

Voltage Drops - OD and Other Circuits

By Richard Ewald

I had a couple of people write and ask me to post the procedure to the list, so I will.

Before I get into the specifics of the OD circuit, I am going to explain how an ohmmeter works, the problem with using an ohmmeter to find resistance, why this is so, a little on ohms law, the advantage of testing the circuit dynamically, how do the test, how to interpret the results and finally how to use the test to isolate problems. (Sorry if this seems long and ambling, but you can take the instructor out of the classroom, but you can't take the classroom out of the instructor, so grab a beverage and let's go)

How an ohmmeter works:

An ohmmeter puts a very small voltage (about .6-.75 Volts at 0. no amps) out on one lead, and measures what comes back on the other lead. The circuitry then calculates the resistance based on the return voltage. This is fine for large resistances, but does not work very well for small resistances in automotive applications.

The problem with an ohmmeter to find a resistance problem:

Consider your basic LBC starter motor circuit + cable--> Battery --> - cable (long bastard under the car)--> solenoid -->cable -->starter --> engine ground strap (assuming a + ground car)

One day after a spirited drive the car won't start.

You use an ohmmeter to check the continuity on the battery cables, all show good.

So:

- **You replace the battery. No joy.**
- **You replace the starter. No joy.**
- **You replace the solenoid. No joy.**
- **You replace the ground cable and ground strap even though they test good. No joy.**

You have now replaced every part in the starting circuit except for that long bastard cable under the car. So you climb under the car to get it out so that you can get one made and you find that on your last drive you hit a rock that somehow hit the cable and severed 99 out of the 100 strands of copper inside the negative cable. There is only one single solitary strand of wire connecting the two parts of the cable.

"But I tested it, and it tested good" you cry. Yup you did, and yes it did. The problem is the ohmmeter is a static test at 0.no amps. As long as that one last strand is intact, the cable shows good with an ohmmeter. The problem is that the starter motor requires 100 amps or more to start your LBC. There is no way in hell you can pump 100 A though that one strand. What you need is a dynamic test that tests the circuit under actual operating conditions.

A bit about Ohm's law.

$E=IR$ or if your prefer $V= A \times R$. Think of Ohm's law as a teeter totter. For any given voltage if resistance goes up, amperage goes down. If resistance goes down amperage goes up. If the resistance remains constant and the current draw goes up, the voltage drop goes up. So when subjected to a 100A draw the resistance of the battery cable caused a huge voltage drop which caused the car not to start. (I actually had this exact problem on a car that got towed in once, there were 15 strands out of a 200 or so, the car did not start.)

Let's do a bit of math:

Example 1 $100\text{A} \times .005 \text{ ohm resistance in cable} = .5 \text{ volt drop in the cable not bad.}$

Example 2 $100\text{A} \times .05 \text{ ohm resistance in cable} = 5 \text{ volt drop, car probably won't start.}$

A dynamic test:

If there was only a way to test a circuit dynamically you cry. Ah grasshopper there is. Rather than measure the resistance and try and guess the effect on a circuit, how about we just measure the voltage lost due to the resistance while the circuit is in operation. We will then know instantly if there is a problem. Even better if we go and fix something we can retest at will and see the effect of our repairs.

How to do the test:

What you will need:

Your basic DVOM (Digital Volt Ohm Meter) It can be a \$20 special from Radio Shack or Harbor Freight or a Fluke 88 it does not matter as long as it will read DC voltage to .01Volts.

Depending on the length of circuit some jumper wires with alligator clips.

"I got that", you say, "how do I do the test?"

OK let's go back to our basic LBC starter circuit

+ cable--> Battery --> - cable (long bastard under the car)-->

solenoid -->cable -->starter --> engine ground strap (assuming a + ground car)

We want to test the negative cable circuit Here is how:

- 1. Connect one lead from the DVOM to the negative battery post.**
- 2. Connect the other DVOM lead (using jumper wires as needed) to the battery cable lead on the starter.**
- 3. Set the DVOM to read DC voltage**
(now this next step is critical, write this down, highlight it if you print these instructions but for God's sake don't forget this step)
- 4. Energize the circuit, in this case crank the car. The reading will fluctuate a bit and after a few seconds settle down to one value. This value is your reading. Write it down**

Please note you are not disconnecting anything, you are adding the voltmeter in parallel to the existing battery cable.

How do I interpret the results?

Just like golf a low score wins. In a perfect world all voltage drop readings would be zero, indicating no resistance in the circuit, but guess what, we don't live in that perfect world. You will always get some type of reading. The object is getting the number as low as possible.

Let's say you get a reading of 1 Volt. That means if you put 11 Volts into the cable at the battery (this is the voltage of a very healthy 12V battery while cranking) you will get 10 Volts out the other end as 1 Volts is being lost to resistance.

If I got less than 1 Volt drop between the battery and the starter I would probably be happy (particularly if you consider the length of that one cable). But for the sake of conversation let's say I get a reading of 3 Volts. This means that if I put 11 Volts into the cable I am only getting 8 Volts out the other end. This is starting to get real marginal and might leave me stranded. At this point I want to pin point the exact cause of the resistance.

How to isolate the problem:

Test the circuit in sections. In our LBC starter scenario you could test:

- **Battery post to battery cable clamp (a might hard with the OE cap style battery cable end I admit)**
- **Battery end of the cable to solenoid end of cable**
- **Across the solenoid itself (you could even get creative and first check cable end to cable end, and then come back and check solenoid stud to solenoid stud. If the second reading is less than the first one or both of the connections at the solenoid have resistance. If they are both the same, but high, it is a bad solenoid.)**
- **Cable from solenoid to stud sticking out of the starter.**

Don't forget that current must be flowing for each and every test. That means in this case you have to crank the car.

Let's say after all of these tests I find high voltage drops at the following points:

- **Battery post to cable end**
- **Across solenoid**
- **Solenoid to starter motor stud.**

At this point I would pull the connections apart, clean them with steel wool, apply dielectric grease and reassemble. When I was all done, I would retest. If the voltage drop was now acceptable I am done. If say the drop across the solenoid was excessive I would hit the catalog up for a new solenoid.

The trick here is to isolate the circuit into sections and test / repair/ retest / move to next problem until you have the voltage drop under control.

One last thing about Voltage drops

Don't forget two things:

- 1. You have to energize the circuit to get a proper reading.**
- 2. Don't forget the problem could be on the ground side of the circuit. You have to test both sides.**

Great now how do I fix my \$#^&*%\$# over drive?**

Based on the comment about flicking the switch several times to get the OD to operate, I am thinking there are some world class voltage drops in this circuit. If you don't have enough voltage, the solenoid won't function. If it were me I would test in the following order:

- 1. Battery to switch hot lead (again, circuit has to be energized, that is key on, trans in 3 or 4, OD switch on)**
- 2. Across switch (should be damn near zero)**
- 3. Switch to OD solenoid.**

I suspect that the OD switch has a BIG voltage drop. But any and all Lucas connectors in the harness are suspect. If you find a problem at a Lucas connector, you can:

- 1. Pull connector apart**
- 2. Clean bullet ends with steel wool**
- 3. Clean inside of connector with a small wire bottle brush (or go crazy and replace them)**
- 4. Apply dielectric tune up grease to the connector**
- 5. Reassemble**

A question from the group

>>"At this point I would pull the connections apart, clean them with steel wool, apply dielectric >>grease and reassemble"

Hi Rich,

I really want to thank you for your expertise and help in this area of black magic. But, I always thought that dielectric grease went on after assembly, to prevent moisture from getting into and corroding the contacts. If you put it on first - would you have any contact at all?

Richard Mayor

Assuming we are talking about a regular tin to tin connection and not gold or something else exotic, you would apply the grease before.

Here is the reasoning:

Tin is conductive, tin oxide is not conductive. When exposed to air, the surface of tin rapidly becomes tin oxide. A proper connection when connected will scrape the tin oxide off of both the male and female and leave direct tin to tin contact. There is a risk with tin connectors. If there are small movements due to heat or vibration the male and female connectors can move very slightly in relation to each other and a layer of tin oxide can then build up between the two parts of the connector. This can cause an apparent open circuit even though the connector is connected. Often just unplugging and replugging the connector can fix this problem temporarily. To prevent this from happening you can do three things:

Move connectors to areas of low vibration / heat strap

connectors so the parts cannot move in relation to each other.

Use dielectric grease to keep the oxygen out. On modern cars with water tight connectors the dielectric grease is applied before the connector is assembled otherwise there would be no way to get in there afterward. A good connector will scrape the dielectric grease and the tin oxide out of the way to ensure proper tin to tin contact. (Note to anyone working on a modern car, do not use dielectric grease on O2 sensor connections, it will poison the O2 sensor.)

The concern here is not so much moisture as it is oxygen. A side benefit of dielectric grease is it will help moisture out also. Double win!

I hope this answers your question.

Rick

I did all the voltage drops, corrected the problems, but my OD/starter/radio/whatever still does not work, any other suggestions?

Yes, one.

Push the LBC out of the garage. With chalk draw a pentagram on the garage floor large enough to park your car on. Push the car back over the pentagram. Place a candle at each corner of the pentagram, walk counterclockwise around the car 4 times* while chanting "Oh great dark lord protect you noble minion and show me the light to your mighty power."

At this point drink a Guinness and then repeat your tests in the morning.

For particularly troublesome problems it may require consumption of additional bottles of Guinness to isolate and repair the problem.



***Northern Hemisphere only, clockwise in the Southern Hemisphere**