Figure 55-1  The digital multimeter should be set to read DC volts, with the red lead connected to the positive (+) battery terminal and the black meter lead connected to the negative (-) battery terminal.

Figure 55-2  A scan tool can be used to diagnose charging system problems.
FREQUENTLY ASKED QUESTION:
What Is a Full-Fielding Test?

Full-fielding is a procedure used on older noncomputerized vehicles for bypassing the voltage regulator that could be used to determine if the alternator is capable of producing its designed output. This test is no longer performed for the following reasons:

- The voltage regulator is built into the alternator, therefore requiring that the entire assembly be replaced even if just the regulator is defective.
- When the regulator is bypassed, the alternator can produce a high voltage (over 100 volts in some cases) which could damage all of the electronic circuits in the vehicle.

Always follow the vehicle manufacturer’s recommended testing procedures.

TECH TIP: Use a Test Light to Check for a Defective Fusible Link

Most alternators use a fusible link or mega fuse between the output terminal and the positive (+) terminal of the battery. If this fusible link or fuse is defective (blown), then the charging system will not operate at all. Many alternators have been replaced repeatedly because of a blown fusible link that was not discovered until later.

A quick and easy test to check if the fusible link is okay is to touch a test light to the output terminal. With the other end of the test light attached to a good ground, the fusible link or mega fuse is okay if the light lights. This test confirms that the circuit between the alternator and the battery has continuity. SEE FIGURE 55–3.

Figure 55-3: Before replacing an alternator, the wise technician checks that battery voltage is present at the output and battery voltage sense terminals. If not, then there is a fault in the wiring.
This accessory drive belt is worn and requires replacement. Newer belts are made from ethylene propylene diene monomer (EPDM). This rubber does not crack like older belts and may not show wear even though the ribs do wear and can cause slippage.

**TECH TIP: The Hand Cleaner Trick**

Lower-than-normal alternator output could be the result of a loose or slipping drive belt. All belts (V and serpentine multigroove) use an interference angle between the angle of the Vs of the belt and the angle of the Vs on the pulley. As the belt wears, the interference angles are worn off of both edges of the belt. As a result, the belt may start to slip and make a squealing sound even if tensioned properly.

A common trick used to determine if the noise is belt related is to use grit-type hand cleaner or scouring powder. With the engine off, sprinkle some powder onto the pulley side of the belt. Start the engine. The excess powder will fly into the air, so get away from under the hood when the engine starts. If the belts are now quieter, you know that it was the glazed belt that made the noise.

**Chart 55-1**

Typical belt tension for various widths of belts. Tension is the force needed to depress the belt as displayed on a belt tension gauge.
Check service information for the exact marks where the tensioner should be located for proper belt tension.

**TECH TIP:** Check the Overrunning Clutch

If low or no alternator output is found, remove the alternator drive belt and check the overrunning alternator pulley (OAP) or overrunning alternator dampener (OAD) for proper operation. Both types of overrunning clutches use a one-way clutch. Therefore, the pulley should freewheel in one direction and rotate the alternator rotor when rotated in the opposite direction. See Figure 55–6.

Figure 55–6  This overrunning alternator dampener (OAD) is longer than an overrunning alternator pulley (OAP) because it contains a dampener spring as well as a one-way clutch. Be sure to check that it locks in one direction.
Figure 55-7  Testing AC ripple at the output terminal of the alternator is more accurate than testing at the battery due to the resistance of the wiring between the alternator and the battery. The reading shown on the meter, set to AC volts, is only 78 mV (0.078 V), far below what the reading would be if a diode were defective.

**TECH TIP: The Lighter Plug Trick**

Battery voltage measurements can be read through the lighter socket. Simply construct a test tool using a lighter plug at one end of a length of two-conductor wire and the other end connected to a double banana plug. The double banana plug will fit most meters in the common (COM) terminal and the volt terminal of the meter. This is handy to use while road testing the vehicle under real-life conditions. Both DC voltage and AC ripple voltage can be measured. **SEE FIGURE 55-8.**

Figure 55-8  Charging system voltage can be easily checked at the lighter plug by connecting a lighter plug to the voltmeter through a double banana plug.
A mini clamp-on meter can be used to measure alternator output as shown here (105.2 Amp). Then the meter can be used to check AC ripple by selecting AC Amps on the rotary dial. AC ripple current should be less than 10% of the DC current output.

Voltmeter hookup to test the voltage drop of the charging circuit.

A typical tester used to test batteries as well as the cranking and charging system. Always follow the operating instructions.
Figure 55-12 The best place to install a charging system tester amp probe is around the alternator output terminal, as shown.

TECH TIP: Use a Fused Jumper Wire as a Diagnostic Tool

When diagnosing an alternator charging problem, try using a fused jumper wire to connect the positive and negative terminals of the alternator directly to the positive and negative terminals of the battery. If a definite improvement is noticed, the problem is in the wiring of the vehicle. High resistance, due to corroded connections or loose grounds, can cause low alternator output, repeated regulator failures, slow cranking, and discharged batteries. A voltage drop test of the charging system can also be used to locate excessive resistance (high voltage drop) in the charging circuit, but using a fused jumper wire is often faster and easier.

TECH TIP: Bigger Is Not Always Better

Many technicians are asked to install a higher output alternator to allow the use of emergency equipment or other high-amperage equipment such as a high-wattage sound system. Although many higher output units can be physically installed, it is important not to forget to upgrade the wiring and the fusible link(s) in the alternator circuit. Failure to upgrade the wiring could lead to overheating. The usual failure locations are at junctions or electrical connectors.
Replacing an alternator is not always as easy as it is from a Buick with a 3800 V-6, where the alternator is easy to access. Many alternators are difficult to access, and require the removal of other components.

**TECH TIP: The Sniff Test**

When checking for the root cause of an alternator failure, one test that a technician could do is to smell the alternator. If the alternator smells like a dead rat (rancid smell), the stator windings have been overheated by trying to charge a discharged or defective battery. If the battery voltage is continuously low, the voltage regulator will continuously supply full-field current to the alternator. The voltage regulator is designed to cycle on and off to maintain a narrow charging system voltage range.

If the battery voltage is continually below the cutoff point of the voltage regulator, the alternator is continuously producing current in the stator windings. This overcharging can often overheat the stator and burn the insulating varnish covering the stator windings. If the alternator fails the sniff test, the technician should replace the stator and other alternator components that are found to be defective and replace or recharge the battery.

Always mark the case of the alternator before disassembly to be assured of correct reassembly.
FREQUENTLY ASKED QUESTION

What Is a "Clock Position"?

Most alternators of a particular manufacturer can be used on a variety of vehicles, which may require wiring connections placed in various locations. For example, a Chevrolet and a Buick alternator may be identical except for the position of the rear section containing the electrical connections. The four through bolts that hold the two halves together are equally spaced; therefore, the rear alternator housing can be installed in any one of four positions to match the wiring needs of various models. Always check the clock position of the original and be sure that it matches the replacement unit. SEE FIGURE 55–15.

Figure 55-15
Explanation of clock positions. Because the four through bolts are equally spaced, it is possible for an alternator to be installed in one of four different clock positions. The connection position is determined by viewing the alternator from the diode end with the threaded adjusting lug in the up or 12 o'clock position. Select the 3 o'clock, 6 o'clock, 9 o'clock, or 12 o'clock position to match the unit being replaced.

Figure 55-16
Testing an alternator rotor using an ohmmeter.
If the ohmmeter reads infinity between any two of the three stator windings, the stator is open and, therefore, defective. The ohmmeter should read infinity between any stator lead and the steel laminations. If the reading is less than infinity, the stator is grounded. Stator windings cannot be tested if shorted because the normal resistance is very low.

Typical diode trio. If one leg of a diode trio is open, the alternator may produce close to normal output, but the charge indicator light on the dash will be on dimly.

A typical rectifier bridge that contains all six diodes in one replaceable assembly.
Figure 55-20 A brush holder assembly with new brushes installed. The holes in the brushes are used to hold the brushes up in the holder when it is installed in the alternator. After the rotor has been installed, the retaining pin is removed which allows the brushes to contact the slip rings of the rotor.

**REAL WORLD FIX: The Two-Minute Alternator Repair**

A Chevrolet pickup truck was brought to a shop for routine service. The customer stated that the battery required a jump start after a weekend of sitting. The technician tested the battery and charging system voltage using a small handheld digital multimeter. The battery voltage was 12.4 volts (60% charged), but the charging voltage was also 12.4 volts at 2000 RPM. Because normal charging voltage should be 13.5 to 15 volts, it was obvious that the charging system was not operating correctly.

The technician checked the dash and found that the charge light was not on. Before removing the alternator for service, the technician connected the voltage terminal to the alternator. When the connector was removed, the charge light was not illuminated. Upon checking the voltage, it was determined that the charging system was not receiving the correct voltage. Therefore, the technician determined that the problem was due to a loose or corroded wire connection. After the contacts were cleaned, the charging system was restored to normal operation. The technician had learned that the simple things should always be checked first before tearing into a big or expensive repair.

**ALTERNATOR OVERHAUL 1**

Before the alternator is disassembled, it is spun tested and connected to a scope to check for possible defective components.
ALTERNATOR OVERHAUL 2
The scope pattern shows that the voltage output is far from being a normal pattern. This pattern indicates serious faults in the rectifier diodes.

ALTERNATOR OVERHAUL 3
The first step is to remove the drive pulley. The rebuilder is using an electric impact wrench to accomplish the task.

ALTERNATOR OVERHAUL 4
Carefully inspect the drive pulley for damage of embedded rubber from the drive belt. The slightest fault can cause a vibration, noise, or possible damage to the belt and pulley.
ALTERNATOR OVERHAUL 5

Remove the external fan (if equipped) and then the spacers as shown.

ALTERNATOR OVERHAUL 6

Next pop off the plastic cover (shield) covering the stator/rectifier connections.

ALTERNATOR OVERHAUL 7

After the cover has been removed, the stator connections to the rectifier can be seen.
Using a diagonal cutter, cut the weld to separate the stator from the rectifier.

Before separating the halves of the case, this technician uses a punch to mark both halves.

After the case has been marked, the through-bolts are removed.
ALTERNATOR OVERHAUL 11
The drive-end housing and the stator are being separated from the rear, slip-ring-end housing.

ALTERNATOR OVERHAUL 12
The stator is checked by visual inspection for discoloration or other physical damage, and then checked with an ohmmeter to see if the windings are shorted-to-ground.

ALTERNATOR OVERHAUL 13
The front bearing is removed from the drive-end housing using a press.
A view of the slip-ring-end (SRE) housing showing the black plastic shield, which helps driver air flow across the rectifier.

A punch is used to dislodge the plastic shield retaining clips.

After the shield has been removed, the rectifier, regulator, and brush holder assembly can be removed by removing the retaining screws.
The hear transfer grease is visible when the rectifier assembly is lifted out of the rear housing.

The parts are placed into a tumbler where ceramic stones and a water-based solvent are used to clean the parts.

This rebuilder is painting the housing using a high-quality industrial grade spray paint to make the rebuilt alternator look like new.
The slip rings on the rotor are being machined on a lathe.

The rotor is being tested using an ohmmeter. The specifications for the resistance between the slip rings on the CS-130 are 2.2 to 3.5 ohms.

The rotor is also tested between the slip ring and the rotor shaft. This reading should be infinity.
A new rectifier. This replacement unit is significantly different than the original but is designed to replace the original unit and meets the original factory specifications.

Silicone heat transfer compound is applied to the heat sink of the new rectifier.

Replacement brushes and springs are assembled into the brush holder.
The brushes are pushed into the brush holder and retained by a straight wire, which extends through the rear housing of the alternator. This wire is then pulled out when the unit is assembled.

Here is what the CS alternator looks like after installing the new brush holder assembly, rectifier bridge, and voltage regulator.

The junction between the rectifier bridge and the voltage regulator is secured.
The plastic deflector shield is snapped back into location using a blunt chisel and hammer. This shield directs the airflow from the fan over the rectifier bridge and voltage regulator.

Before the stator windings can be soldered to the rectifier bridge, the varnish insulation is removed from the ends of the leads.

After the stator has been inserted into the rear housing the stator leads are soldered to the copper lugs of the rectifier bridge.
New bearings are installed. A spacer is placed between the bearing and the slip ring to prevent the possibility that the bearing could move on the shaft and short against the slip rings.

The slip-ring-end (SRE) housing is aligned with the marks made during disassembly and is pressed into the drive-end (DE) housing.

The retaining bolts, which are threaded into the drive-end housing from the back of the alternator, are installed.
The external fan and drive pulley are installed and the retaining nut is tightened on the rotor shaft.

The scope pattern shows that the diodes and stator are functioning correctly and voltage check indicates that the voltage regulator is also functioning correctly.