Engineer's Notebook

Power Harmonics

They're being discussed and searched for in commercial and industrial facilities everywhere. But what are they, why are they important, and how do you tell if they're causing trouble in your power systems?

What Are Power Harmonics, and Where Do They Come From?

Harmonics are, very simply put, high-frequency current and voltage distortions within your power system. Their frequencies are integer multiples of the fundamental system frequency; e.g., if the fundamental frequency (the first harmonic) is 60 Hz, the second harmonic is 120 Hz; the third, 180 Hz; the fourth, 240 Hz; and so on.

Power harmonics have become much more prevalent with the development of high-efficiency electronic equipment. Personal computers, medical test equipment, solid-state motor drives, uninterruptible power supplies (UPS), etc., are designed to draw current only in pulses, during the peak of the incoming voltage wave. This results in a non-linear load, which, in turn, creates the distorted (non-sinusoidal) wave-forms that cause harmonics to flow back into the power system. Harmonics can be present in both single- and three-phase non-linear loads.

Ramifications and Symptoms of Power Harmonics

Left "untreated," harmonics can cause a multitude of problems, from compromised performance to overheating and component or system failure. Circuit breakers may trip at low current or fail to trip when they should. Of particular concern are harmonics called "triplens:" the third, ninth, fifteenth, etc. Triplens cause a buildup of current in the neutral conductor. In fact, in four-wire systems with numerous single-phase, non-linear loads, neutral current can exceed phase current, leading to dangerous overheating since there is no breaker on the neutral conductor. Excessive current in the neutral conductor can cause higher than normal voltage drops between neutral and ground at the 120V outlet and can also lead to bus bar overload.

Symptoms reflecting the presence of power harmonics are fairly straightforward. An early indicator is noise in your phone lines. Since telecommunications lines are generally run next to the power cables, inductive interference caused by triplens can be heard on a phone or can cause problems in your fax lines.

Other common symptoms are vibrating and buzzing electrical panels; premature transformer and motor failures; blown capacitors; circuit breakers tripping under normal loads; and hot-to-the-touch power system components. Personal computers are extremely sensitive to voltage harmonics, and may reset due to undetected, momentary power loss.

Not Always the Culprit

As troublesome as power harmonics can be, it's important to remember that they may not be the true problem. It's become fashionable to blame "PH" for system malfunctions, when simple explanations—such as defective equipment—are in order. So, it's often as vital to prove that harmonics don't exist in your power system as it is to discover that they do.

Troubleshooting Power Harmonics

Once you suspect the presence of harmonics, you can take steps to pinpoint specific trouble spots. A visual survey of your facility's in-use equipment, as well as a check of transformers for excessive heating, will give you a good idea of where to start. The next step is to choose the proper measuring and testing tools. These fall generally into three categories.

The basic tools are those used for checking current load and frequency, e.g., true RMS digital multimeters and clamp-ons. These typically feature peak (or crest), min and max modes, along with fast response time to detect transients and surges. Some have an LCD bargraph with the digital display so that frequency and current can be observed simultaneously.

The next level of instrumentation, harmonic analyzers, provides extended capabilities. These analyzers measure a wider array of parameters and feature a graphical display, which provides a scope-like "snapshot" of waveforms. In addition, such units can measure and display individual harmonic components out to the 31st; as well as total harmonic distortion (THD).

For the most sophisticated analysis work, select a power harmonics datalogger. As the analyzer reading is a "snap-shot" of harmonics, the logger is a "video." This has advanced measurement functions—such as power factor; phase angle; VARs; THD; odd, even, triplen harmonics; etc.—and full data logging and output capabilities. It allows you to record measurements with respect to time, which is extremely valuable in isolating factors causing harmonic distortion. The data logger's powerful software enables comparisons, analysis, reporting, and storage on your PC.

Return To Index