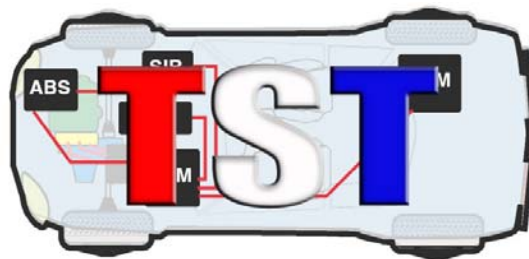


October 2009



Technicians Service Training

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Mike Bowdish

Editor

Jerry "G" Truglia

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Diagnosing Electrical Problems on Today's Motor Vehicles EXCERPTS

Because none of us were born electricians, yet we end up having to buy the tools that they use, TST has been doing some specific focus on electrical training. We bet you picked up some new things along the way that made the investments in your tools worth it.

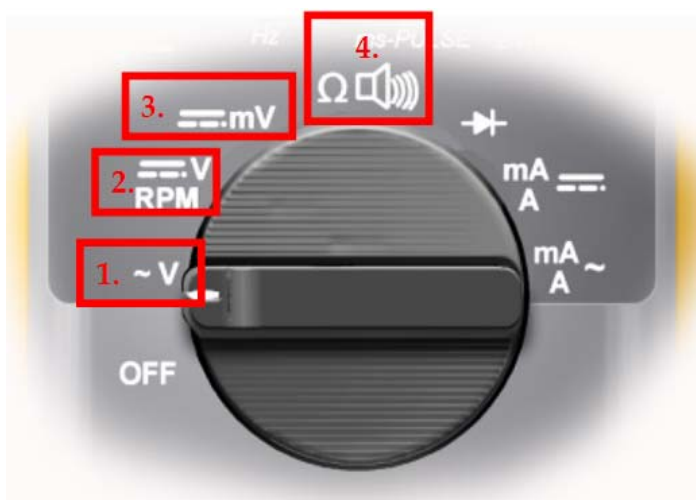
In continuing this emphasis, we'll be including some excerpts of an upcoming new book by TST President G Truglia.

METERS

They have many names (Digital MultiMeter, DMM; Digital Volt-Ohm meter, DVOM) but they measure the same

things. We highlight only the ones you'll likely use:

1. Volts AC – Measures AC voltage, good for detecting excess AC ripple.
2. Volts DC and rpm – Used with the majority of our voltage tests.
3. Millivolts DC – Same as Volts DC, but measures only mV – makes it easier to detect voltage drops.
4. Ohms – Used to check continuity. **(Con't on page 3)**



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Currently there are **TST chapters in Connecticut, Massachusetts, New Jersey, New York** and membership continues to grow. For more information you can call

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What is TST?

TST is a group of dedicated technicians and instructors committed to the continuing education of our fellow technicians. We provide once a month training seminars to technicians at a reasonable price. TST brings our members nationally known instructors and state of the art training.

Our Goal & Mission Statement

- *Keep our fellow technicians up to date with the latest technology.*
- *Provide training seminars for a reasonable price.*
- *Deliver information that the technician can use now.*
- *Keep technicians informed of information affecting our industry.*
- *Increase consumer awareness of what a good technician is.*

Why join TST?

TST membership includes special pricing on once a month week-day night seminars and the occasional full Saturday seminar. With a **\$75.00 yearly membership, the monthly seminars are only \$65.00.** **TST classes are NOT sales or product seminars.** The instructors that TST brings in are all “hands-on” industry experts with up to date, cutting edge knowledge that you can use in your shop the next day. That’s 65 dollars for a seminar in which you are able to learn something useful, for fixing those tough jobs that we all see on a regular basis. Our instructors are masters at making the complex understandable. Membership also includes a Monthly Newsletter full of real world technical articles, diagnostic case studies, and solutions to the kinds of problems you see in your bays each week.

The following are some of TST’s regular instructors:

Bernie Thompson of ATS www.ATSnrm.com

John Thornton formerly of Team AVI

Wayne Colonna of ATSG www.ATSGmiami.com

Jorge Menchu the “Labscope Guru,” owner of AES

www.aeswave.com/aboutaes.htm

John Anello Auto Tech On Wheels www.autotechonwheels.com

Luis Ruiz Mechanic’s Education Association

www.meatraining.com

Jerry “G” Truglia National Instructor & owner of A.T.T.S. Inc.

www.attstraining.com

Diagnosing Electrical Problems (con't from p. 1)

Using Amps (A)

Using your meter, you will be using amps mode to check solenoids, jump circuits, or check for parasitic draw (shown to the right). You should use an amp clamp, but we will cover that separately.



Here are some A (Amp) mode pointers:

- On cars, you'll never really need to use the mA jack. Put some electrical tape over it, because all you can do is blow a costly fuse by mistake. It can only handle 400 milliamps/0.4 A.
- Most meters will blow an internal fuse that you can't get at your local electronic store if you measure anything more than 10 A. If you are going to measure anything that requires more than a few A, like starter current, you need to use an amp clamp.
- Just to be on the safe side, always connect a 10 A fuse attached to a fuse harness to your red test lead (in series) so if there are too much A the fuse in the harness will blow, and not the one in the meter. The meter's fuse is expensive, so this will save you time and money.
- When you switch to A mode, always make sure to follow these steps in order to avoid blowing a fuse.
 - By default, your leads should always be plugged into the COM and V/mV ports
 - Switch your meter to A mode.
 - Plug your red lead in the A, not the mA, port.
 - Attach a 10 A fuse in series with your red lead.

When you are done, pull out the red lead and put back in the V/mV port. All these rules sound silly, but in the real world we end one job only to start another, and when we pull out the meter again we forget that the red lead is still in the A port. So, we can blow a fuse by not habitually following the steps above. (Con't on page 4)

Diagnosing Electrical Problems (con't from p. 3)

Key-Off Battery Drains with Amp Clamp

So, how can we tell if we have a normal Key-Off Battery Drain we can attribute to KAM or if we have a parasitic draw? Here's the **ONLY** recommended method for finding out.

We need a **low-amp probe**. Connect it to your meter in *mV* mode or scope. Every 10 *mV* on the meter's display equals 1 *mA* (that's what 100mV=1 Amp translates into). Connect the probe around all the negative cables with the clamp totally closed. If you measure more than 75 *mV* (and therefore 750 *mA* or .75 A, they're both the same thing), it's time to look for a parasitic draw.



The typical parasitic draw culprits are anything that stays on when it is not supposed to. A glove box or trunk light might be staying on, because its switch is not adjusted properly. There might be a short circuit or a damaged microprocessor consuming energy.

Note: Some electric components stay on for up to a few hours before entering sleep mode. This might make your initial Key-Off Battery Drain measurements high.

Measuring Parasitic Draws Over a Prolonged Period of Time

Often, we have intermittent parasitic draws or there are components that take a while to go to sleep mode, so we're unsure there is truly a parasitic draw or not. What do we do? With a graphing meter or scope and an amp clamp, put them in "movie mode" and record the measured voltage (which we convert to amps) over a few hours.

Hours later, we might find that parasitic draw is not a problem, as all the electrical components hours later enter sleep mode. We may have just an ordinary a KAM-related key-off battery drain. To the contrary, hours later you might find that there is indeed a persistent parasitic draw. Meters are great, but sometimes we simply need a scope!

(Con't on page 7)

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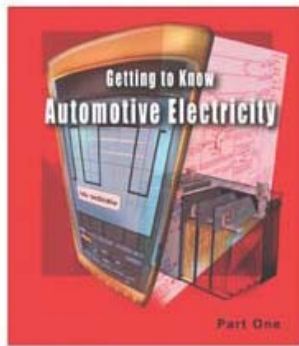
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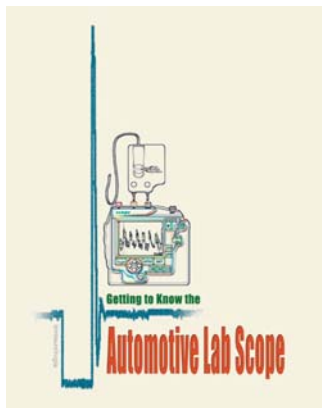
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Diagnosing Electrical Problems (con't from p. 4)

Voltage Drop Tests

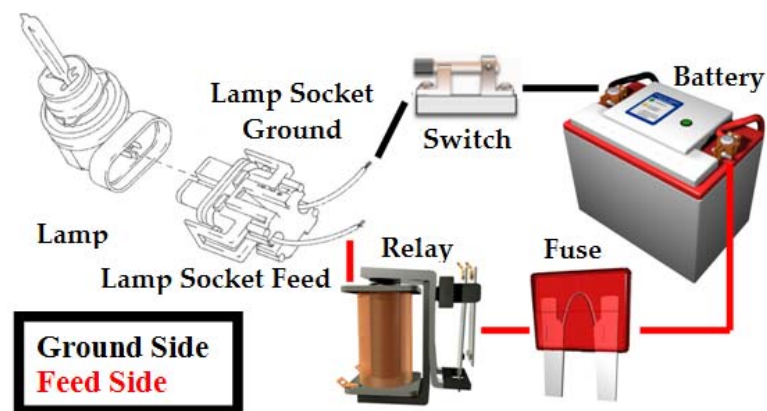
Now, not every electrical problem you run into is the result of an open in the circuit.

Let's say a car pulls in with one headlamp that's bright and the other one dim. Just replace the bulb, right? WRONG!

We are going to have to remember some of the testing techniques we just learned and add a new one to our repertoire: the voltage drop test.

Essentially, a voltage-drop test measures how much resistance electricity runs into as it passes through a load—here, a headlight. Ideally, a load like a headlight will permit zero volts to pass through it. In reality, nothing is perfect and a reading of up to 200 mV is permissible. If you are dealing with a computer component, 100 mV or less is permissible.

Here's an extremely simplified lamp circuit diagram that we will be working with:



Voltage Drop Tests

Bad Reading:

More than 200mV

Bad Reading for **Com-**
puter Electronics:

More than 100mV

(Con't on page 9)

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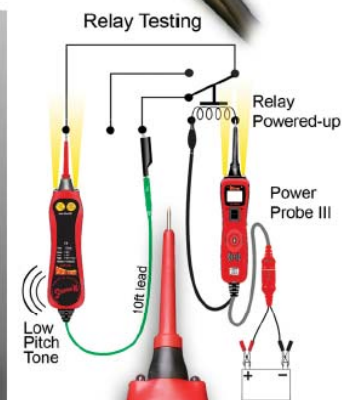


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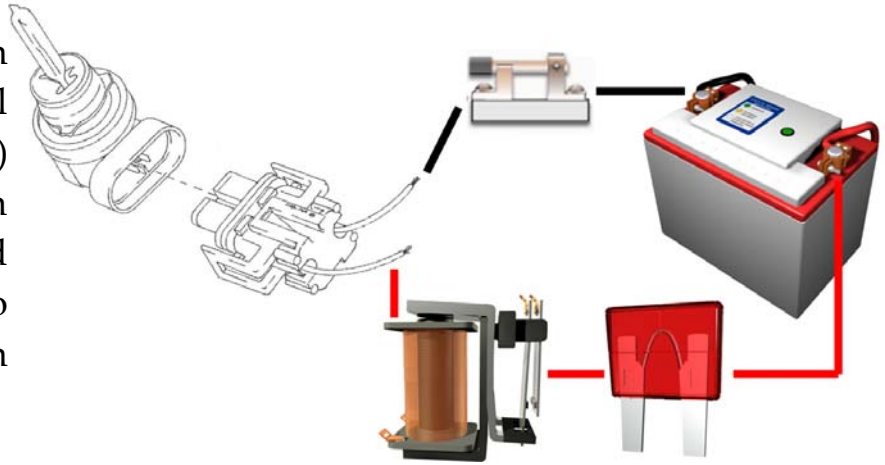
The Perfect Compliment to the Power Probe III

Diagnosing Electrical Problems (con't from page 7)

Voltage Drop Tests Continued

Isolate where the problem is in the circuit by doing a quick *voltage drop test*.

All the test does is tell us which side of the circuit has electrical resistance (hence, "voltage drop") that prevents electricity from flowing: the feed or the ground side. Once we know where to look, it makes everything much easier!



So, to find out if we have a good voltage drop on the feed side, all we do is put our red lead on the positive terminal of the battery and our black lead on the feed (positive) side of the lamp. Positive to positive. To find out if I have a voltage drop on the ground (negative) side, we put our black lead on the negative battery terminal and the red lead on the ground side of the lamp. Negative to negative.

Positive to positive, negative to negative—that's a voltage drop test!

Voltage Drop Test On the Feed Side

Let's say our voltage drop test shows *a* voltage drop on the feed side. Here's how we find it.

- Check voltage at the load by putting the black lead on the ground side of the battery and put the red lead on the feed side of the lamp (load) You should have a 12.6 V reading, because unless electricity runs into resistance, it should not drop until it gets consumed by a load. If this is not the case, this means you have a voltage drop (resistance) occurring on the feed side
 - While you are at it, take your red lead and now touch the ground side of the lamp socket (load). With your meter switched to DC mV, you should have 200 mV or less. If not, we have more problems (covered on the next page)
- Let's switch back to V DC and bring the red lead to the fuse. You should have 12.6 V.
 - If not, your problem is between the battery's positive (+) terminal and the fuse. corrosion, loose connections, and obvious damage to the wire are the likely culprits creating resistance that decrease electric flow.

(Con't on p. 11)

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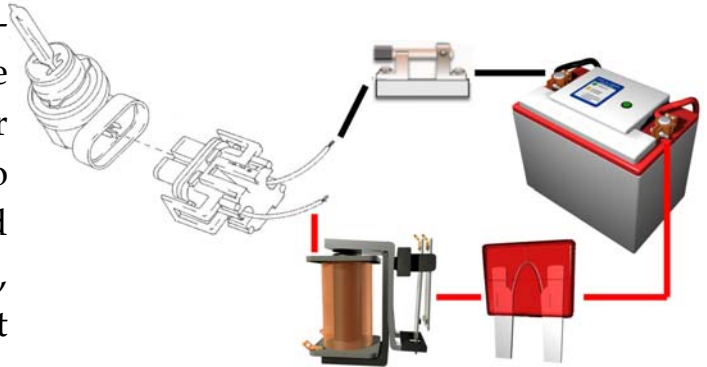
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Thank you,
G Truglia

Diagnosing Electrical Problems (con't from page 9)

Feed Side Voltage Drop Tests CONTINUED

- Assuming everything leading up to and including the fuse is good, take your black lead and connect it to the fuse and take your red lead to the relay. Again, voltage should be about 12.6.

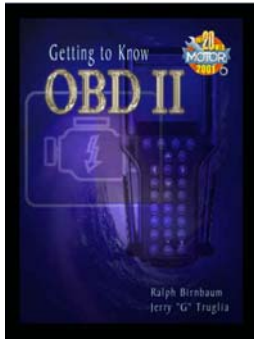


- Same rules in number three apply. If you're not reading 12.6 V, the problem is located where you last good reading was (the fuse) and the bad one (the relay). Check out the likely culprits.
- Lastly, check between the relay and the lamp. If you did not find the problem before, one of the likely culprits is to blame now unless the problem is on the ground side.

Voltage Drop Test on the Ground Side

You are not done yet! Make sure that there are no problems on the ground side! We need to make sure that we are not victim to the likely culprits again.

- On mV DC mode with the black lead on the negative side of the battery, and the red lead on the ground side of the lamp (load); do a voltage drop test again.
- A reading of 200 mV or less means the ground side is good and we should look **on the feed side or the load itself**. The lamp is consuming the voltage.
- A reading where *both the ground AND feed sides have equal voltage* with your black lead on the negative (-) battery terminal and the red lead probing both sides of the load means you have an **open on the ground side ALWAYS**.
- The electricity will run right through the lamp at the same voltage until it hits the open in the circuit.
- If you have an open on the feed side, the lamp will show zero volts on both sides—the part of the wire before the open with the same voltage all the way through, and the other part after the open with 0 V. **(C't on page 12)**



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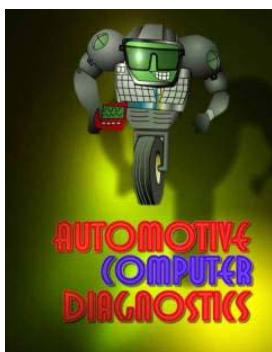


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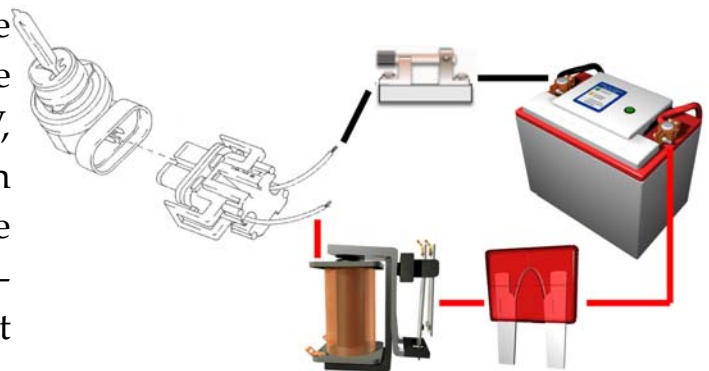
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Diagnosing Electrical Problems... (con't from page 11)

Voltage Drop Test on the Ground Side CONTINUED

A reading on the ground side of the lamp, like 900 mV, means we have high resistance on the ground side of the circuit. While there isn't an open, not enough voltage is running its way through the ground side of the circuit.



- If we have high resistance on the ground side or an open, look out for the likely culprits.

-Trace between the different components on the ground side just like we did testing the feed side.

-Here, all we have is a switch. So, we keep our black lead on the battery's negative terminal and put the red lead on the ground side of the switch, looking for 12.6 V—any less means there's resistance between the leads.

-If there was another component between the switch and the lamp, we place our red lead on the ground side of that component looking for 12.6 V.

-Let's say we found our problem...Let's double check by jumping the ground side of the circuit.

-Switch your meter onto A or use a jumper wire to connect from the negative (-) terminal of the battery and the ground side of the lamp (load). If the lamp lights up perfectly now, we know all we need to do is deal with those likely culprits on the ground side!

- If jumping it does not work, make sure to scratch off a good connection on the negative (-) side of the battery or any good ground and put a T-Pin into the ground side of the lamp (load). The lamp will light well now, and all you will have to worry about is bad connections.

(Con't on page 13)

Diagnosing Electrical Problems... (con't from page 12)

Voltage Drop Test on the Ground Side CONTINUED

- To isolate where the connection problems are and where the likely culprits are lurking, jumper between the lamp and the switch, and the switch and the lamp.
 - If jumping between the lamp and the switch fixes the problem, then we know that's where the problem is.
 - If the same occurs between the switch and ground, then the problem is there.
 - If only jumping directly from the ground side of the lamp (load) and a good ground (i.e. negative (-) battery terminal) works, then the likely culprits are to blame in both parts of the circuit.
- If absolutely nothing is wrong with the circuit, check the voltage drop across the load!
 - If bad, jump the headlamp socket (load) itself. If it doesn't work, then the headlight socket (load) is to blame!

Whenever there is resistance in a circuit, the load (here, a lamp) cannot efficiently consume all the electricity, making the voltage drop above 200 mV and the voltage we measure between parts of the circuit below 12.6 V.

So, using the lamp example, if we check everything and cannot find a problem we will suspect the load itself. To test the load, we check its voltage.

All we do, speaking of the lamp, is put our red lead on the load's feed side and the black lead on the load's ground side. If your meter's reading is not equal to the battery's voltage, in our example 12.6 V, then the load itself is to blame.

Often, we are checking components with the car running, such as a fuel pump. We measure voltage at the load the same exact way, putting our leads on the ground and feed side of the load. Because the alternator is turning, our battery and system voltage will be about 13.5 to 15 V. Any decline from these values more than half a volt when checking voltage at the load means the fuel pump will run slower, reducing fuel pressure, hurting performance and storing a Diagnostic Trouble Code (DTC).



(Con't on page 14)

Diagnosing Electrical Problems (con't from page 13)

Voltage Drop Tests CONTINUED

We will be measuring about 12.6 V for most lights and relays (though they can be as high as 17 V). On new cars, most sensors run at 5 V.

If we run into a different voltage, we will need to consult a wiring diagram to verify how much voltage we *should* be looking for. After confirming our measurements do not meet specifications, we can safely assume that there is resistance in the circuit not permitting enough voltage to the load.

The more we practice and use voltage drop tests in the shop, the more all of this will become second nature to us. Remember, electricity is not our first nature, so don't feel bad! We'll learn!

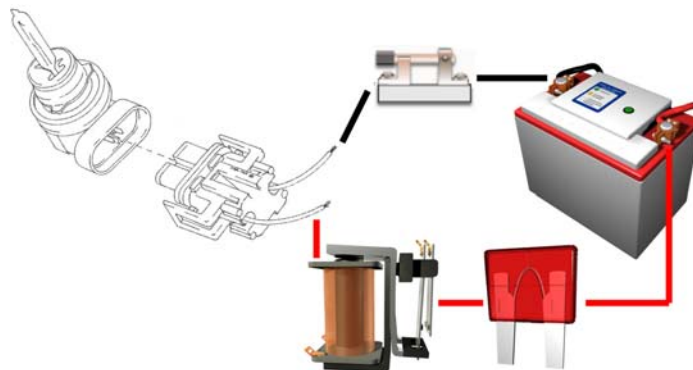
Quick Voltage Drop Tips:

In reality, as you get more familiar with electricity and know the theory like the back of your hand, you will take short cuts.

For example, after a visual inspection, you might assume that there has to be something wrong with the load itself. So, here are quick voltage drop tests:

1. Red lead on (-) battery terminal and black lead on ground side of load.

2. Black lead on (+) battery terminal and the red lead on feed side of load.



There is much more in this book, including the basics you need to know, essential tools and tests, batteries, alternators, starters, Power Probe usage, and Labscope waveform diagnostics. The book takes the tech that knows nothing about electricity and assists in the mastering of meter and then scope usage.

Article courtesy of G Truglia, President

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