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Backstage at Fluke Development:

Using the Fluke 6100A Electrical Power Standard to test the Fluke 430 Series Power Quality Analyzers

Technology at Work

Diagnosing power quality problems can test the ability of any technician. A host of factors—including harmonics, sags and swells, spikes, flicker, phase imbalance and more—can impair power quality, sometimes simultaneously.

And yet, because clean power is essential to keeping systems of all kinds up and running, accurate power quality analysis has never been more important.

Writing in EDN (March 2004), contributing editor David Marsh said "power quality rather than availability has become the dominant concern of electronics designers and systems engineers alike—and, ironically, the profusion of electronic systems is the prime cause."

That's why Fluke has been working for years to understand the factors that determine power quality. Now Fluke is putting that knowledge to work, creating sophisticated instruments that replicate power quality problems and introducing test tools that help technicians find and solve power quality issues.

The rulemakers

Power quality problems have drawn attention from both industry and regulators. European standards bodies are leading the way with rules and guidelines designed to control how electrical equipment affects power quality and ensure equipment is compatible with other electrical devices.

Though the standards are developing in Europe, they have global influence. Any firm that manufactures electrical equipment for the European market must know and comply with these standards.

Key regulations are included in International Electrotechnical Commission-European Normative (IEC/EN) 61000 series of standards, which relate to interactions between equipment and the power line. Major components include 61000-1-x definitions and methodology; 61000-2-x environment; 61000-3-x limits; 61000-4-x tests and measurement; 61000-5-x installation and mitigation; and 61000-6-x generic immunity and emissions standards.

A key section of the regulations, IEC 61000-4-30, governs tests and measurements. This section defines the method of measurement and interpretation of results for 11 power quality parameters in single and three-phase 50/60 Hz power supply systems. It also sets performance standards for measurement instruments. In the specification, for example, a Class A instrument must measure voltage to 0.1 % accuracy.

Consistent performance is a key principle. When instruments comply to the IEC 61000-4-30 class A measurements algorithms, all measurements, regardless of instrument manufacturer, must read the same, within the stated accuracy of the instrument, when testing the same waveforms.

Contracts as well as human health and welfare could be at stake, so it only makes sense that power quality measurement must meet high standards for accuracy and repeatability. In fact, vendors could be asked to prove that their test tool was calibrated against a verifiable and certified standard, and show a direct linkage between the calibration device and the national quality standards set by such agencies as the U.S. National Institute of Standards and Technology (NIST).

Fluke power quality development

In June 2002, Fluke introduced a solution: the Fluke 6100A Electrical Power Standard. The instrument quickly became the benchmark for instrument manufacturers, certification and standards bodies, utilities and third-party calibration companies, to design, calibrate and verify the performance of power quality test instruments.

The Fluke 6100A generates highly accurate electrical power signals—not just clean power, but a wide range of standard forms of distortion too. Users can program the 6100A to generate harmonic distortions, interharmonics, sags and swells, user-definable flicker and phase imbalances—and mix multiple distortions at once. This makes the 6100A ideal for simulating "real world" power quality phenomena and assessing the accuracy of power quality test tools.

At about the same time, Fluke introduced the 43B Power Quality Analyzer. The 43B united the capabililties of a digital multimeter, oscilloscope and single-phase power quality analyzer in one handheld tool. It measured power harmonics and captures waveforms, true-rms voltage and current, frequency, voltage sags, transients and inrush current.

Encouraged by the popularity of the Fluke 43B, Fluke designers set out to create a three-phase handheld power quality analyzer.

"We got more and more feedback from customers that they liked the 43, but they really needed a unit to measure all three phases simultaneously," says Henk ter Harmsel, Fluke product planner located in Almelo, the Netherlands, where the 430 Series was developed.

"With the development of IEC 61000 and the EN 50160 (electrical quality) standards, power quality, especially in Europe, is a hot item, because there are starting to be some legal implications. There have been lawsuits between big suppliers and big customers."

To understand the engineering principles behind the rather complex standards, the design team spent days discussing those standards with key standards committee members.

The design requirements were challenging. The new analyzer needed to be handheld and easy to use, deliver Fluke-level accuracy and safety, and measure all of the multiple factors that affect power quality: voltage, current, frequency, power, power consumption, unbalance and flicker, harmonics, dips and swells, transients, interruptions, voltage changes and inrush.

To solve the problem, the design team drew on Fluke's expertise in power quality, using the Fluke Precision Measurement 6100A Electrical Power Standard to test the performance of the Fluke 430 Series prototypes.

Testing all night long

As they developed the 430 Series, Fluke engineers programmed the 6100A to generate a variety of power characteristics, frequently letting it run overnight, feeding signals to the prototypes. In the morning, they examined the data the power analyzers had collected.

"I don't see how we could have done this amount of testing any other way," says ter Harmsel. "There are other ways to do individual tests, but the power of the 6100A is that you can perform multiple conditions at the same time, as required for the implementation verification per IEC61000-4-30. You can generate volts, frequency deviation, harmonics, interharmonics, flicker—all at the same time, and be able to prove that your instrument still works within specification."

Multiple conditions at once, of course, are just what the real world serves up.

The measurement algorithms used in the Fluke 430 Series are implemented according to the IEC 61000-4-30 Class A standards, including the flagging concept as described in the standard. The tools measure all four voltage channels, including neutral, with 0.5 % accuracy. Most competing handhelds calculate neutral, and could miss such problems as ground faults. Current, too, is measured on three phases and neutral.

In addition, these are the first power quality analyzers on the market that meet the CAT IV 600 V and CAT III 1000 V safety standard required for use at the service entrance.

"It's important to be able to test power at the service entrance," says Peter Harwood-Stamper, product manager for the 430 Series. "Not all power quality problems begin inside the plant or facility."

"Historically, building a handheld three-phase power analyzer was cost prohibitive," says Harwood-Stamper. "Now, with the advent of color screens and faster processors, as well as Fluke internal tools and expertise, we can deliver a lot more power in a handheld meter."

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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

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