Basic Charging System Tips

Alternator Alley is our new series on alternator diagnosis and service. Instead of covering a specific alternator in this first installment, I'm going to review some troubleshooting tips that apply to all charging systems. These are tips borne of experience—our experience and that of savvy electrical specialists. Our collective experience tells me these points are well worth repeating!

Some of you are extremely skilled and experienced automotive electricians. But some of you are still intimidated by charging systems. Some of you are extremely well equipped and insist on doing your own unit repairs and reconditioning. Some of you prefer not to open up an alternator for any reason. You install only new or remanufactured units. So be it!

With all of this in mind, we'll make a few assumptions here:

- The most common reason for checking a charging system is the fact that the battery is discharged or discharging.
- Most electrical problems occur during periods of heavy electrical demand.
- You want to isolate the problem or problems—and their causes—as quickly as possible. On today's cars, there are no guarantees that you'll encounter just *one* problem in the system! And if you aren't thorough, you'll invite electrical comebacks.
- If you spin its drive pulley and power its field (excite the field), any alternator should charge.

Now, let's talk shop.

The Battery

There's absolutely no substitute for a quality high-capacity battery. Installing a marginal-capacity battery is false economy. A marginal battery can strain the alternator by making it charge harder—and charge more often—in order to keep the battery up.

Weak or dead batteries kill more alternators than you realize. Experts tell us that most alternators just aren't designed to charge full-bore for extended periods of time. Sure, we've all had to jump-start cars in sub-zero weather and rely on the alternator to charge the battery because a tow truck, a free bay, or a free battery charger wasn't available at the time. You may get away with this some of the time, but you won't get away with it every time. If you—or the customer—insist on letting the alternator do all the work in these situations, you're going to fry an alternator! And if you don't cook the alternator right then and there, you'll probably *shorten* the life of that alternator. So wherever and whenever possible, avoid using the car's alternator as a substitute battery charger!

You say you aren't sure what the battery's rating is? If that's the case, applying a heavier load will

always give you a better idea of the battery's character than applying a lighter load will. I'm not encouraging you to flunk every battery you load test. But I'm not encouraging you to pass every one, either!

How a battery recovers from a load test can be a valuable clue. You'll need a good accurate digital voltmeter to analyze this "recovery." If your load tester doesn't have one, connect a digital voltmeter to the battery terminals alongside the load tester leads. Perform the routine load test. If the battery flunks the load test, watch what happens after you remove the load. Does the battery voltage climb back to 12.4 or more? If it does, it usually means the battery is working—but it lacks the capacity (CCAs) to do the job.

The Alternator

Different technicians interpret alternator output tests different ways. Some look for output that's within the proverbial 10 percent of the rated output. Some measure the car's total accessory load and then look for the alternator to exceed that load by five amps, 10 amps, or 10 percent.

How much output is really enough? Experts tell us that the total accessory load shouldn't exceed 75 percent of the alternator's peak output. The higher this percentage of output is, the harder the alternator has to work to keep the battery charged. On the better designed electrical systems, they tell us, the total accessory load is closer to 50 percent of alternator output than it is to 75 percent!

We've all seen vehicles that were factory-equipped with marginal-capacity alternators. We've all seen customers increase the load by adding accessories to the vehicle. When that accessory load tops 75 percent of alternator output, you and your customer may find that the most cost-effective way to solve the car's problems is to replace and/or *upgrade* the alternator!

Full-Field With Care

I've watched guys fry lots of expensive parts because they full-fielded charging systems carelessly. In this age of on-board computers and digital dash displays, be careful! Be sure you've turned off all the accessories inside the car. Then full-field the alternator at idle. The moment you see the voltage reading increase, stop!

Voltage Drop Tests

Remember that allowable voltage drops vary according to the number of connections in the circuit and the amount of current flowing through that circuit. However, most technicians demand go/no-go limits for everything they test. Although I prefer zero voltage drop, I suggest the 0.3-0.4 volt limits here only as working reference points.

Charging system voltage drops can cause everything from undercharging to overcharging to poor electronic fuel injection performance. The myriad of connections, junction blocks, fusible links, and auxiliary grounds on today's cars just increases the opportunities for bad connections. So ignore the voltage drop checks at your own risk!

Alternator Ripple Patterns

I happen to prefer the dirty old analog scope for checking alternator ripple patterns. Over the years, manufacturers have developed various go/no-go lights, meters, scales, and indicators that interpret the ripple pattern for you. Experience has shown that some of these ripple-readers work better than others do. Let the buyer beware!

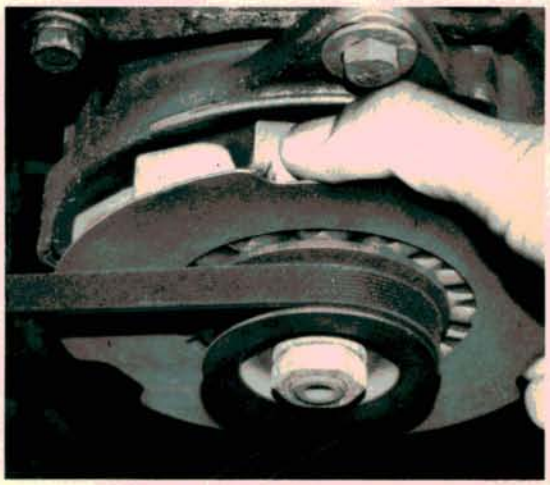
Conclusion

Let's say 1) the battery passes a load test; 2) there are no serious voltage drops; 3) the alternator produces enough output to handle the accessory load; 4) the ripple pattern is good; and 5) the voltage regulator's regulating at the proper voltage. These things tell you the entire system is healthy.

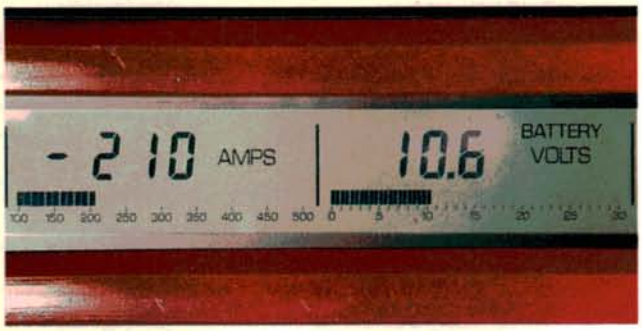
Today, most alternators have internally mounted voltage regulators. So what? So if the belt's tight and the unit's receiving its excitation voltage, low output or no output usually means you have to pull the alternator off the car.

I hope these tips help you solve some problems. In the meantime, good night and good luck!

—By Dan Marinucci



For a quick, convenient tension check, grab the pulley (where possible) and try to turn it by hand. If you can spin the pulley inside the belt, you know the belt's too loose. Also, watch the ammeter when you load test the alternator. If the output reading peaks and then suddenly drops off, you can bet the belt is loose!



Load-testing is the quickest, most accurate way to isolate a weak or under-capacity battery. Sure, hydrometer readings can be helpful. But only a load test tells you how that battery will perform when you put it back in the car. Load the battery to half its cold-cranking amp (CCA) rating for 15 seconds. If you don't know the CCA rating, a 190-200 amp load is usually a good starting point. A marginal battery not only makes the car harder to start, it also taxes the alternator.

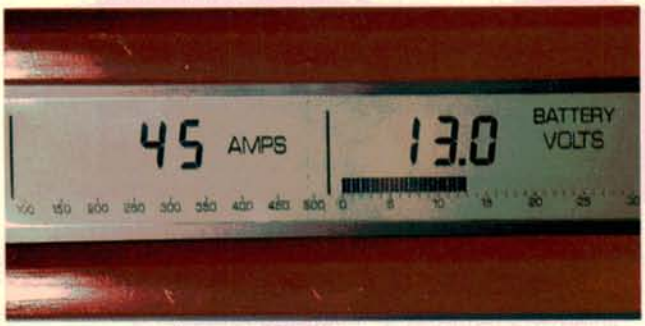
Because I've seen stupid voltage drops create so many bizarre charging system problems, I routinely voltage drop every system I test. Clip one voltmeter lead to the alternator output terminal, clip the other to the positive battery post. Load the alternator. A charging system can usually tolerate a 0.3-0.4 volt loss between the alternator and battery. If you measure a serious voltage drop here, trace the output wire until you find the cause.

Depending upon how a car is wired, it may be difficult to get the ammeter pickup around just the alternator output wire. Clip the pickup around the wires that merge into the positive battery terminal. Turn the key on, note the ignition draw. If it draws six amps, add six amps to the output reading when you load test the alternator.

Never, ever remove a battery cable while the engine's running. Removing a cable removes the normal electrical load from the charging system. Once you've removed the cable, the charging voltage could skyrocket to several *hundred* volts before the voltage regulator has a chance to shut down the alternator! That voltage can do incredible damage to the electrical system as it races around trying to find a good ground.

You need a bionic memory to remember which alternators need an external ground and where these grounds are on the car. If the charging system's misbehaving, don't worry about them unless the ground circuit flunks a voltage drop test. Clip one voltmeter lead onto the alternator case, clip the other lead onto the negative battery post. Then load the alternator. If the voltage drop's greater than about 0.3-0.4 volt, try grounding the alternator temporarily with a heavy jumper wire.

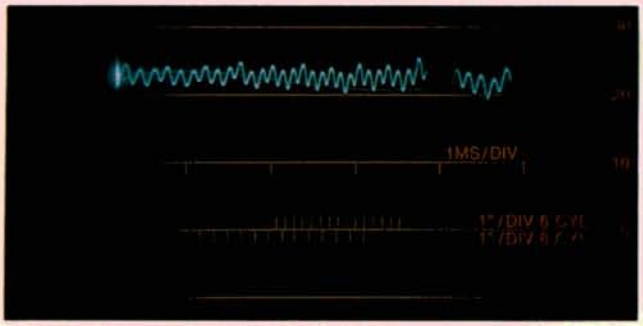
Sometimes you suspect that someone's installed an under-capacity alternator on the car. Okay, turn the key switch on (engine off) and turn on as many accessories as possible. Don't forget the air conditioner and the rear defroster! When the ammeter reading peaks, shut everything off. This total accessory drain shouldn't exceed 75 percent of the alternator's output. Here, I measured 38 amps total drain. That turned out to be exactly 75 percent of the alternator's 51-amp peak output!



Load-testing is the safest, most accurate way to check alternator output. Loading the battery lowers battery voltage. Until you lower the battery voltage, the voltage regulator won't tell the alternator to charge! Full-fielding an alternator (bypassing the regulator) and snapping the throttle is both an inaccurate and risky output test. This approach can create dangerously high voltages that damage on-board computers or burn up accessories on the car that you forgot to shut off!

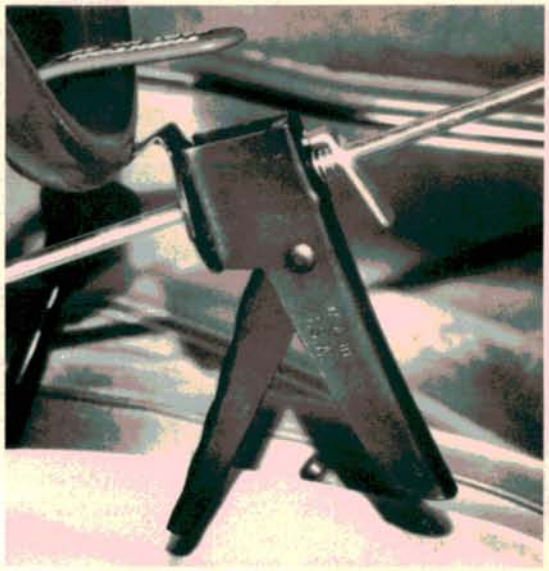
Ideally, you should check alternator output at a specified voltage and RPM. However, you can usually do a decent output test by running the engine at 2000-2500 RPM and loading the battery down to 12.0-12.5 volts. If your engine analyzer does a cranking compression test, it may help you get a quick-and-dirty output measurement. At the end of this test, shut the key off. Wait a moment. Then start the engine, floor the gas pedal, and watch the alternator output reading on the analyzer's ammeter.

In order to check the voltage regulator setting accurately, the system should be calm and stable. The battery must already be fully charged and any voltage drops should already be repaired. The regulator should be at operating temperature. If you don't have any specs handy for that system, run the engine at fast idle until the ammeter stabilizes at something less than 10 amps. When it stabilizes, the voltage reading you see is the regulator setting. Usually, 13.8-14.8 volts is okay.



Whenever you scope-test an alternator, always apply a load with your load tester or else turn on lots of accessories inside the car. Otherwise, you may miss a diode/stator problem. Remember that voltage drops within the charging system can easily upset the accuracy of your scope check—especially if you're reading the ripple pattern at the battery terminals. Do the charging system voltage drop checks I described elsewhere in this story *before* you connect the scope.

Want to safely and accurately read key-off drain with-a digital VOM? Then fabricate a resistor such as the one we showed you in the March *Import Service* (page 42). Or, purchase one from Interstate Batteries. After you connect this resistor in series with the negative cable, connect your VOM across the resistor. A 0.05-volt reading here means there's a 50 milliamp drain. Any drain less than 50 milliamps is okay.



If you don't have any other test specs available, check alternator output at 2000-2500 RPM. I needn't tell you that on many of these engines, you can't reach the throttle linkage easily unless you remove the air cleaner. When the engine's scalding hot and the throttle linkage is hard to reach, I use an adjustable prop such as this one to hold engine RPM steady for me.