

2004 STARTING & CHARGING SYSTEMS

Starters - H2

DESCRIPTION & OPERATION

The PG-260L is a non-repairable starter motor. It has pole pieces that are arranged around the armature within the starter housing. When the solenoid windings are energized, the pull-in winding circuit is completed to ground through the starter motor. The hold-in winding circuit is completed to ground through the solenoid. The windings work together magnetically to pull in and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. At the same time, the plunger closes the solenoid switch contacts in the starter solenoid. Full battery voltage is then applied directly to the starter motor and it cranks the engine.

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

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

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

STARTER MOTOR USAGE

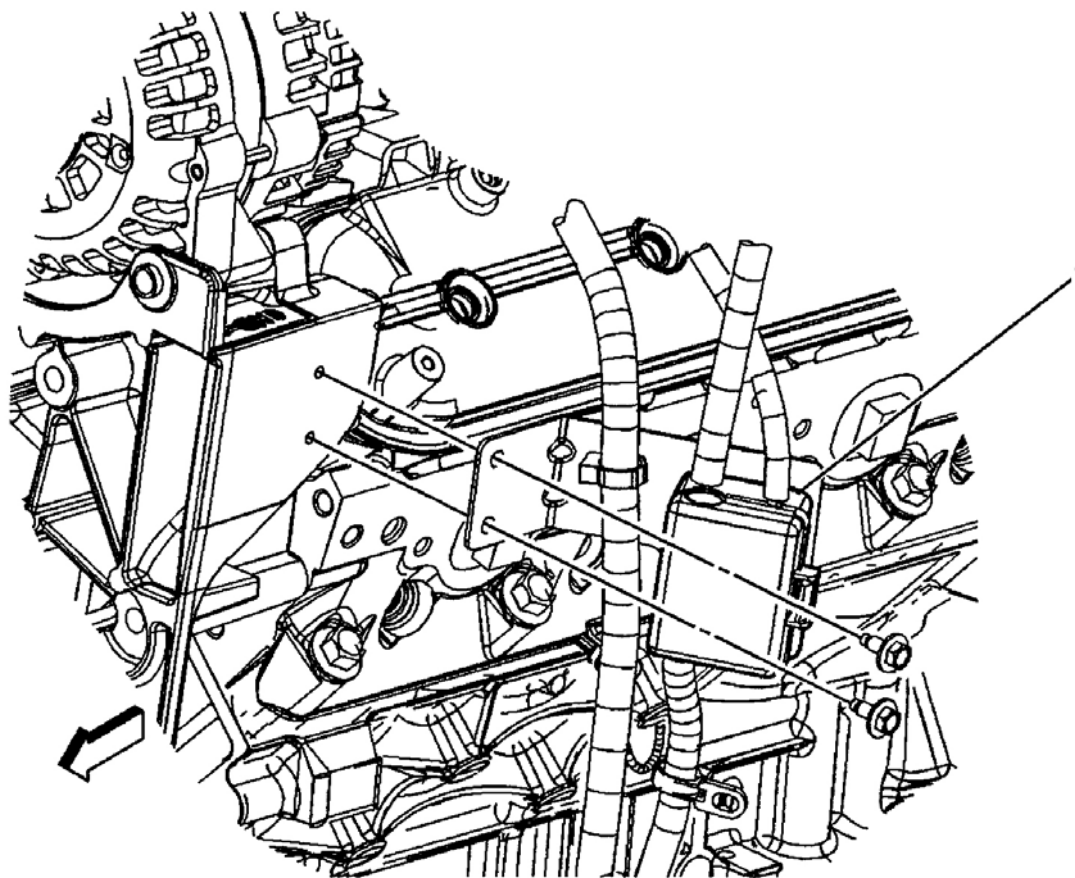
Vehicle uses starter model PG-260L.

BATTERY USAGE

BATTERY SPECIFICATIONS

Application	Rating
Cold Cranking Amperage (CCA)	880 Amps
Reserve Capacity Rating	115 Minutes
Replacement Battery Number	79-6YR

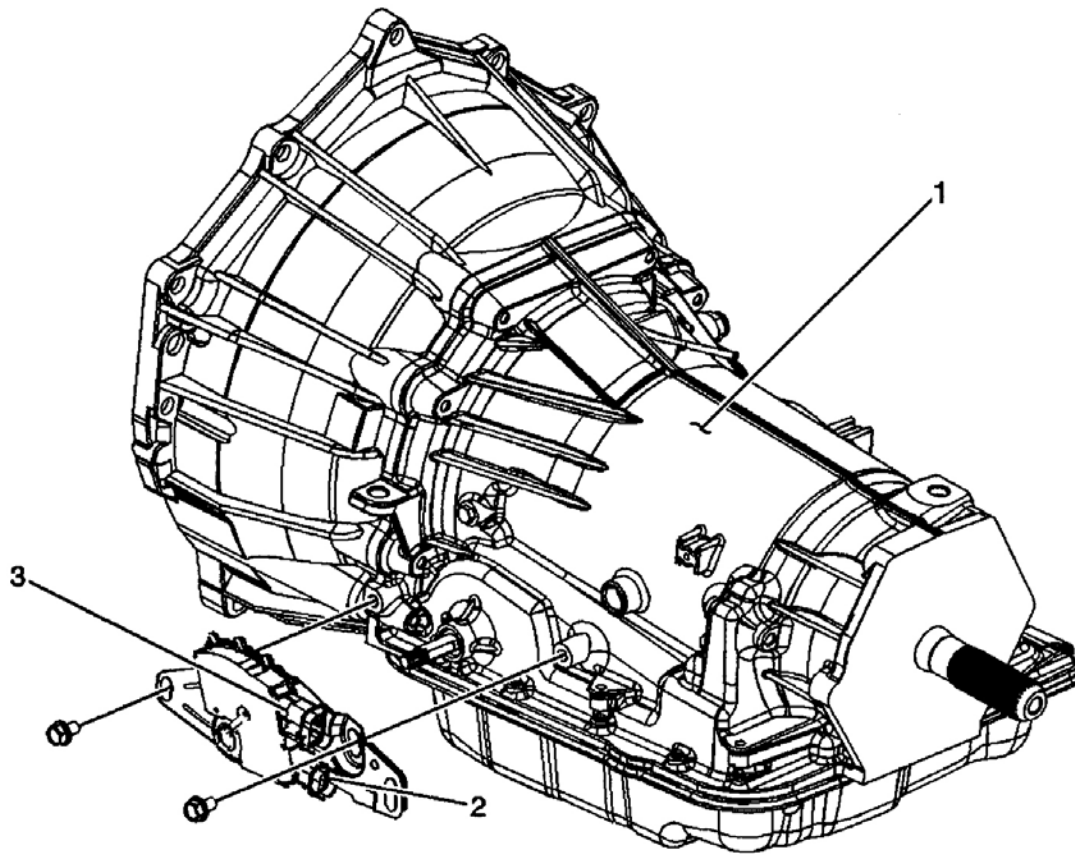
COMPONENT LOCATOR



(1) Junction Block-Battery Cable

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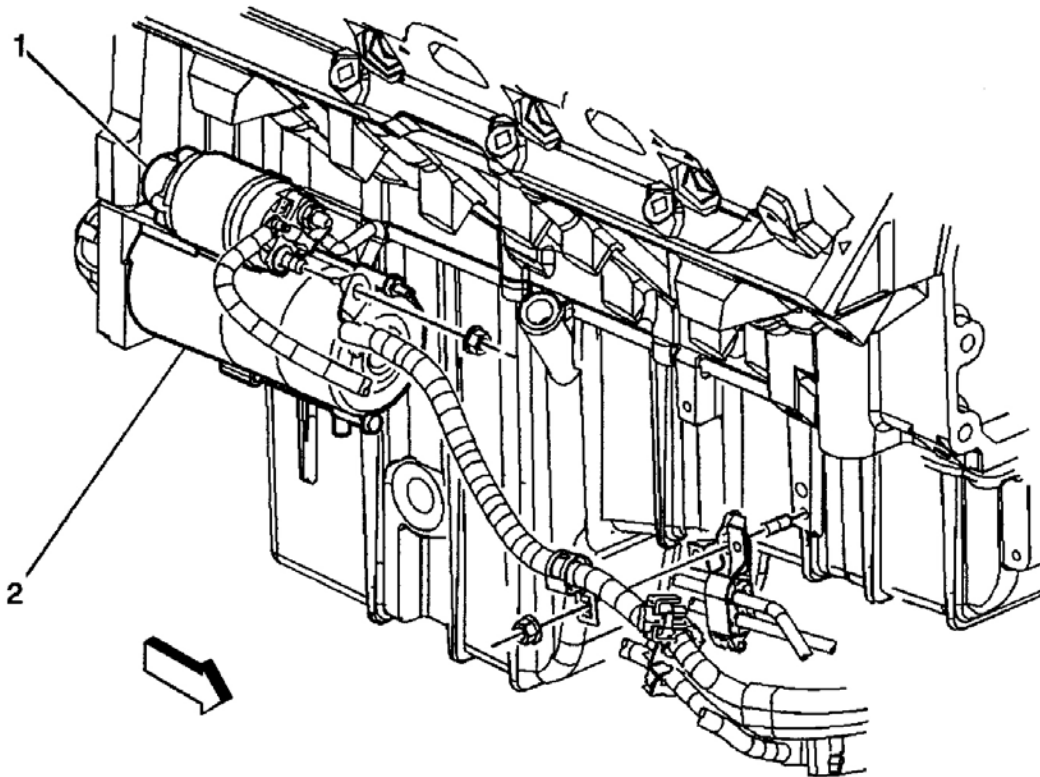
Fig. 1: Locating Battery Cable Junction
Courtesy of GENERAL MOTORS CORP.



- (1) Automatic Transmission 4L60-E
- (2) PNP Switch-C1
- (3) PNP Switch-C2

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Fig. 2: Locating Park/Neutral Switch (A/T)
Courtesy of GENERAL MOTORS CORP.



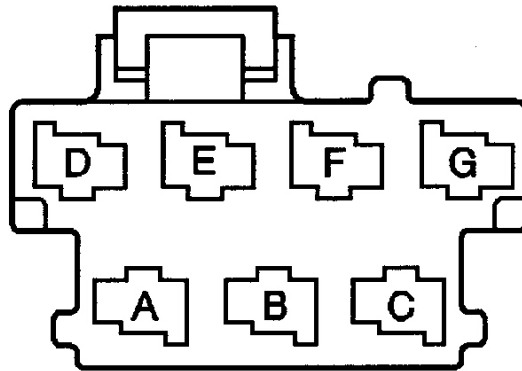
(1) Starter Solenoid

(2) Starter

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Fig. 3: Locating Starter Assembly & Starter Solenoid
Courtesy of GENERAL MOTORS CORP.

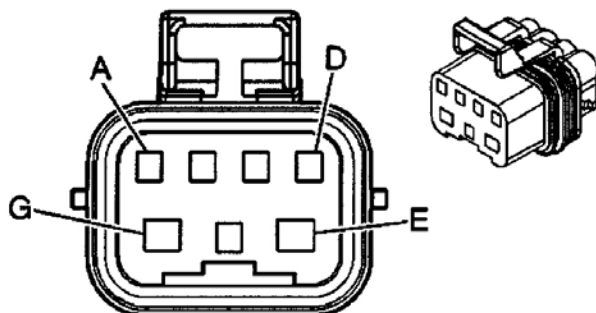
ENGINE ELECTRICAL CONNECTOR END VIEWS



Connector Part Information		<ul style="list-style-type: none"> • 10400853490 • 7-Way F Kostal N Series (BLK) 	
Pin	Wire Color	Circuit No.	Function
A	BRN	4	Accessory Voltage
B	RED/WHT	342	Battery Positive Voltage
C	PNK	3	Ignition 1 Voltage
D	YEL	5	Crank Voltage
E	WHT	1390	Acc/Run/Crank Voltage
F	RED	142	Battery Positive Voltage
G	ORN	300	Ignition 3 Voltage

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Fig. 4: Identifying Ignition Switch Harness Connector Terminals
 Courtesy of GENERAL MOTORS CORP.



Connector Part Information		<ul style="list-style-type: none"> • 12129840 • 7-Way F Metri-Pack 150 280 (MD GRY) 	
Pin	Wire Color	Circuit No.	Function
A	--	--	Not Used
B	LT GRN	275	Park Neutral Position Switch Park Signal
C	PNK	839	Ignition 1 Voltage
D	BLK/WHT	451	Ground
E	PNK	639	Ignition 1 Voltage
F	GRY	1524	Backup Lamp Supply Voltage
G	DK GRN	1433	Start Switch Signal

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Fig. 5: Identifying Park/Neutral Switch Harness Connector Terminals
 Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC STARTING POINT - ENGINE ELECTRICAL

Begin the system diagnosis with the Diagnostic System Check - Engine Electrical. See **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL**. The Diagnostic System Check will provide the following information:

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

The use of the **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL** will identify the correct procedure for diagnosing the system and where the procedure is located.

DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL

1. Did you perform the Battery Inspection/Test? If yes, go to next step. If no, go to **BATTERY INSPECTION/TEST (NON-HP2)**.

2. Install a scan tool. Does the scan tool power up? If yes, go to step 4 . If no, go to **SCAN TOOL DOES NOT POWER UP** .

3.

NOTE: **The engine may start during the following step. Turn OFF the engine as soon as you have observed the Crank power mode.**

Access the Class 2 Power Mode in the Diagnostic Circuit Check on the scan tool. Rotate the ignition switch through all positions while observing the ignition switch power mode parameter. Does the ignition switch parameter reading match the ignition switch position for all switch positions? If yes, go to next step. If no, go to **POWER MODE MISMATCH** .

4. Turn ON the ignition, with the engine OFF. Attempt to communicate with each module on the class 2 serial data circuit. If using a Tech 2, obtain this information using the Class 2 Message Monitor feature. Does the scan tool communicate with any module on the class 2 serial data circuit? If yes, go to next step. If no, go to Scan Tool Does Not Communicate with Class 2 Device in BODY CONTROL MODULES
5. Select the Display DTCs function for each module. If using a Tech 2, use the Class 2 DTC Check feature in order to determine which modules have DTCs set. Record all of the displayed DTCs the DTC status and the module which set the DTC. Does the scan tool display any DTCs? If yes, go to next step. If no, go to **SYMPTOMS - ENGINE ELECTRICAL** .
6. Does the scan tool display any DTC beginning with "U"? If yes, go to Diagnostic Trouble Code (DTC) List. If no, go to next step.
7. Does the scan tool display any DTC beginning with "P"? If yes, go to Powertrain DTC list in Engine Controls. If no, go to next step.
8. Does the scan tool display any DTC beginning with "B"? If yes, go to Diagnostic Trouble Code (DTC) List.

BATTERY INSPECTION/TEST (NON-HP2)

Diagnostic Aids

NOTE: **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. 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:
 - A. Disconnect the negative battery cable.
 - B. Disconnect the positive battery cable.
 - C. Install the test adapters on the terminals.
 - D. 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:

- A. Disconnect the negative battery cable.
- B. Disconnect the positive battery cable.
- C. Install the tester adapters.
- D.

NOTE: **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.**

Follow the instructions for testing a removed battery.

- E. 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. If the adapters that are provided with the J-42000 require replacement, use GM P/N 12303040. 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.

Diagnostic Procedures

CAUTION: Before servicing any electrical component, the ignition key must be in the OFF or LOCK position and all electrical loads must be OFF, unless instructed otherwise in these procedures. If a tool or equipment could easily come in contact with a live exposed electrical terminal, also disconnect the negative battery cable. Failure to follow these precautions may cause personal injury and/or damage to the vehicle or its components.

1. Inspect the battery for a cracked, broken, or damaged case, which may be indicated by battery acid leakage. Is the battery OK? If yes, go to next step. If no, 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? If yes, go to next step. If no, go to step 19 .
3. Does the hydrometer display a yellow dot? If yes, go to next step. If no, 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? If yes, go to step 19 . If no, go to next step.
5. Turn OFF the ignition. Attempt to rotate the negative battery cable connector clockwise with light finger pressure. Does the negative connector rotate? If yes, go to next step. If no, go to step 7 .
6. Use a torque wrench in order to verify the torque to loosen the negative battery terminal bolt. Is the torque above the specified value? 10 N.m (88 lb in). If yes, go to step 8 . If no, go to next step.

7. Disconnect the negative battery cable. Is the cable disconnected? If yes, go to step 9 . If no, go to next step.
8. Disconnect the negative battery cable. 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. After repairs, go to next step.
9. Rotate the positive battery cable connector clockwise with light finger pressure. Does the positive connector rotate? If yes, go to next step. If no, 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). If yes, go to step 12 . If no, go to next step.
11. Disconnect the positive battery cable. Is the cable disconnected? If yes, go to step 13 . If no, go to next step.
12. Disconnect the positive battery cable. 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. After repairs, go to next step.
13. Clean and wire brush the lead face of both battery terminals and the metal contact rings in both cable connectors. Remove the bolts from the cable connectors in order to provide access to the connector rings as needed. 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? If yes, go to next step.
14. Connect the positive battery cable to the battery positive terminal. Tighten the cable bolt to the specified value. Is the cable bolt properly tightened? 15 N.m (11 lb ft). If yes, go to next step.
15. Connect the negative battery cable to the battery negative terminal. Tighten the cable bolt to the specified value. Is the cable bolt properly tightened? 15 N.m (11 lb ft). If yes, go to next step.
- 16.

NOTE: Ensure that all of the electrical loads are turned OFF.

Install the J-42000 Battery Tester. Follow the directions supplied with the tester. Follow any direction displayed on the tester. Did the tester pass the battery? If yes, go to next step. If no, go to step 18 .

17. Press the CODE button on the J-42000. For warranty purposes, write the displayed code on the repair order.
18. Press the CODE button on the J-42000. For warranty purposes, write the displayed code on the repair order. Replace the battery. Refer to **BATTERY REPLACEMENT** .
19. Replace the battery. Refer to **BATTERY REPLACEMENT** .

SCAN TOOL DOES NOT POWER UP

Circuit Description

The data link connector (DLC) is a standardized 16 cavity connector. Connector design and location is dictated by an industry wide standard, and is required to provide the following:

- Scan tool power battery positive voltage at terminal 16.
- Scan tool power ground at terminal 4.
- Common signal ground at terminal 5.

The scan tool will power up with the ignition OFF. Some modules however, will not communicate unless the ignition is ON and the power mode master (PMM) module sends the appropriate power mode message.

Test Description

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

4 - If the battery positive voltage and ground circuits of the DLC are functioning properly. The malfunction must be due to the scan tool.

Diagnostic Procedures

1. Test the battery positive voltage circuit of the data link connector (DLC) for an open or a short to ground. Did you find and correct the condition? If yes, go to Body Control Module for the applicable Diagnostic System Check. If no, go to next step.
2. Test the ground circuit from pin 4 of the DLC for an open or high resistance. Did you find and correct the condition? If yes, go to Body Control Module for the applicable Diagnostic System Check. If no, go to next step.
3. Inspect for poor connections and terminal tension at the DLC. Did you find and correct the condition? If yes, go to Body Control Module for the applicable Diagnostic System Check. If no, go to next step.
4. The scan tool may be malfunctioning. Refer to the scan tool user guide. Did you obtain a properly operating scan tool? If yes, go to Body Control Module for the applicable Diagnostic System Check.

POWER MODE MISMATCH

Circuit Description

Normal vehicle class 2 communications and module operations will not begin until the system power mode has been identified. Discrete wires from the ignition switch contacts are monitored by the power mode master (PMM) module in order to determine the correct power mode. The PMM communicates the system power mode to all class 2 modules on the class 2 serial data line. Refer to appropriate BODY CONTROL MODULE article for System Description and Operation to identify which module is the PMM and the applicable power mode look up table.

Test Description

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

6 - This step tests for battery voltage on the signal circuits that are not required.

7 - This step tests for no battery voltage on the required signal circuits.

8 - If any ignition switch parameters that should be inactive in the present ignition switch position are active, 2 ignition switch signal circuits may be shorted together.

9 - This step eliminates open circuits as the cause of the malfunction.

Diagnostic Procedures

NOTE: This table is used if the observed vehicle power mode does not match the ignition switch position.

NOTE: Open the driver door and leave it open during this test. This will disable the RAP power mode and eliminate this power mode from the power mode parameter list.

1. Install a scan tool. Turn OFF the ignition. With a scan tool, under the Diagnostic Circuit Check menu observe the Class 2 Power Mode parameter. Does the displayed power mode parameter match the actual ignition switch position? If yes, go to next step. If no, go to step 6 .
2. Turn the ignition switch to the UNLOCK position. With a scan tool, under the Diagnostic Circuit Check menu observe the Class 2 Power Mode parameter. Does the displayed power mode parameter match the actual ignition switch position? If yes, go to next step. If no, go to step 6 .
3. Turn ON the ignition, with the engine OFF. With a scan tool, under the Diagnostic Circuit Check menu observe the Class 2 Power Mode parameter. Does the displayed power mode parameter match the actual ignition switch position? If yes, go to next step. If no, go to step 6 .

4.

NOTE: The engine may start during this procedure. Turn the ignition OFF after verifying this power mode.

Turn the ignition switch to the CRANK position. With a scan tool, under the Diagnostic Circuit Check menu observe the Class 2 Power Mode parameter. Does the displayed power mode parameter match the actual ignition switch position? If yes, go to next step. If no, go to step 6 .

5. Turn the ignition switch to the ACCY position. With a scan tool, under the Diagnostic Circuit Check menu observe the Class 2 Power Mode parameter. Does the displayed power mode parameter match the actual ignition switch position? If yes, problem is intermittent. If no, go to next step.

6.

NOTE: The engine may start during this procedure. Turn the ignition OFF after verifying this power mode.

Turn OFF the ignition. Disconnect the PMM. Hold the ignition switch in the position that indicated the incorrect power mode. With a test lamp attached to a good ground, test the PMM ignition switch inputs for voltage. Is voltage present on only the inputs specified for the ignition switch position? If yes, go to next step. If no, go to step 8 .

7.

NOTE: The engine may start during this procedure. Turn the ignition OFF after verifying this power mode.

Hold the ignition switch in the position that indicated the incorrect power mode. With a test lamp attached to a good ground, test the PMM ignition switch inputs for voltage. Refer to Body Control Module. Is voltage not present on any inputs specified for the ignition switch position? If yes, go to step 9 . If no, go to step 11 .

8. Disconnect the ignition switch. Test the PMM ignition switch input circuits for a short to voltage. Test the PMM ignition switch circuits for a short between circuits. Did you find and correct the condition? If yes,

go to step 14 . If no, go to step 10 .

9. Disconnect the ignition switch. Test the PMM ignition switch input circuits for an open. Did you find and correct the condition? If yes, go to step 14 . If no, go to next step.
10. Inspect for poor connections and terminal tension at the harness connector of the ignition switch. Did you find and correct the condition? If yes, go to step 14 . If no, go to step 12 .
11. Inspect for poor connections and terminal tension at the harness connector of the PMM. Did you find and correct the condition? If yes, go to step 14 . If no, go to step 13 .
12. Replace the ignition switch. After repairs, go to step 14 .
- 13.

NOTE: **After replacement of the PMM perform the programming or set up procedure if required.**

Replace the PMM. After replacement, go to next step.

14. **NOTE:** **The engine may start during this procedure. Turn the ignition OFF after verifying all power modes.**

Reconnect all disconnected components. With a scan tool, under the Diagnostic Circuit Check menu observe the Class 2 Power Mode parameter. Cycle the ignition switch through all possible positions one at a time. Does the displayed power mode parameter match the actual ignition switch position? If yes, system OK. If no, go to step 1 .

SCAN TOOL DATA LIST

Scan Tool Data List

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Ignition On, With Engine Off			
Ignition 1 Signal	Engine 1,2 Data	Volts	9-14 volts
GEN L-Terminal Signal Command	Engine 2 Data	OK/No Output	OK
GEN F-Terminal Signal	Engine 2 Data	%	10-90%

SCAN TOOL DATA DEFINITIONS

Ignition 1 Signal - The scan tool displays the current voltage at the battery.

GEN L-Terminal Signal Command - The scan tool displays OK/No Output. The scan tool displays OK until malfunction is detected on the generator L-terminal circuit, then it reads No Output.

GEN F-Terminal Signal - The scan tool displays 0-100%. The scan tool displays 0-5% until the engine is running, then the percentage value varies depending on electrical loads.

DIAGNOSTIC TROUBLE CODE LIST

Diagnostic Trouble Code List

DTC	Module(s)
B1327	BCM
B1328	BCM
P0562	PCM
P0563	PCM
P0615	PCM
P1637	PCM

DIAGNOSTIC TESTS

DTC B1327

Circuit Description

All vehicle modules monitor system voltage. The system voltage message is sent to other modules via Class 2 message. When the system voltage drops below the specified range DTC B1327 shall set within the affected module.

Conditions For Running 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, except when the DTC B1390 is set current.

Conditions For Setting DTC

- This DTC shall be set as current when the voltage falls below 9.0 volts for 1.2 seconds.
- When the vehicle exits START the module shall delay checking the voltage for 2 seconds.

Action Taken When DTC Sets

- A message shall be sent out on the class 2 lines to notify all other modules of low battery voltage.
- The modules disable the setting of U codes and other DTCs.

Conditions For Clearing 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 the ON-Board clearing DTCs feature.
- Use a scan tool.

Test Description

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

- 3 - Tests for the proper voltage at battery positive voltage sense circuit of the module, if voltage is not within the proper operating range, the voltage sense circuit needs to be tested.
- 4 - Tests the circuit for high resistance.
- 5 - Tests for the proper ground circuit for the module.

Diagnostic Procedures

1. Did you perform the Engine Electrical Diagnostic System Check? If yes, go to next step. If no, go to **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL**.
2. Install a scan tool. Turn ON the ignition, with the engine OFF. With a scan tool, observe the battery voltage parameter in the affected module data list. Or with a DMM, measure the battery voltage at the appropriate circuit of the module. Does the voltage measure greater than the specified value? 9.4 V. If yes, go to step 6 . If no, go to next step.
3. Turn OFF the ignition. Disconnect the harness connector of the module setting the DTC B1327. 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. If yes, go to step 6 . If no, go to next step.
4. Test the batter positive voltage circuit of the module setting the code for a high resistance or an open. Did you find and correct the condition? If yes, go to step 8 . If no, go to next step.
5. Test the ground sense circuit of the module setting the code for a high resistance or an open. Did you find and correct the condition? If yes, go to step 8 . If no, go to next step.
6. Inspect for poor connections at the harness connector of the module setting the DTC. Did you find and correct the condition? If yes, go to step 8 . If no, go to next step.

7.
NOTE: Perform the setup procedure for the module setting the code, if necessary.

Replace the module setting the DTC. Refer to Body Control Module. After replacement, go to next step.

8. Use the scan tool in order to clear the DTCs. Operate the vehicle within the **CONDITIONS FOR RUNNING DTC** . Does the DTC reset? If yes, go to step 2 . If no, system OK.

DTC B1328

Circuit Description

All vehicle modules monitor system voltage. The system voltage message is sent to other modules via Class 2 message. When the system voltage is above the specified range DTC B1328 shall set within the affected module.

Conditions For Running 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, except when the DTC B1390 is set current.

Conditions For Setting DTC

This DTC will set as current when the voltage is greater than 15.9 volts for 1.2 seconds and DTC B1390 is not set current in the affected module.

Action Taken When DTC Sets

- A message shall be sent out on the class 2 lines to notify all other modules of high than normal battery voltage.
- The modules disable the setting of U codes and other DTCs.

Conditions For Clearing DTC

- The DTC will clear current status when the voltage is less than 15.5 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.

Diagnostic Aids

Using a battery charger to jump start the vehicle may set DTC B1328 as a history code.

Test Description

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

- 3 - Tests for the proper voltage at the affected module. If the voltage is not within the proper operating range, the charging system needs to be checked
- 4 - Setup procedure for the module replacement.

Diagnostic Procedures

1. Did you perform the Engine Electrical Diagnostic System Check? If yes, go to next step. If no, go to **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL**.
2. Install a scan tool. Turn ON the ignition, with the engine OFF. With a scan tool, monitor the DTC Information for DTC B1328 in the affected module. Does the scan tool indicate that DTC B1328 is current? If yes, go to step 4. If no, go to next step.
3. With a scan tool, monitor the DTC Information for DTC B1328 in the affected module. Does the scan tool indicate that DTC B1328 is current? If yes, go to next step. If no, go to **DIAGNOSTIC AIDS**.
- 4.

NOTE: Perform the setup procedure for the module setting the code, if necessary.

Replace the module setting the code. Refer to Body Control Module. After replacement, go to next step.

5. Use the scan tool in order to clear the DTCs. Operate the vehicle within the **CONDITIONS FOR RUNNING DTC** . Does the DTC reset? If yes, go to step 2 . If no, system OK.

DTC P0562

Circuit Description

The 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.

Conditions For Running DTC

- Engine run time more than 20 seconds and above 1200 RPM.
- Vehicle speed above 8 km/h (5 mph).

Conditions For Setting DTC

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

Action Taken When 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 instrument panel cluster (IPC) displays a message.
- The malfunction indicator lamp (MIL) will not illuminate.

Conditions For Clearing DTC

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

Diagnostic Procedures

1. Did you perform the Engine Electrical Diagnostic System Check? If yes, go to next step. If no, go to **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL** .
2. With the scan tool monitor the Ignition 1 signal voltage in the PCM data list. Does the scan tool display Ignition 1 voltage greater than the specified value? 11 V. If yes, go to step 4 . If no, go to next step.

3. Test the ignition feed circuit to the PCM for high resistance or open. Did you find and correct the condition? If yes, go to step 7 . If no, go to step 5 .
4. Inspect for poor connections at the PCM. If you find a poor connection, repair the condition as necessary. Did you find and correct the condition? If yes, go to step 7 . If no, go to step 6 .
5. Repair the ignition feed circuit to the PCM for an open or a short to ground. After repairs, go to step 7 .
- 6.

NOTE: The replacement PCM must be programmed.

Replace the PCM. Refer to Powertrain Control Module (PCM) Replacement. After repairs, go to next step.

7. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC Information option using the scan tool. Operate the vehicle within the **CONDITIONS FOR RUNNING DTC** . Does the DTC reset? If yes, go to step 2 . If no, 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.

Conditions For Running DTC

- The engine run time is more than 20 seconds.
- Engine running above 1200 RPM.
- Vehicle speed above 8 km/h (5 mph).

Conditions For Setting DTC

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

Action Taken When 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 DTC

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

Diagnostic Procedures

1. Did you perform the Engine Electrical Diagnostic System Check? If yes, go to next step. If no, go to **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL**.
2. Turn OFF all the accessories. Measure the battery voltage at the battery using the DMM. Operate the engine speed above 2000 RPM. Is the battery voltage less than 19 V? If yes, go to step 4 . If no, go to next step.
3. Replace the generator. Refer to **GENERATOR** . After replacement, go to step 5 .
- 4.

NOTE: The replacement PCM must be programmed.

Replace the PCM. Refer to Powertrain Control Module (PCM) Replacement. After replacement, go to next step.

5. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC Information option using the scan tool. Operate the vehicle within the **CONDITIONS FOR RUNNING DTC** . Does the DTC reset? If yes, go to step 2 . If no, system OK.

DTC P0615

Circuit Description

The PCM uses Output Driver Modules (ODMs) to control many functions of the engine. The ODMs supply the ground path for the PCM controlled device when the PCM commands the device ON. Each ODM is able to control several outputs. The PCM monitors the ODMs for circuit conditions that are incorrect for the commanded state of the ODM. If the PCM detects an improper circuit condition in the ODM that controls the starter relay, DTC P0615 will set.

Conditions For Running DTC

System voltage is between 8-16 volts.

Conditions For Setting DTC

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

Action Taken When DTC Sets

- The PCM will not illuminate the Malfunction Indicator Lamp (MIL).

- The PCM will store the conditions present when the DTC set as Fail Records data only.

Conditions For Clearing DTC

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

Diagnostic Aids

Ignition system DTCs set with the ignition switch in the START position if the starter relay or the starter is inoperative. When the PCM enables starter operation, the PCM also initiates the diagnostic test routines for DTC P0335. If a condition exists which prevents the engine from cranking, the PCM will not receive signal input from the CKP and CMP sensors, and the DTCs will set.

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

Test Description

The number(s) below refer to the step number(s) on the diagnostic table.

2 - Listen for an audible click when the Start 1 relay operates. Turn the ignition switch back and forth from the ON to START positions. Repeat this as necessary.

3 - Tests for voltage at the coil side of the Start 1 relay. The PCM IGN fuse supplies power to the coil side of the Start 1 relay.

4 - Verifies that the PCM is providing ground to the Start 1 relay.

5 - Tests if ground is constantly being applied to the Start 1 relay.

Diagnostic Procedures

1. Did you perform the Engine Electrical Diagnostic System Check? If yes, go to next step. If no, go to **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL**.
2. Install a scan tool. Turn ON the ignition, with the engine OFF. Turn the ignition back and forth from the ON to START positions. Does the Start 1 relay turn ON and OFF with each command? If yes, problem is intermittent. If no, go to next step.
3. Turn OFF the ignition. Disconnect the Start 1 relay. Turn ON the ignition, with the engine OFF. Probe the battery positive voltage of the Start 1 relay coil circuit with a test lamp that is connected to a good ground. Does the test lamp illuminate? If yes, go to next step. If no, go to step 8 .
4. Connect a test lamp between the control circuit of the Start 1 relay and the battery positive voltage of the Start 1 relay coil circuit. Turn the ignition back and forth from the ON to START positions. Does the test lamp turn ON and OFF with each command? If yes, go to step 6 . If no, go to next step.
5. Test the control circuit of the Start 1 relay for a short to voltage or an open. Did you find and correct the condition? If yes, go to step 11 . If no, go to step 7 .
6. Inspect for poor connections at the Start 1 relay. Did you find and correct the condition? If yes, go to step 11 . If no, go to step 9 .

7. Inspect for poor connections at the PCM. Did you find and correct the condition? If yes, go to step 11 . If no, go to step 10 .
8. Repair the battery positive voltage circuit of the Start 1 relay. After repairs, go to step 11 .
9. Replace the Start 1 relay. Did you complete the replacement? After replacement, go to step 11 .
- 10.

NOTE: The replacement PCM must be programmed.

Replace the PCM. Refer to Powertrain Control Module (PCM) Replacement. After replacement, go to next step.

11. Review and record the scan tool Fail Records data. Use the scan tool in order to clear the DTC. Operate the vehicle within the **CONDITIONS FOR RUNNING DTC** . Using the scan tool, observe the Specific DTC Information for DTC P0615 until the test runs. Does the scan tool indicate that DTC P0615 failed this ignition? If yes, go to step 2 . If no, system OK.

DTC P1637

Circuit Description

The powertrain control module (PCM) uses the generator turn on signal circuit to control the generator. A high side driver within the PCM allows the PCM to turn the generator ON and OFF. When Generator operation is desired, the PCM sends a 10-11 volt signal to the voltage regulator via the generator turn on signal circuit. This causes the voltage regulator to begin controlling the generator field circuit. Once the Generator is enabled by the PCM, the voltage regulator controls generator output independently of the PCM. Under certain operating conditions, the PCM can turn Off the generator by turning Off the 10-11 volt signal on the generator turn on signal circuit. The PCM has fault detection circuitry which monitors the state of the generator turn on signal circuit. If the fault detection circuit senses a voltage other than what is expected, this DTC will set. The voltage regulator also contains fault detection circuitry. If the regulator detects a problem, the regulator will ground the generator turn on signal circuit, pulling the voltage low. This also causes the PCM to set the DTC.

Conditions For Running DTC

- The ignition is ON.
- System voltage between 9.0-18.0 volts.

Conditions For Setting DTC

- An improper voltage level has been detected on the generator L-terminal circuit.
- The conditions are present for at least 30 seconds.

Action Taken When DTC Sets

The PCM stores conditions which were present when the DTC set as Failure Records only. This information will not be stored as Freeze Frame Records.

Conditions For Clearing DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction free warm-up cycles.
- The PCM receives a clear code command from the scan tool.

Diagnostic Procedures

1. Did you perform the Engine Electrical Diagnostic System Check? If yes, go to next step. **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL**.
2. Install a scan tool. Start the engine. With a scan tool, monitor the DTC information for DTC P1637 in Engine Controls. Does the scan tool indicate that DTC P1637 has passed? If yes, problem is intermittent. If no, go to next step.
3. Turn ON the ignition, leaving the engine OFF. Disconnect the generator harness connector. Measure the voltage between the generator turn on signal circuit and ground. Does the voltage measure near 10-11 volts? If yes, go to step 5 . If no, go to next step.
4. Test the generator turn on signal circuit for a short or open. Did you find and correct the condition? If yes, go to step 8 . If no, go to step 6 .
5. Inspect for poor connections at the harness connector of the generator. Did you find and correct the condition? If yes, go to step 8 . If no, go to **GENERATORS & REGULATORS** .
6. Inspect for poor connections at the harness connector of the PCM. Did you find and correct the condition? If yes, go to step 8 . If no, go to next step.
- 7.

NOTE: The replacement PCM must be programmed.

Replace the PCM/ECM. Refer to Powertrain Control Module (PCM) Replacement. Is action complete? If yes, go to next step.

8. Use the scan tool in order to clear the DTCs. Operate the vehicle within the **CONDITIONS FOR RUNNING DTC** . System OK

SYMPTOMS - ENGINE ELECTRICAL

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

- Perform **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL** before using the Symptom Tables in order to verify that all of the following are true:
 - A. There are no DTCs set.
 - B. The control module(s) can communicate via the serial data link.
- Review the system operation in order to familiarize yourself with the system functions. Refer to one of the following system operations:
 - A. Battery Description and Operation.
 - B. Starting System Description and Operation. See **DESCRIPTION & OPERATION** .
 - C. Charging System Description and Operation. See **GENERATORS & REGULATORS** .

VISUAL/PHYSICAL INSPECTION

- Inspect for aftermarket devices which could affect the operation of the Starting and Charging Systems.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

INTERMITTENT

Faulty electrical connections or wiring may be the cause of intermittent conditions. Check for intermittent and poor connections in wiring systems.

SYMPTOM LIST

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

- Starter Solenoid Does Not Click. See **STARTER SOLENOID DOES NOT CLICK**.
- Starter Solenoid Clicks, Engine Does Not Crank. See **STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK**.
- Engine Cranks Slowly. See **ENGINE CRANKS SLOWLY**.
- Battery Inspection/Test. See **BATTERY INSPECTION/TEST (NON-HP2)**.
- Charge Indicator Always On. See **CHARGE INDICATOR ALWAYS ON**.
- Charge Indicator Inoperative. See **CHARGE INDICATOR INOPERATIVE**.
- Charging System Test. See **CHARGING SYSTEM TEST (CS/AD/SI GENERATORS)**.
- Generator Noise Diagnosis. See **GENERATOR NOISE DIAGNOSIS**.

TROUBLE SHOOTING

STARTER SOLENOID DOES NOT CLICK

1. Did you preform the Engine Electrical Diagnostic System Check? If yes, go to next step. If no, go to **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL**.
2. Turn the ignition switch to the START position. Does the engine crank? If yes, problem is intermittent. If no, go to next step.
3. Turn the ignition switch to the START position. Does the starter motor relay click? If yes, go to step 11 . If no, go to next step.
4. Turn OFF the ignition. Disconnect the powertrain control module (PCM) harness connector. Connect a test lamp between the Crank Voltage circuit of the PCM harness and a good ground. With the transmission in park, turn the ignition switch to the START position. Does the test light illuminate? If yes, go to step 7 . If no, go to next step.
5. Inspect for poor connections at the PCM connector, Underhood Fuse Block or ignition switch harness connector. Did you find and correct the condition? If yes, go to step 29 . If no, go to next step.
6. Test the supply voltage circuit of the crank voltage circuit and Crank fuse for an open or high resistance. Did you find and correct the condition? If yes, go to step 29 . If no, go to step 27 .

7. Turn OFF the ignition. Disconnect the PCM harness connector. Connect a test lamp between the crank voltage circuit (starter enable relay control) of the PCM harness and a good ground. Turn the ignition to the START position. Does the test lamp illuminate? If yes, go to step 19 . If no, go to next step.
8. Remove the starter motor relay. Connect a test light from the supply voltage circuit of the starter motor relay coil circuit to ground. With the transmission in park, or clutch pedal depressed, turn the ignition switch to the START position. Does the test light illuminate? If yes, go to next step. If no, go to step 10 .
9. Connect a test light from the supply voltage circuit of the starter motor relay coil circuit to the control circuit of the starter motor relay coil circuit. With the transmission in park, or clutch pedal depressed, turn the ignition switch to the START position. Does the test light illuminate? If yes, go to step 17 . If no, go to step 14 .
10. Turn OFF the ignition. Disconnect the Park Neutral Position (PNP) switch. Refer to Automatic Transmissions. Turn ON the ignition, with the engine OFF. Connect a 10 amp fused jumper between the starter motor relay coil control circuits of the PNP switch or clutch pedal position switch. With the transmission in park, or clutch pedal depressed, turn the ignition switch to the START position. Does the test lamp illuminate? If yes, go to step 18 . If no, go to step 15 .
11. Turn OFF the ignition. Disconnect the starter motor relay. Connect a test lamp between the battery positive voltage circuit of the starter motor relay switch circuit and a good ground. Does the test lamp illuminate? If yes, go to next step. If no, go to step 23 .
12. Connect a 30 amp fused jumper between the battery positive voltage circuit of the starter motor relay switch circuit and the supply voltage circuit of the starter solenoid. Does the engine crank? If yes, go to step 17 . If no, go to next step.
13. Does the fuse in the jumper open? If yes, go to step 24 . If no, go to step 16 .
14. Test the control circuit of the starter motor relay for an open or high resistance. Did you find and correct the condition? If yes, go to step 29 . If no, go to step 25 .
15. Test the supply voltage circuit of the starter motor relay coil circuit for an open or high resistance. Did you find and correct the condition? If yes, go to step 29 . If no, go to step 21 .
16. Test the supply voltage circuit of the starter solenoid for an open or high resistance. Did you find and correct the condition? If yes, go to step 29 . If yes, go to step 22 .
17. Inspect for poor connections at the starter motor relay. Did you find and correct the condition? If yes, go to step 29 . If no, go to step 25 .
18. If equipped with an Automatic Transmission, inspect for poor connection at the PNP switch harness connector. If OK, perform the Park/Neutral Position Switch Adjustment 4L60-E for Automatic Transmission. If equipped with a Manual Transmission, inspect for poor connection at the clutch pedal position switch harness connector. Did you find and correct the condition? If yes, go to step 29 . If no, go to step 26 .
19. Inspect for poor connections at the harness connector of the PCM. Did you find and correct the condition? If yes, go to step 29 . If no, go to next step.
- 20.

NOTE: The replacement PCM must be programmed.

Replace the PCM/ECM. Refer to PCM Replacement. After replacement, go to step 29 .

21. Inspect for poor connections at the ignition switch harness connector. Did you find and correct the condition? If yes, go to step 29 . If no, go to step 27 .

22. Inspect for poor connections at the starter solenoid. Did you find and correct the condition? If yes, go to step 29 . If no, go to step 28 .
23. Repair the open or high resistance in the battery positive voltage circuit of the Starter Motor relay switch circuit. After repairs, go to step 29 .
24. Repair the short to ground in the supply voltage circuit of the starter solenoid. After repairs, go to step 29 .
25. Replace the Starter Relay. After replacement, go to step 29 .
26. Replace the PNP switch. Refer to Automatic Transmission. After replacement, go to step 29 .
27. Replace the Ignition Switch. After replacement, go to step 29 .
28. Replace the starter. Refer to **STARTER MOTOR REPLACEMENT** . After replacement, go to next step.
29. Operate the system for which the symptom occurred. Did you correct the condition? If yes, system OK. If no, go to step 2 .

STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK

1. Did you perform the Engine Electrical Diagnostic System Check? If yes, go to next step. If no, go to **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL** .
2. Turn the ignition to the START position. Did the starter solenoid click? If yes, go to next step. If no, go to **STARTER SOLENOID DOES NOT CLICK** .
3. Inspect the engine and belt drive system for mechanical binding (seized engine, seized generator). Does the engine move freely? If yes, go to next step. If no, go to Engine Mechanical.
4. Test the battery positive cable between the battery and the starter solenoid for high resistance. Did you find and correct the condition? If yes, go to step 8 . If no, go to next step.
5. Test the ground circuit between the battery and the starter motor for a high resistance. Did you find and correct the condition? If yes, go to step 8 . If no, go to next step.
6. Inspect for poor connections at the starter. Did you find and correct the condition? If yes, go to step 8 . If no, go to next step.
7. Replace the Starter. Refer to **STARTER MOTOR REPLACEMENT** . After replacement, go to next step.
8. Operate the system for which the symptom occurred. Did you correct the condition? If yes, system OK. If no, 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.
- Engine - Make sure the engine is not seized. Refer to Symptoms in Engine Mechanical.

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**.

BATTERY INSPECTION/TEST (NON-HP2)

Diagnostic Aids

NOTE: The battery test using the J-42000 Battery Tester requires correct connections to the battery terminals. 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. 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 test adapters on the terminals.
 - 4.

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

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. If the adapters that are provided with the J-42000 require replacement, use GM P/N 12303040. 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.

Diagnostic Procedures

1. Inspect the battery for a cracked, broken, or damaged case, which may be indicated by battery acid leakage. Is the battery OK? If yes, go to next step. If no, 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? If yes, go to next step. If no, go to step 19 .
3. Does the hydrometer display a yellow dot? If yes, go to next step. If no, 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? If yes, go to step 19 . If no, go to next step.
5. Turn OFF the ignition. Attempt to rotate the negative battery cable connector clockwise with light finger pressure. Does the negative connector rotate? If yes, go to next step. If no, go to step 7 .
6. Use a torque wrench in order to verify the torque to loosen the negative battery terminal bolt. Is the torque above 10 N.m (88 lb in)? If yes, go to step 8 . If no, go to next step.
7. Disconnect the negative battery cable. Is the cable disconnected? If yes, go to step 9 .
8. Disconnect the negative battery cable. 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? If yes, go to next step.
9. Rotate the positive battery cable connector clockwise with light finger pressure. Does the positive connector rotate? If yes, go to next step. If no, 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 10 N.m (88 lb in). If yes, go to step 12 . If no, go to next step.
11. Disconnect the positive battery cable. Is the cable disconnected? If yes, go to step 13 .
12. Disconnect the positive battery cable. 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. After repairs, go to next step.
13. Clean and wire brush the lead face of both battery terminals and the metal contact rings in both cable connectors. Remove the bolts from the cable connectors in order to provide access to the connector rings as needed. 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? If yes, go to next step.
14. Connect the positive battery cable to the battery positive terminal. Tighten the cable bolt to the specified value. Is the cable bolt properly tightened? 15 N.m (11 lb ft). If yes, go to next step.
15. Connect the negative battery cable to the battery negative terminal. Tighten the cable bolt to the specified value. Is the cable bolt properly tightened? 15 N.m (11 lb ft). If yes, go to next step.
- 16.

NOTE: Ensure that all of the electrical loads are turned OFF.

Install the J-42000 Battery Tester. Follow the directions supplied with the tester. Follow any direction displayed on the tester. Did the tester pass the battery? If yes, go to next step. If no, go to step 18 .

17. Press the CODE button on the J-42000. For warranty purposes, write the displayed code on the repair order. Did you complete this action? If yes, battery OK.
18. Press the CODE button on the J-42000. For warranty purposes, write the displayed code on the repair order. Replace the battery. Refer to **BATTERY REPLACEMENT**.
19. Replace the battery. Refer to **BATTERY REPLACEMENT**.

CHARGE INDICATOR ALWAYS ON

1. Did you perform the Engine Electrical Diagnostic System Check? If yes, go to next step. If no, go to **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL**.
2. Turn ON the ignition, with the engine OFF. Observe the Charge indicator on the instrument cluster (IPC). Does the charge indicator illuminate? If yes, go to next step. If no, go to **SYMPTOM LIST**.
3. Turn OFF the ignition. Disconnect the generator connector. Turn ON the ignition, with the engine OFF. Does the charge indicator illuminate? If yes, go to next step. If no, go to Charging System Test in **GENERATORS & REGULATORS**.
4. Test the charge indicator control circuit for a short to ground. Did you find and correct the condition? If yes, go to step 6 . If no, go to next step.
- 5.

NOTE: The replacement PCM must be programmed.

Replace the PCM. Refer to Powertrain Control Module (PCM) Replacement. Is the action complete? If yes, go to next step.

6. Operate the system in order to verify the repair. Did you correct the condition? If yes, system OK. If no, go to step 2 .

CHARGE INDICATOR INOPERATIVE

1. Did you perform the Diagnostic System Check for Starting and Charging? If yes, go to next step. If no, go to Diagnostic System Check in Engine Electrical.
2. Turn ON the ignition, with the engine OFF. Does the battery charge indicator illuminate during the bulb check? Problem is intermittent. If yes, go to next step.
3. Replace the charge indicator bulb. Did you complete the replacement? If yes, go to next step.
4. Operate the system in order to verify the repair. Did you correct the condition? If yes, system OK. If no, go to step 2 .

CHARGING SYSTEM TEST (CS/AD/SI GENERATORS)

1. Did you perform the Engine Electrical Diagnostic System Check? If yes, go to next step. If no, go to Diagnostic System Check in Engine Electrical.
2. Start the engine. Observe the charge indicator on the instrument cluster (IPC). Does the charge indicator illuminate or message center (DIC) display a charging system message? If yes, go to next step. If no, go to Symptoms in Engine Electrical.
- 3.

NOTE: The green POWER lamp of the tester should remain illuminated while the tester is being used.

Turn OFF the ignition. Connect the red lead of the J-41450-B Universal CS Generator Test Harness to the generator output terminal. Connect the black lead of the J-41450-B to the metal generator housing. Does the green POWER lamp on the tester illuminate? If yes, go to step 6 . If no, go to next step.

4. Measure the voltage from the output terminal of the generator to the generator metal housing. Does the voltage measure equal to the specified value? 12.0 V. If yes, go to step 14 . If no, go to next step.
5. Measure the voltage from the output terminal of the generator to the battery negative terminal. Does the voltage measure equal to the specified value? 12.0 V. If yes, go to step 12 . If no, go to step 11 .
- 6.

NOTE: Ensure that all generator output circuit wires pass through the inductive probe.

Turn OFF completely the load tool before connecting or disconnecting a carbon pile load tester to the battery. Otherwise, sparking at the terminals could cause battery gasses to explode. Connect a carbon pile tester to the vehicle. Connect an inductive ammeter to the output circuit of the generator. Disconnect the generator harness connector. Locate the matching harness connector on the J-41450-B , and connect the connector to the generator. Does the red DIAGNOSTIC lamp on the tester illuminate? If yes, go to next step. If no, go to step 13 .

7. Start the engine and allow it to idle for 30 seconds. Increase the engine speed to 2,500 RPM. Does the red DIAGNOSTIC lamp on the tester illuminate? If yes, go to step 15 . If no, go to next step.
- 8.

NOTE: If the generator is not capable of producing the Load Test amps, operate the generator at it's maximum possible output.

Maintain the engine speed at 2,500 RPM. Turn ON the load of the carbon pile tester and increase the load until the generator output is equal to the Load Test value given in Generator Usage. See **GENERATORS & REGULATORS** . Does the red DIAGNOSTIC lamp on the tester illuminate? If yes, go to step 15 . If no, go to next step.

9. Maintain the engine speed at 2,500 RPM and continue to operate the generator at the load test value. Measure the voltage drop from the output terminal of the generator to the positive terminal on the battery. Does the voltage measure greater than the specified value? 0.5 V. If yes, go to step 11 . If no, go to next step.
10. Maintain the engine speed at 2,500 RPM and continue to operate the generator at the load test value. Measure the voltage drop from the battery negative terminal to the metal housing of the generator. Does the voltage measure greater than the specified value? 0.5 V. If yes, go to step 12 . If no, go to step 16 .
11. Repair the high resistance or an open in the output circuit of the generator. Did you complete the repair? If yes, go to step 16 .
12. Repair the high resistance or open in the ground circuit of the generator. Did you complete the repair? If yes, go to step 16 .
13. Disconnect the J-41450-B tester harness connector from the generator, but leave the alligator clips connected so that the green POWER lamp remains illuminated. Connect a jumper lead, with an in-line 100-ohm resistor between the J-41450-B tester harness connector terminal B of the generator and a good

- ground. Does the red DIAGNOSTIC lamp illuminate? If yes, go to step 15 . If no, go to next step.
14. There is a problem with the J-41450-B. Refer to the manufacturers instructions, how to test the J-41450-B for proper operation. Has the J-41450-B tester been replaced? If yes, go to step 3 .
 15. Replace the generator. Refer to Generator Replacement in **GENERATORS & REGULATORS** . Did you complete the replacement? If yes, go to next step.
 16. Operate the vehicle in order to verify the repair. Did you correct the condition? If yes, system OK. If no, 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.

Diagnostic Procedures

1. Test the generator for proper operation using the Generator Tester. Refer to **GENERATORS & REGULATORS** . Is the generator operating properly? If yes, go to next step. If no, go to step 11 .
2. Start the engine. Verify that the noise can be heard. Turn OFF the engine. Disconnect the 4-way connector from the generator. Start the engine. Listen for the noise. Has the noise stopped? If yes, go to step 11 . If no, go to next step.

3.

NOTE: The replacement PCM must be programmed.

Replace the PCM. Refer to Powertrain Control Module (PCM) Replacement. Is the action complete? If yes, go to next step. If no, go to step 11 .

4. Inspect the generator for a loose pulley and/or pulley nut. Is the generator pulley or pulley nut loose? If yes, go to step 11 . If no, go to next step.
5. Loosen all of the generator mounting bolts. Tighten the generator mounting bolts to specifications and in the proper sequence (if necessary). Refer to Generator Replacement in **GENERATORS & REGULATORS** . Install the drive belt. Start the engine. Has the noise decreased or stopped? If yes, system OK. If no, go to next step.
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? If yes, go to next step. If no, go to step 8 .
7. Reroute the electrical connections to relieve the tension. Reroute the hoses, etc. away from the generator. Start the engine. Has the noise decreased or stopped? If yes, system OK. If no, go to next step.
8. Inspect the drive belt for proper tension. If yes, go to next step. If no, go to step 10 .
9. Replace the drive belt tensioner. Start the engine. Has the noise decreased or stopped? If yes, system OK.

If no, go to step 11 .

10. Compare the vehicle with a known good vehicle. Do both vehicles make the same noise? If yes, system OK. If no, go to next step.
- 11.

NOTE: **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 in **GENERATORS & REGULATORS** . Has the noise decreased or stopped? If yes, go to next step.

12. Operate the system in order to verify the repair. Did you correct the condition? If yes, system OK. If no, go to step 2 .

STARTER NOISE DIAGNOSIS

Diagnostic Aids

- Inspect the flywheel ring gear for damage or unusual wear.
- Shim the starter if applicable.
- In order to add pinion to ring gear clearance a full size shim must be used. Do not shim only 1 starter mounting bolt. There are 3 shims available in different shapes for clearance. All are 1 mm (0.039 in) thick.

Diagnostic Procedures

1. Did you perform the Engine Electrical Diagnostic System Check? If yes, go to next step. If no, go to **DIAGNOSTIC SYSTEM CHECK - ENGINE ELECTRICAL** .
2. Start the engine. Does the starter operate normally? If yes, problem is intermittent. If no, go to next step.
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? If yes, go to step 6 . If no, go to next step.
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? If yes, go to step 7 . If no, go to next step.
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? If yes, go to step 8 . If no, go to step 7 .
6. Inspect the flywheel ring gear for a chipped gear teeth, missing gear teeth or milled teeth. Is the flywheel bent, or does it have damaged teeth? If yes, go to step 9 . If no, go to step 10 .
7. Remove the starter motor. Refer to **STARTER MOTOR REPLACEMENT** . Inspect the starter motor bushings and clutch gear. Does the clutch gear have chipped or milled teeth or worn bushings? If yes, go to step 10 . If no, go to next step.
8. Shim the starter motor away from the flywheel by adding shims between the starter motor and the engine

block one at a time. Flywheel runout may make this noise appear to be intermittent. Did you complete the repair? If yes, go to step 11 .

9. Replace the flywheel. Refer to Engine Mechanical. Did you complete the replacement? If yes, go to step 11 .
10. Replace the starter motor. Refer to **STARTER MOTOR REPLACEMENT** . Did you complete the replacement? If yes, go to next step.
11. Operate the system in order to verify the repair. Did you correct the condition? If yes, system OK. If no, go to step 3 .

BATTERY DIAGNOSIS & SERVICING

BATTERY CHARGING

- Use J-42000 Battery Tester.
- 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.

BATTERY STATE OF CHARGE

NOTE: Using voltage to determine the batteries state of charge (SOC) is only accurate after the battery has been at rest for 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.
- 4.

NOTE: The table is accurate to 10 percent only after the battery has been at rest

for 12 hours.

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

BATTERY STATE OF CHARGE

Battery Voltage	% Charge At 0°C (32°F)	% Charge At 25°C (75°C)
12.75 V	100%	100%
12.70 V	100%	90%
12.60 V	90%	75%
12.45 V	75%	65%
12.20 V	65%	45%
12.00 V	40%	20%

Use the SOC information as follows:

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

CHARGING TIME REQUIRED

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

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

CHARGING PROCEDURE

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

NOTE: Use the correct fastener in the correct location. Replacement fasteners must be the correct part number for that application. Fasteners requiring replacement or fasteners requiring the use of thread locking compound or sealant are identified in the service procedure. Do not use paints, lubricants, or corrosion inhibitors on fasteners or fastener joint surfaces unless specified. These coatings affect fastener torque and joint clamping force and may damage the fastener. Use the correct tightening sequence and specifications when installing fasteners in order to avoid damage to parts and systems.

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 the battery side terminal adapters to 15 N.m (11 lb ft). Use the following procedure to charge the battery:

1. Turn OFF the charger.
2. Ensure that all of the battery terminal connections are clean and tight.
3. Connect the charger positive lead to the battery positive terminal on the battery or the remote jumper stud underhood.
- 4.

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.

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

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.

- Verify that the battery and charging system are in proper working order. Refer to **BATTERY DIAGNOSIS & SERVICING**.
- 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(R), 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 Module 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.
-

NOTE: **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 RUN-DOWN RATING

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

Diagnostic Procedures

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.**

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

1. Disconnect the battery negative cable from the battery negative terminal.
2. Install the male end of the J-38758 to the battery ground terminal.
3. Turn the J-38758 knob to the OFF position.
4. Install the battery negative cable to the female end of the J-38758.
5. Connect a 10A fused jumper wire to the test switch tool terminals.
6. Turn the J-38758 knob to the ON position.
7. Road test the vehicle and activate ALL of the accessories, including the radio and air conditioning. This may take up to 30 minutes.
8. Park the vehicle. Turn the ignition switch to the OFF position and remove the ignition switch key.
9. Turn the J-38758 knob to the OFF position. The current now flows through the jumper wire.
10. Wait 1 minute. If the fuse blows, install an inductive ammeter and go to step 20.
11. Remove the fused jumper wire.
12. Set a digital multimeter to the 10A scale.
13. Connect the digital multimeter to the test switch tool terminals.
14. Turn the J-38758 knob to the OFF position. The current flows now through the digital multimeter.
15. Wait 1 minute. Check and record the current reading.
 - A. When there is a current reading on 2A or less, turn the J-38758 knob to the ON position. The electrical current will now pass through the switch.
 - B. Then switch the digital multimeter down to the 2A scale for a more accurate reading when the J-38758 knob is turned OFF.
16. Turn the J-38758 knob to the OFF position. Wait 15 minutes for most vehicles.
17. Check and record the current reading.
18. Note the battery reserve capacity, amp hour rating. Refer to **BATTERY USAGE**.
 - A. Divide the reserve capacity by 4, amp hour rating by 2.4.
 - B. 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, go to next step.
20. Using the MIN/MAX function of the digital multimeter, monitor the parasitic drain overnight or during the day. This will determine if something has been activated during that time frame.
- 21.

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.

NOTE: 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.

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 Wiring Diagrams to diagnose exactly which part of the suspect circuit is causing the parasitic drain. In some cases a non-fused circuit or component, such as a relay, is the cause of excessive parasitic current drain.

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

BATTERY COMMON CAUSES OF FAILURE

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

- A vehicle accessory was left on overnight.
- The driving speeds have been slow with frequent stops 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. A slipping belt
 - B. 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.

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 ($+20^{\circ}\text{F}$). 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:

1. **NOTE: If a green dot is not visible in the hydrometer, charge the battery. Refer to BATTERY CHARGING.**

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

2. **CAUTION: Before servicing any electrical component, the ignition key must be in the OFF or LOCK position and all electrical loads must be OFF, unless instructed otherwise in these procedures. If a tool or equipment could easily come in contact with a live exposed electrical terminal, also disconnect the negative battery cable. Failure to follow these precautions may cause personal injury and/or damage to the vehicle or its components.**

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

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:
 - A. Place the automatic transmission in PARK.
 - B. Block the wheels.
 - C. Set the parking brake.
 - D. Turn off all electrical loads that are not needed. Leave the hazard flashers ON.
 - E. Turn OFF the ignition switch.

3.

NOTE: 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.

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.
- 6.

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.

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:
 - A. Turn the ignition OFF.
 - B. Allow the booster vehicle engine to run at approximately 1,500 RPM for 5 minutes.
 - C. 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.

REMOVAL & INSTALLATION

BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE (SINGLE BATTERY)

Removal Procedure

1. Turn off all the lamps and accessories.
2. Turn the ignition OFF.
3. Remove the battery ground negative cable and bolt from the battery.

Installation Procedure

NOTE: Clean any existing corrosion from the battery terminal bolt flange and the battery cable end.

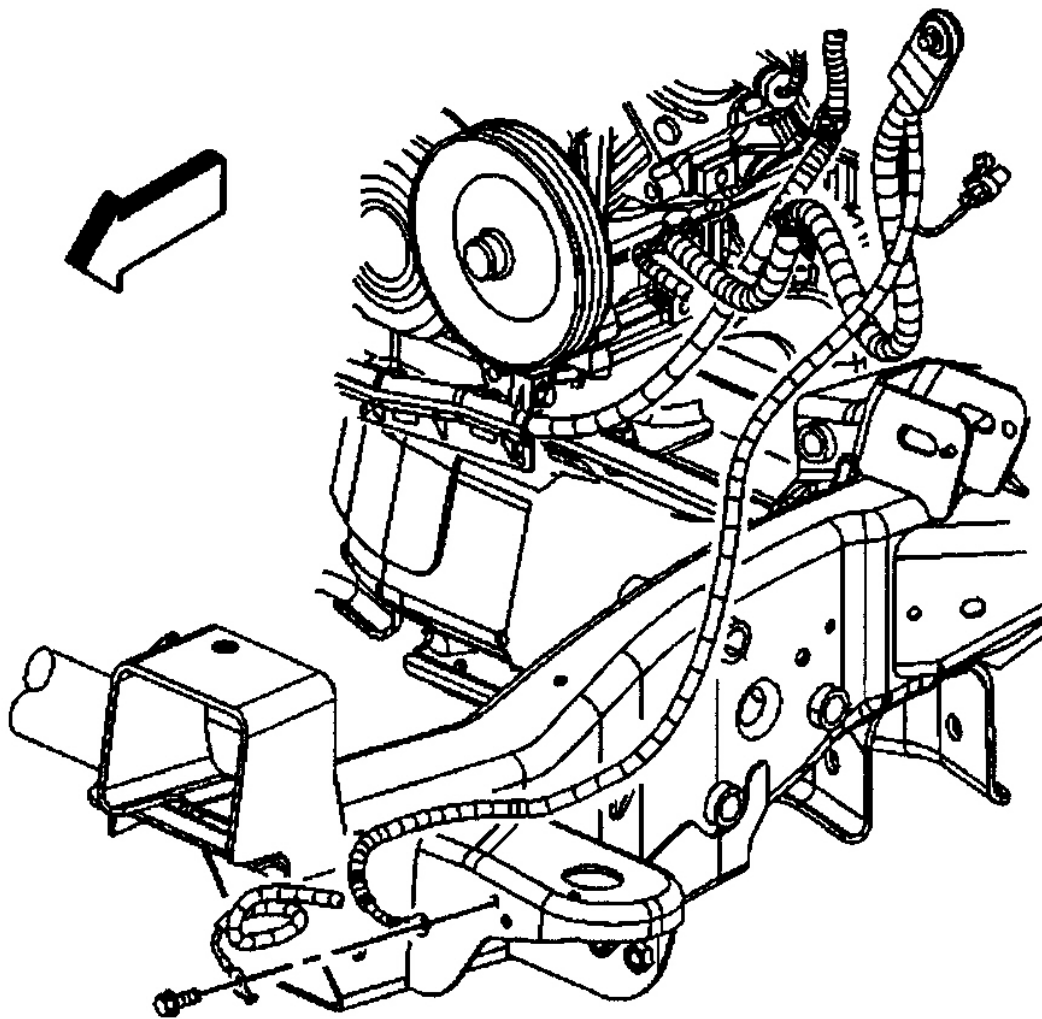
Install the battery ground negative cable and bolt to the battery. Tighten the battery terminal bolt to 17 N.m (13 lb ft).

BATTERY NEGATIVE CABLE REPLACEMENT

Removal Procedure

CAUTION: Before servicing any electrical component, the ignition key must be in the OFF or LOCK position and all electrical loads must be OFF, unless instructed otherwise in these procedures. If a tool or equipment could easily come in contact with a live exposed electrical terminal, also disconnect the negative battery cable. Failure to follow these precautions may cause personal injury and/or damage to the vehicle or its components.

1. Disconnect the battery negative cable from the battery. See **BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE (SINGLE BATTERY)**.
2. Raise and suitably support the vehicle with safety stands.
3. Remove the engine protection shield.
4. Remove the forward lamp wiring harness ground/negative cable bolt.
5. Remove the engine wiring harness ground/negative cable bolt.
6. Remove the negative battery cable.



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Fig. 6: Locating Negative Battery Cable-To-Engine Connection
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the negative battery cable.
2. Position the negative cable and forward lamp wiring harness ring terminals to the frame. Insert the anti-rotation tab on the forward lamp wiring harness into the hole in the frame.
3. Install the forward lamp wiring harness ground/negative cable bolt. Tighten the forward lamp wiring harness ground/negative cable bolt to 9 N.m (80 lb in).
4. Position the negative cable and engine wiring harness ring terminals to the engine block. Position the anti-rotation tab on the negative cable in the correct location.

5. Install the engine wiring harness ground/negative cable bolt. Tighten the engine wiring harness ground/negative cable bolt to 25 N.m (18 lb ft).
6. Install the engine protection shield.
7. Lower the vehicle.
8. Install the negative cable clip to the positive cable clip.
9. Connect the negative battery cable. Refer to **BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE (SINGLE BATTERY)**.

BATTERY POSITIVE CABLE REPLACEMENT

Removal Procedure

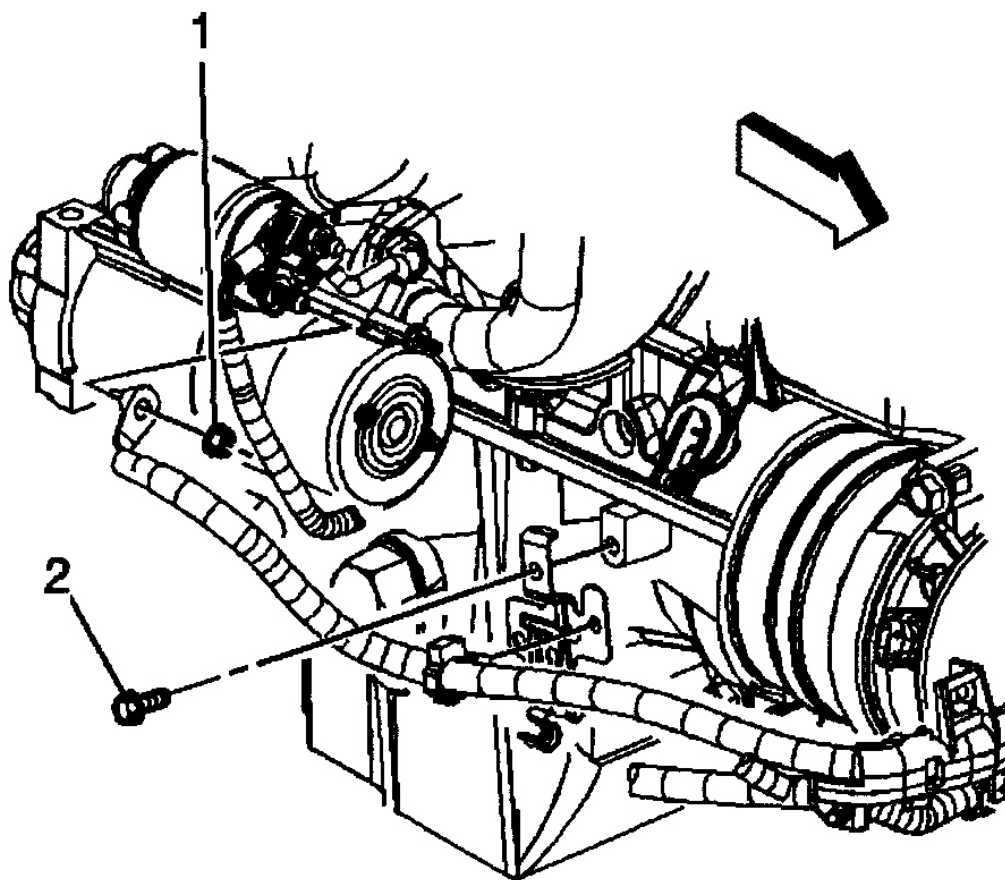
CAUTION: Before servicing any electrical component, the ignition key must be in the OFF or LOCK position and all electrical loads must be OFF, unless instructed otherwise in these procedures. If a tool or equipment could easily come in contact with a live exposed electrical terminal, also disconnect the negative battery cable. Failure to follow these precautions may cause personal injury and/or damage to the vehicle or its components.

1. Disconnect the negative battery cable. Refer to **BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE (SINGLE BATTERY)**.
2. Unsnap the positive battery cable cap.
3. Disconnect the positive battery cable.
4. Remove the underhood bussed electrical center (UBEC) cover. Position the lower cover to the side.
- 5.

NOTE: The bolt is integral to the battery cable and is not removable.

Remove the positive battery cable bolt at the UBEC.

6. Unsnap the junction block cover.
7. Remove the positive battery cable (1) from the junction block. See **Fig. 1**.
8. Raise and suitably support the vehicle with safety stands.
9. Remove the engine protection shield.
10. Remove the positive battery cable channel bolt.
11. Slide the channel pin out of the oil pan tab.
12. Remove the positive battery cable from the channel.
13. Remove the positive cable nut
14. Remove the positive cable from the starter.
15. Remove the positive cable clip from the clip on the oil pan.
16. Remove the positive cable from the clip on the oil pan.
17. Remove the positive battery cable.



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Fig. 7: Identifying Positive Battery Cable-To-Starter Connection
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the positive battery cable.
2. Install the positive cable to the clip on the oil pan.
3. Install the positive cable to the starter.
4. Install the positive cable nut. Tighten the nut to 9 N.m (80 lb in).
5. Install the positive battery cable to the channel.
6. Slide the channel pin into the oil pan tab.
7. Install the positive battery cable channel bolt. Tighten the bolt to 12 N.m (106 lb in).
8. Install the engine protection shield.

9. Lower the vehicle.
10. Install the positive battery cable (1) into the junction block. Tighten the nut to 9 N.m (80 lb in).
11. Snap the junction block cover closed.
12. Tighten the positive cable bolt at the UBEC. Tighten the bolt to 9 N.m (80 lb in).
13. Position the UBEC lower cover.
14. Install the UBEC cover.
15. Connect the positive battery cable. Tighten the bolt to 17 N.m (13 lb ft).
16. Snap the positive battery cable cap closed.
17. Connect the negative battery cable. Refer to **BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE (SINGLE BATTERY)**.

BATTERY REPLACEMENT

Removal Procedure

CAUTION: Before servicing any electrical component, the ignition key must be in the OFF or LOCK position and all electrical loads must be OFF, unless instructed otherwise in these procedures. If a tool or equipment could easily come in contact with a live exposed electrical terminal, also disconnect the negative battery cable. Failure to follow these precautions may cause personal injury and/or damage to the vehicle or its components.

1. Disconnect the negative battery cable. Refer to **BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE (SINGLE BATTERY)**.
2. Disconnect the positive battery cable.
3. Remove the battery hold down retainer bolt and retainer.
4. Remove the battery.
5. Remove the battery insulator.

Installation Procedure

1. Install the battery insulator, if necessary.
2. Install the battery.
3. Install the battery hold down retainer and bolt. Tighten the battery hold down retainer bolt to 25 N.m (18 lb ft).
4. Connect the positive battery cable. Tighten the positive battery cable bolt to 17 N.m (13 lb ft).
5. Connect the negative battery cable. Refer to **BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE (SINGLE BATTERY)**.

BATTERY TRAY REPLACEMENT

Removal Procedure

1. Remove the battery. Refer to **BATTERY REPLACEMENT**.
2. Remove the bolts from the battery tray support.
3. Remove the battery tray.

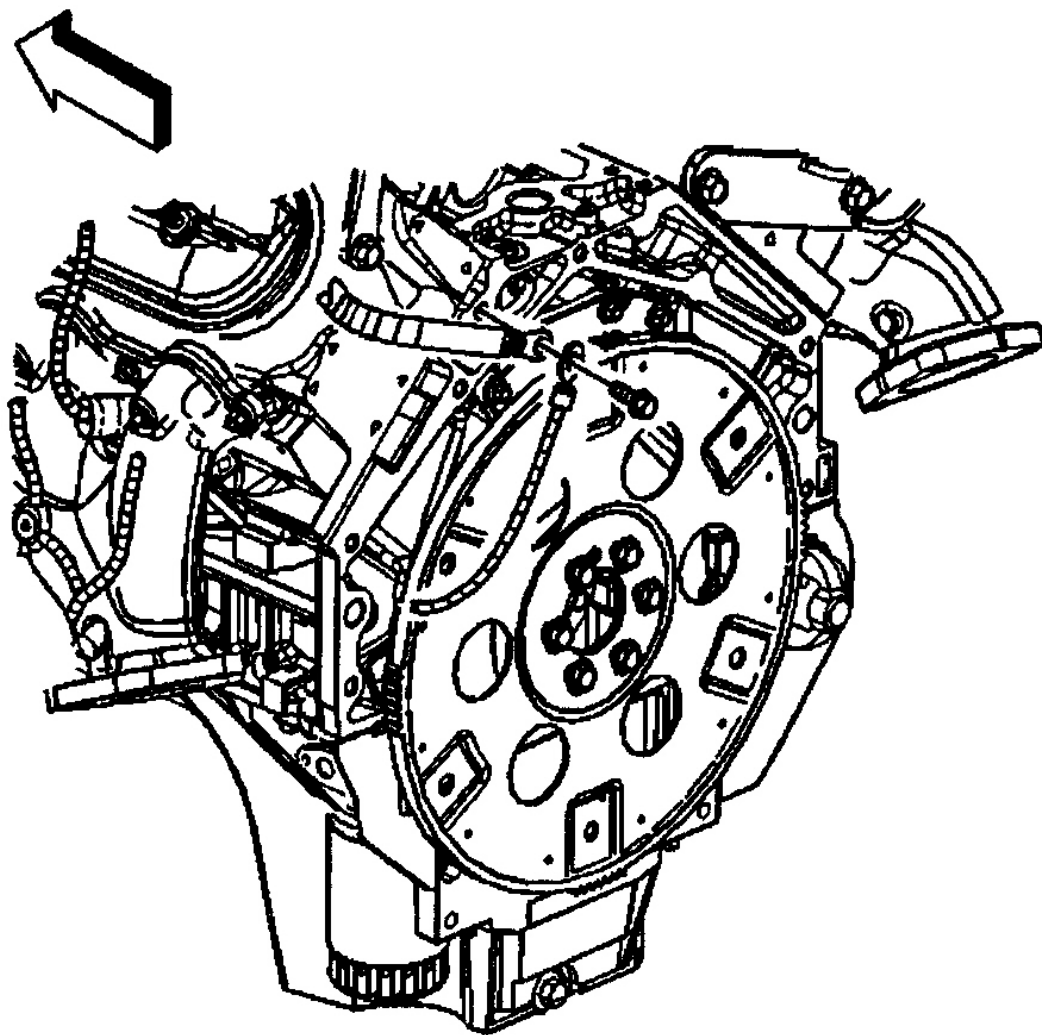
Installation Procedure

1. Install the battery tray. Install the bolts to the battery tray support until snug.
2. Tighten the battery tray bolts. Tighten the bolts to 9 N.m (80 lb in).
3. Install the battery. Refer to **BATTERY REPLACEMENT**.

GROUND STRAP REPLACEMENT

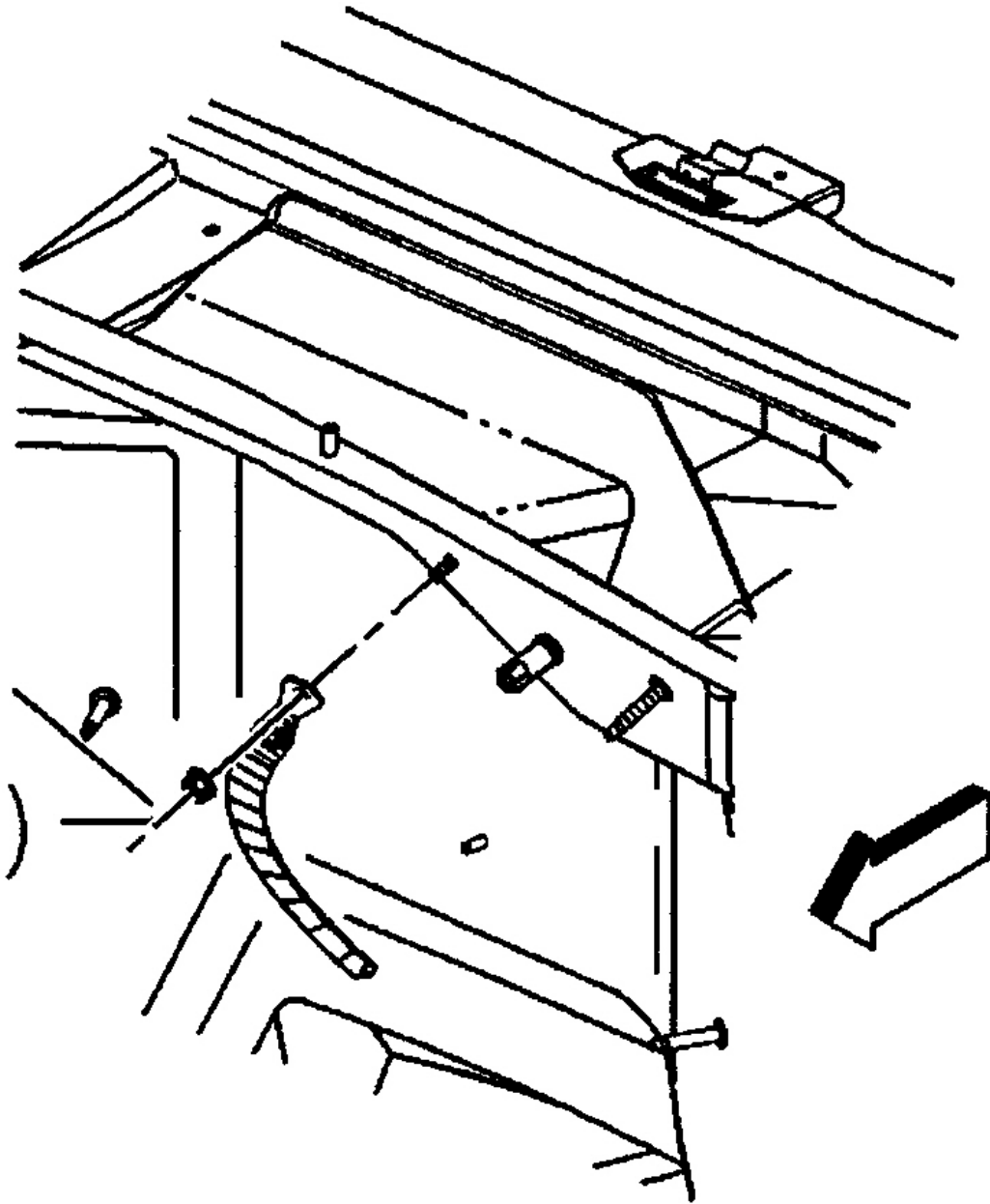
Removal Procedure

1. Remove the left hand catalytic convert.
2. Remove the engine wiring harness ground bolt. See **Fig. 8** .
3. Lower the vehicle.
4. Remove the ground strap nut from the stud at the front of dash. See **Fig. 9** .
5. Remove the ground strap from the stud.



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Fig. 8: Locating Engine Wiring Harness Ground Bolt
Courtesy of GENERAL MOTORS CORP.



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Fig. 9: Locating Ground Strap At Front Of Dash
Courtesy of GENERAL MOTORS CORP.

1. Install the ground strap to the stud.
2. Install the ground strap nut to the stud at the front of dash. Tighten the nut to 9 N.m (80 lb in).
3. Raise the vehicle.
4. Position the ground strap and engine wiring harness ground.
5. Install the engine wiring harness ground bolt. Tighten the bolt to 16 N.m (12 lb ft).
6. Install the left hand catalytic convert.
7. Lower the vehicle.

STARTER MOTOR RELAY REPLACEMENT

Removal Procedure

1. Remove the underhood bussed electrical center (UBEC) cover.
2. Remove the starter motor relay.

Installation Procedure

1. Install the starter motor relay.
2. Install the underhood bussed electrical center (UBEC) cover.

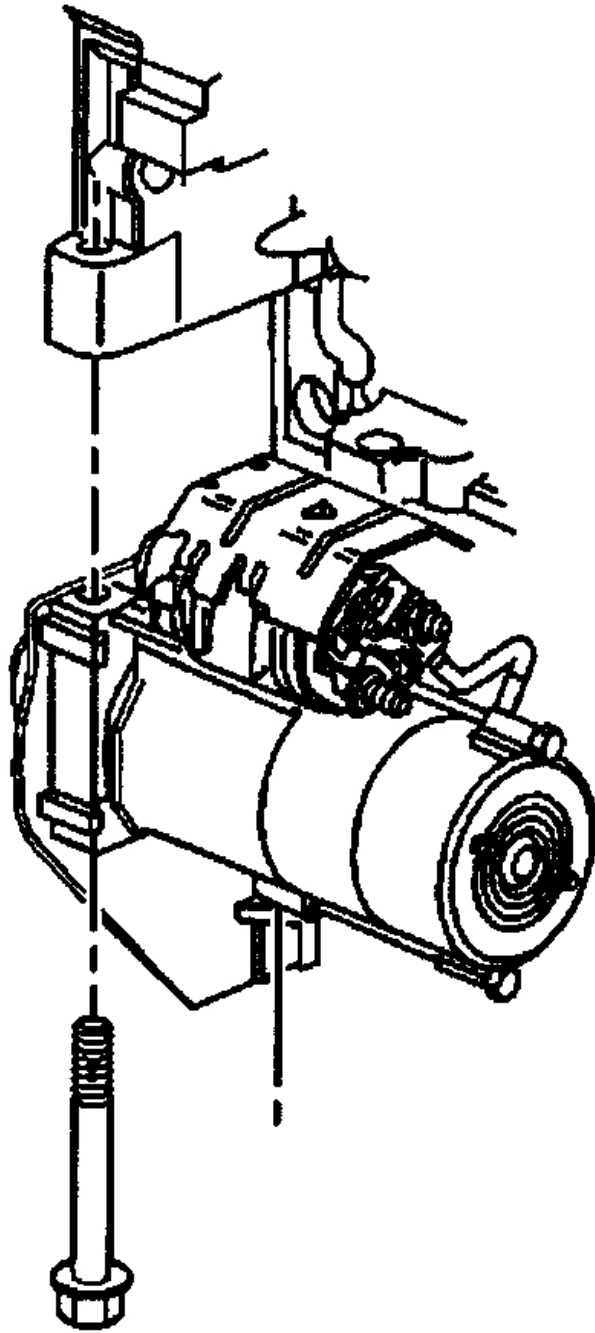
STARTER MOTOR REPLACEMENT

Removal Procedure

CAUTION: Before servicing any electrical component, the ignition key must be in the OFF or LOCK position and all electrical loads must be OFF, unless instructed otherwise in these procedures. If a tool or equipment could easily come in contact with a live exposed electrical terminal, also disconnect the negative battery cable. Failure to follow these precautions may cause personal injury and/or damage to the vehicle or its components.

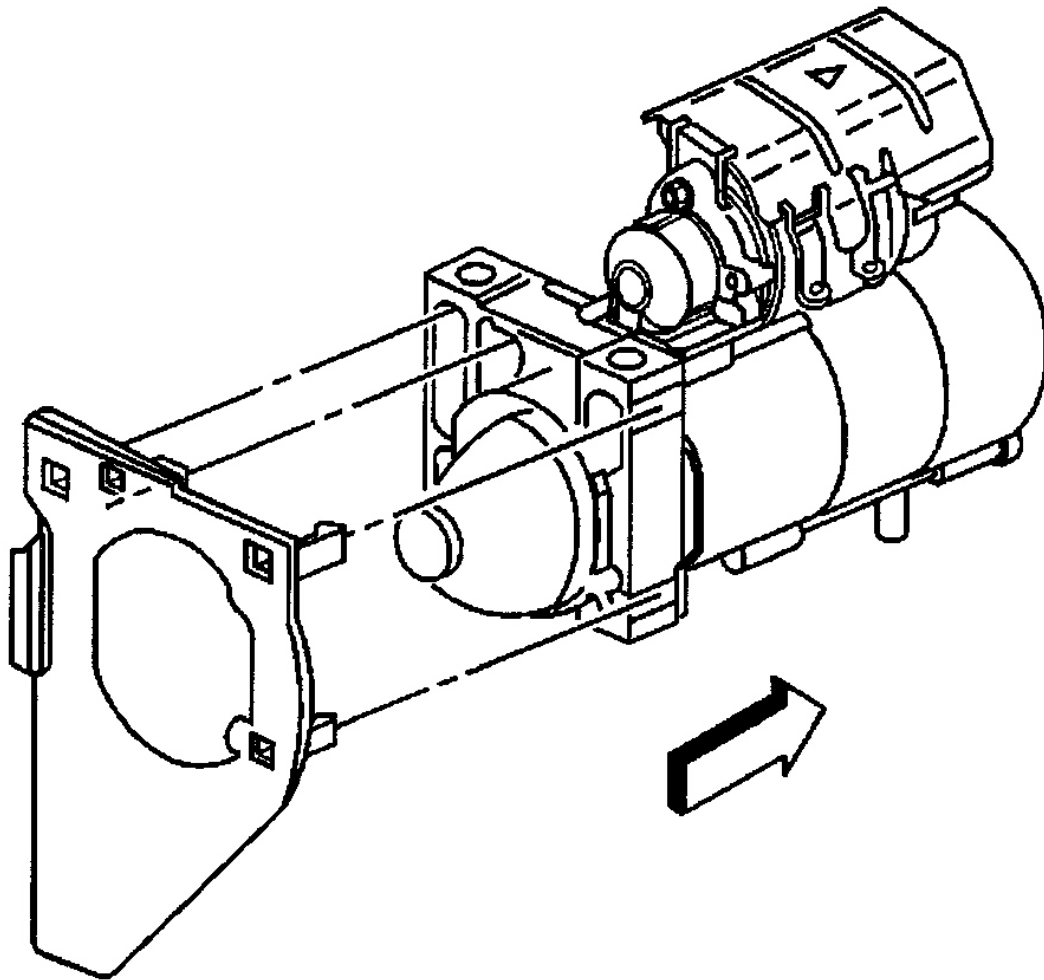
1. Disconnect the negative battery cable. Refer to **BATTERY NEGATIVE CABLE REPLACEMENT**.
2. Raise and suitably support the vehicle.
3. Remove the engine protective shield.
4. Remove the transmission cover bolt.
5. Remove the starter bolts. See **Fig. 10**.
6. Disconnect the oil level sensor electrical connector.
7. Slide the starter forward until the starter clears the transmission.
8. Remove the starter lead nut.
9. Remove the starter lead from the starter.
10. Remove the positive cable nut.

11. Remove the positive cable from the starter.
12. Place the starter on a workbench.
13. Unsnap the transmission cover from the starter.
14. Remove the starter heat shield. See **Fig. 11** .



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Fig. 10: Removing Starter Assembly From Engine
Courtesy of GENERAL MOTORS CORP.



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Fig. 11: Identifying Starter Heat Shields
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the starter heat shield.
2. Snap the transmission cover to the starter.
3. Install the positive cable to the starter.
4. Install the positive cable nut. Tighten the positive cable nut to 9 N.m (80 lb in).
5. Install the starter lead to the starter.
6. Install the starter lead nut. Tighten the starter lead nut to 3.4 N.m (30 lb in).
7. Position the starter into place.

8. Install the starter bolts. Tighten the starter bolts to 50 N.m (37 lb ft).
9. Connect the oil level sensor electrical connector.
10. Install the transmission cover bolt. Tighten the transmission cover bolt to 9 N.m (80 lb in).
11. Install the engine protective shield.
12. Lower the vehicle.
13. Connect the negative battery cable. Refer to **BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE (SINGLE BATTERY)**.

TORQUE SPECIFICATIONS

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Application	Ft. Lbs. (N.m)
Battery Cable Bracket Bolt	18 (25)
Battery Hold-Down Retainer Bolt	18 (25)
Battery Tray Nut	18 (25)
Engine Wiring Harness Auxiliary Negative Battery Cable Bolt	12 (16)
Engine Wiring Harness Ground Bolt	12 (16)
Engine Wiring Harness Ground/Negative Cable Bolt	18 (25)
Front Axle Mounting Bracket Nut	70 (95)
Generator Bracket Bolt	37 (50)
Generator Bolt	37 (50)
Negative Battery Cable Bolt	13 (17)
Positive Battery Cable Bolt	13 (17)
Starter Bolt	37 (50)
	INCH Lbs. (N.m)
Battery Cable Channel Bolt	106 (12)
Battery Tray Bolt	80 (9)
Forward Lamp Wiring Harness Ground/Negative Cable Bolt	80 (9)
Front End Diagonal Brace Bolt	80 (9)
Generator Cable Nut	80 (9)
Ground Strap Nut	80 (9)
Positive Cable Nut	80 (9)
Positive Cable At UBEC Bolt	80 (9)
Starter Lead Nut	30 (3.4)
Surge Tank Bolt/Nut	80 (9)
Transmission Cover Bolt	80 (9)