

Transient Surges

What are transients?

A transient (surge, impulse, spike) is defined as a temporary rise in voltage and current on an electrical circuit that has been disturbed. They are high energy (with magnitudes in the thousands of volts) and short duration (with rise times in the 1 to 10 microsecond range). Since they are sub-cycle events they should not be confused with longer duration events such as swells or temporary overvoltages. They disrupt, damage or destroy our electrical and electronic equipment in an instant and/or cause cumulative damage over a period of time resulting in unexplained failures.

How Transients are Created?

External

Lightning strikes and utility company grid switching are the major external sources of transients. The ground surge from nearby lightning strikes can ravage electrical systems by entering unprotected circuits through the system ground. Cloud-to-cloud lightning discharges are capable of inducing electrical field intensities in the hundreds to thousands of volts per meter. If this type of transient appears across an unprotected power, telephone, data, or coaxial line the result can be system destruction. The bad news is that power utility companies have little or no control over the surges induced on their power lines. Noisy electrical neighbors sharing your electrical distribution system, such as welding shops, can also be a major source of transients.

Examples of externally generated surge sources include:

Lightning Strikes

Direct Strikes (Cloud to Ground) - reach as high as 25,000 Volts

Induced (Cloud to Cloud) - reach as high as 15,000 Volts

Utility Impulse Generators

Load Shedding for Demand - reach as high as 15,000 Volts

Power Factor Correction - reach as high as 15,000 Volts

Internal

Any time the flow of electrical energy is altered, transient activity can be the result. The simple act of turning on (or off) a light, motor, copy machine or any other electrical device can disturb the electrical circuit and create transients. In general, the larger the load current the greater the disturbance when the load is switched off or on. The switching of high ampacity loads such as electric welders and electric motors are known to create damaging transients. The simple fact is that the normal operation of most electrical equipment creates voltage surges and spikes. While they vary in magnitude and duration, they are constantly present in all unprotected circuits.

Examples of internally generated surge sources include:

Local Capacitive Loads - reach as high as 10,000 Volts

Static Electricity - reach as high as 5,000 Volts

Loose Wiring - reach as high as 3,000 Volts

Inductive Load switching - reach as high as 7,000 Volts

Switch Bounce On Starters/Contactors - reach as high as 10,000 Volts

Electronic Loads Added - reach as high as 5,000 Volts

Ground Potential Differences - reach as high as 10,000 Volts

Other sources of internally generated transients include:

Variable frequency drives Electronic or computer loads

Electronic lighting ballasts Energy management systems

Switch mode power supply or SCR's HVAC Systems

Voltage Switching Space Heaters

Copiers Printers

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Some of these sources can and do produce immediate catastrophic damage and interruption of your operation. This damage is readily noticeable due to the large volumes of smoke and sometimes the fire that is caused when such an event is allowed to occur unchecked. Others produce cumulative damage. This damage occurs a little at a time over a period of time. Sort of like the damage you do to a block of ice with an ice pick. Each chip doesn't amount to much but the cumulative affect is devastating.

However, in the high tech world of today, the threshold between cumulative damage and catastrophic damage is swinging more and more to the low end of the spectrum of magnitude and duration. What that means to you, as an engineer, maintenance director, or consumer is that surge suppression is no longer an option, it is a necessity.

What is a Surge Suppressor?

A Transient Voltage Surge Suppressor (TVSS) or Surge Protection Device (SPD), as they are also called, is a device that accomplishes two basic functions. It first provides a place for a rise in current and voltage to equalize (other than across your equipment) and secondly, it absorbs or diverts the excess energy to places other than the protected load. The object is to do all of this as quickly and effectively as possible, to be reliable enough to be ready when the next transient event occurs whether it be in 10 nano-seconds or 10 cycles and, to be able to repeat this performance over hundreds of thousands of events without failure.

How Does Surge Suppression Work?

The major design goal is to divert as much of the transient energy away from the load as possible by providing a lower impedance path and then to address the effects of the surge with the components of the SPD. Various types of surge suppression components are used to provide this low impedance pathway, depending on the specific application of the device.

The most common component found in AC voltage devices is the Metal Oxide Varistor (MOV). Under normal conditions the MOV presents itself as a high impedance element. However, when the voltage level rises to a level exceeding the threshold of the MOV, the resistance of the MOV drops rapidly (within nanoseconds) providing a low impedance path of flow. The MOV has become the component of choice in AC power applications (over 95% of AC SPD's use MOV's) because of its high energy handling capability and reliable clamping performance.

To enhance the performance of the tried and true MOV, we incorporate other components in our SPD's. This Hybrid Network approach to TVSS design allows our devices to have faster reaction time as well as a longer life expectancy. This will be discussed in greater detail later in this paper.

Also, due to the lower magnitude of transient energy, the devices used for protection of computer data lines and telephone communication equipment contain components that vary drastically from those found in AC power devices. The goal is the same however, to provide effective/reliable protection as fast as possible and as many times as necessary to assure the survival of the protected equipment.

Who Needs Transient Voltage Surge Protection?

Everyone who uses electricity (grid supplied or locally generated), telephone lines (voice only or fax/modem/data), computer data lines (data collection, data transmission, computer communication) needs some type of Transient Voltage Surge Suppression (TVSS). In short, anyone who uses wire to accomplish any of these functions is in need of effective/reliable surge suppression.