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Dirty power, can I have it and not know it?

Our thanks to Fluke for allowing us to reprint the following article.

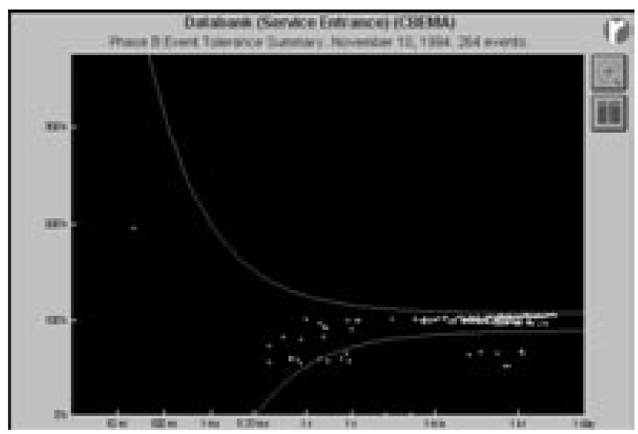
Equipment failures raise costs, while reducing revenue. The failure of one small component in a manufacturing process can idle an entire plant for hours, and poor power quality (aka “dirty power”) is a common cause of unplanned shutdowns and equipment failures. Just as clean water is essential for our health, so is clean power essential for the health of electrically- powered equipment — and the livelihoods that depend on that equipment. So what types of tests can you perform to determine if you have “clean” or “dirty” power?

First determine the loads in your plant or facility that are mission critical and are likely victims of dirty power. Controls for manufacturing processes, critical sensors, environmental controls and computer networks are some places to look. Obviously any load that could affect life-safety or security should be considered critical.

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.

Fluke Portable Power Recorder

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 as well. 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.



Fluke Power Quality software allows user to plot events against selectable tolerance curves.

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....

1547 N. Trooper Road • P. O. Box 1117 • Worcester, PA 19490-1117 USA
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• 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.

If you haven’t experienced any of the failures above, a good way to determine the health of your distribution system is to take measurements and make visual observations at critical points in the system. This will also help you establish a baseline which you can refer back to the next time you inspect and measure. Your best friend in this case is an accurate one-line diagram. You’ll also need something to log your results. A clipboard will work, but these days a laptop computer has many advantages. Walk through your system in a systematic manner. Start from either the critical loads or the service entrance and move in one direction.

You have to be aware of the loading profile of the system at each particular point. If you are looking at a piece of production equipment that is running fullbore, a single set of measurements may suffice. If you are looking at a transformer, or the building service entrance, you will want to log measurements for an entire business cycle — usually a day or a week. Take the measurements under various load conditions. Here are the measurements you should take for a complete analysis:

• Feeder and branch currents on each phase and neutral. Look for overloading and imbalance.
• Feeder and branch voltages on each phase, and from neutral to ground. Look for high or low voltage levels over a full business cycle. Low neutral to ground voltages point to illegal bonds and high neutral to ground voltages point to overloading.
• Voltage drop across switches or circuit breakers under high load. More than a few volts of drop may mean contacts are failing and impair the ability of the system to respond to loads changes.
• Total harmonic distortion of voltage. Voltage distortion should not be more than 5 %.
• Harmonics profiles of voltage and current. High voltage distortion can cause overheating and loss of efficiency. Current distortion is normal and expected. If you see even harmonics in voltage or current, something is injecting dc into your system and must be isolated.
• Ground currents. Observe both the magnitude and the waveform if possible. Highfrequency noise can affect sensitive equipment and high ground currents can lead to deadly “touch potentials.”
• Phase balance, especially on across-the-line motors. Voltages should be the same within 5 %.

With these measurements and others, you can conduct an efficient investigation into your dirty power problems.


Fluke 43BPower Quality Analyzer

Before you do repairs, try to complete your analysis. If you see something strange, look for a root cause; something that would explain all or most of the symptoms. Before you change anything, record the “as found” condition at the input and output of the point of repair. For example, if you repair a connection in a distribution panel, test for electrical characteristics on each side of the connection before and after repair. The more active the component, the more this practice is crucial. Never repair or replace motors or transformers without taking “as founds.”

Efficiently answering the dirty power question begins with basic power quality analysis. Once you’ve determined that your power is clean, you’ll have to periodically study your system to make sure it stays that way. A well-planned, proactive testing program will allow you to keep your power clean.

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