Figure 53-1  A theft deterrent indicator lamp on the dash. A flashing lamp usually indicates a fault in the system, and the engine may not start.

Figure 53-2  Voltmeter hookups for voltage drop testing of a solenoid-type cranking circuit.
TECH TIP: Voltage Drop Is Resistance

Many technicians have asked, "Why measure voltage drop when the resistance can be easily measured using an ohmmeter?" Voltage drop is the difference in voltage at any point along the circuit. For example, if the battery tested 24 volts at the battery terminal, but 22 volts at the starter terminal, the voltage drop is 2 volts. Voltage drop increases resistance in the circuit, thereby reducing the amount of current delivered to the starter, which could result in the starter not turning the engine over. Although the resistance of the wires is measurable using an ohmmeter, it does not indicate the voltage drop. The resistance reading is just the result of the voltage divided by the current. The voltage drop is calculated by subtracting the voltage measured at any point in a circuit from the preceding voltage. For example, if the battery voltage is 12 volts and the voltage measured at the starter is 10 volts, the voltage drop is 2 volts. This voltage drop must be used to calculate the resistance of the wires. The following are the three voltage drop ranges:

- Low voltage drop = Low resistance
- High voltage drop = High resistance

How much is too much? According to Bosch Corporation, all electrical circuits should have a maximum of 3% loss of the circuit voltage to resistance. Therefore, in a 12 volt circuit, the maximum loss of voltage in cables and connections should be 0.36 volt (12 X 0.03 = 0.36 volt). The remaining 97% of the circuit voltage (11.64 volts) is available to operate the electrical device (load). Just remember:

- Low voltage drop = Low resistance
- High voltage drop = High resistance

TECH TIP: A Warm Cable Equals High Resistance

If a cable or connection is warm to the touch, there is electrical resistance in the cable or connection. The resistance changes electrical energy into heat energy. Therefore, if a voltmeter is not available, touch the battery cables and connections while cranking the engine. If any cable or connection is hot to the touch, it should be cleaned or replaced.
To test the voltage drop of the battery cable connection, place one voltmeter lead on the battery terminal and the other voltmeter lead on the cable end and crank the engine. The voltmeter will read the difference in voltage between the two leads, which should not exceed 0.20 volt (200 mV).

A starter amperage tester uses an amp probe around the positive or negative battery cables.

**TECH TIP: Watch the Dome Light**

When diagnosing any starter-related problem, open the rear of the vehicle and observe the brightness of the dome or interior lights.

The brightness of any electrical lamp is proportional to the voltage of the battery.

Normal operation of the starter results in a slight dimming of the dome light.

If the light remains bright, the problem is usually an open in the control circuit.

If the light goes out or almost goes out, there could be a problem with the following:

- A shorted or grounded armature or field coils inside the starter
- Loose or corroded battery connections or cables
- Weak or discharged battery
Figure 53-6  The starter is located under the intake manifold on this Cadillac Northstar engine.

Figure 53-7  An exploded view of a typical solenoid-operated starter.

Figure 53-8  GM solenoid ohmmeter check. The reading between 1 and 2 (S terminal and ground) should be 0.2 to 0.4 ohms when it is working. The reading between 1 and 3 (S terminal and M terminal) should be 0 to 0.4 ohms (pull-in winding).
Figure 53-9  Measuring an armature shaft for runout using a dial indicator and V-blocks.

Figure 53-10  Replacement starter brushes should be installed so the beveled edge matches the rotation of the commutator.

Figure 53-11  A shim (or half shim) may be needed to provide the proper clearance between the flywheel teeth of the engine and the pinion teeth of the starter.
TECH TIP:

Reuse Drive-End Housing to Be Sure

Most GM starter motors use a pad mount and attach to the engine with bolts through the drive and hous mounting flange. Many times when a starter is replaced on a GM vehicle, the starter makes noise because of improper pinion-to-engine flywheel gear clearance. Instead of spending a lot of time determining the new clearance, simply remove the drive-end housing from the original starter and install it on the replacement starter. Service the bushing in the drive-end housing if needed. Because the original starter did not produce excessive gear engagement noise, the replacement starter will also be okay. Reuse any shims that were used with the original starter. This is preferable to reworking and reinstalling the replacement starter several times until the proper clearance is determined.

STARTER OVERHAUL 1

This dirty and greasy starter can be restored to useful service.

STARTER OVERHAUL 2

The connecting wire between the solenoid and the starter is removed.
STARTER OVERHAUL 3
An old starter field housing is being used to support the drive-end housing of the starter and is being disassembled. This rebuilder is using an electric impact wrench to remove the solenoid attaching screws.

STARTER OVERHAUL 4
A Torx driver is used to remove the solenoid attaching screws.

STARTER OVERHAUL 5
After the retaining screws have been removed, the solenoid can be separated from the starter housing. This rebuilder always replaces the solenoid.
STARTER OVERHAUL 6  The through-bolts are being removed.

STARTER OVERHAUL 7  The brush end plate is removed.

STARTER OVERHAUL 8  The armature assembly is removed from the field frame.
Notice that the length of a direct-drive starter armature (top) is the same length as the overall length of a gear-reduction armature except smaller in diameter.

A light tap with a hammer dislodges the armature thrust ball (in the palm of the hand) from the center of the gear reduction assembly.

This figure shows the planetary ring gear and pinion gears.
A close-up of one of the planetary gears, which shows the small needle bearings on the inside.

The clip is removed from the shaft so the planetary gear assembly can be separated and inspected.

The shaft assembly is being separated from the stationary gear assembly.
The commutator on the armature is discolored and the brushes may not have been making good contact with the segments.

All of the starter components are placed in a tumbler with water-based cleaner. The armature is installed in a lathe and the commutator is resurfaced using emery cloth.

The finished commutator looks like new.
Starter reassembly begins by installing a new starter drive on the shaft assembly. The stop ring and stop ring retainer are then installed.

The gear-reduction assembly is positioned along with the shift fork (drive lever) into the cleaned drive-end housing.

After gear retainer has been installed over the gear reduction assembly, the armature is installed.
New brushes are being installed into the brush holder assembly.

The brush end plate and the through-bolts are installed, being sure that the ground connection for the brushes is clean and tight.

This starter was restored to useful service by replacing the solenoid, the brushes, and the starter drive assembly plus a thorough cleaning and attention to detail in the reassembly.