BroadcastEngineering®

Backup power

Find out what type of UPS system is best for your facility.

BY PAUL HEILIGENBERG, EE

Facility AC power is often taken for granted. Unfortunately, when it fails, or when it becomes noisy or intermittent, the problems those issues cause may become serious.

The primary reason to install UPS systems is to protect against power outages. The key point to remember is that UPS systems are not designed to supply long-term power. A UPS should be considered a *bridge* to an alternative power source, typically a generator or secondary AC mains. Unless the UPS system has a huge stack of batteries, backup power may last from two to perhaps 15 minutes.

UPS systems come in a wide range of sizes, with many features and functions. The bottom line for engineering managers should not be: Do I need UPS protection? Rather, it should be: What type of UPS system is best for my application?

Let's look at some options.

Types of UPS solutions

There are three basic types of UPS technology: passive-standby (offline), line-interactive and double-conversion (online). Each of these three technologies do basically the same thing — provide back-up power long enough to safely shut down systems or get a generator started. However, the differences in how they operate and the performance level offered need to be examined in light of user goals.

A *standby UPS*, sometimes called an *offline UPS*, is the least expensive of the three technologies. (See Figure 1.) The key differentiating component is the transfer switch. It routes primary AC to the load during normal operation. If the AC mains fail, the relay switches to the output of the inverter, which is powered by the battery.

A key drawback of this design is the time it takes for the mechanical transfer relay to operate. Switching times of 1.5ms to 6ms are common. Older, analog equipment often faired quite well if a power blip was sufficiently short. An analog TBC might perk along without notable interruption. But with digital technology, a power drop — even for a few milliseconds — can result in any number of scenarios, most of which are not career enhancing.

If the power supply of the downstream device can ride out periods of AC interruption, this technology provides a cost-effective solution. If, however, key downstream digital devices cannot handle even brief power outages, consider an alternative.

A *line-interactive* UPS, shown in Figure 2, 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.

This solution does not suffer from the outage problem of a transfer switch like the standby UPS. The DC-to-AC inverter is always connected to the load. And this solution provides some degree of line noise filtering and conditioning, so it is better in that respect than a standby solution.

One potential issue with this design is that if your facility suffers from low voltage (sags, which are described below), the batteries are continually in use. This may result in shorter battery life.

The *double-conversion, online UPS technology* shown in Figure 3 totally isolates the load from the primary AC line. Noise,

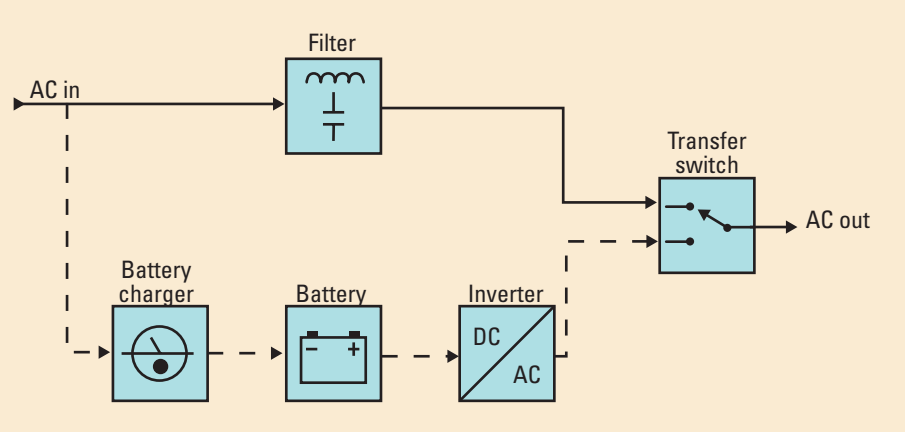

Figure 1. The least expensive backup solution is the passive-standby (offline) UPS. However, unless your equipment can endure the outage time of the transfer switch, it may not be the best solution.

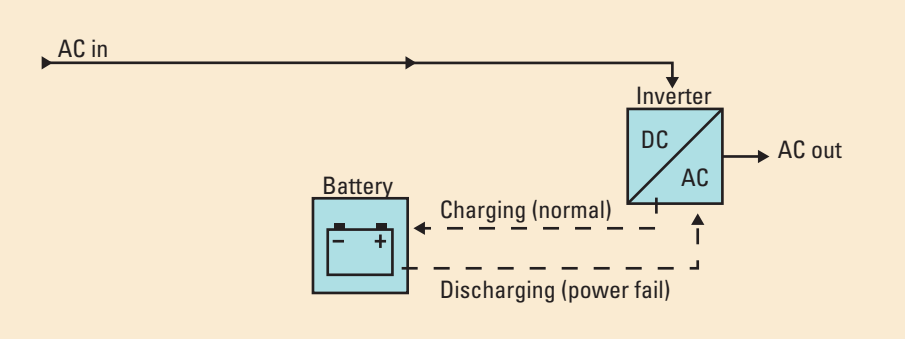

Figure 2. Line interactive UPS solutions are commonly used for 0.5kVA to 5kVA loads. Because the inverter is always on, loads are provided with additional filtering and lower switching transients compared to the standby UPS solution.

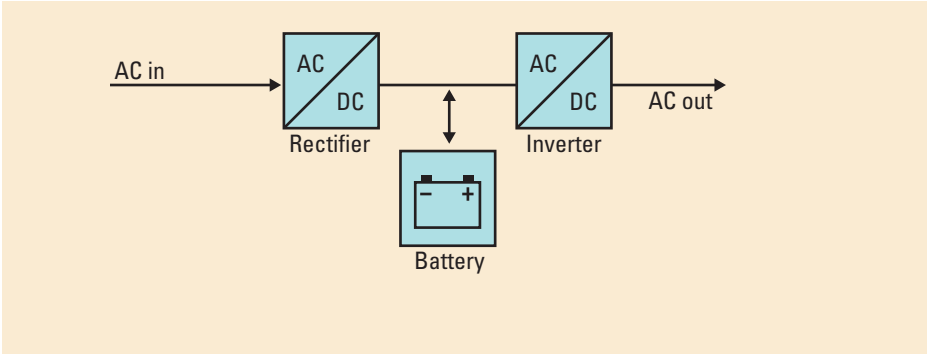

Figure 3. A key advantage of a line-interactive, double conversion UPS is that the load never sees a primary AC interruption.

sags, swells and outright power failure issues never reach the load.

The supply takes the incoming utility AC power and converts it to DC. The DC voltage is used to both charge the batteries and, more importantly, provide all of the downstream power. This process of converting AC to DC and then back to AC is called *double conversion*. These UPS systems can power 10kVA and larger loads.

The output voltage of this type of online UPS is not interrupted if the main power fails because it is continually producing output AC power through the DC/AC inverter. When the power fails, the batteries feed the inverter, and the output power continues uninterrupted.

The output of a double-conversion, online UPS is typically cleaner than line interactive devices because the double-conversion process removes any noise that may be on the incoming AC lines. The output is a regenerated clean and noise-free sine wave output.

Power quality

A second, and often less well-understood, issue about selecting backup power systems concerns voltage stability. Any power swell (increase) or sag (decrease) that exceeds +20 percent or -30 percent of the nominal voltage for more than 20ms (1.2 cycles) is likely to cause some digital equipment to fail outright, or generate errors.

If sags or swells are reflected through a device's power supply, they can play havoc with performance. For example, equipment designed to initialize upon startup may re-initialize after a severe sag. It confuses the sag with the turn off and turn on of power. Other equipment may simply shut down and stay that way if the voltage drops below a certain value for more than a few milliseconds.

Particularly disruptive situations may occur if a sag causes some devices in an integrated system to shut down and then restart after recovery, but the balance of the equipment does not. Consider that IP routers and modems require a specific boot-up sequence to reliably initialize themselves. If devices come back online in errant order, a 3ms power blip could turn into an engineering nightmare.

The opposite of a voltage sag is a voltage swell. Most consumer power runs a nominal 120VAC. If the AC mains swell by 10 percent, that means 132VA is being fed to every device. While most laptop power supplies can handle anything from 120VAC to 240VAC without problems, the same cannot be said about rack-mounted broadcast gear.

Over voltage can shorten the life of equipment, cause device failures and cause overheating. If equipment power supplies run hotter than normal, capacitors may dry out faster. Also, the extra heat generated places an additional load on a facility's HVAC and may stress nearby, rack-mounted equipment. The bottom line is that UPS that provides proper voltage regulation is a plus.

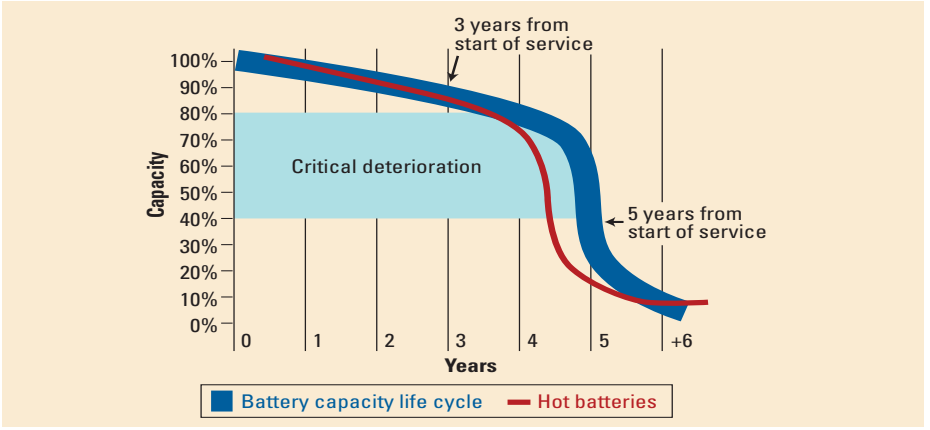

Figure 4. The IEEE recommends battery replacement within one year if its capacity is determined to be below 80 percent of the manufacturer's rating. Figure courtesy IEEE.

Battery life

The last aspect of UPS operation we'll discuss is that of batteries. Each UPS technology affects the life of its batteries differently. One point should be obvious: The more a battery is used or the hotter it gets, the shorter its lifespan. See Figure 4.

In a fluctuating voltage scenario, a single-conversion (line interactive) UPS will switch to battery power often, sometimes for less than a second. Even such brief operations deplete the battery power and shorten their service life. More critically, depleted batteries have less energy available for the true power outages.

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 are 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.

Finally, and not to be understated, batteries are classified as hazardous waste. Federal law requires that all used lead-acid [Pb] batteries be managed as Universal Waste under the CFR, Title 40 – Protection of Environment, Part 273 – Standards for Universal Waste Management. For this reason alone, facilities with a large number of Pb valve regulated or wet cell/flooded batteries often hire approved firms to handle all battery installation/maintenance and replacement. The potential for spills, improper disposal and resulting liability are just too great. Anyone recall the days of PCB disposal?

Fortunately, today's UPS technology is mature, reliable and cost-effective. If your facility needs this type of short-term bridging backup, you have many options from which to choose. BE

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