

**POWER QUALITY GUIDEBOOK**

**SOLAHD**



**Available through Newark**

**RECOGNIZE ELECTRICAL DISTURBANCES. UNDERSTAND THEIR IMPACT. SELECT THE CORRECT POWER SOLUTION.**

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## **INTRODUCTION**

### **POWER QUALITY'S INCREASED IMPORTANCE**

Industrial environments depend on electronic equipment to succeed in today's highly competitive, efficiency-driven business world. Computers, drives, motion controllers and sensors have become essential for optimal productivity, consistency and quality. However, these sensitive components require clean and stable electrical quality to perform properly. Power quality issues, such as voltage fluctuations, harmonic distortions, noise and power outages, disrupt production, damage equipment and corrupt valuable data.

### **WHERE DO POWER QUALITY ISSUES ORIGINATE?**

Poor power quality is characterized by electrical disturbances, such as transients, surges, sags, power interruptions and harmonics. The disturbances can originate externally without warning, but are often generated within your facility.

Eighty percent of electrical disturbances that cause poor power quality come from within your facility. Powering on and off very large equipment, wiring errors, poorly specified or improperly-serviced power conversion equipment, grounding loops and even normal daily operations can foster power quality issues that lead to production disturbances and lost data.

Severe weather, utility fault clearing, power line accidents and other external network issues like grid switching or power-factor correction capacitors represent the remaining twenty percent of power quality problems. These disturbances often generate spikes or power interruptions that can instantly damage equipment. Worst of all, these incidents are completely unpredictable and beyond anyone's control.

### **PROTECT YOUR PRODUCTION AND EQUIPMENT**

One solution is typically not enough to ensure reliable power. Due to the numerous sources and types of power disturbances, maintaining power quality requires a multi-tiered approach. Protecting your facility begins by isolating all power offending devices, such as drives, motors, welders and large compressors. Essential and sensitive equipment, such as PLCs, monitors, drives, vision systems and industrial computers must be safeguarded with Active Tracking Filters and Surge Protective Devices. It is also critical to specify high-quality power conversion products, including K-Factor and Drive Isolation transformers. Last, but not least, all panel points should utilize Surge Protective Devices.



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VSU

## VOLTAGE SURGE

A voltage surge, also referred to as an overvoltage or a line swell, is a temporary voltage level increase for durations from a half cycle to a few seconds. These disturbances can also last as long as several cycles.



### CAUSE

Voltage surges can be caused by large load shut-downs, such as switching off high-power electric motors, and the normal cycling of HVAC systems. They can also be caused externally as loads are shed from the utility.

PI

## POWER INTERRUPTIONS

Power interruptions are a complete loss of voltage for an extended time period.



### CAUSE

This total power disruption is typically created through an accident or equipment failure in the utility's generation or distribution network.

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## BROWNOUTS

Brownouts, or voltage reductions, are conditions in which the supplied voltage level has been restricted below normal minimum levels for an extended period that may last days.



### CAUSE

Overcapacity and other network issues can force utilities to intentionally create a brownout condition to compensate for high demand on the electrical power grid.

VSA

## VOLTAGE SAGS

Voltage sags, sometimes called undervoltage, are a temporary decrease in the voltage level. The drop typically lasts at least one half cycle, but can endure for up to several cycles.



### CAUSE

Voltage sags are a result of large load start-up and utility switching. While short-lived, these disturbances can reduce the efficiency and life span of electrical equipment.

**EFFECTS**

Surges and swells can lead to significant equipment and hardware damages.

**SOLUTION**

UPS  
**Power Conditioners\***  
Voltage Regulators



Solatron™ Plus Power Conditioner

**EFFECTS**

Power interruptions halt production and can decrease the life span of electrical equipment. The sudden nature of most power interruptions can also create hardware failures and crashes in PLCs and other computer based equipment.

**SOLUTION**

**UPS\***  
Generators



S5K UPS  
(Modular)

**EFFECTS**

Brownouts can negatively impact the efficiency and life span of electrical equipment. They can also result in hardware crashes and occasional equipment failure, reduce efficiency and life span of electrical equipment particularly motors.

**SOLUTION**

**Voltage Regulators\***



MCR Voltage Regulator

**EFFECTS**

Similar to voltage reductions, repeated exposure to voltage sags can result in hardware failures and crashes in PLCs and other computerized equipment.

**SOLUTION**

**UPS\***  
Power Conditioners  
Voltage Regulators  
Power Supplies with sag immunity



UPS

\* Optimal solution

VT

## VOLTAGE TRANSIENTS

Voltage transients, also called spikes and impulses, are the result of sudden massive increases in voltage.



### CAUSE

Voltage transients can come from outside the facility through lightning strikes, power outages and utility grid switching. They can also originate inside the facility from short circuits, tripped breakers and the start-up of heavy equipment.

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## FREQUENCY VARIATIONS

While rare in utility power, frequency variations are most common with back-up power systems, such as standby generators.



### CAUSE

Frequency variations can exist if local power generation has poor speed regulations or by faults in the system. This disturbance can also be created by the disconnections of a large block or load or source of generation.

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## HARMONIC DISTORTION

Voltage Distortion created by multiples of the fundamental frequency (for example, 180 Hz in a 60 Hz system).



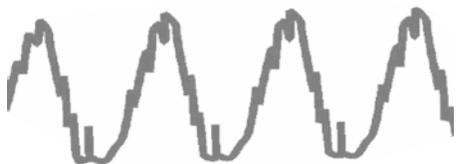
### CAUSE

This sinewave distortion is typically generated by non-linear loads similar to switchmode power supplies used by personal computers, office equipment, variable-frequency drives and solid-state electronics.

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## ELECTRICAL NOISE

Electrical noise is a low amplitude, low current, high-frequency disturbance.



### CAUSE

Electrical noise can be caused from both inside and outside the facility. It is also be generated by both powerful electric disruptions, as well as normal equipment operations and poor maintenance. Distant lightning strikes, switching power supplies, electronic circuits, poor brush contacts on motors, improper wiring and utility switching are just some examples of electrical noise sources.

### EFFECTS

Sensitive electronic equipment is most at risk from these disruptions. A voltage transient may cause system lock-up or failure, which can corrupt or lead to loss of valuable data.

### SOLUTION

#### Surge Protective Devices\*

Power Conditioners  
Isolation Transformers



Surge Protective Devices

### EFFECTS

Frequency variations can cause system crashes and equipment damage, even ones that have UPS protection.

### SOLUTION

#### UPS\*



DIN Rail DC UPS

### EFFECTS

Harmonics represent trouble for equipment throughout industrial facilities by overheating neutral conductors and transformers, tripping breakers, creating a high neutral current, reducing system capacities and even loosening electrical connectors.

### SOLUTION

#### Line Reactors\*

K-Rated Transformers  
UPS  
Power Conditioners



SLR Line Reactors

### EFFECTS

These random noise signals are superimposed on voltage waveforms and can cause computer bugs, glitches and other hard-to-diagnose computer maladies. They also produce undesirable effects in the circuits of control systems.

### SOLUTION

#### Isolation Transformers\*

Active Tracking Filters  
Power Conditioners  
UPS



Isolation Transformers

\* Optimal solution

## ACTIVE TRACKING® FILTERS & SURGE PROTECTIVE DEVICES

### STV & STF SERIES

The STV 100/400K series is a hardwired surge protective device and the STV 25K is a DIN Rail mountable surge protective device. Installed in electronic control cabinets, they both can be found in harsh industrial environments such as the factory floor or remote locations. The SolaHD STF Series offers the original active tracking technology to guard against common, but very damaging, lower energy transients. Offering excellent noise reduction, the filter continuously tracks the input AC power line and responds instantly upon detecting extraneous high frequency noise.

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#### Applications

- Service entrance
- Branch and control panels
- Telecommunications equipment
- POS terminals
- Security systems
- Laboratory equipment

### STFV PLUS SERIES & STFE ELITE SERIES

The STFV Plus Series & STFE Elite Series combines Active Tracking filtration for low energy noise and surge protection for high energy transients. These products continuously track the input AC power line and respond instantly upon detecting extraneous high frequency noise and high voltage transients caused by everyday events such as turning on machinery, motors, or equipment. The STFV Plus Series is available for panel mount applications and the STFE Elite Series is available for DIN Rail mounting applications.

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#### Applications

- Branch and control panels
- Point-of-use industrial service
- Factory automation installations
- Programmable logic controllers
- Dedicated industrial and machine tools equipment

### STC SERIES

The STC series protects all susceptible low-voltage cable routes entering a facility and at key points within the building. These devices can be used as part of a multi-stage protection strategy which involves clamping the initial high-energy impulse, filtering any remaining noise or transients to the PLC or sensitive equipment and finally, protecting the Data/Signal lines entering and leaving the control panel.

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#### Applications

- Power-over-Ethernet
- Data lines
- CCTV head & camera end
- Telephone lines
- Laboratory equipment
- Data lines



Power conditioners hold output voltages steady relative to the wide swings in input voltage. They also mitigate noise and other disturbances generated throughout the facility. SolaHD's power conditioners ensure that the power reaching your equipment is free from damaging voltage transients, voltage reductions, sags, surges, harmonics and noise.

**CONSTANT VOLTAGE TRANSFORMERS HARDWIRED CVS SERIES**

Constant Voltage Transformers are excellent for industrial applications requiring tight voltage regulation. Using a patented ferroresonant transformer technology, the CVS and MCR series provide the trusted solution against power disturbances.



**Applications**

- Factory automation
- Industrial automation control PLCs
- Electronic equipment
- Machine tools
- Robotics

**MCR SERIES**

The MCR Series provides excellent noise filtering and surge protection to protect connected equipment from damage, degradation or misoperation. These units are a perfect choice where dirty power caused by impulses, swells, sags, brownouts and waveform distortion can lead to costly downtime because of damaged equipment.



**Applications**

- Computers/printers
- POS terminals
- Laboratory equipment
- Telephone/fax systems
- Security systems
- LAN networks

**SOLATRON™ PLUS THREE PHASE POWER CONDITIONER**

The rugged design of the SOLATRON™ Plus series ensures high performance through inductive loads and poor power factors. This power quality solution for three phase equipment is able to handle many power quality problems including isolation, voltage regulation and surge protection. The lack of fans or batteries ensures long life and maintenance-free reliability.



**Applications**

- Automatic packaging machinery
- Large machine tool equipment
- UPS bypass circuits
- Retail store
- Process equipment



## UNINTERRUPTIBLE POWER SUPPLIES - OFF-LINE

SolaHD's Off-line Uninterruptible Power Supplies (UPS) provide economical protection from damaging impulses and power interruptions for smaller, less critical, stand-alone applications. They are ideal for computers and workstations that can tolerate the 2 – 4 milliseconds of transfer time when the UPS switches from AC input to battery power. SolaHD has UPS systems that protect your equipment from all power disturbances.

### SDU AC DIN RAIL UPS

The SDU DIN Rail AC UPS combines an industry leading compact design with a wide operation temperature range and unique installation options. These units include easy to wire screw terminations for critical devices needing battery back-up such as computer-based control systems.



#### Applications

- Programmable logic controllers
- Factory automation
- Robotics
- Computer-based control systems
- Conveying equipment



### MINI TOWER OFF-LINE UPS

These units include separate outlets; one for critical devices needing battery back-up such as the CPU and the other surge-protected outlet can be used for non-critical devices like printers and fax machines. The S1K is ideal for office and POS use.



#### Applications

- PCs
- Workstations
- Computer terminals



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## UNINTERRUPTIBLE POWER SUPPLIES - LINE-INTERACTIVE

SolaHD's Line-Interactive Uninterruptible Power Supplies (UPS) feature technology that combines highly-effective power conditioning with battery back-up capabilities. Advanced voltage regulation allows SolaHD's UPS's to provide clean power while conserving battery life, even during abnormal input voltage conditions. These UPS's are particularly applicable in areas where power outages are rare, but where frequent power fluctuations create voltage transients, voltage reductions, sags, surges and noise.

### MINI TOWER LINE-INTERACTIVE

These units protect against over and under voltages by raising and lowering utility power to the right level for sensitive equipment. Most power corrections are accomplished without transferring to the internal battery. Utility power is continually protected and internal battery life is optimized. The S3K2U is the ideal choice for networking or process control racks.



### Applications

- Workstations
- PLCs
- Robotics and process control
- Automatic service & dispensing equipment
- Industrial automation systems

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## UNINTERRUPTIBLE POWER SUPPLIES - DC UPS

DC Uninterruptible Power Supplies (UPS) provide higher conversion efficiencies by reducing the number of AC to DC conversions. This minimizes heat generation and increases energy efficiency for maximum reliability and a smaller housing design.

### UNINTERRUPTIBLE POWER SUPPLIES - SDU DC DIN RAIL

The SDU DIN Rail DC UPS is an advanced 24 Vdc uninterruptible power system that combines an industry leading design with a wide operational temperature range and unique installation options. The SDU DC UPS is a powerful, microprocessor controlled UPS that provides protection from power interruptions.



### Applications

- Industrial/machine control
- Automation process control
- Control rooms
- Computer-based control systems
- Conveying equipment
- DeviceNet™
- Material handling



## UNINTERRUPTIBLE POWER SUPPLIES - ON-LINE

SolaHD's On-Line Uninterruptible Power Supplies (UPS) provide highly-effective power conditioning and battery back-up. Advanced voltage regulation allows the UPS to provide clean power to the load while conserving battery life, even during abnormal input voltage conditions. SolaHD's series of On-Line UPS's protect equipment from all power disturbances, but are particularly useful where frequent power fluctuations create voltage transients, voltage reductions, sags, surges and noise.

### S4K2U INDUSTRIAL ON-LINE SERIES

The S4K2U series eliminates a wide range of power problems, even difficult-to-track harmonics and frequency variations that are common with standby generator operation. The slim 2U (3.5") package maximizes available space.



### S4K 6 & 10 KVA INDUSTRIAL ON-LINE SERIES

The S4K 6 and 10 kVA Industrial UPS Series are the first true On-Line industrial UPS that provide flexible output voltage, an integrated maintenance bypass switch and internal batteries all in slim enclosures. These units feature true On-Line (double conversion) topology providing the ultimate in protection against a wide range of potential power problems. The 6 kVA unit is available in 50 Hz international units.



#### Applications

- Industrial computers
- Robotics and process controls
- Industrial automation systems
- Enterprise telecommunication systems
- Pharmaceutical and medical diagnostic equipment
- Network servers
- Printing and publishing machinery

### S5K MODULAR SERIES

The S5K Modular Series was designed to be fully configured, tested and shipped in the configuration you need. It is scalable from 4 to 20 kVA. The optional N+x redundancy provides a fault-tolerant group of power modules and controls. Each modular component can be hot-swapped making it easy to increase power or extend back-up runtime without interrupting power to the load.



#### Applications

- Network servers
- Enterprise telecommunications systems
- LAN gateways, bridges and routers
- Mini-computers, superservers and server clusters
- Clusters of PCs or workstations and peripherals
- RAID arrays and other large-scale data handling systems



## DRIVE ISOLATION TRANSFORMERS & LINE REACTORS

SolaHD Drive Isolation Transformers are specifically designed for use with SCR controlled variable speed motor drives. They isolate variable speed drives from other non-linear devices on the same circuit and handle large voltage changes. Line Reactors manage rapid changes in electrical current, as well as regulate harmonics and electronic noise. They are smaller, lighter and less expensive than drive transformers, but don't provide isolation, step-up or step-down voltages.

### DRIVE ISOLATION TRANSFORMERS

Designed for use with SCR (Silicon Control Rectifier) variable speed motor drive applications, drive isolation transformers magnetically isolate the incoming line from the motor drive. These units also provide a voltage change to match the required voltage of the SCR drive. Standard designs are delta primary and secondary to match the common power sources required in most three phase rectifier circuits.

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#### Applications

- SCR variable speed drives



### SLR LINE REACTORS

The SLR Series is a CE style, DIN Rail Mounted line reactor that provides safe, compact protection for high frequency drives and electronic equipment. The SLR inductive filter prevents damage to any three phase electronic system plagued by capacitor or large load switching. Other benefits include reduced harmonics and input line distortion.

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#### Applications

- Variable frequency drives
- Robotics
- Any three phase electronic products subject to high current anomalies such as Power Factor Correction capacitor switching
- SCR variable speed drives



## FREQUENTLY ASKED QUESTIONS

### What is a constant voltage power conditioner?

Although a constant voltage power conditioner (sometimes referred to as constant voltage transformer or voltage regulator) is a transformer-like device, its design and function are totally different. The function of a constant voltage power conditioner is to provide a voltage across its secondary terminals within a specified tolerance (usually  $\pm 5\%$ ) as long as the voltage impressed on the primary is within the specified bandwidth (usually  $+10\%$  to  $-20\%$ ).

### What are the differences between SolaHD power conditioners?

All three products use SolaHD's patented ferroresonant technology. The primary design considerations for the CVS series were voltage stabilization and magnetic isolation. This group provides  $\pm 1\%$  output voltage regulation with an input voltage range of  $+10\%/-20\%$  with moderate (1000:1) normal (transverse) noise attenuation.

The MCR series was designed to address both voltage regulation and magnetic isolation. This group offers  $\pm 3\%$  output regulation with an input range of  $+10\%/-20\%$  but also offers magnetic isolation for excellent 1,000,000:1 common mode and 1000:1 normal (transverse) mode attenuation.

The Three Phase power conditioners utilize micro-processor-based tap switching technology to provide  $\pm 5\%$  regulation in three phase installations. The CVS and MCR Series are single phase only.

### Are there any special considerations needed when I select a constant voltage power conditioner?

Special consideration must be given to the type of load to be powered (inductive loads need to be sized to start up currents), load power factor, ambient temperature and where the unit will be installed.

### What exactly is Ferroresonance?

Ferroresonance is the principle behind SolaHD's very popular CVS and MCR power conditioners. Ferroresonance is the property of a transformer design in which the transformer contains two separate magnetic paths with limited coupling between them. The output contains a parallel resonant tank circuit and draws power from the primary to replace power delivered to the load. Note that "resonance" in ferroresonance is similar to that in linear circuits with series or parallel inductors and capacitors, where the impedance peaks at a particular frequency. In a nonlinear circuit, such as SolaHD's ferroresonant transformers, "resonance" is used to reduce changes in supply voltage to provide a more consistent voltage to the load.

A magnetic device is nonlinear. Its reluctance changes abruptly above a certain magnetic flux density. At this point, the magnetic device is defined as being in saturation. The design of the SolaHD transformer allows one magnetic path (the resonant path) to be in saturation, while the other is not (See Figure 1). As a result, further change in the primary voltage will not translate into changes in the saturated or secondary voltage and voltage regulation results.

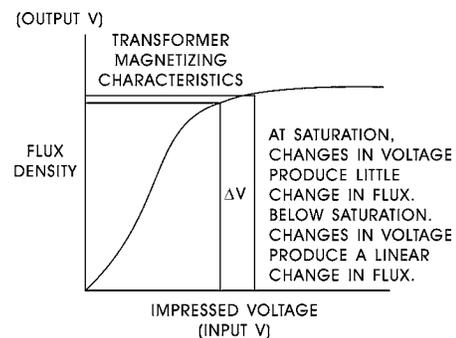


Figure 1: Saturation Curve

**Will harmonic currents affect ferroresonant power conditioners?**

A SolaHD ferroresonant power conditioner will have essentially harmonic-free output because of the addition of a neutralizing coil. This coil neutralizes the harmonics in a manner best explained by first considering the device as a conventional transformer with the neutralizing coil disconnected. Though this coil is now open circuited, it has a voltage induced in it as a portion of the magnetic flux passes through the center leg of the core to the outer legs. Since some of the primary flux links this coil, fundamental voltage is present. The resultant voltage has a high odd-harmonic content due to the leakage flux from the output winding.

This leakage flux can return to the output winding by two paths. One bypasses the neutralizing coil. The other path links the neutralizing coil completely. By controlling the reluctances of these magnetic paths, one can control the degree of secondary flux coupled to the neutralizing coil.

The neutralizing coil is connected with its polarity additive to the secondary (or output coil) as shown in Figure 2. The output of the newly formed regulator has constant voltage with a waveshape almost completely free of harmonics.

The harmonics are still present in the output winding and also in the neutralizing coil. Since those harmonics present in the neutralizing coil are induced by the flux from the secondary winding, the harmonics in each coil are approximately 180° out of phase. This results in their cancellation. Proper control of turns ratio and magnetic path reluctance contribute to the generation of a sinusoidal output – even with a square wave input.

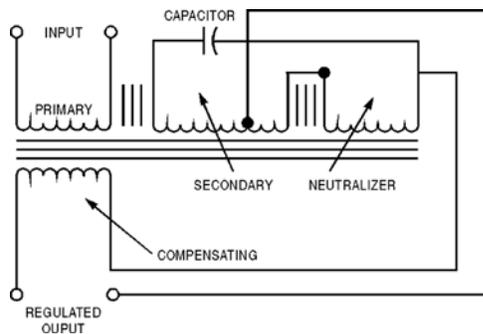


Figure 2: Schematic Diagram

**Are there different constant voltage power conditioner designs?**

Yes, there are two basic design concepts. A tap switching design utilizes an electronic circuit along with a traditional transformer core and coil assembly to control the output voltage. As a result, the output voltage tends to be a stepped waveform rather than a smooth sinewave.

A ferroresonant design utilizes the electromagnetic induction principle exclusively to produce the desired output voltage. Consequently, the output voltage waveform is a smooth sinewave. The ferroresonant design attenuates transient electrical noise, provides surge protection per ANSI/IEEE Standards and provides a harmonic free output. These important benefits are not always available with other designs.

**Should I use a constant voltage power conditioner instead of a UPS?**

The question involves two different technologies used for differing reasons. 95% of all power quality problems are caused by transient noise, voltage surges, harmonics or frequently changing voltage conditions. Ferroresonant power conditioners provide the solutions for almost all of these power quality problems.

The primary function of any Uninterruptible Power Supply (UPS) is to provide an alternative voltage source (batteries) to a critical load for some period of time should a complete power failure occur. Complete power failures account for less than 5% of all power quality problems. For the other 95% of all power quality problems, unless the UPS is the on-line version, the UPS is of no help.

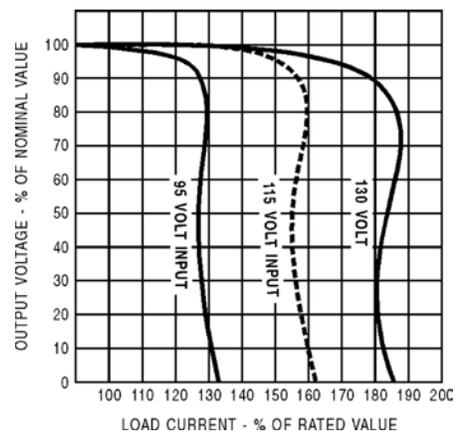


Figure 3: Output Voltage Tolerance

## FREQUENTLY ASKED QUESTIONS

### How should Surge Protective Devices be applied?

- SPDs should be installed with the shortest lead length possible and as close as possible to the load it is protecting.
- SPDs protecting panels should be wired in parallel with the service entrance or distribution panels. A disconnecting means must be provided for servicing and for short circuit and over-current protection.
- When a circuit breaker cannot be installed, install a tap on the buss or lugs. Wire in a fused disconnect to provide the above mentioned protection for the SPD. This method of installation allows the SPD to be replaced safely without shutting down the power.
- SPDs must be wired and grounded according to the (NEC) National Electrical Codes.
- Using Whole Facility Protection would safeguard your electrical system against most transients. This means that the protection is staged; service entrance protection, sub-panel protection, and point-of-use protection.

### What loads should not be powered by a UPS?

Loads that are highly inductive may cause a UPS to malfunction. Examples of equipment that should not be powered by a UPS include:

- Air conditioners
- Drills
- Space heaters
- Vacuum cleaners
- Buffing machines
- Fans
- Laser printers
- Transformers (step up/step down)

The majority of loads that require UPS protection are electronic type loads. For example; process control, automation equipment, computer, and telecommunication. A UPS is also recommended to support microprocessor-based technology type loads.

In addition, CVS and MCR power conditioner products are not recommended for use on the input and or output side of the UPS.

### Why should only an on-line UPS be used with a standby generator?

An on-line UPS accepts input power with relatively wide variations in voltage and frequency, a common occurrence in power produced by standby generators. The true on-line (double conversion) technology provided by an on-line UPS handles these variations by converting the input power from AC to DC and then converting DC to AC output power. Generators should be equipped with an electronic governor to minimize frequency variations. Always check the frequency range of the generator output as the use of a mechanical governor does allow for large changes in frequency to reach the load. A wide frequency swing may cause the UPS to switch to the battery more frequently.

An off-line or line-interactive UPS is not recommended for use with a standby generator. An off-line UPS passes utility power straight through to the load. When a variation is detected, it can protect the load from the frequency variations of the standby generator by transferring to battery power. Occasionally, the input frequency will match the specifications of the off-line UPS and it will transfer back from battery. These occurrences are infrequent and short lived, but the battery may not have sufficient time to recharge. It will support the load only until it is completely depleted and then shut down the load.

A line-interactive UPS faces the same issue as the off-line. The power conditioning (tap switching) functions of the line-interactive units focus on correcting voltage variations and have no effect on frequency variations. It reacts to out-of-spec frequencies similar to the off-line UPS.

The same input frequency variations that would cause an off-line or a line-interactive UPS to transfer to battery are of little concern or have no effect on the on-line UPS. On-line UPS's compensate for generator frequency variations while prolonging battery life.

**AC (Alternating Current)** - Current that reverses direction in response to voltage that is changing polarity.

**Attenuation** - Decrease in signal voltage or power.

**Battery Run Time** - The amount of time (in minutes) a battery system can support a load.

**Blackout** - Slang term for the total loss of electrical power for more than one minute.

**Bypass** - A mechanical or electronic switch to provide an alternate path for the line current.

**CE Mark (Conformité Européenne)** - A marking that shows the product meets the fundamental safety, health, environmental and consumer protection requirements of the European Community.

**Common-Mode Noise** - Noise that occurs between the current carrying conductors and ground.

**Constant Current Power Supply** - A power supply that regulates its output current for changes in line, load, ambient temperature, and time.

**Constant Voltage Power Supply** - A power supply that regulates its' output voltages for changes in line, load, ambient temperature, and time.

**CVT (Constant Voltage Transformer)** - A power conditioner that provides a stable and regulated sinewave output voltage.

**Continuous Duty** - The service requirement that demands operation at a constant load for an indefinite period of time.

**Control Transformer** - Usually referred to as an Industrial Control transformer. Designed for good voltage regulation characteristics when low power factor and /or large inrush currents are drawn (5 to 15 times normal).

**Cross-Regulation** - In a multiple output power supply, the percent voltage change at one output caused by the load change on another output.

**Crowbar** - An overvoltage protection circuit which rapidly places a low resistance shunt across the power supply output terminals if a predetermined voltage is exceeded.

**CSA** - Canadian Standard Association.

**DC (Direct Current)** - Current that flows in only one direction.

**Derating** - The specified reduction in an operating parameter to improve reliability.

**Differential Mode Noise** - Noise that occurs between the current carrying conductors.

**DIN Rail** - A standard rail (typically 35 mm wide) that mounts to the chassis and allows other electrical components to be installed and replaced easily.

**Drift** - The change in output voltage of a power supply over a specified period of time, following a warm-up period, with all other operating parameters such as line, load, and ambient temperature held constant.

**Dynamic Load Regulation** - The ratio of change in output voltage to change in load current.

**Eddy Currents** - Additional currents caused by a magnetic field.

**Efficiency** - A measure of energy loss in a circuit.

**EMC (Electromagnetic Compatibility)** - A directive necessary to get the CE Mark, which shows the electrical device will not create high levels of EMI and will not fail due to normal levels of EMI.

**Encapsulated** - A method of sealing a device with epoxy to resist environmental effects.

**Ferroresonance** - A method of producing a constant voltage by use of a special saturated transformer. Invented and patented by Joseph Sola in 1938.

**Ferroresonant Power Supply** - A stabilized power supply (CVDC) driven by a constant voltage transformer.

**Filter** - A device that reduces unwanted electrical noise.

**Foldback Current Limiting** - A power supply output protection circuit whereby the output current decreases with increasing overload, reaching a minimum at short circuit.

**Force Air Cooled** - A means of accelerating heat dissipation to lower the temperature rise of an electrical device.

**Frequency (Hertz)** - Cycles per second.

**Harmonics Distortion** - The distortion of the AC waveform due to the addition of sine waves of different frequencies being added to the AC voltage.

**Holdup Time** - The length of time a power supply's output voltage remains within specifications following the loss of input power.

**Impulse** - A high amplitude, short duration spike (milliseconds) superimposed on the normal voltage or current.

**Input Line Filter** - A low-pass or band-reject filter at the input of a power supply which reduces line noise fed to the supply. This filter may be external to the device.

**Input Voltage Range** - The high and low input voltage limits within which a device meets its specifications.

**Inrush Current** - The peak instantaneous input current drawn by a device at turn-on.

**Inrush Current Limiting** - A circuit which limits the inrush current during turn-on of a device.

**kVA Rating** - A measurement of apparent power. 1 kVA = 1000 VA.

**KW Rating (kilowatts)** - A measurement of real power delivered to a load 1 KW = 1000 VA x Power Factor.

**Line Regulation** - The change in output voltage due to a variation in input voltage.

**Linear Power Supply** - A power supply that uses a control device, like a transistor, in series (or parallel) with the load. The control device adjusts the effective resistance to give a constant voltage output.

**Load Regulation** - The change in output voltage due to a variation in load.

**Noise/Electrical Noise** - Also called electromagnetic interference, or EMI. Unwanted electrical signals that produce undesirable effects and otherwise disrupt the control system circuits.

**Off-Line UPS** - A UPS where the inverter is normally off until there is a power failure. Also known as a Standby UPS.

## GLOSSARY OF TERMS

**On-Line UPS** - A UPS where the inverter is always powering the load. AC is converted to DC to charge the battery then DC is converted to AC to power the load. On-Line UPS are often referred to as “Stand-by UPS” or “Double Conversion UPS”.

**Output Current Limiting** - An output protection feature which limits the output current to a predetermined value in order to prevent damage to the device under overload conditions.

**Output Voltage** - The nominal value of the voltage at the output terminals of a device.

**Overshoot** - A transient change in output voltage, in excess of specified output accuracy limits, which can occur when a power supply is turned on or off, or when there is a step change in line or load.

**OVP (Overvoltage Protection)** - A power supply feature which shuts down the supply, or crowbars or clamps the output, when its voltage exceeds a preset level.

**Parallel Operation** - The connection of the outputs of two or more identical devices to obtain a higher output power.

**PARD (Periodic and Random Deviation)** - A term used for the sum of all ripple and noise components measured over a specified bandwidth and stated in either peak-to-peak or RMS values.

**PE (Protective Earthing)** - The incoming earthing conductor provided by the utility.

**PI Filter** - A commonly used filter at the input of a switching supply or DC/DC converter to reduce reflected ripple current. The filter usually consists of two parallel capacitors and a series inductance and is generally built into the supply.

**Post Regulator** - A linear regulator used on the output of a switching power supply to improve line and load regulation and reduce output ripple voltage.

**Power Boost™** - Describes the advanced overload capability of the SDN and SDP power supplies to power high inrush loads without oversizing.

**Power Factor** - The ratio of true power (Watts) to apparent power (VA).

**Power Fail Detection** - A power supply option which monitors the input voltage and provides an isolated logic output signal when there is loss of line voltage.

**Pre-regulation** - The regulation at the front-end of a power supply, generally by a type of switching regulator, this is followed by output regulation, usually by a linear type regulator.

**Rated Output Current** - The continuous load current that a device was designed to provide.

**Redundancy** - The addition of extra devices to provide a backup in the event of the loss of one of those devices.

**Remote Sensing** - The ability for a power supply to sample the load voltage located a distance away, and adjust for the resulting voltage drop.

**Reverse Voltage Protection** - A feature which protects a power supply against a reverse voltage applied at the input or output terminals.

**Ripple** - A small AC voltage on the DC output of a power supply that remains after filtering.

**Ripple and Noise** - A small AC voltage on the output of a power supply at a specified bandwidth. This is the result of feed through of the rectified line frequency, internal switching transients and other random noise.

**Sag** - A temporary drop in the RMS voltage, which may last from one cycle to a few seconds.

**Short-Circuit Protection** - A feature which protects the device from a short-circuit so that the device will not be damaged.

**SPD (Surge Protection Device)** - Protects equipment from damage due to voltage transients.

**Swell** - A temporary increase in the RMS voltage, which may last from a half cycle to a few seconds.

**Switching Frequency** - The rate at which the voltage is switched in a DC-DC converter or switching power supply.

**Switching Regulator** - A high efficiency circuit used to regulate output voltages.

**Switchmode Power Supplies (SMPS)** - A power supply that uses a switching regulator.

**Thermal Protection** - An internal safeguard circuit that shuts down the unit in the event of excess internal temperatures.

**THD (Total Harmonic Distortion)** - The ratio of the harmonic content to the fundamental frequency expressed as a percent of the fundamental.

**Transfer Time** - The amount of time a device takes to switch from one mode of operation to another.

**TVSS (Transient Voltage Surge Suppressor)** - See SPD.

**Transformer** - An electrical device that changes AC voltage from one level to another.

**Transient** - A high amplitude, short duration (milliseconds) spike superimposed on the normal voltage or current. Sometimes called a spike or a surge.

**Transient Recovery Time** - The time required for the output voltage of a device to settle within specified output accuracy limits following a step change in output load current or a step change in input voltage.

**UL (Underwriters Laboratories)** - Acronym for Underwriters Laboratories tested.

**UL Recognized** - Designation given to components that when used properly in an end product are deemed to be safe.

**UL Listed** - Designation given to products ready for end use.

**Undervoltage** - See Brownout.

**UPS (Uninterruptible Power Supply)** - A device which supplies power to the critical load when the existing AC line voltage is not within normal operating values, or fails completely.

**VA (Voltamp)** - A measure of power. 1000 VA = 1 kVA.





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