Low ohms measurements you can trust

Application Note

Half an hour ago, a key piece of production equipment stopped dead in its tracks — and the pressure is on. You've managed to get the system to give you an error code, but you can't identify what in particular is wrong. You call the equipment vendor, and explain what you've found. The vendor says, "Well, that can mean a bad connection at one of 16 different points, or possibly a circuit board crack. Or, it could even be a bad RTD input. If we could send a tech out there with a low ohms instrument, we could identify the problem."

You smile. Clipped to your belt is a Fluke 87. Your smile widens, because you also have a Fluke 187. And you know either instrument will allow you to measure low ohms. After getting some instructions from the vendor, you can start making measurements. But, do you know how to take such measurements accurately?

To do the job right, you can't use just any DMM. Resolution is one reason why. Many models of DMM have a resolution of only 0.1 ohms — the Fluke 87 and 187 do 10 times better than that. But at this resolution, another factor comes into play: lead resistance — which typically adds 0.1 to 0.3 ohms to your reading. So, the meter needs fine resolution and it needs to somehow compensate for lead resistance — or the measurement will be grossly inaccurate. The Fluke 87 and 187 provide both the resolution and the means of compensating for lead resistance. Before we explain how to take accurate low ohms measurements with your 87 or 187, let's look more closely at why you might make such measurements in the first place.

- Connections. You can check the resistance across any connection, whether it's bolted, pressure-spliced, welded, or made via some other means. The higher the resistance, the sooner you can expect that connection to cause problems or simply fail outright. Checking a connection right after you make it allows you to ensure the new connection is good, before you move on to make the next connection — no hunting for a mysterious bad connection later. But you can also schedule these checks for predictive and preventive maintenance. Grounding systems, power distribution systems, controls, and process instrumentation systems all benefit from monitoring connection resistance so you can correct connection quality defects before a failure occurs.
- RTDs. Some processes rely on Resistive Temperature Devices (RTDs) for temperature inputs to the control system. The standard calibration procedure is to compare the RTD resistance to the expected resistance at a given temperature. This typically involves a lag bath set up on a calibration bench and rise/fall measurements at low, mid, and high temperature steps. And the right DMM is handy for this. But, what if you want to do a single-point check for troubleshooting in the field? Rather than pull the RTD out, you can measure it in place to see if its resistance agrees with the expected resistance — assuming you have a known, stable temperature.

- Low value resistors. Suppose you want to do a loop check on an RTD-input control system. The standard way to do this is to use a variable resistance source, such as a decade box. To know the precise value of this source, you need a DMM with lead compensation and low ohms resolution. Other circuits provide similar challenges, requiring similarly suitable meters. For example, some control systems use precision º ohm resistors, and electronic circuits often use even smaller resistors.
- Relay contacts. When relay contacts are closed, what's the resistance across the contacts? With enough resolution, your meter reading will tell you how clean the contacts are and how evenly they are mating. You can also test circuit breaker contacts this way. As contacts age, their surfaces pit and corrode — resistance goes up resulting in melted contacts.
- Circuit boards. Following a circuit trace with a low-ohms measurement will tell you the condition of that trace. Suppose you measure a trace with a meter that doesn't read low ohms, and you see zero ohms. You might be reading across a carbon track that forms a bridge across a crack in a trace — but your meter is blind to it. The only way to know if a trace is sound is to do a low ohms measurement across it.

Making the measurements

This is actually pretty easy. Essentially, you measure the resistance of the test leads, then subtract that value from the actual measurement. You could do this with paper and pencil, if your meter doesn't have relative mode. But, then you would be working with the display resolution rather than the internal resolution — you'd get the kind of "rounding errors" people encounter when manually using results from calculators or spreadsheets. Plus, who really has the patience to do those calculations for every measurement? The easiest and most reliable way is to let the meter do the job.

First, set the meter to the Ohms mode. Next using the Fluke 87, push the yellow button (far left side) for 1 or 2 seconds (depending on the meter vintage) to place the meter in the high-resolution mode. The 187 will go there automatically. You now have 0.01 ohms of resolution on the 400-ohm range.

Next, short the test leads directly together, making sure to get solid contact. Don't try to short them, by, for example, clipping one to an enclosure bolt and the other to the enclosure frame — remember, we are measuring low ohms now. When the leads are shorted, the meter will display the resistance of the leads. At this point, press the Relative (REL) button. You'll see the display go to zero, and You'll also see a small triangle appear off to the left of the scale.

You can now make an accurate low ohms measurement, with those test leads "zeroed out." When you're done, short them together again and press the Relative button. You will see the lead resistance again. If you are making many critical measurements, short the leads between measurements and check that the display reads zero. There's one other thing you should do, to ensure accurate critical measurements. The Fluke 87 has an internal 1K precision resistor. Test your meter against this by connecting a test lead from the V-ohms jack to the microA/A jack while the meter is in Ohms mode. Don't forget to zero out that test lead, first — simply put the lead between the v-ohms and COM jacks and press the Relative button.

Keep in mind that dirt, oil, solder, flux, and corrosion that you can't even see can alter your resistance reading. Therefore, make sure you have solid contact between clean surfaces. If, for example, you are checking a grounding connection, you aren't interested in measuring the surface corrosion of the wires going into the connection. You want to be on bare, clean wire with your probes.

With your Fluke 87 or 187, you can easily make low ohms measurements while making sure that your leads Don't get in the way.

Fluke Corporation
PO Box 9090, Everett, WA USA 98206

Fluke Europe B.V.
PO Box 1186, 5602 BD
Eindhoven, The Netherlands

For more information call:
In the U.S.A. (800) 443-5853 or
Fax (425) 446-5116
In Europe/M-East/Africa (31 40) 2 675 200 or
Fax (31 40) 2 675 222
In Canada (800) 36-FLUKE or
Fax (905) 890-6866
From other countries +1 (425) 446-5500 or
Fax +1 (425) 446-5116
Web access: http://www.fluke.com

Printed in U.S.A. 3/2004 2140111 A-ENG-N Rev A