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White Paper

UPS Risks

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What You Should Know About Using Uninterruptible or Stand-by Power Supplies to Protect Critical Loads From Power Disturbances

The use of computers and other electronic systems has skyrocketed, and with it, so has the need to protect these systems from damage and service interruptions. Uninterruptible and Stand-by power systems were created to fill the gap when sudden power disturbances threaten the operation of electronic equipment. However, there is a general misconception that UPS systems offer adequate protection against all major power disturbance problems including outages, noise, line regulation and voltage transients. Unfortunately, UPS systems often do not adequately protect against voltage transients.

Using a UPS system as the sole source of protection from power problems will leave computers and other electronics vulnerable to several distinct risks. Three key equipment risks to consider when evaluating UPS or Stand-by power systems are harmonic distortion, the volume of bypass mode switching, and transient surges.

How UPS and Stand-by Systems Work

In a UPS system, AC utility voltage is converted to DC voltage through the rectifier circuit in the converter section to charge the battery and supply the inverter. The inverter changes the DC voltage back to 60 cycle AC power to feed the attached equipment. When the utility AC voltage has failed or falls outside a preset electrical tolerance, the battery alone supplies DC voltage to the inverter section until the utility AC voltage is restored or the battery runs down (Fig. 1).

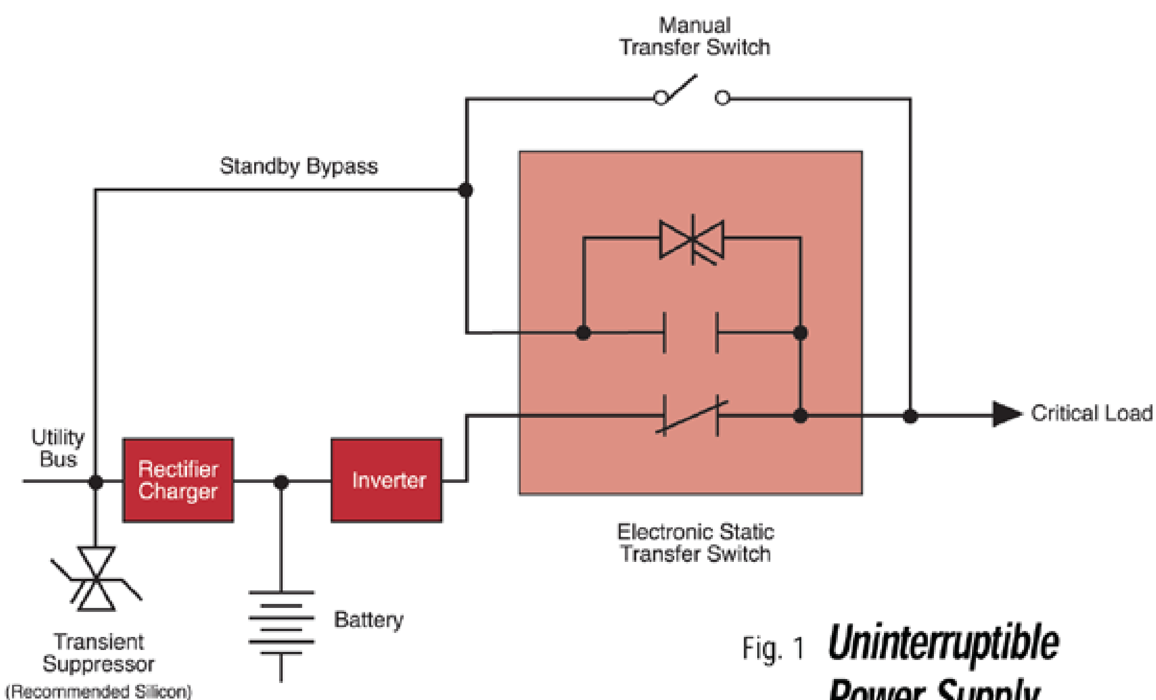

Fig. 1 *Uninterruptible Power Supply*

A Stand-by power supply consists of the same basic components as a UPS with a rectifier circuit maintaining a charge on a battery. The key difference is that a Stand-by system operates primarily in the bypass mode, meaning the raw utility AC voltage passes directly through the system to the equipment load unless the utility voltage fails or runs outside set limits. When this happens, a transfer switch shifts the load to an inverter, changing battery power to AC until utility power is restored or the battery drains(Fig. 2). Because the utility AC power must be outside preset limits before the equipment load is switched to the inverted battery power, this transfer can result in as much as a full cycle of voltage dropout.

Harmonic Distortion Risks

Depending upon the type of power supply used, harmonic distortion can heavily impact computer system operations.

In the past, linear power supplies were often used, but switch mode power supplies that are much more susceptible to operational upset from harmonic distortion have all but replaced these linear systems.

We tested a number of UPS systems for harmonic distortion and found that even under a no-load condition,their harmonic distortion exceeded the standard 3% limit(Ref. 3). When we subjected these UPS systems to tests including linear and complex loads, their harmonic distortion increased dramatically.

Bypass Switching Risks

Our tests on UPS systems also uncovered a higher than expected volume of switches to the bypass line, including instances when the test load was less than the unit's load rating. This bypass switching can allow raw utility power and transient voltages directly through to the equipment load more often than expected. Of course, Stand-by systems operate this way by design, but in both cases,raw power holds the potential to damage the equipment load.

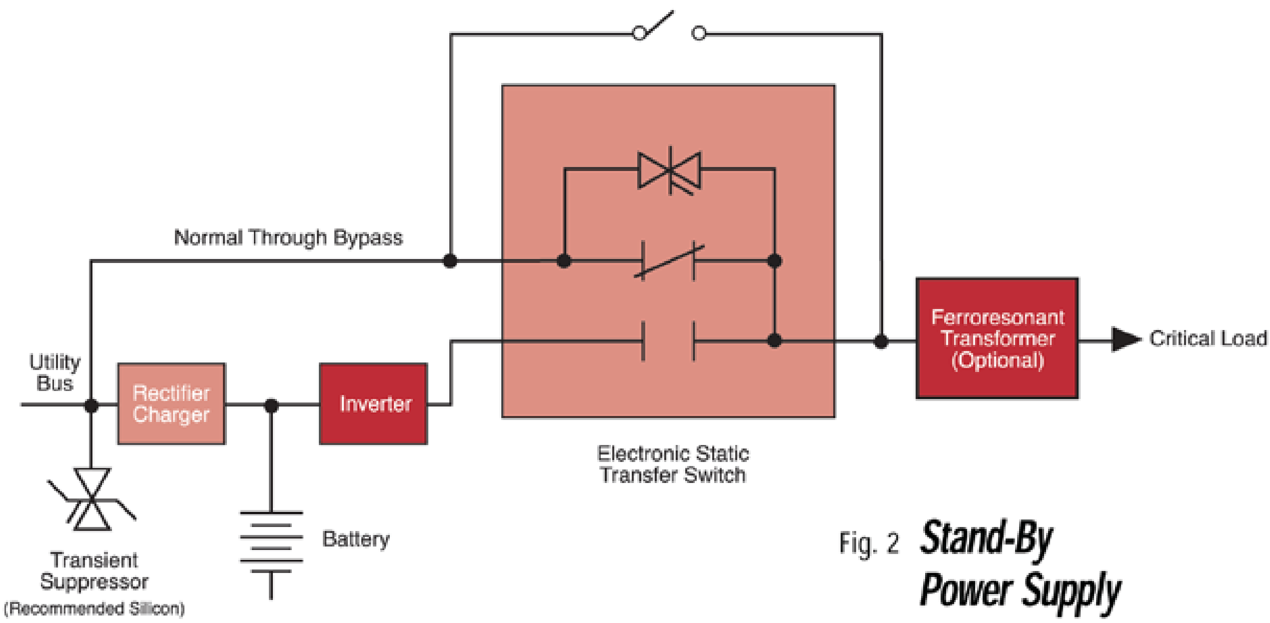

Fig. 2 **Stand-By Power Supply**

Transient Surge Risks

A power line disturbance engineering study (Ref. 1)revealed that a mere 0.5% of the power disturbances during the test period was due to outages, only an additional 11%was attributed to over and under voltages. The majority,88.5% of occurring disturbances, was caused by transient voltage (dv/dt) conditions.

How Transients Get Through UPS & Stand-by Systems

With this high percentage of power disturbances attributed to transient voltages, it is important to note there are several instances when these transients can bypass a UPS or Stand-by system, or pass directly through them to potentially damage the attached equipment.

How a Transient Gets Past a UPS or Stand-by System Under Failure, Power Disturbance or Maintenance Circumstances

When a UPS systems fails, is under service, or must protect itself from problems caused by the critical load or utility power, a transfer occurs, allowing utility AC voltage through the static transfer switch, or manual maintenance by-pass switch. The equipment load becomes vulnerable to transients through either of these two switches, which are typically unprotected.

How a Transient Gets Past a Static Transfer Switch The static transfer circuits of a UPS are semiconductors,typically thyristors (back-to-back silicon controlled rectifiers). Because of the conductivity of these thyristors,transient conditions (dv/dt) can pass directly through the transfer switch to the critical load, even when the UPS is online and functioning properly.

How a Transient Gets Past an Inverter

Both UPS and Stand-by systems are similar to an L/C filter,a form of a frequency-dependent noise attenuator. All frequency-dependent L/C filters have the same basic shortcoming in attempting to suppress transient voltages they are a tuned circuit and only attenuate certain frequency bands within their design limitations. Therefore, UPS and Stand-by systems can pass transients that fall outside these frequency bands through the rectifier and inverter with sufficient voltage and current to damage the equipment load. This problem is magnified further if the batteries are located some distance from the UPS electronic circuits.

How a Transient Gets Past Ferroresonant Transformers in Stand-by Systems

Frequently, Stand-by systems have a ferroresonant transformer to provide some noise filtering and voltage regulation, but these transformers can pass transients directly through to the equipment load due to capacitive coupling, and the fact that the ringing frequency of the transient is near the 60 Hz fundamental frequency of domestic AC power. This is typical of inductive and capacitive induced transients (Ref. 2). When UPS systems operate in the battery backup mode, the same transient problem exists.

Lower frequency transients do not attenuate naturally along AC power lines and DC systems like high frequency transients do. Most UPS systems only filter in one frequency range though, and it is currently not possible to build a filter that can mitigate all high and low frequency transients.

Built-in MOV TVSS Is Not Adequate Protection

Transient over voltage suppression in UPS and Stand-by systems varies widely from no protection at all to metal oxide varistor (MOV) suppressors. While the inexpensive 130 volt RMS rated MOV units commonly used for UPS systems can keep the final clamp voltage somewhat low,under high current surge events their clamp point is not low enough to adequately protect computers and other electronic loads. Higher voltage rated MOVs produce worse results because of their higher clamping voltages.

In addition to the high clamping disadvantage of MOV technology, the 130 volt MOV units are extremely vulnerable to thermal runaway conditions on 120 VAC service. An MOV suppressor unit is in thermal runaway when it degrades to the point that its turn-on voltage is near the peak of the sine wave, causing more current to flow through the MOV. When this happens, the unit will overheat and fail. With MOV units, degradation into failure mode is generally quite rapid in any event, but thermal runaway greatly accelerates the process.

UPS Systems Are Electronic & Vulnerable to Transients

In many of today's UPS and Stand-by systems, the solid-state electronics (the rectifier/battery charger, inverter controls and electronic transfer switches) are made up of a large number of semiconductors and integrated circuits. This makes the electronics of the UPS system itself vulnerable to failure or errors caused by transient voltage conditions, and requires a higher degree of protection than MOVs can provide.

Reducing the Risks with Upstream SASD

To reduce these risks of damage through a UPS or Stand-by power system, install a solid-state silicon transient suppressor in front of the UPS or Stand-by system (see Figures 1 & 2). This installation will protect both the UPS or Stand-by unit and the equipment load from transients passing through the static transfer or manual maintenance transfer switches, as well as from transients passing directly through the inverter or the ferroresonant transformer under normal operation. Further, a good solid-state silicon suppressor will not be prone to the problems of MOV-based protection systems and will provide the required protection levels for both the critical load and the UPS or Stand-by systems without degradation.

References

Ref. 1 - "Monitoring Of Computer Installations for Power Line Disturbances" by George Allen and Don Segull of IBM Systems Development Division - IEEE/PES Conference Paper C74-199-6 January, 1974.

Ref. 2 - F. Martzl of published paper "Lower Is Not Necessarily Better"(Zurich International EMC Symposium 1989).

Ref. 3 - Transtector Systems proprietary research.

Please contact us for questions or further information on this topic.

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