

ERITECH[®]

Coordinated Facility Protection

Selecting Surge Protection



ERICO[®]

Introduction

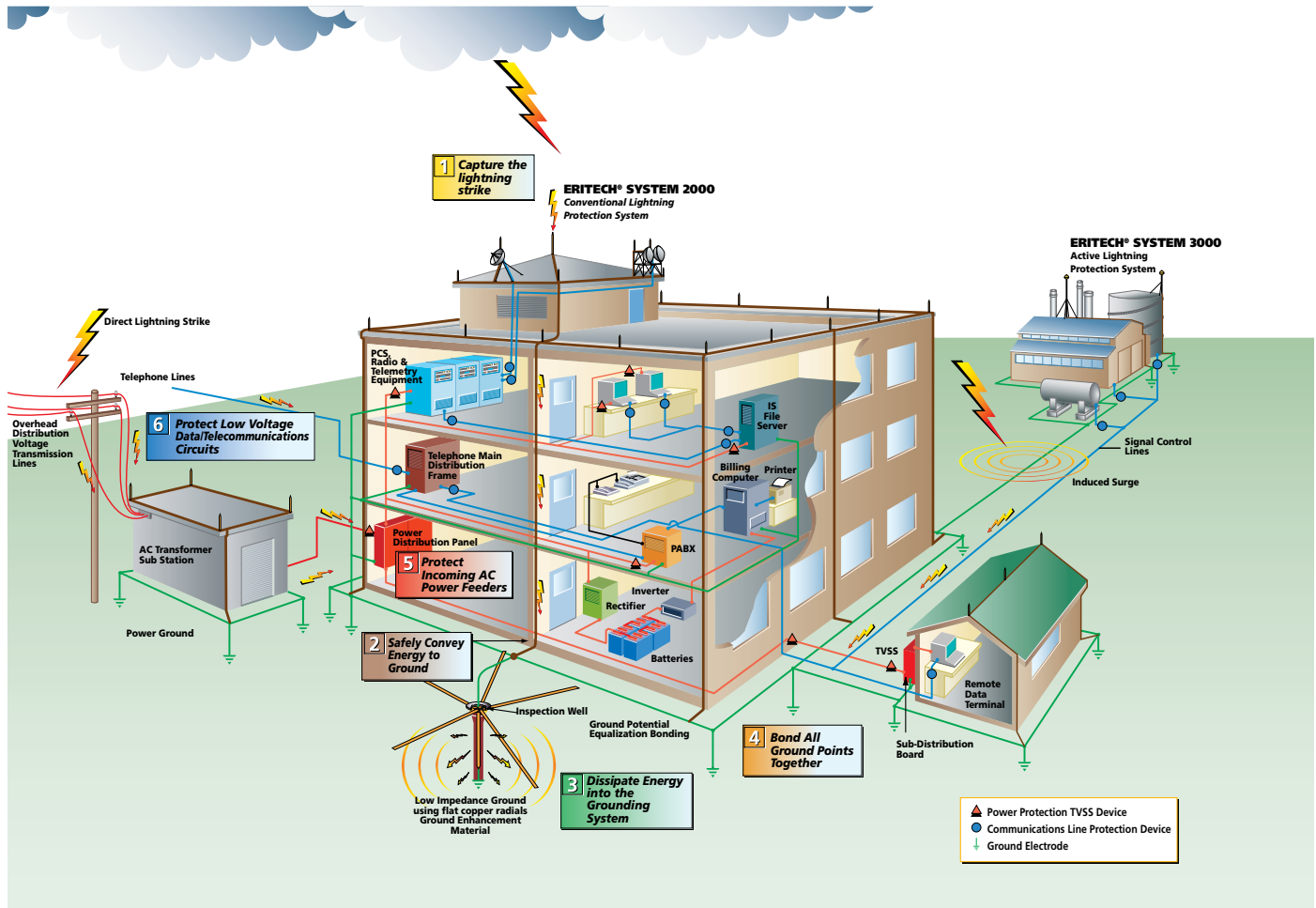
By following the Six Point Plan of Protection, ERICO® customers are able to implement the most effective solutions to individual lightning, grounding and surge problems while retaining an integrated protection philosophy.

Point 5 of the Six Point Plan advocates a coordinated approach to surge protection, where the first stage of defense is the installation of primary protection devices at the mains supply service entrance, followed by secondary protection at distribution branch panels and where necessary, at point-of-use applications.

Point 6 recognizes the need to provide effective surge protection on cables supplying telecommunications, signal and data management equipment.

The Six Point Plan of Protection from ERICO

- 1 Capture the lightning strike.**
Capture the lightning strike to a known and preferred attachment point using a purpose-designed air terminal system.
- 2 Safely convey this energy to ground.**
Conduct the energy to the ground safely via a purpose-designed downconductor.
- 3 Dissipate energy into the grounding system.**
Dissipate energy into a low impedance grounding system.
- 4 Bond all ground points together.**
Bond all ground points to eliminate ground loops and create an equipotential plane.
- 5 Protect incoming AC power feeders.**
Protect equipment from surges and transients on incoming power lines to prevent equipment damage and costly operational downtime.
- 6 Protect low voltage data/telecommunications circuits.**
Protect equipment from surges and transients on incoming telecommunications and signal lines to prevent equipment damage and costly operational downtime.



The Need for Coordinated Protection

Critical Factors

Critical factors need to be considered when determining the need for facility protection. Many factors can be determined by answering the following questions:

- What is the risk to personnel?
- What is the risk of equipment damage?
- What are the consequences of equipment failure?
- Is the equipment associated with an essential service?
- How will equipment failure affect overall facility operation and revenue generation?
- What are the legal implications of providing inadequate protection?

The statistical nature of lightning and the broad spectrum of energy delivered by a lightning flash, the problems created by various power generation and distribution systems, and the continued trend to more sensitive and specialized electronics, requires careful selection of available technologies if adequate protection is to be provided.

What are the costs of inadequate protection?

The costs that can result from inadequate protection are many and varied. The type of equipment within a facility will have a direct impact on the damage that can occur. Robust equipment, such as lighting and air-conditioning systems, are often able to withstand impulses as high as 1500 volts and are not as sensitive to the rapid rate-of-rise exhibited by the pre-clamped surge waveform as are electronics. These systems are often not critical to the continuing operation of the site and therefore usually do not require the premium level of protection that is essential for more sensitive equipment.

However, significant damage can occur, even to the more robust systems, as a result of lightning induced surges resulting within a radius of several kilometers, or from switching induced surges.

Costs can range from degradation of electrical or electronic systems to data loss, equipment destruction or injury to personnel. Some of these costs can appear relatively minor but the loss of an essential service or revenues associated with a facility or plant shut down can be enormous.

According to the Insurance Information Institute, NY, (NY Press Release 11 August 1989): Lightning and over-voltage transients cause damage to property, electrical, electronic and communications equipment estimated to be more than US\$1.2 billion dollars per year in the US alone. This represents approximately 5% of all insurance claims in the US. Costs in more lightning prone regions of the world are even greater.

According to Holle, et al., Journal of Applied Met, Vol 35, No.8, August 1996: Insurance claims to lightning and over-voltage damage amount to US\$332 million annually in the US. On average this represents one claim for every 57 lightning strikes in the US.

Sources of Transients and Surges

Although lightning is the most spectacular form of externally generated surges, it is only one source of over-voltage. Other sources include the switching of power circuits, the operation of electrical equipment by neighboring industries, the operation of power factor correction devices, and the switching and clearing of faults on transmission lines. It is important to note that lightning does not need to directly strike a power line for such damage to occur; a strike several hundred meters away can induce large damaging transients, even to underground cables.

It is estimated that 70 to 85% of all transients are generated internally within one's own facility by the switching of electrical loads such as lights, heating systems, motors and the operation of office equipment.

Modern industry is highly reliant on electronic equipment and automation to increase productivity and safety. The economic benefits of such devices are well accepted. Computers are commonplace and microprocessor-based controllers are used in most manufacturing facilities. Microprocessors can also be found embedded in many industrial machines, security & fire alarms, time clocks and inventory tracking tools. Given the wide range of transient sources and the potential cost of disruption, the initial installed cost of surge protection can readily be justified for any facility.



Damage to vital equipment caused by destructive surges and transients.

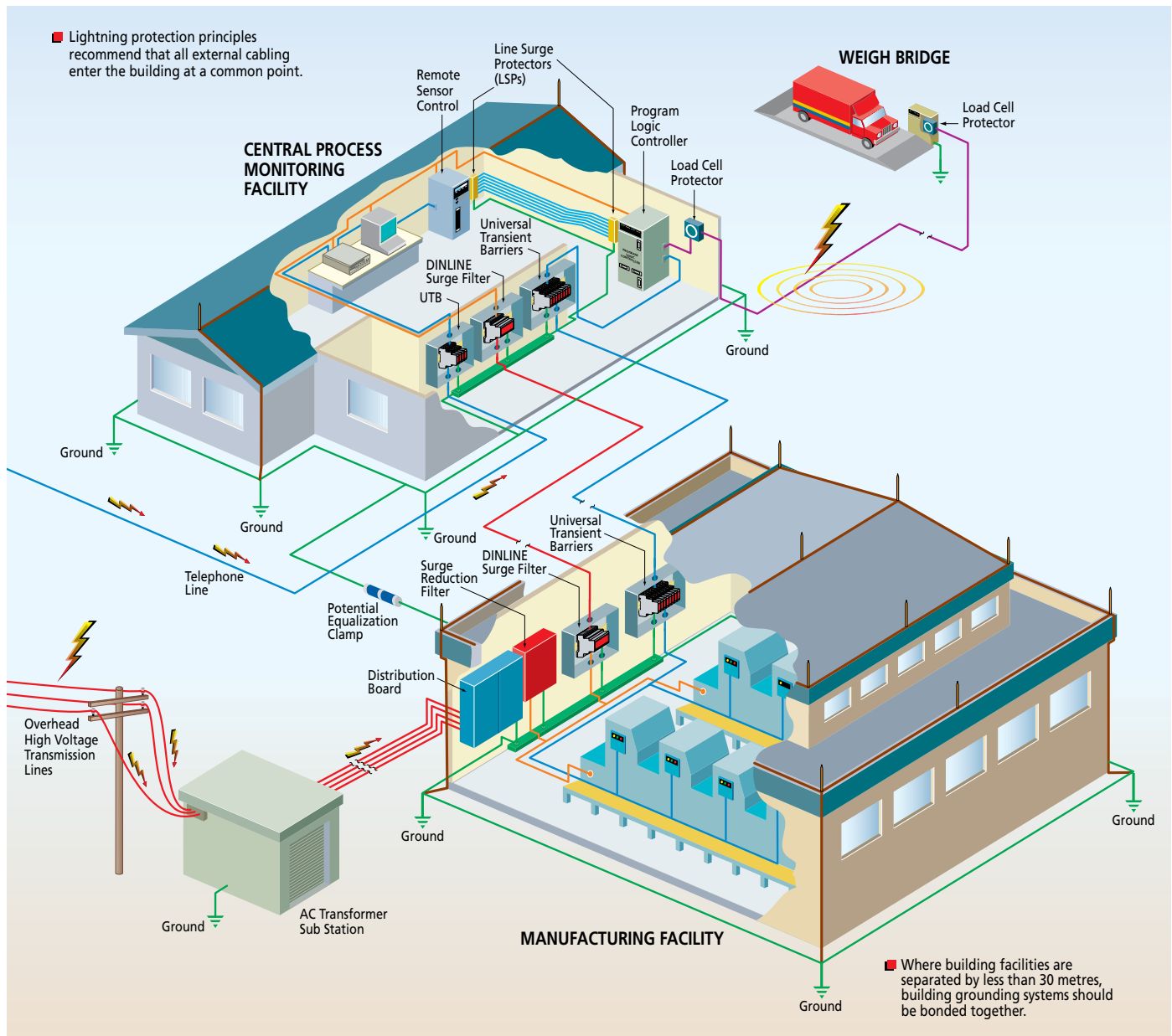
As a guide, the cost of protection should be approximately 10% of the cost of the facility's economic risk.

The Need for Coordinated Protection

Reliable protection of structures, industrial and commercial operations and personnel, demands a systematic and comprehensive approach to minimizing the threats caused by transient over-voltages. Grounding, bonding, lightning protection and surge protection all need to be considered for comprehensive facility electrical protection. Each of these are interdependent disciplines that need a holistic design approach to ensure the facility is not left with a vulnerable "blind spot". The investment in surge protection can be wasted if "blind spots" exist. For example, installing a surge protection device on the power supply to a programmable logic controller is of little value if the I/O lines are not also protected. In addition,

an air terminal on the facility may capture the lightning energy but without a dependable ground system, this energy cannot be safely dissipated. Equally, even the most expensive Surge Protection Devices (SPDs) are poor performers if a low impedance equipotential ground is not provided. These interdependent disciplines are best applied when looking at a total facility rather than at an individual piece of equipment or portion of the facility.

It is for these reasons that ERICO® developed the Six Point Plan of Protection. The plan prompts the consideration of a coordinated approach to lightning protection, surge and transient protection and grounding, an approach that embraces all aspects of potential damage, from the more obvious direct strike to the more subtle mechanisms of differential earth potential rises and voltage induction at service entry points.



The Six Point Plan applied to a manufacturing facility. Surge and transient protection principles applied to a total facility rather than individual pieces of equipment.



Selecting Surge Protection

RECOMMENDED SURGE RATINGS (8/20 μ s)					
ANSI/IEEE C62.41			CAT C	CAT B	CAT A
IEC 61643 Test Class	I		I, II	II	III
VDE Classification	A		B	C	D
	POINT-OF-ENTRY HIGHLY EXPOSED OR CRITICALLY IMPORTANT SITES	POINT-OF-ENTRY EXPOSED OR RURAL SITES	POINT-OF-ENTRY INNER CITY SITES	SUB CIRCUITS OR NEAR TO POINT-OF-ENTRY	DISTRIBUTED CIRCUITS, POWER OUTLETS, CIRCUITS REMOTE FROM POINT-OF-ENTRY
EXPOSURE					
HIGH Ng >2	100kA	70kA	40kA	20kA	10kA
MED. Ng 0.5-2	65kA	40kA	20kA	20kA	5kA
LOW Ng <0.5	65kA	40kA	15kA	5kA	3kA

Ng = strikes/km²/year.

RECOMMENDED PRODUCTS					
PRODUCT SERIES					
		SES200			
		SES40 120/240			
		TDS Movtec & MPM			
		TDX200			
		TDX100			
			TDX50		
		TSG - SRF			
		TSG / SGD			
		DSD1150			
		TDS / DSD1100			
		DSD160 & DSD380			
		TDS / DSD140 & TDS / DSD340			
				TDS130	
				DSD110	
				TDF	
				DSF6A	

Selecting Surge Protection

Recommended Surge Ratings – A Comparison between IEC® and IEEE® Recommendations

Competition between SPD manufacturers has seen ever-increasing surge ratings being offered to the market, to the point where surges of this magnitude are unlikely to ever occur in nature. A number of sources provide information on the statistical distribution of the current discharge of the direct lightning strike. Many studies have shown that peak lightning discharges above 100kA are likely to occur less than 5% of the time. Combined with the fact that most discharges do not strike the power line directly but are magnetically or capacitively coupled to it, and that even under a direct lightning discharge the energy will split in either direction and be attenuated by the distribution arresters and line losses, it is not difficult to determine that a smaller fraction of the initial lightning energy typically enters the facility in question.

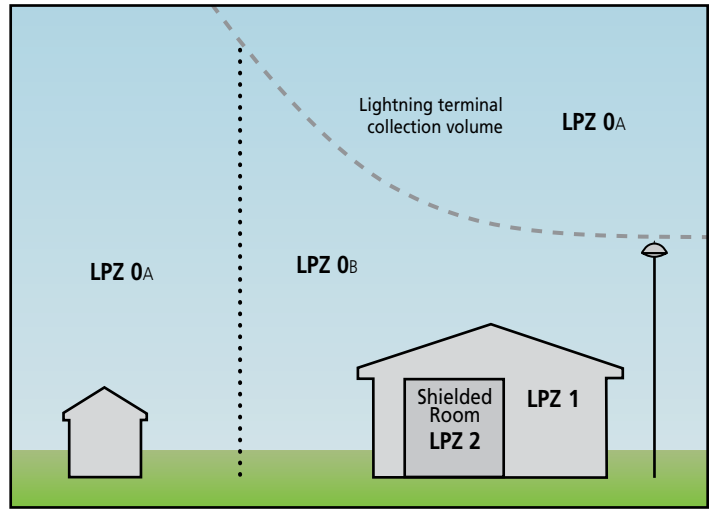
ANSI/IEEE standard C62.41 has classified the “point-of-entry” environment as CAT. B/C. Under this classification the highest expected energy level is 10kA 8/20µs. In contrast, the IEC61312 and DIN VDE 0675 defines some differing guidelines. IEC 61000-5-6 and IEC 61312-1 describe protection zone concepts. This is similar in nature to the ANSI/IEEE C62.41 concept of Category A, B & C locations.

A “Zone” is where the lightning electromagnetic environment can be defined/controlled. The zones are characterized by significant changes of electromagnetic conditions at these boundaries. These will typically be building boundaries, or the point where protection is installed.

- LPZ OA Zone subject to direct strikes
- LPZ OB Zone not subjected to direct strikes, but unattenuated electromagnetic fields may occur.
- LPZ 1 Zone not subjected to direct strikes and where currents in this zone are reduced compared to Zone OB
- LPZ 2... If further reductions in current from LPZ 1 are achieved/required further zones can be created.

Actual surge ratings required in each of these zones is not exactly defined and is largely determined by some site-specific details. However, to assist with this the VDE0675 Part 6 standard defines the minimum class of product that can be applied to each of these Zones as shown below:

- Class A : Arrester for use in low-voltage overhead lines
- Class B : Arrester for lightning current equipotential bonding (must withstand 100kA 8/80µs or 10As charge, twice). Zones OB to 1 (Main distribution Boards, Sub-Boards)
- Class C : Arrester for over-voltage protection (must have a nominal surge rating of at least 5kA 8/20µs) Zones 1 to 2 (mainly sub-boards or low exposure main boards)
- Class D : Arrester for portable use on socket-outlets (must have a nominal surge rating of at least 1.5kA 8/20µs)



Protection zones defined by specific product application.

As it can be shown, protection equipment for power supply systems are classified as follows, according to its task →

- Lightning Current Arrester
- Over-voltage Arrester

Lightning current equipotential bonding arresters must be capable of conducting a portion of the lightning current without being destroyed. Over-voltage arresters are only used for limiting over-voltages at relatively smaller surge currents. The different “protection zones” assume the division of the initial lightning current, from zone 0 to higher zones. For zone 0, it is required for the user to select the lightning protection class, from I - IV : (i.e. these refer to maximum energy within a direct lightning strike).

Protection Level	Current Magnitude	% Exceeded
Level I	200kA (10/350µs)	~ 0.2%
Level II	150kA (10/350µs)	~ 1.5%
Level III - IV	100kA (10/350µs)	~ 3%

The above levels can be selected based on the statistical level of protection required. A lightning current of 200kA (10/350µs) can be expected for the Protection Level I. This lightning current is divided as follows in the most exposed sites:

- 50% (100kA, 10/350µs) discharges via the ground system.
- 50% (100kA, 10/350µs) flows into the supply systems connected to it, via the three phase equipotential bonding lightning arresters.

On the other hand IEEE has adopted a Scenario II event, in which the building lightning protection system is subjected to a direct strike and the energy level sustained by the equipotential bonding surge arrester(s) is taken to be 10kA (10/350µs) or approximately 100kA 8/20µs as a worst case.

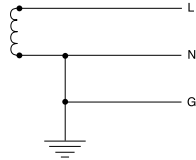
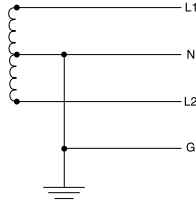
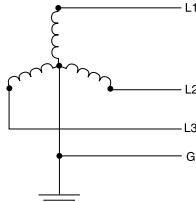
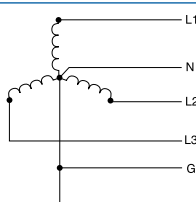
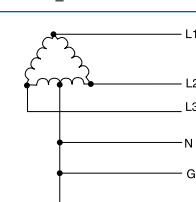
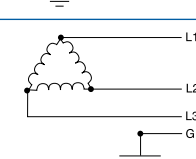
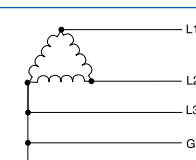
If we adopt IEC or DIN VDE Standard and assume a level of III-IV lightning protection system, each equipotential bonding surge arrester connected to a three phase, four wire, power system is assumed to experience a 12.5 kA (10/350µs) energy level at the Zone 0 interface due to lightning current sharing.



A Guide to Common Power Distribution Systems

Throughout the world a number of different power distribution systems are used. This guide identifies the more common of

these systems. The individual product specification tables detail system suitability.

Description	Source Configuration	Typical Supply Voltages	
Single Phase 1Ph, 2W+G		110V 120V 220V 240V	(L-N)
Single Phase 1Ph, 3W+G Also known as Split phase or Edison system		120/240V	(L-N/L-L)
Three Phase WYE without neutral 3Ph Y, 3W+G		480V	(L-L)
Three Phase WYE with neutral 3Ph Y, 4W+G		120/208V 220/380V 230/400V 240/415V 277/480V 347/600V	(L-N/L-L)
Delta High leg 3Ph Δ, 4W+G		120/240V	(L-N/L-L)
Delta Ungrounded 3Ph Δ, 3W+G		240V 480V	(L-L)
Delta Grounded corner 3Ph Δ, 3W+G		240V 480V	(L-L)

A Guide to Common Power Distribution Systems

The IECSM 60364 series of standards characterizes low-voltage distribution systems by their grounding method and the arrangement of the neutral and protective earth conductors. The selection of SPDs must consider among other issues, the level of over-voltage that may temporarily occur within the distribution system due to ground faults. IEC 61643-12 details the temporary over-voltages that may occur during fault conditions for these systems. To conform with European wiring rules an SPD with a U_c rating equal to, or greater than, this value should be selected. Effective protection does not

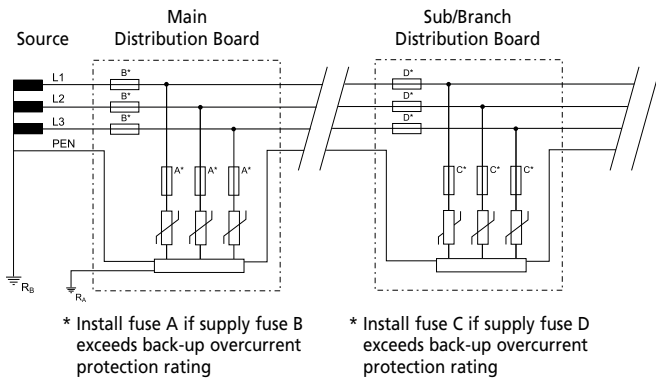
require SPDs to be installed in all the modes detailed. The following diagrams provide guidance on the selection and installation of SPDs on the more common distribution systems. While three phase WYE systems are shown, similar logic can be applied to single phase, delta and other configuration sources.

U_o = Line to neutral voltage of the system

U_n = Nominal country specific system voltage (typically $U_o \times 1.10$)

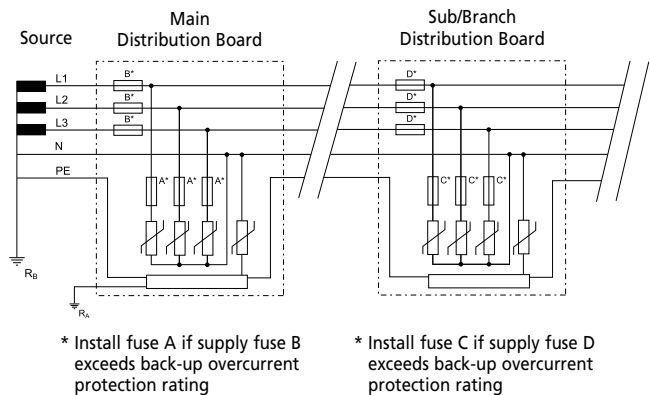
TN-C System

The neutral and protective earth conductor combine in a single conductor throughout the system. All exposed-conductive-parts are connected to the PEN conductor.



TN-S System

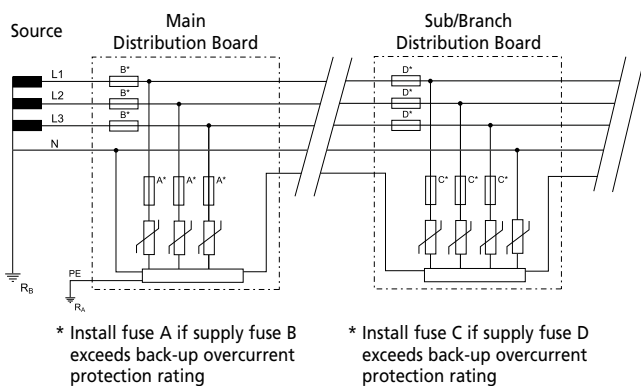
A separate neutral and protective earth conductor are run throughout. The protective PE conductor can be the metallic sheath of the power distribution cable or a separate conductor. All exposed-conductive-parts of the installation are connected to this PE conductor.



SPDs shown connected L-N and N-PE.
May also be connected L-PE and N-PE.

TN-C-S System

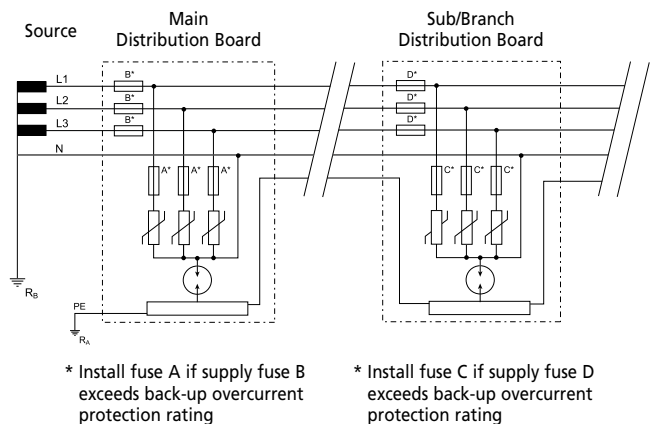
A separate neutral and protective earth combine in a single PEN conductor. This system is also known as a Multiple Earthed Neutral (MEN) system and the protective conductor is referred to as the Combined Neutral Earth (CNE) conductor. The supply PEN conductor is earthed at a number of points throughout the network and generally as close to the consumer's point-of-entry as possible. All exposed-conductive-parts are connected to the CNE conductor.



SPDs shown connected L-PE and N-PE.
May also be connected L-N and N-PE.

TT System

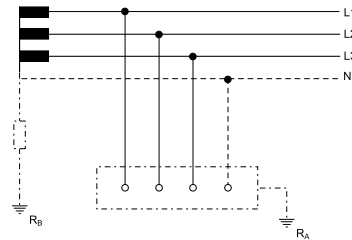
A system having one point of the source of energy earthed and the exposed-conductive-parts of the installation connected to independent earthed electrodes.



A Guide to Common Power Distribution Systems

IT System

A system having no direct connection between live parts and earth but all exposed-conductive-parts of the installation being connected to independent earthed electrodes.



Distribution Network Configuration

	TN-C	TN-S TN-C-S	TT	IT with neutral conductor	IT without neutral conductor
Between					
Phase (line) and Neutral Conductor	X	$1.45 U_0$	$1.45 U_0$	$1.45 U_0$	X
Each Phase (line) Conductor and PE	X	$1.45 U_0$	$\sqrt{3} U_0$	$\sqrt{3} U_0$	$\sqrt{3} U_0$
Neutral Conductor and PE	X	U_0	U_0	U_0	U_0
Each Phase (line) Conductor and PEN	$1.45 U_0$	X	X	X	X

SPD U_c Selection:
 U_0 = Voltage between phase (line) and neutral conductor
 X = Not applied

SPD selection must consider the level of over-voltage that may occur within the distribution system due to ground faults. The above IEC® table shows over-voltages that may occur during fault conditions for the various systems. An SPD with a U_c equal or greater than this value should be selected.

Metal Oxide Varistors (MOVs)	Gas Discharge Tubes (GDTs)	Other Symbols
<p>Conventional MOV With thermal disconnect With overcurrent fusing With Transient Discriminating Technology</p>	<p>Two terminal gas arrester Three terminal gas arrester With failsafe device</p>	<p>Spark Gap Triggered Spark Gap Silicon Protection Audible Alarm</p>

8/20 μ s Current Waveshape

A current impulse with a virtual front time of 8 μ s and a time to half-value of 20 μ s.

Aggregate Surge Rating

The sum of the surge ratings of individual voltage limiting components, connected in parallel, in the device.

Note: This figure does not indicate the maximum discharge current (I_{max}) of the device. It does however provide an indication of the expected SPD life. Users should be aware that certain manufacturers may incorrectly claim the aggregate surge rating of MOV material used in their device as its I_{max} . Non-perfect current sharing between parallel MOVs, and the inability of series over-current or thermal disconnects to carry the full surge current, generally means that the maximum discharge current which the SPD can withstand is less than its aggregate surge rating.

Attenuation

The ability of an SPD to reduce electrical noise interference, measured in decibels. Attenuation varies with frequency, so it is usual to specify the attenuation of the SPD at a particular frequency; commonly 100kHz.

Backup Overcurrent Protection

An external overcurrent protective device installed prior to the SPD. Such a device may be required if the overcurrent limiting device on the service is larger than that required by the SPD or connecting wiring.

Class I test

SPD tested with maximum impulse current (I_{imp}) and nominal discharge current (I_n).

Class II test

SPD tested with maximum discharge current (I_{max}) and nominal discharge current (I_n).

Class III test

SPD tested with combination wave

Distribution System

Defines the electrical power distribution system. The distribution system is usually described by configuration of the phases, neutral and ground conductor configuration on the secondary side of the supply transformer. Refer to pages 10-12 for further information.

Follow Current (I_f)

The current supplied by the electrical power distribution system which flows through the SPD after a discharge current impulse. The follow current is significantly higher than the operating current, and is normally high for voltage switching type SPDs (e.g. spark gaps) since the arc voltage falls below the AC supply voltage after firing.

Impulse Current (I_{imp})

Peak impulse current withstand with a 10/350 μ s current waveshape. This is often used for the classification of SPDs tested to Test Class I, but is not the only acceptable waveshape.

Insertion Loss

The insertion loss of an SPD is usually only stated for two port devices for use on low voltage data systems. It is a measure of the ratio of voltage at the output to the input at the device under test. The insertion loss is usually stated for a given frequency and measured in decibels.

Leakage Current

The current flowing to the ground conductor when the SPD is connected to the nominal supply voltage U_n .

Let-through Voltage

Another term often used to describe the measured limiting voltage.

Note: This measurement may be carried out with, or without, the presence of the nominal AC power (U_n) being applied to the SPD. As such, the results may be different and the user should take cognizance of this in making any comparative assessments.

Location Categories

Various standards attempt to define the electrical environment at which an SPD may be installed, into location categories or zones.

Note: The user should be aware that international consensus has not been reached on these classifications, nor on the size of expected surge activity, which may occur. Further, the user should note that the demarcation of these zones do not form literal boundaries, but are rather a gradual transition.

Maximum Continuous Operating Voltage (U_c)

The maximum r.m.s. or d.c. voltage which may be continuously applied to the SPD's mode of protection without degradation or inhibiting its correct operation.

Note: Specifications given in the catalog generally are phase (L-N) voltages.

Maximum Discharge Current (I_{max})

The maximum single shot current, having an 8/20 μ s waveshape, which the SPD can safely divert.

Measured Limiting Voltage

The maximum voltage measured across the SPD's terminals during the application of an impulse of specified waveshape and amplitude.

Modes of Protection

SPDs may provide protection line-to-ground, line-to-neutral, neutral-to-ground or in combinations thereof. These paths are referred to as the modes of protection.

Note: The user is advised that not all modes require protection, and more is not necessarily better when selecting an SPD. As an example, the N-G mode is not required when the SPD is installed at the primary service entrance of a TN-C-S electrical distribution system, due to the Neutral-Ground bond at this point. The L-L mode is generally not provided for systems with neutral conductors since the L-N modes also protect the L-L modes. Similarly, the L-G mode can be protected via the L-N and N-G modes.

Nominal Discharge Current (I_n)

The peak value of the current flowing through the SPD during the application an 8/20 μ s waveshape.

Note: IEC 61643-1 requires SPDs tested to Test Class II, to withstand 15 impulses at I_n followed by 0.1, 0.25, 0.5, 0.75 and 1.0 times I_{max} .

Nominal (System) Voltage (U_n)

The L-N voltage by which an electrical power system is designated. Under normal system conditions, the voltage at the supply terminals may differ from the nominal voltage as determined by the tolerance of the supply system (normally +/- 10%).

One-port SPD

An SPD connected in shunt (parallel) with the circuit to be protected. A one port device may have separate input and output terminals, but without a specific series impedance between these terminals. This type of connection is also known as a Kelvin connection.



Operating Current

The current drawn (per phase) by the SPD when energized at the nominal operating voltage U_n .

Note: For SPDs with integral series filtering, the total current drawn may be greater than the real rms current consumption (i.e. VA may be greater than Watts). This is due to the presence of the internal filtering capacitance.

Over-current Protection

An over-current device, such as a fuse or circuit-breaker, which could be part of the electrical distribution system located externally and up-stream of the SPD. May provide protection to the SPD, the connecting wiring and provide a means of externally isolating the SPD.

Protective Earth (PE)

The IEC 60364 series characterizes low-voltage distribution systems by their grounding methods and the configuration of the neutral and protective conductors. The Protective Earth is commonly referred to as "ground", or "earth", in many regions.

Rated Load Current (IL)

Maximum continuous rated current that can be supplied to a load connected to the protected output of an SPD. Normally only stated for two port, series connected, SPDs.

Residual Voltage

In IEC terminology this refers to the peak value of the voltage that appears between the terminals of an SPD due to the passage of discharge current I_n . NZS/AS 1768 refers to this as the let-through voltage, a measurement obtained when the stated test impulse is superimposed on top of the nominal system voltage U_n .

Secondary Surge Arrester

A loosely used term given to SPDs intended for operation on medium voltage systems (>1kV). Within the USA, a secondary surge arrester defines an SPD Listed by Underwriters Laboratories Inc. for use on LV and MV systems at locations prior to the main overcurrent disconnect to the facility.

Note: Secondary Surge Arrester Listing is generally considered to have less demanding safety requirements than those for UL 1449 Transient Voltage Surge Arrester Listing.

Short Circuit Current Rating (SCCR)

The short-circuit current rating of the SPD. Required by USA National Electric Code (NEC) for TVSS devices.

SPD Disconnect

An IEC term used to describe a device (internal and/or external) for disconnecting an SPD from the electrical power system.

Note: This disconnecting device is not required to have isolating capability. It is to prevent a persistent fault on the system and is used to give an indication of the SPD failure. There may be more than one disconnecter function, for example an over-current protection function and a thermal protection function. These functions may be integrated into one unit or performed in separate units.

Spark-over Voltage

The voltage at which a switching type SPD (generally of the spark gap type) will initiate conduction. This value is normally specified for a voltage increasing at 1kV/s.

Stand-off Voltage

The maximum voltage, which can be applied to an SPD, without triggering it into a fully conductive state.

Note: This voltage is normally higher than the maximum continuous operating voltage U_c of the SPD. It is not intended that the SPD be operated at this voltage.

Status Indicator

A device(s) that indicates the operational status of the SPD, or of a particular mode of its protection.

Note: Such indicators may be local with visual and/or audible alarms and/or may have remote signaling and/or output contact capability.

Suppressed Voltage Rating (SVR)

A special case of the measured limiting voltage specific to the UL 1449 Listing of an SPD.

Note: This test is performed using a small 500A 8/20 μ s current limited impulse, and the clamping voltage recorded at the ends of 6" connecting leads. The result obtained is rounded up to the nearest value given in a table.

Surge Protection Device (SPD)

An IEC term used to describe a device intended to limit transient over-voltages and divert surge currents. It contains at least one non-linear component.

Surge (Reduction) Filter

A two-port series filtering type of SPD specifically designed to reduce the rate-of-rise of voltage (dv/dt) of the pre-clamped waveform. Such a device normally contains a filter with low-pass performance.

Transient Voltage Surge Suppressor (TVSS)

An SPD tested to meet the safety requirements of UL 1449 - Standard for Transient Voltage Surge Suppressors. UL 1449 defines the basic safety requirements for TVSS devices installed on electrical circuits up to 600V. The United States National Electric Code (NEC) only permits TVSS devices to be installed after (downstream of) the main over-current disconnect to a facility.

Two-port SPD

An SPD with two sets of terminals, input and output (line and equipment), and with a specific impedance inserted between these terminals. These are often referred to as series (in-line) connected SPDs and generally contain wave-shaping filters in addition to simple shunt-only protection.

Voltage Protection Level (Up)

Similar to the measured limiting voltage, the voltage protection level characterizes the performance of an SPD in limiting the voltage across its terminals

Note: The voltage protection level is the measured limiting voltage recorded under a specified current magnitude and waveshape, and rounded up to the next highest voltage selected from a list of preferred values found in IEC 61643-1 Standard for surge protective devices connected to low-voltage power distribution systems. For SPDs tested to Test Class I, Up is generally stated using a 10/350 Iimp and for SPDs tested to Test Class II, using an 8/20 μ s Imax.

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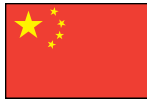


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