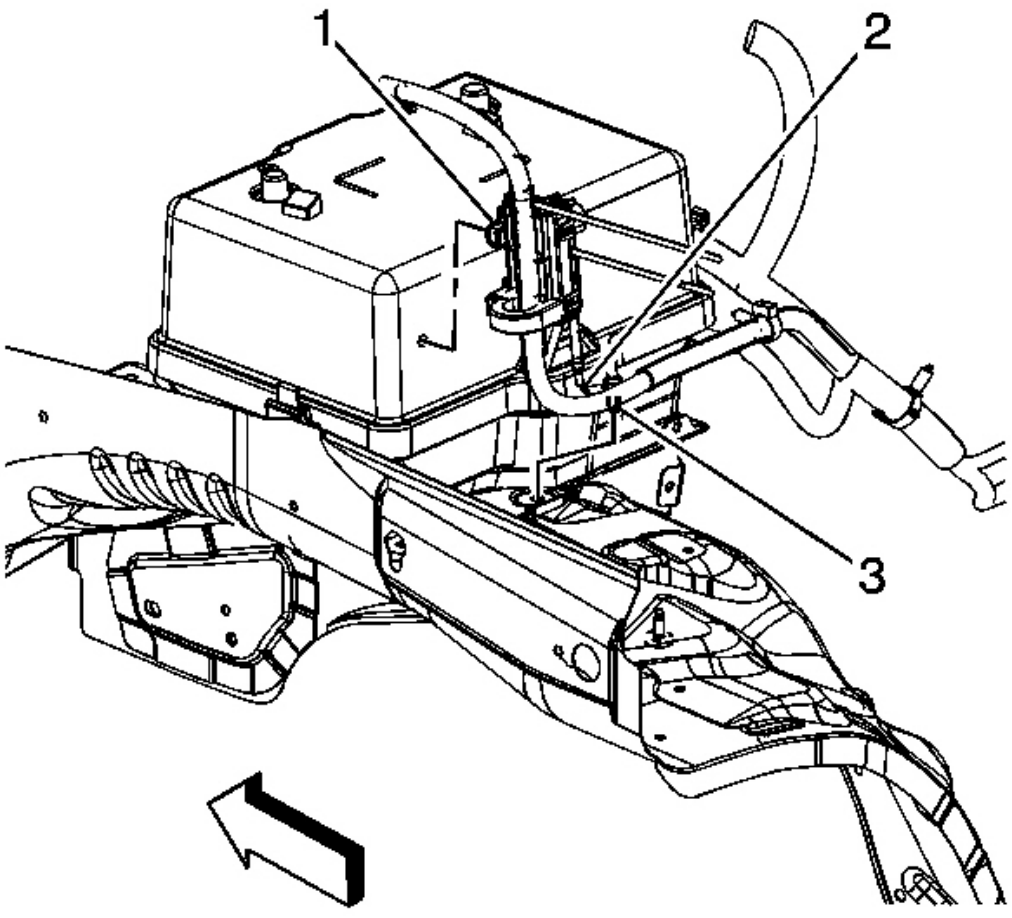


Fig. 36: Locating Negative Battery Cable Ground Bolt & Control Module Clip
Courtesy of GENERAL MOTORS CORP.

5. Remove the generator battery control module clip (1) from the upper battery box.

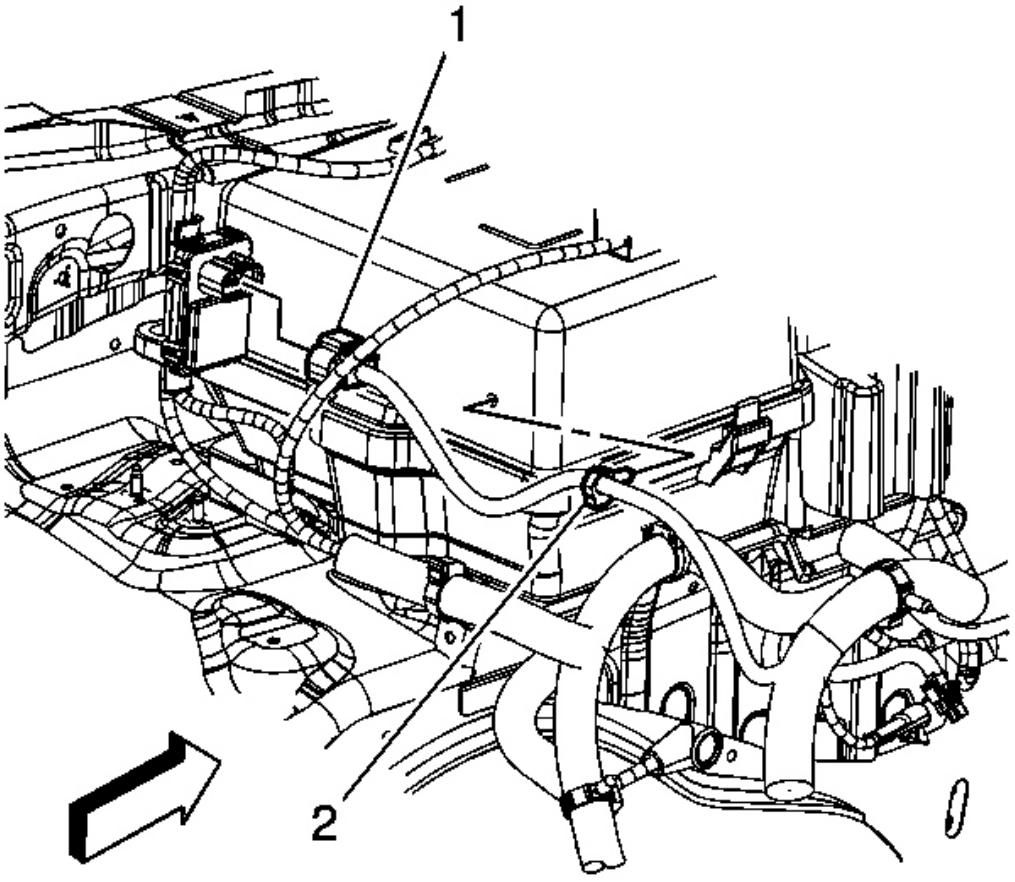


Fig. 37: Identifying Engine Wiring Harness Connector & Retaining Clips
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine wiring harness clip (2) from the upper battery box.

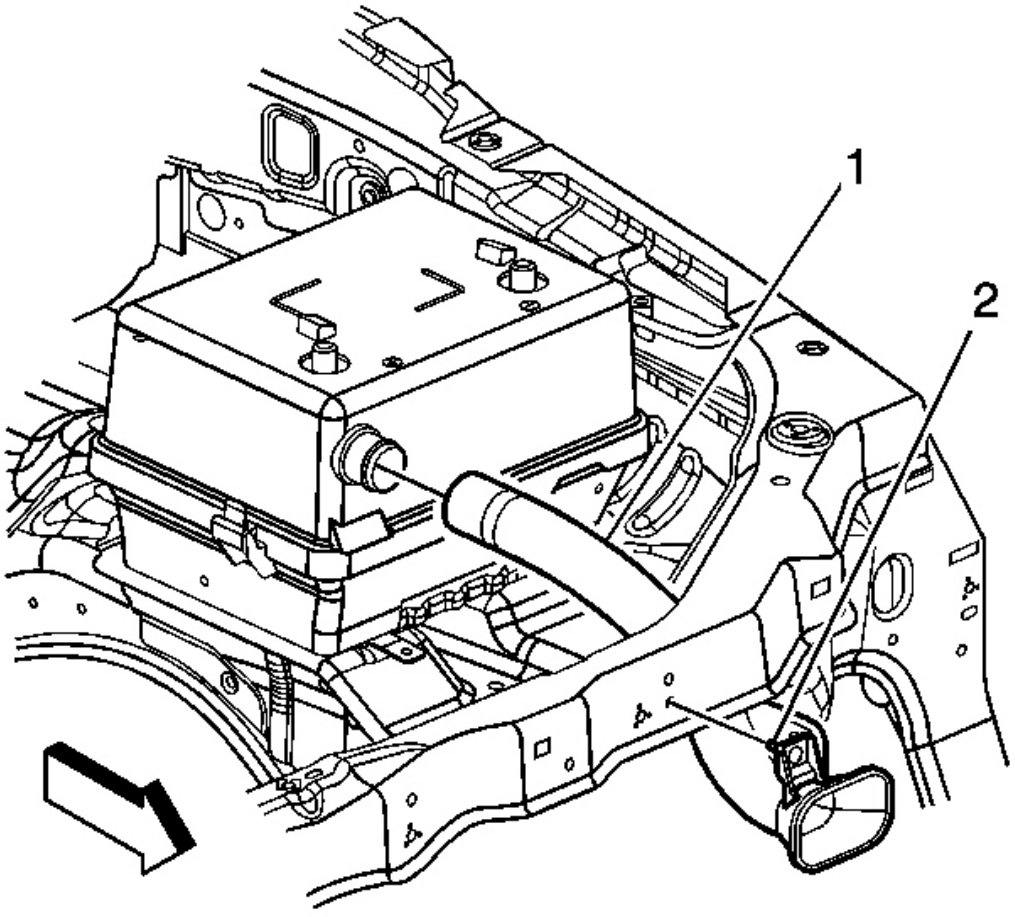


Fig. 38: Identifying Battery Vent Duct
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the battery vent duct from the upper battery box (1).

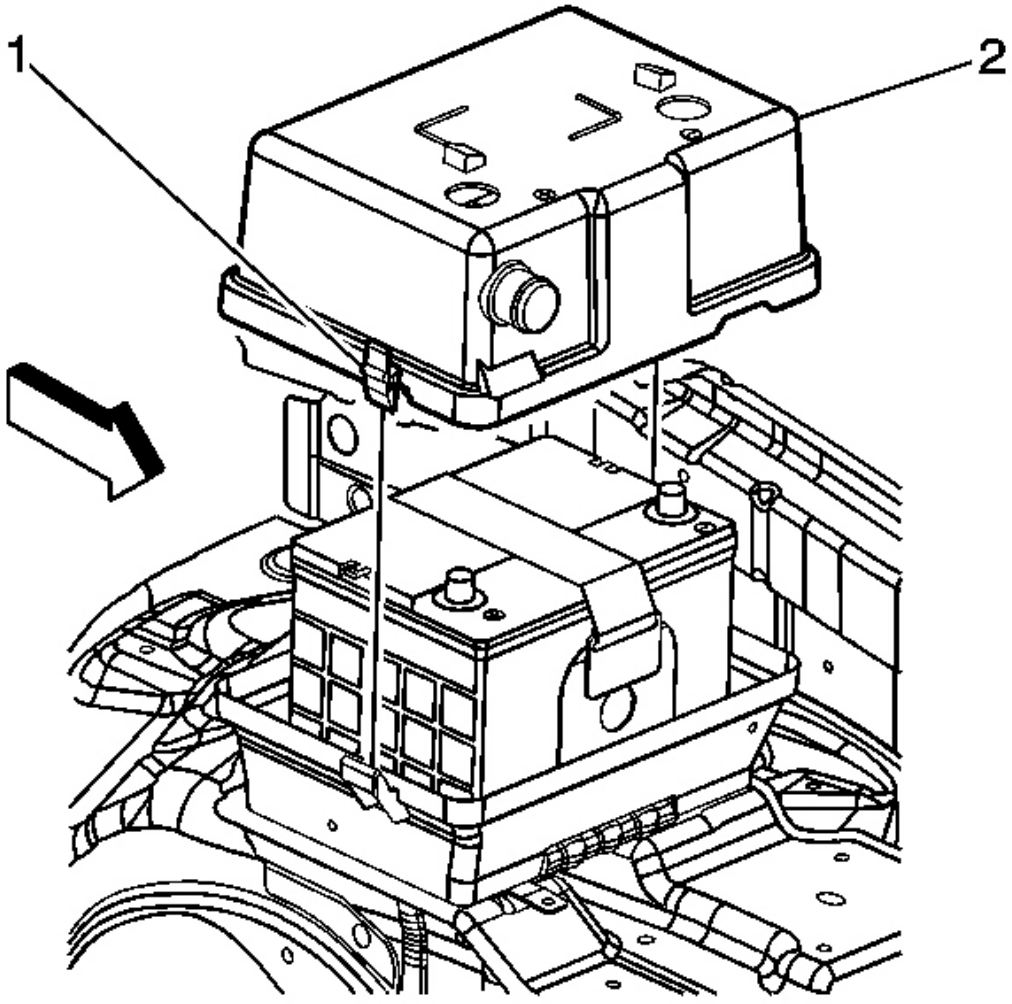


Fig. 39: Identifying Upper Battery Box Cover
Courtesy of GENERAL MOTORS CORP.

8. Press the locking tabs (1) inward in order to remove the upper battery box (2) from the lower battery box.

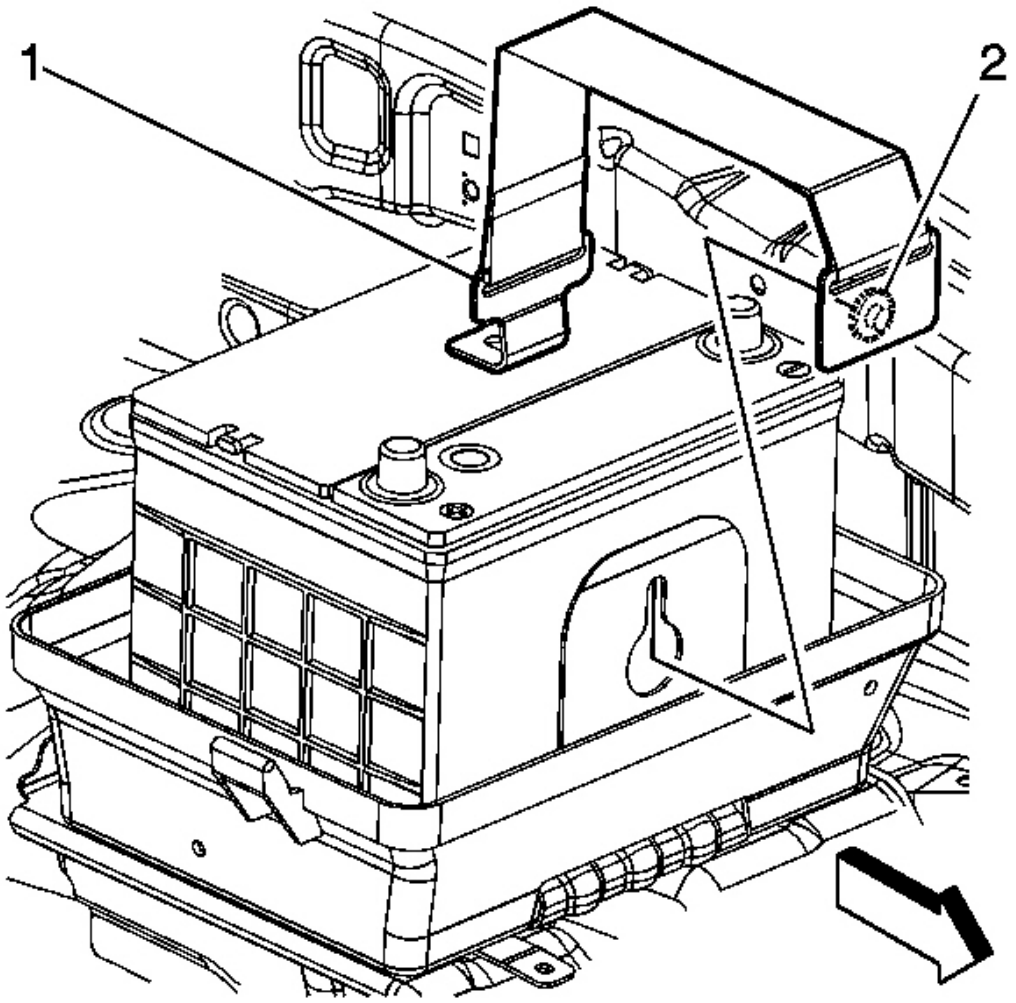


Fig. 40: Identifying Battery Strap Pin
Courtesy of GENERAL MOTORS CORP.

9. Disengage the battery strap pin (2) from the battery tray bracket stopper.

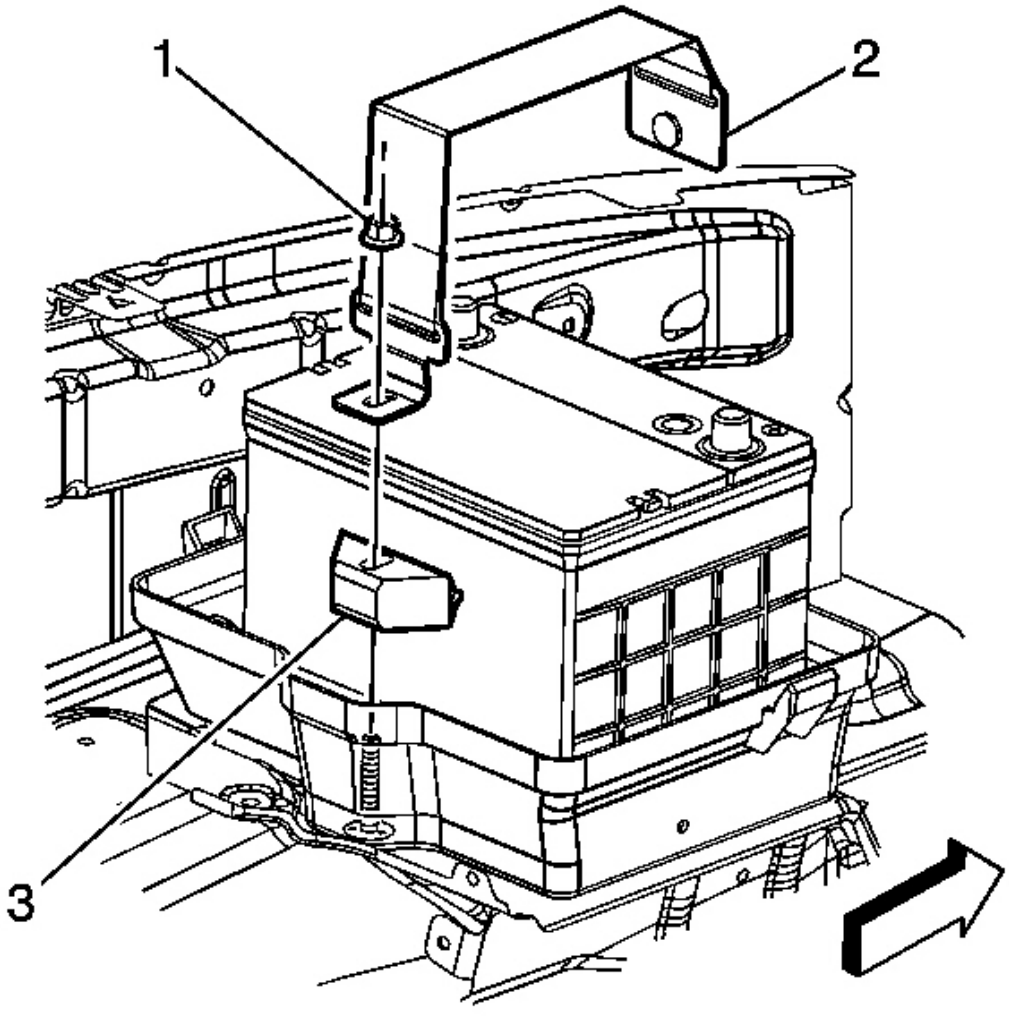


Fig. 41: View Of Battery Strap & Nut
Courtesy of GENERAL MOTORS CORP.

10. Remove the battery retainer nut (1).
11. Remove the battery tray strap (2).
12. Remove the battery retainer (3).

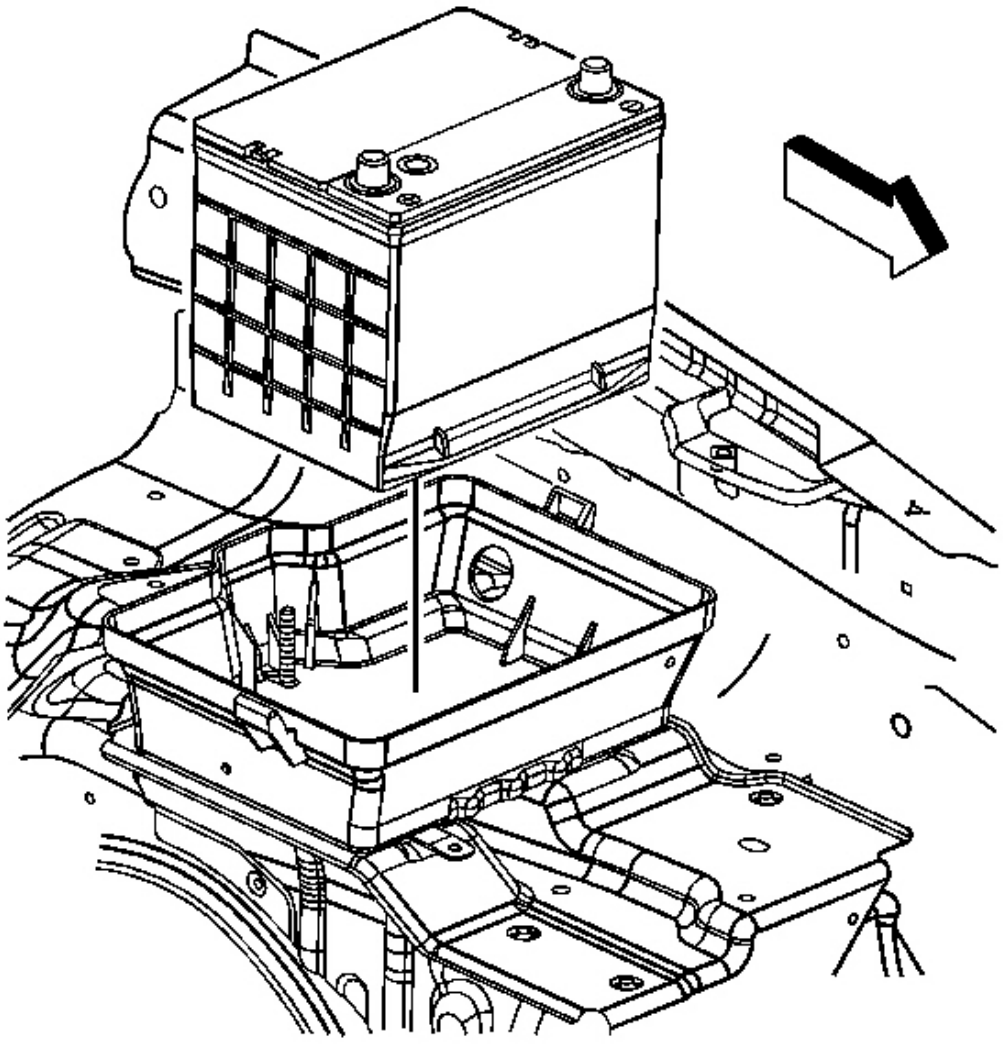


Fig. 42: Removing/Installing Battery
Courtesy of GENERAL MOTORS CORP.

13. Remove the battery from the lower battery box.

Installation Procedure

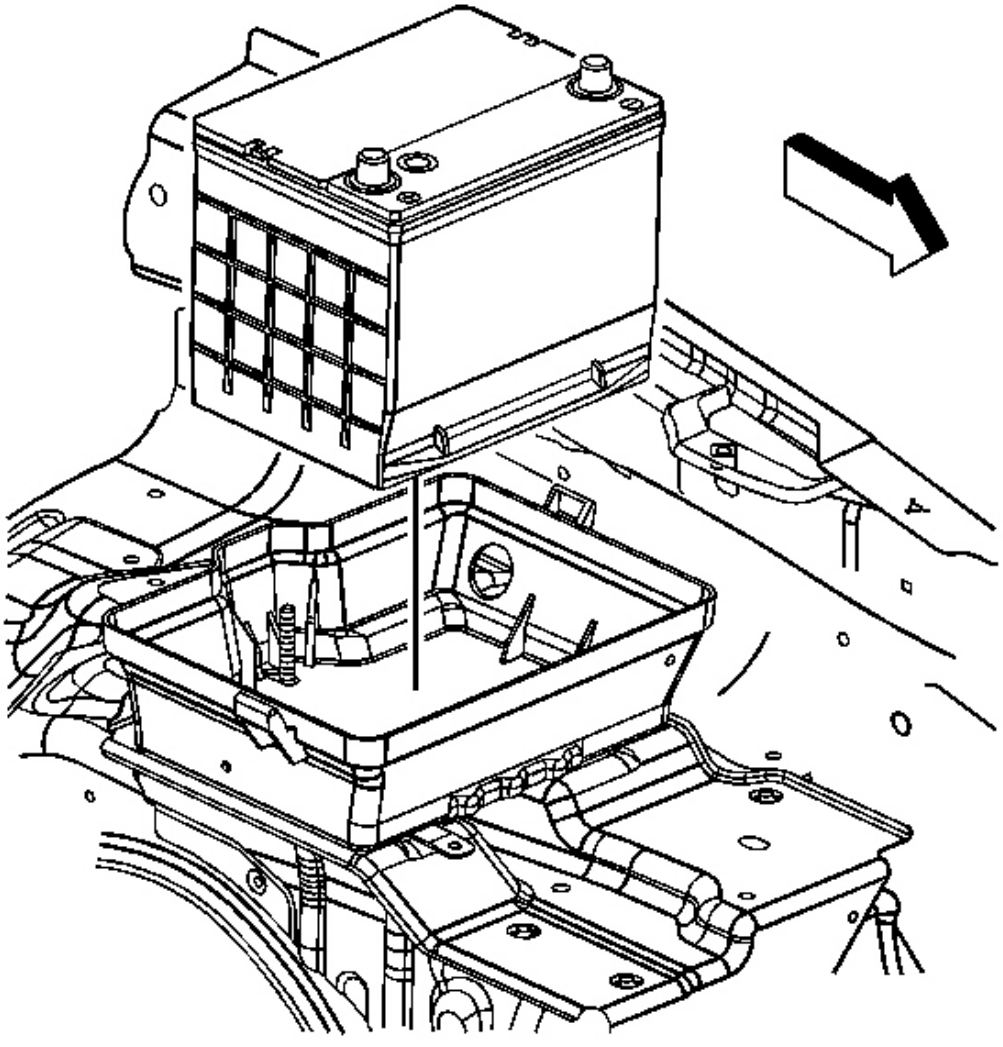


Fig. 43: Removing/Installing Battery
Courtesy of GENERAL MOTORS CORP.

1. Install the battery to the lower battery box.

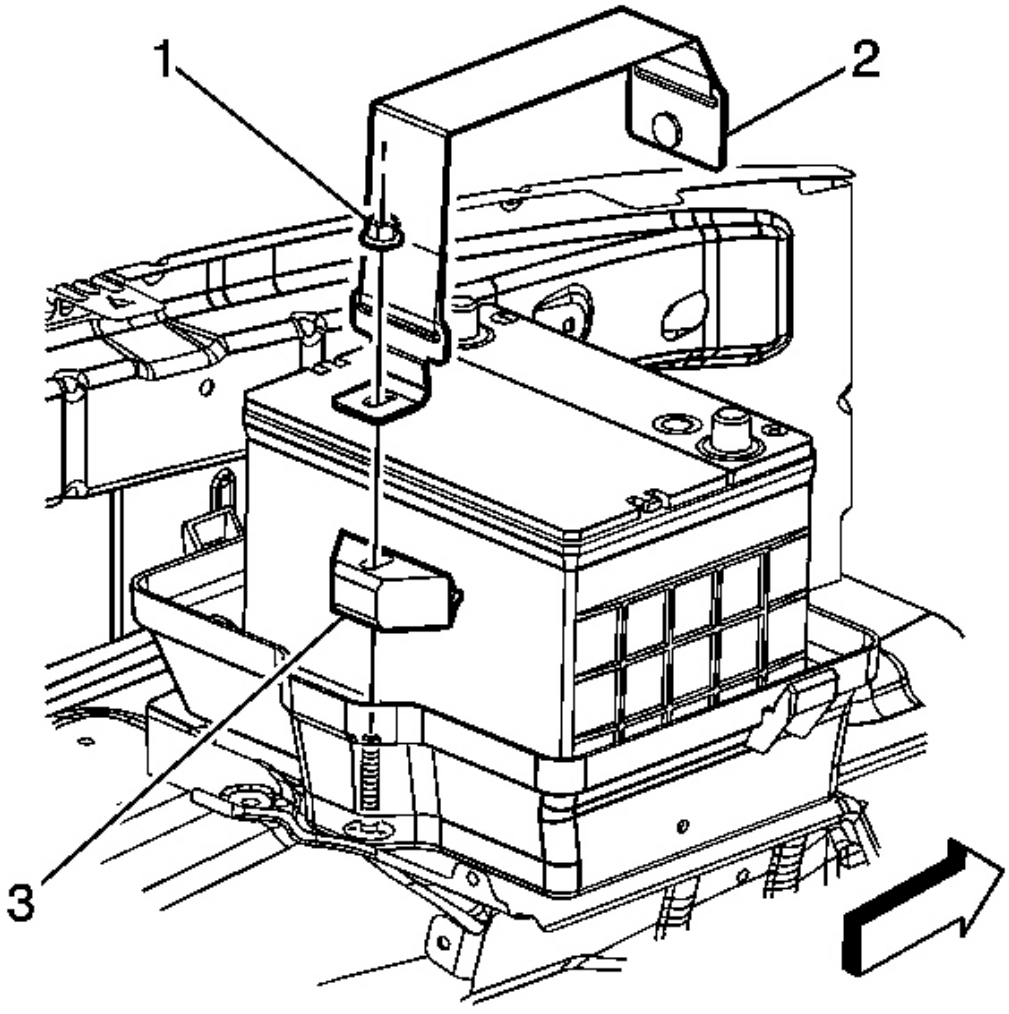


Fig. 44: View Of Battery Strap & Nut
Courtesy of GENERAL MOTORS CORP.

2. Install the battery retainer (3).
3. Install the battery tray strap (2).

NOTE: Refer to Fastener Notice .

4. Install the battery retainer nut (1).

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

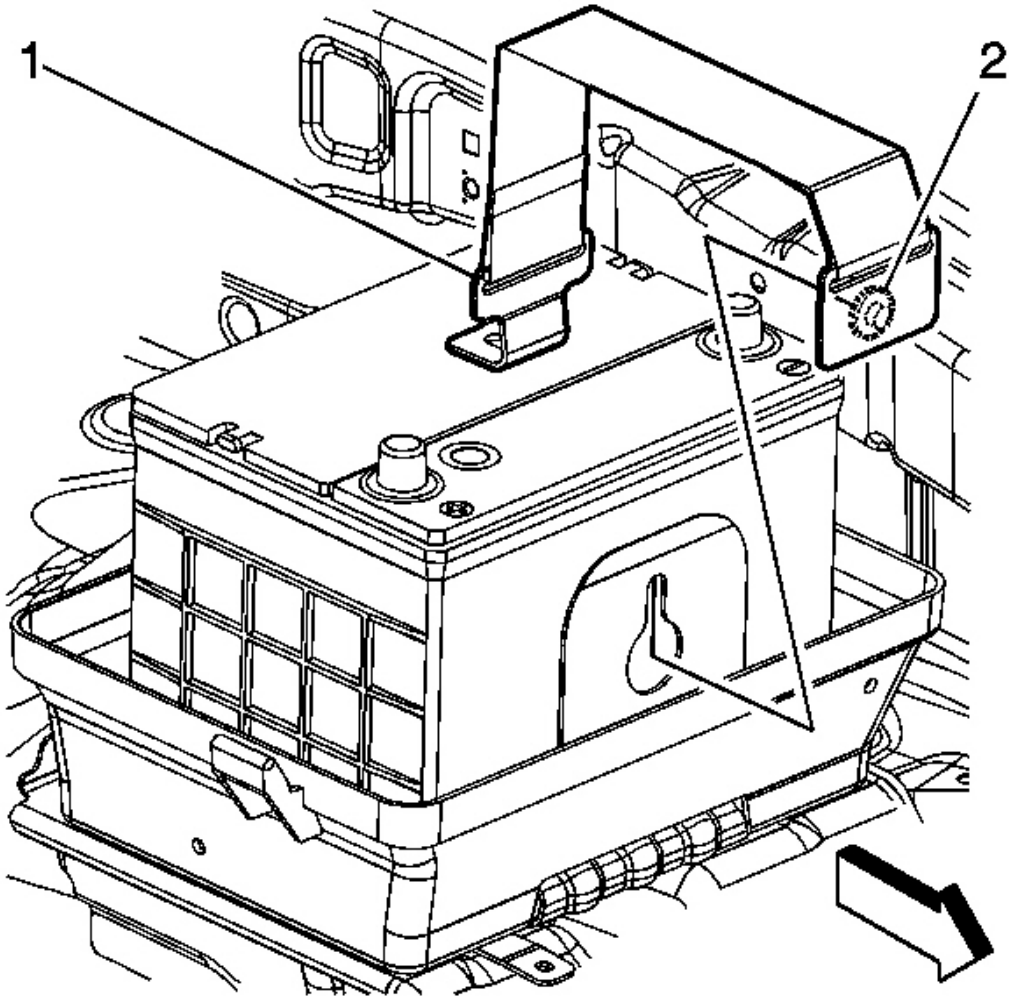


Fig. 45: Identifying Battery Strap Pin
Courtesy of GENERAL MOTORS CORP.

5. Engage the battery strap pin (2) to the battery tray bracket stopper.

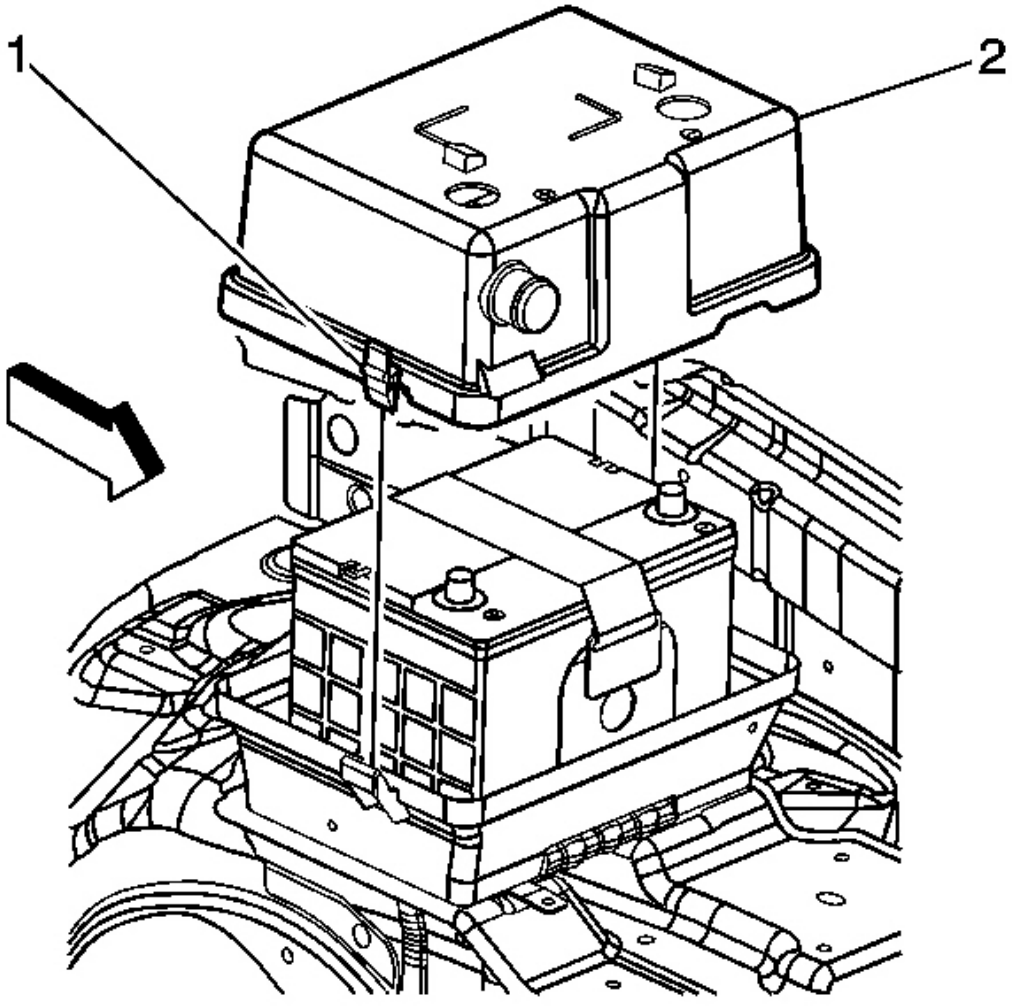


Fig. 46: Identifying Upper Battery Box Cover
Courtesy of GENERAL MOTORS CORP.

6. Install the upper battery box (2) over the battery, engage the locking tabs (1) into the lower battery box.
7. Connect the battery vent duct to the upper battery box (2).

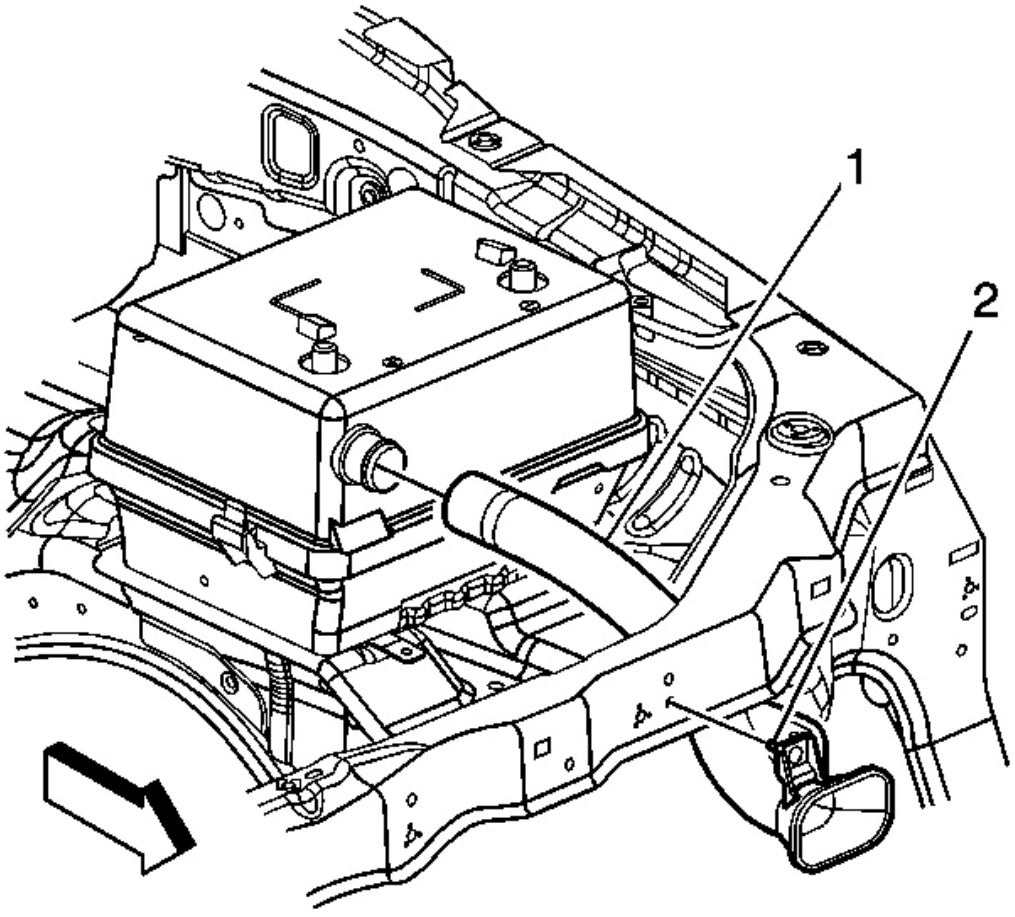


Fig. 47: Identifying Battery Vent Duct
Courtesy of GENERAL MOTORS CORP.

8. Connect the battery vent duct to the upper battery box (1).

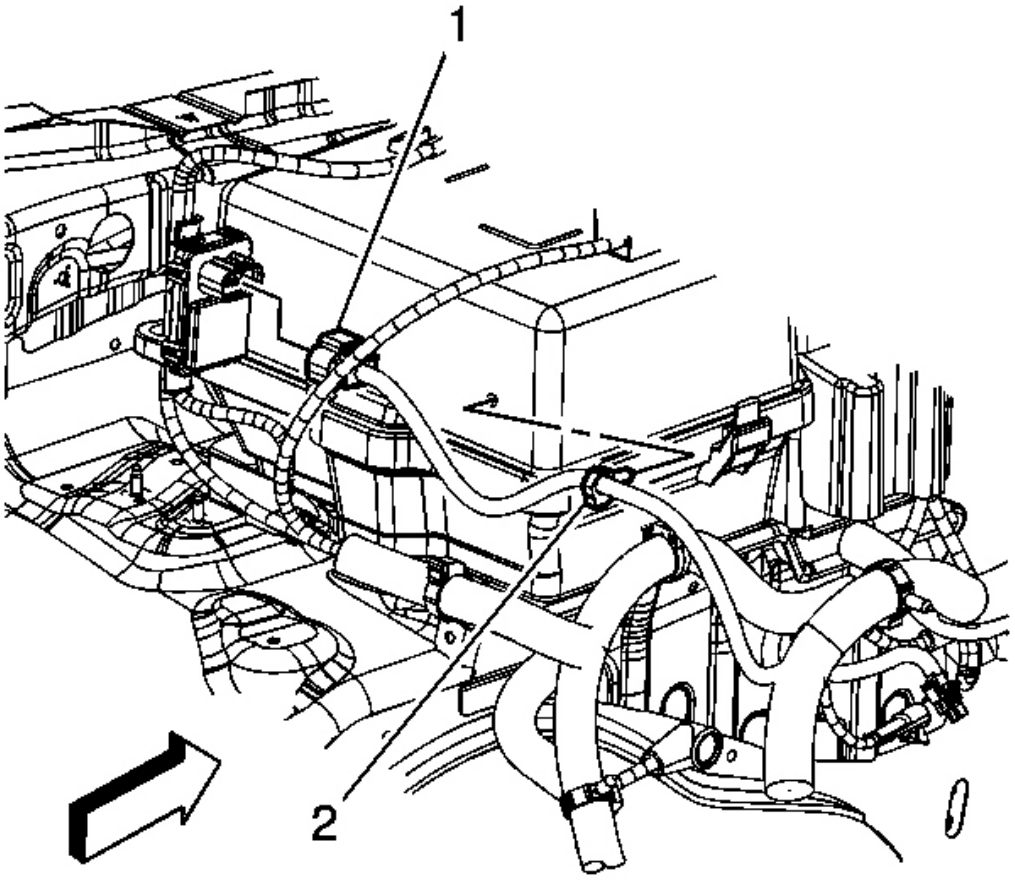


Fig. 48: Identifying Engine Wiring Harness Connector & Retaining Clips
Courtesy of GENERAL MOTORS CORP.

9. Install the engine wiring harness clip (2) to the upper battery box.

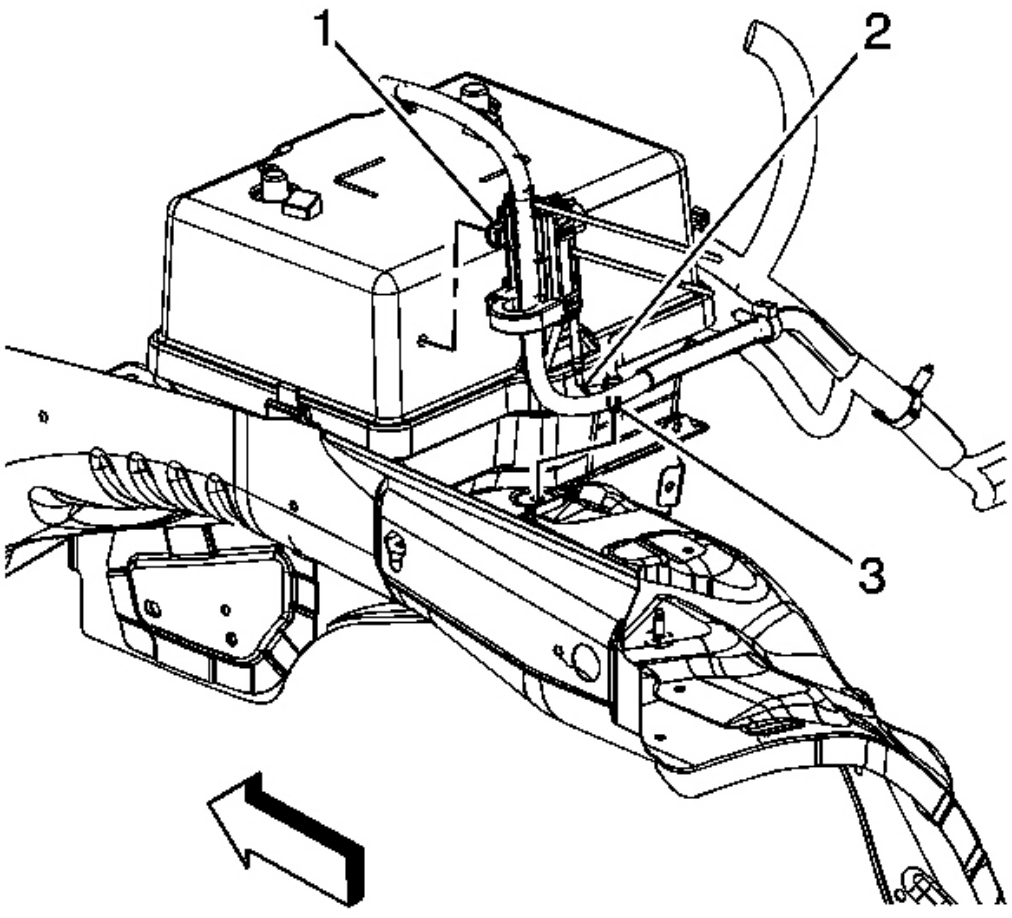


Fig. 49: Locating Negative Battery Cable Ground Bolt & Control Module Clip
Courtesy of GENERAL MOTORS CORP.

10. Install the generator battery control module clip (1) to the upper battery box.

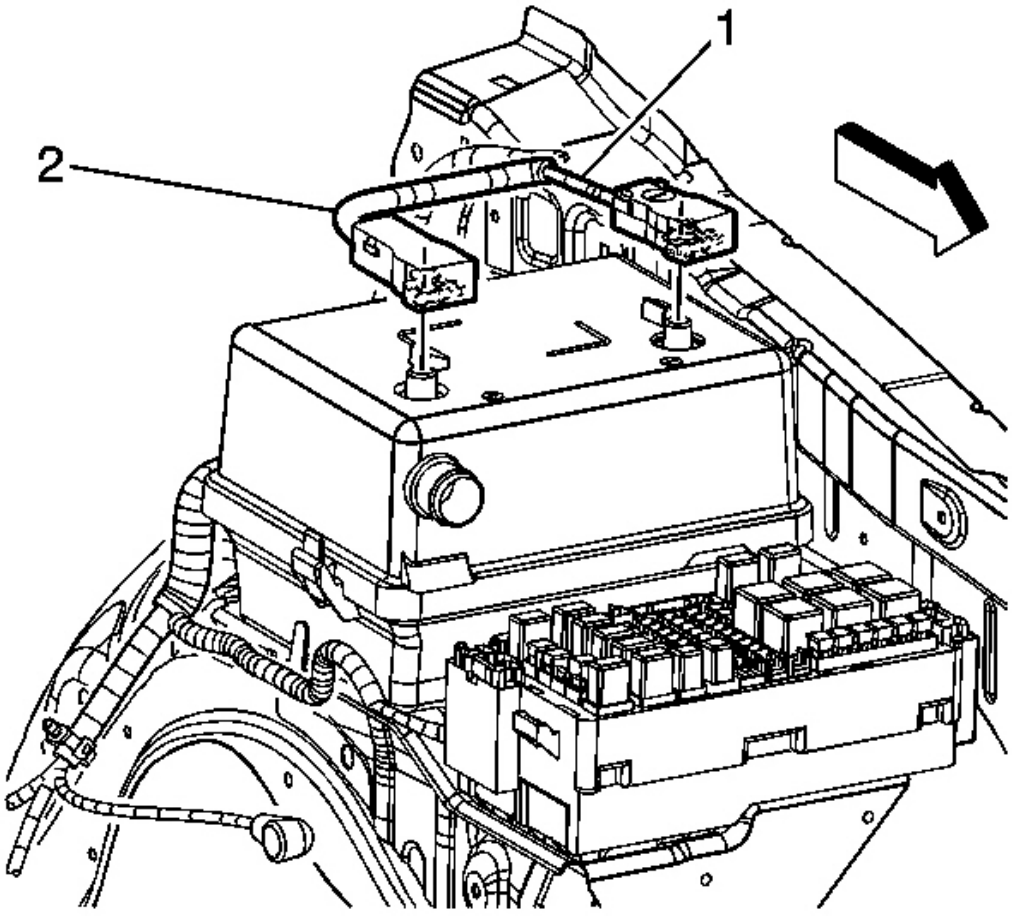


Fig. 50: Identifying Battery Cables
Courtesy of GENERAL MOTORS CORP.

11. Clean any existing corrosion from the battery terminal and battery cable using a wire brush.
12. Connect the positive battery cable (2) to the battery.

    Tighten: Tighten the nut to 9 N.m (80 lb in).

13. Close the protective cover over the positive battery cable terminal.
14. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY BOX REPLACEMENT

Removal Procedure

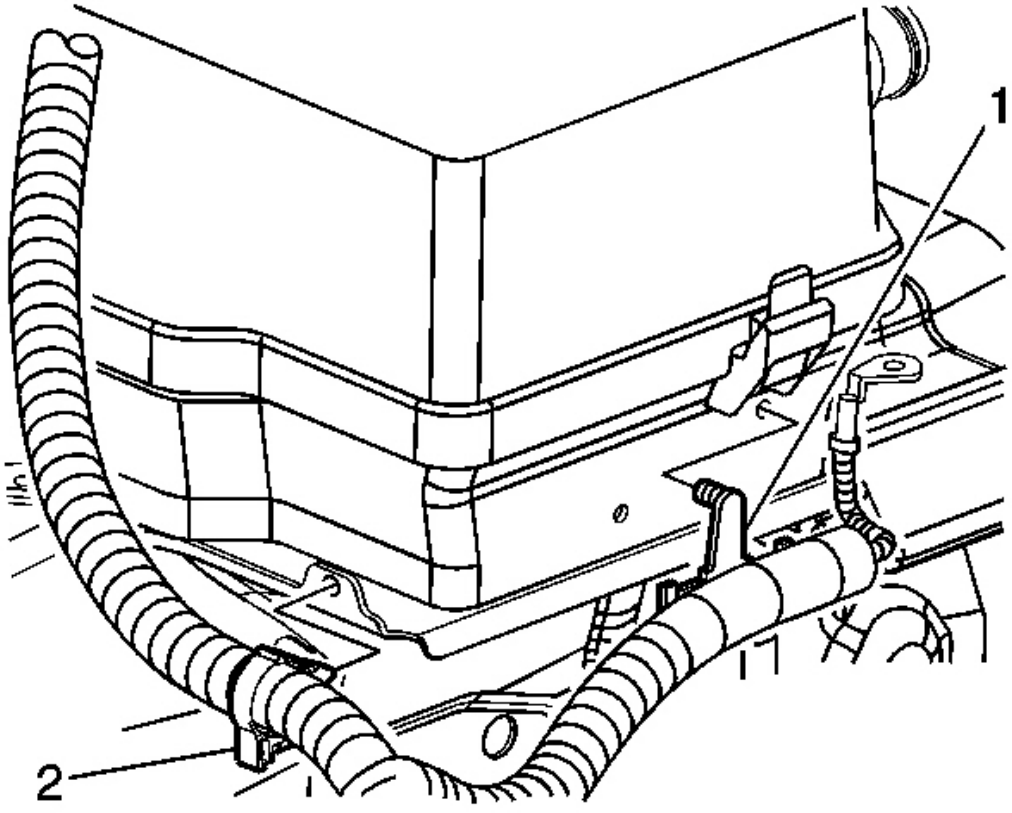


Fig. 51: Identifying Battery Cable Harness Clips
Courtesy of GENERAL MOTORS CORP.

1. Remove the battery. Refer to **Battery Replacement**.
2. Remove the battery cable harness clips (1, 2) from the battery tray.

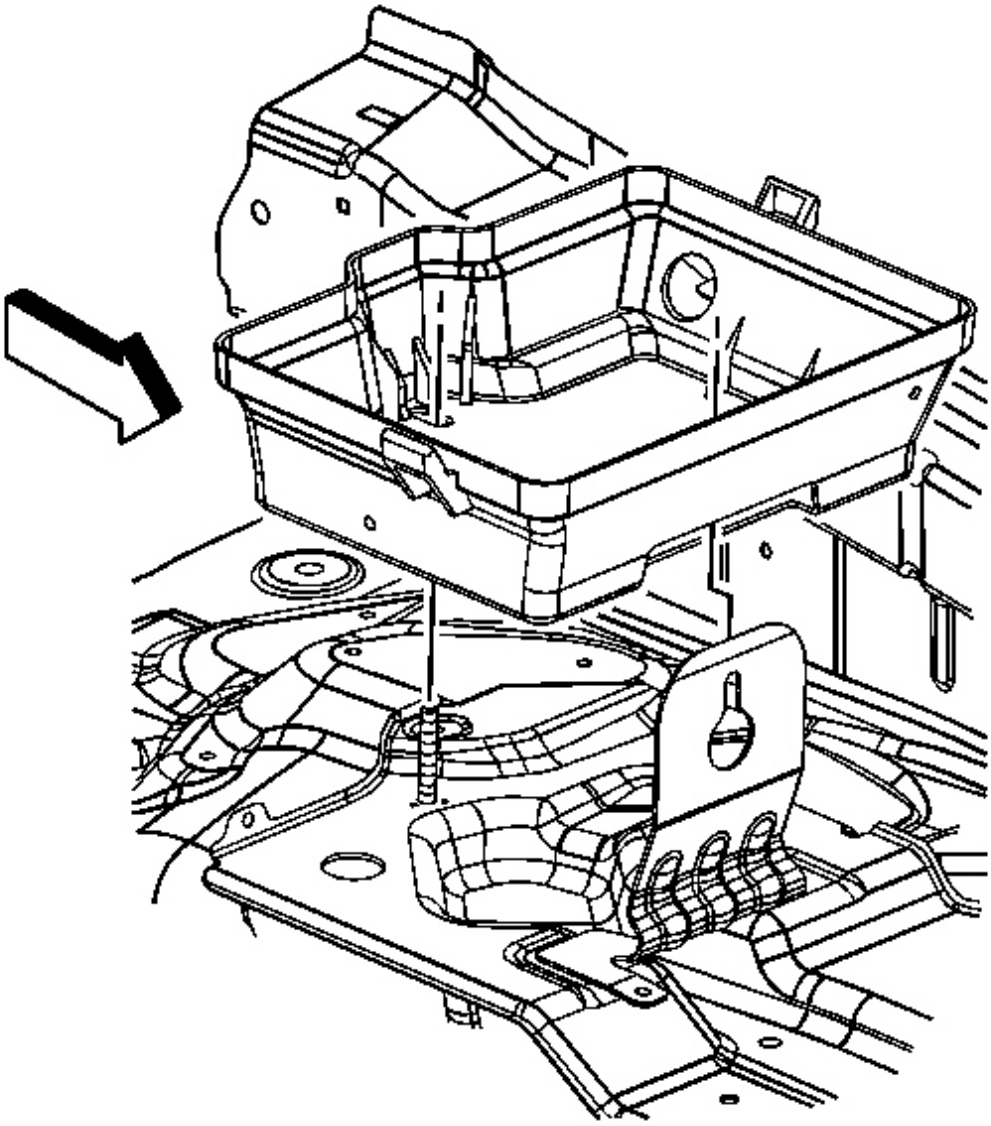


Fig. 52: View Of Lower Battery Box
Courtesy of GENERAL MOTORS CORP.

3. Lift the lower battery box upward from the battery tray.

Installation Procedure

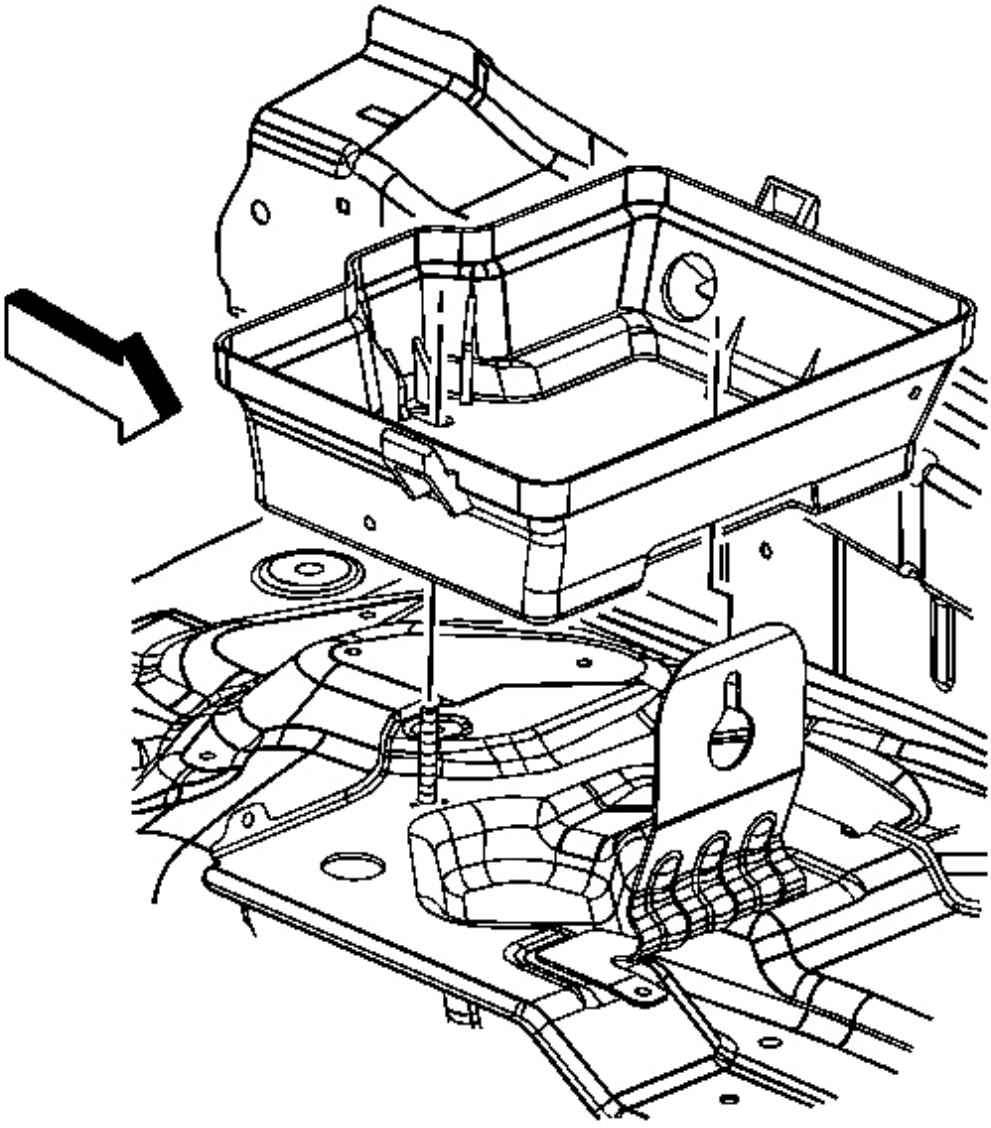


Fig. 53: View Of Lower Battery Box
Courtesy of GENERAL MOTORS CORP.

1. Install the lower battery box to the retainer stud and battery tray.

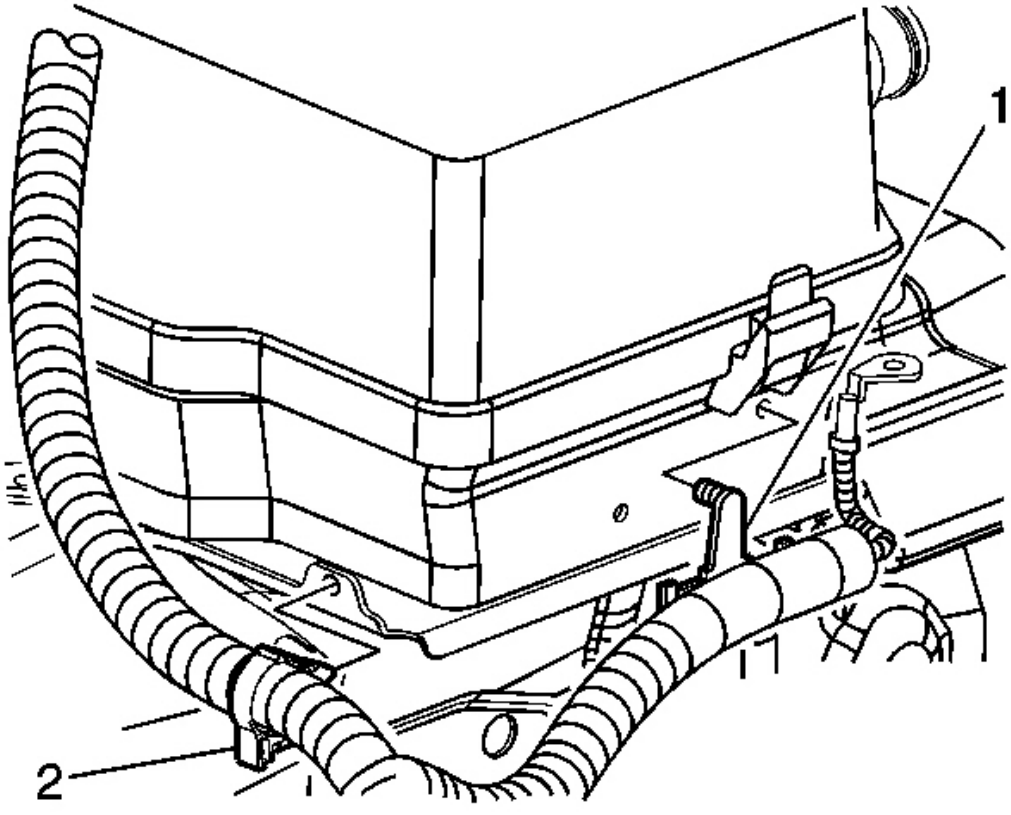


Fig. 54: Identifying Battery Cable Harness Clips
Courtesy of GENERAL MOTORS CORP.

2. Install the battery cable harness clips (1, 2) to the battery tray.
3. Install the battery. Refer to **Battery Replacement**.

STARTER MOTOR REPLACEMENT

Removal Procedure

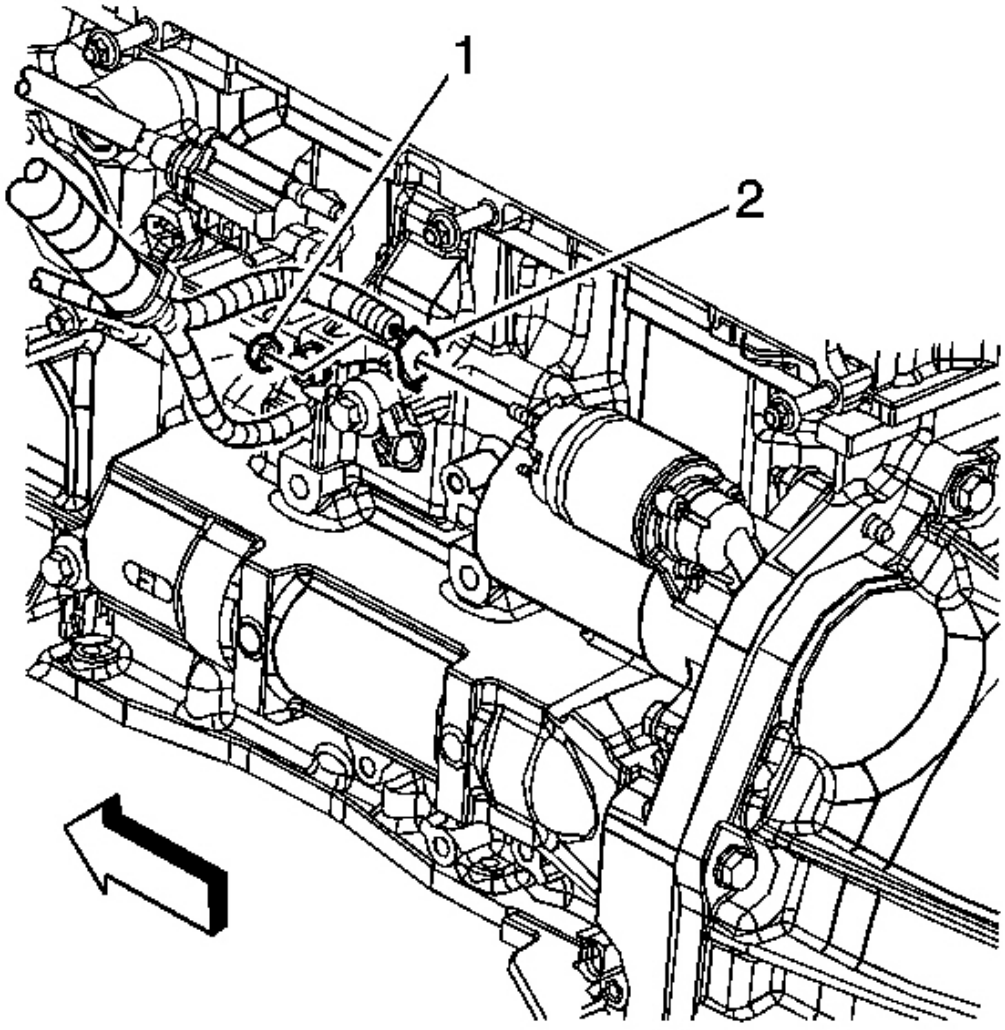


Fig. 55: View Of Starter Wiring
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
2. Remove the starter solenoid S terminal nut and disconnect the lead from the starter.
3. Remove the starter terminal nut (1) and disconnect the positive battery cable (2) from the starter.

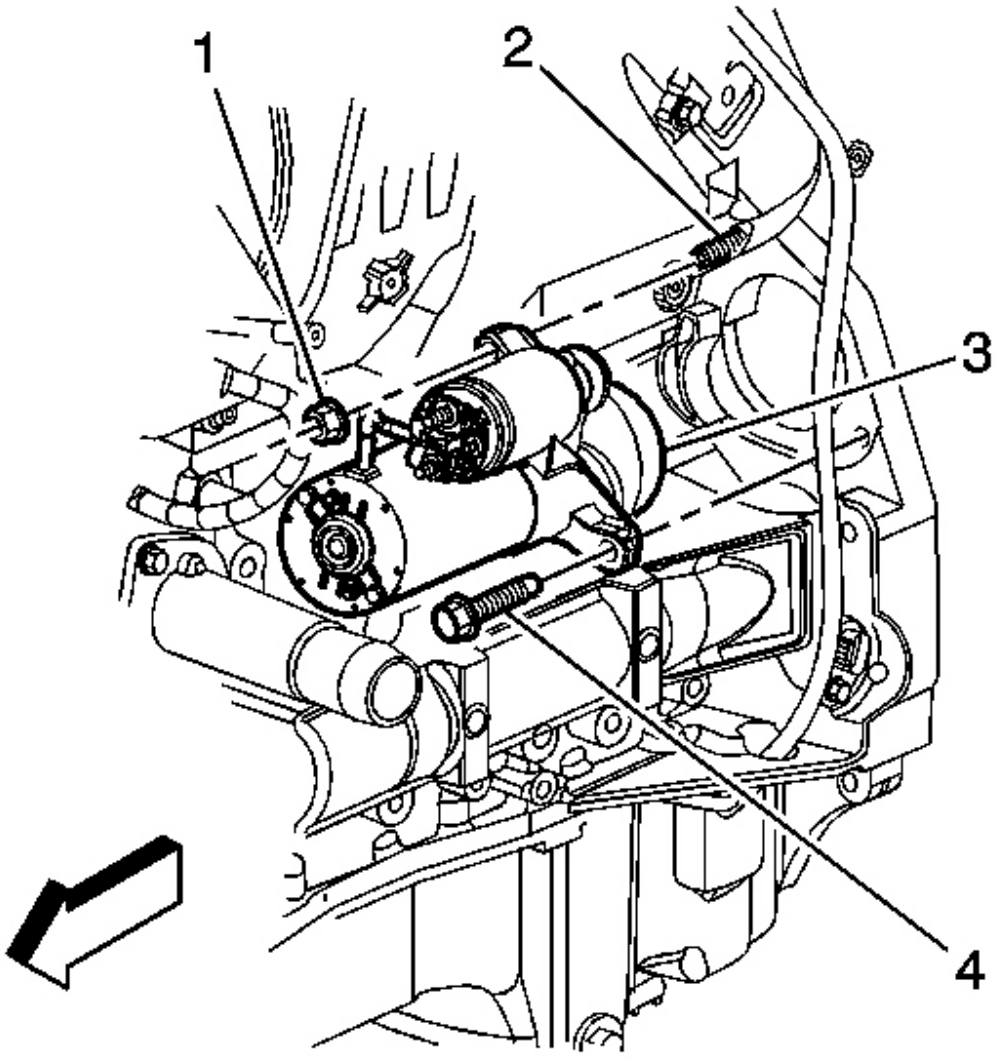


Fig. 56: View Of Starter Motor
Courtesy of GENERAL MOTORS CORP.

4. Remove the starter motor nut (1) and bolt (4).
5. Remove the starter motor (3).

Installation Procedure

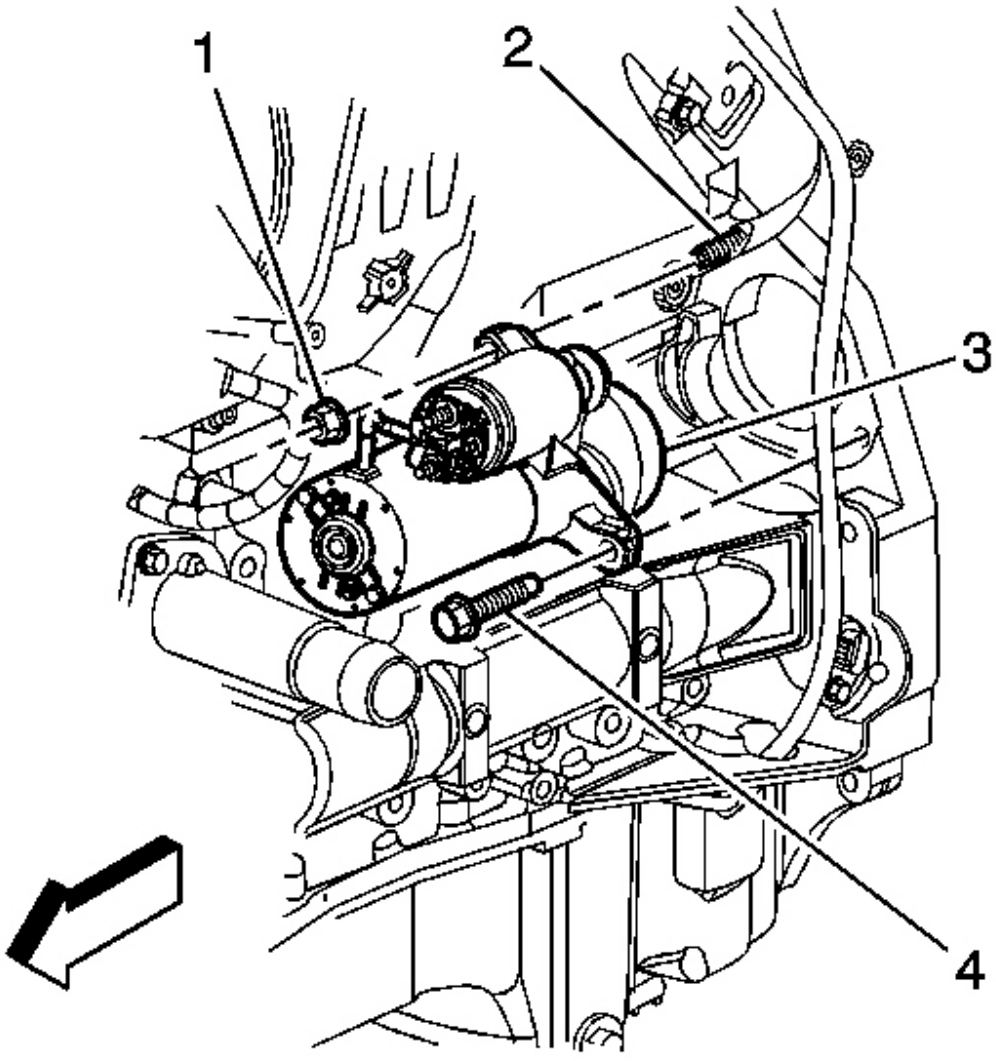


Fig. 57: View Of Starter Motor
Courtesy of GENERAL MOTORS CORP.

1. Position the starter motor (3) over the stud (2).

NOTE: Refer to Fastener Notice .

2. Install the starter motor nut (1) and bolt (4).

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

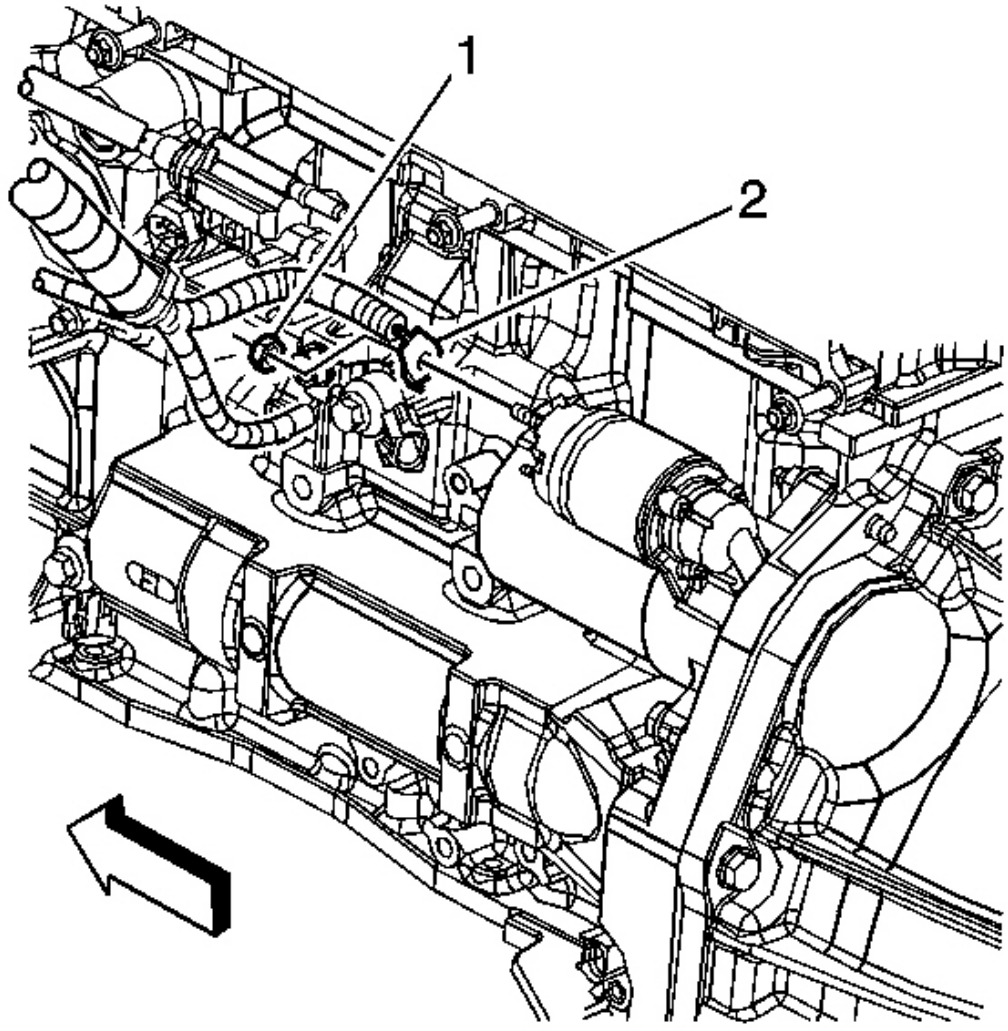


Fig. 58: View Of Starter Wiring
Courtesy of GENERAL MOTORS CORP.

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

   Tighten: Tighten the nut to 9 N.m (80 lb in).

4. Connect the lead to the starter solenoid and install the starter solenoid S terminal nut.

Tighten: Tighten the nut to 3.5 N.m (31 lb in).

5. Install the intake manifold. Refer to **Intake Manifold Replacement** .

GENERATOR REPLACEMENT

Removal Procedure

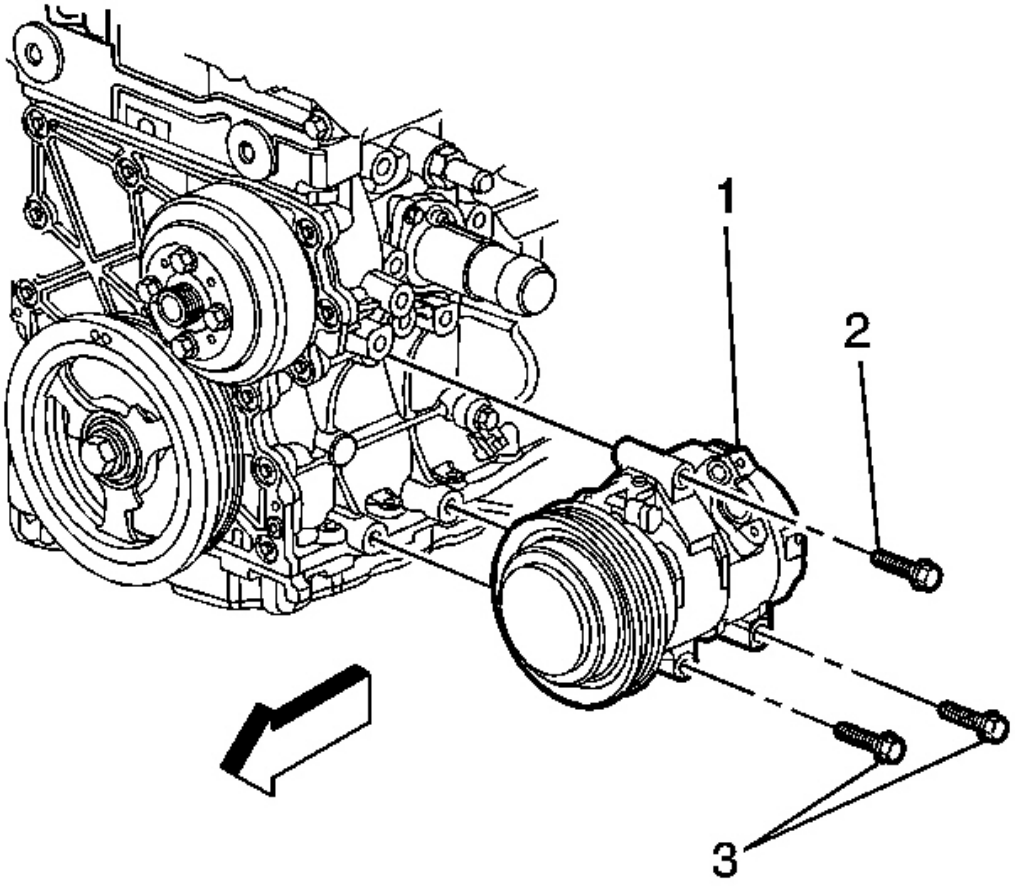


Fig. 59: View Of A/C Compressor
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the drive belt. Refer to **Drive Belt Replacement (Without A/C)** or **Drive Belt**

Replacement (With A/C) .

3. Raise and support the vehicle only high enough to access the air conditioning (A/C) compressor through the wheelhouse. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the left front wheel. Refer to **Tire and Wheel Removal and Installation** .
5. Remove the left wheelhouse liner. Refer to **Wheelhouse Panel Replacement (Front)** or **Wheelhouse Panel Replacement (Rear)** .
6. Disengage the A/C compressor electrical connector from the bracket.
7. Recover the A/C system. Refer to **Refrigerant Recovery and Recharging** .
8. Disconnect the A/C condenser and evaporator lines from the compressor.
9. Remove the A/C compressor mounting bolts (2, 3) ONLY.

   The upper mounting bolt (2) will remain with the A/C compressor (1).

10. Lower the vehicle.

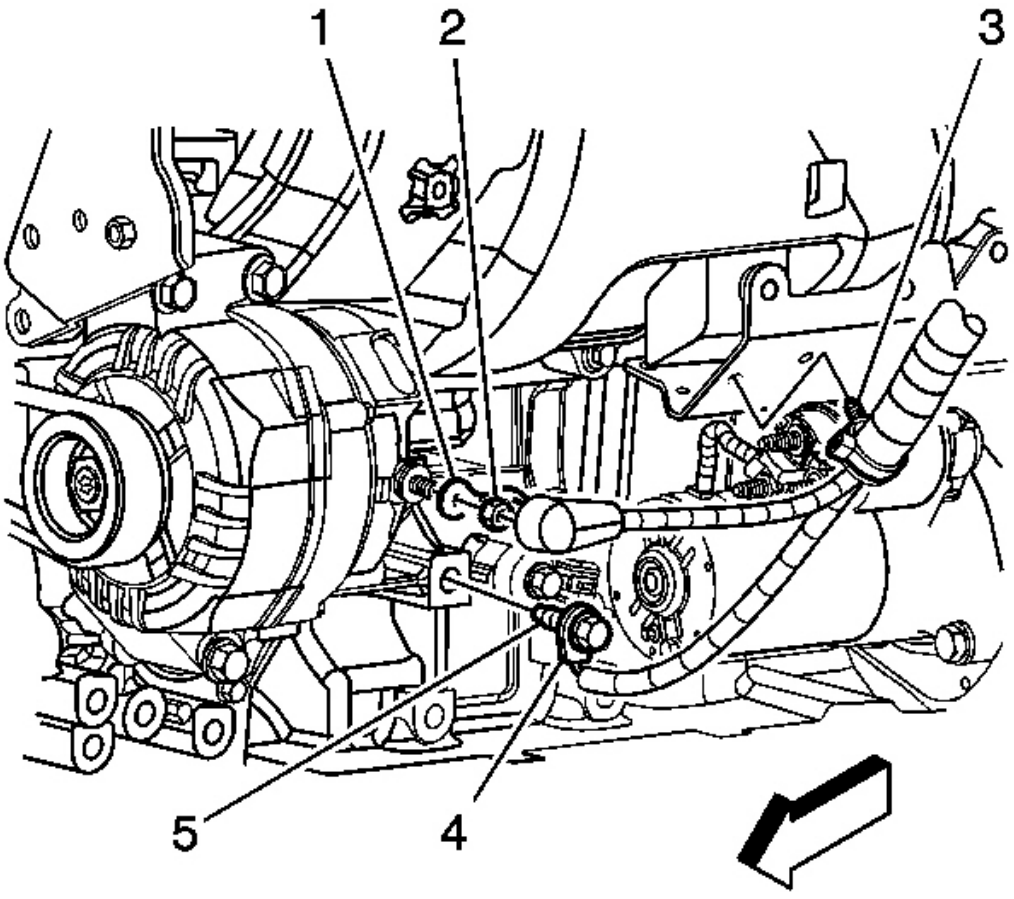


Fig. 60: Identifying Generator/Starter Wiring
Courtesy of GENERAL MOTORS CORP.

11. Reposition the protective boot from the generator output BAT terminal.
12. Remove the generator output BAT terminal nut (2) and remove the generator lead (1) from the generator.
13. Disconnect the generator electrical connector.

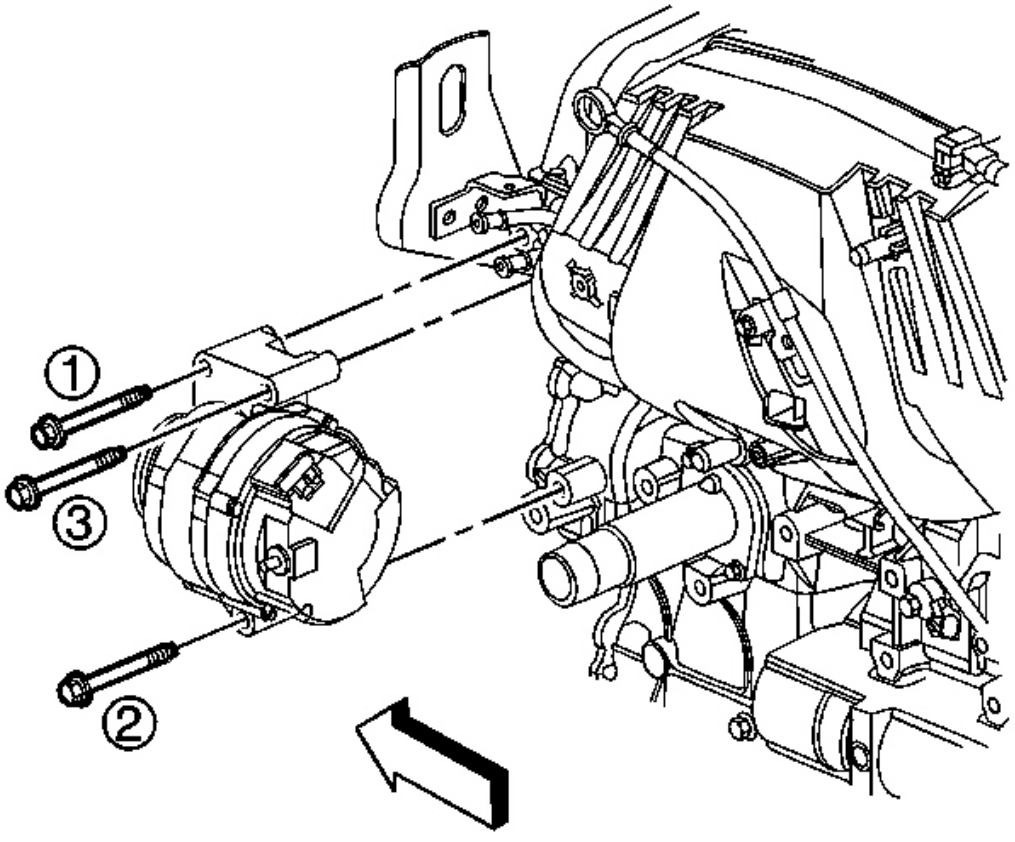


Fig. 61: View Of Generator Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the 3 generator bolts.
15. Position the A/C compressor forward, in order to gain clearance to remove the generator.
16. Remove the generator.

Installation Procedure

1. Position the generator to the engine.

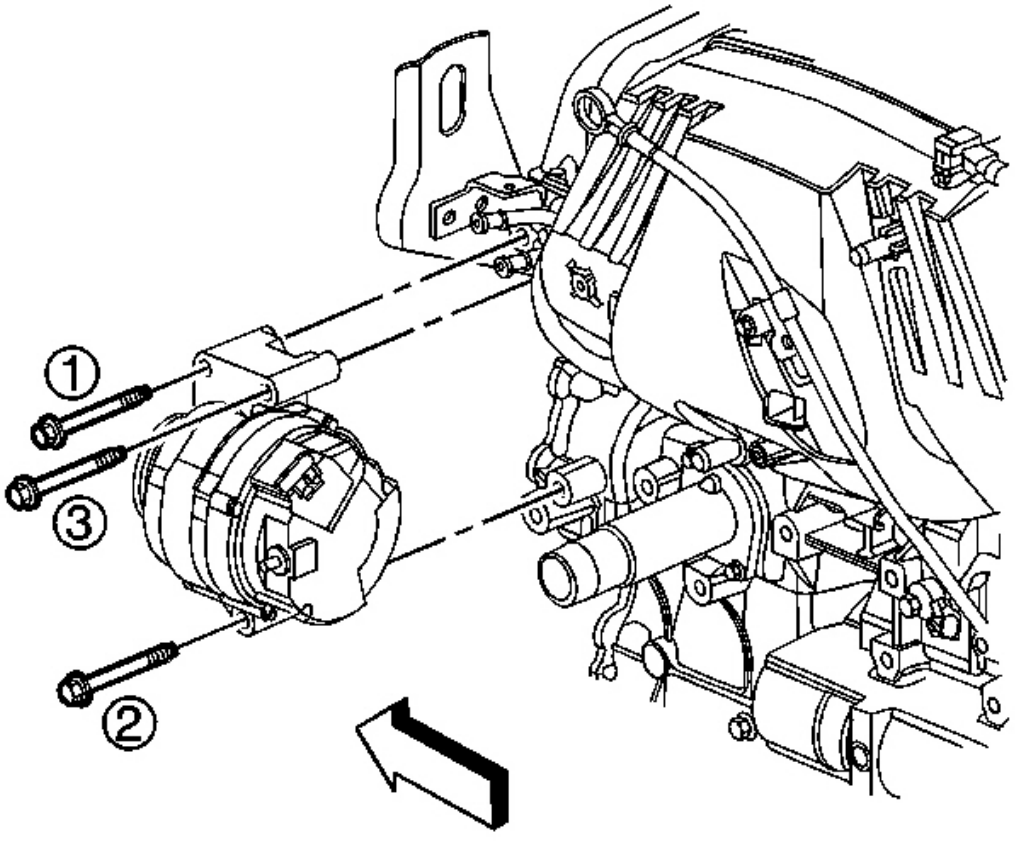


Fig. 62: View Of Generator Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

2. Install the 3 generator bolts.

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

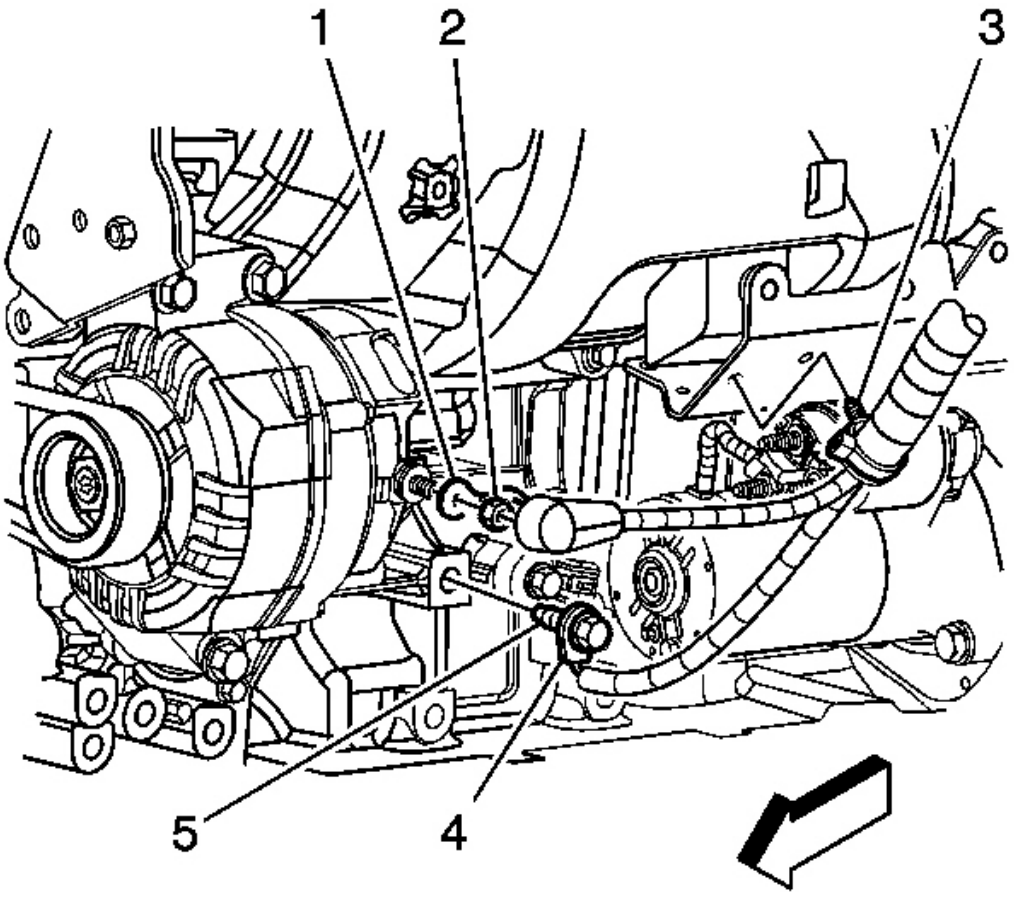


Fig. 63: Identifying Generator/Starter Wiring
Courtesy of GENERAL MOTORS CORP.

3. Install the generator lead (1) to the generator and install the generator output BAT terminal nut (2).

   Tighten: Tighten the nut to 20 N.m (15 lb ft).

4. Position the protective boot onto the generator output BAT terminal.
5. Connect the generator electrical connector.
6. Raise and support the vehicle only high enough to access the A/C compressor through the wheelhouse. Refer to **Lifting and Jacking the Vehicle** .

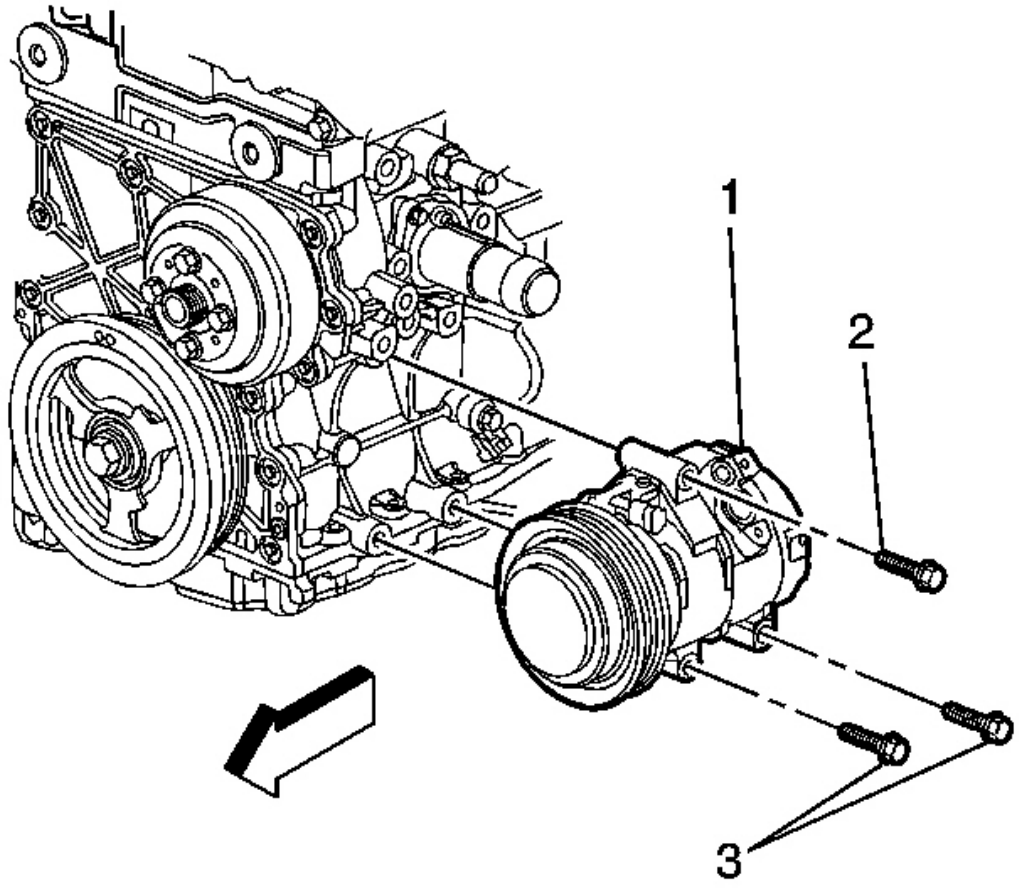


Fig. 64: View Of A/C Compressor
Courtesy of GENERAL MOTORS CORP.

7. Position the A/C compressor (1) to the engine.
8. Install the A/C compressor mounting bolts (2, 3).

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

9. Connect the condenser and evaporator lines to the compressor.
10. Attach the A/C compressor electrical connector to the bracket.
11. Install the left wheelhouse liner. Refer to **Wheelhouse Panel Replacement (Front)** or **Wheelhouse Panel Replacement (Rear)** .

12. Install the left front wheel. Refer to **Tire and Wheel Removal and Installation** .
13. Lower the vehicle.
14. Install the drive belt. Refer to **Drive Belt Replacement (Without A/C)** or **Drive Belt Replacement (With A/C)** .
15. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
16. Charge the A/C system. Refer to **Refrigerant Recovery and Recharging** .

DESCRIPTION AND OPERATION

BATTERY DESCRIPTION AND OPERATION

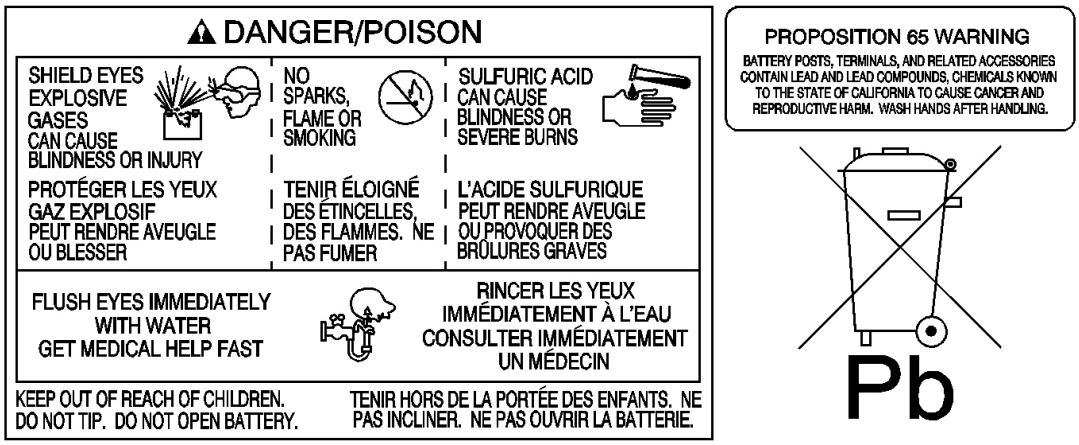


Fig. 65: View Of Battery Danger Label
Courtesy of GENERAL MOTORS CORP.

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.**

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

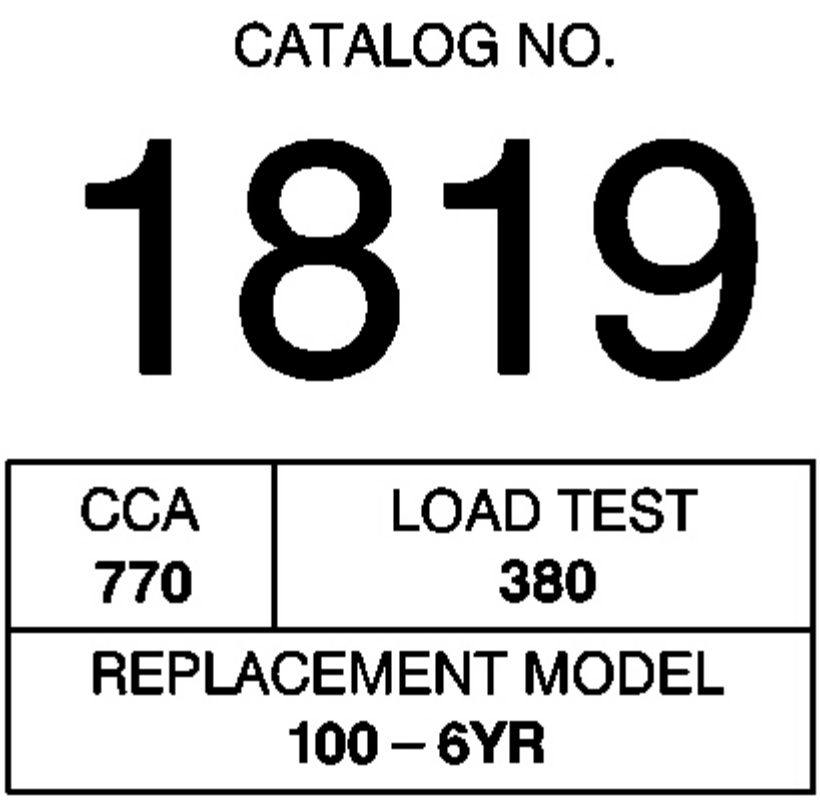


Fig. 66: View Of Battery Specification Label
Courtesy of GENERAL MOTORS CORP.

Battery Ratings

A battery has 2 ratings:

- 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**.

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.

Auxiliary Battery

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

CHARGING SYSTEM DESCRIPTION AND OPERATION

Electrical Power Management (EPM) Overview

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

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

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

The SOC can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout key-on the algorithm continuously estimates SOC based on adjusted net amp

hours, battery capacity, initial SOC and temperature.

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

In addition, the EPM function is designed to perform regulated voltage control (RVC) to improve battery SOC, battery life and fuel economy. This is accomplished by using knowledge of the batteries SOC and temperature to set the charging voltage to an optimum battery voltage level for recharging without detriment to battery life.

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

Charging System Components

Generator

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

Generator Battery Control Module

The generator battery control module is a class 2 device. It communicates with the powertrain control module (PCM), instrument panel cluster and the body control module for electrical power management (EPM) operation. It is a serviceable component that is connected to the negative battery cable at the battery. It directly controls the generator field control circuit, charge indicator control, input to the generator. It continuously monitors the generator field duty cycle signal circuit and the battery voltage. If the generator battery control module loses communication with the PCM, the default voltage will be set to 13.8 volts and the module will set U1016. If the generator battery control module loses communication with the body control module (BCM), the module will set U1064.

Powertrain Control Module (PCM)

The PCM provides information over the class 2 serial data circuit to the generator battery control module. The generator battery control module monitors the following data parameters provided by the PCM:

- Intake air temperature
- Fuel grams per second
- Throttle position
- Engine cooling fan speed
- Engine coolant temperature
- Exterior Environment - Outside Air Temperature

The generator battery control module uses these data parameters for different charging system modes depending on the required voltage needed.

Instrument Panel Cluster (IPC)

The instrument panel cluster (IPC) provides a means of customer notification in case of a failure. There are 2 means of notification, a battery charge indicator and a driver information center message of SERVICE CHARGING SYSTEM FAILURE and CHARGING SYSTEM FAULT.

Charging System Operation

The purpose of the charging system is to maintain the battery charge and vehicle loads. There are 9 modes of operation and they include:

- Charge Mode
- Fuel Economy Mode
- Voltage Reduction Mode
- Start Up Mode
- Headlamp Mode
- Battery Sulfation Protection Mode
- Windshield Wiper Voltage Boost Mode
- Fuel Pump Voltage Boost Mode
- De-Ice Voltage Boost Mode

The generator battery control module monitors the generator performance though the generator field duty cycle signal circuit, the generator field control circuit and the battery positive voltage circuit. The generator battery control module controls the generator through the generator field

control, charge indicator control, circuit. The signal is a 5-volt pulse width modulation (PWM) signal of 128 Hz +/- 5 percent with a duty cycle of 0-100 percent. The duty cycle sent by the generator battery control module is limited between 36-90 percent. When the engine is turned OFF, the module will send 0 percent duty cycle, low voltage. When there is loss of class 2 communication with the PCM, the module will send 100 percent duty cycle, 13.8 volts. The following table shows the commanded duty cycle and output voltage of the generator:

Charging System Description and Operation

Commanded Duty Cycle	Generator Output Voltage
10%	11.0 V
20%	11.56 V
30%	12.12 V
40%	12.68 V
50%	13.25 V
60%	13.81 V
70%	14.37 V
80%	14.94 V
90%	15.5 V

The generator provides a feedback signal of the generator voltage output through the generator field duty cycle signal circuit to the generator battery control module. The signal is a 5-volt PWM signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-99 percent. Between 0-5 percent and 100 percent are for diagnostic purposes.

Charge Mode

The generator battery control module will enter Charge Mode when at least one of the following conditions is met:

- The electric cooling fans are on high speed.
- The rear defogger is ON.
- The battery state of charge is less than 80 percent.
- The battery current is not between -8 and +15 amps.
- The estimated ambient air temperature is less than 0°C (32°F).
- DTC B1516 is set.

Once one of these conditions are met the generator battery control module will set the targeted generator output voltage to the nominal optimum battery voltage which is from 13.9-15.5 volts,

the voltage set point is based on the batteries state of charge and estimated battery temperature. The battery voltage ramps up to the targeted set point at a rate of 20 mV per second.

Fuel Economy Mode

The generator battery control module will enter Fuel Economy Mode when all of the following conditions are true:

- Estimated ambient air temperature is equal to or greater than 0°C (32°F).
- The calculated battery current is less than +15 amperes and greater than -8 amperes.
- The battery state of charge is greater than or equal to 80 percent.
- The rear defoggers are turned OFF.
- The electric cooling fans are on low speed or OFF.

The targeted generator output voltage is 13 volts. The generator battery control module will exit this mode once the criteria are met for Charge Mode or it will boost voltage to a pre-determined set point for the fuel pump, headlamps or windshield wipers.

Voltage Reduction Mode

The generator battery control module will enter Voltage Reduction Mode when the calculated ambient air temperature is above 0°C (32°F). The calculated battery current is less than +2 amperes and greater than -7 amperes, the generator field duty cycle is less than 99 percent. The rear defoggers are turned OFF and the electric cooling fans are on low speed or OFF. Its targeted generator output voltage is 87 percent of the Charge Mode set point but limited to 12.9 volts. The generator battery control module will exit this mode once the criteria are met for Charge Mode or it will boost voltage to a pre-determined set point for the fuel pump, headlamps or windshield wipers.

Start Up Mode

After the engine has started the generator battery control module sets a targeted generator output voltage of 14.5 volts for 30 seconds.

Headlamp Mode

The generator battery control module will enter the Headlamp Mode when the headlamps, low or high beams, are turned ON. The voltage will ramp up or down to 14.5 volts at a rate of 10 mV/second. The module will exit this mode once the headlamps are turned OFF and enter Charge Mode, Fuel Economy Mode or Voltage Reduction Mode.

Battery Sulfation Mode

The generator battery control module will enter this mode when the interpreted generator output voltage is less than 13.2 volts for 45 minutes. Once in this mode the generator battery control module will set the targeted output voltage to the nominal optimum battery voltage, see Charge Mode, for 3 minutes. The generator battery control module will then determine which mode to enter depending on vehicle conditions.

Windshield Wiper Voltage Boost Mode

When the generator battery control module is in Fuel Economy Mode or Voltage Reduction Mode, the module will boost battery voltage to 14.5 volts when the windshield wipers are ON, intermittent, low or high speed, after 8 seconds. The voltage will ramp to 14.5 volts at a rate of 50 mV/second. The module will exit this mode once the Windshield Wipers are OFF for 5 seconds and the module will enter Charge Mode, Fuel Economy Mode or Voltage Reduction Mode.

Fuel Pump Voltage Boost Mode

When the generator battery control module is in Fuel Economy Mode or Voltage Reduction Mode, the module will immediately boost battery voltage to 13.4 volts when the instantaneous fuel flow is greater than 21k grams/second and the throttle position sensor pedal position is greater than 90 percent. The module will exit this mode once the instantaneous fuel flow is less than 5k grams/second and enter Charge Mode, Fuel Economy Mode or Voltage Reduction Mode.

De-Ice Voltage Boost Mode

The generator battery control module will enter De-Ice Voltage Boost Mode when the estimated ambient air temperature is less than or equal to -1°C (+30°F) and the engine coolant temperature is less than or equal to 75°C (167°F). The module will be in Charge Mode if the above conditions are true. Once the engine coolant temperature becomes greater than 75°C (167°F), the module will remain in Charge Mode or enter Fuel Economy Mode or Voltage Reduction Mode based on the vehicle conditions.

Instrument Panel Cluster (IPC) Operation

Charge Indicator Operation

The instrument panel cluster (IPC) illuminates the charge indicator in the message center when the one or more of the following occurs:

IMPORTANT: The generator battery control module is not set up to set a DTC if the battery voltage is too high or too low. Check with the PCM to see if they set a DTC when the battery voltage is too high or too

low.

- 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 body control module (BCM) indicating there is a system voltage range concern.
- The IPC performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.
- The ignition is ON, with the engine OFF.
- The generator battery control module determines there is a fault and sends a class 2 message to the IPC to illuminate the charge indicator.

Charging System Failure

The generator battery control module will send a class 2 message to the IPC for the CHARGING SYSTEM FAILURE message to be displayed. It is commanded ON when DTC B1487 sets. The message is turned off when the conditions for clearing the DTC have been met and after an ignition cycle.

Service Charging System

The generator battery control module will send a class 2 message to the IPC for the SERVICE CHARGING SYSTEM message to be displayed. It is commanded ON when DTC B1390, B1488, B1492 or B1516 sets. The message is turned off when the conditions for clearing the DTC have been met and after an ignition cycle.

Voltmeter Operation

The IPC displays the system voltage as detected at the ignition 1 input of the IPC. When the engine is ON, the gage should be between 10-16 volts. The voltmeter will be noticeably different than previous model year vehicle as far as voltage fluctuations. If there is a concern with gage operation ensure to compare to a known good like vehicle.

ELECTRICAL POWER MANAGEMENT DESCRIPTION AND OPERATION

Electrical Power Management

The 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), extends battery life.

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

Idle boost is activated in incremental steps, idle boost 1 must be active before idle boost 2 can be active. The criteria used by the body control module (BCM) to regulate EPM are outlined below.

Electrical Power Management 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 -10° C (+14°F)	Greater Than 12 V	Battery has a net loss less than 0.2 AH	First level Idle boost request cancelled
Idle Boost 2 Start	-	-	Battery has a net loss greater than 1.6 AH	Second level Idle boost requested
Idle Boost 2 Start	-	Less Than 10.9 V	-	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12 V	Battery has a net loss less than 0.8 AH	Second level Idle boost request cancelled
Idle Boost 3 Start	-	-	Battery has a net loss of 10.0 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 V	Battery has a net loss of less than 6 AH	Third level Idle boost request cancelled

STARTING SYSTEM DESCRIPTION AND OPERATION

The starter motors on these vehicles are non-repairable starter motors. They have pole pieces that

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

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

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

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

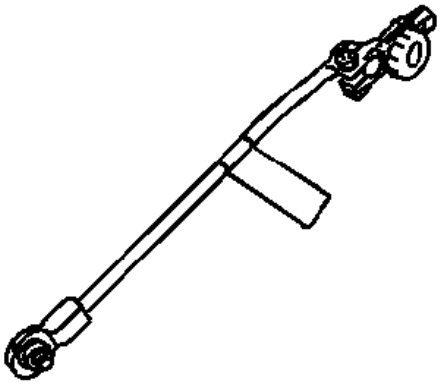
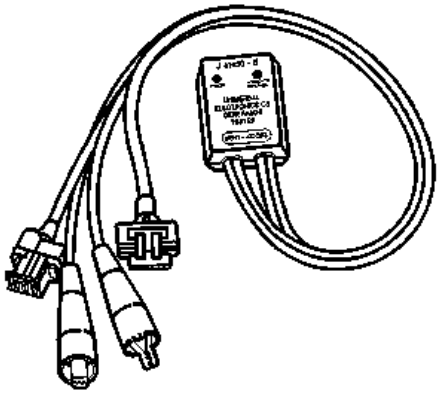
Circuit Description

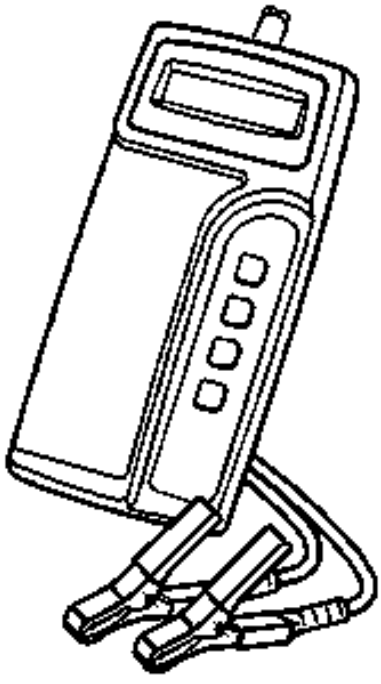
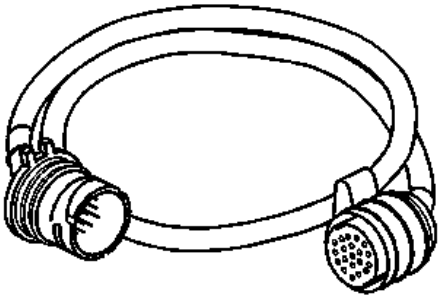
Moving the ignition switch to the START position signals the body control module (BCM) that engine crank has been requested. The BCM verifies that theft is not active and sends a serial data message to the powertrain control module (PCM) requesting engine start. The BCM also energizes the RUN/CRANK RELAY. When the RUN/CRANK RELAY switch side closes and the vehicle is in Park/Neutral or with the clutch fully depressed, if equipped, supply voltage is applied to the PCM CNTRL relay coil. The PCM verifies the transmission is in Park/Neutral or if the clutch is fully depressed, if equipped. The PCM will then ground the control circuit of the PCM CNTRL relay, closing the switch suppling voltage to the starter solenoid. On some vehicles the starter will continue to crank the engine with the key released until it starts, the crank command has timed out to prevent excessive heat build up in the starter circuitry or the PCM receives an engine run flag.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Special Tools

Illustration	Tool Number/Description
	J 38758 Parasitic Draw Test Switch
	J 41450-B Universal CS Generator Tester Harness

	J 42000 Battery Tester
	J 45681 Jumper Harness