How to Select the Right Power Protection for Biomedical and Laboratory Instrumentation

by

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Most laboratory professionals understand that it is imperative to follow the instructions of the manufacturer's site preparation guide in order to avoid system malfunctions and maximize the throughput and productivity of new sequencers, Gas-Chromatography/Mass Spectrometers (GC/MS) and other scientific instruments. Typically, there is a significant investment of capital in the system, its installation and operation. Operational costs include reagents, test samples and the scientist man hours. Ideally, these systems are set up to operate for five to ten years and even longer, which is extremely important to government agencies and organizations that operate on tight budgets. To help meet the equipment manufacturer's site preparation recommendations, this paper will focus on often overlooked or misunderstood power quality requirements of laboratory equipment.

Don't Take Chances with the Power Grid

There are a number of important issues that must be addressed by lab professionals weeks before their new equipment arrives to assure smooth implementation. One of the most vital issues is to assure that the lab's AC power is clean and stable to power the new equipment. There is often a common assumption that AC power coming from the wall outlet is reliable. It is not until one experiences a catastrophic power event, such as the blackout of 2003, that one becomes aware of the precarious nature of the power grid. Other damaging power anomalies, such as harmonics, high voltage transients and surges, are not as obvious as blackouts, but can cause serious equipment performance and reliability problems that may arise several months later.

Furthermore, generator backup systems fall short of the power quality demanded by sensitive laboratory instruments. Generator systems are unable to protect against poor power quality, have unstable output frequencies and create switch-over dropouts when the utility power is lost.

Selecting the Right Power Protection

In order to protect equipment from these costly power problems, many equipment manufacturers specify the use of an uninterruptible power system (UPS). Most site preparation guides that specify UPS installation frequently do not specify the UPS type and quality level that is required to

meet their equipment's demanding needs. The Institute of Electrical & Electronic Engineers (IEEE) defines UPS topologies in the following categories: "Off-line," "Line-interactive" (hybrid) and dual-conversion On-line. Due to the sensitive nature of lab instruments, a double-conversion "On-line" UPS is the best choice since it solves the widest spectrum of power problems. Line-interactive and Off-line UPS, while more economical, do not provide the high level of power protection and conditioning demanded.

The difference between these UPS topologies is often not clearly understood. About 90% of the UPSes on the market today are actually Off-line or Line-interactive designs. These battery backup units are low–cost and designed to address the basic backup needs of home PCs and office desktop computers. They leave the equipment connected directly to the power utility source until power is lost and then switch over to the inverter, creating a 10-20 millisecond drop out during the switch-over. This may be acceptable for PCs, but not for sensitive laboratory equipment.

Furthermore, the Line-interactive UPS or "Smart UPS" incorporates a boost/buck automatic voltage regulator (AVR). This provides a crude method of output voltage regulation when the UPS is operating from utility power. To accomplish this, the AVR senses the utility voltage and when out of a ±8 to 12% nominal voltage range, switches transformer taps in an attempt to keep the output voltage within acceptable levels. This is actually a band-aid approach and often causes more problems if used with laboratory instruments. Unfortunately, the AVR feature does not provide the continuous ±2-3% voltage regulation needed by the equipment. Additionally, the AVR must switch to battery mode to make transformer tap changes, which can cause excessive battery cycling and reduce the overall UPS battery life resulting in costly premature battery replacement.

By contrast, the dual conversion On-line UPS regenerates totally new sinewave power both in utility and battery backup modes. It converts the incoming AC power to DC, then filters and regulates it, and finally regenerates clean, new tightly regulated AC power. This active approach assures superior ±2 to3% output voltage regulation and provides the highest level of power conditioning demanded by sensitive laboratory equipment. Additionally, in contrast to Off-line and Line-interactive UPS designs, the On-line UPS only uses battery power when utility power is not present. Therefore, battery life is typically much longer than other UPS topologies. The On-line UPS has no disruptive switch-over drop when utility power is lost or restored. Most new On-line UPSes also provide input power factor

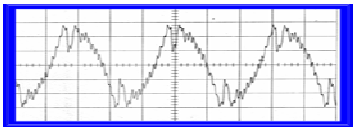

Fig. 1 Dirty and distorted power wreaks havoc with sensitive lab equipment.

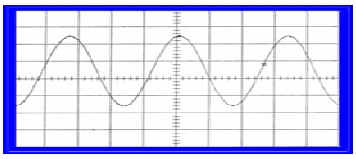

Fig. 2 Clean waveform after being regenerated by the Falcon On-line UPS. Noise, voltage drop-outs and distortion have been completely removed. Only pure sinewave power is being supplied continuously by the UPS output.

correction. This greatly reduces harmonics that may adversely affect building wiring and other equipment operating inside a lab.

Finally, another feature available with some On-line UPSes is galvanic isolation. This electrically isolates equipment from common mode noise paths, and increases equipment accuracy and data communications reliability.

The following is a real-world example of an application where power problems were an obvious issue and investing in an On-line UPS proved to be the final and reliable solution for lab productivity.

Real World Example: Veolia Environmental Services

In order to give their customers timely and accurate information to comply with California's stringent laws governing the disposal of waste by-products by manufacturers, Veolia Environmental Services relies on their Agilent GC/MS systems to give precise information on samples sent in by the hundreds for analysis.

Utilizing Veolia's services, customers are able to properly dispose of chemical waste, the byproduct of manufacturing electronics, computer recycling, blending fuel and other toxic materials in accordance with California's stringent environmental requirements. As part of this requirement, stringent tests are required in a controlled environment that has steady temperature and power. Several hours are needed in order to complete a testing run that yields the demanding results mandated by the Environmental Protection Agency (EPA). The tests are conducted at Veolia Environmental Services by a number of GC/MS instruments. A GC/MS is a very sophisticated system that draws power for both a heating element and the microprocessor-based on-board computer. For a short period of time after a test begins, the GC oven draws a very high current for the heating element. This brief power consumption presents a problem if the power is not clean or the voltage is unstable. A typical test involves 100 samples, takes 14 hours to complete and is conducted overnight.

Prior to installing the Falcon SG Series 3kVA On-line UPS units to power the spectrometer, Veolia would experience unexpected shutdown even if the power fluctuated momentarily. This in turn would render a total loss of the test run and any scheduled runs thereafter. Since the spectrometer would assume that the power failed - even if there was a surge, spike or other brief power anomaly – the unit would go into stand-by mode, rendering the test run a complete loss. In order to combat this situation, Veolia installed a popular brand Line-interactive uninterruptible power supply (UPS).

“According to the GC and GC/MS manufacturers, a UPS protecting this equipment has to be able to deliver power instantly and cannot have any switchover delays. After we installed the UPS, we noticed the problems didn’t go away and realized that the UPS had a switch-over time of several milliseconds, which proved too long for the spectrometer to continue its test run,” explained Shafiqul Alam, Technical Support Manager at Veolia. “After discussing the situation with the GC manufacturer, I realized that we needed a true On-line UPS, one that didn’t have this switch-over. I researched various vendors’ UPS technical specifications and found out that Falcon Electric offers an extensive line of true On-line systems that could meet our needs. I contacted Falcon Electric and discussed my requirement with their engineers. After reviewing my requirement, they recommended the SG Series 3kVA UPS (SG3k-1T). They simply did not stop there – they offered me a unit for purchase with a trial period. I accepted the offer and evaluated it for my application. Using the supplied UPSilon® 2000 software, I was able to monitor UPS activities, including load tests for various oven temperature ramps. It definitely met my requirement – I was very happy with the UPS’s capability and its price. Since then, Alam has purchased seven more and decided to include Falcon SG Series UPS with all delicate equipment in future additions.”

Falcon offers a true On-line, double conversion UPS which means that there is no switch-over. In fact, their UPSes are similar to a solid state power generator which, by design, continuously provides a steady stream of 220 volts at 60Hz.

Since installing Falcon’s SG Series UPS with power monitoring software, Veolia has not lost one test because of power pollution or voltage fluctuations. Alam added, “The monitoring software is especially useful since I have proof that a power anomaly occurred. Prior to installing the UPS, a power surge ‘fried’ an entire board because the power exceeded the limited tolerance of the spectrometer. Though the vendor was very responsive and made the needed repairs, the resulting downtime was a problem. Since the Falcon UPS has been on duty, we haven’t experienced any burned out boards. While it is hard to say if this is solely the result of installing the UPS, I know that power anomalies have been the reason for the spectrometer shutting down. This is a tremendous benefit for our business. In addition, since I installed the power monitoring software I have noticed, on several occasions, that power problems occur during the night.”

Conclusion:

By the nature of laboratory environment, the work being performed is exacting. The reliability of lab equipment and its test results must be absolutely assured as the very credibility of your lab may be at stake. Don’t take the unnecessary risk of ineffective power protection. Protect all of your key laboratory equipment with a high quality, double-conversion On-line UPS.