

# Impulses: Clamping vs. Filtering

# Application Note - AN-14

Transient Voltage Surge Suppression (TVSS) is an important part of any power conditioning strategy. High energy impulses are one of the most damaging and visible type of power problem. A successful power conditioning strategy must protect sensitive equipment from these impulses.

## Filtering and Clamping

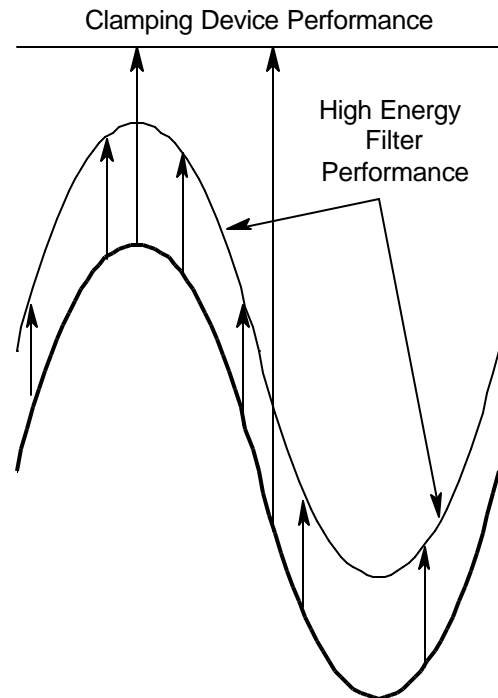
There are two methods of suppressing high energy voltage transients. **Clamping** devices use a non-linear element that conducts or shorts when exposed to overvoltage. These clamping elements absorb a large portion of the impulse energy, converting it to heat. Clamping devices are the most common form of impulse protection.

**Filtering** devices use capacitive and inductive elements to absorb the impulse energy. Off-the-shelf noise filters (EMI/RFI) do not provide effective transient protection. Only specially designed high performance filters can provide effective attenuation of these impulses.

## Benefits of Filtering Impulses

Filtering an impulse is almost always preferable to simply clamping the transient. Benefits of using a high performance filter are:

- 1) The let-through voltage of almost all impulses is much lower for a filter than for a clamping device.
- 2) Filters use passive capacitive and inductive elements that are not susceptible to degradation or failure.
- 3) Filters can attenuate low energy impulses (such as ring waves) to a few volts!
- 4) Filters provide other power conditioning benefits: noise filtering, harmonic attenuation, and reducing the output impedance at harmonic current frequencies.



## Filtering Devices

Filtering transient impulses is superior to clamping these impulses. However, selecting the proper type of filter and filtering components is important to ensure that the device effectively attenuates transient voltages and high frequency impulses.

Two requirements of a filter for TVSS use are a **High Energy** design, and selection of **High Frequency** components.

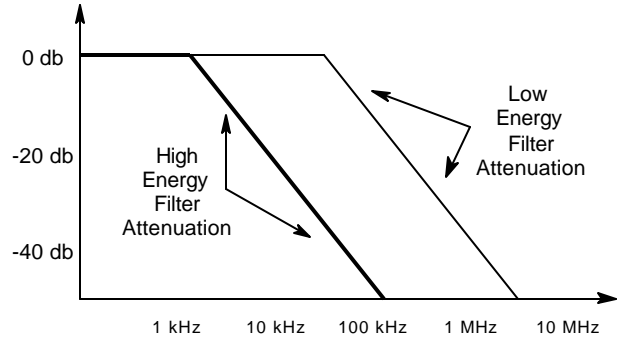
High Energy design is achieved by selecting a high value of capacitance, designed to handle high surge currents. These capacitors must also have a low internal impedance so that they effectively capture and filter the high frequencies associated with many types of impulses.

## Standard Filters

There are many types of low energy, noise level filters that are used to protect the power supplies of electronic equipment. (Electro-magnetic Interference or EMI filters) Most of these are not suitable to protect equipment from high energy impulses. The capacitive elements of a small EMI filter are designed for noise frequencies (~500 kHz) and voltage levels (~5 Volts) and not for frequency and voltage levels found in high energy impulses (6000 Volts / 20 kHz)

Another device used to enhance power quality is a **shielded isolation transformer**. While these devices provide good grounding and noise reduction, the internal capacitance is much lower than that required to filter transient impulses.

Many manufacturers add clamping elements, such as Metal Oxide Varistors, to these low energy filters in order to provide TVSS protection. However, this combination of low energy filter and clamping device is much less effective than a high performance filter.



A Bode Plot of filter attenuation vs. frequency shows the difference between a high energy filter (effective at attenuating transient impulses) and a low energy filter.

## Combining Clamping and Filtering Devices

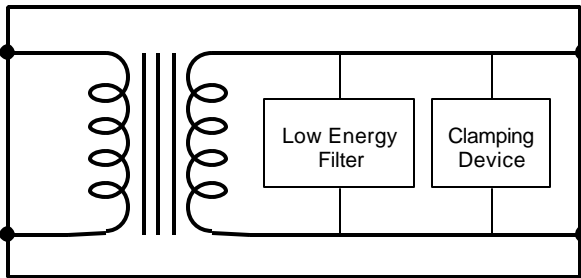
In power conditioners, which incorporate high energy filtering and isolation transformers, it is common to find clamping type surge suppressors in addition to the primary protection provided by the filter. Benefits of this type of hybrid protection include:

- 1) The high energy filter provides primary impulse attenuation. As a result, the clamping device is required only during the absolute worst case impulses.
- 2) Clamping device failure is not as critical, since the high energy filter will remain active to provide superior protection
- 3) The high energy filter provides protection from the fast rising edge of high frequency transients. Lead length and response time for the clamping element is less critical.

Because of these reasons, many power conditioning manufacturers choose MOV based clamping devices as a cost-effective device to supplement the impulse protection of filters and transformers.

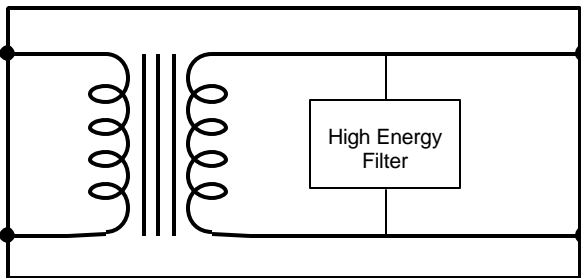
**TEAL Electronics** has developed Low Impedance, High Performance filters that make TEAL power conditioners the best performing devices available.

### Power Conditioner



Most power conditioners use a combination of clamping device and low energy filter to attenuate transient impulses.

### Power Conditioner



A High Energy filter provides better protection levels of protection.