



## **The Need for Rugged Power Protection Is Your UPS Surgeworthy?**

By George Oughton

### Introduction

Providing proper power protection for today's advanced broadband networks is essential in the highly competitive telecommunications industry. Service interruptions, even for a few seconds, are no longer acceptable. As telecommunications networks begin to provide important on-line services, consumers will become even more intolerant of service interruptions. The use of uninterruptible power systems (UPS) is critical to any network operator wishing to establish a respected presence in the telephony and entertainment industry. UPSs are the main defense against power problems, helping to prevent network downtime and system component damage. There are a number of dependable, trusted power protection products on the market, but not all UPSs are the same.

There are both AC and DC UPSs. An example of a DC UPS is a telecom rectifier used in the telephone industry feeding a battery, which in turn feeds the load. These DC UPSs can be stand-alone or imbedded into a product. The opportunity for imbedded DC UPSs is rapidly growing as distributed power architectures become more popular. There are three distinct AC UPS topologies: standby, line-interactive, and on-line. Standby (also known as off-line) UPSs consist of a basic battery/power conversion circuit and a switch that senses irregularities in the electric utility. The load (a computer or some other type of electronic device) is usually connected directly to utility power. Power protection is only available when there is an outage. However, some stand-by UPSs include surge suppression circuits or power line conditioners to increase the level of protection they offer. Line-interactive UPSs offer a higher level of performance by adding voltage regulation features to conventional standby designs. Like standby models, line-interactive UPSs try to protect against power surges by passing the surge voltage to the load until it hits a predetermined limit. At this point the unit switches to battery, but only after passing most surges through to the load. Line-interactive units can provide moderate protection against high-voltage spikes and high frequency transients, although they do not provide complete isolation for the load. On-line AC UPSs use a double-conversion (AC to DC, DC to AC) power circuit, while DC UPSs eliminate the final AC to DC conversion stage. Both types of on-line UPSs continually power the protected load, providing both conditioned electrical power and outage protection. An on-line UPS, whether it be DC or AC, provides complete isolation from most types of power problems. But a special type of rugged UPS can protect against and withstand a particularly troublesome type of transient - the low-frequency, high energy surge. Few manufacturers can claim to protect against this type of power problem.

Most notably is Exide Electronics, a leader in the power management industry for more than 30 years.

### Ruggedness

Smart sailors will not embark on a boating trip without a complete understanding of their ship. The boat must be reliable, able to navigate calm seas. But the boat also must be rugged, able to withstand even the most stormy weather conditions. Network managers should not expect less from their UPSs. Managers need to have a UPS that is reliable enough to protect their critical loads. But as with boats, the network environment can also be very demanding. To assure constant and consistent power protection, the UPS must be rugged as well. Ruggedness is the foundation of reliability.

Unfortunately, a reliable UPS does not automatically make for a rugged UPS. Power problems come in many different forms, ranging from long-lasting blackouts to quick, sharp spikes. Most UPSs are reliable, designed to protect and withstand the most notable power problems. However, low-frequency, high energy surges are very difficult to protect against and can cause considerable damage both to the UPS and to the load. A rugged on-line UPS handles low-frequency, high energy surges by preventing it from passing beyond the UPS rectifier. A standby or line-interactive UPS lets the surge through, passing the damaging energy directly to the load and exposing it to potentially harmful consequences.

### Surges

Power surges may be periodic or random events and can appear in any combination of line, neutral, or grounding conductors. Some surges may have sufficient amplitude, duration, or rate of change to cause equipment damage or operational upset. Input surge transients, in particular, are receiving growing attention because of the increasingly widespread use of complex electronic devices that can be damaged by voltage surges. There are two main types of input surge transients:

#### High-voltage, fast surges

#### Low-frequency, high energy surges

It is the low-frequency, high energy surge that the network manager needs to be most aware of because, as discussed above, this type of damaging surge usually passes straight through off-line or line-interactive UPSs - and through some models of on-line UPSs. A low-frequency surge can quickly cause considerable damage to sensitive components such as broadband amplifiers. A low-frequency surge waveform is taller and narrower than a normal sine wave, but is not nearly as tall and narrow as a high-voltage spike. Ironically, many people believe it is the high voltage spike that can cause the most damage. However, the reverse is usually true because the high-voltage spike can easily be clamped down and its duration is a fraction of a low-frequency surge. The following excerpt, taken directly from the IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits,

supports the fact that low-frequency surges have the potential for greater damage: "It is not uncommon for the frequency of a capacitor switching surge to be much less than five kHz, as low as 300 Hz. The lower the frequency, the greater available energy." In other words, the greater the available energy, the greater the possibility of damage to the load if allowed to pass through the UPS. These damaging low-frequency, high energy surges are more common than many network managers realize and are caused by normal, everyday events including:

Foreign objects on the utility line, such as squirrels and tree branches, creating a short and causing a circuit breaker to open.

Power factor correcting capacitor banks, which are used by utilities and large facilities running many large motors. These capacitor banks can draw tens of thousands amps of surge when switched on. If they switch on at the time the sine wave is near or is at its peak, the resulting low-frequency surge will be most damaging.

Survive and Buffer

Think of high-voltage, fast surges and low-frequency, high energy surges as potholes and the UPSs as shock absorbers on a car traveling 60 miles per hour. A high-voltage spike is analogous to a pothole nine inches wide and six feet deep. This type of pothole would cause little to no damage to the vehicles passing over it. The shock absorbers on the vehicle are designed to absorb the small, quick bumps. Low-frequency, high energy surges, on the other hand, are comparable to a pothole six feet wide and nine inches deep. A pothole of this nature will cause considerable damage to the vehicle passing over it, for most shock absorbers cannot withstand or protect against such bumps.

Most UPSs are designed to handle a high-voltage spike, a common occurrence, by utilizing surge suppression components, such as metal oxide varistors (MOVs) and spark gaps. These surge suppression devices clamp down on the spike, at between 200 and 300 percent of the normal voltage level, diminishing its energy to the point where it cannot cause harm to the load. A low-frequency surge, however, is usually not effected by surge suppression components because its voltage is lower than their clamping level. Also, the fact that these surges have a longer duration than high-voltage spikes is what allows them to deliver more damaging energy.

Not all UPSs on the market are rugged enough to survive and buffer these low-frequency surges. Engineers and network managers should be aware of the IEEE C62.41-1991 recommendations that contains the recommended practices for surge voltages in low-voltage AC power circuits. The recommendation provides a practical basis for selecting voltage and current tests to be applied in evaluating how well equipment can withstand power surges when connected to utility power circuits. This recommended practice covers a wide range of topics including the origin of surge voltages, rate of occurrence, and source impedance. The recommendation urges "designers and users to consider the

specific application environment and call for additional waveforms if their knowledge of the environment justifies the added complication of testing for these additional waveforms.”

#### Bulkless Front End

The difficulty that low-frequency, high energy surges present create the need for a special on-line UPS design. Figure 3 shows a conventional power factor corrected high frequency converter DC UPS, the type most power protection providers manufacture. The conventional design has two conversion stages. The first stage is a power factor corrector that utilizes a boost converter to send incoming line power up to a bulk capacitor. The second stage is a high frequency converter that outputs power through a high frequency transformer. A low-voltage, high energy surge passes directly through and into the bulk capacitor. The capacitors are usually electrolytic and have very limited overvoltage capability. Their high capacitance values (typically 1000 ufd/KW) can cause very high (up to 1000A) input surge currents which, in turn, can overstress input components.

In contrast, the high frequency series resonant converter shown in Figure 4 is designed to provide a high input power factor (>.99) without the need of a separate power factor correction stage. This eliminates the bulk input capacitor, creating what is known as a “bulkless front end” and eliminates the problems associated with the conventional design. As compared to the conventional design, the input capacitance can be as low as two ufd/KW, reducing input surge currents to less than 50A.

#### Beyond Reliability

Power management is key in designing and operating an efficient and reliable network. Choosing the best UPS for your broadband network is not an easy task, but should be approached with a critical eye and a demand for the highest quality possible. Don't be fooled by manufacturers that tout reliability as their only selling point. Reliability is only one consideration in a detailed selection process. The ruggedness of the UPS is not a visible characteristic, but one that should be strongly considered in the purchase decision.

Solving easy power problems is relatively simple to do. Solving the difficult power problems, such as low-frequency, high energy surges, requires a UPS with an extra edge. But whether the power problem is easy or hard to solve, the end result will be the same. Your network will suffer the consequences of an unacceptable interruption, potentially causing component failure, or worse, loss of your customer's trust unless protected by the proper UPS.

Is your UPS surgeworthy?

Take this opportunity to contact us at [info@psd.invensys.com](mailto:info@psd.invensys.com) if you have any questions.