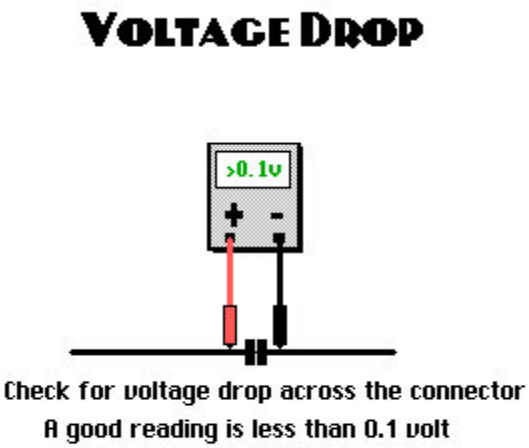
Voltage Drop Testing

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.

Battery Testing

The only way to know if your battery is GOOD or BAD is to test it. Many auto parts stores will test your battery for free. If your vehicle is drivable or you can get it going with a jump start, drive to a nearby auto parts store that offers free testing and have them test your battery and charging system. If you can't get your car started, remove the battery and get a friend to give you a ride to the auto parts store so you can have the battery tested. Many repair shops will also test your battery and charging system, but they usually charge a fee for this service (some will test your battery for free or offer to apply their diagnostic fee towards the cost of repair).

CAUTION: *Conventional wet cell car batteries are filled with a mixture of water and sulfuric acid. Wear gloves and handle the battery with care so no liquid spills on your skin or clothing. Battery acid can cause severe burns. If a spill does occur, wash with plenty of water and neutralize the acid by applying baking soda.*

There are essentially two ways to test a battery. The "old fashioned way" is to use a Load Tester. For accurate results with a load tester, the battery must first be recharged before it is tested. The tester applies a calibrated load to the battery (typically half the battery cold cranking amp [CCA] capacity or three times its amp/hour rating). While the load is applied, the tester monitors battery voltage. If the battery voltage drops below 9.6 volts during the test, the

battery is BAD and needs to be replaced. If the voltage remains about 9.6 volts, the battery is GOOD and can be returned to service.

The other (and must faster) method for testing your battery is to use an electronic "conductance" tester like the one shown here. A conductance tester sends a alternating frequency signal through the battery to determine the condition of the cell plates inside the battery. As a battery ages, its internal conductance declines. Shorts, opens and other cell defects also reduce conductance, so measuring conductance gives an accurate indication of battery condition. The best feature of this type of test is that the battery does NOT have to be recharged prior to testing. Most conductance testers will give an accurate reading even if the battery is almost dead.

Some electronic battery testers can also analyze the battery's CCA capacity, which can be used to estimate the battery's remaining service life. Some testers can also measure the amps drawn by the starter while cranking the engine, and analyze charging system output under load once the engine is running. Some testers even provide a built-in voltmeter for checking connections.

Bad Battery Connections

If an electronic tester can calculate the battery/s CCA rating, it can also be used to diagnose bad ground connections. First the CCA capacity is tested at the battery terminal connections, then again using a ground point on the engine or elsewhere. More than a 25 percent difference in the CCA readings between the two tests indicates a bad ground connection.

Diagnostic Tip: You also can use a digital voltmeter to check for voltage drop across all circuit connections, too. Ideally, you should see less than 0.1 volt drop across a good connection. More than 0.4 volts drop indicates high resistance and a dirty or loose connection.