Tech Basics 2
Delco-Remy 10DN Charging Systems

COLUMN BY WES GRUENINGER

Note from Wes Grueninger: *This article is one of eight troubleshooting guides in the Tech Basic series. Even though these guides deal with early charging systems, year after year they continue to be one of the most popular downloads from the Electrical Rebuilder's Association Technical Library.*

During the years these charging systems were popular, I made many, many trips to repair garages to diagnose the "real" problem after one of our remanufactured alternators had been installed. Usually this was done as a free customer service. As our business grew it became increasingly hard to offer this service. There just wasn't time for me to do it and I couldn't afford to send an employee. The Tech Basic series was my answer to providing customer support. Simply faxing one to a customer usually allowed him to solve the problem without my presence and also build customer goodwill as well.

I have received criticism over the years that the explanations and testing procedures are too simple. I agree that in a professionally run shop, with the latest equipment and trained technicians, there are better ways to test and diagnose. But, keep in mind, that these guides were created for the person whose test equipment consists of a two dollar test light and to whom the words "voltage drop" have no meaning. When viewed in that light, they have been very successful in getting the job done.

All eight Tech Basic articles are available in a ready-to-print format. They are available for download in the ERA Technical Library.

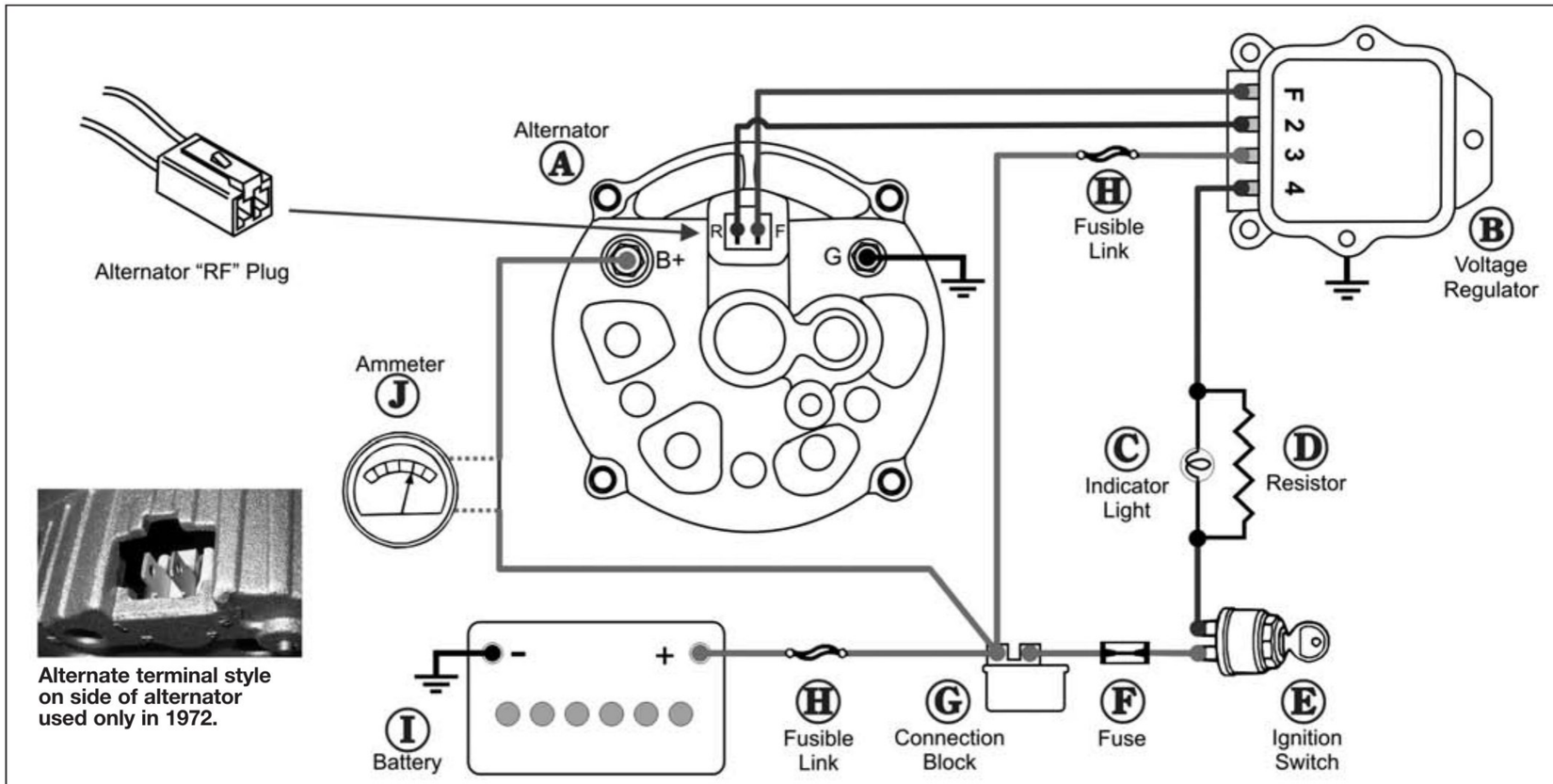


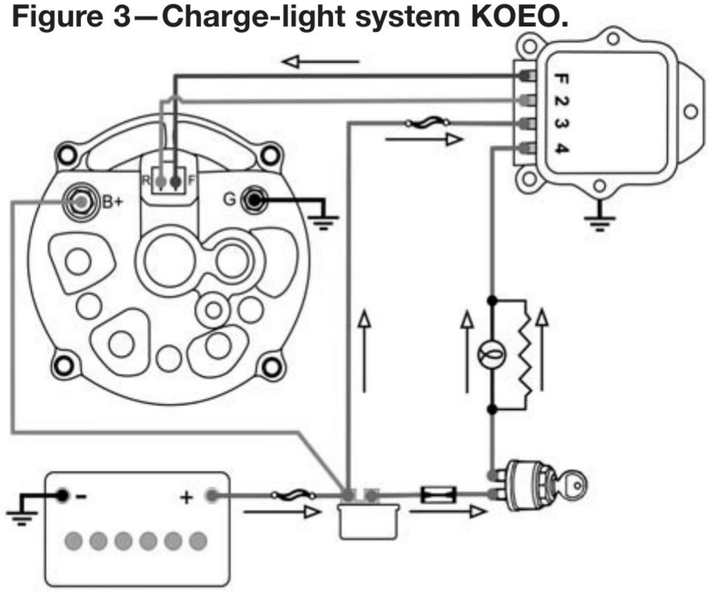
Figure 1—Components of a typical 10DN charging system with a charge-light.

The 10DN charging system was widely used during the 1960s and early 1970s. It was used primarily on General Motors vehicles, but it can also be found on AMC, International and many industrial applications. There are variations of the wiring depending on the application. Some charging systems have a transistorized voltage regulator. Some have a separate charge-light relay. This article discusses the most common system you are likely to work on: classic GM vehicles. Some vehicles have a charge light, and some have only a gauge. Figure 1 shows the components in a charge-light system (gauge-only systems will be discussed later). The following is a list of the components in both systems, along with some of their common problems. You should read this list and familiarize yourself with the parts, no matter which system you are troubleshooting.

A) Alternator—Be sure to clean corrosion off the grounding areas where the alternator mounts. Make certain the two-terminal "R-F" plug is corrosion-free. It's not unusual to find the plastic plug has been replaced with two crimp-on spade terminals. This is not good. It's very easy for the connectors to short to ground or to each other. Touching the "F' terminal to ground will destroy the voltage regulator faster than you can say, "Oh nuts!" You should replace a missing plug with a new one (see Figure 1). It is also a good idea to coat the terminals with dielectric grease to prevent corrosion.

B) Voltage Regulator—must be properly grounded. Some vehicles have a ground wire from the alternator to a regulator mounting screw. If a ground wire isn't there, you should install one. Remember, these are older and usually rusty vehicles. You can't always count on body grounds to be good conductors. Use

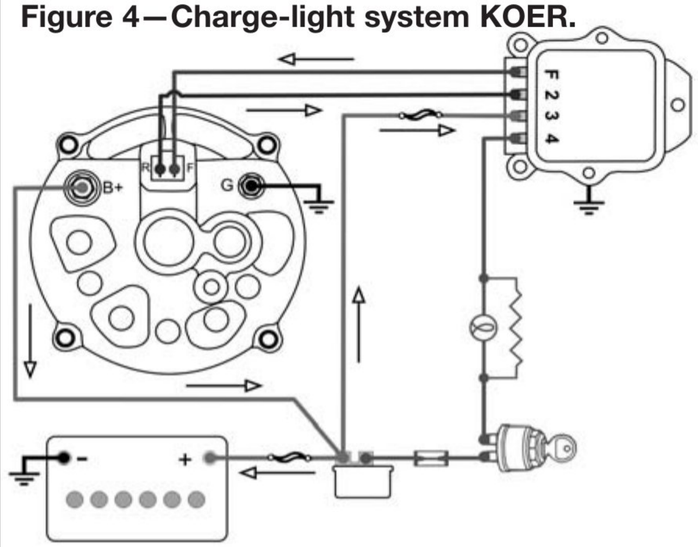
Figure 3—Charge-light system KOEO.



KOEO current flow

- Regulator grounds the "4" terminal
- Regulator connects the "3" terminal to the "F" circuit
- Charge-light is on
- Alternator field is energized

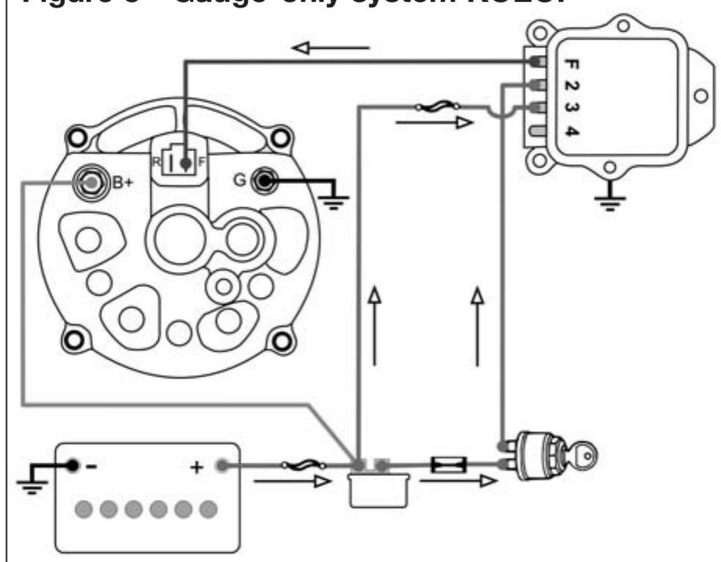
Figure 4—Charge-light system KOER.



KOER current flow

- Alternator "R" terminal provides ½ voltage to the regulator "2" terminal
- Regulator opens the "4" terminal and light goes out
- Current produced by alternator flows from B+ terminal
- Regulator controls current to the "F" circuit to control alternator output

Figure 5—Gauge-only system KOEO.



KOEO current flow

- Ignition switch sends power to the regulator "2" terminal
- Regulator connects "3" terminal to the "F" circuit
- Alternator field is energized

dielectric grease on all connections.

C) Indicator Light—bulb can fail. Not used in gauge-only vehicles.

D) Resistor—allows current to flow in case of bulb failure. Most GM vehicles use a 10 ohm resistor wire. This wire is specially calibrated to offer a certain resistance over its length. Be careful when replacing wires on these vehicles. Try to reuse the old wire whenever possible (not used in all vehicles).

E) Ignition Switch

F) Charging-System Fuse—located in the fuse box. It may also protect other dash warning lights and gauges.

G) Connection Block—(see Figure 2, page 14). Some vehicles use a horn relay. Some use a small junction block, and some have all the connections inside the wiring harness. By the late 1960s, GM moved this connection to the battery cable connection of the starter solenoid. This is a good place to check for poor connections. Use dielectric grease to coat all connections.

H) Fusible Link(s)—protect the wire to the alternator B+ stud and the voltage regulator "3" terminal. Some cars have no fusible links. Some cars have two—one on the alternator B+ wire and one on the regulator "3" wire.

I) Battery—should be fully charged and load tested before diagnosing any charging problem.

J) Ammeter—Some vehicles have only an ammeter. Some have a charge-light and an ammeter.

Charge-light system

How it works

The system with a charge-light has two stages of operation.

The first stage is *KOEO* (key on, engine off).

During KOEO, current flows from the battery, through the fuse, through the ignition switch, through the charge-light/resistor, to the voltage regulator "4" terminal.

What's the resistor for?

1. It's there as a backup for the charge-light bulb. If the filament in the bulb breaks, current will bypass the bulb and still get to the "4" terminal on the voltage regulator. Without the resistor, a blown charge-light bulb could disable the charging system!
2. It allows more current to flow to the "4" terminal than just the bulb filament alone. This causes the alternator to start charging at low engine rpm.

As soon as the voltage regulator sees current at the "4" terminal it does two things:

1. It directs the current at the "4" terminal to ground. This completes the charge-light circuit and the bulb lights up.
2. It directs current from the "3" terminal out of the "F" terminal to the alternator. Current flows into the "F" terminal on

the alternator and causes the rotor to become an electromagnet.

That's it for KOEO. The charge-light is on, and the alternator rotor is energized. It's time to start the engine.

The second stage is KOER (key on, engine running).

As soon as the alternator starts charging, it sends current out of the "R" terminal to the voltage regulator "2" terminal.

The current leaving the alternator "R" terminal is not at full charging-system voltage. On a good alternator, it will always measure about one-half the alternator charging voltage. For example, if you measure 14.0 volts across the battery, the "R" voltage at the alternator will be approximately 7.0 volts.

The alternator "R" terminal output has only one purpose. It sends current to the voltage regulator "2" terminal. As soon as the voltage regulator senses voltage at the "2" terminal, it opens the connection between the "4" terminal and ground, thereby turning off the charge-light.

Once the charge-light is off, the system will keep charging as long as the alternator is spinning (the charge-light circuit has been grayed-out in Figure 4, page 7, to indicate that it is no longer needed).

If alternator speed drops below a certain level, it can't produce a strong enough "R" signal, and the voltage regulator will turn on the charge-light. If you are having problems with the charge-light coming on at idle, check that the engine idle speed is set to specs. Pulley size can also affect alternator speed. Many speed enthusiasts install a very large pulley to slow down the alternator and gain horsepower. While this might help their track times, it makes it unlikely that the charging system will work at low speeds.

And that's it. The regulator keeps supplying current to the "F" circuit as long as it receives a signal from the alternator "R" terminal. Anything that causes the alternator to stop charging, such as a broken belt or worn brushes, will interrupt the "R" signal, and the regulator will turn on the charge-light.

Gauge-only system

How it works

Gauge-only systems have two stages of operation.

The first stage is KOEO (key on, engine off).

During KOEO, current flows from the battery, through the fuse, through the ignition switch, to the voltage regulator "2" terminal. As soon as the voltage regulator "sees" voltage at the "2" terminal, it directs current from the "3" terminal to the "F" circuit. This current flow causes the rotor to become an electromagnet.

The voltage regulator "4" terminal is not used in gauge-only systems.

That's it for KOEO. The alternator is energized. It's time to start the engine.

The second stage is KOER (key on, engine running).

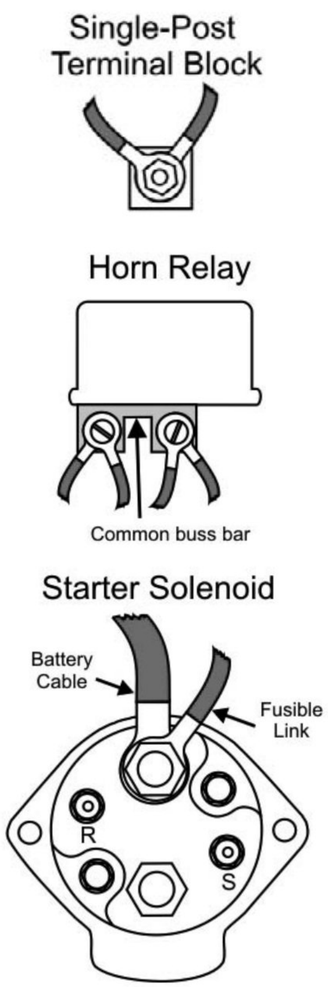
As soon as the alternator starts charging, it sends current out the B+ terminal. The charging system will keep working as long as the ignition key is on and the engine is running.

How to test and repair

Start by doing a charging system test.

Step 1: The battery must be fully charged and load tested. The engine must be off. Be sure the alternator belt is properly tensioned. Connect the negative lead of a voltmeter to the negative battery post and the positive voltmeter lead to the pos-

Figure 2—Types of alternator B+ wire connections.



Common junction styles used with 10DN systems

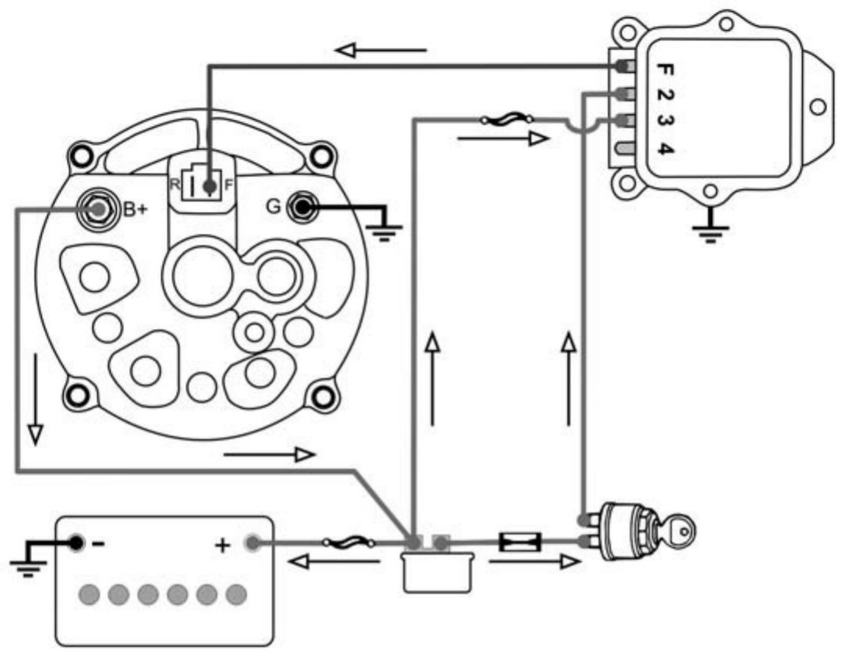
(Always check for poor connections.)

Most early 1960s cars use either the single-post terminal or the horn relay as a junction block for wiring-harness connections. Some cars have fusible links, and some don't.

By the late 1960s, most had moved the alternator B+ wire to the starter solenoid.

Fusible links are always found within the first four inches of the protected wire.

Figure 6—Gauge-only system KOER.



KOER current flow

- Ignition switch sends power to the regulator "2" terminal
- Current produced by alternator flows from B+ terminal
- Regulator controls current to the "F" circuit to control alternator output

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(Continued from page 14)

itive battery post. Write down this reading—it will be referred to as "base voltage." Do both of the following tests:

Load test: Start the engine. Turn the headlights on and the heater/ac fan motor to high. Increase engine speed to 2,000 rpm. Check the voltage across the battery terminals. See Table 1 for results.

No-load test: Turn off the accessories, decrease engine speed to 1,500 rpm and check the voltage across the battery terminals again. See Table 2 for results.

If both the load test and the no-load test pass and the charge-light is out (if present), the charging system is working correctly.

If the load test fails, skip to Step 2.

If the no-load test fails, remove the plug from the voltage regulator. If overcharging stops, skip to Step 2. If it is still overcharging with the plug removed, there is a short in the wiring harness between the "3" wire and the "F" wire. Repair and repeat Step 1.

Steps 2 to 4 are performed with the engine off.

Step 2: Use a voltmeter or a test light and check for power at the B+ stud on the alternator and the "3" terminal at the regulator. If both have power, then skip to Step 3. If neither has power, check the fusible link (if so equipped). If the alternator B+ has power, but not the regulator "3" terminal, check the junction points shown in Figure 2.

Step 3: Remove the wiring-harness plugs from the voltage regulator and the alternator. Use a short piece of wire to jump from terminal "F" to terminal "3" of the voltage regulator plug as shown in Figure 7. Use a test light or a voltmeter to test for power at the "F" terminal of the alternator plug. If there is no power at the "F" terminal of the alternator plug, check for bad connections or a broken wire.

LOAD TEST VOLTAGE READINGS	RESULT
Voltage increases at least 0.5 volts over the "base voltage"	Pass
Voltage does not increase at least 0.5 volts over the "base voltage"	Fail

Table 1—Load test voltage readings.

NO-LOAD TEST VOLTAGE READINGS	RESULT
Voltage is less than 2.0 volts over "base voltage"	Pass
Voltage is more than 2.0 volts over "base voltage" (overcharging)	Fail

Table 2—No-load test voltage readings.

Keep the jumper wire in place and reconnect only the alternator plug. Touch the flat edge of a screwdriver to the alternator rotor shaft at the center of the pulley. You should feel a magnetic attraction. If not, the alternator should be replaced. Reconnect the voltage regulator plug and go to Step 4 for Charge-Light System or skip to Step 7 for Gauge-Only System.

Step 4: Charge-light system: Turn the key to the "run" position and look at the charge-light. If it comes on, skip to Step 5. If it does not, remove the plug from the voltage regulator and, with the key still on, use a voltmeter or a test light to check for power at the regulator plug "4" terminal. If the regulator plug "4" terminal does not have power, the most likely cause is a bad fuse. If the fuse is good, it's time to start checking for unusual problems. Check for corroded connectors, corroded fuse-box terminals, cut wires, a loose plug at the instrument cluster or a bad ignition switch. What about the bulb? A bad bulb will not prevent power from flowing to the regulator plug "4" terminal, since the resistor offers an alternate path. The time to test the bulb is after restoring power to the regulator plug "4" terminal. Just ground the "4" terminal from the voltage regulator plug—the charge-light will come on if the bulb is good. Reconnect the plug to the voltage regulator. If the charge-light comes on, go to Step 5. If the charge-light does not come on, check that the voltage regulator is properly grounded. If the charge-light is still not on, replace the voltage regulator and redo Step 4.

Step 5: Charge-light system: Start the engine. Do the following test at idle, with the engine warm and the voltage regulator plugged in. Test the voltage at the "2" terminal and the "4" terminal of the voltage regulator. The "2" terminal should be about one-half the voltage of the "4" terminal. If no voltage is present at the voltage regulator "2" terminal, check the voltage directly at the "R" terminal on the alternator. If correct voltage is at the alternator, repair the wire. If there is no voltage or low voltage directly at the alternator, replace the alternator. Go to Step 6.

Step 6: Charge-light system: Reconnect everything and start the engine. If the charge-light is still on, then the voltage regulator is bad. Replace the voltage regulator. At this point, you have verified every function of the system. Go to Step 8.

Step 7: Gauge-only system: Turn the key to the "run" position. Remove the wiring-harness plug from the voltage regulator and, using a voltmeter or a test light, check for power at the harness plug "2" terminal. If the harness plug "2" terminal does not have power, the most likely cause is a bad fuse. If the fuse is good it's time to start checking for unusual problems. Check for corroded connectors, corroded fuse-box terminals, cut wires or a bad ignition switch. When you have found and repaired the problem, and voltage is present at the wiring-harness plug "2" terminal, go to Step 8.

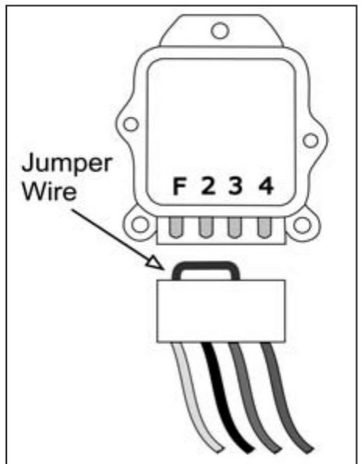

Figure 7–Jumper between "F" and "3."

Step 8: Charge-light system or gauge-only system: Be sure all wires are reconnected and run the engine at 1,500 rpm for several minutes or until battery voltage stabilizes. Repeat the load and no-load tests done in Step 1.

If the system fails the load test, remove the alternator and have it bench tested. Replace the alternator if it is bad. If the system fails the load test with a good alternator, replace the voltage regulator.

If the system fails the no-load test, replace the voltage regulator.

The final test is to verify that the entire system is working correctly. Repeat the load and no-load tests done in Step 1.

Courtesy of the Electrical Rebuilder's Association. This Technical Document, CS-0908A, along with other technical and membership information, may be accessed at electricalrebuilders.org.

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