FLUKE®

New Fluke 117 Digital Multimeter drives the ghosts out of the attic
(and the electric circuits)

Application Note

Testing Functions **Case Study**

Tool: Fluke 117 Electrician's Multimeter

Profile: Eldon Walstad, Rodgers Electric

Measurements: High impedance for troubleshooting sensitive electronic or control circuits, and low impedance for detecting ghost voltages

As an electrician, Eldon Walstad's job can be like that of a radar operator when it comes to detecting the invisible. He has to be able to determine what is real and what is not, and separate what is dangerous from what only appears to be. Now Walstad has a new tool that can help him make those critical decisions—the Fluke 117 Digital Multimeter (DMM).

In an average week Walstad, a journeyman electrician with Rodgers Electric in Everett, WA., handles all kinds of issues related to electrical installation, maintenance and repair. A frequent challenge is to determine why a device isn't operating, and track down the faulty contact, fuse, relay or broken wire that's preventing current from flowing.

But occasionally a digital multimeter will show voltage present, even on a circuit that should not be energized. Is it real and potentially dangerous voltage, or merely "ghost voltage" caused by capacitive coupling between energized wiring and adjacent unused wiring?

"The other day I had a situation where I had 73 volts showing up on a circuit," says Walstad, a second-generation electrician with more than 30 years experience. The circuit in question: a control circuit on a concrete transfer cart used to move material from the mixer to the molds in a factory making precast concrete light poles. In

the wet, dirty plant environment, the potential problems were many. "It should have been either 110 volts, or nothing."

Hunting down the ghosts

In the past, tracking down such a voltage indication could send the technician off on a time-wasting wild goose chase, looking for a problem connection that was never there. He could ferret out the ghost voltage with a low-impedance analog meter or a solenoid tester, or 'wiggy' – but that would require packing or fetching an extra tool.

But Walstad had extra help. The Fluke 117 Digital Multimeter he was using that day has dual impedance capability; incorporating both regular high impedance test capabilities and low impedance functions for detecting ghost voltages. By switching to the meter's Auto-V/LoZ (low impedance) test setting, Walstad could see instantly that the 73 volts was only a ghost. "It saved me a trip back to the truck to get another meter," Walstad says.

Ghost voltage can look real

Ghost voltages are caused when energized circuits and non-energized wiring are located in close proximity to each other, such as in the same conduit or raceway. This condition forms a capacitor and allows capacitive coupling between the energized wiring and the adjacent unused wiring.

When you place your multimeter leads between the open circuit and the neutral conductor, you effectively complete the circuit through the input of the multimeter. The capacitance between the connected, hot conductor and the floating conductor forms a voltage divider in conjunction with the multimeter input impedance. The multimeter then measures and displays the resulting voltage value.

Most digital multimeters today have an input impedance that's high enough to show this ghost voltage, giving a false impression of a live conductor. The meter is actually measuring voltage coupled into the disconnected conductor. But at times, these voltages can be 80–85 % of what the "hard" voltage should be. If not recognized as a ghost voltage, additional time, effort and money will be lost troubleshooting circuit problems.

How impedance affects testing

Most digital multimeters for testing industrial, electrical and electronic systems have high impedance input circuits greater than 1 megohm. This means that when the DMM is placed across a circuit for a measurement, it will have little impact on circuit performance. This is the desired effect for most voltage measurement applications, and is especially important for sensitive electronics or control circuits.

Older troubleshooting tools such as analog multimeters and solenoid testers generally have low impedance input circuitry around 10 kilohms or less. While these tools aren't fooled by ghost voltages, they should only be used for testing power circuits or other circuits where the low impedance will not negatively impact or alter circuit performance. They rarely comply with the current IEC 61010 safety standards and North American regulatory requirements.

The best of both worlds

With dual impedance meters, technicians can safely troubleshoot sensitive electronic or control circuits, as well as circuits that may contain ghost voltages, and can more reliably determine whether voltage is present on a circuit.

On the Fluke 114, 116 and 117 DMMs, the meter's regular Vac and Vdc switch positions are high impedance. Use these switch positions for most troubleshooting scenarios and especially on sensitive electronic loads.

The Fluke low impedance function is called Auto-V/LoZ.

- Auto-V stands for automatic volts. This feature automatically determines whether the measured signal is ac voltage or dc voltage, selects the correct function and range, and displays the correct information.
- LoZ stands for Low Impedance (Z). This feature presents a low impedance input to the circuit under test. This reduces the possibility of false readings due to ghost voltages and improves accuracy when testing to determine absence or presence of voltage.

Use the Auto-V/LoZ switch position on the DMM when readings are suspect (ghost voltages may be present) or when testing for the presence of voltage. When the leads are placed on an open circuit that contains a ghost voltage, the low input impedance will cause the ghost voltage to dissipate and the meter will display a reading near zero volts indicating no voltage present. When the leads are placed on a live circuit, however, the input senses the presence of "hard" voltage and then displays the actual voltage present.

Non-contact voltage detection

The Fluke 117 DMM also includes the built-in VoltAlert™ non-contact voltage function. Located on the top of the meter above the LCD display, it's another feature handy for detecting the invisible. The VoltAlert function detects the presence of ac voltage, sounds an audible tone and activates a red LED indicator light on the top center of the LCD display. Using this feature before making a contact measurement can add an extra layer of safety. Users should, of course, still test for the presence of voltage using test leads with the meter in the volts setting.

Four user groups, four meters

The new Fluke DMMs include four distinct models, each aimed at a specific group of users. The 114 Electrical Multimeter is ideal for electrical troubleshooting and straightforward 'go/no go' testing in the residential electrical setting, and also is designed for use in electric utility applications to test circuits before turning power back on at the meter. The 115 Multimeter is optimized for electrical and electronic testing by field service technicians. The 116 Multimeter features temperature and microamps measurements useful for heating, ventilation, air conditioning and refrigeration (HVAC/R) technicians. And the 117 Electrician's Multimeter tested by Eldon Walstad is designed for commercial electricians. All are rated for use in 600 V CAT III environments, and all except the 115 include the LoZ low impedance test capability.

"I like it," Walstad says of the 117. "When you're trying to prove something, you've got to know whether you've got real power there or not. If you think you've got power but don't, then you can go off in a different direction trying to find problems when you really need to be back here working on something. You're not wandering aimlessly, looking for it."

And there are no ghosts in sight.

Fluke. *Keeping your world up and running.*™

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Web access: http://www.fluke.com

Printed in U.S.A. 9/2006 2747091 A-EN-N Rev A