Surge Suppression 101

Why Surge Protection?
Until the introduction of solid state devices, most AC-powered equipment was too insensitive to be upset by "dirty" or surging power. However, electrical power surges and the damage they can cause are commonplace today. Our home and workplace are comprised of solid state devices vulnerable to surges. We deal daily with computers, office machines, data, telecommunication equipment, major appliances, etc. All of these depend on solid state devices which are vulnerable to surge.

Solid state devices depend on consistent,, good-quality power. A single powerful surge literally melts, welds, pits, and burns its way through solid state circuits and components.

Device failure is often the result of many small surges and the cause is often not detected by the repairing technician. In addition to the loss of use, priceless stored data can be lost and meaningful input or output information is turned into nonsense. The driving force to shrink device geometries to increase speed and storage capacity will continue to make solid state devices even more sensitive to dirty power and surges.

Many people think of surge damage as being caused by a single, catastrophic event such as a lightening strike. While lightning is one of the most powerful and destructive surges, it's not always the cause of most of the surge damage. In reality, surges range from mighty to the minuscule.

Smaller surges occur several times a day, or hundreds of times an hour. Almost continuous surges can be produced by sources ranging from 250 to over 1,000 volts. Typically, they are caused by the operation of electric motors or other inductive loads such as elevators, office machines. Microwave ovens, vacuum cleaners, lame dimmers and countertop appliances are some of the surge sources in the home.

Powerful, random surges result from the switching of an inductive load such as an electric motor starter, arc welder, furnace ignition, compressor, etc. and these momentary surge sources range from 250 to over 3, 000 volts.

Over or under voltage power conditions 250 to 6,000 volts usually accompanies a utility switching lines to meet changes in demand, or when correcting a brownout or blackout.

While mother nature provides the most visible and spectacular surges in the form of lightning, the surge damage you suffer can be generated by the power company, your own equipment, other equipment in the building you occupy, or from a source some distance from your facility. Surges travel on AC lines, data lines, communication lines, coaxial cable, metal fences, metal conduit, metal duct work, as well as through the ground and air. Surges travel via any conductor they can find.

Surge damage can be classified into three categories:

» Hard failures
» Glitches
» Latent failures

Hard failures cause damage requiring repair or replacement of electrical components. Glitches usually do not cause permanent damage, just temporary damage or lost data.

Latent failures result from continuous exposure to smaller, non-catastrophic surges that erode equipment and its performance. In the end, the equipment suffers hard failure and the cause is unseen.

Noise is another problem in power lines. Conducted noise is the most destructive type. It is usually present in your AC power source and you are surrounded by these radiated noises.

Noises can come from the most simple device, such as an electric razor or fluorescent lamp. Cars, TV's, cellular phones, electrical transformers, lamp dimmers, office machines, etc. are other examples. The list is endless. To solid state devices, this is an invisible and lightning-fast destructive force.

A high quality surge suppression system is your first, best and only defense against these potential threats to your equipment, data and operation.

No one can guarantee to protect you from direct and catastrophic lightning strike. Even the best lightning protection systems have their limits. A properly designed and installed surge suppression system can provide you the best defense against all but the catastrophic direct lightning strike. It is important that a surge suppression system be just that - a system, not individual units of spot protection.

In designing the system, many factors should be taken into consideration. Every facility has some equipment that is critical to the overall operation of the facility. That equipment will probably require higher levels of protection than less critical equipment. How susceptible is the equipment to a surge? Equipment controlled by solid state devices is more susceptible to surge damage. Each facility is different and will require different levels of protection for perhaps even similar equipment.

The Institute of Electrical and Electronic Engineers (IEEE) has developed a schematic showing the levels of surge severity relative to location device or equipment. If surge sensitive equipment is located on the same circuit as equipment that generates surges, it must have protection. The only way to properly design a system of protection is careful evaluation of each and every facility.

Different surge suppression units offer varying levels of protection. All have the same basic job, to prevent damaging voltage spikes from reaching the device it is intended to protect. More sophisticated suppression units also filter noise.

Only a thorough survey of your facility and its power supply, an examination of electrical layout, circuit plans and inventory of devices (present and future) connected to all circuits can provide the information to form a recommended plan of protection.

High quality surge suppression units, when properly applied in surge suppression systems, are one of the best investments you can make. Considering the small cost, it will be hard to find a higher return on any investment.

Checklist for Surge Protection Devices

1. Are all building electrical and systems grounds common and bonded together? Is neutral bonded properly to ground at the service entrance?

2. Do you have a low resistance grounding system? Has it ever been checked or measured? Is there any bonding of the AC neutral and ground at electrical sub panels? Are all your electrical outlets equipped with life safety ground?

3. Are metallic plumbing and sewer pipes entering your building(s) bonded to ground? Is the steel reinforcement and framing of your building(s) bonded to your common ground?

4. Are all metal fences attached to your building bonded to your grounding system? Are parking lot or exterior pole lights grounded properly?

5. Is your main electrical service equipped with a panel protector on the load side of the main breaker? Are your sub panels equipped with panel protectors? Do you have an isolated ground electrical panel with panel protectors for your sensitive loads such as computers?

6. Are terminals and CPU in different buildings? If so, surge suppressors should be installed at both ends of the wire that connect them.

7. If all terminals and CPU are in the same building, make sure there is only one meter (electrical service) providing power to the building. IF there is more than one meter, the grounds must be electrically bonded. If the electrical services are not bonded, a difference in the ground potential will exist. Problems associated with this condition will show up as I/O port problems on computer systems.

8. Are telecommunication lines running between buildings from your computer network, PBX, key telephone system, security system, video security system, fire alarm system, PA system, or environmental control system? Any metallic lines must be surge protected at both ends of the wire entering or leaving the building. (Remember they must share a common ground reference.)

9. Are long runs of low voltage cable surge protected? Are these lines in conduit, underground or just lying on the ceiling system? Are they within 12 inches of fluorescent light fixtures?

10. Are roof top electrical/mechanical systems surge protected? Do you have a bonded lightning protection system on your building? Are satellite earth stations, coaxial cable, and power or control lines surge protected?

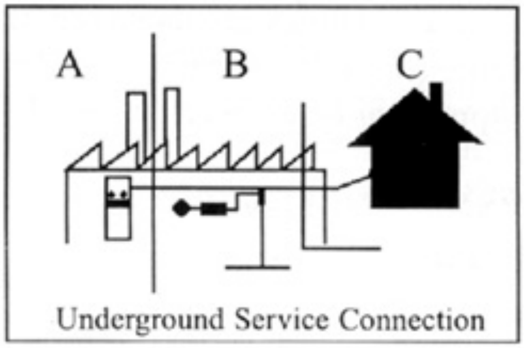
Main and Sub-Panel Protectors
Main and sub-panel surge suppressors usually come in two general types, series protectors and parallel protectors. Series protectors are load bearing devices and have no conform to the current the power company delivers to the main and sub-panel. Parallel protectors are non-load bearing devices and therefore can be used regardless of current delivered to the main or sub-panel.

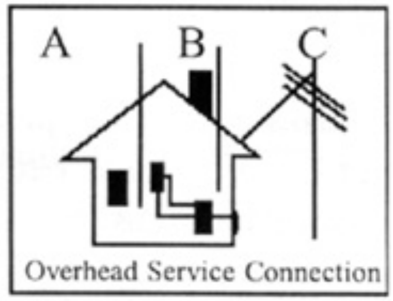
Series protectors are usually very expensive and require breaking the incoming line to install. Parallel protectors are usually installed on the load side of the main breaker and are quite efficient. Underwriters Laboratories (UL) under 1449, has chosen to rate surge suppressors in pass-through voltage categories. There is one serious fault in their testing. Some manufactures of parallel type surge suppressors utilize plug-in modules, which allow for the replacement of damaged modules. The ratings are obtained at the module itself without consideration for the length of wire required for the installation. A module rated at 400 volt pass voltage with an additional two feet of wire added for the installation actually becomes a 1000 volt pass voltage. When placed in a 24" x 24" box, two feet of wire would be minimal for the installation, therefore ratings of this modular type panel protector can be deceptive.

Surge suppressors are designed to protect the electrical and electronic equipment to which they are connected. In rare cases, when extremely large surges occur, the surge suppressor will be sacrificed to save the protected equipment. This is the purpose of a surge suppressor. Some surge suppressors claim to have a rating of 100,000 amps or more. The ANSI/IEEE 587 and UL ratings have a maximum test of 10,000 amps. This is more than adequate for the main service electrical entries.

The measurement of a surge suppressor's performance is the pass voltage (actual voltage) your equipment sees after a suppressor does its job. High current ratings do not mean low pass voltage. PSI surge suppressors have a lifetime warranty and have been protecting customer facilities and equipment for 10 years. During this time, PSI's customers have experienced no equipment losses.

Category	Exposure	Voltage/Amperage		Waveforms
C1 C2 C3	Low Medium High	6,000 V 10,000 V 20,000 V	3,000 A 5,000 A 10,000 A	Impulsive Waveforms 1.2µsx50µS Voltage 8µsx20µs Amperage
B1 B2 B3	Low Medium High	2,000 V 4,000 V 6,000 V	1,000 V 2,000 A 3,000 A	Impulsive Waveforms 1.2µsx50µS Voltage 8µsx20µs Amperage
B1 B2 B3	Low Medium High	2,000 V 4,000 V 6,000 V	170 A 330 A 500 A	Ring Waveforms .5µsx100KHZ.
A1 A2 A3	Low Medium High	2,000 V 4,000 V 6,000 V	70 A 130 A 200 A	Ring Waveforms .5µsx100KHZ.





A. Outlets and Long Branch Circuits
- All outlets at more than 10m (30ft) from Category B with wires #4 - 10
-All outlets at more than 20m (60ft) from Category C with wires #14 - 10

B. Major feeders and short Branch Circuits
- Distribution panel devices
- Bus and feeder systems in industrial plants
- Heavy appliance outlets with short connections to the service entrance
- Lightning system in commercial buildings

C. Outside and service entrance
- Service drop from to building entrance
- Run between meter and distribution panel
- Overhead line detached buildings
- Underground lines to well pumps

Transient Voltage Surge Suppression Terminology

<u>Amperage</u>
The unit of measure for current flow. One ampere equals 1 coulomb of electrons passing a point in a circuit in one second.

<u>ANSI</u>
American National Standards Institute

<u>Capacitor</u>
A device that can store an electrical charge.

<u>Circuit Breaker</u>
An automatic protective device that will allow current to flow under normal conditions, but will open the circuit under abnormal conditions to prevent damage from excessive current.

<u>Clamping Device</u>
A component whose action is triggered by a predetermined voltage. A clamping device will activate (turn on) and deactivate (turn off) at specific predetermined voltages.

<u>Current</u>
The flow of electrons through a conductor. Current is measured in amperes.

<u>EMI/RFI</u>

The interference in a signal transmission or reception resulting from the radiation of undesirable electrical or magnetic and electrical fields.

Gas Tube
A surge suppression component that is made up of two or three electrodes in a sealed envelope that contains a rarefied gas. A gas tube is a crowbar device.

Ground
A voltage reference point which may be connected to earth ground.

Grounding Conductor
The conductor used to connect electrical equipment to a grounding electrode, i.e., ground rod.

Grounding Electrode
A conductor or a group of conductors (usually a rod, pipe, or plate) in direct contact with the earth, providing a connection to the earth.

IEEE
Institute of Electrical and Electronic Engineers.

Impedance
A unit of measure, expressed in Ohms, of the total opposition (resistance, capacitance and inductance) offered to the flow of alternating current.

Inductance
The ability of a coil to store energy and oppose changes in current flowing through it.

Inductor
A number of turns of wire wrapped around a core used to provide inductance in a circuit. Also called a coil.

Joule
The unit of measure of energy equal to one watt second. 3,600,000 joules equal one kilowatt hour.

Kilo
Metric prefix meaning thousand or 10^3. The abbreviation is k.

Load
A device that receives electrical energy from a source, draws current and/or provides opposition to current, requires voltage, or dissipates power. Resistors, light bulbs and electronic motors are examples or loads.

Metal Oxide Varistor
A solid state surge suppression component that can handle large amounts of current and reacts in the low nanosecond time range.

Micro
Metric prefix meaning one millionth or 10^{-6}. The abbreviation is the Greek letter mu

(a lower case u can be used).

Milli
Metric prefix meaning one thousandth or 10^{-3}. The abbreviation is m.

NEMA
National Electrical Manufactures Association.

Nano
Metric prefix meaning one billionth or 10^{-9}. The abbreviation is n.

Ohn
The unit of measure of resistance equal to the resistance in a conductor in which one volt of potential produces a current flow of one ampere.

Phase
Term used to describe the hot line or lines in AC power.

Pico
Metric prefix meaning one trillionth or 10^{-12}. The abbreviation is p.

Potential Difference
A measure of force produced between charged object that moves electrons. *See Volt*.

Power
The rate at which work is performed or heat is generated. Power is measured in watts. The abbreviation is P.

Power Dissipation
The ability of a component to dispense power, usually in the form of heat energy. The rating of a component's ability to dissipate power.

RMS Voltage
Applied to an AC sine wave, the RMS value is also known as the effective voltage and is .707 times the peak voltage.

Silicon Avalanche Diode
A solid state surge suppression component that is extremely fast, but lacks the ability to handle heavy current.

Surge
A short-term voltage increase that exceed the established upper limits for less than 2.5 seconds.

Surge Suppression
The process by which transient voltage surges are prevented from reaching electrical or electronic equipment.

Transient
An abrupt change in voltage of short duration, which may cause signal impairments,

loss of memory or physical damage to electrical and electronic equipment.

Volt
The unit of measure of potential or electromotive force. One volt is the force required to cause one amp to flow through a conductor with a resistance of one ohm. The abbreviation is V.

Voltage
Potential energy difference (electrical pressure).

Volt-ampere (VA)
Base unit of apparent power; 120 electrical degrees.

Watt
The unit of measure of power equivalent of one joule per second. A watt is equal to the power in a circuit in which a current of one amp flows at a potential of one volt. The abbreviation is W.

Waveform
The graphic depiction of a progressive disturbance propagated from point to point.