Innovative Technology
TVSS Products

Technical Document

Benefits of Hybrid Filtering in Surge Protection Devices

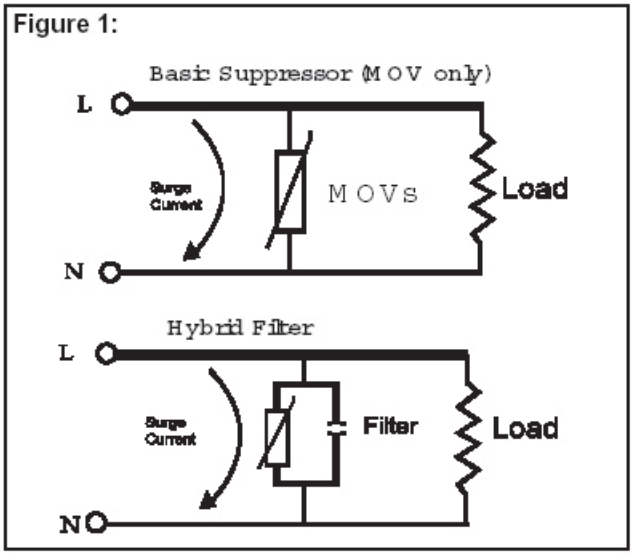
BENEFITS OF HYBRID FILTERING IN SURGE PROTECTION DEVICES

A surge suppressor (TVSS device) prevents harmful surge voltages from damaging or disrupting sensitive electronic equipment. There are two types of suppression devices:

1) ***"Basic Suppressor"*** Devices - transient suppressors that use only voltage dependent components such as Metal Oxide Varistors (MOVs) or silicon avalanche diodes (SADs).

2) ***"Hybrid Filter"*** Devices - hybrid devices that employ a parallel capacitive filter circuit in addition to MOVs. Since these products are able to eliminate low amplitude transients and high frequency EMI/RFI noise, they are widely specified for commercial, hospital and industrial facility construction projects (See Figure 1).

Figure 1:



Unfortunately it is often difficult to distinguish between *"hybrid filter"* and "*basic suppressors"* when reviewing the performance specifications provided by the manufacturer of either type of device. In addition, specifying consultants are often unsure of the practical benefits offered by the filter components. This Tech Note describes the differences between the two technologies when installed in an electrical distribution system.

A *"hybrid filter"* protects sensitive electronic equipment against high amplitude lightning impulses, low level ringing transients and EMI/RFI noise disturbances. In comparison, *"basic suppressors"* do not have filter components and can only suppress high voltage disturbances. Table 1 summarizes the key differences between the two technologies.

a) Ringing Transient Suppression

Studies performed by ANSI/IEEE and other organizations indicate the oscillatory ringwave is the most common type of transient waveform occurring within a facility's electrical distribution system. Normal impedance characteristics of a low voltage distribution system create ringing oscillatory waves at frequencies between 50 kHz and 250 kHz, 100 kHz is the most common ring frequency. Internal transients at these frequencies are common and can result in damaged integrated circuits, system lock-ups, reboots or other operational problems. To model this ringing effect, ANSI/IEEE C62.41 (1991) recommends testing all suppression devices to the 100 kHz Ringwave (Category B3; 6000 V, 500 A waveform) see Figure 2. Published let through voltages are then used to compare suppression performance.

Figure 2

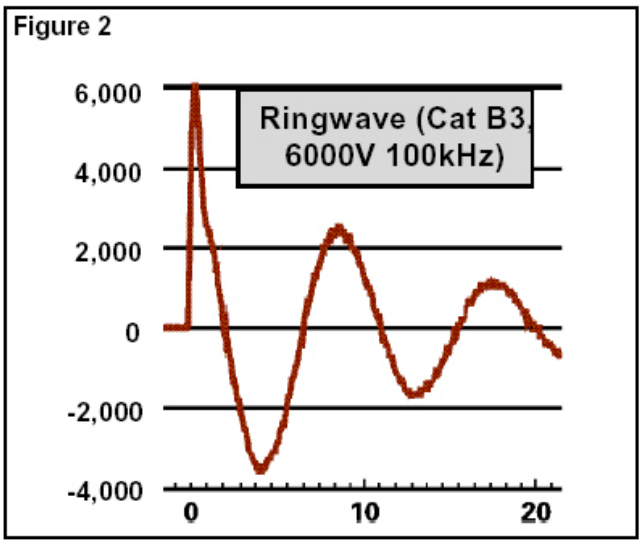


Table 1: Comparison of Suppressor Technologies

TVSS Performance Criteria:	"Hybrid Filter"	"Basic Suppresor"
a. Repetitive surge withstand capability:	longer life expectancy	limited life
b. Ringing transient suppression:	<100 V Let Through	>900 V Let Through
c. Electrical noise attenuation:	40 dB @ 100 kHz	poor attenuation
d. Facility-wide noise filtering:	coordinated from service entrance to branch panels	not achievable

Figure 3 illustrates the superior performance of a *"hybrid filter"* suppressors when tested to the standard IEEE B3 Ringwave. Filter components provide a low impedance path at higher frequencies (e.g. 100 kHz) allowing impulses to be shunted away from sensitive loads, at any phase angle along the 60 Hz ac sine wave. This "sine wave tracking" feature suppresses disturbances at much lower levels than possible with a *"basic suppressor"* (nonfiltered device).

Without a filter, the MOVs are able to clamp the transient only once when the voltage exceeds the "turn on" point of the MOV. As shown in Figure 3, the MOV let through voltage is significantly higher due to the impedance associated with wire lead lengths and the MOV operating characteristics. This is over 3 times the let through voltage of the TVSS Filter. As a result, the level of protection provided is limited.

b) EMI/RFI Noise Attenuation

Filters remove high frequency EMI/RFI noise associated with loads such as:

- variable speed drives
- photocopiers
- large UPS systems
- arc welders
- SCR controlled loads
- light dimmers

These types of noise generating loads are found in almost every facility. IEEE defines noise as disturbances less than 2 times peak voltage (e.g. less than 340 V peak on 120 V systems).

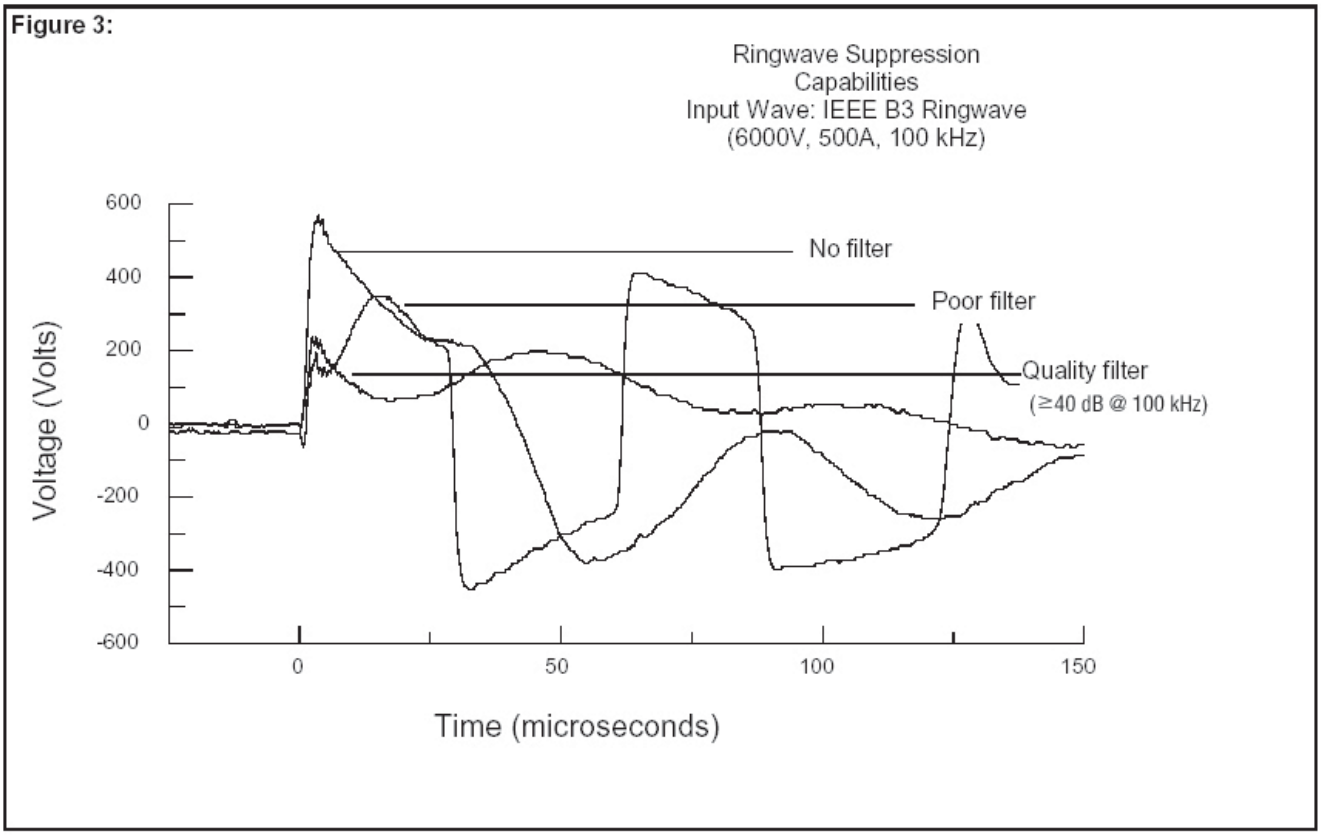
The key performance filter testing standard is the MILSTD-220A, 50 Ohm insertion loss test. Manufacturers should publish noise attenuation levels measured in decibels (dB) obtained at 100 kHz. Test data based on computer simulations such as SPICE programs are not reflective of actual environmental conditions and therefore not acceptable for comparing filter performance. Also note that published dB ratings at frequencies over 1 MHz are meaningless for panel *"hybrid filter"* products. Above 1 MHz, EMI/RFI noise does not travel on the conductor (i.e. it is radiated and travels in the atmosphere).

For premium performance, the filter attenuation should exceed 40 dB @ 100 kHz (based on MIL-STD-220).

Note: To verify if a given Surge Protection Device utilizes hybrid filtering, inspect the specificiations. A true filtering SPD will have a narrow operating range (typically 47-63 Hz line) and have let through voltage test data based on the IEEE Ring Wave.

Note: Have the suppressor supplier provide filter attenuation data to ensure this level of filtering is being provided.

Figure 3:



c) System Noise/Suppression Capability

"TVSS Filters" installed at the service entrance and branch panels meet with the IEEE recommended approach to facility protection (Refer to TD37H03ASE, Facility Wide Surge Suppression).

In addition, a system wide suppression design provides enhanced normal mode and common mode noise attenuation - significantly greater than a stand alone device.

Summary

"TVSS Filters" offer significant benefits that enhance the power quality within a facility. This Tech Note illustrates why *"sine wave tracking"* SPDs are now the most commonly specified suppression technology.

Manufacturers may offer misleading claims and avoid publishing accurate performance standards. Engineers should ensure the suppression device chosen offers sufficient ringwave suppression, noise attenuation and provides coordinated facility protection. TVSS manufacturers claiming to offer sine wave tracking or filter components must support these claims by submitting test results and spectrum analysis. Without these submittals, it is likely a low end suppressor will be supplied rather than the required "*hybrid filter".* All Innovative Technology models have high performance filter systems. Please call our Customer Service personnel (1-800-647-8877) for any questions concerning surge suppression or for application assistance.

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