

## Attenuation

The reduction of a signal or electrical surge from one point to another. Wire resistance, surge protective devices (SPDs), high voltage arresters, and power conditioners attenuate surges to varying degrees. Attenuation is used to describe the EMI/RFI filtering characteristics on Surge Protection Devices at a specific frequency and is usually expressed in decibels.

## Canadian Standards Association (CSA)

CSA is an independent, non-profit, product-safety testing and standards agency. Accredited by OSHA and is classified as an NRTL, CSA serves industry, government private business and consumers in Canada and in the global marketplace.

## Cascading

The practice of installing surge protective devices at two or more points on the electrical power system. The upstream device is designed to divert the majority of transient surges that comes from external sources (such as lightning, and power companies' induced transients), while secondary devices serve to clamp the residual surge energy as well as any surge activity that originates within the facility. The use of cascading SPD systems also protect against surge impulses entering a facility downstream of service entrance. Please see IEEE 1100 for additional information about cascading.

## Category A, B, C

Categories of location for transient suppression within a facility. Class A refers to outlets and long branch circuits. Class B refers to major feeders and short branch circuits near the distribution panel. Class C refers to the commercial power service entrance and outside the facility (refer to IEEE C62.41).

## CBEMA Curve

A set of curves developed by the Computer Business Equipment Manufacturers Association (CBEMA) that represents the withstand capabilities of computers in terms of the magnitude and duration of a voltage disturbance. It was a standard for measuring

the performance for all types of equipment and power systems until replaced by the Information Technology Industry Council (ITIC) curve.

## Clamping Voltage

The peak voltage that SPDs allow into an electric circuit based on a specific test waveform.

## Common Mode

Common mode refers to the surge protection components placed between L-G and N-G modes of the Surge Protection Device.

## Common Mode Disturbance

The transient event or the noise that is generated between two current carrying conductors and a common point of reference. (Usually between N-G or L-G).

## Cord-Connected SPD

A Surge Protective Device that has a plug for connection into an electrical outlet. These units are commonly known as strip protectors. (See Type 3 SPD).

## Decibel (dB)

A logarithmic function used to simplify MATV calculations. Decibels may be added or subtracted. 0 dB is the standard reference level for all MATV calculations.

## Electromagnetic Interference (EMI)

EMI is a frequency voltage disturbance. They affect sensitive electrical circuitry because of electromagnetic conduction or radiation that is emitted from an external source. EMI is often referred to as "RFI."

## Fault Current Rating

See "Short Circuit Current Rating"(SCCR)

## Filter

The electronic device that limits certain frequency bands while allowing others to pass through. Filter designs that are integral to One-Port Surge Protection Devices are of the band pass variety that attenuates a thin range of frequencies between line and ground mode. Filters that are integral to a

Two-Port Surge Protection Device are mainly of the low-pass variety that allows the 60Hz rms signal to continue to the loads while reducing the higher interference frequencies.

## Follow Current

Current supplied by the electrical power system and flowing through the SPD during and following the passage of discharge current.

## Gas Tube

"Crowbar technology" or a voltage switching type component that has high initial impedance but changes quickly to a low value when a surge has exceeded its threshold. Gas tubes are known for their ability to handle high energy transients, but have a slower response time. This type of technology can remain conductive with low follow currents even after a surge event has passed. Not recommended for DC applications.

## Hard-Wired SPD

See "Permanently Connected SPD"

## Harmonics

When the Electrical Power System sees non linear loading as a result of voltage and current distortions, this is called Harmonics. As an example, for 60Hz systems, the second harmonic is 120Hz. 180Hz is the 3rd, 240Hz is 4th, etc.

## Hybrid SPD Design

Hybrid SPD designs combine 2 or more suppression component technologies. Hybrid designs usually contain multiple protection circuits in an internally cascading or parallel design. When properly configured, the hybrid Surge Protection Device can provide the best possible protection.

## IEEE 1100 (Emerald Book)

IEEE Recommends the "Best Practice" for the Powering and Grounding of Electrical Equipment.

### **IEEE C62.41.1**

This is the IEEE Guide on the Surge Environment in Low-Voltage AC Power Circuit Applications.

### **IEEE C62.41.2**

The IEEE Recommended Practice on the Characterization of Surge Protections in Low-Voltage AC Power Circuits.

### **IEEE C62.45**

The IEEE guide on Surge Testing of Equipment Connected to Low-Voltage AC Power Circuits.

### **IEEE C62.62**

The IEEE Standard Test Specifications for Surge-Protective Devices for Low-Voltage AC Power Circuits.

### **IEEE C62.72**

The IEEE Application Guide for Surge-Protective Devices for Low-Voltage AC Power Circuits.

### **Institute of Electrical and Electronics Engineers (IEEE)**

This organization is an international engineering society of electrical and electronic engineers. The IEEE Standards Association has more than 8000 active members that develop the standards we use today.

### **ITIC Curve**

Replaces the CBMA curve and provides a set of curves developed by the Information Technology Industry Council (ITIC). These curves represent the highest level measurement a computer will withstand in terms of duration and magnitude of the voltage disturbance.

### **Joule Rating**

A Joule is the amount of electrical energy equal to the work done when a current of one ampere is passed through a resistance of one ohm for one second. Joule ratings are commonly quoted but can be very misleading when comparing the performance of a SPD as this rating is based on current duration versus voltage formula. NEMA, ANSI, IEEE or IEC do not recognize

joule ratings as a valid metric to benchmark SPD performance. Kilo Amperes (kA) is the basis of comparison for surge current protective capacity.

### **kA Rating**

See "Maximum Single Impulse Surge Rating"

### **Lightning Arrester**

See "Surge Arrester"

### **Maximum Continuous Operating Voltage (MCOV)**

The maximum steady state voltage at which the SPD can operate and meet its specification within its rated temperature. Per NEC 285, no SPD shall be installed on an electrical system where the MCOV rating of the SPD is less than the maximum continuous phase-to-ground power frequency voltage at the point of application. MCOV ratings for an SPD should be in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449 3<sup>rd</sup> Edition, Section 37.7.3.

### **Maximum Single Impulse Surge Rating**

The maximum 8/20 $\mu$ s surge current pulse an SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10% deviation of clamping voltage at a specified surge current. The Maximum Single Impulse Surge Rating (or kA rating) should be specified by mode since the number and type of components in any SPD may vary by mode.

### **Metal Oxide Varistor (MOV)**

A MOV is a solid state, non-linear, voltage-limiting device typically composed of zinc oxide. MOVs are the protective component of choice for the majority of SPD manufacturers due to their excellent energy handling capabilities and performance.

### **MIL-STD-220B**

Department of Defense Standard for Insertion Loss Measurement of passive, low pass, EMI/RFI filters as a function of frequency. Test methods within this standard are satisfactory for quality control during production operations, but do not represent

conditions that exist in actual installations. MIL-STD-220B superseded MIL-STD-220A in Jan. 2000.

### **Modes of Protection**

Electrical paths where the SPD offers defense against transient surge voltages. Examples for "wye" configured systems include Line to Neutral (L-N), Line to Ground (L-G), and Neutral to Ground (N-G) modes. Examples for "delta" configured systems are Line to Line (L-L) and Line to Ground (L-G) modes.

### **National Electrical Code (NEC)**

NFPA Standard #70. More commonly referred to as the National Electrical Code (NEC). The code is a set of rules, regulations and recommended electrical practices published by the National Fire Protection Association.

### **National Electrical Equipment Manufacturers Association (NEMA)**

NEMA is a standards body comprised of industry members with the objective to develop technical standards in the best interest of the electrical equipment industry and users, establish and advocate industry policies on legislative and regulatory matters and to collect, analyze and disseminate industry data.

### **Nationally Recognized Test Laboratory (NRTL)**

An OSHA accredited Product Safety Testing Laboratory. Per NEMA LS1 and the NEC, all SPD devices must be listed by an NRTL. Examples of NRTLs are UL (Underwriters Laboratories) and ETL (Intertek).

### **NEMA LS1-1992 (R2000)**

In 1992 NEMA published recommendations for SPDs. This document is known as NEMA LS1 and is a written standard established by a committee comprised of SPD technical subject matter experts. The purpose was to have SPD manufacturers prove their product performance. All SPD suppliers should adhere to the basic outline provided by NEMA LS1.

**Update:** NEMA LS-1 has been rescinded

by the NEMA 5VS technical committee. At the time of this release, there has been no NEMA document issued to supersede the LS1 Standard.

### **NFPA**

National Fire Protection Association

### **Noise Filtering**

This is an optional SPD design feature that provides electrical noise attenuation of EMI/RFI interference frequencies. See "Filter"

### **Nominal Discharge Current (In)**

The peak value of the current, selected by the manufacturer, impressed through the SPD having a current wave shape of 8/20ms where the SPD remains functional after 15 applied surges. Testing and assignment of (In) is carried out by an OSHA approved NRTL per the guidelines of UL 1449 3rd Edition Standard.

### **Nominal Voltage**

The normal operating voltage of the electrical system. For three phase systems in the wye voltage configuration that include ground the voltages are typically 120/208 or 277/480. The first number in this voltage configuration is the phase to neutral and phase to ground voltage level. The second number is the phase to phase voltage level.

### **Normal Mode**

Refers to the surge components used to provide protection phase to phase and phase to ground.

### **Normal Mode Disturbance**

Refers to a transient surge event or noise event that occurs phase to neutral or phase to phase.

### **Overvoltage**

An overvoltage is any increase in the nominal phase voltage. The event is typically categorized as an increase of 110% above the nominal voltage for durations lasting longer than 1 minute. The overvoltage is typically below the turn on voltage of the surge protective device.

### **Parallel Connected SPD**

The most commonly accepted method for utilizing surge protection devices is to install them in parallel to the source voltage and the downstream equipment. In this configuration the parallel connected surge device is not restricted by the electrical system load currents.

### **Peak**

The maximum recorded measurement level of an electrical event.

### **Hardwired SPD**

A SPD that is wired or terminated to the electrical distribution system in the field via wiring provided with the surge device, or wiring connected to lugs or terminals inside the surge device.

### **Plug-In SPD**

See "Cord Connected SPD"

### **Radio-Frequency Interference (RFI)**

See "Electromagnetic Interference"

### **Response Time**

The amount of time required for a surge protective device to react to a voltage that exceeds its threshold, or turn on voltage. For surge components this is typically determined by how long it takes for current to flow through the component. Typical surge components such as MOVs and SADs have picosecond or nanosecond response times. Some surge manufacturers market the response time of the individual component(s) used in their devices which is not an accurate method for measuring the system's response time. There are many variables to include how the surge components are arrayed in the design of the SPD as well as the lead lengths for installing the surge device that may have an adverse affect on the installed system's response time.

### **Secondary Surge Arrester**

See "Type 1 SPD"

### **Selenium Cells**

This is an SPD component that is comprised of selenium rectifier circuits. Selenium cell technology has been proven effective in handling sustained and temporary over-voltage conditions.

### **Series Connected SPD**

Series connected SPDs offer excellent surge protective characteristics against incoming transients, but are limited by the amount of load current they can support. Unlike the more popular "parallel" design SPDs, Series connected devices are ampere dependent. The higher the ampere rating of the intended protected load, the larger and more costly a Series Connected SPD will be. Series SPDs can only protect downstream equipment connected to same electrical conductor.

### **Short Circuit Current (SCC)**

The maximum available current that an electrical system can produce under fault conditions.

### **Short Circuit Current Rating (SCCR) of an SPD**

The level at which a SPD is suitable for use on an AC power circuit that is capable of delivering not more than the root-mean square symmetrical current at a declared voltage during a short circuit condition. The SCCR rating of an SPD is assigned by UL, based on abnormal overvoltage testing performed per UL 1449 3<sup>rd</sup> Edition, and is required to be marked on the SPD per article 285 of the National Electrical Code.

### **Silicon Avalanche Diode (SAD)**

Silicone Avalanche Diodes are semiconductor type SPD components that have fast, linear response characteristics, but are limited by their energy handling capabilities. An SPD normally acts as an open circuit but changes to a short circuit when the trigger voltage exceeds a certain amount. SPDs that are designed with SAD technology must utilize costly, high component count arrays to match the energy handling capability of an equivalently rated MOV based SPD design.

**Sine Wave**

The fundamental oscillatory RMS voltage and current waveform which is standard to 50/60Hz electrical power systems.

**Sine Wave Tracking**

A marketing term that is used to describe the EMI/RFI Noise filtering characteristics of an SPD equipped with filter capacitors. All SPDs with capacitive filtering exhibit sine wave tracking abilities.

**Spark Gap**

An "air gap" component used in surge protection. If the surge voltage is high enough, the air will ionize and begin to conduct between the gap. This type of protection is commonly used on utility lines.

**Suppressed Voltage Rating (SVR)**

No longer a valid rating for SPDs with the adoption of UL 1449 3rd Edition release, this was a per mode clamping voltage rating assigned by UL that was based on testing to a 6kV/500A combination surge waveform. SVR ratings have now been superseded by UL 1449 VPR ratings. See "Voltage Protection Rating." Comparisons between VPR and SVR ratings are not possible.

**Surge**

A transient voltage or current with a duration of a few microseconds.

**Surge Arrester**

Often referred to as Lightning Arrestors, Surge Arresters can be classified as a broad range of SPDs that are typically used on circuits above 1kV. Surge Arresters are covered under Article 280 of the National Electrical Code.

**Surge Life Rating**

The number of tested surge impulses that a SPD can be exposed to with less than 10% deviation from pre-test benchmark clamping levels.

**Surge Life Test**

This is a test used to determine the per-mode Surge Life Rating of an SPD based on the repetitive application of a specific surge current waveform across the terminals of the SPD. A commonly used and widely accepted

surge life test waveform is IEEE C62.41 Category C3 applied to the SPD in 1-minute intervals.

**Surge Protective Device (SPD)**

A device composed of at least one non-linear component and intended for limiting surge voltages on equipment by diverting or limiting surge current and is capable of repeating these functions as specified. SPDs were previously known as Transient Voltage Surge Suppressors or secondary surge arresters.

**Surge Rated Disconnect**

A disconnect switch that has been tested and certified for use up to the maximum specified surge current level without failure.

**Surge Rated Fusing**

Fusing components that have been tested and certified for use up to the maximum specified surge current level without failure.

**Temporary Overvoltage (TOV) Withstand Level**

This is the maximum rms voltage limit and duration of a temporary over-voltage event that the SPD can withstand without any changes in operational parameters or functionality.

**Type 1 SPD**

Permanently connected devices approved by UL for installation at any location between the secondary of the utility service transformer and the service entrance primary disconnect. A Type 1 SPDs can also be installed anywhere on the load side of the service entrance and allowed to be installed anywhere on the low-voltage electrical system without requiring a dedicated fuse or breaker.

**Type 2 SPD**

Permanently connected devices approved by UL for installation on the load side of the service entrance primary disconnect. Type 2 SPDs may, or may not require the use of a dedicated fuse or breaker.

**Type 3 SPD**

SPDs installed at a conductor length of 10 meters (30 feet) or greater from the elec-

trical panel. These devices are typically cord connected, direct plug-in, receptacle type SPDs installed at the load equipment being protected.

**Type 4 SPD**

Components and assemblies that do not have a UL Listing. They might carry the UL recognized mark. Examples are Metal Oxide Varistors, (MOV) and gas tubes.

**Transient**

A short duration, fast rising voltage event. Causes include lightning strikes, equipment switching and electrical motors.

**Transient Voltage Surge Suppressor (TVSS)**

Term no longer used, replaced with Surge Protective Devices (SPD).

**Underwriters Laboratories (UL)**

Underwriters Laboratories Inc. (UL) is an independent, not-for-profit product safety certification organization that has been testing products and writing Standards since 1894. UL partners with manufacturers to provide safe products through UL testing, certification and follow-up audits.

**UL 1283**

UL Standard for Electromagnetic Interference Filters. UL 1283 sets product safety testing requirements for EMI/RFI type filters.

**UL 1449**

UL Standard for Surge Protective Devices. UL 1449 sets minimum product safety testing requirements for SPDs.

**UL 96A**

UL Standard for Lightning Protection System installations.

**Voltage Protection Rating (VPR)**

VPR is part of the UL 1449 3rd Edition and is the clamping performance data for SPDs. Each SPD mode is subjected to a 6kV/3kA combination surge wave and its measured clamping value is rounded up to the nearest value based on table 63.1 from UL 1449 3rd Edition.