



By Don Horne

POWER QUALITY STARTS WITH GOOD WIRING AND GROUNDING



The modern requirements for high tech appliances demand top quality wiring and grounding.

Power quality problems occur when the alternating-voltage power source's 60-Hz (50-Hz in Europe) sine wave is distorted. In the past, most power-consuming equipment tolerated some distortion. Today, highly sensitive computers and computer-controlled equipment require a power source of higher quality and more reliability than standard, less

sensitive electricity-consuming equipment of the past like motors and incandescent lights.

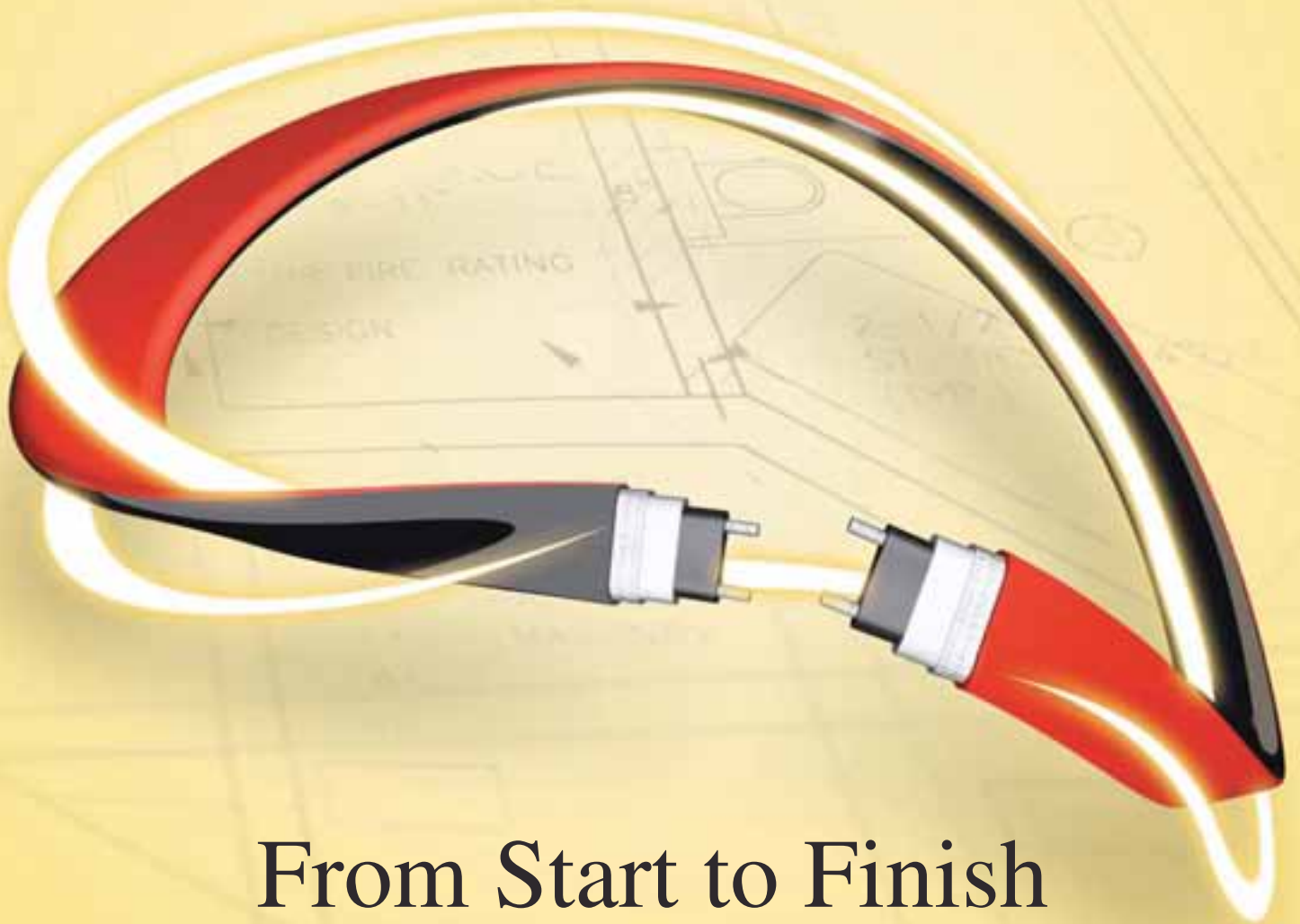
Revisiting electricity 101, an undistorted alternating-voltage sine wave repeats itself every cycle. The time required to complete one cycle is called a period. Because it repeats itself it is referred to as a periodic wave. The flow

of electrons is called current and is measured in amperes. Current times voltage equals electrical power.

To put the cost of power quality problems into perspective, power interruptions and disturbances are measured in the billions of dollars by North American industry. For the utility, ensur-

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ing that the generator can produce power at 60 Hz with little variation while the transmission and distribution sector maintains voltage within a plus or minus of 5 per cent is a never-ending balancing act.

Although Thomas Edison may have been right in touting DC as a far more reliable power source, the inherent disadvantages of Direct Current (such as the inability to transmit large amounts of electricity, as DC is only able to operate at generator voltage) have rendered any argument moot; even today it is difficult to argue with George Westinghouse about the many pluses of Alternating Current.

And thanks to Nikola Tesla and his sinusoidal wave, we are now all children of Alternating Current and the inherent power quality problems associated with it.

The science of analyzing power quality problems is predicated on experience. Measuring the effect of the problem and identifying the type of disturbance from the measurement may seem to some more akin to witchcraft than hard science. A common source of power quality problems is the interruption of the current or voltage sine wave, and this can be divided into two categories:

(1) the utility side of the meter which includes switching operations, power system faults, and lightning;

(2) the end-user side of the meter including non-linear loads, poor grounding, electromagnetic interference, and static electricity.

With today's sensitive equipment, like adjustable speed drives, voltage sags up to 90% of nominal may cause shutdown. Indeed, voltage sags are one of the major causes of production interruptions. This, along with single phasing and reclosure operations, constitute 99% of all interruptions of plant operations. These outages are less than 200 milliseconds (ms) or 12 cycles. The remaining 1% of outages are above 200 ms and more commonly extend to one or more hours.

Setting the standard for power quality are organizations like the Institute of Electrical and Electronics Engineers (IEEE), the American national Standards Institute (ANSI), the National Institute of Standards and Technology (NIST), the National Fire Protection Association (NFPA), National Electrical Manufacturers Association (NEMA), Electric Power Research Institute (EPRI), and the Underwriters Laboratories (UL).

The various bodies each contribute in their own way to setting power quality standards (for example, NFPA-75 protects

computer equipment, NFPA-780-95 covers building lighting from electrical fires while the Underwriters Laboratories are concerned with various electrical appliances and has developed a standard for the safety of transient voltage surge suppressors).

Manufacturers have been designing their equipment to be less sensitive to voltage variations, through such devices as capacitors to deal with voltage sags or by incorporating special K-factor transformers that can tolerate harmonics or use cables with neutrals large enough to carry triplen harmonics.

But with all the high-tech, high-priced power quality equipment on the market, the best solution to preventing power disturbances is to start with good wiring and grounding practices.

Although many electricians wire and ground facilities according to National Electric Code standards, they ignore the power quality aspects of wiring and grounding – and that contributes to 80 to 90 per cent of most power quality problems.

Some of the basic principles of wiring:

– keep the length of the wire to a minimum to avoid an unnecessary voltage drop on the conductor;

– connect wires solidly to panels and switchboards; and

– size and select the type of wires to match the current-carrying requirements of the load are all designed to minimize conductor and connector resistance.

Making the wiring right and grounding right eliminates a lot of power quality headaches down the road. Take the tools for detecting quality faults for example.

The tools to measure power quality are anything but simple.

Anmeters, voltmeters, multimeters, oscilloscopes, flicker meters, electrostatic voltmeters, infrared detectors, radio-frequency interference and electromagnetic interference meters, harmonic and spectrum analyzers, power quality monitors and the various types of wiring and grounding testers are many, reflecting the numerous potential problems confronting electricians in determining where a power quality problem lay.

It is the experienced hand that is needed to determine which tool is needed to find the type of problem, be it voltage swell, sag, any type of interruption, overvoltages, undervoltages, harmonics or transients.

Hours of labour and frustration are needlessly expended (along with a lot of money) when the basics of wiring and grounding are ignored or skimmed on.

It's easy to point the finger of blame at the utility when the power is infrequent and unreliable; but it is all the more likely that a company's power quality problems can be traced back to a wiring or grounding problem that – although meeting minimum code – fails to meet today's power requirements.

Here is a summary of data assembled by EPRI, the Electric Power Research Institute.

Study of 107,834 incidents of voltage variations:

68% involve 1 phase only

19% involve 2 phase only

13% involve 3 phase only

Study of 105 sites experiencing power quality problems:

70% involved 1 phase only

20% involved voltage sags

9% lasted less than 100-200 ms – 6-12 cycles

1% lasted longer than 6 cycles