FLUKE®

Anatomy of a high-quality meter

Application Note

You've heard the war stories. The unexpected jolt that knocked someone off his feet. The digital multimeter that turned to toast because it couldn't handle the measurement it was hooked up to perform. The guy who reached into a tight space to adjust an alligator clip and came out with a little less skin on his finger.

If your job is to measure electricity, the truth is, you're at risk of injury. When it comes to testing and measuring electricity, all that stands between you and a nasty shock or worse is the quality of the test equipment you use on the job and the safety precautions you take.

The hazards of working with electricity aren't new, of course. But as electronic and electrical systems become increasingly complex, the dangers of measuring its flow have increased and unprepared technicians can suddenly be faced with a simple job gone bad.

For example, it's not unheard of for an electrician to find himself the victim of a transient power spike that knocks him flat before he knows it's coming, thanks to a big motor kicking on or off somewhere upline. Occasionally an electrician may end up working with more voltage and energy than he realizes. Choosing the best digital multimeter is critical when you work in such environments. It can help handle an unexpected situation, even if you wander into dangerous territory.

The key is selecting a meter with a high level of safety capabilities. Here's what to look for next time you go shopping for a meter:

Safety-rated fuses. You don't want a meter that uses just any old fuse. Specially designed high-energy fuses dissipate stray voltage before it reaches you and are designed to blow in time to get you out of harm's way. Don't make the beginner's mistake of substituting inferior fuses once you've taken the meter home, and don't ever disable the fuse on a job. Ten is a good number of fingers to have, and you'll want to keep them all. Use only high-energy fuses approved by the meter's manufacturer.

Component spacing. Proper safety design in a digital multimeter begins deep inside each tool. Adequate spacing between internal components provides a measurable margin of safety, but can be hard to check. Look for an approval sticker by an independent third-party testing laboratory. The lab has taken that model apart and stakes its reputation on the fact that the meter is as safe as its manufacturer says it is.

Independent verification. Don't trust the word of just any laboratory, though. Look for those whose analysis has stood the test of time, such as UL, CSA, and TUV. Beware of wording such as "Designed to meet specification..." Designers' plans are never a substitute for independent testing by a reputable laboratory.

Best value, not lowest cost. The truth is, you often get what you pay for. Some cheap meters say they're adequately safety rated and they're not. Selecting the lowest-priced equipment may be a false economy. Treating severe burns from an on-the-job electrical accident will cost more.

Look for category and voltage ratings of test leads and multimeters.

Appropriate CAT ratings. That's a fancy bit of rule-making by the International Electrotechnical Commission (IEC) that sets the safety regulations multimeter manufacturers must adhere to if their products are marketed and sold in Europe. The IEC is your friend. The IEC has set four categories of electrical testing activity, ranging from Category I protected low energy circuits to Category IV installations where high-powered lines can be exposed to outdoor environments.

Meters designed to the IEC standards will carry a category rating and certification label. Use them within their rated categories, and they will be more capable of withstanding the hazards caused by transients and other dangers in today's electrical systems. Always make sure your test tool category rating matches how you're using it, even if that means switching from meter to meter throughout the day. Better yet, invest in a good CAT IV rated meter and use it exclusively — then you never have to worry about which CAT level you are working in.

Category II conditions are most prevalent, but that shouldn't lull those testing electrical circuits and sources into complacency. As soon as you move into an industrial setting, chances are you're dealing with Category III or Category IV. As soon as you get into large industrial motors, you're in Category IV territory. No matter the category, follow all safety procedures and wear appropriate safety equipment. And never work alone.

CAT-rated accessories. A tester is only as good as the accessories that accompany it. Select high-quality leads, clips and probes that also are designed with safety in mind. Look for finger guards and rubber molded grips to provide sure touches. Select probes slender enough to easily reach into tight spots. Most important of all, make sure the CAT safety ratings on your accessories match your meter — and the job at hand. Think of a meter and its accessories as a complete system. And a system is only as good as its weakest component.

Ergonomic design. Proper ergonomic design makes a tester more than comfortable. It also makes it safer to use. A cushioned, over-molded rubber design ensures a strong and stable grip and helps prevent slipping.

So you've selected your meter, and outfitted it with high-quality, safety-rated accessories. You're almost ready to hit the job site. Just a few more tips to make your safety preparations complete.

Read the manual! Yes, we know that goes against the grain. Do it anyway. Manuals actually are chock full of valuable safety information and tips on making the most of your new equipment. Start at the front, the part you usually skip, and hang with it all the way through.

Replace the battery when it says to. Sure, the manufacturer gives you a long lead time before the meter actually goes dead. But a failing battery is not what you want when all that stands between you and a powerful electrical circuit is a meter flashing, "low battery."

Don't ignore what you don't understand. There's probably a good reason something doesn't make sense. Taking the time to find that reason could save your life.

Work safely

- Work on de-energized circuits whenever possible. Use proper lock-out/tag-out procedures.
- When working on live circuits, use protective gear: insulated tools, safety glasses or a face shield, insulated gloves.
- Stand on an insulated mat and remove watches or other jewelry. Wear flame resistant clothing.
- When making measurements on live circuits, connect the ground lead first, then make contact with the hot lead. Remove the hot lead first, the ground lead last.
- Hang or rest the meter if possible. Try to avoid holding it in your hands to minimize personal exposure to transients.
- Use the three-point test method when checking to see if a circuit is inactive. First test a known live circuit. Second, test the target circuit. Third, test the live circuit again. This verifies that your tester worked properly before and after the measurement.
- Use the old electrician's trick of keeping one hand in your pocket. This lessens the chance of a closed circuit across your chest and through your heart.

Get to know your CATs

Category I — typically covers electronic equipment

- Protected electronic equipment
- Equipment connected to (source) circuits in which measures are taken to limit transient overvoltages to an appropriately low level
- Any high-voltage-low-energy source derived from a high-winding resistance transformer, such as the high-voltage section of a copier.

Category II — single-phase receptacle connected loads

- Appliance, portable tools and other household and similar loads
- Outlet and long branch circuits
- Outlets at more than 10 meters from CAT III source
- Outlets at more than 20 meters from CAT IV source

Category III — three-phase distribution, including single-phase commercial lighting

- Equipment in fixed installations, such as switchgear and polyphase motors
- Bus and feeders in industrial plants
- Feeders and short branch circuits, distribution panel devices
- Lighting systems in larger buildings
- Appliance outlets with short connections to service entrance

Category IV — three-phase at utility connection, any outdoor conductors

- "Origin of installations," such as where low-voltage connection is made to utility power
- Electricity meters, primary overcurrent protection equipment
- Outside and service entrance, service drop from pole to building, run between meter and panel
- Overhead line to detached building, underground line to well pump

Overvoltage Installation Category	Working Voltage (dc or ac-rms to ground)	Peak Impulse Transient (20 repetitions)	Test Source (W = V/A)
CAT I	600 V	2500 V	30 Ohm source
CAT I	1000 V	4000 V	30 Ohm source
CAT II	600 V	4000 V	30 Ohm source
CAT II	1000 V	6000 V	30 Ohm source
CAT III	600 V	6000 V	30 Ohm source
CAT III	1000 V	8000 V	30 Ohm source
CAT IV	600 V	8000 V	30 Ohm source

Transient test values for overvoltage installation categories. (50 V/150 V/300 V values not included.)

Fluke. *Keeping your world up and running.*

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 2140271 A-ENG-N Rev A