

Impulse Testing a Power Conditioner Application Note - AN-8

The Problem: *Impulses and transients that are damaging or disrupting your sensitive systems.*

The Solution: *Power Conditioner. Case closed!*

Some conditioners have impulse protection inherent in the design. Other devices rely on add-on components such as filters or clamping surge suppressors. Still other devices do not provide impulse protection. Yet each of these devices can legitimately be called a power conditioner, despite widely varying performance and protection.

Unfortunately, it is not always so easy. There are many poorly designed or manufactured devices on the market masquerading as power conditioners. As an end-user, it is often difficult to separate the high quality devices from the junk. This application note identifies what to look for, and what to test for, when selecting power conditioning equipment.

Specifications

The most common specification for transient voltage attenuation is clamping voltage. This specification is an indication of the maximum output voltage, based on a given input voltage. The specification comes from the TVSS industry, where MOV's and other devices literally "clamp" the impulse voltage.

Power Conditioning Designs

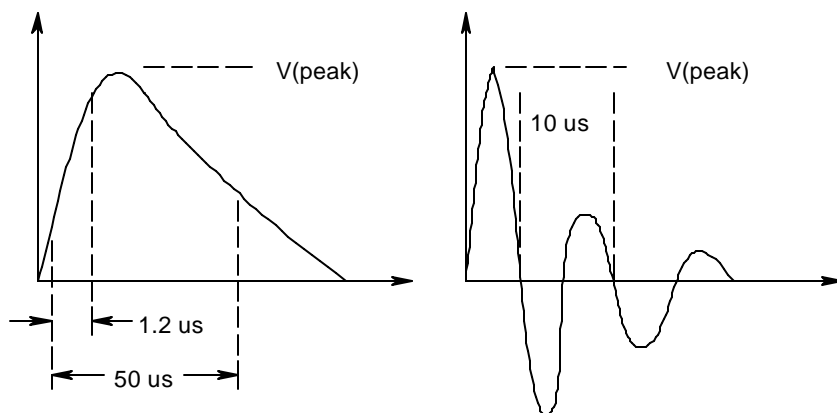
There are many different types of power conditioning devices on the market:

- Shielded Isolation Transformers
- Transient Voltage Surge Suppressors
- Voltage Regulators
- Voltage Synthesizers
- Ferro-resonant conditioners
- UPS Systems

The TVSS industry has developed an industry standard UL-1449 (based on IEEE C62.41) to formalize the impulse conditions with which to rate device performance. Any device that is listed and rated to UL-1449 can be confidently compared to other devices, head to head. Unfortunately, this UL standard is not commonly used for non-TVSS power conditioning equipment.

Each of these has different protection techniques and operating characteristics. Head-to-head comparison is often difficult. Unfortunately, end-users often consider a power conditioner to be a "commodity" item, looking for the lowest cost item without considering features, performance, and reliability.

IEEE C62.41 specifies several standard impulses (waveform, voltage, and current) typical of those found in electrical systems. This standard also defines locations by severity, since some building locations are exposed to higher energy impulses than others. These waveforms are illustrated below.



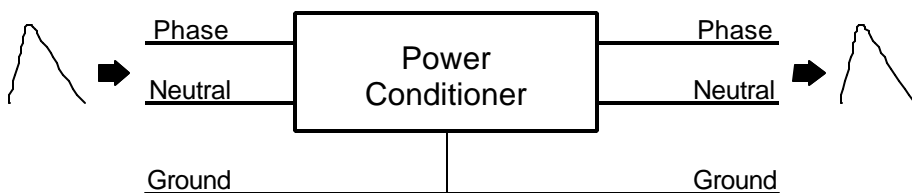
Unidirectional waveforms (left figure) are typically higher power, more likely to be found on feeders and branch circuits closer to the service entrance

Ringing waveforms (right figure) are more typical at outlets far from the facility connection to the utility.

Several manufacturers (e.g. - Keytek and Schaffner) make "Impulse Generators" that will produce these standard waveforms for test purposes.

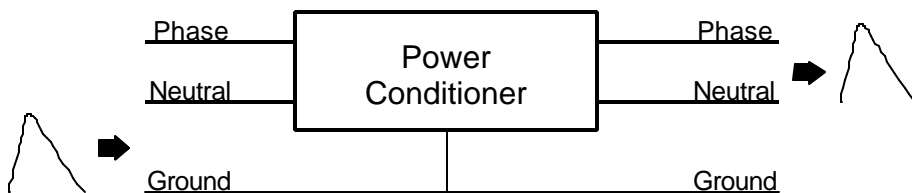
In addition to impulse waveform and energy, there are different paths that an impulse can enter a power conditioner. These paths are Normal Mode (phase-neutral or phase-phase) and Common Mode (phase and neutral to the safety ground). The attenuation of these impulse must be measured in both Common-Mode and Normal Mode.

Some power conditioner topologies can actually convert one type of disturbance into a different mode. TVSS devices for example, may convert Normal Mode impulses into Common Mode impulses. As a result, it is important to test all four coupling paths.



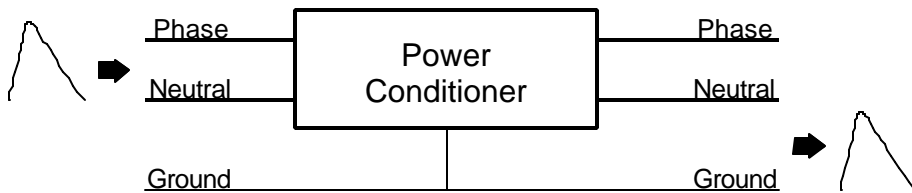
Impulse Injected:
Normal Mode

Impulse Measured:
Normal Mode



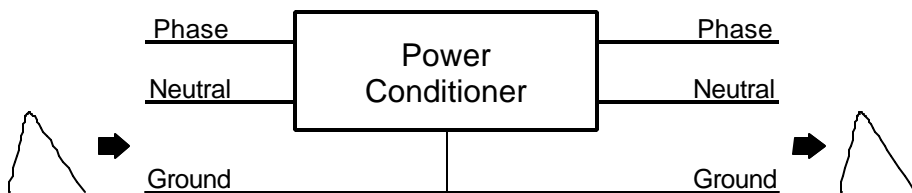
Impulse Injected:
Common Mode

Impulse Measured:
Normal Mode



Impulse Injected:
Normal Mode

Impulse Measured:
Common Mode

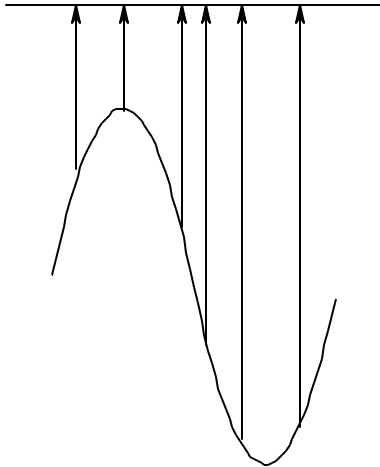


Impulse Injected:
Common Mode

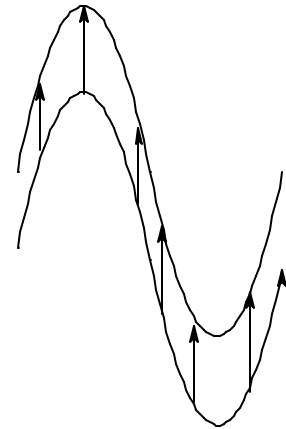
Impulse Measured:
Common Mode

Clamping vs. Filtering

It is important to be aware of whether a clamping or filtering circuit is used to provide attenuation. A clamping technology is more common; most filters do not handle the high energy of transient impulses. However, a high energy filter provides much better attenuation than a simple clamping circuit.



Left:
A Clamping Style Circuit clamps only those impulses that exceed the clamp voltage level. This voltage is dependent upon the clamping device used and the energy of the transient impulse.



Right:
A Filter Style Circuit attenuates the transient impulse regardless of where on the sine wave it occurs. The filter attenuation depends upon the filter characteristics and storage elements, and the impulse frequency content.

Impulse Clamping

Impulse Filtering

Things to Look Out For

It may not be possible to perform full impulse testing on a power conditioner. However, a careful look at the device specifications can uncover clues about a power conditioner's ability to attenuate impulses:

- Specifications in db (decibel) only. This typically indicates *low energy* (noise) attenuation, not *impulse attenuation*
- Attenuation specifications without a frequency or amplitude reference. For example, **-100 db @ 100 kHz, 20 Volts RMS** is a good specification; whereas **-100 db** is meaningless.
- Impulse clamping levels without a reference to a standard test waveform (ANSI/IEEE C62.41)
- Manufacturers using the theoretical or data-sheet clamping specifications of the installed devices (usually Metal Oxide Varistors or Silicon Avalanche Diodes) without attention to the actual device attenuation, as installed.

For More Information

Impulse testing standards are published by the IEEE. Particular standards of interest include

C62.33-1982 (R1994)

IEEE Standard Test Specifications for Varistor Surge-Protective Devices

C62.41-1991 (R1995)

IEEE Recommended Practices on Surge Voltages in Low-Voltage AC Power Circuits

PC62.42 D.9 April 1999 (Unapproved Draft)

Draft Guide for the Application of Component Surge-Protective Devices for Use in Low-Voltage Circuits

C62.45-1002 (R1997)

IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits

Teal Electronics combines low impedance transformers with clamping devices and high energy filters to provide the optimum in impulse protection in both normal mode and common mode.