FLUKE®

What you can learn from loop impedance testing on a branch circuit

Application Note

Branch circuit loop checks

How much time does it take you to find an intermittent connection on one lug of a 120 V receptacle, if it's one of ten receptacles on a circuit? Think of the steps involved for checking all those receptacles, and how long it usually takes you to isolate the problem. Think of how many hours that eventually adds up to — hours when you are under pressure because something isn't working.

What if technology allowed you to check every receptacle connection without even removing a faceplate? And what if you could apply the same technology to all branch circuit devices, not just receptacles? Would that be worth something to you? Would it help you even more to know the exact impedance of a branch circuit at 120 V, not the 9 V from your DMM?

Today, we can do this — and more — with an instrument designed for power distribution branch circuit loop testing. Several models are on the market, and it's worth taking a look at what's out there.

Some insulation testers make branch circuit loop test measurements easier than others. The Fluke 1650 has ergonomic dashboard-like controls, and a neck strap that frees you from having to hold the instrument or have someone hold it for you-no third hand required.

The right stuff

Simply put, a branch circuit loop test measures circuits to look for high-impedance connections. And it's a simple test, if you have the right equipment. If you've done an insulation resistance test, you'll have no problem doing a branch circuit loop test. As with an insulation resistance test, you can't do this test with a DMM. Connections that may appear fine with no load can show high impedance when the connection heats up with a 15 A load. Thus, testers designed for branch circuit loop testing use a test voltage and current that matches the circuit under test. With confirmation that the installation is safe and reliable for use, electricians can avoid costly callbacks, save valuable troubleshooting time and provide proof of workmanship to customers.

It works for you

If you've spent any time pulling out one receptacle after another, tearing connections apart and redoing them only to *think* you found the problem, then you are probably already thinking this test can save you money, improve your productivity, and reduce your frustration. And you're thinking along the right lines. Here are some areas to consider.

Troubleshooting. Let's say Joe the electrician goes to the job site to fix a problem with "outlets not working right." The customer complains of intermittent equipment operation. So, Joe starts at one end of the circuit and starts examining receptacles. On the third receptacle, he finds a loose neutral wire. Joe repairs the connection. Now, do you want Joe to remove and check the other seven receptacles on that circuit while he's there? Probably not, because if he does that he might create other problems and it's likely those receptacles are fine anyway. Given the cost and the potential for further problems, most of us would just assume the problem was in the one receptacle and not in the others.

The normal procedure, after fixing a problem like this, is to plug in equipment and show that it runs right. Joe does this, and there's no problem. Until a week later — when another connection — one that would have shown up on an impedance test Joe didn't do — heats up and begins to cause a repeat of the symptoms.

So, Joe pulls every receptacle and checks the screw terminal connections. They are all tight, but the problem persists. Now, Joe has to go back through the receptacle boxes and redo every twist-on connector, hoping he'll chance upon the problem that way. On a standard 3-wire system, that would be three or four connectors per box (assuming pigtails to each non-GFCI receptacle). How long will it take Joe to take apart and remake all 30 or more connections? Does he have that kind of time? Do you have that kind of money? Does the end-user have that kind of patience? And what if Joe inadvertently creates another loose connection — easily done when pulling on wires — while fixing the original problem? And he isn't aware of that?

Now, imagine the same job again. Joe goes to the end of the circuit, plugs in his tester and finds high impedance. He then moves down the circuit, plugging his tester into each receptacle in order until he finds one that has the proper amount of impedance. Now he knows where the problem lies - somewhere between the last receptacle with high impedance and the first that showed normal impedance. He tracks down the problem, fixes it, then takes one last measurement at the end of the circuit. If the impedance there is normal, the problem is solved and he knows he's not going to have a callback on it because he can see all of the connections are sound.

Documenting. With the right tester, you can store test results for later download. Suppose Joe gets called out three days later about a receptacle problem on that same circuit. Who picks up the tab for that callback? If the work has tested as being done right, the problem is not the work Joe did — and probably not in the receptacle circuit at all. You have the results documented right there. Or, suppose there's a fire or other event that might be attributable to bad wiring of a branch circuit. Your ability to document the condition of the work you completed can short-circuit an attempt to sue you. And in today's lawsuit-crazy environment, that's a definite advantage. Let your competitors spend their time trying to build a defense — you *already* have your proof.

Loss prevention. If you're doing preventive maintenance, you can spot problems in branch circuits as they begin to emerge. Excess humidity, age, and vermin can all cause connections to deteriorate. At first, there's no problem with this — just a little energy waste through heat. That's the ideal time to identify and repair these connection problems. Left to fester, they result in nuisance breaker trips, low voltage at the point of use, outright failure, mind-numbing intermittent problems, or even fire.

Installation inspector. Electrical inspectors can save time with these tests and get more meaningful information than they can by poking around in completed work to visually check connections. So can a contractor, thus preventing callbacks like the one Joe dealt with in our example.

Going to the next level

Now, here's an interesting twist. How about troubleshooting the problems before the callback? Before the drywall goes up and you're stuck with refinishing costs? The Europeans are doing exactly that, by doing branch circuit tests in the normal course of construction.

You can quickly see that consistently doing these tests provides compelling benefits. Because these tests are so quick and easy to do at the time of installation, the added labor cost is inconsequential. You can now eliminate problems before you leave the jobsite. This means your customer is happy and your costs of operation are lower.

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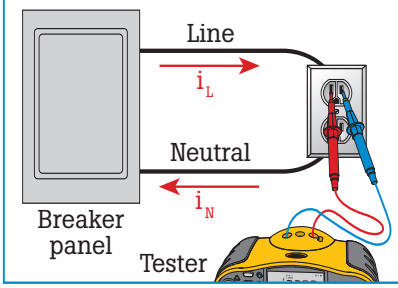
What is loop impedence?



Loop impedence is another another way of thinking about voltage drop. The loop being tested starts at the panel, passes through the tester, and returns to the panel. High loop impedence is a strong indicator of a problem; bad connections, or too long a run for the wire diameter.

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Printed in U.S.A. 3/2004 2140194 A-ENG-N Rev A