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AC-Alternating Current(AC) Electrical current that continually reverses direction, with this change in direction being expressed in Hertz, or cycles per second.

AC Equipment Ground (ACEG) A normally non-current carrying conductor provided for the protection of personnel and equipment. The green color code distinguishes the lead from the current carrying grounded conductors (neutrals) that are natural, gray or white.

Ampere Quantitative unit of measurement of electrical current. Abbreviated as Amp or A.

ANSI C62.41-1991 A technical Standard that characterizes the electrical power line surge environment. Originally published by the Institute of Electrical and Electronic Engineers as Standard IEEE 587 -1980, it was updated in 1991 and now recognized as an American National Standard.

Arrester A device that exhibits non-linear impedance. An arrester acts as an open circuit at voltages above normal. The arrester is used to divert high voltage surges caused by lightning to ground.

Building Earth Ground System (BEGS) The Building Earth Ground System (BEGS) is usually a series of interconnected ground rods, and a buried copper bare conductor bonded to the ground rods to form a ring or grid for a low resistance path to earth. A metallic well casing could also be used instead of or in addition to the ground field.

Building Structural Steel (BSS) A ground bond connected to structural steel or reinforcing steel rods contained within the building walls, roofs, floors, footings or foundations.

Capacitor An electrical component which stores electrical charges. It consists of two metallic plates separated by a dielectric (non-conducting) material. When used in conjunction with other components it can provide a high-frequency filtering capability.

Clamping Level This generally is used to describe the voltage level which causes the surge diversion device to start to divert surge energy. A related, but more important parameter is the Suppressed Voltage.

Combination Pulse A high energy test pulse specified by ANSI C62.41-1991. Also called a "unipolar pulse".

Common Mode Voltage Voltage, that appears on the phase and neutral wires of the power system when compared with the system ground wire.

Current Current, expressed in units of amperes, or simply amps, is the flow of electrons through a conductor. AC, or alternating current, is a current in which the flow of electrons reverses periodically. In the United States the current reversal occurs 60 times a second.

Electro-Static Discharge Protection (ESD) Extra protection is usually required to reduce electronic component damage related to static voltage discharges. In a work area with low relative humidity personnel or moving air can typically generate static charges.

EMI - Electro-Magnetic Interference Electrically induced noise or transients.

Exothermic Connection An Exothermic connection is a process for making a weld instead of using a gas or arc welding apparatus. A chemical process using a unique powdered metallic mixture is used together with special graphite molds. The powder reacts to produce molten copper that flows around and slightly melts the items being joined. The result is a permanent, high quality, strong and low resistance joint.

External Building Metallic Water System A public or private water system that includes an outdoor section of buried metallic water pipe at least 10 feet in length and belonging to the building.

External Coax Ground Bar (CGB) A copper ground bar provided for terminating any coax shields and other grounding conductors on the Tower and at the coax entry port at the building.

External Waveguide Ground Bar (WGB) A copper ground bar provided for terminating waveguide shields and other grounding conductors on the Tower and at the waveguide entry port at the building.

Floor Bar (FB) A copper ground bar that is located on each floor of a multiple floor switch site to provide a common bonding point for building structural steel and the Vertical Equalizer. It is used for the common connection of multiple grounding conductors on the same floor of a high-rise multi-story building; also known as a Central Office Ground Bar

Frame Ground Bar (FGB) A copper ground bar which is isolated from its mounting surface and used as a distribution point for any safety conductors connected to equipment frames, usually in the non-IGZ area, but not to include battery return.

Frequency The frequency of alternating voltage is the number of times per second that it changes polarity from positive to negative. In the United States, the power line frequency is 60 Hertz, 60 cycles per second.

Frequency Filter Consists of a combination of components that allows only certain frequencies, or a band of frequencies, to pass.

Ground For safety reasons, electrical systems in the USA have a wire connected to earth ground at the service entrance. This "ground" wire is run along with the two current carrying wires.

Ground Electrode System A series of interconnected ground rods buried and in direct contact with soil to provide a low impedance path to earth ground. Commonly referred to as a "ground field" or "earth ground system."

Ground Loop Ground loops exist when there is more than one electrical path from a point in a circuit to a reference ground connection. Such parallel paths to ground are normally not a problem if associated with the non-sensitive circuitry located outside the Isolated Ground Plane (IGP). Ground loops are undesirable for equipment located inside the Isolated Ground Plane (IGP).

Ground Ring Line of Ground Rods; Deep Driven Electrode; and Other special purpose ground electrodes.

Ground Rod A term which describes any metallic body in direct contact with soil, usually a copper clad steel rod that is eight (8) feet long and 5/8 inch in diameter. Eight (8) foot rods are placed at minimum 16-foot (length X 2) intervals on the Buried Earth Ground System (BEGS). Ground rods are usually copper-clad steel and a minimum of 8 feet long and 5/8-inch diameter. Longer and larger diameter rods are available. Stainless steel rods are required if objects of corrosion-prone metal are buried near the copper of the ground system.

Ground Window Bar (GWB) A copper ground bar provided for the common connection of any equipment located within the building. These are called Ground Window Bars (GWB) but are really collection points for multiple grounding conductors within a ground zone.

Halo A ring of bare wire mounted on the equipment room walls that serves to connect the non-electrical powered miscellaneous metal, non-surgings equipment and objects to a common ground at the Master Ground Bar (MGB).

Handhole A non-conductive enclosure installed below earth surface to access and inspect connection points of earth grounding conductors. Handhole enclosures should be large enough to make connections, as well as have an appropriate drainage system to remain dry.

Hertz The unit of frequency, one cycle per second of alternating current.

Headroom Headroom is the voltage difference between the peak of the 50/60 Hz power line sine wave voltage and the "Threshold voltage" of the MOV (or other) suppression elements. A minimum spacing of 15% above the sine wave peak is considered essential.

IEEE 587-1980, ANSI C62.41-1991 A technical Standard originally published by the Institute of Electrical and Electronic Engineers (IEEE) in 1980, updated in 1991, and now recognized as an American National Standard.

Impedance Similar to electrical resistance, since it is a measure of the opposition to the flow of electrical current. Impedance is meaningful only for a changing current and changes value as the frequency of the applied waveform changes.

Inductance The property of an electrical component, which opposes the flow of electric current. An inductor has the property of impedance, the opposition to the flow of electric current.

Insulating Joints Non-conducting inserts provided at specified points in metallic framework of equipment located inside the Isolated Ground Plane (IGP). These are provided to insulate the Isolated Ground Plane (IGP) equipment from outside ground connections.

Internal Coax Ground Bar (CGB) A copper ground bar (sometimes referred to as the bulkhead) located inside the building at the coax entry port and provided for terminating coax shields and the entry port plate inside the building.

Internal Waveguide Ground Bar (WGB) A copper ground bar (sometimes referred to as the bulkhead) located inside the building at the waveguide entry port and provided for terminating waveguide shields and the entry port plate inside the building.

Isolated Ground Plane (IGP) A dedicated area within an office building in which all equipment is electrically insulated from all external grounds except through a single ground reference point between the Ground Window Bar (GWB) and the Master Ground Bar (MGB). The isolated area should preferably extend a minimum of six feet (1.8 meters) on all sides from the equipment frames and framework, and where practical be separated from other equipment by permanent walls. The Isolated Ground Plane (IGP) will normally house sensitive electronic components. (ISOLATED AREA).

Joule A joule is a measure of the energy contained in an impulse or conversely it is a measure of the absorption capability of a surge protection device. 1 joule = 1 watt x 1 second.

Let-Through Voltage The residual transient voltage that would appear across equipment after an upstream surge protection device has operated. It is important to remember that the "let-through" voltage is the sum of the voltage drop across the surge protector itself plus the voltage drops that appear across the wiring that connects the protector to the power lines. The protector clamping

voltage is only one part of the let-through voltage and frequently is of secondary importance to the wiring drop.

Logic Ground Bar (LGB) A copper ground bar that is isolated from its mounting surface and used for the proper grounding of logic return in standard switch frames.

Main Distribution Frame (MDF) A distribution frame where outside plant cables are terminated on vertical protection assemblies. Cable pairs are also cross-connected on this frame to CO line equipment terminated on horizontal blocks.

Main Distribution Frame Bar (MDFB) A copper ground bar typically provided at the bottom of the Main Distribution Frame (MDF) used as the connection point for inside telephone cable entrance (tip) cable shields and Main Distribution Frame (MDF) protector assemblies. The Main Distribution Frame Bar (MDFB) may be used as a Master Ground Bar (MGB) in small buildings.

Main Distribution Frame Protector Assembly A Main Distribution Frame Protector Assembly consists of a protector module and a connector module.

Master Ground Bar (MGB) A copper ground bar used as a single connection point for surge producers, surge absorbers, Non Isolated Ground Plane (NON-IGP) equipment grounds, and Isolated Ground Plane (IGP) equipment grounds. The Master Ground Bar (MGB) is normally non-current carrying and isolated from the building/structural ground.

Maximum Operating Voltage Maximum allowable continuous sinusoidal voltage (RMS) at 50-60hz. If suppressor is exposed to a continuous voltage higher than RMS voltage stated in specification, the suppressor may suffer damage.

Measured Limiting Voltage The maximum magnitude of voltage that is measured across the terminals of the SPD during the application of impulses of specified wave shape and amplitude.

Modes of Protection Refers to the presence of MOV (or other) components connected between phases to neutral, phases to ground, neutral to ground and between phases.

MOV-Metal Oxide Varistor In many respects a nearly ideal suppression component. In standby mode, the MOV presents a very high resistance in shunt with the power line – drawing negligible current. When an incoming transient exceeds a critical voltage threshold, the MOV switches rapidly to a near "short-circuit" diverting mode -handling many thousands of transient amperes. When the transient surge expires, the MOV components reset instantly to the reset mode-ready to respond to future transients.

Multi-Grounded Neutral (MGN) A power distribution system that provides a grounded conductor that has multiple direct connections to earth ground. In this system, at least four grounds must be provided in each mile of line, excluding grounds at individual services. This multiple grounding arrangement provides a very low resistance/impedance path to earth ground for absorbing lightning and switching surges. It also provides a return path for residual (unbalanced) currents resulting from less than perfect balance on associated three-phase power distribution systems.

Neutral One of the wires used in the USA to distribute power within a building. The neutral wire is generally bonded to earth ground at a building service entrance, but unlike the ground wire, the neutral wire also carries load current.

Noise A signal frequency(s) that may be riding on top of the power line sine wave. A number of systems use the power lines to carry signals and data to other locations. Attempts to filter out the "so called noise" may disrupt the current or future operation of these systems. It is wiser to provide L/C filtering immediately in front of sensitive equipment, if it is ever needed. It seldom is!

Normal Mode Voltage Voltage, appearing between the phase wires and neutral of the power system wiring.

NRTL Nationally Recognized Testing Laboratory, one example of which is Underwriters Laboratories, Inc. (UL).

Outside Inspection Ground Bar (OIGB) A copper ground bar provided for the common connection of any conductors within a handhole.

Peak Current – I peak A common measure, used by marketing people, to express the relative peak current handling capability (8/20us) of a surge suppression device. Frequently, it merely represents the peak current rating of an MOV multiplied by the number of MOV's in parallel. The "true" peak current rating of a protector requires a careful assessment of the fuse characteristics, the number of parallel protection circuits, are all of them monitored etc. Bellcore specifications to protect their Central Offices, a highly computerized facility, have found and specified surge current values of 20kA, (8/20 us) waveform, to be satisfactory.

Phase Angle The point on the sine wave at which a transient occurs. IEEE states that transients can occur at any phase angle. It is important to be able to see suppression device response to transients at varying phase angles.

Positive/Negative Reference Conductor The Positive (+)/Negative (-) Reference conductor is a connection between the positive +/- battery terminal and the Master Ground Bar (MGB). This is not normally a DC power current carrying conductor and is provided only for equalizing voltage differences. Depending on the polarity of the DC battery source, the ground becomes either a positive (+) or negative (-) conductor.

Power Power, in watts, is the product of voltage (in volts) and current (in amps). Energy in joules is equal to power (in watts) multiplied by time (in seconds).

Resistance A property of electrical conductors or electrical insulators which characterizes their ability to conduct or resist the flow of electricity. Resistance is the path or conductor, which enables voltage (in the form of current) to flow.

Response Time The time it takes a surge protection device to switch from its "off" condition to an "on", diverting mode. This occurs when an incoming surge voltage exceeds the clamping threshold level of the MOV or other suppression component. Organizations such as IEEE, NEMA and Underwriters laboratories consider response time to be a non-issue since MOV's, Avalanche diodes etc (and the surge protectors that use them) have response times that are 100 to 1000 times faster than any transient that they are likely to encounter.

Ringwave A low-energy test waveform specified by ANSI C-62.41-1991.

Safety Conductors All conductors in the Building Safety Protection System are intended to be "non current" carrying conductors under normal conditions, When a fault occurs the conductor is intended to return the cult current to its source in order to trip the circuit breaker if current exceeds breaker rating. This will remove the voltage, thus the conductor then becomes a "fault clearing" conductor.

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 **Safety Protection
Grid Solutions**

Series Type Surge Protector A form of surge protector which handles the continuous AC power line current but opposes surge current flow toward the load. Series type surge protectors must be rated to handle the continuous 50/60 Hertz current, hence they are seldom employed at building entry or mid-building locations. See Shunt Type Surge Protectors.

Service Life The number of surges of given magnitude that can be suppressed by the suppressor, a measure of reliability.

Shunt Mode Shunt type surge protector which divert large surge current directly to ground, are not constrained by the continuous power line currents and thus are employed effectively on power systems with capabilities exceeding 5000 Amps (rms).

Sine Wave The waveform that appears on the AC power lines. The 50/60 Hertz sine wave is a periodic voltage waveform that oscillates above and below a zero axis. When displayed on an oscilloscope it appears as an undulating wave with voltage appearing on the "y" axis and time on the "x" axis.

Single Phase The portion of a power source that represents only a single phase of the three phases that are often available.

Single Point Ground System (SPGS) A grounding system using a single point, usually the Master Ground Bar (MGB), to provide a zero reference potential to ground for an entire office switching system. While the voltage at this connection point may rise above zero volts-to-earth-ground under fault conditions, the entire switching system will also rise at the same rate to the same voltage. This helps reduce any circulating currents between switching components during a condition of lightning or power surge.

SPD Surge Protection Device. Also referred to as TVSS (Transient Voltage Surge Suppressor).

Spike Nonzero high-frequency impedance (when a load demands a large amount of current, then stops demanding it suddenly, there will be a dip or spike in the voltage due to the inductances in the power supply line).

Surge A brief transient wave of voltage, current or power in an electrical circuit, lasting for less than 1% of the power wave cycle duration.

Surge Absorbers (A) Surge absorbing paths with a low resistance connection to remote earth ground. A grounding element that has a low resistance path to earth ground is considered a primary surge absorber. There are only three primary surge absorbers: (1) The External Building Earth Ground System (EBEGS), (2) The power system Multi-Ground Neutral (MGN), and (3) Metallic water system.

Surge Energy Maximum allowable energy (in joules) for a single impulse on a 10/1000 μ s current waveform. Indicative of the maximum amount of energy that the suppressor can dissipate. This energy is dependent upon three (3) variables: Voltage, Current, and Time. Any variation of the three will effect this figure.

Surge Producers (P) Connections to metallic sources of lightning or power surges. For example, radio/microwave towers, telephone cable shields, telephone cable pairs and power system conductors.

Surge Protective Device Categories (C), (B) and (A) Classes described by the ANSI Standard C62.41 that define the surge waveforms that would be representative at various locations within a building. Category C products are intended for use at the main service panel or distribution panels

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that require large surge current handling capability. Category B defines mid-building, branch panel situations while Category A defines the local service panel or specific equipment.

Surge Suppressor A device used to dissipate undesirable surges on different types of conductors that enter the building. These devices are typically used on telephone, power and transmission lines.

Suppressed Voltage Rating SVR Suppressed Voltage Rating is a rating based on the measured limiting voltage determined during the transient-surge suppression test. UL 1449 2nd edition designates the rating of a surge suppressor range from 330 volts up to 6 kV. SVR ratings are not in themselves indicative of superior performance, since installation and cabling play a critical role in overall performance.

Swell When the RMS voltage exceeds the nominal voltage by 10 to 80% for 0.5 cycle to 1 minute, the event is called a "swell". A momentary voltage increase of the power line voltage, lasting up to several seconds. A swell is not considered to be a transient over voltage, but the TVSS device must operate at a level in excess of the peak voltage of the swell voltage. Otherwise, the surge protector will be attempting to clip the power line 50/60 Hz waveform and will sustain major damage. This necessary spacing is called headroom.

Telephone Cable Entrance Ground Bar (CEGB) A copper ground bar provided for terminating incoming telephone cable shields on a common connection point after demarcation. The bar is normally located close to the entrance location.

Transient An abnormal over voltage of microsecond duration. Also called a surge or spike.

Transient Voltage Surge Suppressor (TVSS) See Surge Suppressor.

TVSS Transient Voltage Surge Suppressor. Now called Surge protection Device (SPD).

Ufer System Named after the engineer who first developed this grounding technique, this term refers to the method of bonding all Grounding Electrodes together either at one point or at several different extension points by approved crimp connections or exothermic connection attached to the grounding conductor.

UL Underwriters Laboratories, Inc.

UL 1449 2nd Edition A safety testing specification for power line surge suppressors based in large part on ANSI C62.41 and C62.45 Waveform and Testing Standards. UL 1449 2nd Edition addresses the issue of "SLOW BURN" in which end-of-life failure of suppression components could result in significant damage to the TVSS product.

UL 1449 3rd Edition

One of the more significant changes made to UL 1449 is way the Suppressed Voltage Rating (SVR) is measured and assigned. The changes are two-fold: 1. The peak current magnitude is now 500A versus the prior value of 3kA. 2. • The measured limited voltage is now measured at the ends of 6" leads that extend from the terminals of an OEM product or 6" from the enclosure of a wall-mounted product.

It is important to note that the SVR is not a clamping voltage, let-through voltage or a voltage that the protected equipment will experience. It is simply an assigned value based on testing that is useful when comparing the protective characteristics of different SPDs.

The voltage that the protected equipment experiences is a function of:

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- MOV protective characteristics
- SPD parasitic inductance
- Lead lengths when installed on the facility system
- Magnitude and rate of rise of the surge event
- How the surge event attenuates in the facility system.

Uninterruptible Power System (UPS) A system designed to provide AC power automatically, without delay or transients, during any period when the normal AC power supply is incapable of performing acceptably.

Voltage Drop The change in potential between two points in a circuit caused by a current flow through components within a circuit.

Voltage Protection Rating (VPR) A rating selected from a list of preferred values as given in Table 63.1 of ANSI/UL 1449 and assigned to each mode of protection. The value of the VPR is determined as the nearest highest value taken from Table 63.1 to the measured limiting voltage determined during the transient-voltage surge suppression test using the combination wave generator at a setting of 6 kV, 3 kA.

Voltage Reference A voltage point from which a measurement is taken.

Voltage Threshold The voltage level at which the connected circuit changes its response.

Watts The unit of measure of actual power. Watts are the product of volts times current.

Waveform The graphic depiction of an electrical voltage, current or power, typically versus time.