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Wired for quality

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Commercial, institutional, and industrial electrical power applications all have one thing in common—an increased dependence on sophisticated electronics. The result is a trend toward increased capabilities and decreased equipment footprints. It is not only likely that this trend will continue, but also intensify in this new millennium. Unfortunately, as capabilities increase so does the equipment's vulnerability to power related problems. Therefore, to provide adequate protection and to assure optimal power quality it is important to understand power-related threats and solutions.

Sources

Let's begin by discussing the sources of poor power quality. It is common to think of power-related issues in terms of catastrophic events in the form of brownouts and blackouts caused by lightning, utility equipment failure and construction accidents. The truth is brownouts and blackouts account for approximately 5 percent of all disturbances, while nearly 95 percent of disturbances are caused by sags, surges and impulses. None the less, these less blatant power quality culprits result in the generation of electrical noise and noise is known to cause erratic data transmission between system components, data losses and equipment damage.

Another interesting fact is that 90 to 95 percent of power-related problems arise from within the facility. They are caused by:

- High harmonic distortion levels generated by adjustable speed drivers.
- Transient overvoltages resulting from capacitor and other in-plant switching operations.
- Resonance resulting from the use of power factor correction capacitors.
- Large surges and spikes that feedback into the electrical system caused by the very equipment we are trying to protect.
- Harmonic currents produced by fluorescent light fixtures and nonlinear loads created by equipment such as computers, printers and copy machines.

The good news is that nearly 75 percent or more of all power quality problems can be solved through proper grounding and power distribution, as you will see by the following examples.

Commercial and industrial facilities

Commercial and industrial power quality concerns can be divided into two broad categories: AC power and communications lines. Proper grounding is the best defense for both AC-powered equipment and communications lines. A standard grounding practice is to tie all electrically operated equipment to the facility's single-point ground. While this serves to equalize potential differences between neutral and ground, it may not be enough to protect equipment that is reliant on sophisticated electronics from lead inductance and/or stray capacitance.

Proper power distribution

and protection

Several additional steps can be taken to prevent noise from creating its own path in this fashion. First, equipment chassis can be tied together with a short and wide ground strap. Second, power strips can be used to provide single-point grounding close to the equipment.

Power strips are effective because they guard against ground loops, the phenomenon in which as frequency increases, the inductive reactance of a straight wire also increases. As a case in point, equipment plugged into a power source just 50 to 200 feet away can look like a high value resistor to a noise signal. Additional protection can be gained for sensitive electronic equipment through the addition of an isolated ground to the power distribution unit. This allows neutral and ground to be bonded together for specific pieces of critical equipment, reducing the potential for ground loops. In addition to grounding, various areas or departments critical to operations should be considered for surge protection.

On the AC power side these areas would include:

- The main service disconnect for the
- facility.
- Fire and security alarm panels.
- Motor control centers and HVAC.
- Branch circuit panels.
- Computer rooms.
- Process control centers.
- Workstations and computers.
- Office equipment .
- Lighting panels.

Critical operations and data storage areas should be protected further through the use of uninterruptible power supplies (UPS). However, on-line UPS systems are large and expensive. They require large battery-storage areas and maintenance. Therefore the current trend is to use point-of-use UPS in the form of stand-by systems.

Communications areas recommended for surge protection include:

- The facility's primary telephone service.
- Incoming data lines.
- Industrial data networks and PLCs.
- LAN and workstation communications.
- Fax and modem lines.

Surge protectors for primary telephone lines should be UL497 Listed to comply with Article 800 of the NEC. Operating frequencies are an important specification factor for devices protecting data communications lines to assure they do not interfere with normal data transmissions from RS232/422, Token Ring and Ethernet.

The telecom closet

Power distribution is perhaps the most critical factor in the protection of data and telecommunications equipment. Unfortunately it is often the last issue to be addressed. With more and more boxes being stacked into the same square footage, a number of creative power distribution methods have emerged. One such method is the use of a "daisy chain," the result of several power strips plugged together. This practice creates the potential for loose fittings, which more often than not lead to noise problems such as voltage drops. Additionally, while the length of the circuit wire increases, remember so does the probability of developing ground loops, leaving sensitive telecommunications circuitry at risk.

Critical healthcare facilities

No other single application has the critical demand for clean uninterruptible power than the healthcare industry. So much so that they go to great lengths to achieve high degrees of power system redundancy. In fact, it is becoming a common practice for healthcare facilities to go beyond backup power generators to use

dual utility feeds. This allows the facility to receive power from a secondary power plant if the primary power plant goes down.

Assuring continuous power is quite a different challenge than attaining optimal power quality. For applications such as healthcare facilities, the primary concerns include harmonics, voltage spikes and radio frequency interference (RFI). The first measure taken toward clean power is the installation of a transient-voltage surge suppressor (TVSS) at the main distribution board. To achieve the power quality level required for critical applications, TVSS should also be added to distribution switchboards of individual essential loads.

Site selection

Site selection for this second-tier of protection is determined by equipment sensitivity to surges, spikes and noise. Critical areas in a healthcare facility would include linear-accelerators, X-ray, computerized-tomography (CT Scans), magnetic resonance-imaging (MRI), electro-physiology and cardiac-catheterization laboratories. This is a small price to pay for protection against dirty power lines, carrying constant voltage spikes, which will inevitably destroy expensive medical equipment. Additionally, some medical equipment generates large surges and spikes. These disturbances are fed back into the electrical system, and can eventually damage other equipment.

Other concerns

Other power-quality concerns include the generation of harmonic currents by non-medical equipment and systems.

Computers, printers and copying machines are examples of nonlinear loads that can result in harmonic currents. Every measure should be taken to separate distribution for these areas from critical medical equipment distribution. Fluorescent light fixtures also create harmonic distortion.

Although recent design advancements have resulted in the development of fluorescent light fixtures with low total harmonic distortion (THD) electronic ballast, older facilities who have not upgraded their fixtures still have to deal with this issue. Finally, variable-frequency drives (VFDs) used for running motors in HVAC systems also produce harmonics in the electrical-distribution system's 60-Hz sine wave. In these cases, power conditioning is the best solution.

Basically, a power conditioner is an isolated transformer. The device has two coils including the primary and secondary transformer windings, physically separated from each other by air and insulating materials. The role of the power conditioner is to eliminate stray current paths through the unit, the load or differential between the primary and secondary windings by holding ground and anything referenced to it at the lowest possible impedance. They significantly reduce noise magnitude and strip away high-frequency components leaving only rounder, easier to tolerate noise.

Many hospitals also require uninterruptible power supplies. As with commercial and industrial facilities the current trend is toward point-of-use UPS. The advantages of the stand-alone UPS tied to specific equipment includes:

- Reduction of initial cost through the elimination of large battery banks and additional distribution equipment.
- Reduction in square footage requirements.
- Flexibility to easily move stand-alone
- UPS systems when equipment and personnel are relocated.

However, UPS do not protect against surges in the system like TVSS units.

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