

SPDs and the Benefits of Filtering

Lightning or switching transients are characterized by an impulse of very fast rise time. It is not uncommon to experience $10\text{kA}/\mu\text{s}$ rise times in current and much the same in voltage.

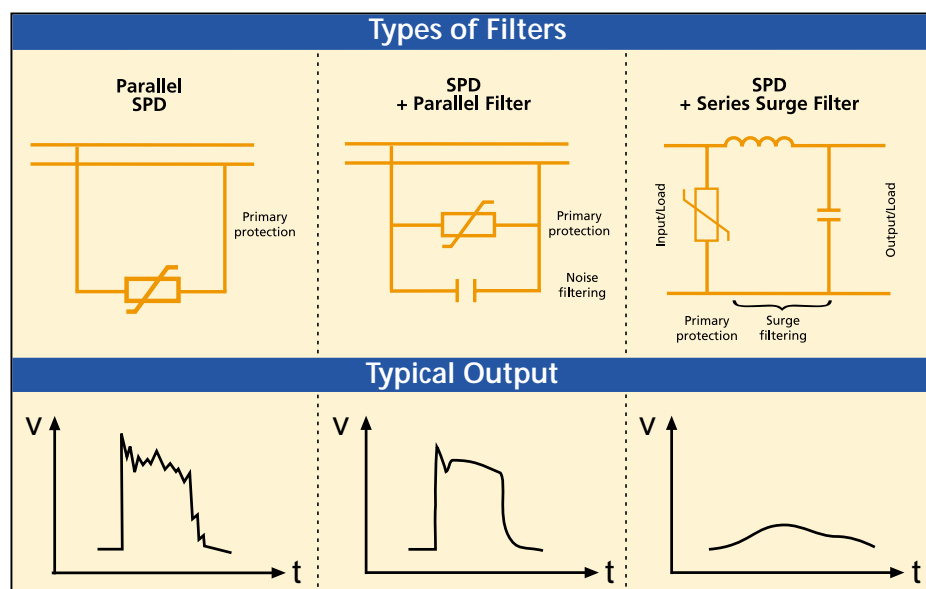
Electronic equipment is sensitive not only to the absolute magnitude of the voltage, but also to the rate of rise of this impulse. Much of the damage which occurs in sensitive electronic circuits using power semiconductor components such as MOSFETs, thyristors and IGBTs is the result of these steep changes in dv/dt and di/dt rather than simply the peak voltage. Such fast changes can cause these components to switch into conduction at the wrong point in their conduction cycle and self-destruct.

Protection of sensitive electronic circuits requires more than simply limiting the voltage of the transient. It is also extremely important to slow down the inherently fast rates of voltage and current rise – in effect to condition the waveshape of the incident surge.

The inclusion of a “low pass filter” is well suited to such a role. As its name implies, such a device will pass low frequencies, such as the 60Hz mains voltage with little attenuation, while it will attenuate and slow down the higher frequency components of a fast transient event.

Surge protection devices may include such a filtering stage to help condition the waveshape, thereby providing superior protection for sensitive electronics. This said, it is important to realize that a number of different topologies of filter circuit exist, each providing significantly different performance. At its simplest, a manufacturer may include a capacitor in parallel with the output. This will serve to reduce any fast ringing voltages and will also absorb the energy in a small transient thereby providing a level of attenuation.

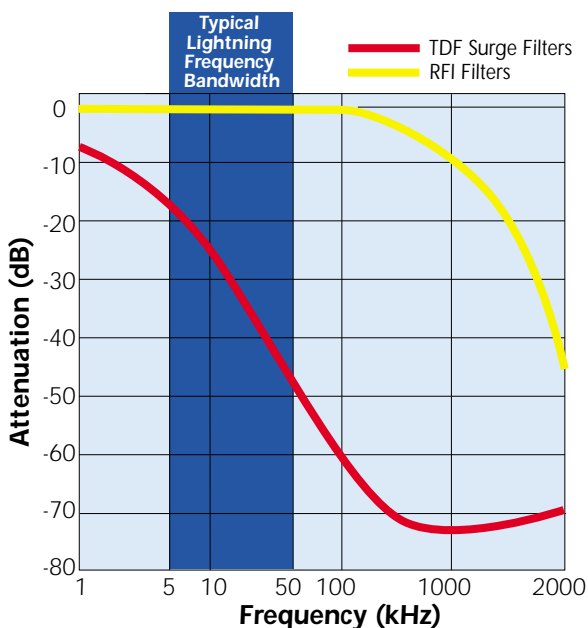
A far more effective approach is the series LC filter. This type of filter is connected after the surge limiting components and is in series with the supply powering the equipment. It consists of a series inductor and parallel capacitors. Surge protection devices of this nature are often referred to as “two port” devices since they have a distinct input and output side. The inclusion of the series inductor means that this type of surge protection device needs to be rated for the continuous load current drawn. ERICO manufactures its TDF and SRF range of protection devices with series current capabilities from 3A to 200A. These products efficiently reduce the dv/dt of the surge from a nominal $10,000\text{V}/\mu\text{s}$ to less than $100\text{V}/\mu\text{s}$ – a one hundred-fold improvement.



A single port SPD is a device installed in parallel with the equipment to be protected and serves to simply clamp the peak of the transient voltage. The performance of this clamping depends upon the technology used (e.g. MOVs, Silicon, Spark Gap, etc.) and the construction/design. The main limitation of the parallel diverter is that prior to the activation of the device, little is done to modify the leading edge of the incident surge waveshape.

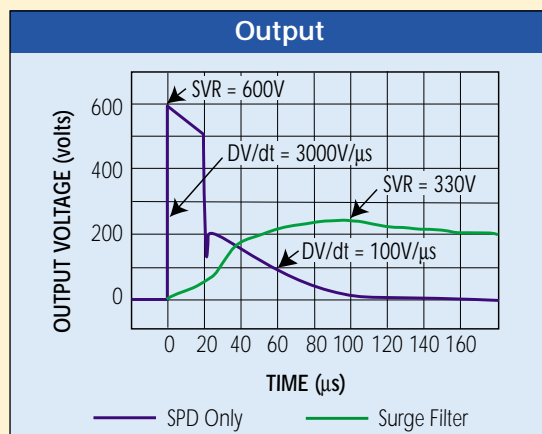
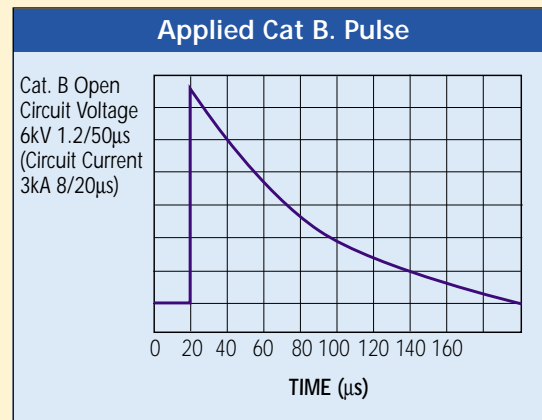
A single port SPD with parallel filter stage adds to the above a small amount of capacitance, typically in the order of $2\mu\text{F}$. The purpose of this is to attenuate the higher order frequencies, such as noise, and to dampen the oscillations of faster ring wave impulses. Again this product does little to modify the leading edge of the incident surge. Some manufacturers market such devices using impressive jargon such as Sinewave Filtering – this is of more marketing value than technical benefit.

Two port SPD devices contain a series inductance and typically parallel capacitance. Such devices with a low pass series filter provide superior performance and are well suited to the protection of sensitive microprocessor-based electronics such as SCADA and PLC systems. A well designed two port SPD will provide attenuation to not only the higher frequency RFI/EMI (Radio Frequency Interference/Electro-magnetic Interference) but critically to the 25 to 100kHz band (the fundamental frequency range of most lightning induced interference and where 70-90% of the energy is contained).



These filters offer two benefits:

- 1) They further reduce the transient voltage reaching the equipment.
- 2) Most importantly they alter the rate of rise of the leading edge of the impulse. The residual leading edge spike after a standard SPD, although it may only be 500V in amplitude, can cripple electronics due to its extremely high rate of voltage rise of 3,000-12,000V/ μs . The Series Surge Filter reduces this rate of rise to less than 100V/ μs . This slower change in voltage is better withstood by electronic equipment using switched mode power supplies. The filter also attenuates small signal RFI/EMI noise problems.



Improved reduction in dv/dt of Surge Filter





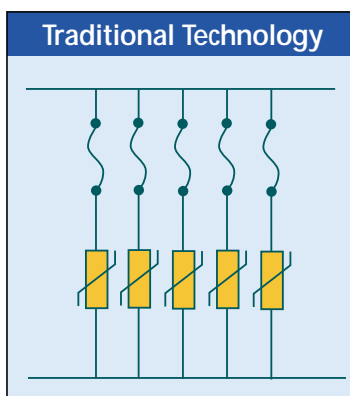
The Benefits of TD Technology

To meet the fundamental requirements of performance, longer service life and greater safety under real world conditions, ERICO has developed Transient Discriminating (TD) technology.

This quantum leap in technology adds a level of “intelligence” to the Surge Protection Device enabling it to discriminate between sustained abnormal over-voltage conditions and true transient or surge events. Not only does this ensure safe operation under practical application, but it also prolongs the life of the protector since permanent disconnects are not required as a means of achieving internal over-voltage protection.

Traditional Technologies

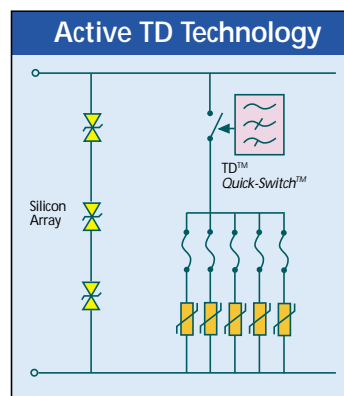
Conventional SPD technologies utilize metal oxide varistors and/or silicon avalanche diodes to clamp or limit transient events. However, these devices are susceptible to sustained 50/60Hz mains over-voltage conditions which often occur during faults to the utility system. Such occurrences present a significant safety hazard when the suppression device attempts to clamp the peak of each half cycle on the mains over-voltage. This condition can cause the device to rapidly accumulate heat and in turn fail with the possibility of inducing a fire hazard.



The Core of TD technology

The secret to ERICO’s Transient Discriminating Technology is its *active frequency discrimination* circuit. This patented device can discriminate between a temporary over-voltage

(TOV) condition and a very fast transient, which is associated with lightning or switching-induced surges. When the transient frequencies are detected, the patented Quick-Switch™ within TD activates to allow the robust protection to limit the incoming transient. The frequency discriminating circuit that controls the Quick-Switch™ ensures that the SPD device is immune to the effects of a sustained 50 or 60Hz TOV. This allows the device to keep operating, providing safe and reliable transient protection, even after an abnormal over-voltage condition has occurred.



Meeting & Exceeding UL Standards

The CRITEC® range of surge protection devices from ERICO employing TD technology has been specifically designed to meet and exceed the new safety requirements of UL 1449 Edition 2. To meet the abnormal over-voltage testing of UL 1449 Edition 2, many manufacturers of SPD devices have incorporated fuse or thermal disconnect devices which permanently disconnect all protection from the circuit during an over-voltage event. Transient Discriminating technology on the other hand will allow the SPD device to experience an abnormal over-voltage up to twice its nominal operating voltage and still remain operational even after this event! This allows the device to provide safe, reliable and continuous protection to your sensitive electronic equipment. TD technology is especially recommended for any site where sustained over-voltages are known to occur, and where failure of traditional SPD technologies cannot be tolerated.



The UL 1449 testing standard addresses the safety of a TVSS device under temporary and abnormal overvoltage conditions, but does not specifically mandate a design that will give a reliable, long length of service in the real world. Specifically, UL 1449 tests that the TVSS remains operational at 10% above nominal supply voltage, allowing SPD manufacturers to design products that permanently disconnect just above that. Most reputable manufacturer's designs allow for up to a 25% overvoltage, while ERICO's TD Technology gives even greater overhead.

TD Technology - Features & Benefits:

- Long life by eliminating SPD failure under TOV conditions.
- Fully compliant with UL 1449, Edition 2.
- Extended Maximum Continuous Operating Voltage makes this technology ideal where the integrity of the utility power can not be guaranteed.
- No reliance on permanent over-voltage disconnects means continued protection even after abnormal over-voltage events.
- High surge capacity with low suppressed voltage ratings.

