



## SURGE PROTECTION DEVICE (SPD) FAQs & Definitions



## FAQs

What are the different types of power anomalies and what are their characteristics?

Although often used as separate terms, transients and surges are the same phenomenon. They are current, voltage, or both that have peak values more than 10 kA or 10 kV. They are typically a very short duration in time with a rapid rise to peak and then fall off at a much slower rate.

- Temporary overvoltages (TOVs) are oscillatory and can last anywhere from a few cycles to seconds to several minutes. They can be caused by load switching, ground impedance, or other means. An extended TOV can cause permanent damage to a surge protection device (SPD) and render it inoperable.
- Noise is a distortion of the normal sine wave and can be caused by radar, fluorescent lights, power control circuits, or many other similar types of devices.
- Harmonics are frequencies that are multiples of the fundamental frequency. Noise and harmonics can sometimes affect SPD diagnostics.
- Undervoltage conditions and outages are where voltage drops below nominal level or to zero. These typically have little effect on an SPD as they do not recognize undervoltage as a problem.

What is ANSI/UL 1449?

ANSI/UL 1449 is the standard required to List (or Recognize) a Surge Protective Device or component to Underwriters Laboratories, LLC specifications for safety and performance. UL labels are required on every UL Listed or Recognized SPD, indicating Voltage Protection Ratings (VPR), Short Circuit Current Rating (SCCR), the type of SPD, the Maximum Continuous Operating Voltage (MCOV) and Nominal Discharge Current Rating (In).

What is the difference between the terms “Surge Arrester”, “Transient Voltage Surge Suppressor (TVSS)” and “Surge Protective Devices (SPD)”?

Up until the 3rd edition of UL 1449 – Standard for Surge Protective Devices was introduced in 2006 (compliance required in 2009), there were various terms used when referencing devices intended to limit the effects of a surge event. Surge arresters were originally developed for the line side of power distribution systems, protecting the system structure and not necessarily the connected equipment and loads. A TVSS as it was defined must be applied to the load side of the main service disconnect. It had a tighter “clamp” or limiting effect on transient voltages to protect sensitive electronics. Both terms were scrapped and replaced with the more generic “Surge Protective Device (SPD)” when the UL 1449 3rd edition was adopted. This UL edition and Article 285 of the NEC introduced different types of SPDs, with Type 1 replacing the original surge arrester for line side applications, and Type 2 replacing the TVSS for load-side applications. The term “surge arrester” now only applies to devices over 1000 V and is covered by Article 280 of the National Electrical Code (NEC).

What do waveforms such as 8/20  $\mu$ s and 10/350  $\mu$ s mean?

Lightning-induced surge currents are characterized as having very rapid rising “front edges” and long decaying “tails”. The first number signifies the time (in microseconds) taken for the surge to reach 90% of its peak value. The second number is the time taken for the surge to decay to half of the peak value. An 8/20  $\mu$ s wave form represents an indirect lightning strike to a conductor whereas a 10/350  $\mu$ s waveform represents a direct lightning strike.





What do the various product markings on an SPD mean? Why are they important?

Underwriters Laboratories (UL) requires certain markings be on all listed and recognized SPDs.

- **SPD Type** – Describes the intended location of the SPD in regard to the main breaker
  - **Type 1** – Between the secondary of the service transformer and the line side of the main breaker
  - **Type 2** – Permanently connected SPD on the load side of the main breaker
  - **Type 3** – Point of utilization SPD, like a receptacle, must be within 10 meters (30 feet) of the panel
- Nominal System Voltage – Should match the utility system voltage being protected
- MCOV – The Maximum Continuous Operating Voltage, this is the most voltage allowed before the device starts to clamp. Typically 15-25% more than the nominal system voltage
- Nominal Discharge Current – The peak value of the current through the SPD having an 8/20 waveform where the device is still functional after 15 surges. The manufacturer chooses which level to test: 5 kA, 10 kA, 20 kA
- VPR – The Voltage Protection Rating, which is the average limiting voltage of an SPD when subjected to a 6 kV, 3 kA 8/20 combination waveform generator. VPR is a clamping voltage measurement rounded up to one of the standardized table of values. All VPR tests are conducted with 6-inch leads outside of the SPD enclosure
- A short circuit current rating (SCCR) is the amount of fault current to which an SPD can be subjected and still safely disconnect from the power source
- Enclosure Type – NEMA rating for environmental conditions and locations where the SPD can be installed

What are multi-mode SPDs? Why do I need L-L (line-to-line) and N-G (neutral-to-ground) protection?

Multi-mode SPDs have several SPD components in one package, providing different modes of protection that can be connected. This protects against internally generated transients where ground may not be the preferred return path. This can be particularly helpful if the SPD is more than 10 meters (30 feet) from a neutral-to-ground bond. A general rule of thumb is that near the service entrance neutral-to-ground bond, you can get away with less modes of protection and the further away you need more modes of protection.

Is the joule rating of an SPD important?

Because joule ratings can easily be manipulated, many of the industry standards and guidelines (UL and IEEE) do not recommend the comparison of joules. Instead, they focus on actual performance of the SPDs by testing the Nominal Discharge Current, which tests the SPDs durability along with the VPR testing that reflects the let-through voltage.

What about repetitive low-level transients?

The majority (80%) of all transients are generated internally at a facility. They typically have less energy and are generated from the different loads cycling on and off. It is important to know where these low-level transients are originating, and to have a proper SPD at that location.

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How can I protect equipment that operates on dc?

Protection of equipment connected to direct current (dc) sources or power supplies generally involves installing protection at the alternating current (ac) input to the power supply. However, there is a growing need for dc protection when it comes to applications such as telecom. When applying an SPD to a dc bus, the SPD needs to be marked and approved for these types of applications.

Speed of response – is this important?

Yes and No. The ability of an SPD or surge component to respond to a voltage which exceeds its “turn-on” or “clamping” threshold, will govern the residual measured limiting voltage which the downstream equipment will be required to withstand. If the device is too slow, the clamping voltage will be high, and the equipment may not be adequately protected. This said, too much is often made of a manufacturer’s “speed-of-response”. All SPD components are fast enough. For example, an 0.5 ns response time is much faster than the fastest transients moving at  $\mu$ s speeds. What is more important is the “clamping or residual voltage” performance of the SPD. This is limited more by the internal printed circuit board (PCB) traces and the installed SPD’s wire length than any individual component’s actual response time.

What is distributed protection?

Distributed protection is the process of coordinating protection between the primary service entrance to a large facility and the internal distribution and branch panels. This is commonly referred to in the industry as layering or cascading of surge protection.

Where is the best place to fit protection?

Ideally, protection should always be installed at the main service entrance. It is good practice to utilize cascaded protection for the sub panels and equipment, especially in larger facilities where the critical loads are far away from the main.

What is the concern about sustained overvoltages?

Sustained overvoltages are not transient events yet are the leading cause of SPD failures. It is important to note that a sustained overvoltage event will continue until the upstream breaker is tripped, so an SPD that has a thermal disconnect, or would otherwise fail open, may not adequately protect the system. Littelfuse has a number of products designed to protect from sustained overvoltages including 3-Phase Voltage/Phase Monitors (201A, 455 and 460 series) and many others. Visit [Lttelfuse.com](http://Lttelfuse.com) for details.



## DEFINITIONS

**8/20 Current Impulse:** Impulse with a virtual front time<sup>1</sup> of 8  $\mu$ s and a time to half-value<sup>2</sup> of 20  $\mu$ s.

Note 1: The front time is defined according to IEC 60060-1

Note 2: The time to half-value is defined as the time between the virtual origin and the 50% point on the tail

**Clamp Voltage:** The peak MOV (Metal Oxide Varistor) terminal voltage measured with an applied 8/20  $\mu$ s pulse of rated impulse current.

**Clamping:** Can be used to adapt an input signal to a device that cannot make use of or may be damaged by the signal range of the original input.

**Clamping Circuit:** (also known as a clamper) Will bind the upper or lower extreme of a waveform to a fixed dc voltage level. These circuits are also known as dc voltage restorers. Clampers can be constructed in both positive and negative polarities. When unbiased, clamping circuits will fix the voltage lower limit (or upper limit, in the case of negative clampers) to 0 volts.

**Inductive Load:** An inductive load is typically a motor load in which the current waveform is lagging the voltage waveform. An inductive load pulls a large amount of current (an inrush current) when first energized. After a few cycles or seconds, the current settles down to the full-load running current.

**Industrial Control Panel:** An assembly of two or more components consisting of one of the following:

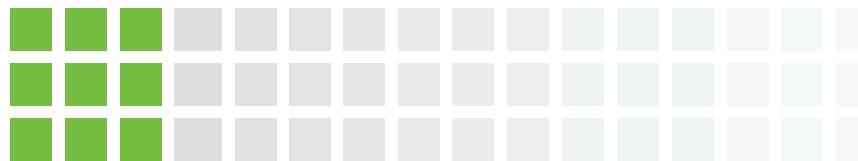
1. Power circuit components only, such as motor controllers, overload relays, fused disconnect switches, and circuit breakers
2. Control circuit components only, such as push buttons, pilot lights, selector switches, timers, switches, and control relays
3. Selector switches, timers, switches, and control relays;
4. A combination of power and control circuit components.

**Joule:** The unit of energy or work done when the point of application of 1 newton moves a distance of 1 meter in the direction of the force. The joule is a derived unit in the International System of Units.

**Labeled:** Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or material, and by who's labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

**Listed:** Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic inspection of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

# SURGE PROTECTION DEVICE (SPD) FAQs & Definitions



**Maximum Continuous Operating Voltage (MCOV):** The maximum rms voltage that may be continuously applied to the SPD (Surge Protection Device) for each connected mode.

**Metal Oxide Varistor (MOV):** An electronic component that is commonly used to divert excessive current to the ground and/or neutral lines.

**Neutral Conductor:** The conductor connected to the neutral point of a system that is intended to carry current under normal conditions.

**Nominal Discharge Current Rating ( $I_n$ ):** Peak value of the current through the SPD (Surge Protection Device), selected by the manufacturer from a list of predetermined values, having a short-circuit current wave shape of 8/20  $\mu$ s where the SPD remains functional after 15 surges.

**Nonlinear Load:** A load where the wave shape of the steady-state current does not follow the wave shape of the applied voltage.

**Overcurrent:** Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault.

**Overload:** An overcurrent that is confined to the normal current path (i.e., not a short circuit). If allowed to persist, will cause damage to equipment and/or wiring. Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload.

**Overvoltage:** When the voltage in a circuit or part of it is raised above its upper design limit. It occurs when the nominal voltage rises above 110% for more than 1 minute. The conditions may be hazardous. Depending on its duration, the overvoltage event can be transient—a voltage spike—or permanent, leading to a power surge. The cause of an overvoltage can be lightning and the switching on or off of inductive loads such as electric motors.

**Panelboard:** A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front.

**Photovoltaic (PV) System:** The total components and subsystem that, in combination, convert solar energy into electric energy for connection to a utilization load.

**Rating:** A designated limit of operating characteristics based on definite conditions such as current rating, voltage rating and interrupting rating.

**Resistive Load:** A resistive load, or resistive load bank, is a non-motor load in which current waveform is in phase with its voltage waveform. They are commonly used as heat generators.

**Short-Circuit Current Rating (SCCR):** The prospective symmetrical fault current at a nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptance criteria.

**Sinewave:** The most familiar ac waveform and derives its name from the fact that the current or voltage varies with the sine of the elapsed time.

**Substation:** A grouping of equipment (e.g., switches, interrupting devices, circuit breakers, buses, and transformers) through which electric energy is passed for the purpose of distribution, switching, or modifying its characteristics.

# SURGE PROTECTION DEVICE (SPD) FAQs & Definitions



**Surge-Protective Device (SPD):** A protective device for limiting transient voltages by diverting or limiting surge current; it also prevents continued flow of follow current while remaining capable of repeating these functions and is designated as follows:

**Type 1:** Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device

**Type 2:** Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel

**Type 3:** Point of utilization SPDs

**Type 4:** Component SPDs, including discrete components, as well as assemblies

**Switchgear:** An assembly completely enclosed on all sides and top with sheet metal (except for ventilating openings and inspection windows) and containing primary power circuit switching, interrupting devices, or both, with buses and connections. The assembly may include control and auxiliary devices. Access to the interior of the enclosure is provided by doors, removable covers, or both.

**Temporary Overvoltages (TOVs):** Undamped or little damped power-frequency overvoltages of relatively long duration (i.e., seconds, even minutes). These overvoltages are typically caused by faults to ground, resonance conditions, load rejection, energization of unloaded transformers, or a combination of these.

**Transient:** (formerly referred to as surge, spike, or impulse) A very short duration, high amplitude excursion outside of the limits of the normal voltage and current waveform. Durations range from fractions of a micro-second to milliseconds, and the maximum duration is on the order of one half-cycle of the power frequency.

**Undervoltage:** A decrease in voltage below 90% of its nominal value for more than one minute. The term “brownout” is sometimes used to describe voltage drops between full power (bright lights) and a blackout (when the voltage drops below 10% of its nominal value).

**Voltage:** The greatest root-mean-square (rms) (effective) difference of potential between any two conductors of the circuit concerned.

**Voltage Protection Level ( $U_p$ ):** Maximum voltage to be expected at the SPD (Surge Protection Device) terminal when subjected to the SPD’s nominal discharge current ( $I_n$ ).

**Voltage Protection Rating (VPR):** A rating per UL 1449 4th Edition, signifying the rounded-up average measured limiting voltage of an SPD (Surge Protection Device) when the SPD is subjected to the surge produced by a 6 kV, 3 kA 8/20  $\mu$ s combination waveform generator.

**Waveform:** A representation of how alternating current (ac) varies with time. The most familiar ac waveform is the sine wave, which derives its name from how current or voltage varies with the sine of the elapsed time.

For more information Visit:  
[www.littelfuse.com/SPD](http://www.littelfuse.com/SPD)

