Surge Protector

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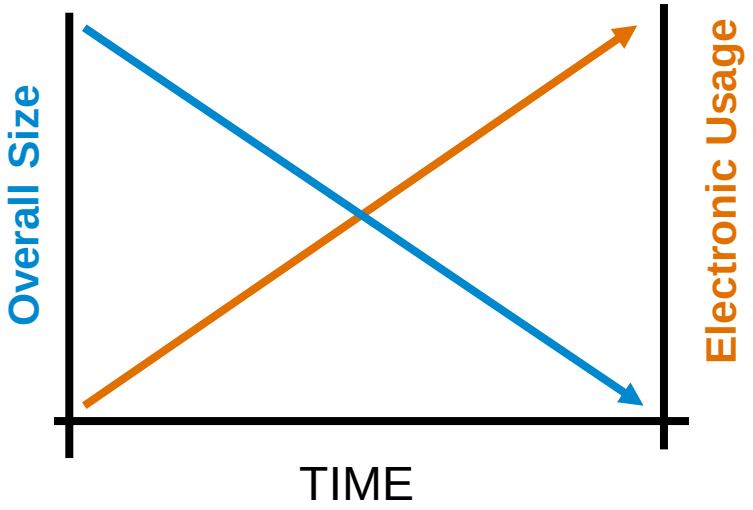


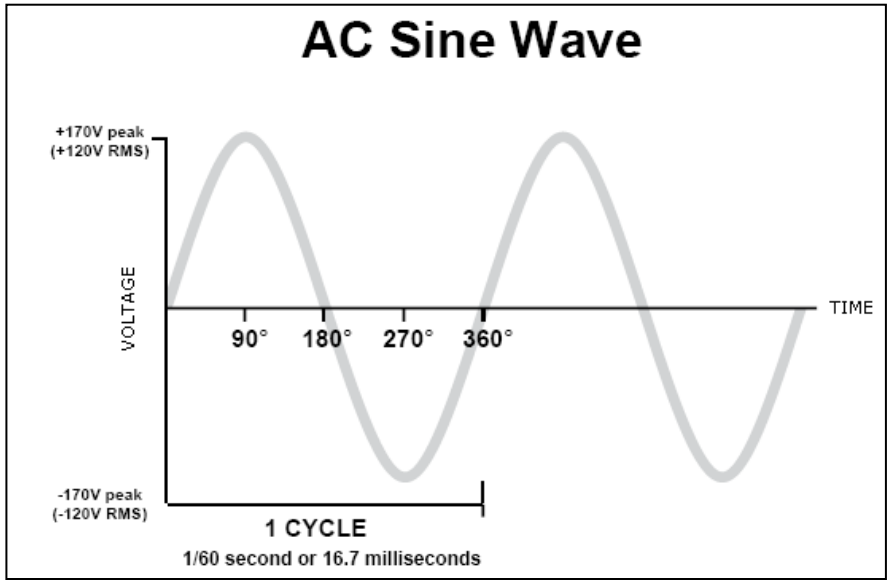
- ❑ Use of electronic equipment has increased
- ❑ Overall size of the equipment has decreased
- ❑ Smaller more compact electronic devices have become more susceptible to over-voltage failures

- ❑ Microprocessor driven devices can be found in almost every commercial, industrial and residential setting, for example:
  - Computer Networks, diagnostic equipment, alarm sensors, CNC machines, etc…
- ❑ Integrated circuit chips are especially sensitive to transient voltage surges due to their:
  - Microscopic size & structure
  - Extremely low operating voltages
  - Increased switching speeds

AC Power Basics

- An AC voltage v can be described mathematically as a function of time by the following equation:

$$\vartheta(t) = V_{peak}.\sin(wt)$$



- The relationship between voltage and the power delivered is:

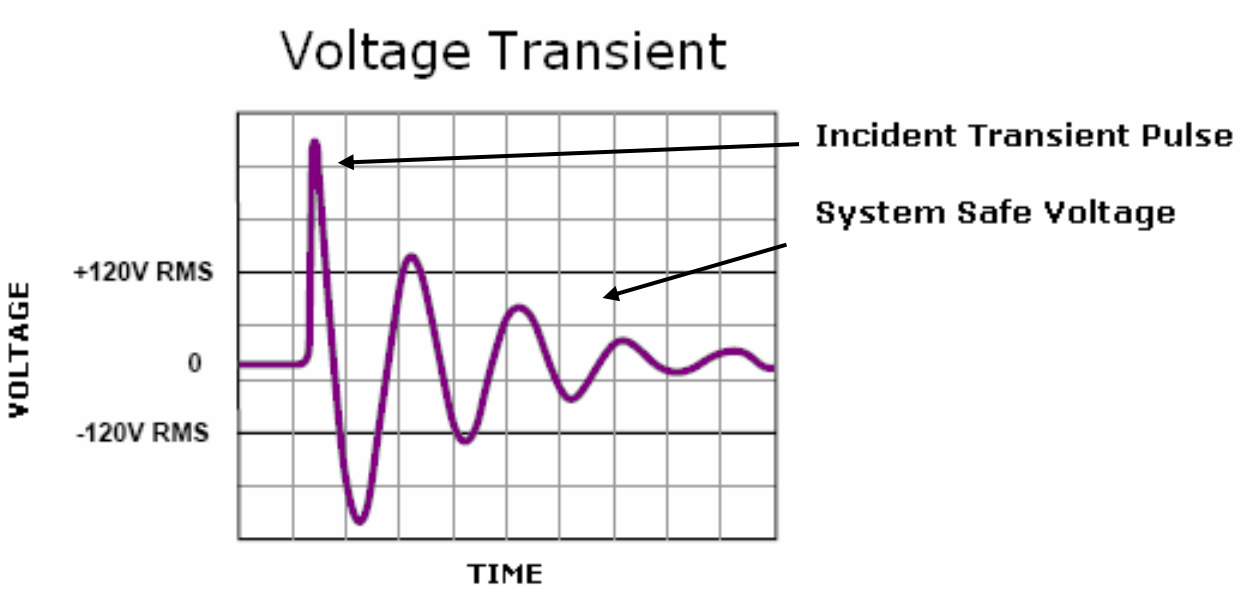
$$p(t) = \frac{v^2(t)}{R}$$

- Rather than using instantaneous power it is more practical to use a time averaged power. Therefore, AC voltage is often expressed as a root mean square (RMS) value, V_{rms}

$$P_{time\ average} = \frac{V^2_{rms}}{R}$$

$$V_{peak} = \sqrt{2}V_{rms}$$

What is a Voltage Surge?



- In general a **surge** is a transient wave of current, **voltage** or power in an electric circuit.

- A voltage surge is any voltage level that is short in duration and is also 10 percent greater than the system's normal operating AC, R. M. S. or. D. C. voltage level.

- Surges, or transients, are brief overvoltage spikes or disturbances on a power waveform that can damage, degrade, or destroy electronic equipment within any home, commercial building, industrial, or manufacturing facility. Transients can reach amplitudes of tens of thousands of volts. Surges are generally measured in microseconds.

Sources of Surges/Transients

- Transients can originate from inside (internal sources) or outside (external sources) a facility:

Internal Sources:

- **Switching of Electrical Loads:** The switching (on and off) and operation of certain electrical loads – whether due to intentional or unintentional operations – can be a source of surges in the electrical system. Switching surges are not always immediately recognized or disruptive as larger externally generated surges but they occur far more frequently. These switching surges can be disruptive and damaging to equipment over time. They occur as part of every day operations.

- **Magnetic and Inductive coupling:** Whenever electric current flows, a magnetic field is created. If this magnetic field extends to a second wire, it will induce a voltage in that wire. This is the basic principle by which transformers work. A magnetic field in the primary induces a voltage in the secondary. In the case of adjacent or nearby building wiring, this voltage is undesirable and can be transient in nature.

Examples of equipment that can cause inductive coupling include: Elevators, heating ventilation and air conditioning systems (HVAC with variable frequency drives), and fluorescent light ballasts, copy machines, and computers.

Cont'd…

External Sources:

- The most recognizable source of surges generated outside the facility is lightning.

Initial direct or indirect strike

Travels through power lines or ground

Enters your facility

- Direct lightning strikes
  - Can be the most damaging
- Indirect lightning strikes
  - Indirect lightning strikes up to 30 miles away can still affect your facility

- **Causes Due to Equipment Switching:** Switching of large transformers, motors, and other inductive loads can generate spikes or transient impulses

Type 1: Utility Switching

Utility Grid Switching

Travels through power lines or ground

Enters your facility

Type 2: Facility generated

Generated from within your facility

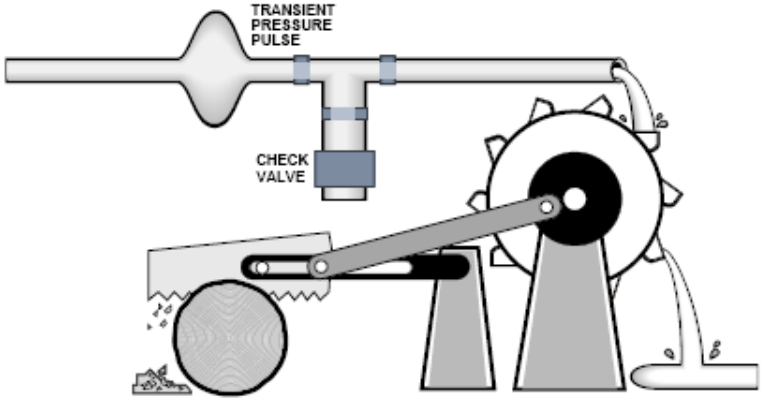
Harmful Effects of Transient Surges

- The most common failures produced by transients within electronic devices are:
  - **Disruptive effects** – Encountered when a voltage transient enters an electronic component and the component then interprets the transient as a valid logic command, resulting in system lock-up, malfunctions, faulty output or corrupted files
  - **Dissipative effects** – Associated with short duration repetitive energy level surges, resulting in long-term degradation of the device
  - **Destructive effects** – Associated with high level energy surges, resulting in immediate equipment failure

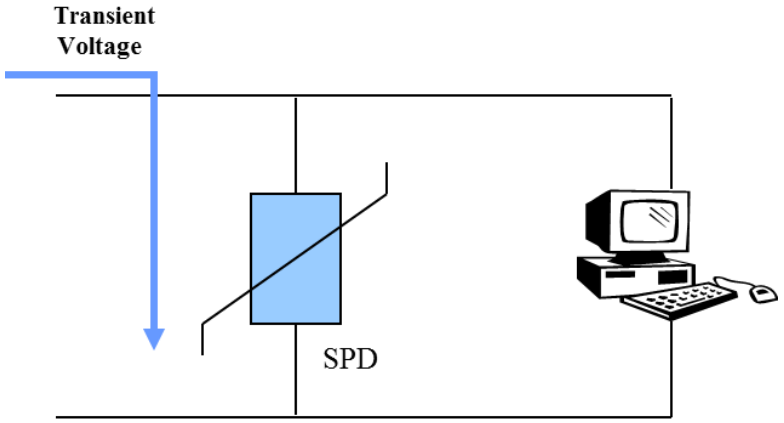
Surge Protective Device (SPD)

- A surge protection devices or SPD (S-Pee-Dee) reduces the magnitude of a voltage transient thus protecting the equipment from their damaging effects.
- SPD's were commonly known in the past as TVSS (Transient Voltage Surge Suppressor).
- A SPD tries to:
  - Send surge away (to ground)
  - Acts as a momentary 'short circuit'
    'short circuit' ≈ voltage equalization ≈ no overvoltage ≈ protected load

How a SPD Works



"The Water Wheel"

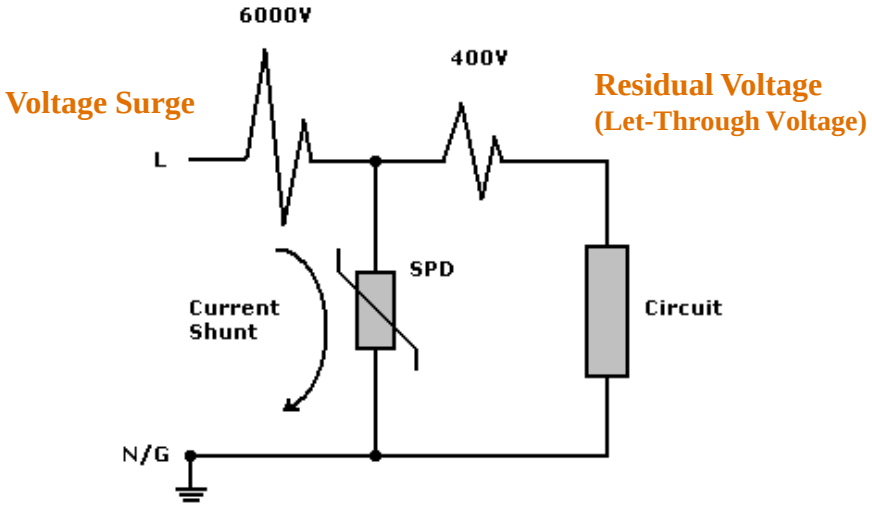


SPD Shunt Path

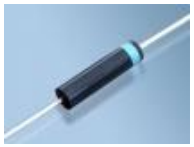
- The SPD acts as a pressure relief valve
- The pressure relief valve (SPD) does nothing until an over-pressure pulse (voltage surge) occurs in the water (power) supply

"Clamping"

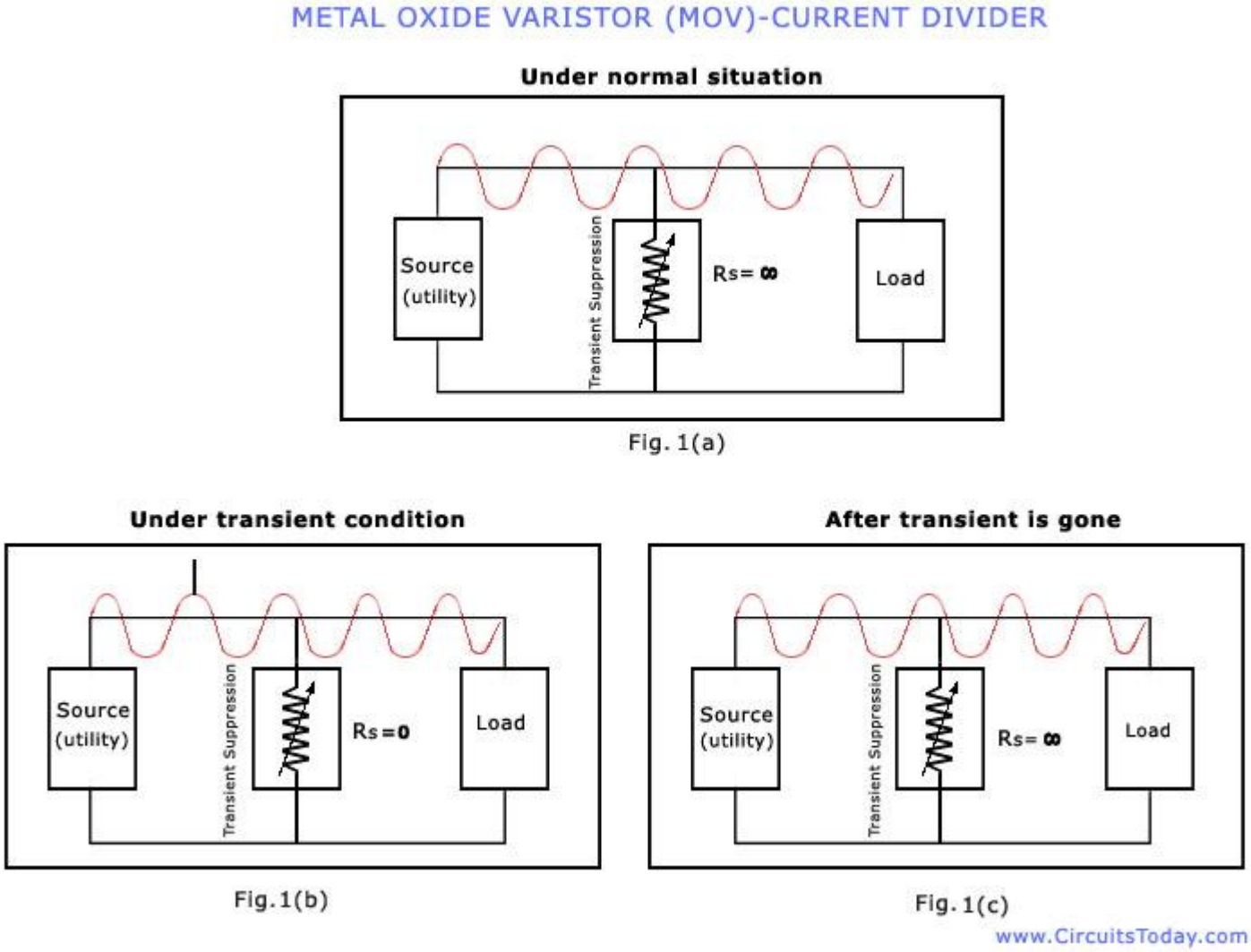
- **Clamping** describes the process by which an SPD reduces voltage transients and surges to a specified lower voltage level suitable for the protected load.



Types of SPD Technologies

Metal Oxide Varistors (MOV) 	Contains a ceramic mass of zinc oxide grains, combined with other metal oxides sandwiched between two metal plates forming a network of back-to-back diode pairs
Silicon Junction Diode 	The diode is installed reverse-biased under normal conditions. When the voltage rises above normal conditions the diode becomes forward-biased
Spark Gap 	If a voltage surge is experienced a spark ignites gases creating an arc across the gap
Gas Tube Arrestor 	Commonly used for telephone lines as they enter a building Sophisticated spark gap that safely shunts the surge to ground

Working of MOV



How to Measure the Effectiveness of Surge Protectors

- **Clamping voltage/Let-through rating:** The clamping voltage indicates the voltage level that will cause the MOV to operate, while the UL 1449 voltage let-through rating defines the average amount of voltage the surge protector "lets through" to the connected equipment following a surge or spike. The lower the let-through rating, the better the protection.

- **Joule rating:** A joule is a basic unit of electrical energy. The joule rating of a surge protector indicates how much electrical energy it can absorb without failing.

How to Select the Right Surge Protector

- Understand the difference between a power strip and a surge protector
- How valuable is the equipment you're trying to protect?
- What level of protection do you need?
- How many outlets do you need?
- How far is the equipment from the wall outlet?
- Where will the surge protector be used and in what type of environment?
- Do you need USB charging ports?
- Do you need data line protection?
- How important is line noise reduction?
- What kind of warranty does the manufacturer offer?
- What other features are important to you?

Small Investment, Big Benefit