

Stepping up to power quality tools

For those who want to break into the field of power quality, the Fluke 43B Power Quality Analyzer is a logical choice

Application Note

By Randy Barnett

When electrical problems arise, every electrical professional knows to grab his digital multimeter and current clamp and start looking for answers. Some problems will be found and answered easily. But other issues will go unanswered without the proper tools and knowledge to investigate distribution systems containing electronic (nonlinear) loads. "Poor power quality" is any deviation in the electrical supply to equipment that results in its mis-operation or reduces its reliability. Such deviations may occur for only milliseconds or less, are often caused by nonlinear loads, and can rarely be found with the digital multimeter.

How important are these power quality issues? Exact dollar estimates vary, but these issues are known to cost facilities billions of dollars annually. Neutrals and transformers overheat, medical imaging equipment locks up and requires a system reboot, employees complain of headaches due to lighting conditions, and a PBX loses calls—all of these typical power quality issues appear in single-phase systems. One utility study of 112 different sites found power quality problems occurring from 114 problems per month in one facility to over 4,000 problems per month in another facility! It is clear that facility operations and maintenance personnel, and contractors who are attempting to help solve client needs, must be able to isolate and solve the causes of power quality disturbances.

Single-phase loads

While it is possible that poor quality power can be delivered to a facility, estimates are that 65 to 85 percent of power quality problems are created by equipment within the facility. Considering that approximately 95 percent of the loads on a 208Y/120 volt panel board in a modern commercial facility are single-phase electronic loads known to cause these problems, it is safe to assume that troubleshooting these loads and their branch circuits should be at least as important to the electrical professional as taking standard voltage and current readings with the digital multimeter.

The first concept to understand when getting started in power quality is that single-phase nonlinear loads, from computers to lighting to some specialized equipment, will cause power quality problems. These same nonlinear loads are also susceptible to power quality problems. Fortunately, the Fluke 43B Power Quality Analyzer is specifically designed for testing and troubleshooting single-phase power problems. For those who are looking for an introduction into the world of power quality while taking the next step beyond the digital multimeter, a single-phase power quality analyzer is the logical choice. Easy to set up and use, the analyzer can give quick and precise answers to allow for intelligent troubleshooting decisions.



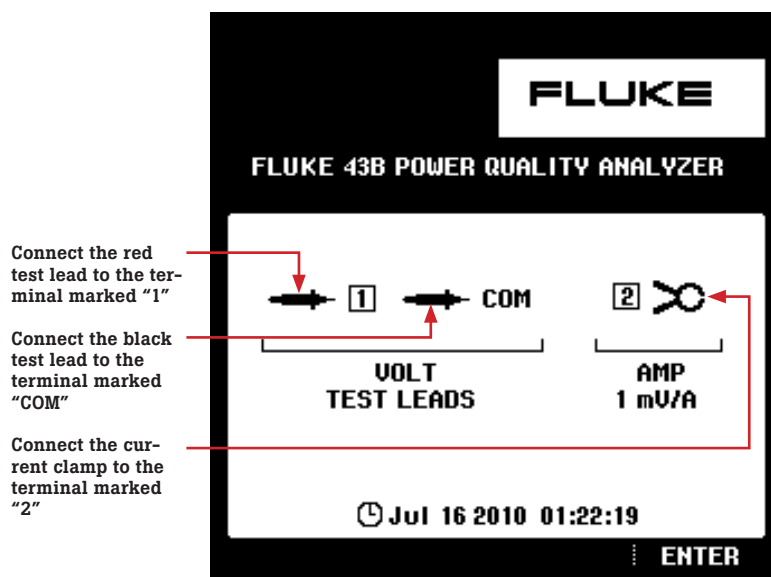
Take a general power survey

Unless you already suspect the cause of the power quality problem, a good place to start is by performing a general power quality survey. Begin as far back toward the service entrance in the distribution system as possible. For example, most commercial buildings utilize a 208Y/120 volt distribution system. So, begin measurements at the first panel board downstream of the 208Y/120 volt transformers. This is where you will find the feeders and branch circuits supplying single-phase loads for the facility. Should possible power quality issues be identified, it will be necessary to drill down further into the distribution system to isolate the problem-causing equipment.

If you know where in the distribution system the problems occur, then start at that location and work back upstream in the distribution system. For example, a programmable logic controller (PLC) intermittently gives over temperature alarms for the system it is controlling. However, investigations reveal no over-temperature problems exists in the process system. It is reasonable to expect a power quality issue occurring intermittently at the plc supply as one possible cause of the false alarms. Therefore, begin measurements and recordings at the 120 volt supply to the plc, checking for a power quality issue. If a power quality problem is found, go back to the panel board supplying the plc branch circuit and begin investigating other loads on the panel board. If one particular load is suspected of causing the problem, then it will be easy enough to check values on that specific piece of equipment as it runs through its operational cycle.

The first screen of the power quality analyzer

The first screen to appear when you turn on the analyzer shows how to connect the test leads to the instrument. Should any instrument adjustments need to be made, pressing the menu key and opening the "instrument setup" screen provides a menu of possible changes. Such adjustments include changing the specific type of probes being used, the harmonic values to be measured, the date and time, and other basic parameters.



The first screen of the power quality analyzer shows how to connect the test leads to the instrument.

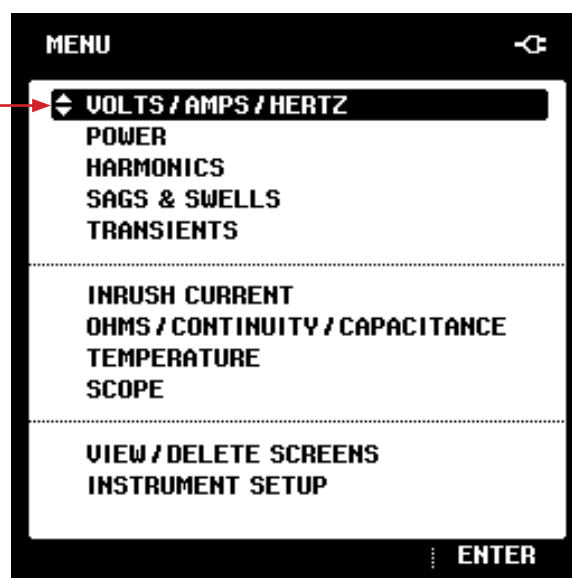
The Volts/Amps/Hertz function

Begin use of the Fluke 43B by depressing the Menu key and observing the instrument menu. Select the Volts/Amps/Hertz function and press Enter. Both voltage and current waveforms appear on the screen. A few quick checks here can determine whether you are at a location in the system that may be presenting some power quality concerns. Notice the severity of any distortion on the voltage and current sine waves. Look for a crest factor (CF) of 1.4 on the voltage sine wave. Crest factor is the ratio of peak voltage to rms voltage. A CF of less than 1.4 indicates the voltage is flattening out across the top of the sine wave. This may cause computer lock-ups and other intermittent problems with electronic loads being supplied.

The Power function

Return to the menu screen and select the Power function. Notice that the analyzer has the capability of measuring either single-phase or three-phase power. If three-phase power is selected, the instrument shows how to connect test leads for such measurements. The Power screen also displays the voltage and current sine waves in addition to power measurement values of kilowatts (kW), kilovolt ampere (kVA), kilovolt ampere reactive (kVAR), power factor (PF), displacement power factor (DPF), and hertz (Hz). The Power function can be a valuable tool as part of an energy management program when used to help determine operational cost of specific pieces of equipment.

Select the VOLTS/AMPS/HERTZ function and press Enter for a quick look at system voltage and current sine waves.



The Fluke 43B Menu screen provides a quick view of instrument functions.

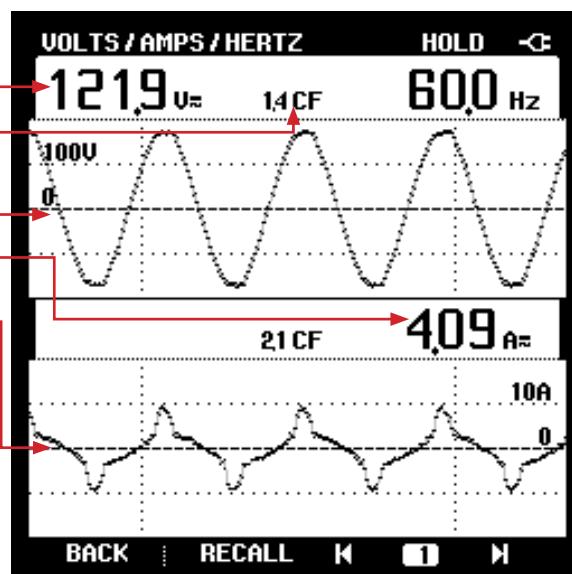
RMS voltage value

Crest factors less than 1.4 indicate potential problems

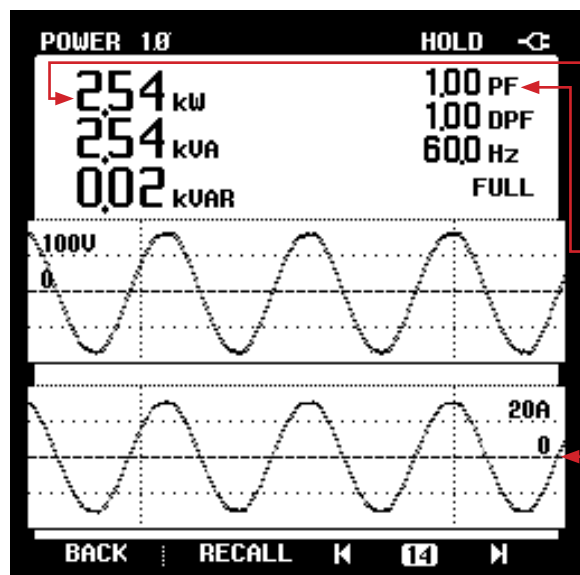
Voltage sine wave

Single-phase amperage

Current sine wave indicates current being drawn by nonlinear type loads



Both voltage and current waveforms appear on the Volts/Amp/Hertz screen.



Multiplying this kW reading by the number of hours of operation can be used to calculate the cost of operating this compressor

Power factor in this single-phase reading is 1.00 at 60 Hz

Current sine wave indicates current is linear and in-phase with voltage

The Power screen provides voltage and current sine waves in addition to the power readings for this compressor motor.

The Harmonics function

Selecting Harmonics from the menu provides the level of each harmonic current in the system. Harmonic currents are multiples of the fundamental 60 Hz frequency. Different harmonic levels present different problems. In a single-phase system, the presence of the third harmonic is common. This harmonic current can cause overheating in neutral conductors and transformers and, as with all harmonics, it will tend to distort the fundamental sine wave. Pay attention to total harmonic distortion (THD) for voltage. It must be 5 percent or less at the service entrance, but may be higher when closer to individual loads. Press the arrow key to move the cursor and note the level of each harmonic current as the cursor passes along the harmonic graph.

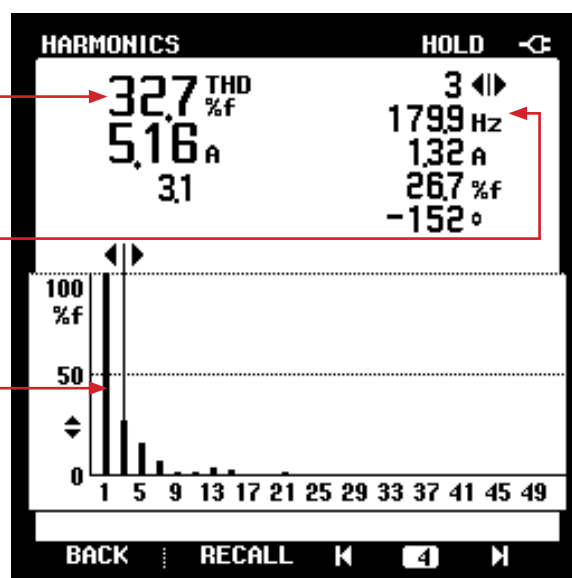
Recording voltage over time

As electronic and larger motor loads cycle off and on in a distribution system, they can present problems for single-phase equipment. Large inrush currents can cause voltage to sag. Quite often it is not one particular power quality event that causes electronic equipment to malfunction. It is sometimes a series of two or more events. For example, the sag in voltage by itself may not be an issue for certain equipment but other nearby equipment with less immunity may be severely affected. Since it is usually impossible to tell exactly when equipment will start, draw large inrush currents and create voltage sags, the Fluke 43B allows for recording of these values over time.

With the cursor over the 3rd harmonic, values for distortion created by this harmonic are indicated

The 3rd harmonic is measured at 179.9 Hz, which is 1.32 amps and 26.7 % of the 60 Hz amperage

The bars provide a graphical representation of the magnitudes of the various harmonic currents



The Harmonics screen supplies valuable information on current flows created in the system by nonlinear loads that add heat and distort the 60 Hz sine wave.

Recording transient conditions

The single-phase power quality analyzer also allows for recording of transient conditions. A transient is a short-duration spike along the voltage sine wave. High energy level transients can occur from lightning strikes and utility switching. Lower energy level transients can occur within a facility as different loads cycle. While high energy level transients can cause immediate failure of electrical equipment, lower level transients can cause damage over time—resulting in unexplained premature failure of equipment.

Additional troubleshooting with the Fluke 43B

The Fluke 43B has additional functions to facilitate troubleshooting in the field. The analyzer can measure ohms, test for continuity and check capacitor values. Temperature can be measured in degrees Celsius or degrees Fahrenheit. A scope function is also available, allowing for troubleshooting of electronic equipment. Additionally, up to twenty screenshots can be saved in the instrument and later reviewed or downloaded to a computer for analysis with the FlukeView® software.

In today's modern electrical environment, problems that were once overlooked can no

longer be ignored. Network communication devices, personal computers and specialized single-phase loads from medical equipment to copy machines must all function properly. Identifying and isolating the source of power quality problems that prohibit the proper functioning of this equipment is the job of the electrical professional. For those responsible for solving such power quality issues, the use of a single-phase power quality analyzer is invaluable. For those desiring to break into the field of power quality, the Fluke 43B Power Quality Analyzer is a logical choice.

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