
Where, When and How To Apply Uninterruptible Power Supplies

The three primary situations that warrant specifying a UPS



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Advances in microprocessor technology have made computerized equipment available to many industries. But the equipment is sensitive to power-line disturbances. A UPS can help.

Reprint from Consulting-Specifying Engineer

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Today's computers have been enhanced with large-scale integration (LSI) and very large-scale integration (VLSI) technologies, resulting in chips containing thousands of semiconductors and their interconnections. The power rating of these logic and memory devices has decreased while response time has improved tremendously.

Despite their improvements, microprocessor-based computers and process-control systems still are extremely sensitive to power anomalies such as brownouts, blackouts, spikes and noise pulses. While electric utilities make every effort to provide steady, relatively stable power, there is no guarantee of problem-free service. Therefore, specifying an uninterruptible power supply (UPS) system is like getting an insurance policy against the consequences of unpredictable power.

There are three primary situations that warrant specifying a UPS. The first is applications that require an orderly shutdown of computers or process equipment during a power outage. Examples include situations where computer data must be saved to weather a lengthy blackout, or chemical-plant personnel need to know the status of critical valves and other operating parameters in the event of a complete process shutdown. (Preserving this data aids in restarting a process quickly.)

The second situation is any application where operation must continue during a total power loss. In these cases, the UPS alternate power source can be either extensive battery backup or a standby motor generator.

The third situation is when power fluctuations are apt to cause errors in test data. Imagine the consequences if a computer read a data entry as 2,000 instead of 2.000, or if a distributed control system (DCS) controlling a volatile refining process experienced a similar data glitch.

Computer Systems

Changes in today's computing systems have changed the way UPS systems are applied. While large data centers with mainframe computers still require larger UPSs to back up their operations, the increasing trend toward local area networks (LANs) and wide area networks (WANs) has reduced power-capacity requirements and system configurations.

A large computer system and peripheral equipment usually are backed up with a high-capacity, centrally located, on-line UPS and batteries. This arrangement may be in the computer room itself or in a separate area near the data center. An on-line UPS protects equipment from all power problems. Battery capacity determines length of operation during a total outage.

A LANWAN is a distributed system made up of many smaller nodes with one or more file servers. This system requires much smaller, standby-type, off-line UPS units, often with self-contained batteries. At minimum, file servers and critical workstations should be protected by an off-line UPS. The amount of battery backup usually is limited to that required for an orderly shutdown of the network.

For additional protection from surges and electrical noise, high quality, three-stage surge suppressors with electromagnetic interference/radio-frequency interference (EMI/RFI) filters should be used on other workstations, printers and peripherals, as well as on fax and modem lines.

Process Protection

For a number of years, some industries have used UPSs as a matter of course in applications requiring uninterrupted process control. These include power-generation facilities, both fossil and nuclear, and petrochemical plants and refineries.

Recently, other types of industrial companies (pulp and paper mills, steel mills, pharmaceutical manufacturing and cogeneration facilities) have created a need for UPSs by incorporating DCSs into their plants to control their processes. Additional control equipment, such as supervisory control and data acquisition (SCADA) systems, energy management systems (EMSs), boiler-control and microprocessor-based instrumentation, give power protection an even more important role in industry.

Automated or integrated manufacturing facilities, using databases and applying statistical process control techniques, make process or production lines more efficient. In smaller manufacturing facilities, this often will be set up as a network. LANs/ WANs, combined with programmable logic controllers (PLCs), are making their way onto the factory floor.

A factory environment can be very hostile to sensitive computer and communications equipment. Wiring a factory floor is somewhat different from wiring office complexes. Most factory networks are connected using broadband methods as recommended by manufacturing automation protocol (MAP). Some companies use either token-ring or Ethernet connections, but they are not as common. Power protection is important on all of these installations.

Hospitals and other health care facilities must have power protection for critical laboratory operations that involve microprocessor-based testing equipment. Power fluctuations can cause errors in test data, and crucial and expensive tests can be ruined completely by blackouts.

Downtime costs, lost data, and ruined or damaged product are all factors in UPS selection. Most computer and DCS manufacturers recommend a UPS for the systems they install. In fact, many electric utilities now offer UPS systems and surge suppressors to their prime customers who demand a high level of clean power.

When Is A UPS Necessary?

One of the first actions recommended before deciding whether to specify a UPS is an analysis of utility power. If the study indicates numerous power-quality problems, it is a strong case for power protection. Environment also can be a factor, especially if the area is prone to frequent electrical storms.

Using microprocessor-based equipment in industrial environments is like putting a computer room right on the plant floor. Operating adjacent equipment with diverse electrical loads may cause power-line fluctuations that can do havoc on the microprocessor-based equipment. This "power pollution" can be caused by turning on and off large industrial motors, using electric welders, switching large circuit breakers and operating other equipment that uses large amounts of power. Steel mills have additional concerns with electric furnaces and other devices contributing to power-line problems.

Electric utilities themselves can add to these troubles when they perform power-factor corrections in large industrial complexes, usually prior to the start of a shift. This procedure can cause a phase shift, which can result in computer-system failure.

UPSs can be assets when using standby generators or when switching between two utility feeds, especially in situations where power breaks are undesirable. In the past, some facilities have installed backup generators without a UPS, but soon found they needed to add one to maintain critical loads.

UPSs can be used with a standby generator to cover power breaks during transfer time. Typically, a computer can tolerate only a 10- to 12millisecond power outage at nominal voltage. Generators are susceptible to load changes, causing current and frequency fluctuations. Another problem can exist when facility power is brought in from two different utility feeds. A large electromechanical switch with contactors is used to transfer from one feed to another upon a failure. This creates a short break in power that cannot be tolerated by today's microprocessors.

Both of these situations can be corrected by using a UPS downstream. With the UPS in place, there will be no power break to critical loads during transfer.

Within sophisticated industrial complexes there is a dynamic power situation. The many process controls, power supplies and other electric apparatus in use often produce their own related power anomalies. While power-conditioning methods, such as using regulation or isolation transformers, can solve part of these problems, only UPSs can handle all of them. They also help protect computers and power supplies from premature component failure due to power surges and abnormal line harmonics (those greater than 5% total harmonic distortion).

Selecting/Applying A UPS

Virtually any type of microprocessor-controlled machinery can benefit from incorporating a UPS in system design. Selecting the proper type of UPS for an application involves a variety of factors. To begin with, the demands of the application must be studied, including the type and size of load to be protected, the environment and other elements.

One of the first decisions that must be made is whether an on-line or offline UPS is necessary. In an on-line system, utility alternating current (ac) is converted to direct current (dc) by a battery charger/rectifier and then converted back to ac with an inverter. True on-line systems are the reverse-transfer type, with the load being powered from the inverter at all times, constantly regenerating a clean power source. In the event of a failure, the batteries instantly supply power to the inverter without a break in current and voltage.

An off-line UPS, also known as a standby power supply, activates only when it senses a drop or loss of utility power. A power loss occurs during transfer, but usually it lasts for only two to three cycles. There is no power conditioning, however, as utility ac power is sent to the protected load during normal operation. Some offline UPS systems, known as hybrids, add regulating techniques using either a ferroresonant transformer or electronic tap changer to help regulate power under normal operation.

On-line systems generally are used when complete protection from all power fluctuations and outages is required. These applications include most critical computers or control systems. Off-line systems can be used in protecting small computers that can tolerate very short power losses without losing data. Office LANs/WANs are a primary application for off-line UPS systems.

On-line systems are more expensive than offline units, but supply a much greater margin of overall protection from all power problems. The choice should be made based on the specific application's needs, including operational requirements and budgetary considerations.

UPS Technologies

Another decision concerns the type of UPS technology desired. Several systems currently are available. These include ferroresonant, pulsewidth modulation (PWM), hybrid and rotary. Each has its advantages and disadvantages, depending on the user's needs.

Ferroresonant UPS systems can handle rough, high-inrush loads and harsh, dirty, high-ambient environments. This is due to their simple design and minimal number of parts.

Some systems feature a separate battery charger/rectifier and inverter, while others incorporate both into one unit. These systems usually are offered in on-line configurations. .

PWM technology operates with more complex circuitry. These units are used primarily in computer rooms and other clean room environment applications. PWM systems generally include the inverter and charger in one unit. PWM technology is used in both on-line and off-line systems.

Hybrid UPS systems can be a combination of PWM and ferroresonant technology. They employ a regulating device during normal operation that, upon loss of utility power or low power conditions, transfers the load to the inverter which operates from a battery.

Rotary systems use a form of motor generator as a source for continuous clean power and to charge batteries for backup service in the event of a power outage. Rotary UPSs are online units used in high-power-capacity applications.

In the past, PWM-based units have maintained a size and noise advantage, but new, ferroresonant designs, using insulated gate bipolar transistors in the inverter bridge design, now offer comparable footprints and noise levels. Both ferroresonant and PWM systems are available with microprocessor control and RS232 interface for monitoring and diagnostics.

The number of batteries required for a UPS system depends on backup time desired And power requirements. Large systems use many batteries, often located in a separate area, while smaller systems have self-contained batteries or an accompanying battery cabinet. Batteries can be of the open wet-cell type or sealed nonventing configurations.

The environment in which the UPS unit will be placed is a critical factor in equipment selection. Units used in factory or power-plant environments must be tolerant of heat, as well as dirt, dust and other airborne contaminants. Ferroresonant UPS systems generally are well suited to these types of operating conditions.

If a UPS is to be placed in a controlled environment such as a computer room or process-control center, a PWM, ferroresonant or hybrid unit can be used with satisfactory results. Rotary units usually are located away from the equipment being protected.

Operational Considerations

Operational considerations are another key factor in selection. Efficiency and reliability often depend on the type of unit, the load and the environment. The higher a unit's efficiency, the lower the operating cost.

Noise emitted by a UPS can be a factor, depending on the surrounding environment. In most cases, UPSs placed in computer centers, control rooms or office-type environments need to operate as quietly as possible. Noise levels vary according to the type of system. UPS manufacturers' specifications generally include noise-level data.

The type of load being protected is an important consideration, too. Microprocessor-based equipment may require a different type of UPS unit than other loads. For example, switching power supplies, found in most computers, react differently to certain types of UPS systems. Today's UPS units should be capable of supplying nonlinear-type loads without derating or degradation in total harmonic distortion.

Load size determines what size UPS is needed. Systems usually are sized in kilovolt-ampere ratings. Before selecting UPS capacity, a profile of critical electrical loads should be computed, listing the power requirements of each piece of equipment to be protected. Most UPS manufacturers also recommend allowing for a 25% to 30% future expansion factor. Systems generally are available in both single-phase and three-phase models to suit the application.

One should determine if the required UPS is an industrial or computer-type system. Computer-room UPS components are more densely packaged to create a smaller footprint. Many times, isolation transformers are removed from the front end of a computer-type UPS rectifier/ battery charger. Although this usually is acceptable in most office/ computer-room environments, it can be a problem in an industrial facility due to the presence of large

noise spikes. Industrial UPS systems typically are designed for harsher environments and excursions up to 122°F without derating.

Recommended reference standards for specifying UPS systems include: American National Standards Institute/Institute of Electrical and Electronics Engineers Inc. (IEEE) 944—"IEEE Recommended Practice for the Application and Testing of Uninterruptible Power Supplies for Power Generating Stations," draft National Electrical Manufacturers Association (NEMA) Standard Pe1-1990-"Uninterruptible Power Systems" and NEMA Standard PE5-"Constant Potential Electric Utility Battery Chargers."

Multiple UPSs or parallel-redundant systems often are used to handle different system loads within the same facility. Other applications may even require absolutely fail-safe operation, such as nuclear power plants which often incorporate up to four channels of UPS redundancy.

Specifiers also should examine the costs for local or factory service (factory trained or third party), recommended spare parts for one-year and five-year period-, and recommended preventative maintenance. And, by all means, ask for references of service work performed on similar installations.

Modern UPS systems are a necessary and valuable addition to many projects. After examining all of the operating criteria, specific requirements usually determine the best type of system to select for the application.