

2003 STARTING & CHARGING SYSTEMS**Starters - CTS****DESCRIPTION & OPERATION****STARTING SYSTEM**

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

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

When the ignition switch is released from the START position, crank voltage is removed from the starter solenoid C1 terminal. Current flows from the motor contacts through both windings to ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now in the opposite direction of the current flow when the winding was first energized.

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

Circuit Description

Moving the ignition switch to the START position sends a 12 V signal to the ECM to command starting. Battery voltage also travels through the switch side of the run/crank relay then through the clutch switch, if equipped with manual transmission, and on through the coil side of the starter relay and then to the ECM. The ECM receives class 2 information from the VTD and TCM to

2003 Cadillac CTS

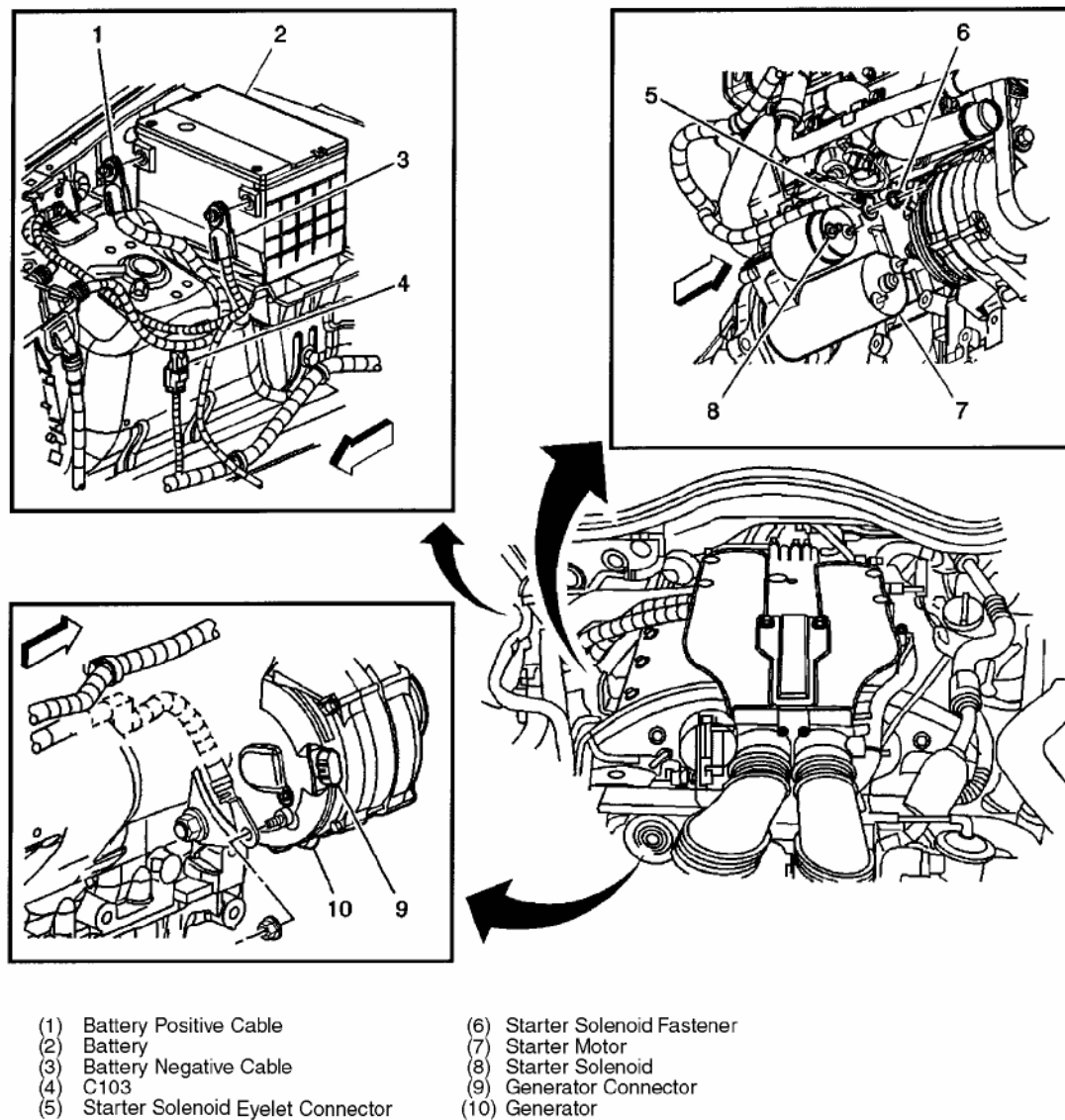
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verify that all parameters are met for starting. When all parameters are met the ECM grounds the control circuit of the starter relay closing the switch providing battery voltage to the starter solenoid through a 30 amp Maxi-Fuse.

COMPONENT LOCATIONS

COMPONENT LOCATIONS

Component	Locations
Engine Control Module (ECM)	In Engine Compartment, In Right Front Corner
STARTER Fuse	In Underhood Fuse Block
Starter Motor ⁽¹⁾	In Engine Compartment, On RR Side Of Engine
STARTER Relay	In Underhood Fuse Block
Starter Solenoid ⁽¹⁾	In Engine Compartment, On RR Side Of Engine, On Top Of Starter
(1) For view of starter components, see Fig. 1 .	



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Fig. 1: Locating Starter Components
Courtesy of GENERAL MOTORS CORP.

PROGRAMMING

ENGINE CONTROL MODULE

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle.

See **COMPUTER RELEARN PROCEDURES** article in **GENERAL INFORMATION** before disconnecting battery.

To program engine control module (ECM), see **ENGINE CONTROL MODULE** under **PROGRAMMING** in **SELF-DIAGNOSTICS** article in **FAULT ISOLATION** in **ENGINE PERFORMANCE**.

TROUBLE SHOOTING

PRELIMINARY INSPECTION

Verify customer complaint by operating suspected system. Visually inspect for obvious signs of mechanical and electrical damage. Inspect for blown fuses and damaged relays. See **FUSES & CIRCUIT BREAKERS** article in **ELECTRICAL**. Inspect for loose or corroded connections, damaged wiring harnesses and/or switches. Check for a broken or partially broken wire inside insulation, which could cause system malfunction but prove good in a continuity/voltage check with system disconnected. Ensure any aftermarket electronic equipment is properly installed. If fault is found, repair as necessary. If no fault is found, perform self-diagnostics. See **SELF-DIAGNOSTIC SYSTEM**.

INTERMITTENTS OR POOR CONNECTIONS

Intermittent faulty electrical connections or wiring may be the cause of intermittent conditions. Check for loose, bent or corroded terminals and terminal tension. Check for cut, bare or pinched wiring. Simulate the condition that is potentially causing intermittent connection, either by wiggling the connections or the wiring, test driving or performing other operations while observing scan tool, DVOM or other testing equipment.

ENGINE ELECTRICAL SYMPTOMS

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

- Perform **ENGINE ELECTRICAL DIAGNOSTIC SYSTEM CHECK** under **SELF-DIAGNOSTIC SYSTEM** before using the symptom table in order to verify that there are no DTCs set and that the control modules can communicate via the serial data link.
- Review the system descriptions and operations in order to familiarize yourself with the system functions. See **DESCRIPTION & OPERATION**.

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. See **INTERMITTENTS OR POOR CONNECTIONS** .

Symptom List

To diagnosis symptom, see **SYMPTOM INDEX** table.

SELF-DIAGNOSTIC SYSTEM**RETRIEVING DIAGNOSTIC TROUBLE CODES**

To retrieve diagnostic trouble codes (DTC), see **RETRIEVING DIAGNOSTIC TROUBLE CODES** under SELF-DIAGNOSTIC SYSTEM in SELF-DIAGNOSTICS article in FAULT ISOLATION in ENGINE PERFORMANCE.

CLEARING DIAGNOSTIC TROUBLE CODES

To clear diagnostic trouble codes (DTC), see **CLEARING DIAGNOSTIC TROUBLE CODES** under SELF-DIAGNOSTIC SYSTEM in SELF-DIAGNOSTICS article in FAULT ISOLATION in ENGINE PERFORMANCE.

ENGINE ELECTRICAL DIAGNOSTIC SYSTEM CHECK

1. If the Battery Inspection/Test was performed, go to next step. If the Battery Inspection/Test was not performed, go to **BATTERY TESTING & INSPECTION** under ON-VEHICLE TESTING in GENERATORS & REGULATORS - CTS article in CHARGING SYSTEM in ELECTRICAL.
2. Install a scan tool. Turn ON the ignition, with the engine OFF. If the scan tool powers up, go to next step. If the scan tool does not power up, go to appropriate BODY CONTROL MODULES article in COMMUNICATION DEVICES in ACCESSORIES & EQUIPMENT.

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

3. 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 Class 2 Power Mode parameter. If the ignition switch parameter reading matches the ignition switch position for all switch positions, go to next step. If the ignition switch parameter reading is not as specified, go to appropriate BODY CONTROL MODULES article in COMMUNICATION DEVICES in ACCESSORIES & EQUIPMENT.

NOTE: Lack of communication may be because of a partial malfunction of the class 2 serial data circuit or due to a total malfunction of the class 2 serial data circuit. The following step will determine the particular condition.

4. Turn ON the ignition, with the engine OFF. Attempt to communicate with each of the following modules on the class 2 serial data circuit:
 - Amplifier (AMP)
 - Climate Control Panel (CCP)
 - Dash Integration Module (DIM)
 - Instrument Panel Cluster (IPC)
 - Onstar (ONS)
 - Radio (IRC)
 - Rear Integration Module (RIM)
 - Remote Function Actuator (RFA)
 - Engine Control Module (ECM)
 - Supplemental Inflatable Restraint (SIR)

If the scan tool communicates with all modules on the class 2 serial data circuit, go to next step. If the scan tool does not communicate with all modules on the class 2 serial data circuit, go to appropriate BODY CONTROL MODULES article in COMMUNICATION DEVICES in ACCESSORIES & EQUIPMENT.

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. If the scan tool displays any DTCs, go to next step. If the scan tool does not display any DTCs, go to **ENGINE ELECTRICAL SYMPTOMS** under TROUBLE SHOOTING.

NOTE: The presence of DTCs which begin with a "U" indicate some other module is not communicating. The following step will collect all the available information before you perform tests.

6. If the scan tool displays any DTCs which begin with a "U", go to appropriate BODY CONTROL MODULES article in COMMUNICATION DEVICES in ACCESSORIES & EQUIPMENT. If the scan tool does not display any DTCs which begin with a "U", go to next step.
7. If the scan tool displays DTC B1000, B1004, B1007, B1009, B1013 or B1014, go to appropriate BODY CONTROL MODULES article in COMMUNICATION DEVICES in ACCESSORIES & EQUIPMENT. If the scan tool does not display the specified DTCs, go to **DIAGNOSTIC TROUBLE CODE DEFINITIONS** table.

DIAGNOSTIC TROUBLE CODE DEFINITIONS

DIAGNOSTIC TROUBLE CODE DEFINITIONS

DTC ⁽¹⁾	Description
<u>P0615</u>	Starter Relay Output Circuit Improper Voltage Level
<u>P0616</u>	Starter Relay Output Circuit Improper Voltage Level
<u>P0617</u>	Starter Relay Output Circuit Improper Voltage Level
(1) Perform appropriate test under <u>DIAGNOSTIC TESTS</u> . Codes listed in this table are only for testing covered in this article. For a complete list of codes, see <u>DIAGNOSTIC TROUBLE CODE DEFINITIONS</u> in SELF-DIAGNOSTICS article in FAULT ISOLATION in ENGINE PERFORMANCE.	

DIAGNOSTIC TESTS

DTC P0615: STARTER RELAY OUTPUT CIRCUIT IMPROPER VOLTAGE LEVEL

Circuit Description

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

Conditions For Running DTC

- System voltage is between 8-16 volts.

- The engine is running.

Conditions For Setting DTC

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

Action Taken When DTC Sets

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

Conditions For Clearing MIL/DTC

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

Test Procedure

1. If the Engine Electrical Diagnostic System Check was performed, go to next step. If the Engine Electrical Diagnostic System Check was not performed, go to **ENGINE ELECTRICAL DIAGNOSTIC SYSTEM CHECK** under SELF-DIAGNOSTIC SYSTEM.

NOTE: Listen for an audible click when the starter relay operates. Turn the ignition switch back and forth from the OFF to START positions. Repeat this as necessary.

2. Turn the ignition back and forth from the OFF to START positions. If the starter relay turns ON and OFF with each command, go to **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If the starter relay does not turn ON and OFF with each command, go to next step.

NOTE: Listen for an audible click when the run/crank relay operates. Turn the ignition switch back and forth from the OFF to ON positions. Repeat this as necessary.

3. Turn OFF the ignition. Disconnect the starter relay. See **STARTER RELAY** under REMOVAL & INSTALLATION. Turn ON the ignition, with the engine OFF. Probe the battery positive voltage of the starter relay coil circuit with a test lamp that is connected to a

good ground. Turn ON the ignition. If the test lamp illuminates, go to next step. If the test lamp does not illuminate, go to step 5 .

4. Connect a test lamp between the control circuit of the starter relay and the battery positive voltage of the starter relay coil circuit. Turn the ignition back and forth from the ON to START positions. If the test lamp turns ON and OFF with each command, go to step 11 . If the test lamp does not turn ON and OFF with each command, go to step 9 .
5. Turn the ignition back and forth from the OFF to ON positions. If the run/crank relay turns ON and OFF with each command, go to step 8 . If the run/crank relay does not turn ON and OFF with each command, go to next step.
6. Turn OFF the ignition. Disconnect the run/crank relay. Turn ON the ignition, with the engine OFF. Probe the battery positive voltage of the run/crank relay coil circuit with a test lamp that is connected to a good ground. If the test lamp illuminates, go to next step. If the test lamp does not illuminate, go to step 13 .
7. Connect a test lamp between the battery positive voltage of the run/crank relay coil circuit and the ground of the run/crank relay coil circuit. Turn ON the ignition. If the test lamp illuminates, go to step 10 . If the test lamp does not illuminate, go to step 14 .
8. Install the starter relay. Connect a 10 amp fused jumper wire between the battery positive voltage of the run/crank relay switch circuit and the ignition No. 1 voltage of the run/crank relay switch circuit. Turn the ignition back and forth from the OFF to START positions. If the starter relay turns ON and OFF with each command, go to step 10 . If the starter relay does not turn ON and OFF with each command, go to step 15 .
9. Test the control circuit of the starter relay for a high resistance or open. If problem was found and corrected, go to step 19 . If problem was not found, go to step 12 .
10. Inspect for poor connections at the run/crank relay. See **INTERMITTENTS OR POOR CONNECTIONS** under REMOVAL & INSTALLATION. If problem was found and corrected, go to step 19 . If problem was not found, go to step 16 .
11. Inspect for poor connections at the starter relay. See **INTERMITTENTS OR POOR CONNECTIONS** under REMOVAL & INSTALLATION. If problem was found and corrected, go to step 19 . If problem was not found, go to step 17 .
12. Inspect for poor connections at the ECM. See **INTERMITTENTS OR POOR CONNECTIONS** under REMOVAL & INSTALLATION. If problem was found and corrected, go to step 19 . If problem was not found, go to step 18 .
13. Repair the high resistance or open in the ignition No. 1 voltage of the run/crank relay coil circuit. After repair, go to step 19 .
14. Repair the high resistance or open in the ground of the run/crank relay coil circuit. After repair, go to step 19 .
15. Repair the high resistance or open in the ignition No. 1 voltage circuit of the starter relay.

After repair, go to step 19 .

16. Replace the run/crank relay. After replacement, go to step 19 .
17. Replace the starter relay. See **STARTER RELAY** under REMOVAL & INSTALLATION. After replacement, go to step 19 .
18. The replacement ECM must be programmed. See **ENGINE CONTROL MODULE** under PROGRAMMING in SELF-DIAGNOSTICS article in FAULT ISOLATION in ENGINE PERFORMANCE. Replace the ECM. See **ENGINE CONTROL MODULE** under COMPUTERIZED ENGINE CONTROLS in REMOVAL & INSTALLATION article in ENGINE PERFORMANCE. After replacement, go to next step.
19. 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 the DTC. Using the scan tool, observe the specific DTC information for DTC P0615 until the test runs. If the scan tool indicates that DTC P0615 failed this ignition, go to step 2 . If the scan tool does not indicate that DTC P0615 failed, the system is okay.

DTC P0616: STARTER RELAY OUTPUT CIRCUIT IMPROPER VOLTAGE LEVEL

Circuit Description

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

Conditions For Running DTC

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

Conditions For Setting DTC

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

Action Taken When DTC Sets

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

Conditions For Clearing MIL/DTC

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

Test Procedure

1. If the Engine Electrical Diagnostic System Check was performed, go to next step. If the Engine Electrical Diagnostic System Check was not performed, go to **ENGINE ELECTRICAL DIAGNOSTIC SYSTEM CHECK** under SELF-DIAGNOSTIC SYSTEM.
2. Install a scan tool. Operate the vehicle within the conditions for running the DTC. Using the scan tool, observe the specific DTC information for DTC P0616 until the test runs. If the scan tool indicates that DTC P0616 has passed this ignition cycle, go to **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If the scan tool does not indicate that DTC P0616 has passed, go to next step.
3. Test the control circuit of the starter relay for a short to ground. If problem was found and corrected, go to step 6 . If problem was not found, go to next step.
4. Inspect for poor connections at the ECM. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 6 . If problem was not found, go to next step.
5. The replacement ECM must be programmed. See **ENGINE CONTROL MODULE** under PROGRAMMING in SELF-DIAGNOSTICS article in FAULT ISOLATION in ENGINE PERFORMANCE. Replace the ECM. See **ENGINE CONTROL MODULE** under COMPUTERIZED ENGINE CONTROLS in REMOVAL & INSTALLATION article in ENGINE PERFORMANCE. After replacement, go to next step.
6. 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** as specified in the supporting text. Using the scan tool, observe the Specific DTC Information for DTC P0616 until the test runs. If the scan tool indicates that DTC P0616 failed this ignition, go to step 2 . If the scan tool does not indicate that DTC P0616 failed, the system is okay.

DTC P0617: STARTER RELAY OUTPUT CIRCUIT IMPROPER VOLTAGE LEVEL

Circuit Description

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

Conditions For Running DTC

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

Conditions For Setting DTC

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

Action Taken When DTC Sets

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

Conditions For Clearing MIL/DTC

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

Test Procedure

1. If the Engine Electrical Diagnostic System Check was performed, go to next step. If the Engine Electrical Diagnostic System Check was not performed, go to **ENGINE ELECTRICAL DIAGNOSTIC SYSTEM CHECK** under SELF-DIAGNOSTIC SYSTEM.
2. Install a scan tool. Operate the vehicle within the conditions for running the DTC. Using the scan tool, observe the specific DTC information for DTC P0617 until the test runs. If the scan tool indicates that DTC P0617 has passed this ignition cycle, go to **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If the scan tool does not indicate that DTC P0617 has passed, go to next step.
3. Test the control circuit of the starter relay for a short to battery. If problem was found and corrected, go to step 6 . If problem was not found, go to next step.
4. Inspect for poor connections at the ECM. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 6 . If problem was not found, go to next step.
5. The replacement ECM must be programmed. See **ENGINE CONTROL MODULE** under PROGRAMMING in SELF-DIAGNOSTICS article in FAULT ISOLATION in ENGINE PERFORMANCE. Replace the ECM. See **ENGINE CONTROL MODULE** under

COMPUTERIZED ENGINE CONTROLS in REMOVAL & INSTALLATION article in ENGINE PERFORMANCE. After replacement, go to next step.

6. 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 the DTC. Using the scan tool, observe the specific DTC information for DTC P0617 until the test runs. If the scan tool indicates that DTC P0617 failed this ignition, go to step 2 . If the scan tool does not indicate that DTC P0617 failed, the system is okay.

SYSTEM TESTS

SYMPTOM INDEX

Symptom	Perform Test
Starter Solenoid Does Not Click (Automatic Transmission)	<u>A</u>
Starter Solenoid Does Not Click (Manual Transmission)	<u>B</u>
Starter Solenoid Clicks, Engine Does Not Crank	<u>C</u>
Engine Cranks Slowly	<u>D</u>
Starter Motor Noise Diagnosis	<u>E</u>

TEST A: STARTER SOLENOID DOES NOT CLICK (AUTOMATIC TRANSMISSION)

1. If the Engine Electrical Diagnostic System Check was performed, go to next step. If the Engine Electrical Diagnostic System Check was not performed, go to **ENGINE ELECTRICAL DIAGNOSTIC SYSTEM CHECK** under SELF-DIAGNOSTIC SYSTEM.
2. Turn the ignition to the START position. If the starter solenoid clicks, go to **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If the starter solenoid does not click, go to next step.
3. Install a scan tool. With a scan tool, observe the Starter Relay Command parameter in the ECM data list. Turn the ignition switch to the START position. If the scan tool displays On, go to next step. If the scan tool does not display On, go to step 5 .
4. Turn the ignition back and forth from the OFF to ON position a few times. If the starter relay clicks each time the ignition is turned to the ON position, go to step 15 . If the starter relay does not click each time the ignition is turned ON, go to step 9 .
5. Turn ON the ignition, with the engine OFF. With a scan tool, observe the Crank Request parameter in the ECM data list. Turn the ignition switch to the START position. If the scan tool displays Yes, go to next step. If the scan tool does not display Yes, go to step 8 .
6. Turn ON the ignition, with the engine OFF. With a scan tool, observe the Start Disabled parameter in the VTD data list. If the scan tool displays Yes, go to appropriate ANTI-

THEFT SYSTEMS article in DOOR LOCKS & ANTI-THEFT SYSTEMS in ACCESSORIES & EQUIPMENT. If the scan tool does not display Yes, go to next step.

7. Turn ON the ignition, with the engine OFF. Verify that the transmission is in Park or Neutral. With a scan tool, observe the IMS Range parameter in the Transmission data list. If the scan tool displays Park or Neutral, go to step 24 . If the scan tool does not display Park or Neutral, go to **DIAGNOSTIC SYSTEM** under SELF-DIAGNOSTIC SYSTEM in DIAGNOSIS - 5L40-E article in AUTOMATIC TRANSMISSION in TRANSAXLE/TRANSMISSION.
8. Turn OFF the ignition. Disconnect the ECM. Connect a test lamp between the Start Command circuit of the ECM and a good ground. Turn the ignition to the START position. If the test lamp illuminates, go to step 24 . If the test lamp does not illuminate, go to step 17 .
9. Turn OFF the ignition. Disconnect the run/crank relay. Connect a test lamp between the battery positive voltage circuit of the run/crank relay coil circuit and a good ground. Turn ON the ignition, with the engine OFF. If the test lamp illuminates, go to next step. If the test lamp does not illuminate, go to step 25 .
10. Turn OFF the ignition. Connect a test lamp between the ignition No. 1 voltage circuit of the run/crank relay coil and the ground circuit of the run/crank relay coil. Turn ON the ignition, with the engine OFF. If the test lamp illuminates, go to next step. If the test lamp does not illuminate, go to step 26 .
11. Connect a 10 amp fused jumper between the battery positive voltage circuit of the run/crank relay switch and the starter relay ignition No. 1 circuit of the run/crank relay switch. Turn the ignition switch to the START position. If the starter solenoid clicks, go to step 20 . If the starter solenoid does not click, go to next step.

NOTE: Leave the fused jumper in place.

12. Disconnect the starter relay. See **STARTER RELAY** under REMOVAL & INSTALLATION. Connect a test lamp between the ignition No. 1 voltage circuit of the starter relay coil and a good ground. If the test lamp illuminates, go to next step. If the test lamp does not illuminate, go to step 27 .
13. Connect a test lamp between the ignition No. 1 voltage circuit of the starter relay coil and the control circuit of the starter relay coil. Turn the ignition to the START position. If the test lamp illuminates, go to step [21](#) . If the test lamp does not illuminate, go to next step.
14. Turn OFF the ignition. Disconnect the ECM. Install the starter relay. Connect a test lamp between the control circuit of the starter relay and a good ground. If the test lamp illuminates, go to step 24 . If the test lamp does not illuminate, go to step 28 .

NOTE: The engine may crank when the fused jumper is put into place.

15. Connect a 30 amp fused jumper between the battery positive voltage circuit of the starter relay switch circuit and the supply voltage circuit of the starter solenoid. If the engine cranks, go to step 21 . If the engine does not crank, go to next step.
16. If the fuse in the jumper opens, go to step 18 . If the fuse in the jumper does not open, go to step 19 .
17. Test the Start Command circuit of the ECM for a high resistance or open. If problem was found and corrected, go to step 34 . If problem was not found, go to step 23 .
18. Test the supply voltage circuit of the starter solenoid for a short to ground. If problem was found and corrected, go to step 34 . If problem was not found, go to step 22 .
19. Test the supply voltage circuit of the starter solenoid for a high resistance or open. If problem was found and corrected, go to step 34 . If problem was not found, go to step 22 .
20. Inspect for poor connection at the run/crank relay. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 34 . If problem was not found, go to step 29 .
21. Inspect for poor connection at the starter relay. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 34 . If problem was not found, go to step 30 .
22. Inspect for poor connection at the starter solenoid. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 34 . If problem was not found, go to step 31 .
23. Inspect for poor connection at the ignition switch. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 34 . If problem was not found, go to step 32 .
24. Inspect for poor connection at the ECM. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 34 . If problem was not found, go to step 33 .
25. Repair the high resistance or open in the ignition No. 1 voltage circuit of the run/crank relay coil. After repair, go to step 34 .
26. Repair the high resistance or open in the ground circuit of the run/crank relay coil. After repair, go to step 34 .
27. Repair the high resistance or open in the ignition No. 1 voltage circuit of the starter relay coil. After repair, go to step 34 .
28. Repair the high resistance or open in the control circuit of the starter relay. After repair, go to step 34 .

29. Replace the run/crank relay. After replacement, go to step 34 .
30. Replace the starter relay. See **STARTER RELAY** under REMOVAL & INSTALLATION. After replacement, go to step 34 .
31. Replace the starter. See **STARTER** under REMOVAL & INSTALLATION. After replacement, go to step 34 .
32. Replace the ignition switch. See appropriate STEERING COLUMN SWITCHES article in ACCESSORIES & EQUIPMENT. After replacement, go to step 34 .
33. Perform the set up procedures for the ECM. See **ENGINE CONTROL MODULE** under PROGRAMMING in SELF-DIAGNOSTICS article in FAULT ISOLATION in ENGINE PERFORMANCE. Replace the ECM. See **ENGINE CONTROL MODULE** under COMPUTERIZED ENGINE CONTROLS in REMOVAL & INSTALLATION article in ENGINE PERFORMANCE. After replacement, go to next step.
34. Operate the system for which the symptom occurred. If problem was corrected, the system is okay. If problem was not corrected, go to step 2 .

TEST B: STARTER SOLENOID DOES NOT CLICK (MANUAL TRANSMISSION)

1. If the Engine Electrical Diagnostic System Check was performed, go to next step. If the Engine Electrical Diagnostic System Check was not performed, go to **ENGINE ELECTRICAL DIAGNOSTIC SYSTEM CHECK** under SELF-DIAGNOSTIC SYSTEM.
2. Depress the clutch pedal. Turn the ignition to the START position. If the starter solenoid clicks, go to **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If the starter solenoid does not click, go to next step.
3. Install a scan tool. Depress the clutch pedal. With a scan tool, observe the Starter Relay Command parameter in the ECM data list. Turn the ignition switch to the START position. If the scan tool displays On, go to next step. If the scan tool does not display On, go to step 5 .
4. Depress the clutch pedal. Turn the ignition back and forth from the OFF to ON position a few times. If the starter relay clicks each time the ignition is turned to the ON position, go to step 17 . If the starter relay does not click each time the ignition is turned ON, go to step 9 .
5. With a scan tool, observe the Crank Request parameter in the ECM data list. Turn the ignition switch to the START position. If the scan tool displays Yes, go to next step. If the scan tool does not display Yes, go to step 8 .
6. Turn ON the ignition, with the engine OFF. With a scan tool, observe the Start Disabled parameter in the VTD data list. If the scan tool displays Yes, go to appropriate ANTI-THEFT SYSTEMS article in DOOR LOCKS & ANTI-THEFT SYSTEMS in ACCESSORIES & EQUIPMENT. If the scan tool does not display Yes, go to next step.

7. Turn ON the ignition, with the engine OFF. Depress the clutch pedal. With a scan tool, observe the Clutch Start Switch parameter in the ECM data list. If the scan tool displays On, go to step 29 . If the scan tool does not display On, go to step 16 .
8. Turn OFF the ignition. Disconnect the ECM. Connect a test lamp between the Start Command circuit of the ECM and a good ground. Turn the ignition to the START position. If the test lamp illuminates, go to step 29 . If the test lamp does not illuminate, go to step 19 .
9. Turn OFF the ignition. Disconnect the run/crank relay. Connect a test lamp between the battery positive voltage circuit of the run/crank relay coil circuit and a good ground. Turn ON the ignition, with the engine OFF. If the test lamp illuminates, go to next step. If the test lamp does not illuminate, go to step 31 .
10. Turn OFF the ignition. Connect a test lamp between the ignition No. 1 voltage circuit of the run/crank relay coil and the ground circuit of the run/crank relay coil. Turn ON the ignition, with the engine OFF. If the test lamp illuminates, go to next step. If the test lamp does not illuminate, go to step 32 .
11. Connect a 10 amp fused jumper between the battery positive voltage circuit of the run/crank relay switch and the ignition No. 1 voltage circuit of the clutch switch. Depress the clutch pedal. Turn the ignition switch to the START position. If the starter solenoid clicks, go to step 24 . If the starter solenoid does not click, go to next step.

NOTE: Leave the fused jumper in place.

12. Disconnect the starter relay. See **STARTER RELAY** under REMOVAL & INSTALLATION. Connect a test lamp between the ignition No. 1 voltage circuit of the starter relay coil and a good ground. Depress the clutch pedal. If the test lamp illuminates, go to next step. If the test lamp does not illuminate, go to step 15 .
13. Connect a test lamp between the ignition No. 1 voltage circuit of the starter relay coil and the control circuit of the starter relay coil. Depress the clutch pedal. Turn the ignition to the START position. If the test lamp illuminates, go to step 25 . If the test lamp does not illuminate, go to next step.
14. Turn OFF the ignition. Disconnect the ECM. Install the starter relay. Connect a test lamp between the control circuit of the starter relay and a good ground. Depress the clutch pedal. If the test lamp illuminates, go to step 29 . If the test lamp does not illuminate, go to step 33 .
15. Turn OFF the ignition. Disconnect the clutch switch. Connect a test lamp between the ignition No. 1 voltage of the clutch switch and a good ground. If the test lamp illuminates, go to step 20 . If the test lamp does not illuminate, go to step 30 .
16. Turn OFF the ignition. Disconnect the clutch switch. With a scan tool, observe the Clutch

Start Switch parameter in the ECM data list. Turn ON the ignition, with the engine OFF. If the scan tool displays On, go to step 26. If the scan tool does not display On, go to step 21.

17. Place the transmission in neutral. Apply the parking brake. The engine may crank when the fused jumper is put into place. Connect a 30 amp fused jumper between the battery positive voltage circuit of the starter relay switch circuit and the supply voltage circuit of the starter solenoid. If the engine cranks, go to step 25. If the engine does not crank, go to next step.
18. If the fuse in the jumper opens, go to step 22. If the fuse in the jumper does not open, go to step 23.
19. Test the Start Command circuit of the ECM for a high resistance or open. If problem was found and corrected, go to step 40. If problem was not found, go to step 28.
20. Test the starter relay coil supply voltage circuit for a high resistance or open. If problem was found and corrected, go to step 40. If problem was not found, go to step 26.
21. Test the clutch pedal position switch signal for a short to battery voltage. If problem was found and corrected, go to step 40. If problem was not found, go to step 29.
22. Test the supply voltage circuit of the starter solenoid for a short to ground. If problem was found and corrected, go to step 40. If problem was not found, go to step 27.
23. Test the supply voltage circuit of the starter solenoid for a high resistance or open. If problem was found and corrected, go to step 40. If problem was not found, go to step 27.
24. Inspect for poor connection at the run/crank relay. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 40. If problem was not found, go to step 34.
25. Inspect for poor connection at the starter relay. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 40. If problem was not found, go to step 35.
26. Inspect for poor connection at the clutch switch. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 40. If problem was not found, go to step 36.
27. Inspect for poor connection at the starter solenoid. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 40. If problem was not found, go to step 37.
28. Inspect for poor connection at the ignition switch. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 40. If problem was not found, go to step 38.
29. Inspect for poor connection at the ECM. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 40. If problem was not found, go to step 39.

30. Repair the high resistance or open in the ignition No. 1 voltage circuit of the clutch switch. After repair, go to step 40 .
31. Repair the high resistance or open in the ignition No. 1 voltage circuit of the run/crank relay coil. After repair, go to step 40 .
32. Repair the high resistance or open in the ground circuit of the run/crank relay coil. After repair, go to step 40 .
33. Repair the high resistance or open in the control circuit of the starter relay. After repair, go to step 40 .
34. Replace the run/crank relay. After replacement, go to step 40 .
35. Replace the starter relay. See **STARTER RELAY** under REMOVAL & INSTALLATION. After replacement, go to step 40 .
36. Replace the clutch switch. After replacement, go to step 40 .
37. Replace the starter. See **STARTER** under REMOVAL & INSTALLATION. After replacement, go to step 40 .
38. Replace the ignition switch. See appropriate STEERING COLUMN SWITCHES article in ACCESSORIES & EQUIPMENT. After replacement, go to step 40 .
39. Perform the set up procedures for the ECM. See **ENGINE CONTROL MODULE** under PROGRAMMING in SELF-DIAGNOSTICS article in FAULT ISOLATION in ENGINE PERFORMANCE. Replace the ECM. See **ENGINE CONTROL MODULE** under COMPUTERIZED ENGINE CONTROLS in REMOVAL & INSTALLATION article in ENGINE PERFORMANCE. After replacement, go to next step.
40. Operate the system for which the symptom occurred. If problem was corrected, the system is okay. If the problem was not corrected, go to step 2 .

TEST C: STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK

1. If the Engine Electrical Diagnostic System Check was performed, go to next step. If the Engine Electrical Diagnostic System Check was not performed, go to **ENGINE ELECTRICAL DIAGNOSTIC SYSTEM CHECK** under SELF-DIAGNOSTIC SYSTEM.
2. Turn the ignition to the START position. If the starter solenoid clicks, go to next step. If the starter solenoid does not click, go to **TEST A: STARTER SOLENOID DOES NOT CLICK (AUTOMATIC TRANSMISSION)** or **TEST B: STARTER SOLENOID DOES NOT CLICK (MANUAL TRANSMISSION)** .
3. Inspect the engine and belt drive system for mechanical binding, seized engine, seized generator. If the engine moves freely, go to next step. If the engine does not move freely, repair as necessary. See appropriate article in ENGINES.

4. Test the battery positive cable between the battery and the starter solenoid for high resistance. If problem was found and corrected, go to step 8 . If problem was not found, go to next step.
5. Test the ground circuit between the battery and the starter motor for a high resistance. If problem was found and corrected, go to step 8 . If problem was not found, go to next step.
6. Inspect for poor connections at the starter. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If problem was found and corrected, go to step 8 . If problem was not found, go to next step.
7. Replace the starter. See **STARTER** under REMOVAL & INSTALLATION. After replacement, go to next step.
8. Operate the system for which the symptom occurred. If problem was corrected, the system is okay. If problem was not corrected, go to step 2 .

TEST D: ENGINE CRANKS SLOWLY

Inspect the following items:

- Battery - Perform the Battery Inspection/Test. See **BATTERY TESTING & INSPECTION** under ON-VEHICLE TESTING in GENERATORS & REGULATORS - CTS article in CHARGING SYSTEM in ELECTRICAL.
- Wiring - Inspect the wiring for damage. Inspect all connections to the starter motor, the solenoid, the battery and all ground connections. See **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING.
- Engine - Verify that the engine is not seized.

If the battery, the wiring, and the engine are functioning properly, and the engine continues to crank slowly, replace the starter motor. See **STARTER** under REMOVAL & INSTALLATION.

TEST E: STARTER MOTOR NOISE DIAGNOSIS**Diagnostic Aids**

Inspect the flywheel ring gear for damage or unusual wear. Shim the starter as required. 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 0.039" (1 mm) thick.

Test Procedure

1. If the Engine Electrical Diagnostic System Check was performed, go to next step. If the

Engine Electrical Diagnostic System Check was not performed, go to **ENGINE ELECTRICAL DIAGNOSTIC SYSTEM CHECK** under SELF-DIAGNOSTIC SYSTEM.

2. Start the engine. If the starter operates normally, go to **INTERMITTENTS OR POOR CONNECTIONS** under TROUBLE SHOOTING. If the starter does not operate normally, go to next step.
3. Start the engine while listening to the starter motor turn. If there is a loud "whoop", it may sound like a siren if the engine is revved while the starter is engaged, after the engine starts, but while the starter is still held in the engaged position, go to step 6 . If there is not a loud "whoop" under specified conditions, go to next step.
4. If you hear a "rumble", a "growl", or, in some cases, a "knock" as the starter is coasting down to a stop after starting the engine, go to step 7 . If you do not hear a "rumble", a "growl" or a "knock" under specified conditions, go to next step.

NOTE: **This is often diagnosed as a starter drive gear hang-in or a weak solenoid.**

5. When the engine is cranked, if you hear a high-pitched whine after the engine cranks and starts normally, go to step 8 . If you do not hear a high-pitched whine under specified conditions, go to step 7 .
6. Inspect the flywheel ring gear for chipped gear teeth, missing gear teeth and milled teeth. If the flywheel is bent, or if it has damaged teeth, go to step 9 . If the flywheel is not bent and does not have damaged teeth, go to step 10 .
7. Remove the starter motor. See **STARTER** under REMOVAL & INSTALLATION. Inspect the starter motor bushings and clutch gear. If the clutch gear has chipped or milled teeth or worn bushings, go to step 10 . If the clutch gear does not have chipped or milled teeth or worn bushings, go to step 9 .
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. After repair, go to step 11 .
9. Replace the flywheel. Remove transmission to access flywheel. See **TRANSMISSION** under REMOVAL & INSTALLATION in REMOVAL & INSTALLATION - A/T article in AUTOMATIC TRANSMISSION in TRANSAXLE/TRANSMISSION. After replacement, go to step 11 .
10. Replace the starter motor. See **STARTER** under REMOVAL & INSTALLATION. After replacement, go to next step.
11. Operate the system in order to verify the repair. If problem was corrected, the system is okay. If problem was not corrected, go to step 3 .

REMOVAL & INSTALLATION

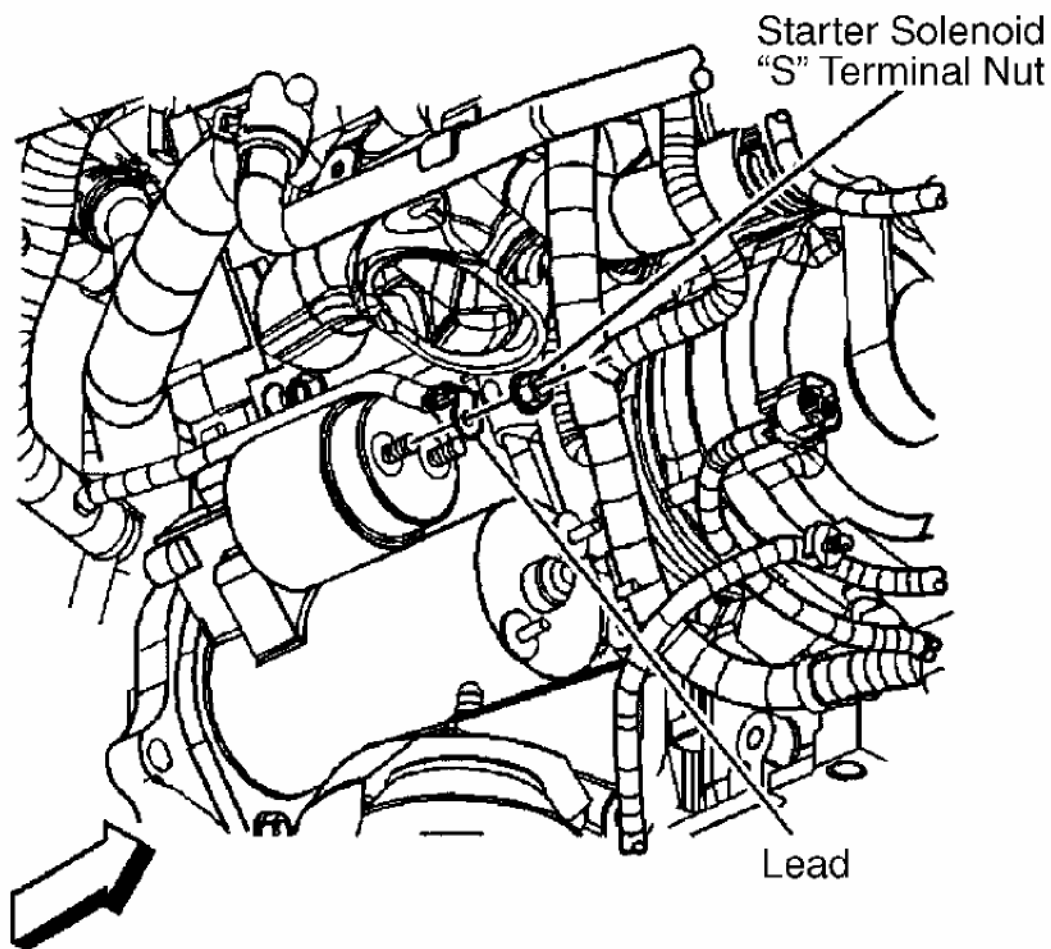
WARNING: Vehicles are equipped with air bag supplemental restraint system. Before attempting any repairs involving steering column, instrument panel or related components, see AIR BAG SAFETY PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM in AIR BAG RESTRAINT SYSTEMS article.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

STARTER

Removal

1. Remove the starter heat shield. See STARTER SHIELD .
2. Remove the starter solenoid "S" terminal nut and disconnect the lead from the starter. See Fig. 2 .
3. Remove the starter terminal nut and disconnect the battery positive cable from the starter. See Fig. 3 .
4. Remove the starter motor mounting bolts. See Fig. 4 . Remove the starter motor from the engine.



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Fig. 2: Removing Starter Solenoid "S" Terminal Nut
Courtesy of GENERAL MOTORS CORP.

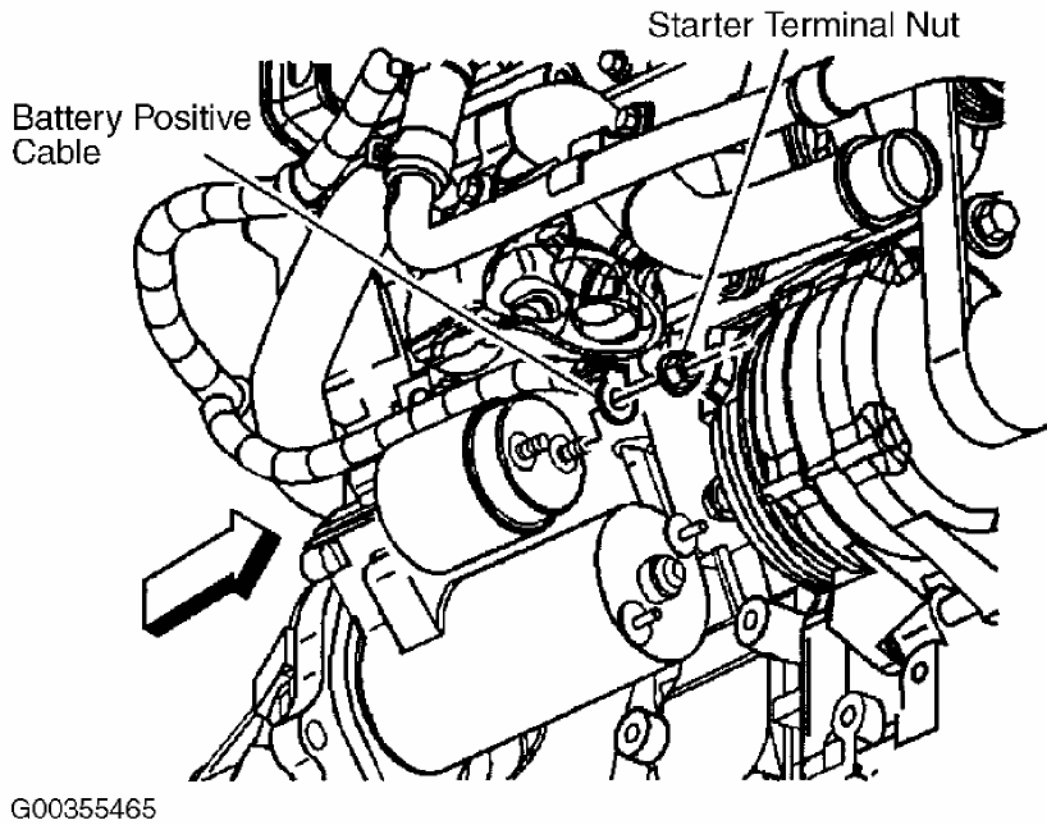
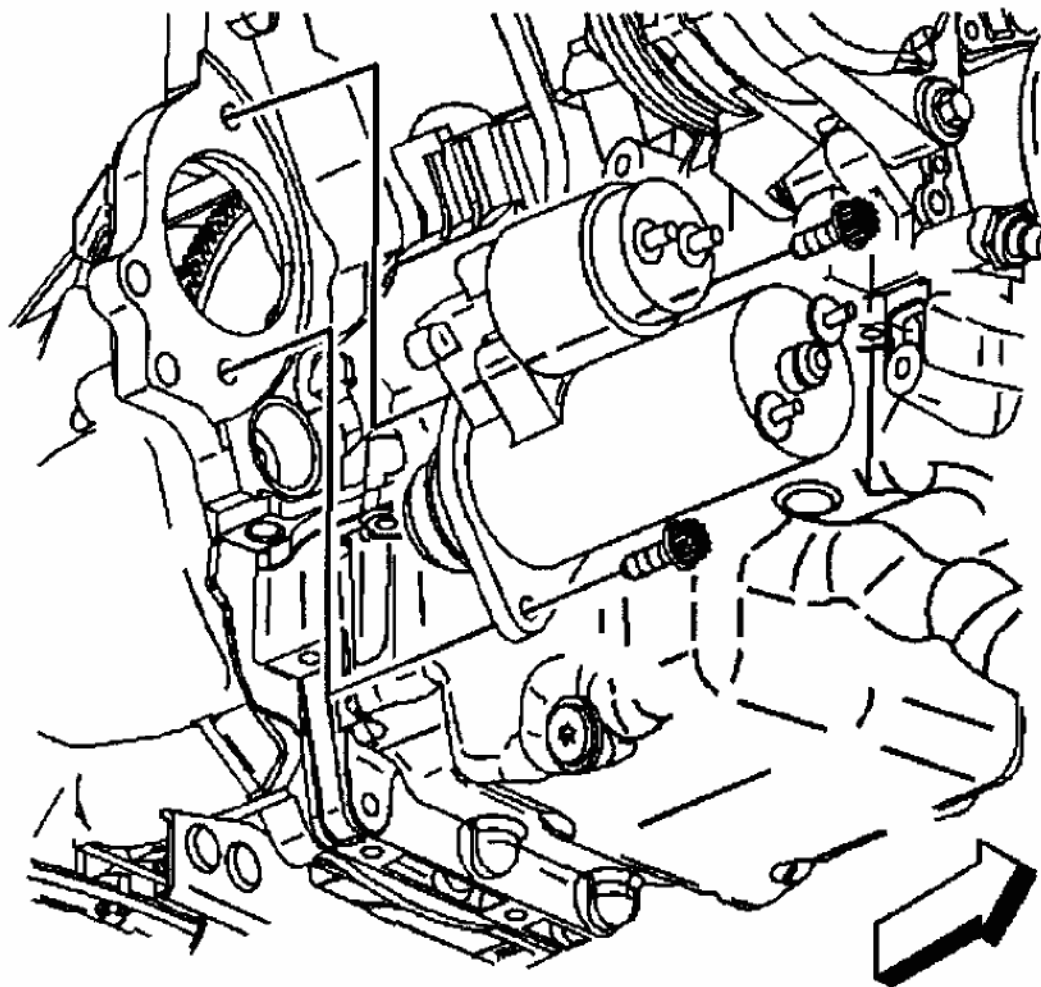


Fig. 3: Removing Starter Terminal Nut
Courtesy of GENERAL MOTORS CORP.



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Fig. 4: Removing Starter Motor
Courtesy of GENERAL MOTORS CORP.

Installation

1. Position the starter motor to the engine. See **Fig. 4**.
2. Install the starter motor mounting bolts. Tighten the starter motor mounting bolts to specification. See **TORQUE SPECIFICATIONS**.
3. Connect the battery positive cable to the starter and install the starter terminal nut. See **Fig. 3**. Tighten the battery positive cable to starter terminal nut to specification. See **TORQUE SPECIFICATIONS**.

4. Connect the lead to the starter solenoid and install the starter solenoid "S" terminal nut. See **Fig. 2** . Tighten the starter solenoid "S" terminal nut to specification. See **TORQUE SPECIFICATIONS** .
5. Install the starter heat shield. See **STARTER SHIELD** .

STARTER RELAY

Removal

NOTE: **Required Tool: Relay Puller Pliers (J-43244).**

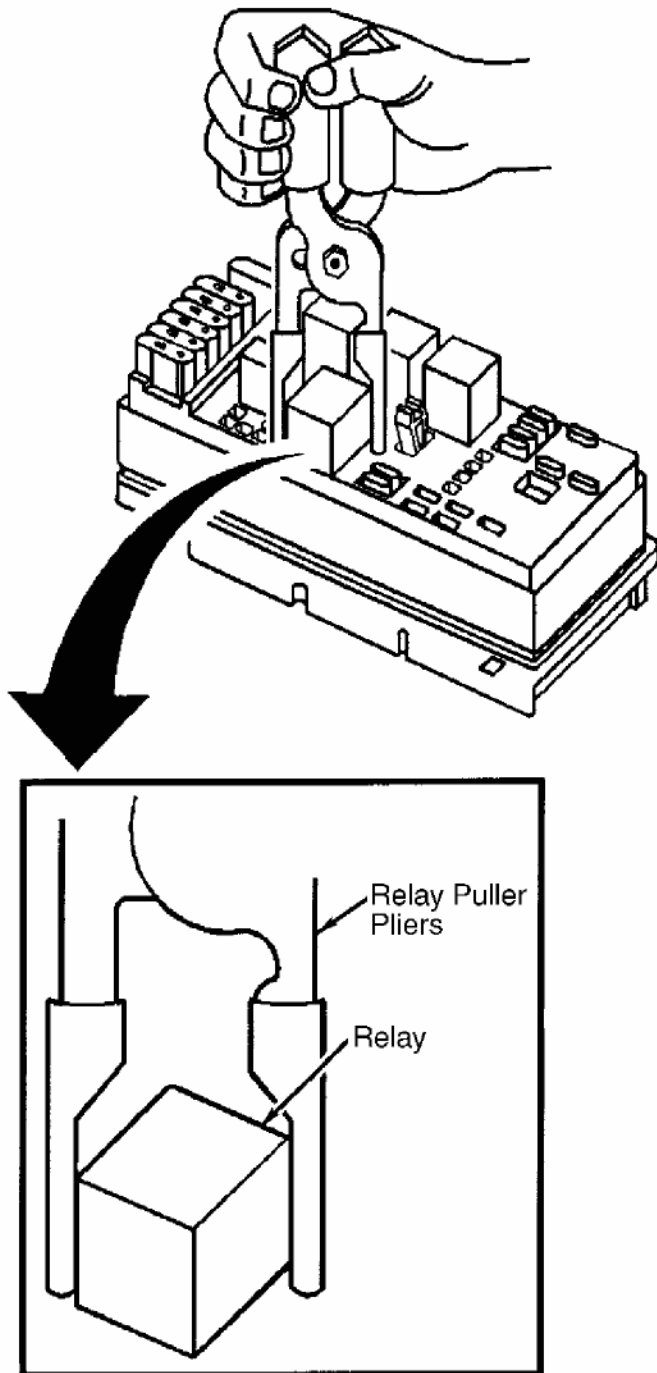
1. Remove the electrical center cover. Locate the relay. See **FUSES & CIRCUIT BREAKERS** article in ELECTRICAL.

NOTE: **Always note the orientation of the relay. Ensure that the electrical center is secure, as not to put added stress on the wires or terminals.**

2. Using the Relay Puller Pliers, position the tool on opposing corners of the relay. See **Fig. 5** .

CAUTION: Use the Relay Puller Pliers to pull the relay straight out from the electrical center terminals. The use of pliers or a flat bladed tool could damage the electrical center.

3. Remove the relay from the electrical center.



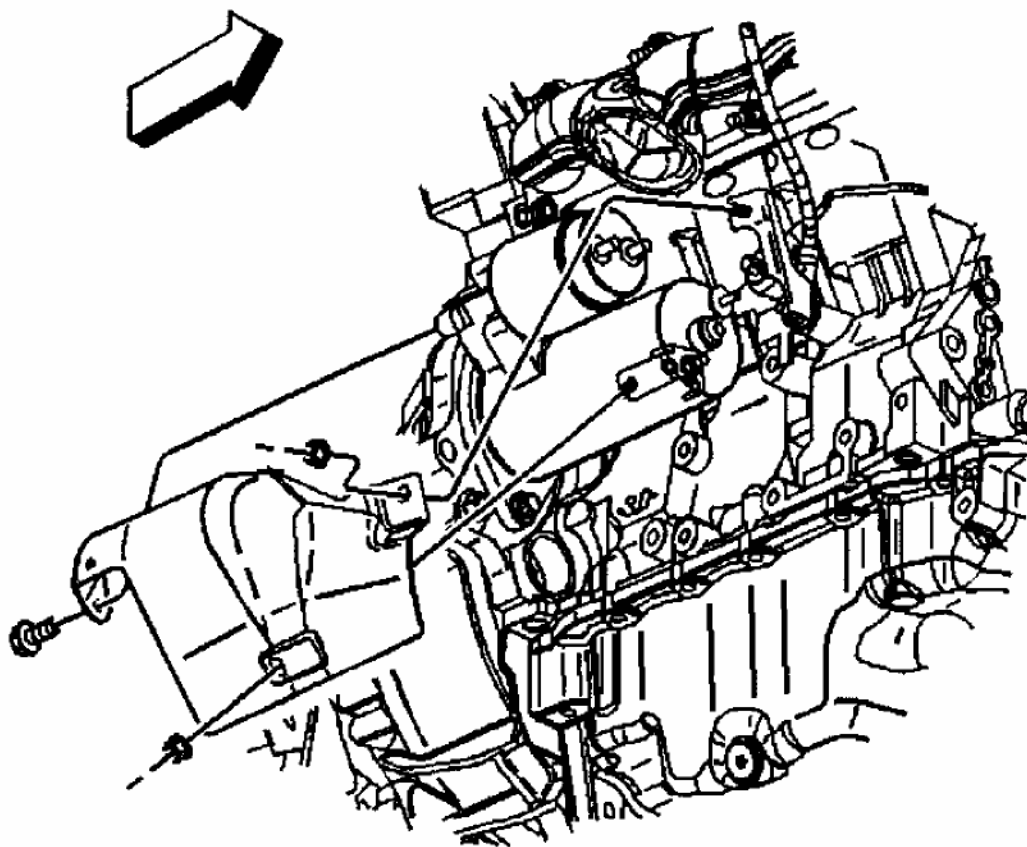
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Fig. 5: Removing Relay From Electrical Center
Courtesy of GENERAL MOTORS CORP.

1. Install the relay in the same position as removed.
2. Install the electrical center cover.

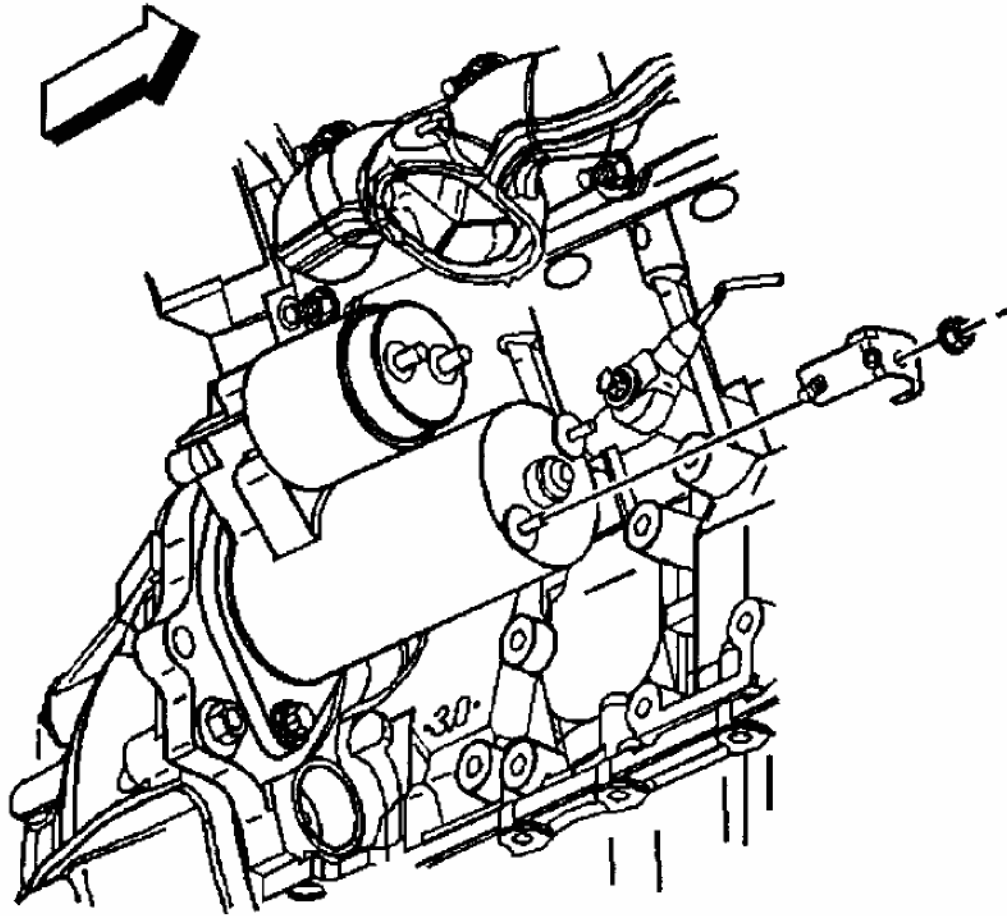
STARTER SHIELD**Removal**

1. Disconnect the battery negative cable.
2. Remove the right catalytic converter.
3. Remove the fasteners securing the starter heat shield to the starter. See **Fig. 6** . Remove the starter heat shield.
4. Remove the nut securing the starter heat shield mounting bracket to the starter. See **Fig. 7** . Remove the starter heat shield mounting bracket.
5. Remove the nut securing the starter heat shield mounting bracket to the engine block. See **Fig. 8** . Remove the starter heat shield mounting bracket.



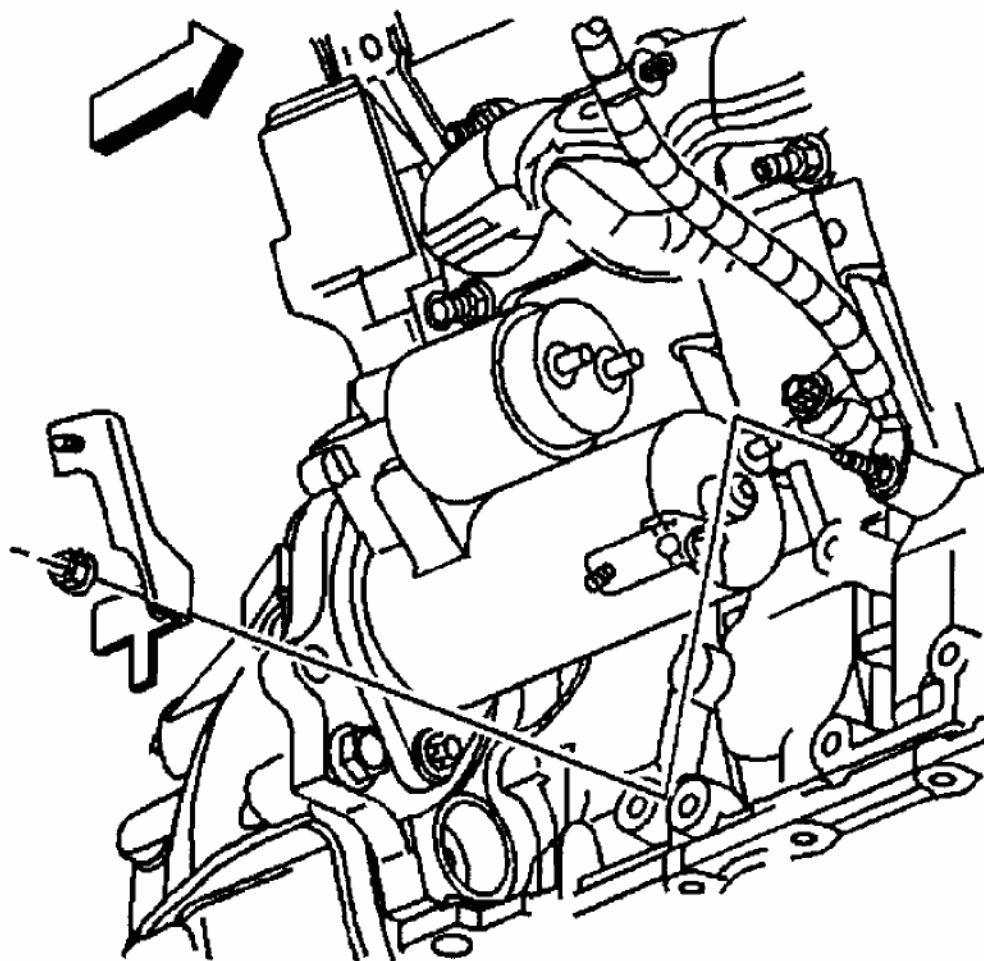
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Fig. 6: Removing Starter Heat Shield
Courtesy of GENERAL MOTORS CORP.



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Fig. 7: Removing Starter Heat Shield Mounting Bracket From Starter
Courtesy of GENERAL MOTORS CORP.



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Fig. 8: Removing Starter Heat Shield Mounting Bracket From Engine Block
Courtesy of GENERAL MOTORS CORP.

Installation

1. Install the starter heat shield mounting bracket to the stud located at the engine block. See **Fig. 8**.
2. Install the nut securing the starter heat shield mounting bracket to the engine block. Tighten the starter heat shield mounting bracket nut to specification. See **TORQUE SPECIFICATIONS**.
3. Install the starter heat shield mounting bracket to the stud located at the rear of the starter

motor. See **Fig. 7** .

4. Install the nut securing the starter heat shield mounting bracket to the starter. Tighten the starter heat shield mounting bracket nut to specification. See **TORQUE SPECIFICATIONS** .
5. Position the starter heat shield to the starter motor and brackets. Install the fasteners securing the starter heat shield to the starter motor and brackets. Tighten the starter heat shield fasteners to specification. See **TORQUE SPECIFICATIONS** .
6. Install the right catalytic converter.
7. Connect the battery negative cable. Tighten to specification. See **TORQUE SPECIFICATIONS** .

OVERHAUL

NOTE: Starter assemblies are not serviceable and should be replaced as complete units.

STARTER SPECIFICATIONS

See **STARTER MOTOR** under STARTING in SPECIFICATIONS under SPECIFICATIONS INDEX in GENERAL INFORMATION.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Battery Negative Cable-To-Battery Bolt	13 (17)
Starter Motor Mounting Bolts	30 (40)
INCH Lbs. (N.m)	
Battery Positive Cable-To-Starter Terminal Nut	111 (12.5)
Starter Heat Shield Fasteners	71 (8)
Starter Heat Shield Mounting Bracket Nuts	71 (8)
Starter Solenoid "S" Terminal Nut	44 (5)

WIRING DIAGRAMS

See **STARTING/CHARGING** in SYSTEM WIRING DIAGRAMS article in ELECTRICAL.