Voltage Drop Testing

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Does your engine crank slowly or not at all, but when you test the battery and starter both are fine? What about an alternator that puts out its normal charging amperage but can't keep your battery fully charged?

An often overlooked cause of these kinds of problems is excessive resistance in the high amperage circuit. Loose, corroded or damaged battery cables or ground straps can choke off the normal flow of current in these circuits. And if the current can't get through, the starter won't have the muscle to crank the engine and the battery won't receive the amperage it needs to maintain a full charge.

Nasty looking battery terminals that are blooming with corrosion obviously need cleaning. But many times corrosion forms an almost invisible paper-thin barrier between the battery terminals and cables. To the naked eye, the terminals and cables look fine. But high resistance in the connections is preventing the high amp current from getting through.

The same goes for battery cables with ends that have been beaten or pried out of shape, or have had the ends replaced. If the clamp isn't making good contact with the battery terminal all the way around as well as its own cable, the cable may have too much resistance and restrict the flow of current. The same goes for ground straps that have loose or corroded end terminals, or make poor contact with the engine or body.

Cranking problems can also be caused by undersized replacement battery cables. A wire's ability to pass current depends on the gauge size of the wire. The fatter the wire, the more current it can safely handle. Some cheap replacement battery cables use smaller gauge wire, which may be camouflaged with thicker insulation to make it appear to be the same size as the original cable. But the cable doesn't have the capacity to handle the current.

It doesn't take much of an increase in resistance to cause trouble. Let's say a 120 amp alternator operates in a circuit that has a normal resistance of 0.11 ohms. If that resistance were increased to 0.17 ohms because of a bad wiring connection, the alternator's maximum output would be limited to 80 amps. In other words, an increase of only 0.06 ohms (almost nothing!) would reduce the alternator's maximum output by almost a third! Under light load, the drop in charging output might not even be noticeable. But in a high load situation, the alternator wouldn't be able to keep up.

CHECKING ELECTRICAL CONNECTIONS

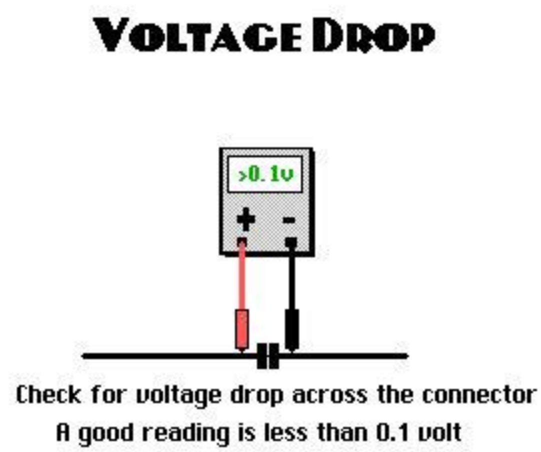
If you use an ohmmeter to measure across a heavily corroded battery cable or ground strap connection, or one with only a few strands of wire that make contact with the end clamp or terminal, the connection may read good because all you're measuring is continuity -- not the ability to handle a high amp current load. The connection may pass a small current, but when a heavy load is applied there may not be enough contact to pass the extra current.

So how do you find these kinds of problems? You do a voltage drop test.

VOLTAGE DROP TEST

A voltage drop test is the only effective way to find excessive resistance in high amperage circuits. It's a quick and easy test that doesn't require any disassembly and will quickly show you whether or not you've got a good connection or a bad one.

To do a voltage drop test, you create a load in the circuit that's being tested. Then you use a digital volt meter (DVM) to measure the voltage drop across the live connection while it is under the load. Voltage always follows the path of least resistance, so if the circuit or connection being tested has too much resistance some of the voltage will flow through the DVM and create a voltage reading.



If a connection is good, you should find little or no voltage drop and see less than 0.4 volts for most connections, and ideally less than 0.1 volts. But if you find more than a few tenths of a voltage drop across a connection, it indicates excessive resistance and a need for cleaning or repair.

ELECTRICAL CHECKS ON THE STARTER CIRCUIT

To check the starter circuit for excessive resistance, you need to measure the voltage drop at the battery, battery cable connections and starter while the engine is being cranked.

The first check is "available battery voltage." For the starter to crank at normal speed, the battery must be at least 75% charged (12.4 volts or higher). Low battery voltage can not only affect the starter but every other electrical system in the vehicle.

A. Set your DVM to the 20 volt scale, then connect meter positive (+) lead to battery positive (+) post (not the clamp or cable), and the meter negative (-) lead to battery negative (-) post.

B. Disable the engine so it will not start when it is cranked. (Ground the ignition coil wire, or disable the ignition circuit or fuel pump relay.) Limit cranking time to 15 seconds or less.

C. While cranking the engine, record the volt reading on the DVM. D. Next, connect your meter positive (+) lead to the battery terminal stud on the starter, and the meter negative (-) lead to the starter housing.

E. While cranking the engine, record the volt reading.

F. Compare the two voltage readings. If both are the same, there are no excessive voltage drops on the positive feed side.

G. If available voltage at the starter is not within one (1) volt of battery voltage, there is excessive voltage drop in the circuit.

The next test is for voltage drop on the positive side of the starter circuit.

A. Make sure the battery is fully charged.

B. Disable ignition.

C. Set DVM on 2 volt scale.

D. Connect meter positive (+) lead to positive (+) battery post, and the meter negative (-) lead to the battery terminal stud on the starter. While cranking the engine, record the voltage reading.

The maximum allowable voltage drop including the solenoid or external relay in the starter circuit should be 0.6 volts or less.

If you find more than a 0.6 volt drop in the starter circuit, you can isolate the bad connection by using the following voltage drop tests.

* Check the positive battery post and cable connection by measuring the voltage drop between the two while cranking the engine. Connect the meter positive lead to the battery post and the meter negative lead to the cable clamp. A good post/cable connection should have zero voltage drop.

* Check the positive battery cable by measuring the voltage drop end to end while cranking the engine. Connect the meter positive lead to the clamp on the positive battery cable, and the meter negative lead to the end of the cable at the starter. Crank the engine and note the voltage reading. A good cable should have a voltage drop of 0.2 volts or less.

* To check the starter solenoid or relay connections, connect the meter positive lead to positive battery terminal on the solenoid or relay, and the meter negative lead to the starter motor terminal. Crank the engine and note the reading. A good connection should have a voltage drop of 0.2 volts or less.

Next, you need to check the negative side of the starter circuit. To check the entire circuit, connect the meter positive lead to a clean spot on the starter motor case and the meter negative lead to the negative battery post. Crank the engine and note the reading. The voltage drop on the negative side should be 0.3 volts or less.

If the voltage drop is too high, set your DVM to the 2 volt scale and start checking each connection on the negative side to find the bad connection or cable. Use the DVM leads to check across each connection while cranking the engine as before.

Check the negative battery post/ground cable connection (should be zero voltage drop).

Check the negative ground cable from the battery to the engine (should be 0.2 volts or less).

Check between the negative battery post and starter housing (should be 0.3 volts or less).

Check between the engine block and starter housing (should be 0.10 volts or less).

ELECTRICAL CHECKS ON THE CHARGING CIRCUIT

To check the alternator connections on the positive side for excessive resistance:

A. Set DVM on 2 volt DC scale.

B. Connect the meter positive lead to the alternator output stud (B+ terminal).

C. Connect the meter negative lead to the positive (+) battery post.

D. With the engine running at 1,800 to 2,000 rpm with all lights and accessories on (except the rear electric defroster), check the voltage drop reading. It should be 0.5 volts or less. If higher, the connections between the alternator output stud and battery need to be cleaned. Also, look for loose connections or undersized cables.

To check the alternator connections on the negative side for excessive resistance:

A. Set DVM on 2 volt DC scale.

B. Connect meter negative lead to alternator case.

C. Connect meter positive lead to battery negative (-) post.

D. With engine running at 1,800 to 2,000 rpm with all lights and accessories on (except rear defogger), check the voltage drop reading. On the negative side, it should be 0.2 volts or less. If excessive, the connections need cleaning or the negative cable needs to be replaced. Some alternators are mounted in rubber bushings and have a separate ground strap. If so equipped, be sure to check the voltage drop across this strap, too.

VOLTAGE DROP TESTING CAN ALSO BE USED TO DETECT CURRENTS IN CIRCUITS

When current flows through a circuit, it creates heat. And heat increases resistance. A voltage drop test can be used to detect current flowing in a circuit by measuring voltage drop across the fuse that protects that circuit. This is a handy method for finding key-off current loads that may be draining the battery.

With the key off, connect the two voltmeter leads to the opposite sides of each fuse in the fuse box or power center. If no current is flowing through a circuit, the voltage drop reading should be zero. If you get a reading (say a few tenths of a volt or more), it indicates current is still flowing in the circuit. This may be a normal load to maintain the memory in a module, or it may indicate the module is not going into "sleep mode" or a low power standby mode after the ignition has been turned off.

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