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 10kA/µs rise times in current and much the same in voltage.

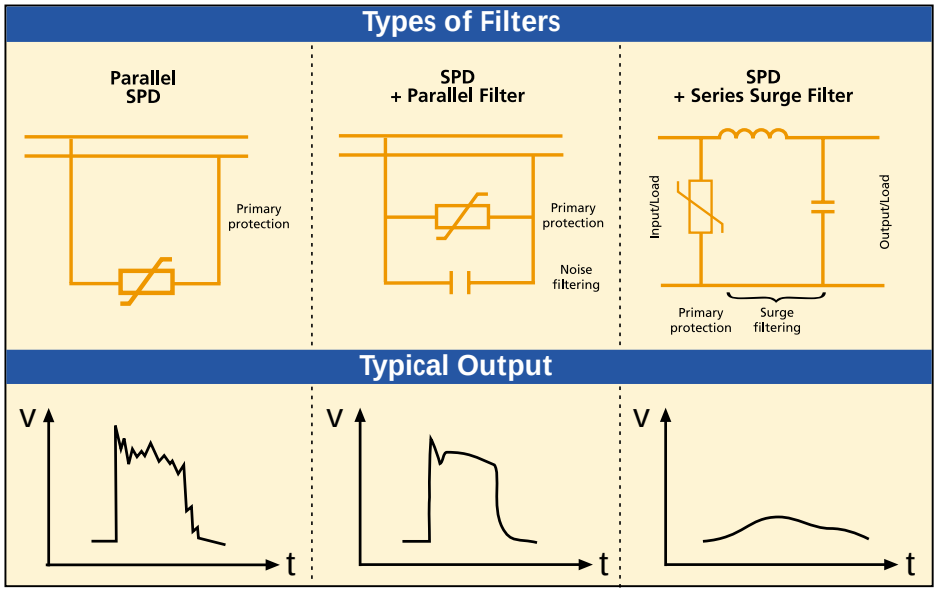
Electronic equipment is sensitive not only to the absolute magnitude of the voltage, but also to the rate of rise of this impulse. Much of the damage which occurs in sensitive electronic circuits using power semiconductor components such as MOSFETs, thyristors and IGBTs is the result of these steep changes 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.

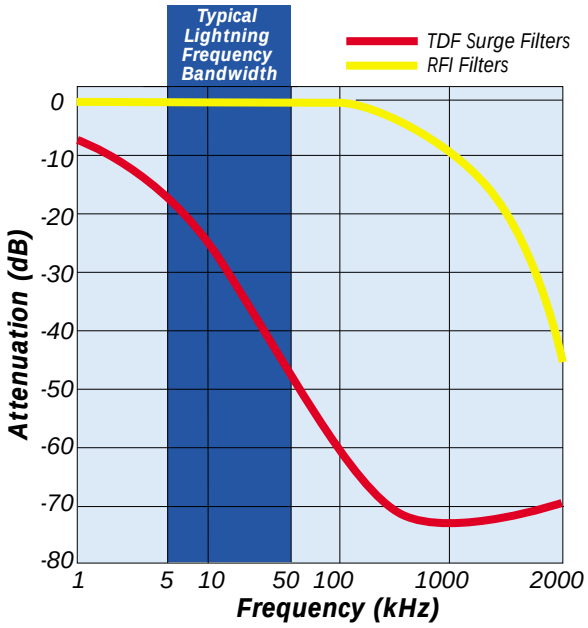
A far more effective approach is the series LC filter. This type of filter is connected after the surge limiting components and is in series with the supply powering the equipment. It consists of a series inductor and parallel capacitors. Surge protection devices of this nature are often referred to 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 2000A. These products efficiently reduce the dv/dt of the surge from a nominal 10,000V/µs to less than 100V/µs – 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.

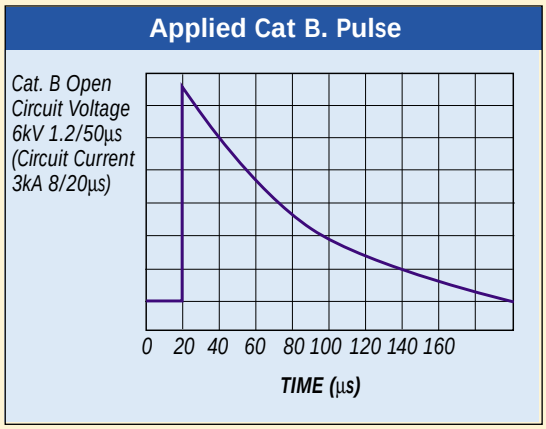
A single port SPD with parallel filter stage adds to the above a small amount of capacitance, typically in the order of 2µF. The purpose of this is to attenuate the higher order frequencies, such as noise, and to dampen the oscillations of faster ring wave impulses. Again this product does little to 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.

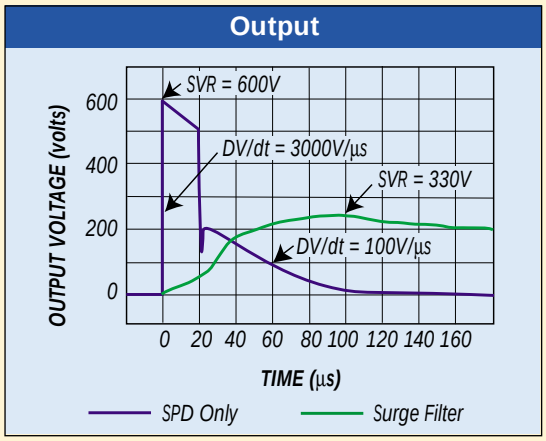
Two port SPD devices contain a series inductance and typically parallel capacitance. Such devices with a low pass series filter provide superior performance and are well suited to the protection of sensitive microprocessor-based electronics such as SCADA and PLC systems. A well designed two port SPD 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/dv of Surge Filter