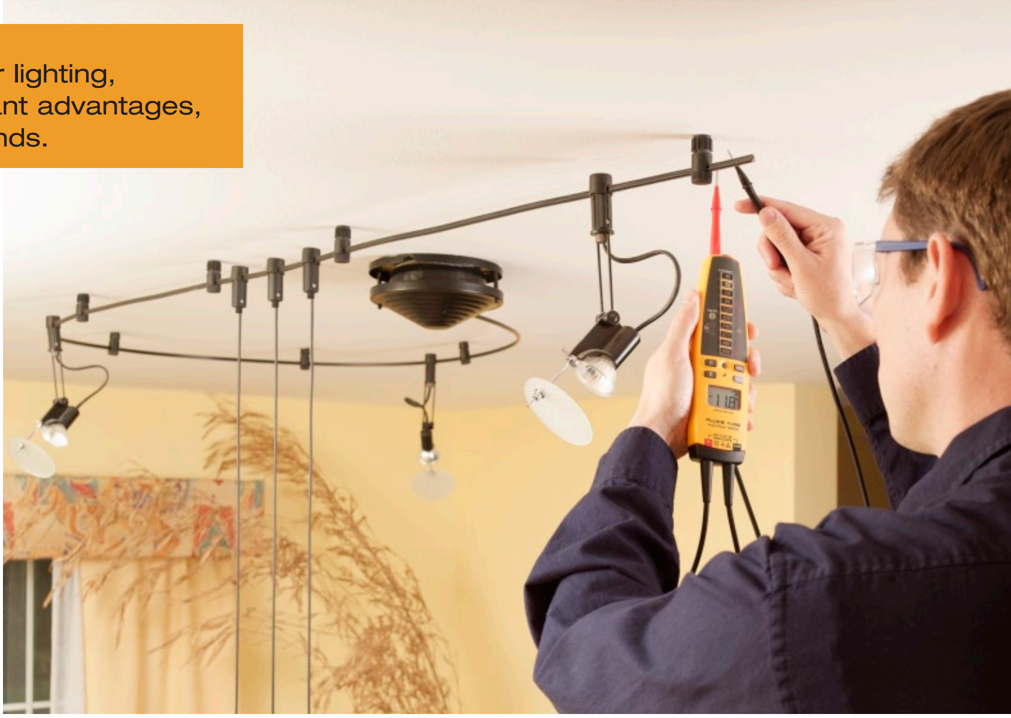
What to watch for in low-voltage test and measurement

Application Note

Low voltage electrical systems for lighting, alarms and controls have significant advantages, but they also make special demands.



Testing for voltage drops at the end of the installation.

Low voltage systems may reduce shock hazard, and the smaller fixtures and bulbs used in low voltage lighting systems give the architect attractive options. In outdoor applications, low voltage systems can be installed without the trouble and expense of deep trenching and conduit that may be required for a similar system running on line voltage.

With less voltage available, however, low voltage systems must push larger amounts of current through to achieve the same output or accomplish the same work as line voltage systems. Conductors must be correctly sized to carry that higher current (see sidebar). And, this higher current flow means that flaws in a circuit, such as a loose or corroded connection, tend to affect low voltage systems more than they would a line voltage system.

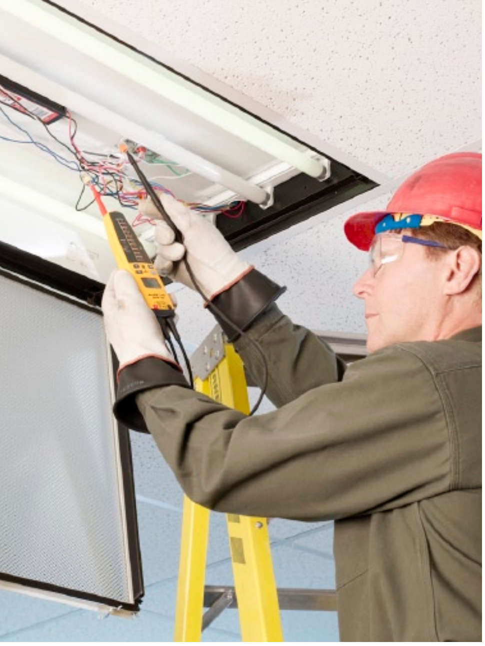
The Fluke T+PRO Electrical Tester was designed to cover the range of voltages most electricians deal with every day, from CAT IV 600 V, CAT III 1000 V conditions down to low voltage (its voltage indicator lights start at 12.0 V).

The LCD display reads from 10.0 V to 50.0 V, with precision to the tenth of a volt. That level of detail is important in low voltage systems, where a seemingly minor change in voltage, a change of less than one volt, can significantly affect system performance. Using the T+PRO, a professional can easily measure the voltage available at points along a low voltage circuit, adjust the tap on the system transformer to deliver the voltage needed, troubleshoot bad lamps and poor connections, and verify that line voltage is normal at the transformer.

Fluke asked several low voltage lighting installation professionals to field test the T+PRO. Here's what they said.

Going to school with the T+PRO

Portland, Ore., School District Electrical Supervisor Louis Bybee's beat includes low voltage systems in many of the district's 200 buildings. "This T+PRO is light, it's small, it's handy, it's quick, and frequently I've noticed I don't have to bring out the larger gun, the bigger meter." On low voltage lighting systems, "The T+PRO gives me an instant quantification whether it's ac, dc, of the voltage levels. It allows me to focus in on the big picture very quickly." Bybee looks for lack of supply to the transformer, excessive draw that causes the transformer's to trip, and poor connections. "You only have so much voltage to work with," he said. "If you start experiencing loose or resistive, corroded connections, things go south pretty quick."



Checking voltage..

Finding a light in the dark

Bob Garland, owner of Shagbark Electric in Illinois, installs a lot of low voltage lighting and irrigation systems at high-end homes. Operating such systems on low voltage is not only safer, but much less costly than line voltage, which normally means wire must be buried deep in conduit, Garland said. "A good thing about this meter is that the voltage lights go down to 12 V," he said. "A lot of them don't. They go down to 24, some go down to 18. It's nice, because after checking the line voltage on the primary side, there's a secondary side on the lighting systems. We can only drop the voltage so much, so this thing will tell me if I'm within the parameters I need to be." Garland uses the T+PRO for a full range of tests: checking circuit voltage end to end, looking for shorts and opens using the continuity function, checking for bad lamps and splices, checking 24 V and 12 V relays to ensure contacts are performing properly. Low voltage relays are used in control circuits for lighting and other applications. The T+PRO's flashlight is especially handy for Garland. Low-voltage outdoor lighting has to be set up and the lamps aimed properly at night, and a meter with flashlight makes the job easier.

Why voltage drop matters on low voltage systems

What would be a negligible voltage drop on a 120 V appliance due to the resistance of a long conductor is a big voltage drop in a 12 V appliance.

Using Ohm's Law, here's why:
Assume you have a 20-foot run of wire powering a 250 W load at 117 V ac, and another 20-foot run of cable powering a 250 W load at 12 V. What are the voltage drops? Let's assume that the wire is the same length and type and has the same resistance over its full length: 0.1 Ω.

We first calculate the current through the circuit, then we calculate the voltage drop from one end of wire to the other. For the 117 V appliance (or light fixture):
I = P/V, so I = 250 W/ 117 V = 2.14 Amperes
V = IR, so the voltage drop in the wire is 2.14 A x 0.1 Ω = 0.21 V

Your 117 V is now 116.8 V at the far end of the wire where the load is located. Not a problem!

However, if the 250 W load operates at 12 V dc, you have a significant voltage drop with this wiring. For this reason, you should use low-resistance, high-ampacity rated cables and connectors. Even with all the right materials used, you should still check for acceptable voltage at the end of a run of wire.

For the 12 V appliance:
I = P/V, so I = 250 W/ 12 V = 20.8 Amperes
V = IR, so the voltage drop in the wire is 20.8 A x 0.1 Ω = 2.1 V

Your 12 V at the transformer secondary winding is now only 8.9 V at the far end of the cable run where the appliance is located. The light will be dim, or the appliance will not operate correctly if at all.

To mitigate this, you need lower-resistance cables and connectors, or you need to switch to a different tap on a multi-tap step-down transformer to achieve 12 V at the far end of the cable where the load is located. It's best to minimize the voltage drop rather than increase the voltage because if you just increase the voltage, you're wasting power as heat in the wiring. 22 A x 2.1 V = 46 watts of power being wasted as heat, not light!

If the voltage drops excessively at the transformer secondary (12 V side) when the appliance is turned on, the transformer is being overloaded and must be up-sized. With low-voltage lighting, make sure not to exceed the recommended maximum voltge for the bulb, which might be 12.0 V or 12.2 V—check with the manufacturer of the bulb. You need a voltage tester that shows you this 1/10th of a volt to make this adjustment or correction. A light bulb designed for 12 V operated above 12 V will have a shorter life than specified by the manufacturer. Operated below 12.0 V, the bulb will be dimmer than expected.

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