Why You May Not be Getting as Much Protection from Your UPS as You Think

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As business assets are becoming increasingly digitized, businesses rely more heavily on computers and other essential electronic equipment. An untimely power outage can be a real headache - or worse - causing lost data, scrapped parts, patient discomfort and more. Uninterruptible Power Supplies (UPS) are often used to protect sensitive downstream equipment from power fluctuations and outages. At least that is the plan. In reality, depending upon the UPS technology employed, the protection may not be what you think - leaving businesses with less protection than they bargained for.

Just as there are multiple ways to get from "point A" to "point B" including cars, motorcycles, bicycles, on horseback, or walking to name a few - there are several UPS technologies available. While they both do the same types of things - provide back-up power to shut down systems, for example, how they achieve these can have significant impact on the business assets that they are designed to protect. Two leading technologies that will be compared and contrasted are line-interactive and online technologies (also called single conversion and double-conversion).

What's My Line?

Line interactive UPS technology is the less expensive of these two technologies, and that is one reason why it is also the most common. Think of this type of UPS as "batteries in a box." This technology monitors the incoming line voltage and supplements it with battery power when the voltage drops below a certain level. Line interactive designs may include a tap-changing transformer which adds voltage regulation by adjusting transformer taps as the input voltage varies. The transfer time, which is inherent with the line-interactive methodology, is typically 4to 6 milliseconds, a period which is noticeable to both human observers and more importantly, downstream sensitive electronic equipment.

Online UPS technology, on the other hand, takes the incoming utility alternating current (AC) and converts is to direct current (DC) which charges the batteries. The direct current (DC) is then converted back to AC (double conversion) which is supplied to the protected load as clean power at the desired voltage. Because the inverter is always connected to the output of the UPS, the double-conversion technology produces a clean sine wave and also reduces harmonics, further protecting downstream equipment. Dropping the incoming voltage does not cause activation of the transfer switch (to batteries) because the input AC is not the primary source - it is the backup power source. An input power failure, therefore, does not cause a transfer, so there is no transfer time.

With this understanding of how each technology operates, let's look at some common situations and how each technology handles them. In our examples we'll assume that the incoming line voltage is nominally 120V, but the scenarios could be presented for any line voltage, including 220, 240, 480, etc.

Power Outage

A power outage is perhaps the most common reason why companies install UPS systems - they want to be protected in case of an emergency. That is why Fonar, a maker of the world's first stand-up MRI, uses a UPS for their patient table.

So what happens when the incoming line voltage drops? With a line interactive UPS the batteries switch on, providing power to the protected load. The time provided by the batteries is dependent upon such factors as how many batteries are available (or how the UPS is sized relative to the protected load), and the condition of the batteries.

In the Fonar example, for instance, if there were a power outage while a patient was undergoing an MRI, there is sufficient power to retract the table from the enclosed MRI area. Without this measure in place, the patient might be stuck inside the tubular area - which can add even more stress to this uncertain situation.

UPS system in a power outage situation

Sags Are More Common but Less Symptomatic

While power outages are the reason that most businesses install UPS systems, they are perhaps the least occurring incidents. A far more common instance is sag, so named because the incoming voltage sags below normal range. Unlike the outage, there is still voltage to the system but it is below normal, acceptable levels.

With a line interactive UPS, a sag can also cause the batteries to switch on, depending upon the severity of the sag. If incoming live voltage is 120 V, and a sag occurs which causes the line interactive UPS to switch to batteries, the power output is not the 120 V that the system is designed for, but usually a lesser figure - maybe 100 V. While this keeps the downstream equipment powered up, it may not be performing optimally. Depending upon the protected load, this voltage shortage may be enough to cause irregularities such as dropped or corrupted data, overheated transformers and other maladies.

Keep in mind that typical utility power is supplied at plus or minus 10 percent of nominal, which means that for a 120 V line a variation of 108 V to 132 V is within standards. If variations in voltage are frequent, the line interactive UPS may be reverting to battery power often - resulting in premature battery failure.

The same scenario with an online, double conversion UPS would yield different results. Because this system is creating a clean, stable sine wave continuously, it can handle sags without even going to battery. Note that when subjected to the same voltage fluctuation which caused the line interactive UPS to switch to battery power, the online UPS is able to produce a steady 120V of power output.

Even locations which have fairly consistent power are subject to sags due to local usage patterns, for instance, in a manufacturing facility where equipment is powered up all at once. Because the demand has gone from near zero to near max, there is a temporary sag in the utility voltage until the supply can catch up to the new demand. Similar instances occur in office buildings where most employees start work (and fire up their computers, lights, etc.) at the same time.

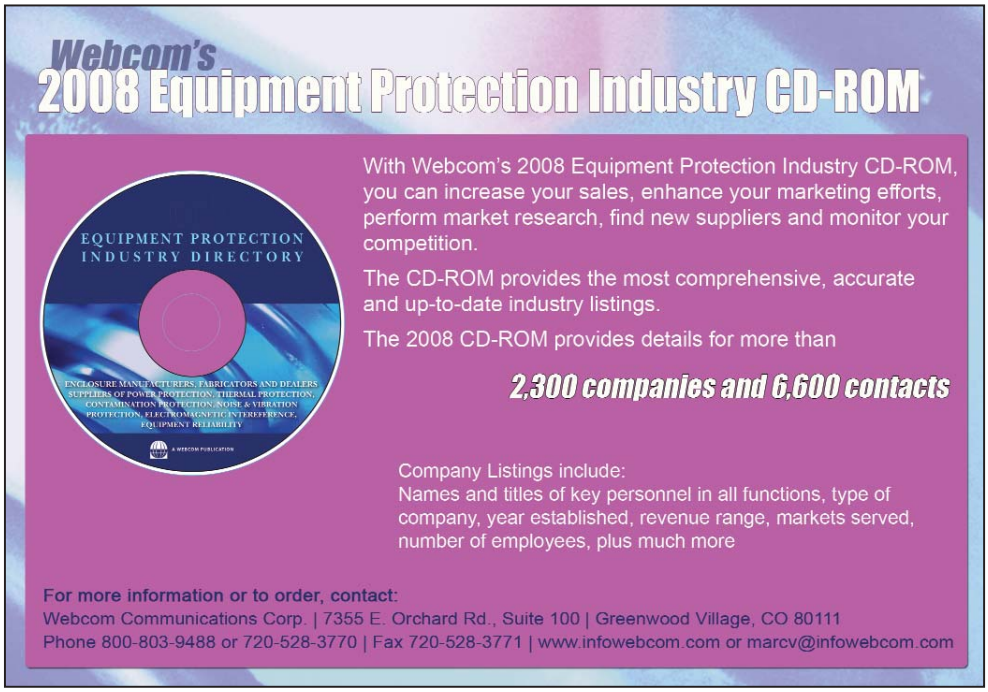
UPS system in a power sag situation

Over-Voltage - Another Hidden Danger

On the opposite side of the spectrum from low voltage situations, or sags, are high voltage situations or "swells" (so named because the voltage "swells" above normal levels). Recall that typical utility voltage is supplied at +/- 10 percent - meaning that incoming line voltage can be as much as 10 percent higher than anticipated. So 120 V line could really be sending 132 V through to the UPS. Whether this happens with regularity or only infrequently, this situation is hard to identify because, like sags, swells present few symptoms.

While swells occur for various reasons, one common occurrence is a sudden drop in demand for power - such as at the end of the day when a lot of computers, lights and production equipment are being powered down for the day.

Swells are problematic for line interactive UPS



technology because there is nothing within the technology to combat this situation. Therefore, increased voltage is merely passed through the UPS and into the protected load. What makes this most precarious is that there are few symptoms presented - other than shortened service life of the equipment, and potentially blown fuse and tripped circuit breakers.

UPS system in a power swell situation

Online UPS technology, however, can accept this situation without difficulty because of the double conversion process. Recall that regardless of the input voltage, the UPS is generating a clean, steady, stable sine wave - allowing it to pass through 120 V power to the protected load.

Harmonics Could Keep Your Equipment (and UPS) Off Key

Harmonic power quality is another variable which is worth considering when discussing the merits and drawbacks of UPS technology. Harmonics are very prevalent and can be found in locations from manufacturing sites to accounting firms. Harmonics is a term used to explain currents and voltages that have multiplied within an electrical system. A harmonic spectrum can exist from the 3rd through the Nth order. A harmonic order is a specific measurable amplitude existing within this spectrum. The presence of harmonics can cause serious distortion of the sine wave, which shows both a normal sine wave, a 5th order harmonic wave and a sine wave distorted by the presence of 5th order harmonics.

Common causes of harmonics include adjustable speed drives, variable frequency drives, electronic welding equipment, transformers and generators, medical imaging equipment, lighting controls & dimmers, computers, copiers and scanners, and more. These may cause problems such as interference with telephones and communications systems, overheated conductors, bus bars and switch-gear, tripped or arcing circuit breakers and overheated motors. Harmonics can also cause wires to become hot (leading to its premature failure), insulation to break down and reduced equipment life.

So what do harmonics have to do with UPS technology? The answer might be "plenty" depending upon what type of UPS is selected. Line interactive UPS technology has no mitigating effect on harmonics. If harmonics are present on the incoming voltage, they will be passed through in the battery-boosted voltage output, and their detrimental effects will also be passed along.

Since online UPS technology creates a clean, stable sine wave - this technology has a mitigating effect on harmonics. If there are harmonics present on the incoming voltage, this will be removed from the output voltage - saving downstream equipment from the harmful effects.

Battery Life and Operating Costs

Batteries are a crucial and sensitive part of a reliable UPS system. The type of UPS chosen can have a dramatic effect on battery life and operating cost.

To determine how much power is needed from the UPS, users should take into consideration what the critical power needs are. For example, will battery power be required to simply shut down the protected load in a systematic and efficient manner (to eliminate scrap, protect business assets, etc.), or is power needed for a longer time period - like bringing an emergency generator online?

UPS manufacturers publish full-load and half-load runtimes. Full-load means the amount of time the UPS will run at its maximum capacity before the batteries are depleted. Half-load is the amount of time the UPS can supply power at half of its maximum capacity. Typically under full-load conditions a UPS will last only 1/3 of the time it would under a half-load demand.

Incoming line voltage stability also plays a part in battery life. As we have seen, when deployed in a fluctuating voltage scenario, single-conversion (line interactive) UPS will go to battery power often. This depletes the battery power and shortens their service life (as well as speeds their replacement interval - thus driving up the cost of ownership). More critically, though, the depleted batteries have less energy for an emergency situation like the power outage that they were initially purchased to protect against. So they have limited availability when they are most needed.

Online double conversion UPS technology, when faced with a fluctuating voltage scenario, can supply the desired voltage without reverting to battery power. That means that the batteries stay fully charged and ready for use during an emergency. Because the batteries stay charged they provide full power during power outages. They also tend to last for the stated service life - driving down operating costs while still providing a stable voltage output.

Sizing

Regardless of which type is selected, the UPS must be properly sized to accommodate the protected load. That means that it should have at least 25 percent greater capacity than the total power capacity requirements of all the equipment that will draw from the system. To determine the power requirements, check the plates on the underside of back side of the equipment. Most likely this will list required voltage. Sometimes the power requirements will be listed in amps - if that is the case, simply multiply the amps by the line voltage (usually120 V in the US).

Once you have the power requirements, multiply this figure by 1.25 to determine the capacity required (be sure to factor in anticipated growth which would add equipment to the system).

There are countless industries and applications which may benefit from the protection that a UPS provides. While cost is surely a factor, the initial purchase price advantage enjoyed by line-interactive UPS technology may be offset with reduced equipment life and other downstream equipment costs which may not be readily apparent. In short, the lowest initial cost approach may not yield the greatest economy in the long term.

There are many applications which can suffice very well with the less expensive line-interactive variety, but there are also applications which would benefit (operationally and economically) from the use of online, double-conversion technology.

One key to making a good decision is gathering pertinent information and weighing appropriate options. One size does not fit all. But a sound decision can provide years of positive returns on the initial investment.

About Staco Energy Products: *Staco Energy Products Co. is a provider of voltage regulation, power conditioning, power factor and harmonic correction plus single and three phase uninterruptible power supplies. For more than 65 years, customers worldwide have relied on Staco Energy Products as their dependable source for standard and custom solutions to a wide range of electrical power problems For more information, visit www.staco-news.com, call 866-266-1191, or write to Staco Energy Products Co, 301 Gaddis Blvd, Dayton, OH 45403, or sales@stacoenergy.com. .*

Why Digital Equipment Needs UPS When Their Predecessors Didn't

Older, analog equipment usually fared quite well following a power-outage because their mechanical switches and knobs stayed in the same positions - so there was no re-setting of the equipment following a power anomaly. But with digital technology, a power drop - even for a mere second - can mean that the equipment must be completely re-configured - a time-consuming manual process. (Think of a power drop to digital equipment as the equivalent of randomly moving all of the switches and dials on analog equipment.) These can be expensive both in terms of raw costs as well as the costs to a company's reputation.

Take the radio broadcast industry as an example. As stations replace their analog consoles and equipment with newer digital versions, they learned the hard way how time consuming it can be to manually re-set the many parameters following a power anomaly. In an industry like broadcasting where time is money - lost time directly impacts the ability to sell ad space (and thus generate revenue). In addition to lost revenue stream, broadcasters must consider the value of their company's reputation. On-location sports broadcast trucks have learned this lesson, which is why rack mounted UPS panels are standard for remote broadcast trucks like those used for sporting events.