FLUKE®

Sensitive electronics require stable, clean power

Application Note

Because dirty power destroys electronic devices, it's an important concern to anyone working with electronics. While there are some things you can do to directly solve dirty power problems, most of the cures involve addressing the electrical infrastructure. So, you must consider the line between your realm of electronics and the realm of electrical infrastructure. As an electronics person, you probably don't have control over the electrical infrastructure. But, you *can* help those who do have control over it to resolve power quality problems quickly.

Don't rely on a simple voltage or current measurements to determine the quality of your power. It is important to check multiple aspects of the power system, including voltage quality, loading, harmonic content and grounding. The results of measurements should always be evaluated by an experienced electrician or engineer, especially if the results are ambiguous or confusing. Harmonics testing, for example, can produce confusing results and you may need to call in the experts. But being armed with the right measurements will help expedite the process and increase your confidence in your power system.

Perfect power at your service entrance doesn't automatically mean clean power throughout your facility. In fact, most dirty power comes from within a particular building. Utility systems generally have a low source impedance that can overcome a lot of what consumers put back on the power grid. Overloaded circuits, undersized conductors, improper wiring, or improper grounding problems are very common causes of dirty power. Semiconductor switching in ASD's, dimmers, or other electronic loads cause waveform distortion and may cause transients if the devices are improperly specified or start to fail. Problems can occur at the service entrance, though. Utilities switching power-factor correction capacitors can cause transients, tap changes can cause some unexpected changes in rms voltage, and outages are not uncommon. Your neighbors can also cause headaches in the form of excessive loading resulting in voltage drops or even transients and harmonic distortion.

Remember, the quality of the power is likely to vary throughout your facility. Even power from the same feeder may appear "dirty" at some loads, but clean to other equipment – power quality will tend to be worse, the farther you get from a transformer.

Also, tolerance of dirty power varies widely by type of equipment. Phase imbalance, for example, is a death sentence to a motor but fairly meaningless to an inductive heater.

How dirty is too dirty? Your power is too dirty when its condition promotes the degradation or failure of specific equipment.

It's a pretty good bet that you have dirty power if....

- Electronic equipment fails. Especially if the diagnosis is a "smoked" power supply.
- Processes run erratically. For example, timers run too fast or motors run too slowly.
- Computers or equipment reset
- Lights flicker or dim
- Breakers trip with no signs of overload
- Motor overloads open for no apparent reason
- Transformers or switchgear run hot, or fail

- Phase-loss sensors trip
- UPSs "kick in" frequently
- Video monitors shimmy
- Conductor insulation or motor windings fail

While it may be the job of the electricians or other facilities folks to fix your dirty power problems, you can do much to help them see what your problem is. A solid troubleshooting approach will address these three areas:

- Grounding
- Wire routing
- Electrical disturbances

You can take specific steps in each area to narrow down the hunt for the source of your dirty power. Let's look at what you can do.

Grounding

- Measure voltages from neutral to ground and hot to neutral. Do this at the circuit boards, back planes, power supplies, and ac source. If you see more than a few volts difference at any one of these points, something isn't right. If it looks fine at the ac source but not downstream of it, you have taken the first step in isolating your grounding problem.
- Measure the voltage between an equipment frame and neutral. Measure between an equipment frame and ground. The neutral to frame reading should be about the same as neutral to ground. You should expect the frame to be at ground potential and the voltage between these to be zero. Neutral to ground should be 2–3 volts in a normally loaded circuit.

Wire routing

- Do you have wires of different voltages running closely together, perhaps in the same wireway? A common problem source is a sensor wire running with power wires. Separate these, rewiring completely, if you have to. Begin at the point of use, and work your way back to the power panel.
- Watch the waveform on a low-voltage wire, such as a signal wire running from a sensor into your system. Operate each electrical device that runs at a higher voltage level — for example, fans and positioning motors. As these turn on and off, noticeable changes in the waveform indicate you likely have a wiring problem.

Electrical disturbances

- Look at the actual waveform. If you don't have a power analyzer like the Fluke 43B, borrow one or have the facilities people use one in your area. Some distortion is acceptable — expecting a perfect waveform is unrealistic. Look for gross distortion and for spikes projecting in either direction beyond the sinusoidal curve.
- Look at the power at specific times. Sample waveforms at the start of the day, during process changeovers, and other times when equipment starts up and shuts down.
- Look for pumps or fans that share the same source as your electronic equipment. These devices can cycle at irregular intervals. Culprits can include HVAC motors, sump pumps, fire pumps, and even water fountains. You'll need to coordinate with the facilities folks to run the HVAC and other such gear while you watch your power waveforms. While the resulting dirty power might not affect most equipment, it can be enough to zap your particular electronics.
- Look at the lighting system. Malfunctioning electronic ballasts, or ballasts with errors in wiring or grounding, can be pumping dirty power into your system. If the lighting seems uneven among similar fixtures, varies in intensity throughout the day, or flickers, the lighting system needs closer inspection. One test you can do, perhaps after hours, is to see if turning off certain banks of lights improves the waveform at the point of use.
- Look for personal equipment such as heaters, blowers, hot plates, coffee pots, and other high-load 120 V items. These do not need to be on the same circuit as your electronic devices to cause a problem.

The cause of any power quality symptom will reveal itself during properly conducted testing. Thus, making the correct measurements with the correct test equipment is a core task in eliminating dirty power and its attendant failures.

Dirty power troubleshooting shares many of the complexities of electronic troubleshooting. For example, clearing up one problem often reveals a problem you couldn't see before. Thus, a methodical approach is crucial. Take before and after measurements, so you can track the effects of each investigative step and each repair. The increased uptime your efforts produce will more than justify your resource investment in solving dirty power problems.

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. 9/2003 2105709 A-ENG-N Rev A