



Filtering and Attenuation

Some caution should be used in evaluating the EMI/RFI filtering capabilities of a surge suppressor. MIL-STD-220B defines the basic testing procedures and test equipment to be used. However, there are certain procedures and measurements that are left up to the user for interpretation. Also, since the standard was developed in 1959, equipment used for testing and equipment being tested has changed. This allows each manufacturer some liberty in interpreting results that are published in technical specifications. There are several industry publications that address the application of filters with non-linear surge protective devices on the mains. One of these, *Protection of Electronic Circuits from Overvoltages* by Dr. Ronald Standler, discusses in detail this application in Chapters 13 and 19. Some of the information contained in this bulletin has been paraphrased from this reference. The performance of linear devices, such as filters alone, is properly characterized with gain or loss in decibels (dB). When nonlinear devices are combined with filters, it is not desirable to specify the attenuation of transient overvoltages with gain or loss in decibels. Nonlinear devices, gas tubes, and varistors are appropriately characterized by a clamping voltage at a specified surge current and wave shape, not by gain.

In order to remove a troublesome noise frequency from a system with a filter located several feet or more from the system, the noise must be at a low enough frequency that the connecting wire impedance will have little to no effect on transmission of these RF signals. Information from the industry standards published by the IEEE in C62.41 and C62.45 shows that most of the energy of transients is at frequencies less than 10 MHz. As frequency increases to 100 MHz, the designs considered for surge protective devices will not be effective. Good RF design practices must be observed to shield, attenuate, and, otherwise control RF energy. Common low pass filter modules designed for commercial service on the mains provide approximately 30 to 70 dB of attenuation in a 50 ohm system at frequencies between 15kHz and 30 MHz. Owing to limitations on the physical size of inductors and capacitors, filters have little attenuation at frequencies below 15 kHz. This same low pass filter design is used in all surge suppressors. Above about 30 MHz, most noise is transferred in or out of a chassis by radiation through space rather than by conduction along wires. The filter design by all manufacturers of parallel surge suppressors follows the same basic concept of using a filter with capacitors in parallel with the suppression components. To add a series filter element such as an inductor or ferrite core torroid would increase the size and cost of the suppression device beyond practicality and, in most instances, compromise the performance as a surge suppressor. Recall that most SPD/TVSS are parallel connected, thus limiting internal componentry to parallel connections too. These type devices are available from several manufacturers for specialized applications.

Noise filter plots look like band-stop filters with maximum attenuation of 50-55dB near 100kHz. At frequencies above and below 100kHz the attenuation levels roll off somewhat. This is expected because the parallel capacitor is a first order device. APT SPDs have demonstrated -52.953dB at 100kHz. APT SPD/TVSS use UL 1283 Recognized "Electromagnetic Interference Filters."

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