

How to Protect Electronic Circuits from Power Surges

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The familiar maxim, “a chain is only as strong as its weakest link,” can apply to any number of technologies including devices intended to protect electronic circuits from potentially dangerous and disruptive power surges. Conventional surge protectors, whose technology originated more than 40 years ago and remains largely unchanged, illustrate the point. Especially when considering that the most important circuit protection issue today is the reliability and endurance of the protection device.

Standard surge protection devices usually rely upon relatively low-cost shunt-mode fixed clamping level components. An independent study by the Electric Power Research Institute (EPRI) flagged these components as often the weakest link during surge events, due to their low maximum continuous operating voltage and acknowledged sacrificial nature. These components will wear out, degrade and ultimately fail over time.

The study concluded that more effective surge protection could be achieved, without fixed clamping level components, using dynamic filter designs engineered to exhibit suppression, higher and safer ratings for maximum continuous operating voltage, exceptional endurance and higher levels of reliability.

In response to the need for more practical, effective, and resilient technology, power quality filters have been developed, which are central to series-mode surge suppression solutions. By design and performance, these offer the capability to outperform and outlast conventional suppression technology as never before and provide critical protection when and where needed, even during worst-case surge events.



Suppressing the Surge

Technically, a surge is a dramatic increase of voltage lasting up to 50 microseconds and a spike represents an

increase of voltage for two nanoseconds or less. If a surge is high enough and lasts long enough, components can heat and burn. And, while surges are inherently worse than spikes, both can damage electronic circuits and shorten service life.

Surges can be classified as external or internal. While external surges (caused by storms and normal power company switching operations) generally will be more severe, internal surges generally will occur more frequently, representing about 80 percent of all surges – when equipment is cycling on and off.

Surges can cause all types of problems, ranging from soft errors where information is scrambled in computing systems to gradual circuit deterioration resulting in premature failure and intermittent operation to outright destruction of circuits. Smaller, internally generated surges can over time wear out delicate circuits, causing intermittent problems and slowing down the operation of a system.

Conventional surge protectors have been taking heat, in part because their technology was developed with an eye toward protecting stand-alone equipment. These days of interconnected and highly complex systems have changed both the landscape and marketplace needs – and traditional technology has been put on notice.

Historical performance problems associated with standard surge protectors can be traced to the fixed clamping level components, called “Metal Oxide Varistors,” or MOVs. These components consist of a piece of metal oxide attached to the hot line with power, two semiconductors, and a grounding wire. (Often, a fuse will be included in the setup.) When voltage hits the protector, the two semiconductors are supposed to divert the excess power to the neutral and grounding wires, sending only the right amount to the hot wire and on to the equipment.

However, if the clamp level is low enough to be reasonably effective, the Maximum Continuous Operating Voltage (MCOV) is so low as to pose a risk if the power voltage increases slightly. If the MCOV is a safe 150 VAC on 120 VAC lines, then the protection level is poor. An optimal design cannot be achieved.

Ultimately, while the essential role of the MOV is to divert surge current, the component’s lifespan shortens and failure becomes imminent as more surges (or spikes)

are diverted. An MOV additionally is required to integrate a “failure indicator,” which is a tacit acknowledgment of a MOV’s sacrificial tendency (“planned obsolescence”). In short, an MOV will wear out after repeated use and one strong surge can spell disaster without forewarning.

Moving Beyond MOVs

For optimum protection from surges and noise, the overriding goal is to keep the surge energy from exceeding the normal power wave region and restrict unwanted surge let-through energy. Power quality filters easily pass the tests by limiting surge current, surge voltage, and surge duration to avoid the problems typically associated with shunt-mode suppressors, such as excessive let-through energy, limited service life, poor filtering, and safety ground wire contamination.

Power quality filters equipped with patented Wide Voltage Range (WVR) technology – without MOVs – rely upon inductive filtering circuitry connected to a neutral power line conductor to store and safely discharge surges without contaminating the critical safety ground reference. The input inductor absorbs the initial surge and capacitors then gradually release the excess energy to neutral when voltage returns to normal. Unlike MOV-based suppressors, which need to be set at a specific over-voltage level, these series-mode filters can sense, track, and suppress all excess voltages on 120 V powerlines, even when the power is low at 85 V or high at 175 V – and anywhere in between. They will additionally remove any EMI/RFI fluctuations from powerlines that otherwise could disrupt signals and degrade equipment over time.

The development of patented Total Surge Cancellation (TSC) technology builds on these positives by adding even more safeguards for the most critical circuit-protection applications. TSC technology entirely eliminates damaging surge energy from protected equipment – instead of merely suppressing a surge to a lower value – and ensures absolutely no let-through of damaging surge energy. The filters additionally will remove potentially harmful EMI/RFI fluctuations from powerlines and the ground line will be preserved, since surges are not diverted to the ground line where they could travel and damage interconnected equipment.



Here’s how TSC technology works: TSC performs by first filtering off the most dangerous surge frequencies and then canceling the remaining residual surge voltage. A transformer canceling winding

immediately begins to develop a canceling voltage due to the surge current flow in the transformer primary winding. The surge is filtered and delayed by the transformer primary inductance and the capacitor, with only some residual low frequency surge components appearing, but delayed in time due to the filtering action. The canceling voltage from the transformer is then added to the filtered surge. Adding the canceling voltage to the delayed residual surge voltage prevents even the residual surge voltage from exceeding the power wave peak voltage, reducing the surge voltage let-through to virtually zero.

Applications Abound

In today’s marketplace, power quality filter technology can be applied successfully to virtually any electronics protection application where degraded performance, intermittent problems, damaged equipment and/or fires simply are not options.

OEM designers, for example, can specify from a growing family of open chassis models ranging from 5 amp capacity to 20 amp capacity for 120 V applications offered in a variety of designs, including DIN rail mount or surface mount configurations. Other products range from plug-in models (from two to 10 outlets), commercial and industrial units for branch circuit protection, and specialty units developed for applications such as emergency management centers and data centers, among others. Custom solutions expand application potential.

One final note, when selecting the most appropriate surge suppression technology to protect sensitive electronic circuits, a reliable rule of thumb is to determine whether product ratings have been based on actual endurance testing. In general, MOV-based suppressor ratings are based only on calculations instead of real-world conditions.

Our recommendations as a best practice to help promote peace of mind and prevent potential damage, check with Underwriters Laboratories (UL) to ascertain whether a manufacturer’s products have been tested for endurance and performance (Adjunct Classification), as well as for safety and ask the supplier for the test results from another nationally recognized testing laboratory (NRTL).

Otherwise, if a surge suppression product is not rated ideally both for performance and endurance, its use can become a dangerous gamble, prompting the startling realization down the road that an ordinary surge protector may prove to be worse than no protection at all.

***About the author:** While at RCA, Harford developed some of the first integrated circuits used in television. In 1989, Harford introduced series mode surge suppression. He was granted two patents for the technology and was named New Jersey Inventor of the Year in 1991 for his work. In 2005, Harford invented and patented Total Surge Cancellation Technology for which he again was named NJ Inventor of the Year in 2006. He is the only individual to receive the award twice. For more information visit www.ZeroSurge.com.*