OFF GRID PV POWER SYSTEMS

SYSTEM INSTALLATION GUIDELINES

SEIAPI Sustainable Energy

SIDSDOCK SMALL ISLAND DEVELOPING STATES ISLAND ENERGY FOR ISLAND LIFE

WORLD BANK GROUP

PPA PACIFIC POWER ASSOCIATION

Acknowledgement

The development of this guideline was funded through the Sustainable Energy Industry Development Project (SEIDP). The World Bank through Scaling Up Renewable Energy for Low-Income Countries (SREP) and the Small Island Developing States (SIDSDOCK) have each provided funding to the PPA as the Project Implementation Agency for the SEIDP. The guidelines have been developed by Global Sustainable Energy Solutions with the support of Dr Herbert Wade and reviewed by PPA and SEIAPI Technical Committees.

These guidelines have been developed for The Pacific Power Association(PPA) and the Sustainable Energy Industry Association of the Pacific Islands (SEIAPI).
They represent latest industry BEST PRACTICE for the Installation of Off-Grid PV Power Systems

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List of Abbreviations

A summary of the main acronyms and terms used in this document is listed below:

AC	Alternating current
Ah	Amp hour
AS	Australian standards
CCC	Current carrying capacity
CSA	Cross section area
DC	Direct current
DVC	Decisive voltage classification
ELV	Extra low voltage
EN	European standards (European norms)
GFPD	Ground fault protective device
ICC	International code council
IEC	International electrotechnical commission
ISO	International organisation of standardisation
K	Kelvin
LV	Low Voltage
MPPT	Maximum power point tracker
NZS	New Zealand standards
NEC	National electricity code
NFPA	National fire protection association
PSH	Peak sun hour
PV	Photovoltaic
PVM	Pulse width modulation
STC	Standard test conditions
UL	Underwriters laboratories
VA	Voltage amperes
Wp	Watts peak (also known as peak-watt)
Wh	Watt-hour

1. Introduction

This document provides the minimum requirements when installing an Off Grid PV Power system.

The array requirements are generally based on the requirements of: IEC 62458: Photovoltaic (PV Arrays-Design Requirements. These are similar to the requirements of AS/NZS5033: Installation and Safety Requirements of PV Arrays. The National Electrical Code (NEC)specifies maximum currents for strings, sub-arrays and arrays of 1.25 times the short circuit currents of the strings, sub-arrays and arrays. For protection and isolation devices the NEC has a required safety margin of 1.25 (125%), thereby having an effective overall oversizing of 156% (1.56 times) the relevant short circuit currents. The NEC requirements are provided as notes where appropriate.

Diagram 1 shows the configuration of a system that provides dc power only. These systems typically range from 100Wp to 1 kWp of solar modules but may be smaller or larger. For all sizes, the principles of design are the same. Most solar installations installed on rural residences use this basic design.

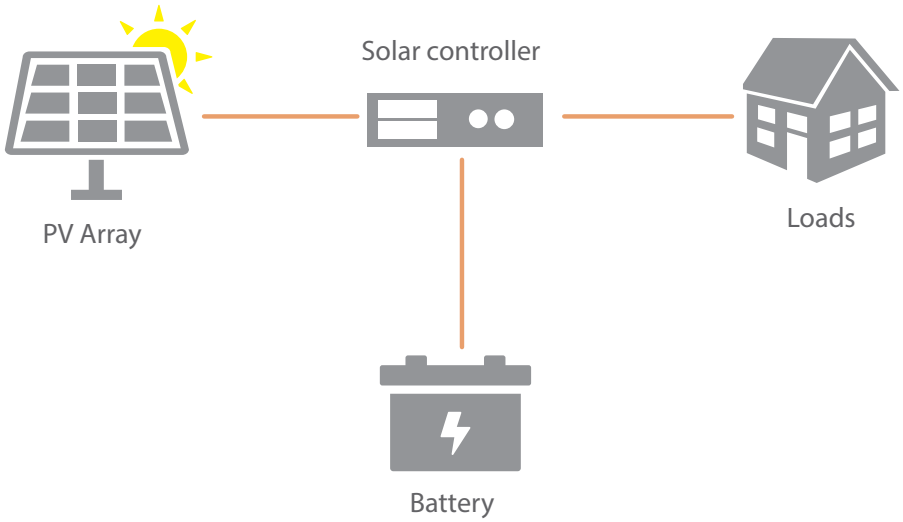


Figure 1: System Powering dc loads only (also known as a simple dc bus system)

Note: Solar controller could be a switching type controller or a Maximum Power Point Tracking (MPPT) Controller

Systems that include an inverter providing ac power to end-user can be provided as either:

- dc bus systems (refer to Figure 2); or
- ac bus systems (refer to Figure 3).

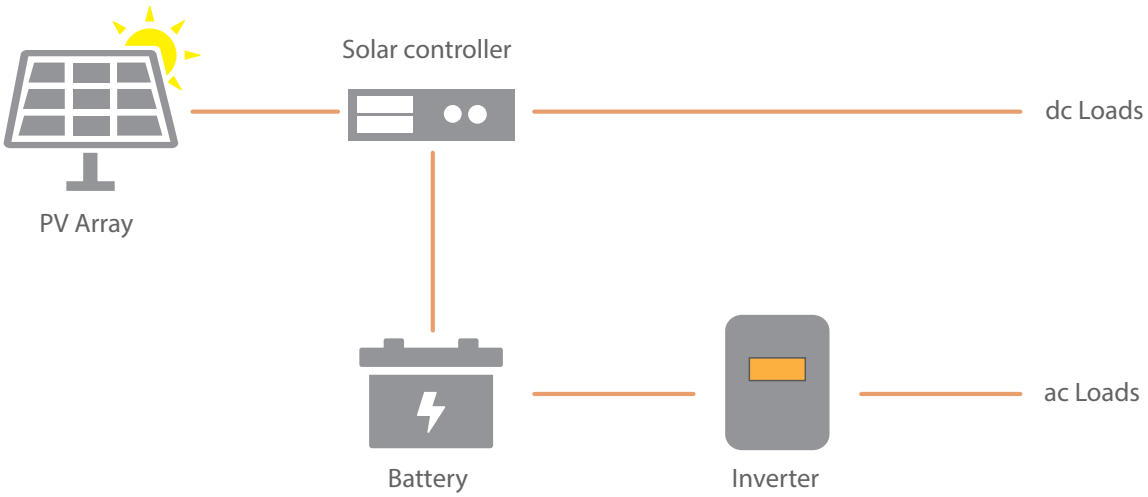


Figure 2: dc bus system

Note: Solar controller could be a switching type controller or a Maximum Power Point Tracking (MPPT) Controller

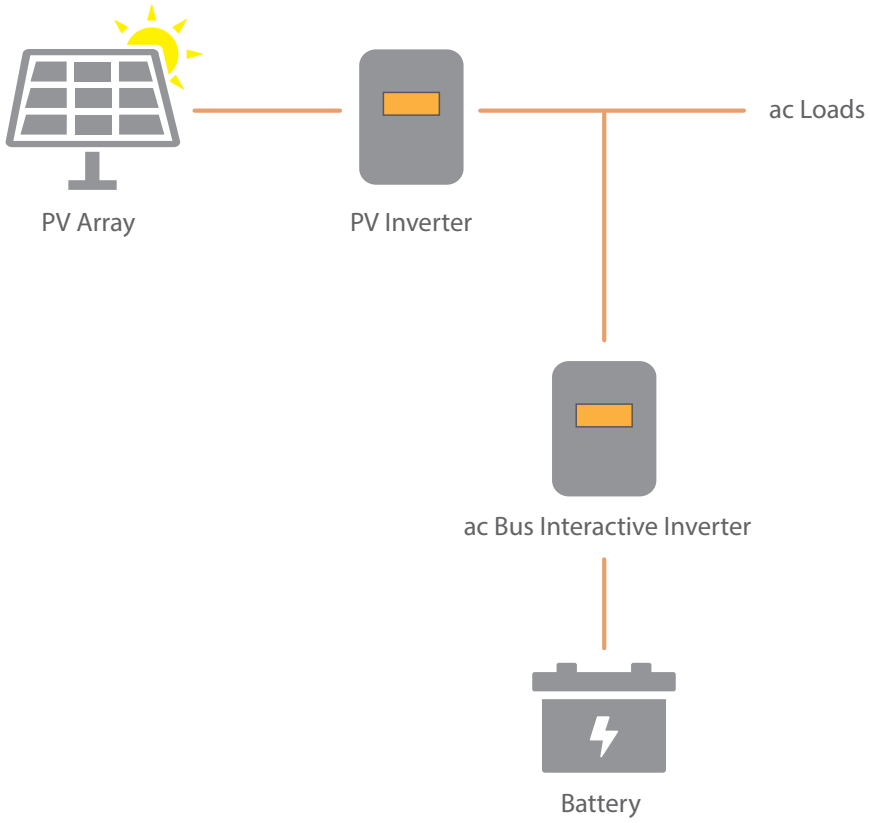


Figure 3: ac bus system

Some systems can be a combination of ac bus and dc bus systems where part of the array is connected by dc through a solar controller to the battery and part of the array is connected directly to the ac load side via a PV inverter.

Note:
1. IEC standards use a.c. and d.c. for alternating and direct current respectively while the NEC uses ac and dc. This guideline uses ac and dc.

2. In this document there are calculations based on temperatures in degrees centigrade (°C). The formulas used are based on figures provided from solar module manufactures where the temperature coefficients are generally expressed in °C while there are some from the USA that have used degrees kelvin (K). A one-degree change in C is equal to a one-degree change in K. So if the module manufacturer provides the temperature coefficient in K, just change the K to a °C.

If your local temperatures are in Fahrenheit, then Appendix 1 has a table showing the conversion of °C to °F from 0°C to 50°C do the calculations.

2. Standards for Installation

System installations should follow any standards that are typically applied in the country or region where the solar installation will occur. The following are the relevant standards in Australia, New Zealand and the USA. Some Pacific island countries and territories follow those standards though with some modifications to better fit local conditions. These standards are often updated and amended so the latest version should always be applied.

In Australia and New Zealand, the relevant standards include:

- AS/NZS 1768	Lightning Protection.
- AS/NZS 3000	Wiring Rules.
- AS/NZS 3008	Electrical Installations-Selection of Cables.
- AS/NZS 4086	Secondary Batteries for use with stand-alone power systems (Note this will soon be superseded by AS/NZS 5139 Electrical installations — Safety of battery systems for use with power conversion equipment).
- AS/NZS 4509	Stand-alone power ststems.
- AS/NZS 5033	Installation and safety requirements for PV Arrays.
- AS 3011	Electrical Installations - Secondary batteries installed in buildings.
- AS 2676	Guide to the installation, maintenance, testing and replacement of secondary batteries in building.
- IEC 61215	Terrestrial photovoltaic (PV) modules - Design qualification and type approval
• IEC 61215-1	Part 1: Test requirements.
• IEC 61215-1-1	Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules.
• IEC 61215-1-2	Part 1-2: Special requirements for testing of thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules.
• IEC 61215-1-3	Part 1-3: Special requirements for testing of thin-film amorphous silicon based photovoltaic (PV) modules.
• IEC 61215-1-4	Part 1-4: Special requirements for testing of thin-film Cu(In,GA)$(S,Se)_2$ based photovoltaic (PV) modules.

- IEC 61215-2 Part 2: Test Procedures.
- IEC 61730 Photovoltaic (PV) module safety qualification.
  - IEC 61730-1 Part 1: Requirements for construction.
  - IEC 61730-2 Part 2: Requirements for testing.
- IEC 62109 Safety of power converter for use in photovoltaic power systems.
  - IEC 62109-1 Part 1: General requirements.
  - IEC 62109-2 Part 2: Particular requirements for inverters.

In USA the relevant codes and standards include:

- Electrical Codes-National Electrical Code and NFPA 70:
  - Article 690: Solar Photovoltaic Systems.
  - Article 705: Interconnected Electric Power Production.
- Building Codes- ICC, ASCE 7
- UL Standard 1703 Flat Plate Photovoltaic Modules and Panels.
- UL Standard 1741 Standard for Inverter, converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources.
- UL 62109 Standard for Safety of Power Converters for Use in Photovoltaic Power Systems.
- UL 2703 Standard for Mounting Systems, Mounting Devices, Clamping/ Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels.
- UL(IEC) 61215 Crystalline silicon terrestrial photovoltaic (PV) modules— Design qualification and type approval.

3. Voltage Limits and Work Restrictions

System voltage classification in this guideline follows the Decisive Voltage Classification (DVC) as defined in IEC 62109 Safety of power converter for use in photovoltaic power systems and as shown in Table 1. The Decisive Voltage Classification has not been adopted by the NEC at this stage.

Table 1: Decisive Voltage Classification (DVC)

Decisive voltage classification (DVC)	Limits of working voltage (V)		
	ac voltage (rms)	ac voltage (peak)	dc voltage (mean)
DVC-A	$V \leq 25$	$V \leq 35.4$	$V \leq 60$
DVC-B	$25 < V \leq 50$	$35.4 < V \leq 50$	$60 < V \leq 120$
DVC-C	$V > 50$	$V > 71$	$V > 120$

Some countries in the Pacific follow the voltage limits as defined in the Australian/New Zealand standard AS/NZS3000 where:

- Extra Low Voltage (ELV) is <120V dc or <50V ac
- Low Voltage (LV) is >120V dc and <1500V dc or >50V ac and <1000 ac

In following this, some countries impose the following requirements on licensed or registered electricians:

Extra Low Voltage Work:

- All extra low voltage wiring should be performed by a 'competent' person, which is defined in various standards: "a person who has acquired through training, qualifications, experience or a combination of these, knowledge and skill enabling that person to correctly perform the task required."

Low Voltage Work:

- All low voltage work: >120V dc or >50V ac should be performed by a trained electrician or similar (e.g. licensed or registered).

In the NEC standard anything above 60V dc is considered dangerous. Except when module inverters are used, grid connect PV arrays have open circuit voltage typically above 120V dc and hence considered LV. LV is dangerous and can kill a person if they come into contact with live terminals.

4. PV Modules

Solar modules shall comply with either:
The following IEC standards:

- IEC 61215 Terrestrial photovoltaic (PV) modules - Design qualification and type approval
  - IEC 61215-1 Part 1: Test Requirements
  - One of IEC 61215 Part 1.1, Part 1.2 Part 1.3, part 1.4 which all relate to specific types of modules e.g. crystalline, thin film amorphous etc (See Section 2)
  - IEC 61215-2 Part 2: Test Procedures
- IEC 61730 Photovoltaic (PV) module safety qualification
  - IEC 61730-1 Part 1: Requirements for construction
  - IEC 61730-2 Part 2: Requirements for testing

Or
The UL standard

- UL Standard 1703: Flat Plate Photovoltaic Modules and Panels

For modules with IEC certification, they must be certified as Application Class A per IEC 61730.

5. PV Array Installation

5.1 General

- PV arrays for installation on domestic dwellings shall not have PV array maximum voltages greater than 600 V.
- Modules that are electrically in the same string shall all be in the same orientation.
- Even for latitudes less than 10°, a minimum tilt of 10° is recommended to take advantage of self-cleaning when it rains. Arrays mounted with a tilt less than 10° may require additional maintenance [cleaning] and this should be included in the recommended maintenance schedule.

5.2 Maximum PV Array Voltage

The PV Array Maximum voltage, the increased open circuit voltage (V_{oc}) of the array when it experiences the lowest effective cell temperature, can be calculated using the minimum expected temperature at a site and the temperature coefficient of a module.

The maximum V_{oc} of a module is determined by calculating the increase in V_{oc} due to the effective cell temperature when the effective cell temperature is less than 25°C (77°F).

The increase in V_{oc} is calculated by multiplying the voltage temperature coefficient (V/°C) by the difference between the effective cell temperature and the STC temperature of 25°C (77°F).

If we use 15°C (59°F) as an example, then the increase in V_{mp} is (15°C – 25°C) = –10°C multiplied by the voltage temperature coefficient (V/°C).

Note: it is an increase because the co-efficient is a negative number and the difference in temperatures is also a negative number, so the two multiplied together becomes a positive number.

The effective V_{oc} of the module due to the minimum temperature = V_{oc} plus the increase in V_{oc}.

Worked Example 1

(Refer to Design Guideline for Off Grid PV Power Systems)
Assume the minimum effective cell temperature is 15°C (59°F),
The module data sheet provides the following information:

- V_{oc} = 37.7V
- V_{oc} temperature coefficient = 0.32%/°C

Therefore, in V/°C the V_{oc} temperature coefficient = -0.32V/100 per degree C x 37.7V
= -0.121V/°C

Based on the minimum temperature of 15°C then the:
Increase in V_{oc} due to temperature = -10°C times the voltage temperature coefficient (V/°C).
= -10°C x -0.121V/°C
= 1.21V/°C

So the effective maximum V_{oc} of the module due to temperature = 37.7V + 1.21V = 38.91V for each module in the string.

(For countries that use °F, use the supplied conversion table (Appendix 1) to convert the minimum temperature in °F to °C then proceed as in the above example)

The maximum V_{oc} of the string is then calculated by multiplying the maximum V_{oc} of one module by the number of the modules in the string. Thus in the example above, if there are 4 modules in a string, the maximum V_{oc} of the string will be 4 x 38.91V = 155.64 V dc.

If the temperature coefficients are not available and the array uses monocrystalline or polycrystalline modules, the PV array maximum voltage can be estimated by using Table 2 that contains the temperature ranges and multiplication factors to correct the voltage. (Note: this table does not apply if the modules are thin-film types, the voltage/temperature coefficient for the specific thin-film modules in use should be obtained from the module manufacturer).

Table 2: Voltage correction factors for monocrystalline and polycrystalline silicon PV modules

Lowest expected operating temperature (degrees Celsius)	Correction factor	Lowest expected operating temperature (degrees Fahrenheit)
24 to 20	1.02	76 to 68
19 to 15	1.04	67 to 59
14 to 10	1.06	58 to 50
9 to 5	1.08	49 to 41
4 to 0	1.10	40 to 32
-1 to -5	1.12	31 to 23
-6 to -10	1.14	22 to 14
-11 to -15	1.16	13 to 5
-16 to -20	1.18	4 to -4
-21 to -25	1.20	-5 to -13
-26 to -30	1.21	-14 to -22
-31 to -35	1.23	-23 to -31
-36 to -40	1.25	-32 to -40

Note: this table does not apply if the modules are thin-film types, the voltages/temperature coefficient for the specific thin-film modules in use should be obtained from the module manufacturer.

5.3 Orientation and Tilt

In off-grid PV systems the solar array is generally mounted:

- on an array frame that is tilted to fix the array at a preferred angle (usually used for flat roofs or for ground mounted), or
- "flat" on the roof so it is parallel to the slope of the roof but raised off the roof, or
- on a pole mounted system separate from the house, or
- ground mounted if it is a large system.

Although the maximum output would be obtained using an array frame that it tilted to fix the array at the optimum angle, because of concerns about wind loadings due to cyclones, the arrays can be mounted parallel to the roof.

For best year-round performance a fixed PV array typically should be mounted facing true north (± 10°) in the South Pacific and true south (± 10°) in the North Pacific at an inclination equal to the latitude angle or at an angle that will produce the best annual average performance taking into consideration: seasonal cloud patterns, local shading and other environmental factors. In the tropics this may vary due to the sun being in the north half of the sky part of the year and in the south half part of the year.

Between latitudes 10° South and 10° North the array should be tilted at a minimum of 10 degrees. If the array is “flat” on the roof (that is parallel to the slope of the roof) or integrated into the building, the array will often not be at the preferred (optimum) tilt angle and in many situations will not be facing due north or due south; however, the effect on energy output due to installations not being at the optimum tilt and orientation is usually small for installations in the tropics.

In the design guideline, a design month was selected based on the relationship between the energy usage and the available solar irradiation. Ideally the array should be tilted at an angle that is best for this design month but this might not always be possible.

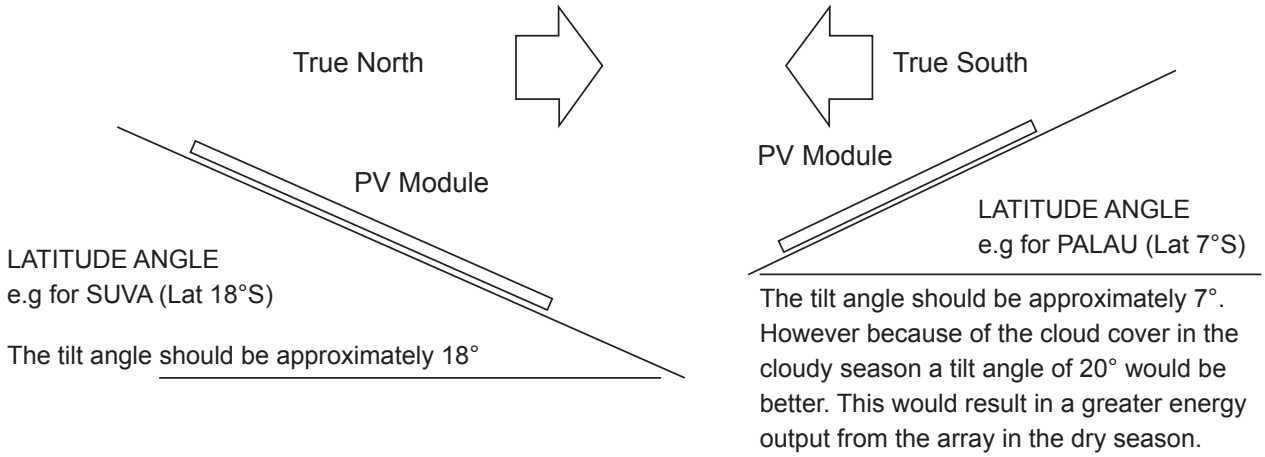


Figure 4: Examples of Tilt Angles

Included with the design guide (Appendix 2) is a set of tables for the following locations:

- Alofi, Niue (Latitude 19°04'S, Longitude 169°55'W)
- Apia, Samoa (Latitude 13°50'S, Longitude 171°46'W)
- Hagåtña, Guam (Latitude 13°28'N, Longitude 144°45'E)
- Honiara, Solomon Islands (Latitude 09°27'S, Longitude 159°57'E)
- Koror, Palau (Latitude 7°20'N, Longitude 134°28'E)
- Lae, Papua New Guinea (Latitude 6°44'S, Longitude 147°00'E)
- Majuro, Marshall Islands (Latitude 7°12'N, Longitude 171°06'E)
- Nauru (Latitude 0°32'S, Longitude 166°56'E)
- Nouméa, New Caledonia (Latitude 22°16'S, Longitude 166°27'E)
- Nuku’alofa, Tonga (Latitude 21°08'S, Longitude 175°12'W)
- Pago Pago, American Samoa (Latitude 14°16'S, Longitude: 170°42'W)
- Palikir, Pohnpei FSM (Latitude 6°54'N, Longitude 158°13'E)
- Port Moresby, Papua New Guinea (Latitude 9°29'S, Longitude 147°9'E)
- Port Vila, Vanuatu (Latitude 17°44'S, Longitude 168°19'E)
- Rarotonga, Cook Islands (Latitude 21°12'S, Longitude 159°47'W)
- Suva, Fiji (Latitude 18°08'S, Longitude 178°25'E)
- Tarawa, Kiribati (Latitude 1°28'N, Longitude 173°2'E)
- Vaiaku, Tuvalu (Latitude 8°31'S, Longitude 179°13'E)

These tables show the average daily total irradiation for each month of the year for: surface at horizontal, a surface tilted at latitude and for a surface tilted at latitude plus 15 degrees.

When the roof is not oriented true north (southern hemisphere) or true south (northern hemisphere) and/or not at the optimum inclination, the output from the array will generally be less than the maximum possible though local conditions may cause some variations in that rule.

Appendix 3 of the design guideline provides tables that show the variation in irradiation due to different tilts and azimuths from the optimums as shown for the locations listed in Table 3. The tables show the average daily total irradiation represented as a percentage of the maximum value i.e. PV orientation is true North (azimuth = 0°) in the Southern Hemisphere or true South in the Northern Hemisphere (azimuth = 180°) with an array tilt angle equal to the latitude angle or 10° whichever is greater[1]. If the location for the system you are designing is not shown it is recommended that you use the site with the latitude closest to your location.

Table 3: Sites for Orientation and Tilt Tables in Appendix 3 of Design Guideline

N°	Site	Latitude	Longitude
1	Nauru	0°32' South	166°56' East
2	Vaiaku, Tuvalu	8°31' South	179°13' East
3	Apia, Samoa	13°50' South	171°46' West
4	Suva, Fiji	18°08' South	178°25' East
5	Tongatapu, Tonga	21°08' South	175°12' West
6	Palikir, Pohnpei FSM	6°54' North	158°13' East
7	Hagåtña, Guam	13°28' North	144°45' East

The tables in Appendix 3 provide values for an array mounted in 36 orientations (azimuths) and 10 inclination (tilt) angles in increments of 10°.

Using these tables will provide the system installer with information on the expected output of a system (with respect to the maximum possible output) when it is located on a surface that is not facing true north (or south) or at an inclination not equal to the latitude angle. The designer can then use the peak sun hour data for the site to determine the expected peak sun hours of sun falling on the array at the actual orientation and tilt angle for the system to be installed. Note that in the case of arrays that are mounted on several roofs at different orientations and tilts, each roof must have the solar input calculated separately as the kWh per individual roof then all the kWh that result can be added together to get the total from all the modules in the installation.

[1] *It is not advisable to mount panels at a tilt angle less than 10° since panels need to be self-cleaned by the rapid run-off of rain.*

5.4 Roof Mounting PV on an Existing Building

- If the modules use crystalline cells, then it is preferable to allow sufficient space below the array (> 50mm or 2 inches) for cooling by natural ventilation. Insufficient cooling will result in high module operating temperatures and lower outputs from the modules.
- It is important to allow sufficient clearance to facilitate self-cleaning of the roof to prevent the build-up of leaves and other debris.
- If fauna (e.g. rats) are a problem in the vicinity of the installation, then consideration should be given as to how to prevent them gaining access to the cables (see cable protection).
- The array structures shall be designed to withstand the aggressively salty atmosphere.
- All array supports, brackets, screws and other metal parts shall be of low-corrosion materials suitable for the lifetime and duty of the system and use materials that do not increase their rates of corrosion when mounted together in an array or when mounted on the surface of the underlying structure. This may include techniques to minimise corrosion rates appropriate to the local environment, including but not restricted to methods such as: inserting non-reactive separators between metal surfaces and under screw and bolt heads and selection of materials with an appropriate type and thickness of anti-corrosive coating.
- Where timber is used it must be suitable for long-term external use and fixed so that trapped moisture cannot cause corrosion of the roof and/or rotting of the timber. The expected replacement time should be stated in the system documentation.
- Any roof penetrations must be suitably sealed and remain waterproof for the expected life of the system. If this is not possible then this must be detailed in the Maintenance Timetable
- If the roof uses tiles, tiles shall sit flat after the installation of tile mounting brackets to ensure the tiles maintain their original water ingress protection. There may be a requirement to grind some of the underside of the tile to enable it to sit correctly.
- For metal roofs the array frame structure should be attached to the roof using brackets that are screwed through the ridges of the roof into a purlin or rafter below.
- All fixings must ensure structural security when subject to the highest wind speeds likely in the region and nearby areas - This may require specific tests of the fixing/substrate combination on that roof. Those countries that have experienced Category 5 cyclones/typhoons in the past shall have the frames and module attachments designed to meet the wind speeds expected in a Category 5 cyclone/typhoon.
- The installer shall ensure that the array frame that they install has applicable engineering certificates verifying that the frame meets wind loadings appropriate for that particular location.
- The installer must follow the array frame suppliers/manufacturers recommendations when mounting the array to the roof support structure to ensure that the array structure still meets the wind loading certification. The installer shall also consider the following:
    - Area of roof applicable for modules to be installed
    - Type, length and gauge of screws to be used
    - Number of screws required per attachment.
    - Size of batten/purlin required per attachment.
- If necessary, refer to the roof manufacturer's guidelines to ensure that the materials introduced by the installation of PV array frame are compatible with the roofing material.

5.5 Free Standing PV Arrays

- The array mounting frames must be wind rated in accordance with relevant wind loading standards. For those countries which have experienced Category 3 to Category 5 cyclones typhoons, the frames shall be designed to remain intact in the wind speeds expected in a Category 5 cyclone/typhoon.
- The array structures shall be designed to withstand the aggressively salty atmosphere.
- Installation of footings, posts, screws and/or in-ground fasteners shall follow manufacturer's instructions and installation manuals.

5.6 Attaching Modules to Array Mounting Structure

- Solar modules should be attached to the array structure either using the mounting holes provided by the manufacturer or via clamps that are suitable for the maximum wind at the site.
- The mounting of the PV modules should allow for the expansion and contraction of the PV modules under expected operating conditions.
- Where modules are installed in such way that a junction box is to the side or at the bottom, care must be taken to ensure this is permitted by the manufacturer.
- When using clamps, the solar module manufacturer's installation instructions shall be followed. The installer shall consider the following:
    - amount of overhang allowed from clamp to end of module
    - size of clamp required

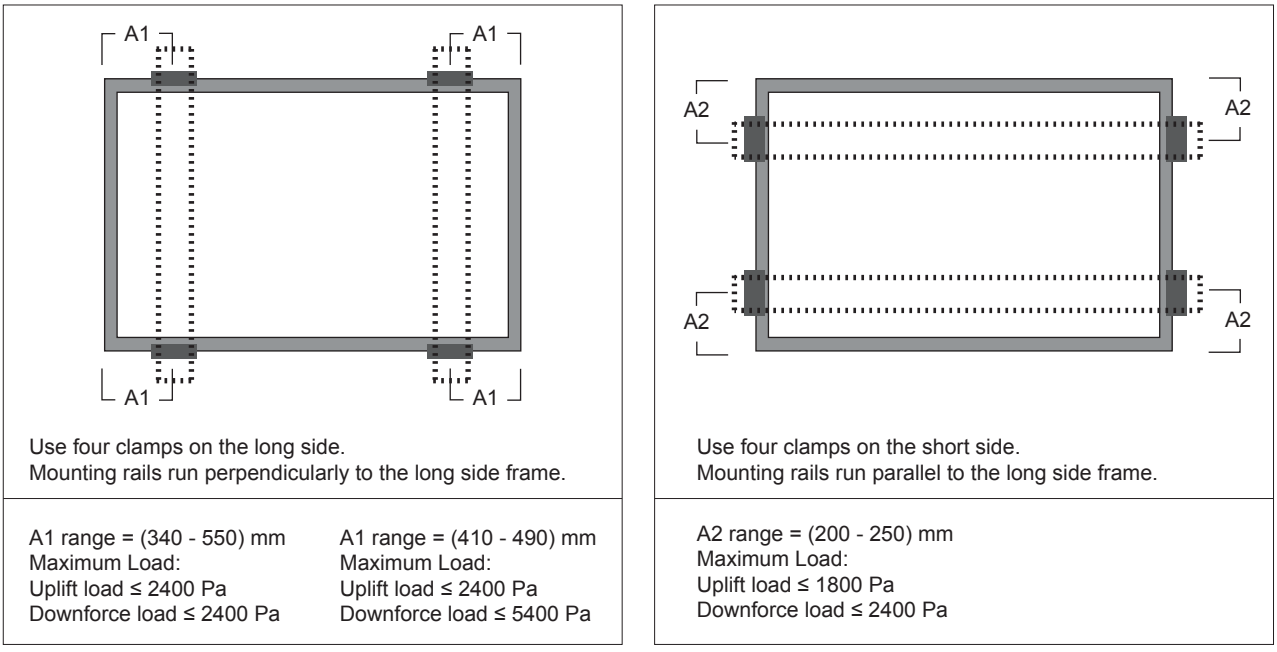


Figure 5: Example of Array Clamps (Source: Canadian Solar)

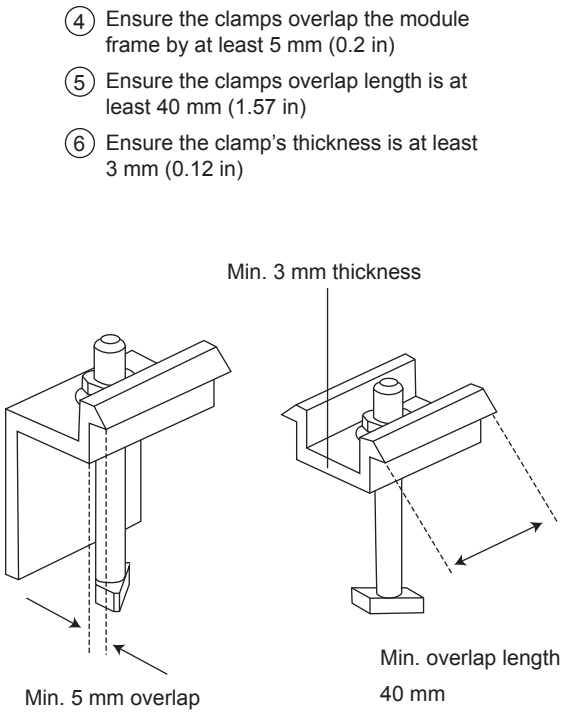


Figure 6: Module Clamps (Source: Canadian Solar)

Note: Attaching a solar module in such a manner that creates a hole in the anodised aluminium frame of the solar module (e.g. drilling, pop riveting) typically voids the manufacturer's product warranty with respect to defects in material and workmanship. If the installer intends to undertake an installation in this manner, they shall obtain written verification from the manufacturer that it does not affect the warranty. This shall be included in the system documentation supplied to the customer.

What clamps should be used in countries that experience Cyclones/Typhoons?
In the last few years in countries that experience category 3 plus cyclones/typhoons there have been a number of failures of dual module clamps due to cyclones which have resulted in a "zipper" effect where by one clamped module comes loose due to wind causing the clamp to vibrate and undergo stress. Then the rest of the modules in that string also come loose since the loss of the module on one side of the dual clamp loosens the clamping force on the module on the other side of the clamp and so on down the string.

Therefore, it is important that the array frame selected has been designed to be suitable for installation to with stand Category 5 cyclones. Array frames that are designed for winds experienced in Category 5 cyclones typically have mid-clamps longer than 50 mm (2 inches) in length and there can be as many as 3 railings per module. In a large system, consideration shall be given to using an end clamp for every fourth module so if one does become loose then only a few other modules would be affected, not necessarily the whole array.

6. Battery Installation

- The battery/batteries must be installed in a dedicated battery room or an enclosure.
- The location and/or enclosure selected must ensure that mechanical protection is guaranteed and access to the batteries is restricted to those people who are authorised to be in proximity to the batteries.
- Sufficient space should be available within the enclosure to allow for ease of battery installation and maintenance, and no metal objects should be in the vicinity such that one could fall across battery terminals and cause a short circuit.
- For large battery banks containing multiple batteries it is recommended that, if possible, the battery enclosure should not be located within an occupied building and the ideal location is within a building (e.g. shed) that is separated from the residence or other occupied building.
- If the battery enclosure is mounted outside, then those batteries that emit explosive fumes should be vented only to the outside.
- If the battery enclosure is a dedicated room and part of an occupied building, then the access should be from the outside and for batteries that emit explosive fumes (e.g. open-cell lead-acid type batteries) the internal walls should not have any vents/penetrations to the inside of the house and there must be venting to the outside.
- Explosive and/or corrosive gas-emitting battery systems should not be located within 500 mm (20 inches) horizontally of any other equipment from 100 mm (4 inches) below the battery terminals (Figure 7), except where there is a solid separation barrier (Figure 8).
- No electrical equipment shall be mounted above explosive and/or corrosive gas emitting batteries.
- No metal devices shall be installed above a battery that could fall onto the batteries.
- The location where the batteries are installed should be dry.
- Batteries must be raised off the ground or concrete floor. If left on the ground, the lower sections of the batteries will adopt the temperature of the ground, which is generally lower than the ambient temperature adopted by the upper sections of the battery systems. With certain chemical based battery systems, this can lead to stratification of the electrolyte and premature failure.
- Luminaires should not be installed directly above or within 200 mm (8 inches) of any battery.
- The enclosure should not be located in direct sunlight and should be in a location that keeps the batteries as cool as possible.
- Adequate ventilation should be available to assist in temperature control and if necessary, to avoid the build-up of hydrogen or other gases associated with charging. The outlet ventilation must be to the outside of the building in which the battery system is located.
- Batteries are typically heavy and the area under the batteries shall be capable of bearing the weight of the batteries without distortion.
- Guard against electrolyte spillage for those battery system types containing liquid chemicals. The material used for the construction of the enclosure should resist the electrolyte specific corrosive effects or be painted with a corrosion resistant paint.
- Ideally any electrolyte spillage should be contained within the enclosure or room.

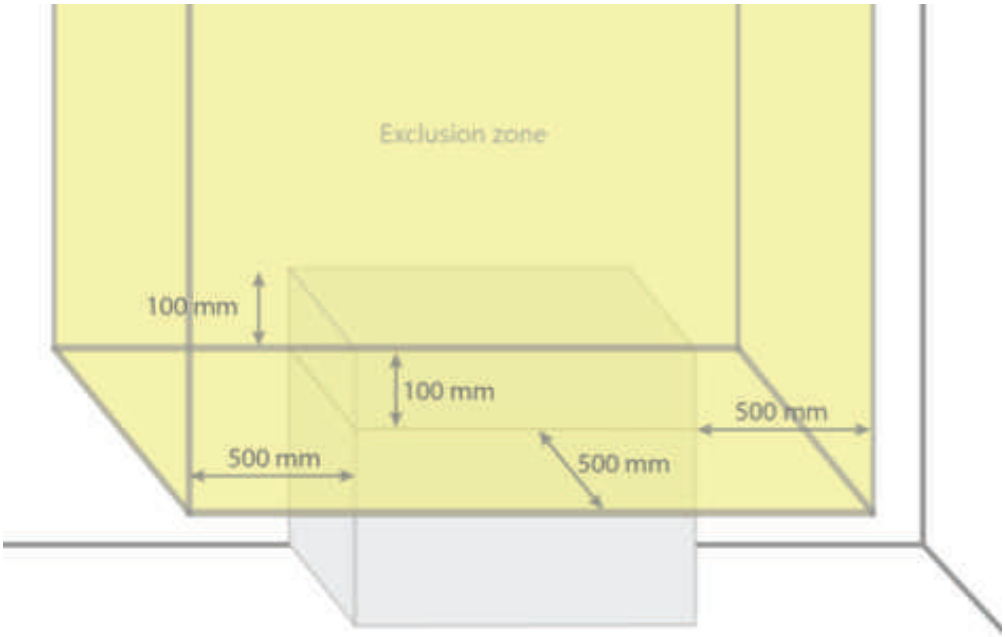


Figure 7: Exclusion zone for equipment located near a battery system (assuming battery terminals are on top surface)

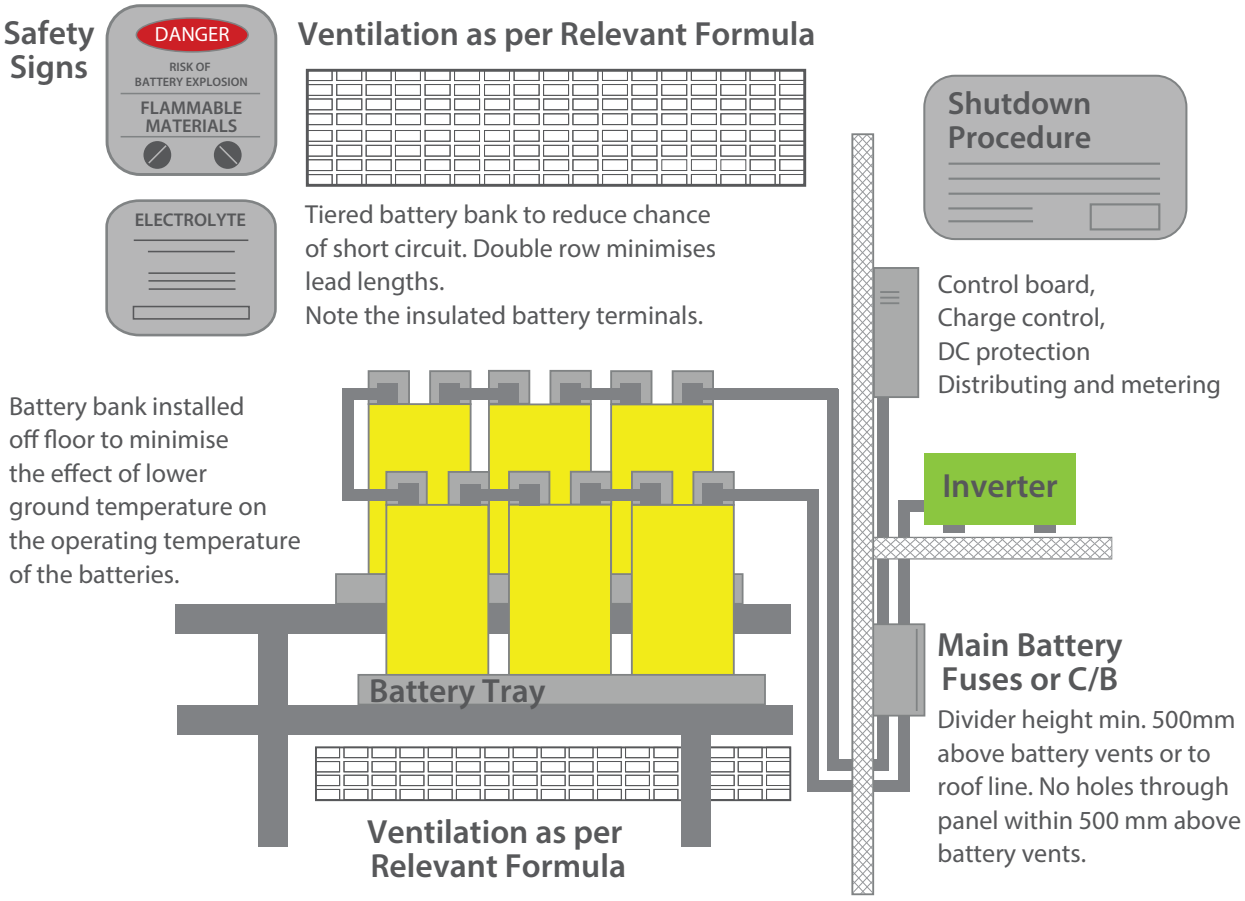


Figure 8: Example of Battery Room Layout with divided Wall

7. Ventilation Requirements

- Battery types that can emit explosive gases shall be installed in enclosures (rooms) with sufficient ventilation to prevent the build-up of explosive gases generated when the battery is being charged.
- Best practice is to provide the input ventilation vents on an outside wall below the level of battery and the output vents on an outside wall on the opposite side of the batteries as high as possible in the enclosure to prevent hydrogen build up (as shown in Figure 9).

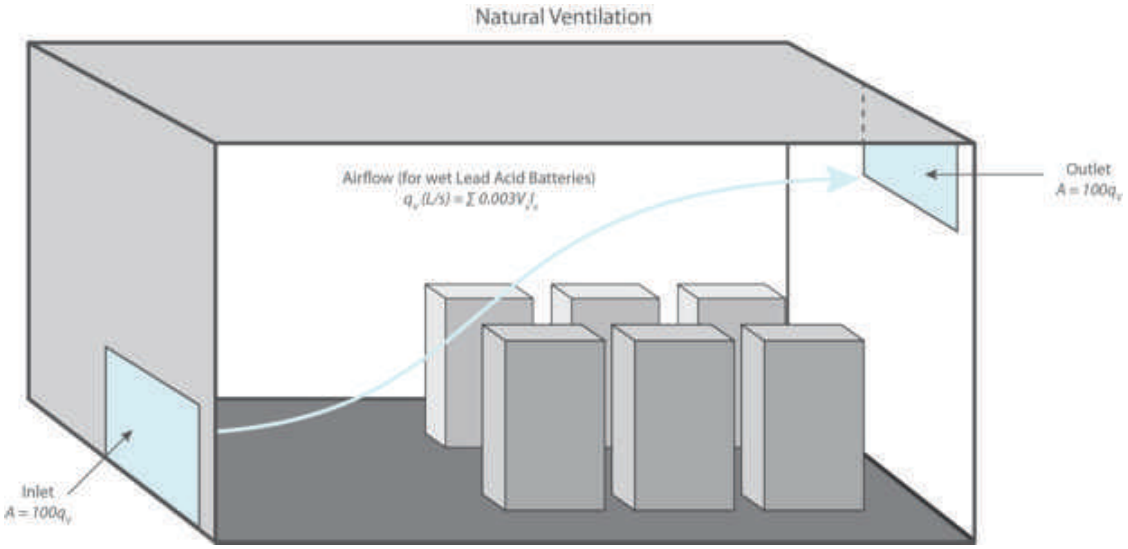


Figure 9: Natural ventilation arrangement for battery systems

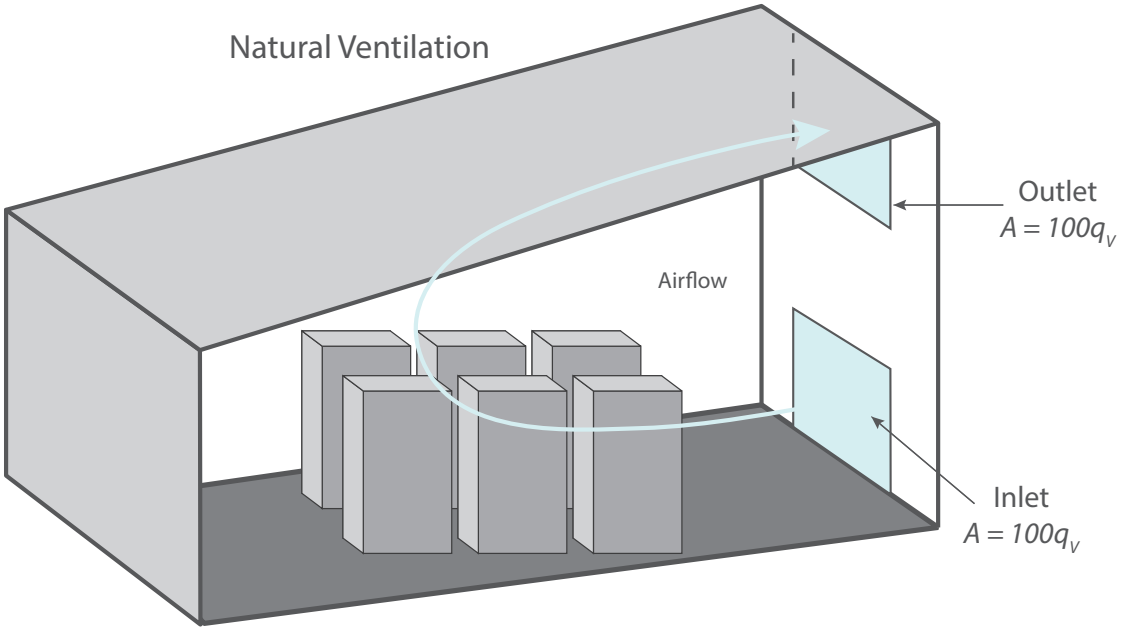


Figure 10: Natural ventilation arrangement for battery systems with vents on one side

7.1 Determining Size of Vents (Metric)

The minimum area required for natural ventilation for both inlet and outlet apertures (for lead acid batteries) are given by:

$$A = 100 \times q_v \text{ cm}^2$$

Where q_v is the minimum exhaust ventilation rate in litres per second = $0.006 \times n \times I$

and n = the number of battery cells

I = the charging rate in amperes

Note: The charging rate in amperes is the maximum output rating of the largest charging source or the rating of its output fuse or circuit breaker. Where two parallel battery banks are used, the charging rate is halved.

7.2 Determining Size of Vents (Imperial)

The minimum area required for natural ventilation for both inlet and outlet apertures (for lead-acid batteries) are given by:

$$A = 15.5 \times q_v \text{ in}^2$$

Where q_v is the minimum exhaust ventilation rate in litres per second = $0.006 \times n \times I$

and n = the number of battery cells

I = the charging rate in amperes

Note: The charging rate in amperes is the maximum output rating of the largest charging source or the rating of its output fuse or circuit breaker. Where two parallel battery banks are used, the charging rate is halved.

7.3 Ventilation for Valve Regulated (Sealed) Batteries

The charging rate I in the ventilation formula is 0.5A per 100Ah at the 3 hour rate (C_3) of discharge of battery capacity for lead-acid batteries.

e.g. battery has C_3 rating of 500Ah therefore the charge current used in ventilation formula is
I = (500Ah/100Ah) x 0.5A = 2.5A

Note: This is based on the charger (either a solar controller in dc bus systems or a battery inverter for ac bus systems) having an automatic overvoltage cut-off. If not, the maximum charge current must be used in the formula.

8. Solar Controller Installation

- The solar controller shall be installed as to the manufacturer`s instructions
- Installation of solar controllers (either switching controllers or MPPTs) should be near batteries or at a convenient monitoring location as close as practical to the batteries.
- For a solar controller not located near batteries, it will be necessary to use a model that has a separate battery voltage sensor connected at the battery terminals to allow for voltage drop in the cables that could cause improper charging if the voltage is measured at the controller instead of at the battery.
- Never install controllers on top or above the enclosure of batteries that emit explosive gases, or near the ventilation vents.
- Solar controllers dissipate heat, there must be sufficient ventilation for these sensitive pieces of equipment. Always follow the manufacturer's recommendations for installation, ventilation and clearances around controller heat sinks.
- If a solar controller is installed outside, the controller should have an IP rating of at least IP56. Due to the humidity and high salt environment in the Pacific region it is recommended that all controllers should have this IP rating or higher.
- Solar controllers are not to be installed in direct sunlight.

8.1 MPPT Earth Fault Indication

- Where the PV array maximum voltage is greater than ELV (DVC-C) an earth fault system shall be installed.
- The alarm system may be an audible signal, indicator light or another form of fault communication, e.g. fax, email, SMS. The fault indication shall be installed in a way that it will make the system owner aware of the fault and initiate an action to correct an earth fault.

9. PV Inverter Installation

- The PV inverter shall be installed as to the manufacturer`s instructions.
- The PV inverters shall be installed in a location that is appropriate for the IP rating of the PV inverter. Where this is not possible then the PV inverter/s should be in an appropriate weatherproof enclosure that has adequate ventilation.
- If a PV inverter is installed outside, the PV inverter should have an IP rating of at least IP56. Due to the humidity and high salt environment in the Pacific region it is recommended that all PV inverter should have this IP rating or higher.
- PV inverters are not to be installed in direct sunlight.
- The PV inverter shall be installed with recommended clearances around the PV inverter as specified by the manufacturer.
- PV Inverters should be installed in dust free locations.
- PV inverters can be heavy; it is important that the surface on which the PV inverters will be mounted is appropriately weight-bearing.
- The PV inverter heat sink shall be clear of any obstacles that may interfere with cooling of the PV inverter.
- Cables connected to the inverter shall be mechanically secured in such a manner that they cannot be inadvertently unplugged from the inverter. This can be achieved by:

- Having the inverter housed in an enclosure (with cables suitably supported).
- The use of an inverter which has the cable connection area of inverter covered by a removable enclosure/cover which protects the supported cables so that there are no exposed, unsupported cable loops.
- The use of conduit and secure wall fixings:
  Where the inverter requires dc connectors to be used, a maximum allowable distance of no more than 200mm (8 inches) of unprotected dc cable shall be permitted between connectors and conduit provided the location is not subject to mechanical damage.

- Where the inverter is exposed to the weather there shall be no open ends of conduit. If a cable is required to exit from a conduit, an appropriate cable gland shall be installed on the end of the conduit to ensure the IP rating is maintained.

9.1 Inverter Earth Fault Indication

- Where the PV array maximum voltage is greater than ELV (DVC-C) an earth fault system shall be installed.
- The alarm system may be an audible signal, indicator light or another form of fault communication, e.g. fax, email, SMS. The fault indication shall be installed in a way that it will make the system owner aware of the fault and initiate an action to correct an earth fault.

9.2 Ground Fault Protection (countries following NEC requirements)

NEC 2017 (690.41) introduced the requirement that PV array shall be with dc ground-fault protection meeting

- The ground fault protective device (GFPD) or system shall detect ground fault(s) in the PV array dc current–carrying conductors and components.
- The circuit with the ground fault shall be interrupted by either:
  - The GFPD disconnecting the conductor with the fault, or
  - The Inverter connected to the conductor with the fault stops providing any output power.

Exception: PV arrays with not more than two PV source circuits and with all PV system dc circuits not on or in buildings shall be permitted without ground-fault protection.

10. Battery Inverter Installation

- Non-separated (i.e. transformerless) battery inverters should not be used if the output of the inverter is going to be hard wired to a switchboard.
- Non-separated inverters should have loads directly connected via a plug to the ac output via the power outlet located on the inverter.
- The battery inverter should be installed as close as possible to the battery system to minimise voltage drop.
- If the battery inverter is installed outside, the battery inverter should have at least an IP rating of at least IP56. Due to the humidity and high salt environment in the Pacific region it is recommended that all PV inverter should have this IP rating or higher.
- Battery inverters are not to be installed in direct sunlight.
- The battery inverter shall be installed with recommended clearances around the battery inverter as specified by the manufacturer.
- Battery inverters should be installed in dust free locations;
- Battery inverters can be heavy, it is important that the surface on which the PV inverters will be mounted is appropriately weight-bearing.
- The battery inverter heat sink shall be clear of any obstacles that hamper cooling of the battery inverter.

11. Safe Installation Practice

A dangerous situation occurs when the person installing the system is able to come in contact with the positive and negative outputs of the solar array or sub-array when the output voltage is rated DVC-C (that is greater than 120V dc). This could occur with dc bus systems using MPPTs as the controller or with ac bus systems using PV inverters.

Most systems use approved solar modules which are connected using double insulated leads with polarised shrouded plug and socket connections.

For ac bus systems or dc bus systems using MPPTs, a dangerous situation is only likely to occur at:

- the PV Array switch-disconnector (isolator) before the PV inverter or MPPT;
  AND
- the sub-array and array combiner boxes (if used).

To prevent the possibility of an installer coming in contact with live wires it is recommended practice that one of the interconnect cables of each string (as shown in Figure 11) is left disconnected until all the wiring is complete between the array and the inverter. Only after all switch-disconnectors and other hard wired connections are completed should the interconnect cable of the array be connected.

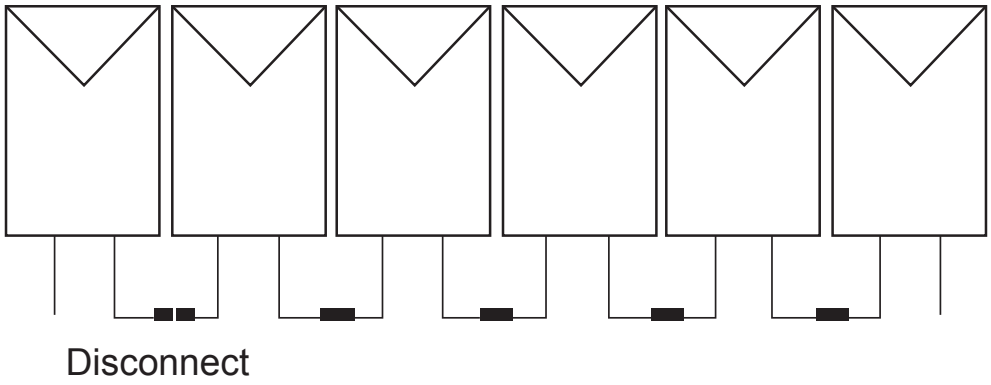


Figure 11: Disconnected interconnect cable

The installer shall ensure that all connectors used are waterproof and connected securely to avoid the possibility of a loose connection. Only connectors of the same type from the same manufacturer are allowed to be mated at a connection point.

When mounted on a roof, the solar module interconnect cables must be supported clear of the roof surface to prevent debris build up or damage to insulation.

12. PV Array Wiring

12.1 Selection of dc Cable for PV Array

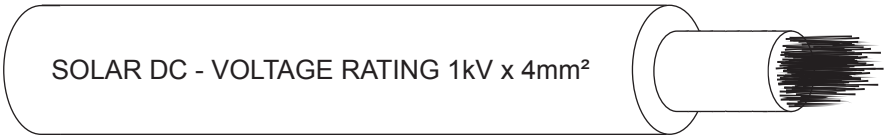


Figure 12: Double insulated solar DC cable

Cables used within the PV array wiring shall:

- Be suitable for dc applications.
- Have a voltage rating equal to or greater than the PV array maximum voltage determined in Section 5.2.
- Have a temperature rating appropriate to the application.
- If exposed to salt environments, used tinned copper, multi-stranded conductors to reduce degradation of the cable over time due to corrosion.
- Be water resistant.
- In all systems operating at voltages above DVC-A, cables shall be selected so as to minimise the risk of earth faults and short-circuits. This is commonly achieved using reinforced or double-insulated cables, particularly for cables that are exposed or laid in a metallic tray or metal conduit.
- It is recommended that string cables be sufficiently flexible to allow for thermal/wind movement of arrays/modules.
- For PV arrays that operate at voltages above DVC-A, cables should comply with PV1-F requirements or UL 4703 or VDE-AR-E-2283-4.

Note: PV1-F cable requirements may be found in the document TUV 2 PfG 1169/08.2007.
Correctly sized cables in an installation will produce the following outcomes:

- No excessive voltage drops (which equates to an equivalent power loss) in the cables.
- The current in the cables will not exceed the safe current handling capability of the selected cables [known as current carrying capacity (CCC)]

12.2 Installation of the PV Array Wiring

- Plastic cable ties are not to be used as the primary means of support.
- Cables shall not lie on roofs or the ground without an enclosure or conduit.
- Cables shall be protected from mechanical damage. Where the presence of fauna (e.g. rats) is expected to constitute a hazard, either the wiring system shall be selected accordingly, or special protective measures shall be adopted.
- All external wiring must be protected from UV either by using UV rated cables or installing the cables in enclosures/conduit.
- All conduits exposed to direct sunlight shall be suitably UV rated.
- The installer shall ensure that all cable connectors used are waterproof and connected securely to avoid the possibility of a loose connection.
- Only cable connectors that are the same type/model and from the same manufacturer are allowed to be mated at a connection point.
- It is recommended that under maximum solar current, the voltage drop from the most remote module in the array to the input of the solar controller or PV inverter should not exceed 3% of the V_{mp} voltage (at STC) for LV PV arrays.

12.3 Wiring Loops

- Cables need to be laid in parallel close together to avoid wiring loops which could cause damaging high voltage surges to the controller or inverter if there are nearby lightning strikes. Figures 13, 14 and 15 give examples on how a conductive wiring loop can be avoided while Figure 16 shows a wiring arrangement that will cause a conductive loop and should not be used. For minimizing lightning generated voltage surges, the positive and the negative wires should always be run together.

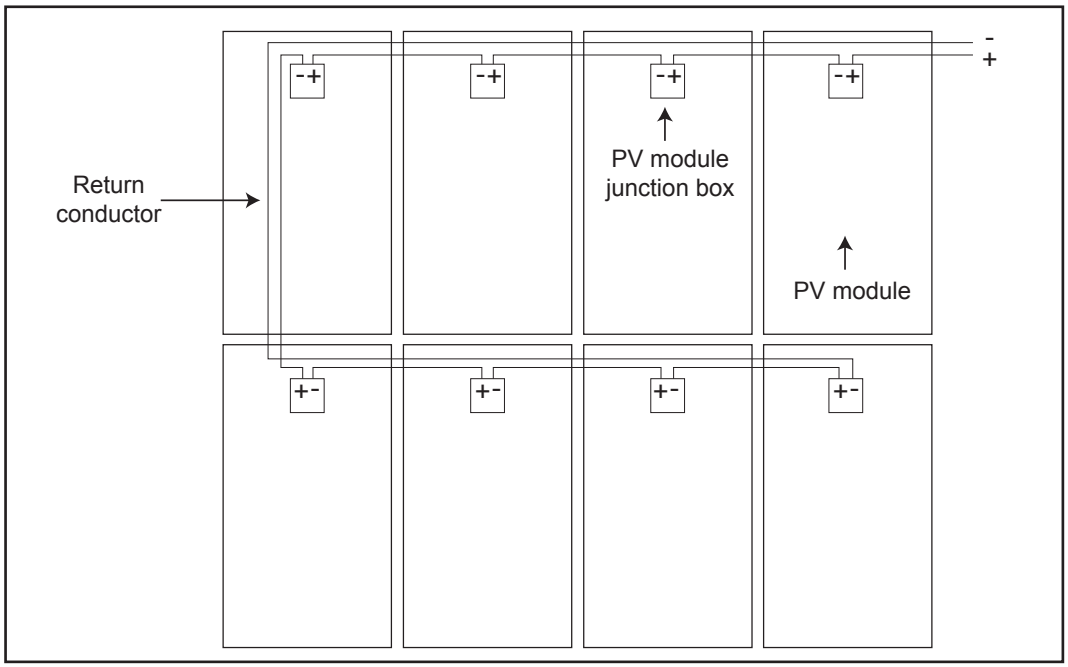


Figure 13: Example of Wiring to avoid Conductive Loops

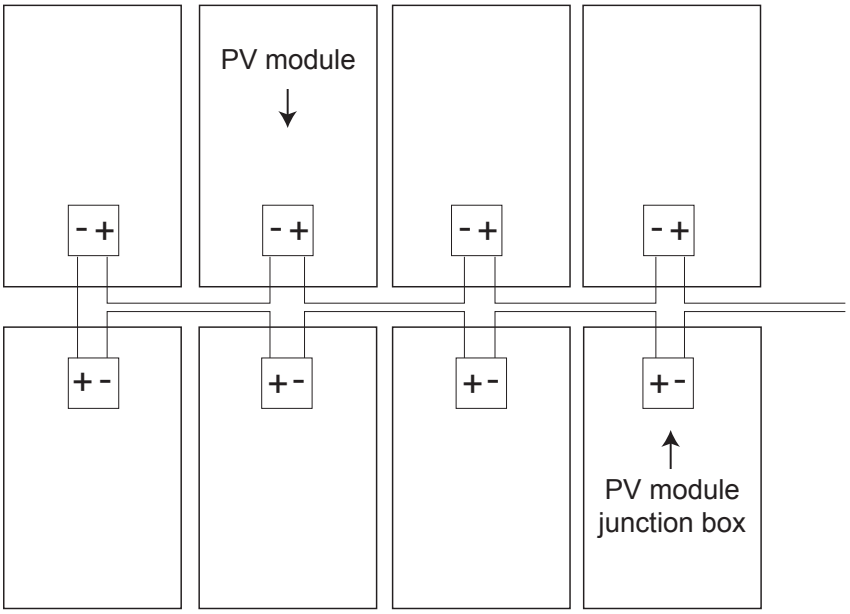


Figure 14: Example of Wiring to avoid Conductive Loops

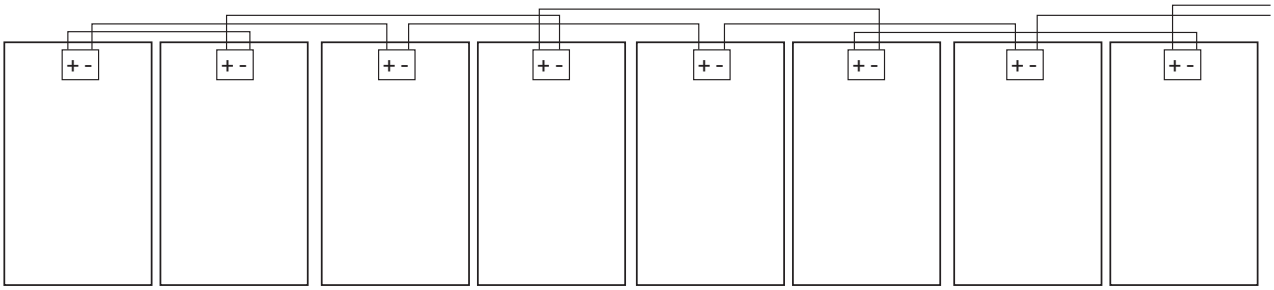


Figure 15: Example of Wiring to avoid Conductive Loops

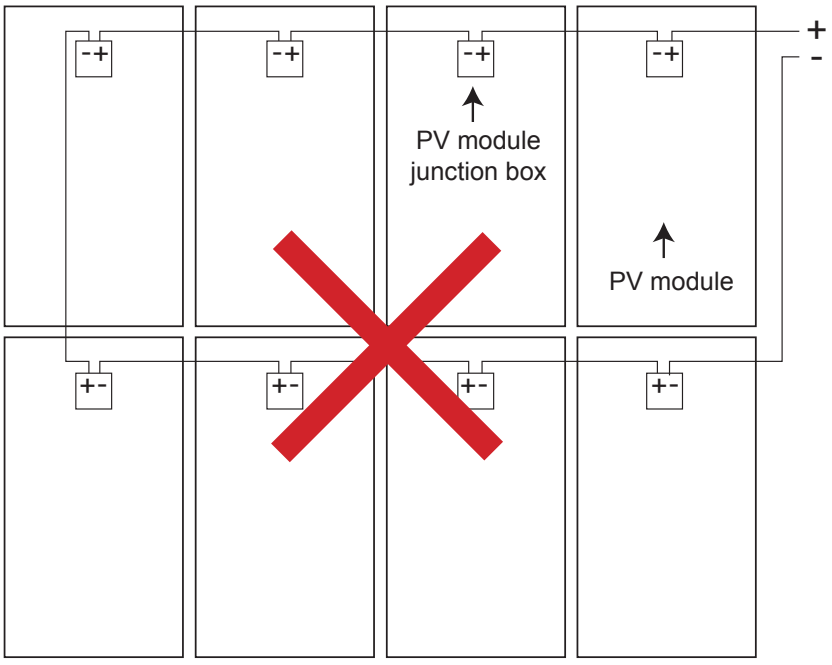


Figure 16: Example of Wiring to be avoided because it includes Conductive Loops

12.4 Selection of Current Carrying Capacity of PV String Cables

- If a fault current protection device is located in the string cable, the string cable must have a rating equal to or greater than the current rating of the fault current protection device. For example, if the fault current protection device is rated at 8A, the string will need to be rated with a current carrying capacity (CCC) of a minimum of 8A.
- If no fault current protection is provided, the current carrying capacity (CCC) of the string cable will be rated according to:

$$CCC \geq 1.25 \times I_{SC\ MOD} \times (\text{Number of parallel connected Strings} - 1) + I_n$$

Where:

$I_{SC\ MOD}$ = short circuit current of PV module

I_n = is the current rating of the nearest downstream overcurrent protection device.

12.5 Selection of Current Carrying Capacity of PV Array Cables

- If a fault current protection device is located in the array cable, the array cable must have a current rating equal to or greater than the current rating of the fault current protection device.
- If no fault current protection device has been included, the current carrying capacity of the PV array cable will be rated according to:

$$CCC \geq 1.25 \times I_{SC\ ARRAY}$$

Where:

$I_{SC\ ARRAY}$ = sum of short circuit currents of all the strings in the array

12.6 Selection of Cables when Array Comprises Sub-Array PV Systems

12.6.1 PV Array Cables

- In a large grid connected PV system the array could consist of a number of sub-arrays. A sub-array comprises a number of parallel strings of PV modules. The sub-array is installed in parallel with other sub-arrays to form the full array. The effect of this is to decrease the potential fault current through different parts of the system.
- If a fault current protection device is located in the array cable, the array cable must have a rating equal to or greater than the current rating of the fault current protection device. Note for dc bus off-grid systems array protection will be required.
- If no fault current protection device has been included (mainly in ac bus system configurations), the current carrying capacity of the PV array cable will be rated according to:

$$CCC \geq 1.25 \times I_{SC\ ARRAY}$$

Where:

$I_{SC\ ARRAY}$ = sum of short circuit currents of all the sub-arrays in the array

12.6.2 PV Sub-Array Cables

- If a fault current protection device is located in the array cable, the sub-array cable must have a current rating equal to or greater than the current rating of the fault current protection device.
- If no fault current protection device has been included, the current carrying capacity of the PV sub-array cable will be rated according to:

$$CCC \geq 1.25 \times I_{SC\ SUB\text{-}ARRAY} + I_n$$

Where:

$I_{SC\ SUB\text{-}ARRAY}$ = sum of short circuit currents of all the other sub-arrays

I_n = current rating of the nearest downstream overcurrent protection device.

12.6.3 PV String Cables

- If sub-array fault current protection is used, the current carrying capacity of the string cable will be the rated trip current of the sub-array fault current device plus the fault current of the other strings in the sub-array:

$$CCC \geq I_{TRIP\_SUBARRAY} + 1.25 \times I_{SC\ MOD} \times (\text{Number of parallel connected Strings - 1})$$

Where:

$I_{TRIP\_SUBARRAY}$ = the rated trip current of the sub-array fault current protection device

$I_{SC\ MOD}$ = the short circuit current rating of the PV module.

- If no sub-array fault current protection device is used, the current carrying capacity of the string cable will be:

$$CCC \geq 1.25 \times (\text{sum of short circuit currents of all other strings in the array})$$

Note: Refer to Grid Installation Guidelines for some worked examples in determining the current carrying capacity in arrays.

13. Installation of PV Array Cable Between Array and Solar Controller (dc Bus System) or PV Inverter (ac Bus System)

- If the PV array has a rated output voltage greater than 120V dc (DVC-C) the PV array cables within buildings installed in: ceiling spaces, wall cavities, under floors and other hidden locations shall be enclosed in heavy-duty (HD) insulating conduit so that the risk of short-circuit is reduced. In all other locations, it shall be installed in medium-duty conduit as a minimum.
- PV array cables shall be installed in UV-resistant conduits if exposed to the outdoor environment.
- Conduits shall be installed so that they are adequately supported.
- Double insulation of each conductor shall be maintained within wiring enclosures (e.g. conduit).
- The wiring enclosure shall be labelled ‘SOLAR’ on the exterior surface of the enclosure at an interval not exceeding 2 metres.
- Where the PV array cable and conduit passes through a tile or steel roof, an appropriate collar flashing (e.g. Dektite*) shall be installed.
- Installing a conduit just through a hole in a metal roof and sealing with silicone is prohibited.

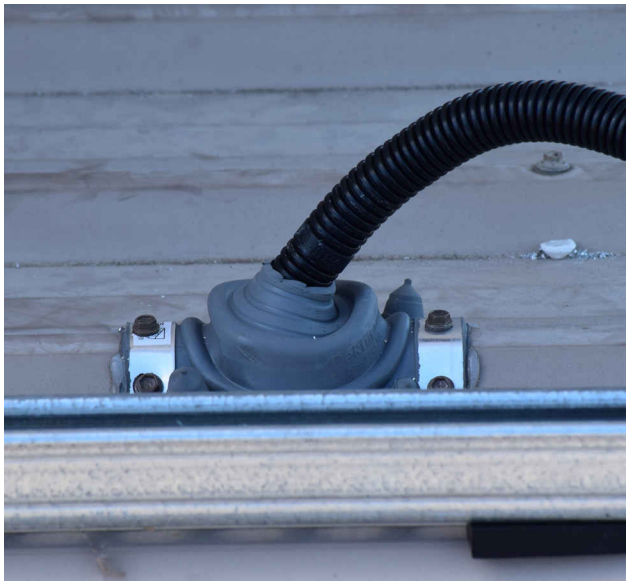


Figure 17: A Dektite* with a metal roof flashing

14. Installation of Cable Between Standard Solar Controller and Battery

- The cables between the standard solar controller and the battery shall have a voltage rating greater than the maximum voltage rating of the battery when being charged.
- The current carrying capacity of the cable between the controller and battery shall be capable of carrying the maximum charge current from the array.
- The current-carrying capacity of the cable between the battery and solar controller shall be based on the dc current rating of the associated over-current protection.
- Any battery cable forming the connection between a battery system terminal and the solar controller, shall be rated to withstand the prospective fault current for a time at least equal to the operating time of the associated over-current protective device
- The dc cables between the solar controller and the battery bank can be single insulated if the battery bank is ELV.
- Cables and conduits shall be installed so that they are adequately supported.
- When using switching controllers, it is recommended that under maximum solar current, the voltage drop from the most remote module in the array to the battery should not exceed 5% of the battery voltage.

15. Installation of Cable Between MPPT Controller and Battery

- If the PV array has a rated output voltage greater than 120V (DVC-C) and the MPPT is not electrically separated between the input and output, the dc cables between the MPPT and the battery bank shall be double insulated and should be in medium duty conduit.
- The cables between a non-separated MPPT and the battery shall have a voltage rating greater than the maximum voltage of the array.
- The cables between a separated MPPT and the battery shall have a voltage rating greater than the maximum voltage of the battery.
- The current carrying capacity of the cable between the controller and battery shall be capable of carrying the maximum charge current from the MPPT.
- The current-carrying capacity of the cable between the battery and MPPT shall be based on the dc current rating of the associated over-current protection.
- Any battery cable forming the connection between a battery system terminal and the MPPT, shall be rated to withstand the prospective fault current for a time at least equal to the operating time of the associated over-current protective device.

16. Installation of Cable Between Battery and Battery Inverter (if applicable)

- For systems using switching type solar controllers, the cable shall have a voltage rating greater than the battery voltage when being charged.
- For systems using a separated MPPT controller, the cable shall have a voltage rating greater than the battery voltage when being charged
- For systems using non-separated MPPT the cable shall have a voltage rating greater than the maximum voltage of the array.
- If the PV array has a rated output voltage greater than 120V (DVC-C) and the solar controller is a non-separated MPPT unit, the dc cables between the battery and the battery inverters shall be double insulated.
- For systems using switching type solar controllers or separated MPPT controllers and the battery bank voltage is ELV, the dc cables between the battery and the battery inverter can be single insulated.
- Any battery system cable forming the connection between a battery system terminal and the inverter, shall be rated to withstand the prospective fault current for a time at least equal to the operating time of the associated over-current protective device.
- The current carrying capacity of the cable between the battery bank and the battery inverter shall be capable of carrying the maximum current based on either the 30 minute power rating of the inverter (if provided) or the continuous power rating of the inverter.
- The current-carrying capacity of the cable between the battery and inverter shall be based on the dc current rating of the associated over-current protection.
- Cables and conduits shall be installed so that they are adequately supported.

17. Voltage Drop

- The voltage drop between the PV array and the battery bank should never exceed 5%
- The voltage drop between the battery bank and any DC load should never exceed 5%
- The voltage drop between the PV array and Solar Controller should never exceed 3% (dc bus)
- The voltage drop between the PV array and PV inverter should never exceed 3% (ac bus)

17.1 Calculating Voltage Drop (Metric) for Systems That Include Switching Type Solar Controllers

This section is for systems that are using standard pulse width modulated (PWM) solar controllers.

Voltage drop is calculated using Ohm's law:

$$V = I \times R$$

Combining this with the formula for calculating resistance, the voltage drop along a cable is given by:

$$V_d = \frac{2 \times L_{CABLE} \times I \times \rho}{A_{CABLE}}$$

Voltage drop (in percentage) = $\frac{V_d}{V_{batt}} \times 100$

Where:

L_{CABLE} = route length of cable in metres (multiplying it by two adjusts for total circuit wire length since a complete circuit requires a wire out and another wire back along the route).

I = current in amperes.

ρ = resistivity of the wire in $\Omega/m/mm^2$

A_{CABLE} = cross sectional area (CSA) of cable in mm^2.

V_{batt} = the nominal voltage of the battery which is the dc system voltage.

For PV arrays connected to a switching type controller, the current is the short circuit current (I_{sc}) of the string, sub-array or array. The battery voltage is the nominal battery voltage of the battery bank.

Worked Example 2

A solar array has been installed and the distance between the output of the array and the solar controller is 10 metres. The short circuit current of the array is 9.6A.
The cable has a cross sectional area of 10 mm^2
The cable is copper with a resistivity of 0.0183 ohms/metres/mm^2
The battery voltage of the system is 12V.

$$V_d = \frac{2 \times L_{CABLE} \times I \times \rho}{A_{CABLE}}$$

= 2 x 10 x 9.6 x 0.0183/10 V
= 0.35V

Voltage Drop in percentage = $\frac{V_d}{V_{batt}} \times 100$

= 0.351/12 × 100
= 2.9%

17.2 Calculating Voltage Drop (Metric) for Systems That Include a MPPT

This section is for systems that are using Maximum Power Point Trackers (MPPT) type solar controllers (dc bus) or a PV inverter that includes an MPPT controller (ac bus).
Voltage drop is calculated using Ohm's law:

$$V = I \times R$$

Combining this with the formula for calculating resistance, the voltage drop along a cable is given by:

$$V_d = \frac{2 \times L_{CABLE} \times I \times \rho}{A_{CABLE}}$$

Voltage drop (in percentage) = $\frac{V_d}{V_{batt}} \times 100$

Where:

L_{CABLE} = route length of cable in metres (multiplying it by two adjusts for total circuit wire length since a complete circuit requires a wire out and another wire back along the route).
I = current in amperes.
ρ = resistivity of the wire in $\Omega/m/mm^2$
A_{CABLE} = cross sectional area (CSA) of cable in mm^2.
V_{MAX} = maximum line voltage in volts

For PV arrays connected to a MPPT type solar controller (dc bus) or PV inverter (ac bus) the current is the short circuit current (I_{sc})of the string, sub-array or array. The maximum line voltage in volts is the maximum power point voltage of the string, sub-array or array (V_{mp}).

Worked Example 3

A solar array has been installed and the distance between the output of the array and the solar controller is 10 metres. The short circuit current of the array is 9.6A.
The cable has a cross sectional area of 4 mm^2
The cable is copper with a resistivity of 0.0183 ohms/metres/mm^2
The array has maximum power point voltage of 154.4V.

$$V_d = \frac{2 \times L_{CABLE} \times I \times \rho}{A_{CABLE}}$$

= 2 x 10 x 9.6 x 0.0183/4 V
= 0.35

Voltage Drop in percentage = $\frac{V_d}{V_{batt}} \times 100$
= 0.88/154.4 x 100
= 0.57%

17.3 Tables Providing Route Lengths for Twin Cable for Various Specified Voltage Drop (Metric)

Table 4: Maximum distance in metres to produce 5% voltage drop (12V system)

Current (A)	1mm^2	1.5mm^2	2.5mm^2	4mm^2	6mm^2	10mm^2	16mm^2
1	16.4	24.6	41	65.6	98.4	163.9	262.3
2	8.2	12.3	20.5	32.8	49.2	82	131.1
3	5.5	8.2	13.7	21.9	32.8	54.6	87.4
4	4.1	6.1	10.2	16.4	24.6	41.0	65.6
5	3.3	4.9	8.2	13.1	19.7	32.8	52.5
6	2.7	4.1	6.8	10.9	16.4	27.3	43.7
7	2.3	3.5	5.9	9.4	14.1	23.4	37.5
8	2.0	3.1	5.1	8.2	12.3	20.5	32.8
9	1.8	2.7	4.6	7.3	10.9	18.2	29.1
10	1.6	2.5	4.1	6.6	9.8	16.4	26.2
11	1.5	2.2	3.7	6.0	8.9	14.9	23.8
12	1.4	2.0	3.4	5.5	8.2	13.7	21.9
13		1.9	3.2	5.0	7.6	12.6	20.2
14		1.8	2.9	4.7	7.0	11.7	18.7
15		1.6	2.7	4.4	6.6	10.9	17.5
16		1.5	2.6	4.1	6.1	10.2	16.4
17			2.4	3.9	5.8	9.6	15.4
18			2.3	3.6	5.5	9.1	14.6
19			2.2	3.5	5.2	8.6	13.8
20			2.0	3.3	4.9	8.2	13.1

Table 5: Maximum distance in metres to produce 3% voltage drop (12V system)

Current (A)	1mm^2	1.5mm^2	2.5mm^2	4mm^2	6mm^2	10mm^2	16mm^2
1	9.8	14.8	24.6	39.3	59.0	98.4	157.4
2	4.9	7.4	12.3	19.7	29.5	49.2	78.7
3	3.3	4.9	8.2	13.1	19.7	32.8	52.5
4	2.5	3.7	6.1	9.8	14.8	24.6	39.3
5	2.0	3.0	4.9	7.9	11.8	19.7	31.5
6	1.6	2.5	4.1	6.6	9.8	16.4	26.2
7	1.4	2.1	3.5	5.6	8.4	14.1	22.5
8	1.2	1.8	3.1	4.9	7.4	12.3	19.7
9	1.1	1.6	2.7	4.4	6.6	10.9	17.5
10	1.0	1.5	2.5	3.9	5.9	9.8	15.7
11	0.9	1.3	2.2	3.6	5.4	8.9	14.3
12	0.8	1.2	2.0	3.3	4.9	8.2	13.1
13		1.1	1.9	3.0	4.5	7.6	12.1
14		1.1	1.8	2.8	4.2	7.0	11.2
15		1.0	1.6	2.6	3.9	6.6	10.5
16		0.9	1.5	2.5	3.7	6.1	9.8
17			1.4	2.3	3.5	5.8	9.3
18			1.4	2.2	3.3	5.5	8.7
19			1.3	2.1	3.1	5.2	8.3
20			1.2	2.0	3.0	4.9	7.9

17.4 Calculating Voltage Drop (Imperial) for Systems that Include a Switching Type Solar Controller

This section is for systems that are using switching type (e.g. PWM) solar controllers.

To determine the voltage drop the following formula is used. The equation is derived from Ohm's Law i.e. V=IR:

$$V_d = \frac{I \times 2 \times d}{1000\ ft/kft} \times \left(\frac{\Omega}{kft}\right)$$

Where:

V_d = voltage drop
d = route length of dc cable in feet (2 x adjusts for total circuit wire length)
I = dc current in amperes (commonly I_{mp})
Ω/kft = ohms/thousand feet (resistance)

The resistance is dependent on the type of material. The resistance also depends on whether the cable is a single strand or multi-stranded.

Voltage drop (in percentage) = $\frac{V_d}{V_{batt}} \times 100$

For PV arrays connected to a PWM controller the current is the short circuit current (I_{sc})of the string, sub-array or array. The battery voltage is the nominal battery voltage of the battery bank.

Table 6 is an extract from the National Electric Code.

Table 6: Cable Resistance for uncoated copper cable at 75°C (167°F)

Wire Size (AWG)	dc Resistance (Ohms per 1000 feet)	ac Resistance (Ohms to neutral per 1000 feet)
14	3.14	3.1
12	1.98	2.0
10	1.24	1.2
8	0.778	0.78
6	0.491	0.49
4	0.308	0.31
2	0.194	0.20
1	0.154	0.16
1/0	0.122	0.13
2/0	0.0967	0.10
4/0	0.0608	0.067

Worked Example 4

A solar array has been installed and the distance between the output of the array and the inverter is 33 feet. The short circuit current of the array is 9.6A.
The cable is AWG 6.
The battery voltage of the system is 12V.

From Table 6, the dc Resistance in Ohms per 1000 feet = 0.491

Therefore:

$$V_d = \frac{I \times 2 \times d}{1000\ ft/kft} \times \left(\frac{\Omega}{kft}\right)$$

= 9.6 x 2 x 33 x 0.491/1000 V
= 0.311V

Voltage Drop (in percentage) = $\frac{V_d}{V_{batt}} \times 100$

= 0.311/12 × 100
= 2.6%

17.5 Calculating Voltage Drop (Imperial) for Systems that Include a MPPT

This section is for systems that are using Maximum Power Point Trackers (MPPT) as the solar controller (dc bus) or a PV inverter that includes an MPPT controller (ac bus).

To determine the voltage drop the following formula is used.
The equation is derived from Ohm's Law i.e. V=IR:

$$V_d = \frac{I \times 2 \times d}{1000\ ft/kft} \times \left(\frac{\Omega}{kft}\right)$$

Where:
V_d = voltage drop
d = route length of dc cable in feet (2 x adjusts for total circuit wire length)
I = dc current in amperes (commonly I_{mp})
Ω/kft = ohms/thousand feet (resistance)

The resistance is dependent on the type of material. The resistance also depends on whether the cable is a single strand or multi-stranded.

Voltage drop (in percentage) = $\frac{V_d}{V_{batt}} \times 100$

For PV arrays connected to a MPPT type solar controller (dc bus) or PV inverter (ac bus) the current is the short circuit current (I_{sc})of the string, sub-array or array. The Maximum line voltage in volts is the maximum power point voltage of the string, sub-array or array (V_{mp}).

Worked Example 5

A solar array has been installed and the distance between the output of the array and the inverter is 33 feet. The short circuit current of the array is 9.6A.
The cable is AWG 10.
The array has maximum power point voltage of 154.4V.

From Table 6, the dc Resistance in Ohms per 1000 feet = 1.24

Therefore

$$V_d = \frac{I \times 2 \times d}{1000\ ft/kft} \times \left(\frac{\Omega}{kft}\right)$$

= 9.6 x 2 x 33 x 1.24/1000 V
= 0.786V

Voltage Drop (in percentage) = $\frac{V_d}{V_{batt}} \times 100$
= 0.786/154.4 x 100
= 0.51%

17.6 Tables Providing Route Lengths for Twin Cable for Various Specified Voltage Drops (Imperial)

Table 7: Maximum distance in feet to produce 5% voltage drop (12V system)

Wire Size-AWG (mm²)	14 (2.08)	12 (3.31)	10 (5.26)	8 (8.36)	6 (13.29)	4 (21.14)	2 (33.61)	1 (42.39)
Current (A)								
1	34.10	54.26	86.23	137.05	217.87	346.56	550.98	694.92
2	17.05	27.13	43.11	68.52	108.93	173.28	275.49	347.46
3	11.37	18.09	28.74	45.68	72.62	115.52	183.66	231.64
4	8.52	13.57	21.56	34.26	54.47	86.64	137.75	173.73
5	6.82	10.85	17.25	27.41	43.57	69.31	110.20	138.98
6	5.68	9.04	14.37	22.84	36.31	57.76	91.83	115.82
7	4.87	7.75	12.32	19.58	31.12	49.51	78.71	99.27
8	4.26	6.78	10.78	17.13	27.23	43.32	68.87	86.86
9	3.79	6.03	9.58	15.23	24.21	38.51	61.22	77.21
10	3.41	5.43	8.62	13.70	21.79	34.66	55.10	69.49
11	3.10	4.93	7.84	12.46	19.81	31.51	50.09	63.17
12	2.84	4.52	7.19	11.42	18.16	28.88	45.92	57.91
13	2.62	4.17	6.63	10.54	16.76	26.66	42.38	53.46
14	2.44	3.88	6.16	9.79	15.56	24.75	39.36	49.64
15	2.27	3.62	5.75	9.14	14.52	23.10	36.73	46.33
16	2.13	3.39	5.39	8.57	13.62	21.66	34.44	43.43
17	2.01	3.19	5.07	8.06	12.82	20.39	32.41	40.88
18	1.89	3.01	4.79	7.61	12.10	19.25	30.61	38.61
19	1.79	2.86	4.54	7.21	11.47	18.24	29.00	36.57
20	1.70	2.71	4.31	6.85	10.89	17.33	27.55	34.75

Table 8: Maximum distance in feet to produce 3% voltage drop (12V system)

Wire Size-AWG (mm²)	14 (2.08)	12 (3.31)	10 (5.26)	8 (8.36)	6 (13.29)	4 (21.14)	2 (33.61)	1 (42.39)
Current (A)								
1	20.46	32.56	51.74	82.23	130.72	207.93	330.59	416.95
2	10.23	16.28	25.87	41.11	65.36	103.97	165.30	208.48
3	6.82	10.85	17.25	27.41	43.57	69.31	110.20	138.98
4	5.11	8.14	12.93	20.56	32.68	51.98	82.65	104.24
5	4.09	6.51	10.35	16.45	26.14	41.59	66.12	83.39
6	3.41	5.43	8.62	13.70	21.79	34.66	55.10	69.49
7	2.92	4.65	7.39	11.75	18.67	29.70	47.23	59.56
8	2.56	4.07	6.47	10.28	16.34	25.99	41.32	52.12
9	2.27	3.62	5.75	9.14	14.52	23.10	36.73	46.33
10	2.05	3.26	5.17	8.22	13.07	20.79	33.06	41.70
11	1.86	2.96	4.70	7.48	11.88	18.90	30.05	37.90
12	1.70	2.71	4.31	6.85	10.89	17.33	27.55	34.75
13	1.57	2.50	3.98	6.33	10.06	15.99	25.43	32.07
14	1.46	2.33	3.70	5.87	9.34	14.85	23.61	29.78
15	1.36	2.17	3.45	5.48	8.71	13.86	22.04	27.80
16	1.28	2.03	3.23	5.14	8.17	13.00	20.66	26.06
17	1.20	1.92	3.04	4.84	7.69	12.23	19.45	24.53
18	1.14	1.81	2.87	4.57	7.26	11.55	18.37	23.16
19	1.08	1.71	2.72	4.33	6.88	10.94	17.40	21.94
20	1.02	1.63	2.59	4.11	6.54	10.40	16.53	20.85

18. Protection Requirements In System

All cables shall be electrically protected from fault currents that could occur.

Figures 18, 19, 20 and 21 show the typical protection and isolation (switch-disconnection) requirements in dc and ac bus systems.

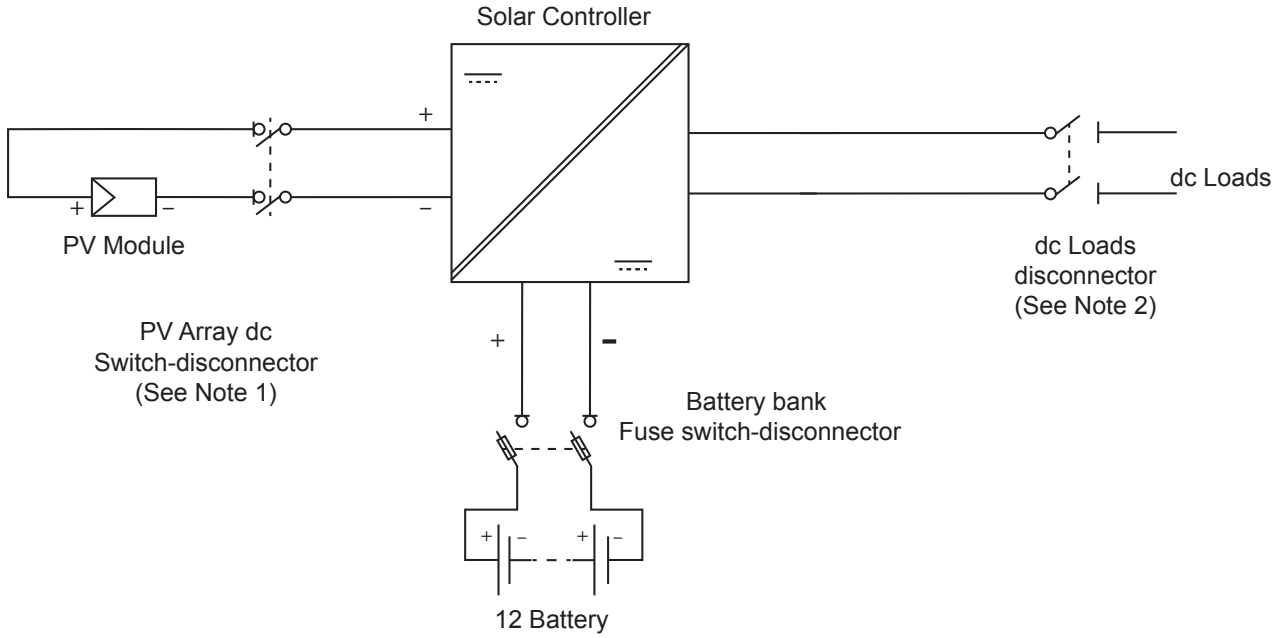


Figure 18: dc bus - simple dc only system (typical for rural residences)

Notes:

1. A PV array dc switch disconnector is recommended because it helps with maintenance and troubleshooting. However many standards allow the battery bank switch fuse to meet the isolation requirement. A switch disconnector will be required to be a protection device (e.g. a non polarised dc circuit breaker) if the battery bank fuse ratings are greater than the current carrying capability of the PV array cables and the solar controller allows back feed from the battery bank.

2. A loads dc switch disconnector is recommended because it helps with maintenance and troubleshooting. However the battery bank switch-fuse can meet the isolation requirement. The switch disconnector will be required to be a protection device (e.g. a non polarised dc circuit breaker) if the battery bank fuse ratings are greater than the current carrying capability of the load cables

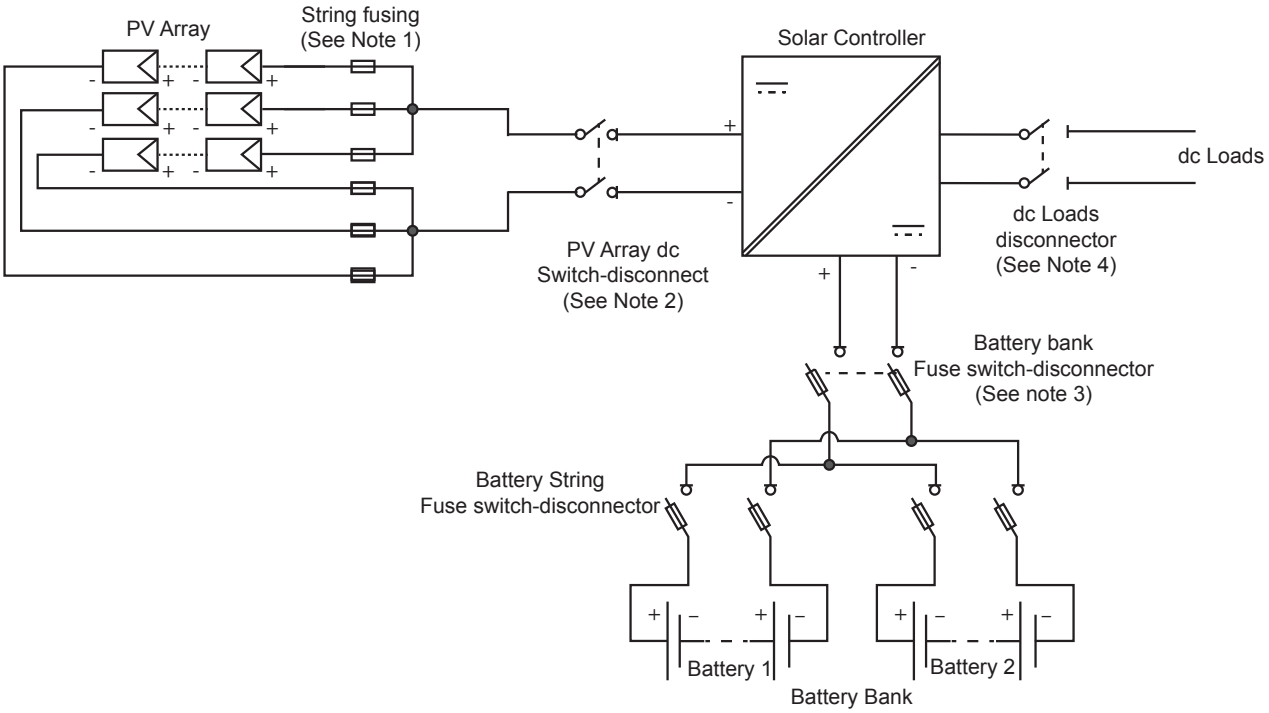


Figure 19: dc bus - larger dc only system

Notes:

1. String fusing is required if the potential fault current is greater than the reverse current rating of the PV module. (Refer section 18.1).

2. The PV array dc switch disconnector is recommended because it helps with maintenance and troubleshooting although many standards allow the battery bank switch fuse to meet the isolation requirement. The switch disconnector will be required to be a protection device (e.g. a non polarised dc circuit breaker) if the battery bank fuse ratings are greater than the current carrying capability of the PV array cables and the solar controller allows back feed from the battery bank.

3. Batteries in parallel each require their own isolation and protection devices. Over-current protection is required for the battery bank cable when the current-carrying capacity of the battery bank cable is less than the sum of all individual battery over-current protection devices. A battery bank switch disconnecting device is recommended because it allows the disconnection of the complete battery bank via the one switch disconnector.

4. The loads dc switch disconnector is recommended because it helps with maintenance and troubleshooting although many standards allow the battery bank switch-fuse to meet the isolation requirement. The switch disconnector will be required to be a protection device (e.g. a non polarised dc circuit breaker) if the battery bank fuse ratings are greater than the current carrying capability of the load cables.

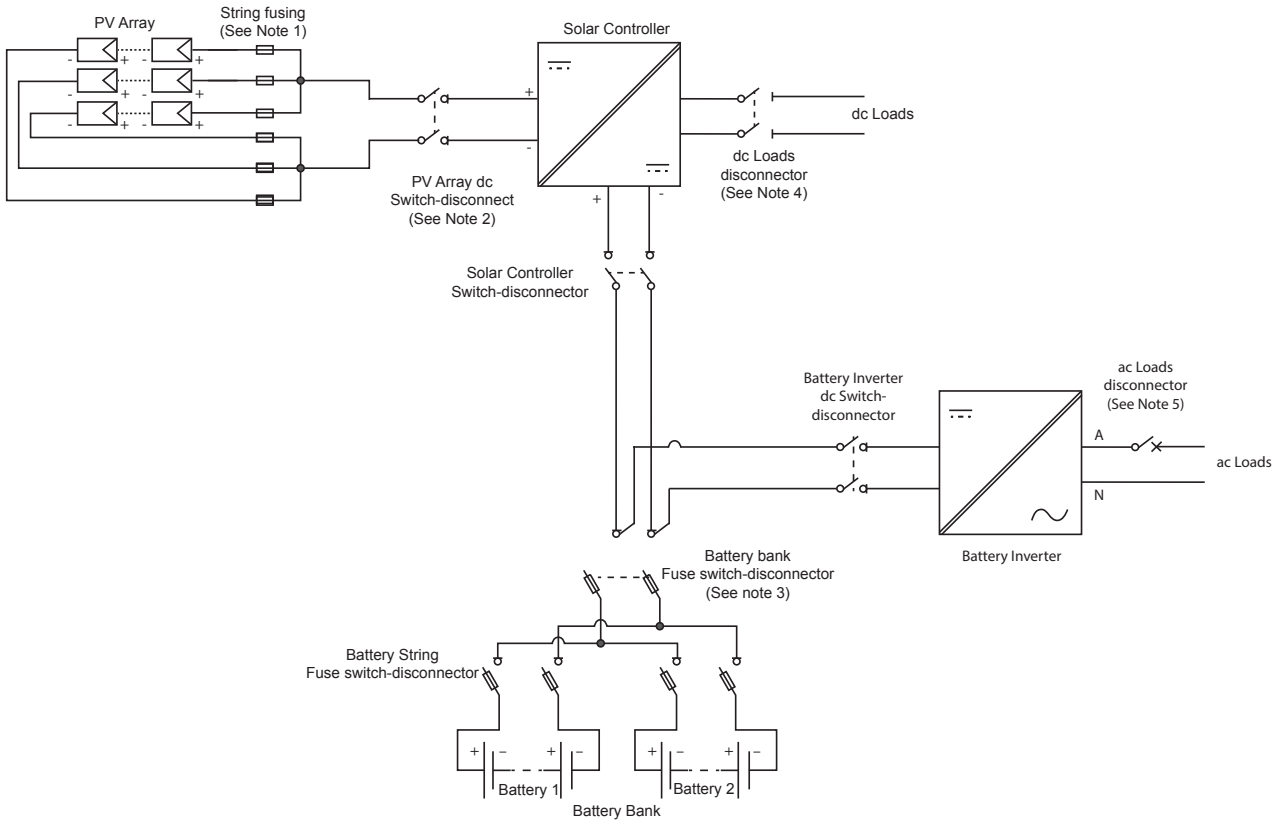


Figure 20: dc bus with dc and ac Loads

Notes:

1. String fusing is required if the potential fault current is greater than the reverse current rating of the PV module. (Refer section 18.1).

2. The PV array dc switch disconnector is recommended because it helps with maintenance and troubleshooting although many standards allow the battery bank switch fuse to meet the isolation requirement. The switch disconnector will be required as a protection device (e.g. a non polarised dc circuit breaker) if the battery bank fuse ratings are greater than the current carrying capability of the PV array cables and the solar controller allows backfeed from the battery bank.

3. Batteries in parallel each require their own isolation and protection devices. Over-current protection is required for the battery bank cable when the current-carrying capacity of the battery bank cable is less than the sum of all individual battery over-current protection devices. A battery bank switch disconnecting device is recommended because it allows the disconnection of the complete battery bank via the one switch disconnector. Sometimes this might be a four (4) pole device to allow different size fuses to protect the inverter cable and the solar controller cable which will be generally be different cross sectional areas (or gauges)

4. The loads dc switch disconnector is recommended because it helps with maintenance and trouble shooting although many standards allow the battery bank switch-fuse to meet the isolation requirement. The switch disconnector will be required to be a protection device (e.g. a non polarised dc circuit breaker) if the battery bank fuse ratings are greater than the current carrying capability of the load cables.

5. A separate ac load disconnector is required if the battery inverter does not have a switch disconnector on the ac output. This will be required as a protection device (e.g. an ac circuit breaker) for protecting the ac load cable.

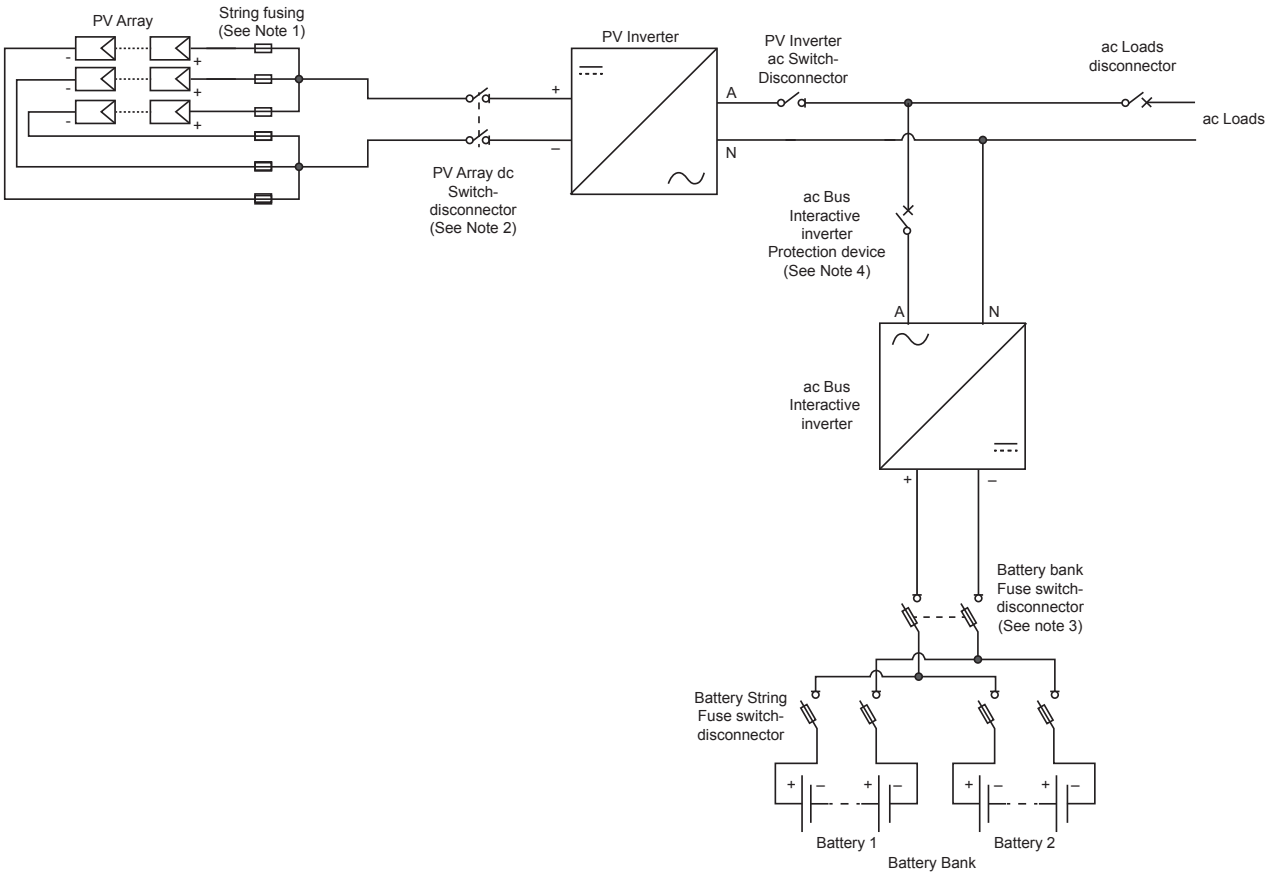


Figure 21: ac bus with ac loads

Notes:

1. String fusing is required if the potential fault current is greater than the reverse current rating of the PV module. (Refer section 18.1).

2. A PV array dc switch disconnector is required but it can be part of the inverter (refer to section 19.2).

3. Batteries in parallel each require their own isolation and protection devices. Over-current protection is required for the battery bank cable when the current-carrying capacity of the battery bank cable is less than the sum of all individual battery over-current protection devices. A battery bank switch disconnecting device is recommended because it allows the disconnection of the complete battery bank using only one switch disconnector.

4. A separate ac bus interactive inverter disconnector device is required if the battery inverter does not have a switch disconnector on the ac output. This will be required to be a protection device (e.g. ac circuit breaker) for protecting the ac load cable.

18.1 Solar Array dc Cable Protection

Each solar module has a maximum reverse current rating provided by the manufacturer. If the array consists of parallel strings such that the reverse current flow into a string with a fault can be greater than the maximum reverse current for the modules in that string, then protection shall be provided in each string. The protection to be used shall be dc rated fuses that meet the specification shown in 18.2.

Worked Example 6

The reverse current rating for a module is 15A while the short circuit current is 8.9A. If the array consists of two (2) parallel strings and a fault occurs in one (1) string then the potential fault current will come from the other one (1) string which is only 8.9A and is less than the reverse current rating so no protection is required. However, if the array consists of three (3) parallel strings and a fault occurs in one (1) string then the fault current could come from the other two (2) strings. This current is 17.8A (2 x 8.9A) and is now greater than the reverse current rating of the module. Protection is now required.

A formula for determining the maximum number of strings allowed before fuses are required is:

Maximum Number of Strings without string protection
= reverse current rating of a module/I_{sc} of the module

So in the above example; Max Number of strings = 15/8.9 = 1.69 rounded up to 2.

18.2 PV Fuses

Fuses used in PV arrays shall —

(a) be rated for dc use;
(b) have a voltage rating equal to or greater than the PV array maximum voltage determined in section 5.2;
(c) be rated to interrupt fault currents from the PV array; and
(d) be of an overcurrent and short circuit current protective type suitable for PV complying with IEC 60269-6 (i.e. Type gPV) or the equivalent through the NEC.

18.3 String Protection

The fuses shall have the following current rating:

$$1.5 \times I_{SC\ MOD} < I_{TRIP} < 2.4 \times I_{SC\ MOD}$$

and

$$\text{Fuse Rating} < I_{RC\ MOD}$$

Where

$I_{SC\ MOD}$ = Module short circuit current
I_{TRIP} = Rated trip current of the fault current protection device.
$I_{RC\ MOD}$ = Module reverse current rating

Note: For countries following NEC the requirements are:

- Minimum fuse rating 1.56 x I_{sc} of module(string)
- Maximum fuse rating less than reverse current rating of the module(string)

18.4 Sub-Array Protection

An array may be broken up into sub-arrays for several reasons; for example, if two sections of the array are installed in separate areas, have different orientations or the array consists of a number of identical sub-arrays. The need for sub-array overcurrent protection is similar in logic to that for string overcurrent protection – one sub-array could be operating differently from the other sub-arrays owing to shading or earth faults. The use of sub-array protection is to stop excessive currents from flowing into a sub-array.

18.5 Requirements of Sub-Array Overcurrent Protection

Sub-array overcurrent protection protects a sub-array made up of a group of strings. It is required if one of the following conditions is present:

- $1.25 \times I_{SC\_ARRAY}$ > Current carrying capacity (CCC) of any sub-array cable, switching and connection device.
- More than two sub-arrays are present within an array

Note: For countries following NEC the requirements are:

- Minimum fuse rating 1.56 x I_{sc} of sub-array

18.6 Sizing the Sub-Array Overcurrent Protection

If sub-array overcurrent protection is required for a system, the nominal rated current for the overcurrent protection device will be:

$$1.25 \times I_{SC\_SUB\text{-}ARRAY} \leq I_{TRIP} \leq 2.4 \times I_{SC\_SUB\text{-}ARRAY}$$

Where:

$I_{SC\_SUB\text{-}ARRAY}$ = short-circuit current of the sub-array.

I_{TRIP} = rated trip current of the fault current protection device.

Note: For countries following NEC the requirements are:

- Minimum fuse rating 1.56 x I_{sc} of sub-array

18.7 Array Cable Protection

Array overcurrent protection is designed to protect the entire PV array from external fault currents. For off grid systems this can only occur in dc bus systems when the solar controller (switching type solar controller or MPPT) allows fault current from the battery bank to back-feed through the controller.

If array overcurrent protection is required for a system, the nominal rated current for the overcurrent protection device will be as follows:

$$1.25 \times I_{SC\_ARRAY} \leq I_{TRIP} \leq 2.4 \times I_{SC\_ARRAY}$$

Where:

I_{SC_ARRAY} = short-circuit current of the array.

I_{TRIP} = rated trip current of the fault current protection device.

Note: For countries following NEC the requirements are:

- Minimum fuse rating 1.56 x I_{sc} of array

18.8 Arc Fault Protection (countries following NEC requirements)

NEC Article 690.11 requires PV systems operating at 80 V dc or greater to be protected by a listed PV arc-fault circuit interrupter. The purpose is to detect and interrupt arcing faults.

There are exemptions including:

- PV systems not installed on buildings or in buildings where the building is a detached structure solely for housing PV system equipment.
- PV circuits and dc-to-dc converter output circuits that are direct buried, installed in metallic raceways, or installed in enclosed metallic cable trays.

Refer to the NEC for further information.

18.9 Rapid Shutdown of PV Systems on Buildings (countries following NEC requirements)

NEC Article 690.12 requires PV systems dc wiring installed on or in buildings to include a rapid shutdown device. (This would only be required for systems operating greater than 80V dc)

There is an exemption for ground mounted arrays frames where:

- the dc array cable never enters a building, or
- when the dc array cable does enter a building, the building is designed specifically to house only PV system equipment.

Refer to the NEC for further information.

18.10 Battery Cable Protection- dc Bus – dc Loads Only

For dc bus systems with dc loads only, as shown in Figures 18 and 19, the only battery cables are those between the battery bank and the controller. The protection devices will be rated to allow the maximum charge current provided by the solar controller and the maximum dc load current that is to be provided by the solar controller.

18.11 Battery Cable Protection- dc Bus – ac and dc Loads

dc bus systems with ac and dc loads as shown in Figure 20 can potentially have two different sized battery cables:

1. The battery cable between the battery bank and the solar controller.
2. The battery cable between the battery bank and the battery inverter.

The protection devices for the cable connected to the solar controller from the battery will be rated to allow the maximum charge current provided by the solar controller to the battery and the maximum dc load current that is to be provided at the output of the solar controller, whichever is larger. This protection device will need to be suited for motors of there are any dc motors connected to the system. These fuses are a specific type to allow for the motor surge capability.

The protection device for the battery cable to an inverter will be determined via the process defined in section 18.13

18.12 Battery Cable Protection - ac Bus

Systems with an ac bus as shown in Figure 21 only have one set of cables from the battery bank and that is to the battery inverter.

The protection device for the battery inverter will be determined via the process defined in section 18.13

18.13 Battery Cable Protection- Battery Inverter

To select the appropriate battery protection for the cable to the battery inverter:

1. Obtain the battery inverter manufacturer's data of:
   - Continuous power rating (Watts)
   - 3 to 10 second surge rating (Watts)
   - Average inverter efficiency (%)

2. Obtain Time-Current characteristics for the overload protection to be used.
   [All manufacturers publish time-current information for their circuit breaker and HRC fuse ranges]

3. For each inverter power rating determine the current drawn from the battery bank using:

$$I = \frac{\text{Inverter Power Rating (W)}}{\text{(inverter efficiency x nominal battery voltage)}}$$

4. Consult the Time-Current characteristic of available overload protection devices to determine the device with an appropriate rating that matches the maximum load and maximum load surge characteristics.

The inverter protection device (if a switch fuse or suitably rated dc circuit breaker) will typically be used as the main battery disconnection device and smaller protection devices will be needed for the protection of the solar controller (in the case of a dc bus system). These smaller would be placed on the output side of the main battery disconnection device and in the circuit for dc cable to the solar controller.

For dc bus systems where the inverter protection is being used for the main battery protection and there are dc loads (connected to the solar controller) then the sizing of the inverter cable protection device shall be sized to meet the current requirements of the inverter (as above) plus any significant dc loads being supplied by the solar controller.

For both dc and ac bus systems often the battery inverter can also act as a battery charger (such as when an ac back up generator has been connected). In that case, the battery inverter fuse is being used as a main battery fuse during charging, so the maximum charge current could be greater than the maximum load current. In this situation the larger of the load current or the charging current will be the determining factor for the protection device rating.

19. Disconnection (Isolation) Requiremements

Switch disconnectors are load breaking devices and sometimes called isolators. Within the off grid PV system switch disconnectors are required as follows:

- A battery switch disconnector between the battery and the solar controller (if installed).
- A battery switch disconnector between the battery and the battery inverter (if installed).
- A PV array dc switch disconnector located near the MPPT controller when the array maximum voltage is LV,
- A PV array dc switch disconnector located near the PV inverter (ac bus).

Note: these dc switch disconnectors must be designed for the dc voltage being seen by the switch. Switches, relays or circuit breakers intended for ac use or for lower dc voltages must not be used as arcing and possible fire damage may result.

It is recommended that a PV array dc switch disconnector be installed near a switching type solar controller– although the battery isolator is accepted by most standards as meeting this function. This switch disconnector is invaluable when fault finding a system.

There should be a switch disconnector for the dc loads being supplied directly by the system.

Battery inverters generally have a built-in switch disconnector at the ac output. If the unit(s) that are installed do not, it is recommended to install one on the ac output of each battery inverter.

Note: Though the disconnection devices are switch disconnectors the signs shall use the word “isolators” for simplicity and consistency with most published standards.

19.1 Disconnection Requirements Within an Array

- Every string shall be capable of being individually disconnected (isolated) from the rest of the system. This disconnection does not have to be one rated for load breaking. The module connectors can perform this function. However, if the module connectors are used it is critical that they do say on them “Do Not Break Under Load”. They can only be disconnected after the main PC array switch disconnector is opened and there is no load on the module connectors.
- Sub-arrays shall be capable of being individually disconnected (isolated) from the rest of the system. It is recommended that this uses a load-break switch disconnector.

19.2 PV Array dc Switch Disconnector Near PV Inverter and MPPT (if array is LV)

- A PV array switch-disconnector/s shall be installed adjacent to the PV inverter and/or MPPT (if Maximum PV voltage is LV (DCV-C)).
- All PV array switch-disconnectors shall be capable of being reached easily for inspection, maintenance or repairs without necessitating the dismantling of structural parts, cupboards, benches or the like.
- For PV inverters with an integrated switch-disconnector: a separate switch-disconnector is not required at the PV inverter if the switch-disconnector is mechanically interlocked with a replaceable module of the inverter and allows the module to be removed from the section containing the switch-disconnector without risk of electrical hazard.

- Where multiple disconnection devices are required to isolate the array(s) from the PV inverter(s) or MPPT's they shall be grouped so that they all operate simultaneously, or they shall all be grouped in a common location and have warning signs indicating the need to isolate all the multiple supplies in order to isolate the equipment.
    - Where there are more than one isolator, they shall be individually labelled e.g. "PV Array DC isolator inverter 1 and MPPT A or MPPT 1"
- Where strings are paralleled at the PV inverter or MPPT, it is recommended that this occurs on the PV inverter or MPPT side of the disconnection device or in the PV inverter/MMPT itself as shown in Figure 22.

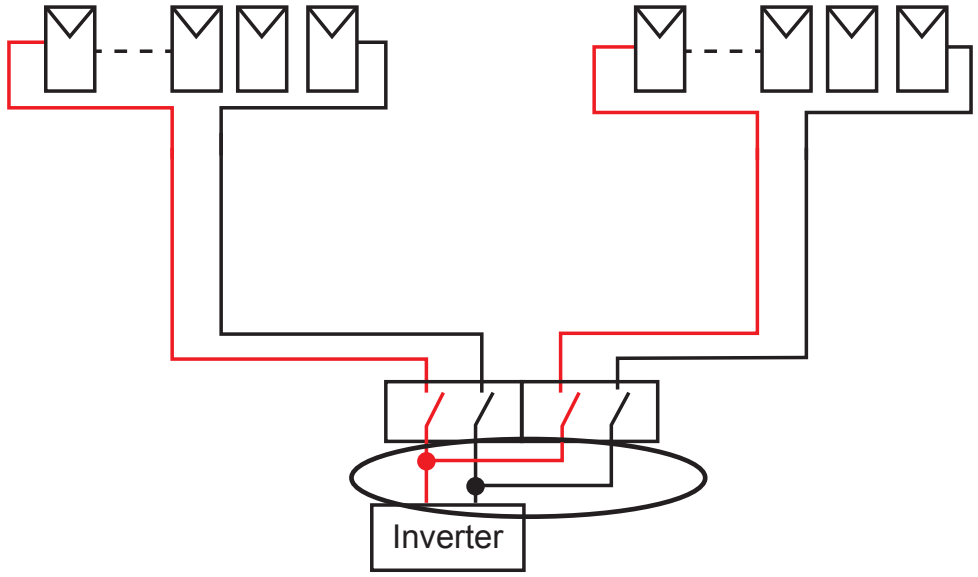


Figure 22: Paralleling strings on inverter/MPPT side of PV array disconnector devices

Note: In Figure 22 the Inverter could also be an MPPT.

- Where the switch-disconnector is exposed to the weather it shall have an IP rating of at least IP 56, however it is recommended that they are rated to IP 66.
- It is recommended that there are no top cable entries into the switch-disconnector and cable drip loops are utilised at the bottom of the switch-disconnector to minimise risk of water ingress.
- PV array switch-disconnectors shall meet the requirements of section 19.6.

19.3 PV Array dc Switch Disconnector Near Standard Solar Controller

For ELV systems this is optional since the battery switch disconnector meets the requirements. However, if a switch disconnector is installed it should meet the following requirements:

- All PV array switch-disconnectors shall be capable of being reached for inspection, maintenance or repairs without necessitating the dismantling of structural parts, cupboards, benches or the like.
- Where multiple disconnection devices are required to isolate the array(s) from the solar controller(s) they shall be grouped so that they all operate simultaneously, or they shall all be grouped in a common location and have warning signs indicating the need to isolate all the multiple supplies to isolate the equipment.
    - Where there are more than one isolator, they shall be individually labelled e.g. "PV Array DC isolator Solar Controller 1".

- Where the switch-disconnector is exposed to the weather it shall have an IP rating of at least IP 56, however it is recommended that they are rated to IP 66.
- It is recommended that there are no top cable entries into the switch-disconnector and cable drip loops are utilised at the bottom of the switch-disconnector to minimise risk of water ingress.
- PV array switch-disconnectors shall meet the requirements of section 19.6.

19.4 Battery Bank Disconnection Devices

- All equipment connected to the battery bank shall be capable of being individually isolated from the battery bank.
- For dc bus systems with dc loads only then the only isolation requirement is for the solar controller.
- For dc bus systems with ac loads then two isolating devices are required:
    - One for the solar controller
    - One for the battery inverter.
- For ac bus systems with ac loads then two isolating devices are required:
    - One for the PV inverter. (which in some cases may be a component in the inverter)
    - One for the battery inverter.
- All battery isolating devices shall be dc switch disconnectors capable of breaking the maximum current for the particular equipment the battery is connected to.
- All battery switch-disconnectors shall be capable of being reached for inspection, maintenance or repairs without necessitating the dismantling of structural parts, cupboards, benches or the like.
- Where the switch-disconnector is exposed to the weather it shall have an IP rating of at least IP 56, however it is recommended that they are rated to IP 66.
- Battery switch-disconnectors shall meet the requirements of section 19.6.

19.5 Load Disconnection Requirements

- All dc and ac load circuits shall be capable of being isolated.
- For dc loads this could be performed by the controller and for dc only systems this could be the battery switch disconnector. However, it is recommended that a separate dc switch disconnector is located in the load output cables from the solar controller.
- For dc bus systems with ac loads, ac switch disconnectors should be located in the output cables from battery inverter unless there is an ac switch disconnector included on the inverter.
- For ac bus systems, ac switch disconnectors should be located in the output cables from
    - a battery inverter,
    - a PV inverter.
- dc load switch disconnectors shall meet the requirements of 19.6
- ac load switch disconnectors shall meet the standard requirements for ac switch disconnectors as required in the country of installation and have minimum current ratings equivalent to the rated output current of the battery inverter and/or PV inverter.

19.6 dc Switch-Disconnector Requirements

dc switch-disconnectors shall:

- be rated for dc use.
- be rated to interrupt the full load and prospective fault currents.
- not be polarity sensitive.
- interrupt all live conductors simultaneously.
- shall not have exposed live parts in the connected or disconnected state.
- Shall comply with the requirements of IEC 60947-3 and shall have a utilization category of at least DC-21B (as per IEC 60947-3)

- For PV array switch connectors, the switch disconnectors shall have voltage ratings as follows:
    - For non-functionally earthed systems with separated PV inverter (transformer based) or separated MPPT: the sum of the voltage rating of both poles together of the switch disconnector shall be at least the PV array maximum voltage (V_{oc} of the array adjusted for the lowest ambient temperature at site)
    - For non-separated inverter (transformerless based) or non-separated MPPT: the voltage rating of each pole of the disconnector shall be at least the PV array maximum voltage (V_{oc} of the array adjusted for the lowest ambient temperature at site)
- For battery switch disconnectors, the switch disconnectors shall have voltage ratings as follows:
    - For non-separated MPPT: the voltage rating of each pole of the disconnector shall be at least the PV array maximum voltage (V_{oc} of the array adjusted for the lowest ambient temperature at site)
    - For all switch type controllers and battery inverters connected to battery banks that are not earthed/grounded the voltage rating of the sum of the two poles (positive and negative) of the switch-disconnector shall be at least the maximum battery voltage expected when under charge
    - For all switching type controllers and battery inverters connected to battery banks that are earthed/grounded the voltage rating of each pole of the switch disconnector shall be at least the maximum battery voltage expected under charge.
- Battery switch disconnectors shall be rated to withstand the prospective fault current for a time at least equal to the operating time of the associated over-current protective device.

20. Earthing (Grounding) of Array Frames for a PV Array With Maximum Voltage Greater Than ELV (including AC modules and micro-inverter systems)

- All exposed metal module frames and array mounting frames shall be earthed (grounded) if the PV array has a PV array maximum voltage greater than ELV (DVC-C) or when ac modules or micro inverters with LV outputs are installed.
- Minimum cable size of 4 mm^2 (NEC states it shall be no smaller than 14 AWG) shall be used but if the array structure is to be earthed (grounded) for lightning protection then it should be minimum 16 mm^2 (6 AWG).
- Earth/ground connection shall be:
    - by a purpose-made fitting providing earthing/grounding or bonding connections for dissimilar metals and fitted to the manufacturer's instructions, or
    - by purpose-made washers with serrations or teeth for the connection between the PV module and mounting frame fitted to the manufacturer's instructions, and
    - arranged so that the removal of a single module earth connection will not affect the continuity of the earthing/grounding or bonding connections to any other module.
- Self-tapping screws shall not be used.
- Ensure that rail joiners (splices) provide earth (ground) continuity. Some rail manufacturers state that the use of a rail joiner (splice) provides earth continuity between rails. If the manufacturer does not provide this information, a conductive earthing strap or shall be installed across the joint.
- The earth/grounding cable can be insulated unsheathed cable. If exposed to direct sunlight the cable shall have a physical barrier to prevent exposure to direct sunlight.
- The earth/grounding cable should be installed in parallel with and in close proximity to the PV array cable (both positive and negative), the inverter and then inverter ac cables going to the switchboard or distribution board.
- The earthing/grounding conductor from the PV array can connect to inverter's main earth conductor in the ac output cable provided the following conditions are met:
    - Installation is not subject to lightning
    - Inverter ac earth is of an appropriate size
- Earth cable cannot pass through a tile or steel roof without additional mechanical protection (conduit) and an appropriate collar flashing (e.g. Dektite). The same conduit used for PV array cable can also be used for the earth cable.
- All grounding cables will be connected to the same earth grounding point. If multiple grounding points are used, all ground points will be connected together with a grounding cable.

21. Installation of Combiner Boxes

- Combiner boxes (PV string or PV array) installed outside shall be at least IP65 and shall be UV resistant.
- PV array and PV string combiner boxes which contain fuses or switch disconnectors shall be located where they can be reached without having to dismantle any structure such as cupboards, structural framing etc.
- Any cable entries into combiner boxes via cable glands or conduit glands should maintain the IP rating of the combiner box.

22. Segregation of dc and ac Circuits

- Within enclosures, segregation shall be provided between dc and ac circuits by insulation barriers.
- Where switches for dc and ac circuits are mounted on a common mounting rail the mounting rail shall not be conductive (e.g. a non-metallic material).
- dc and ac circuits should be clearly marked.

23. Plugs and Sockets

Plugs, sockets and connectors for the PV array shall:

- comply with EN 50521 or UL equivalent;
- be protected from contact with live parts in connected and disconnected states (e.g. shrouded);
- have a current rating equal to or greater than the current carrying capacity for the
- circuit to which they are fitted;
- require a deliberate force to separate;
- have a temperature rating suitable for their installation location;
- if multi-polar, be polarized;
- comply with Class II;
- if exposed to the environment, be rated for outdoor use, be of a UV-resistant type and be of an IP rating suitable for the location;

24. Shutdown Procedure

- A shutdown procedure is required to ensure safe de-energisation of the system.
- The shutdown procedure shall reflect the specific requirements of the individual system.
- All isolating switches (switch-disconnectors) referred to in the shutdown procedure shall correspond to individual switch-disconnector (isolator) labels. e.g “PV array dc isolator 2”, “Battery Isolator 3”.
- In general the shutdown procedure shall require the system to be shut down in the following order:
    - Isolation of PV input. (locations should be specified)
    - Isolation of the AC loads and also DC loads
    - Isolation of the battery bank by disconnecting battery fuses or opening battery circuit breakers.

25. Metering

As a minimum each system should have meters showing:

- battery voltage.
- charge current from solar.
- load current from the battery bank.

26. Signage

- All battery systems that can emit explosive gases shall have a “No Smoking, No Spark, No Flames" Warning sign. (Example provided in Figure 23)
- All battery systems that contain chemicals which could burn the eyes or skin shall have a warning sign prominently displayed. (Example provided in figure 24)
- All disconnectors shall be labelled and where there is more than one, numbered. For example:
    - Battery dc disconnector 2
    - PV array dc disconnector
    - Solar controller dc disconnector
    - dc load disconnector
    - ac load disconnector 3
- A sign showing the proper Shutdown Procedure shall be located near the system.
- Solar cables shall be labelled every 2 metres where exposed.
- Any solar array combiner box should be labelled warning that it is dc supply and if LV (DCV-C) than a prominent sign should warn of hazardous voltages.

Figure 23: Example of Risk of Battery Explosion Warning Sign

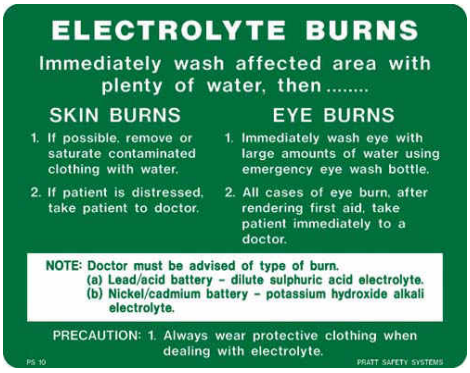


Figure 24: Electrolyte Burns Sign

27. Commissioning

The commissioning sheets provided with these guidelines (Appendix 2) should be completed by the installer. A completed copy shall be provided to the customer as part of the system documentation and a copy retained by the installer that has been initialled by the customer showing it to be a true copy of the commissioning sheets provided to the customer.

27.1 PV Array Short Circuit Current Measurement for arrays Greater than DVC-A

Where short circuit currents are required to be measured, undertake the following steps to measure the short circuit current safely as shown in Figure 25.

- Ensure each string fuse (where required) is not connected or that any LV array is disconnected somewhere in each string as shown in Figure 11 of these guidelines.
- Leave the solar array cable connected to the PV array switch disconnector.
- Remove the cable from the PV array switch disconnector to the inverter.
- With the PV array switch disconnector off - put a link or small cable between the positive and negative outputs of the PV array switch disconnector.
- Install the string fuse for string 1 or connect the string disconnect (figure 11) to complete the wiring of the string. Turn on PV array switch disconnector and using a dc. clamp meter, measure the dc short circuit current for String 1. Turn off the PV array switch disconnector. Disconnect the string fuse for string 1 or remove the disconnector to break the string circuit.
- Repeat for each string

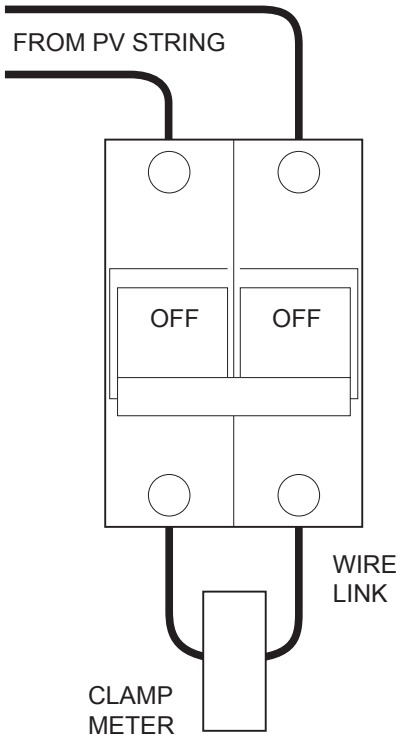


Figure 25: Measuring Short Circuit current

27.2 PV Array Insulation Resistance Measurement

Warning: PV array dc circuits are live during daylight and unlike conventional ac circuits cannot be isolated before performing this test.

This test is required for all arrays where the maximum array voltage is LV, that is, greater than DVC-C. The insulation resistance test should be undertaken when all the system wiring has been completed.

The insulation resistance test shall be carried out with an insulation test device connected between earth and the PV array positive connection, and then the test repeated with the test device connected between earth and PV array negative connection. Test leads should be made secure before carrying out the test. The values of insulation resistance shall be recorded. Table 9 shows the minimum values that should be achieved for different array voltages.

Table 9: Minimum Insulation Resistance

ARRAY VOLTAGE (V × 1.25)	TEST VOLTAGE	MINIMUM INSULATION RESISTANCE, MΩ
< 120	250	0.5
120 – 500	500	1
> 500	1000	1

28. Documentation

All complex systems require a user manual for the customer. Off Grid PV power systems are no exception. The documentation for system installation that shall be provided includes:

- List of equipment supplied with each item's model, description and serial number
- List of action to be taken in the event of an earth fault alarm
- Shutdown and isolation procedures for emergencies and for maintenance
- Maintenance procedures and timetable
- Commissioning sheet and installation checklist
- Warranty information
- A basic connection diagram that includes electrical ratings of the PV array, the battery bank, the solar controllers, battery inverters, PV inverters and the ratings of all overcurrent devices and switches as installed
- System performance estimate including completed load assessment forms.
- Recommended maintenance procedures and timetable for the installed system
- Equipment manufacturer's documentation and handbooks for all equipment supplied
- Array frame engineering certificate for wind and mechanical loading
- Installer/designer's declaration of compliance

Appendix 1: Temperature Conversion Tables

°F	°C	°F	°C	°F	°C
32	0	64	18	96	36
33	1	65	18	97	36
34	1	66	19	98	37
35	2	67	19	99	37
36	2	68	20	100	38
37	3	69	21	101	38
38	3	70	21	102	39
39	4	71	22	103	39
40	4	72	22	104	40
41	5	73	23	105	41
42	5	74	23	106	41
43	6	75	24	107	42
44	6	76	24	108	42
45	7	77	25	109	43
46	8	78	26	110	43
47	8	79	26	111	44
48	9	80	27	112	44
49	9	81	27	113	45
50	10	82	28	114	46
51	11	83	28	115	46
52	11	84	29	116	47
53	12	85	29	117	47
54	12	86	30	118	48
55	13	87	31	119	48
56	13	88	31	120	49
57	14	89	32	121	49
58	14	90	32	122	50
59	15	91	33	123	51
60	16	92	33	124	51
61	16	93	34	125	52
62	17	94	34	126	52
63	17	95	35	127	53

Appendix 2: Installation and Commissioning Sample

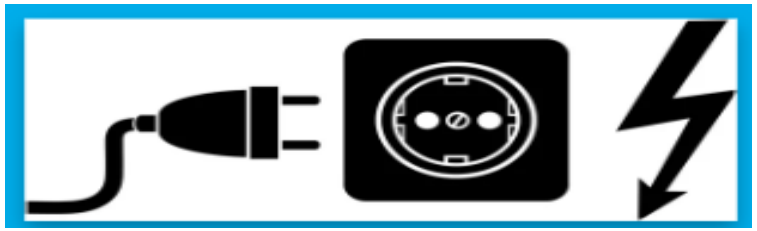
This is just a sample for a small system.

Installer name:	
Installer signature:	
Testing and Commissioning date:	
System Location	
Equipment Data	
PV module manufacturer:	
PV module model number:	
PV module peak power rating:	W_p
PV Module rated short circuit current (I_{sc})	A
PV Module rated maximum power current (I_{mp})	A
PV Module rated open circuit voltage (V_{oc})	V
PV Module rated maximum power voltage (V_{mp})	V
Number of Modules:	
Battery manufacturer:	
Battery model:	
Battery Voltage	V
Battery Capacity	Ah
Solar controller manufacturer	
Solar controller model	
Solar controller input and output current rating.	A
Solar controller voltage ratings	V
Battery Inverter manufacturer	
Battery Inverter model	
Battery Inverter Input current ratings	A
Inverter Input dc voltage rating	V
Inverter Power Rating	W or VA

Switch disconnector manufacturer	
Switch disconnector model	
Switch disconnector current rating	A
Switch disconnector voltage rating	V
Solar battery fuse current rating	A
Solar battery fuse voltage rating	V
Inverter battery fuse current rating (if there are a separate fuses for inverter and	A
solar)	V
Inverter battery fuse voltage Rating (if there are a separate fuses for inverter and	
solar)	W/m²
Testing of System (System Not On Yet)	A
Solar Irradiance at same angle of solar module	V
Module No 1: I_{sc}	A
Module No 1: V_{oc}	V
Module No 2: I_{sc}	
Module No 2: V_{oc}	
Continuity between PV array, dc switch-disconnector and controller:	
Array Positive (Tick if correct)	
Array Negative (tick if correct)	
Correct polarity between PV array and solar controller	
Continuity between controller, fuse holders and battery	
Battery Positive (Tick if correct)	
Battery Negative (tick if correct)	
Correct polarity between controller and battery	
Continuity between battery, fuse holders and inverter	
Battery Positive (Tick if correct)	
Battery Negative (tick if correct)	
Correct polarity between inverter and battery	

Continuity between solar controller, light switch and lights	
Positive (Tick if correct)	
Negative (tick if correct)	
Correct polarity between controller and dc loads (This could be expanded if testing dc circuits if they have been installed as part of system installation)	V
Battery Voltage at Terminals	
If 2V cells than this would be expanded to record each cell voltage	
If batteries are wet lead acid than the specific gravities would be recorded	V
Turn System On - including dc loads	A
Array voltage at Controller input	V
Array current	V
Battery voltage at controller	
Voltage at furthest dc load (array turned off)	
Solar charging the batteries	
Controller operating correctly (tick if correct)	
Inverter operating correctly (tick if correct)	
dc loads operating correctly (tick if correct)	

Surge Protection Now with Latest Selection and Installation Guideline

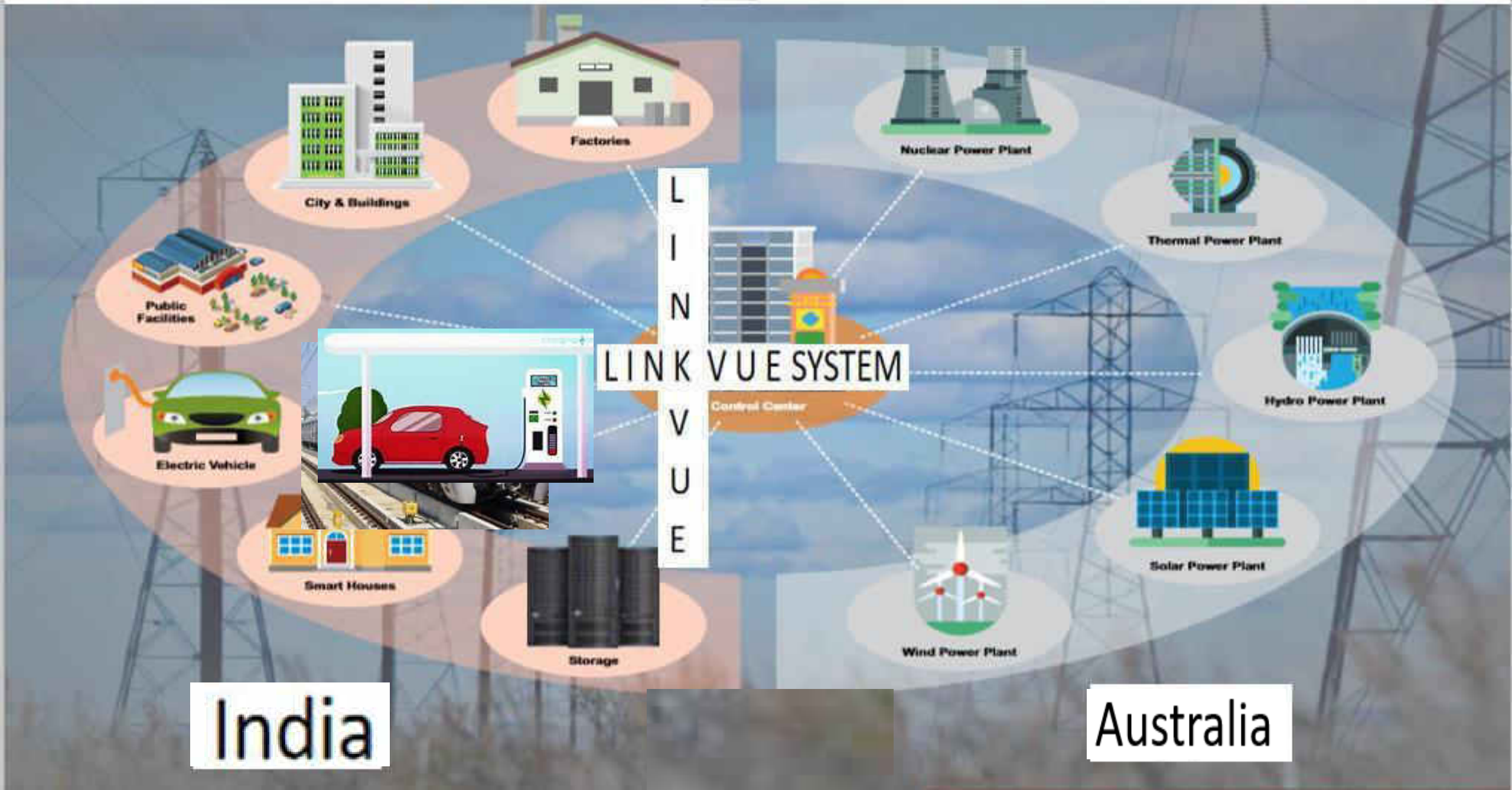


Mahesh Chandra Manav M-9811247237 manav.chandra@linkvuesystem.com www.linkvuesystem.com

IEC 61643-32:2017 describes the principles for selection, installation and coordination of SPDs intended for use in Photovoltaic (PV) systems up to 1 500 V DC and for the AC side of the PV system rated up to 1 000 V rms 50/60 Hz. The photovoltaic installation extends from a PV array or a set of interconnected PV-modules to include the associated cabling and protective devices and the inverter up to the connection point in the distribution board or the utility supply point. This part of IEC 61643 considers SPDs used in different locations and in different kinds of PV systems:PV systems located on the top of a building. PV systems located on the ground like free field power plants characterized by multiple earthing and a meshed earthing system. The term PV installation is used to refer to both kinds of PV systems. The term PV power plant is only used for extended free-field multi-earthed power systems located on the ground. For PV installations including batteries additional requirements may be necessary.

IEC 61643-12:2020 describes the principles for the selection, operation, location and coordination of SPDs to be connected to 50/60 Hz AC power circuits, and equipment rated up to 1 000 V RMS. These devices contain at least one non-linear component and are intended to limit surge voltages and divert surge currents.

Right Solution Partner for your Problems LINK VUE A Genuine Approach Latest Technolgies Adoption



India

Australia

Smart Power Supply System

Energy-efficient windows insulate and reduce noise.

Solar panels let homeowners produce their own power.

Ceiling fans help circulate air.

Heat pump dryers are 40%-50% more efficient than gas dryers.

High levels of **insulation** minimize the effect of outside temperatures on indoor air.

Electric vehicles can run off electricity generated at home!

Induction stoves are safer and healthier to use and keep kitchens cool.

Home appliances use **smart technology** to increase energy efficiency and reduce costs.

Heat pump HVAC systems replace both gas furnaces and air conditioners.

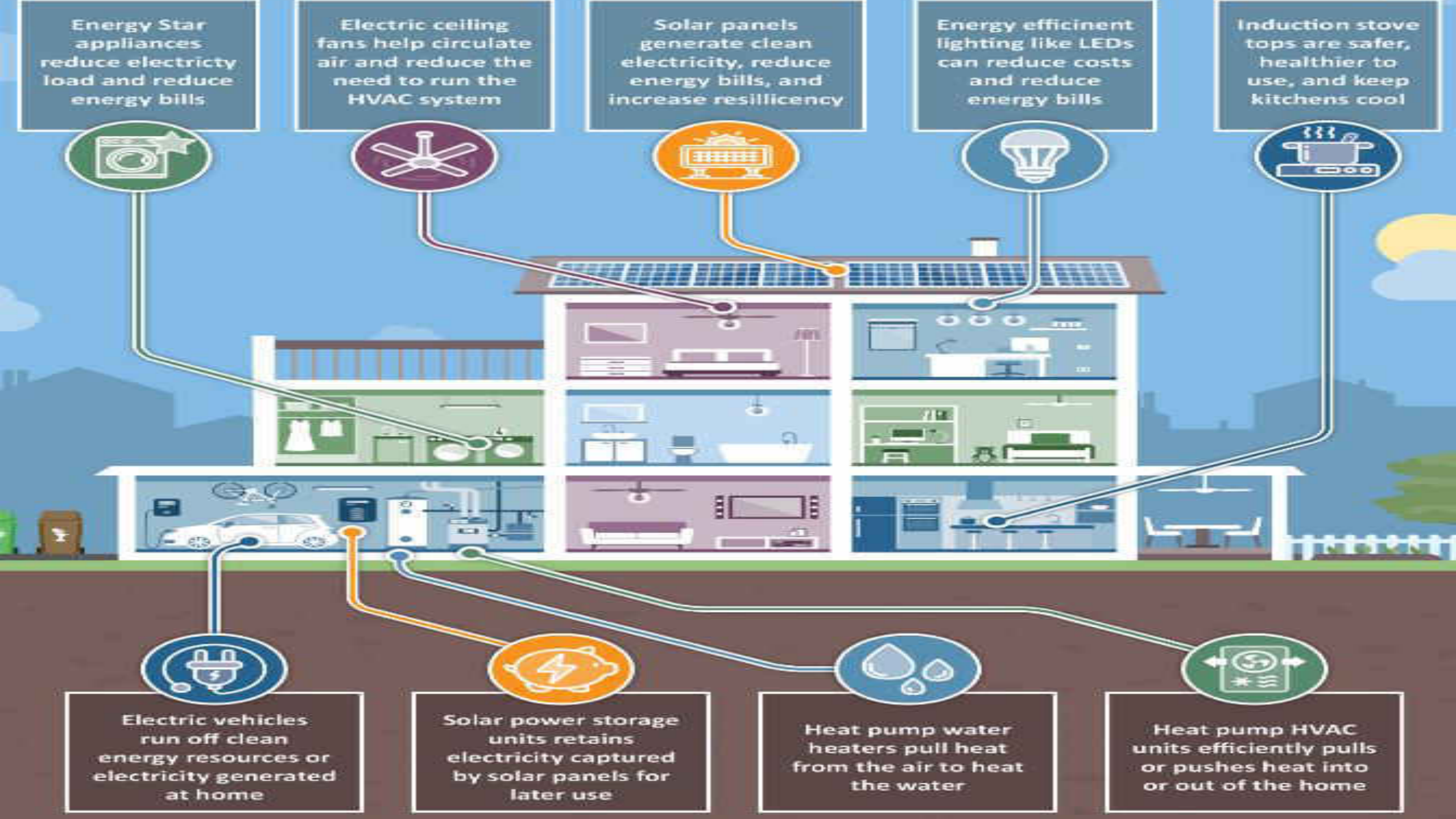
Heat pump water heaters pull heat from the air to heat the water.

Batteries store energy for later use.

Clean All-Electric Features

Clean Energy Features

Energy Efficiency Features


Energy Star appliances reduce electricty load and reduce energy bills
Electric ceiling fans help circulate air and reduce the need to run the HVAC system
Solar panels generate clean electricity, reduce energy bills, and increase resillicency
Energy efficinent lighting like LEDs can reduce costs and reduce energy bills
Induction stove tops are safer, healthier to use, and keep kitchens cool
Electric vehicles run off clean energy resources or electricity generated at home
Solar power storage units retains electricity captured by solar panels for later use
Heat pump water heaters pull heat from the air to heat the water
Heat pump HVAC units efficiently pulls or pushes heat into or out of the home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Link Vue System Pvt Ltd
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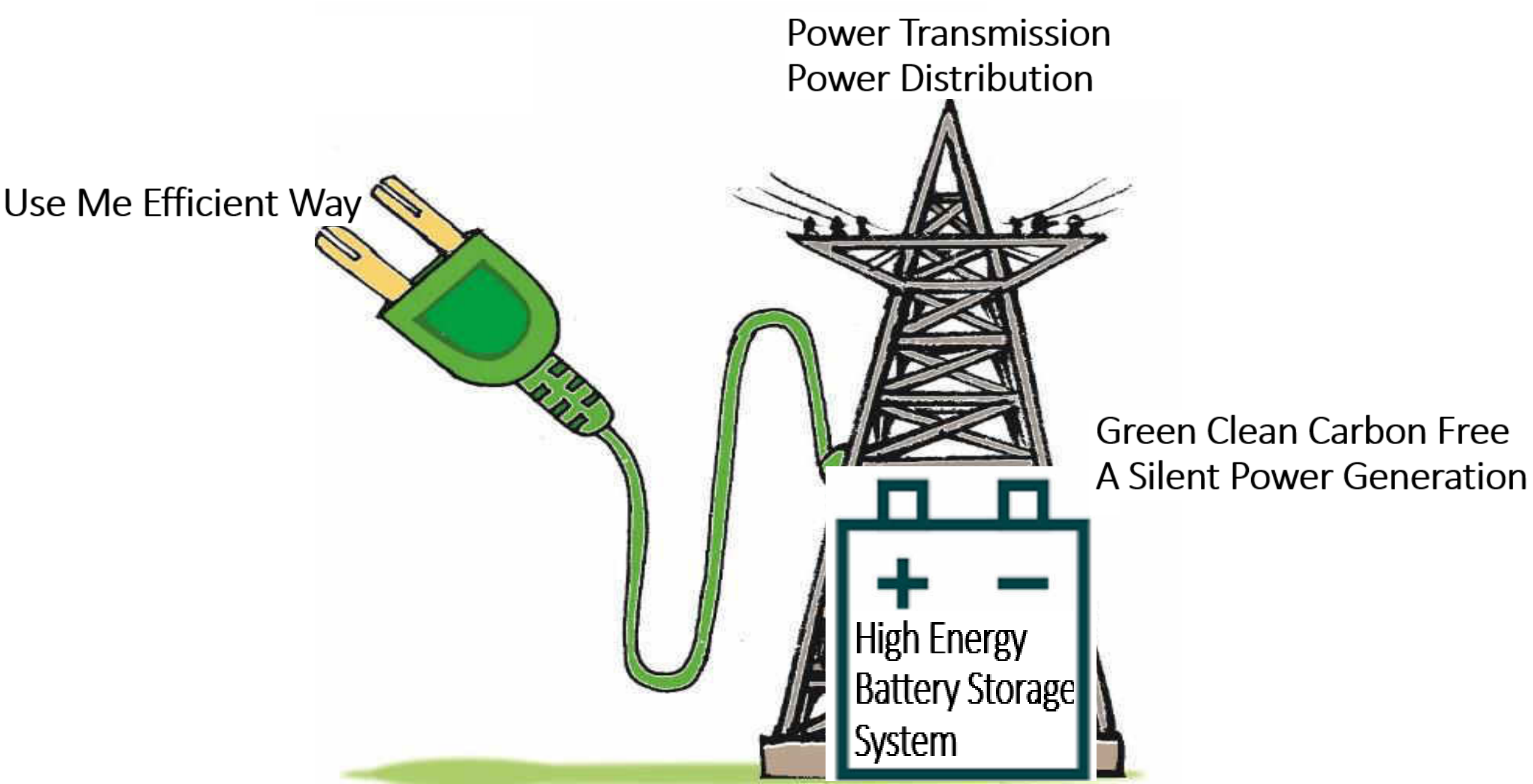
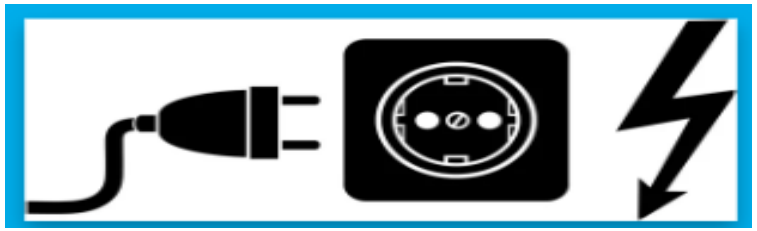
Earthing, Lightning & Surge Protection
Net Working Product Supply & Installation
Ethernet SW, Fiber Optics & Wire Less
Automation Products
Data Logger, RTU's Digital & Analog 1/0's
Protocol Converter, Media Converter,
Cables Connectors & LIU's
Perimeter Intrusion Detection System CCTV,
Fire Alarm, Access Controls & Security System
Cable & Connectors, Plug & Sockets for
Electrical Vehicles, Solar PV, Building Wiring
INDIA
AUSTRALIA

No Body Interested to Know What Behind The Show





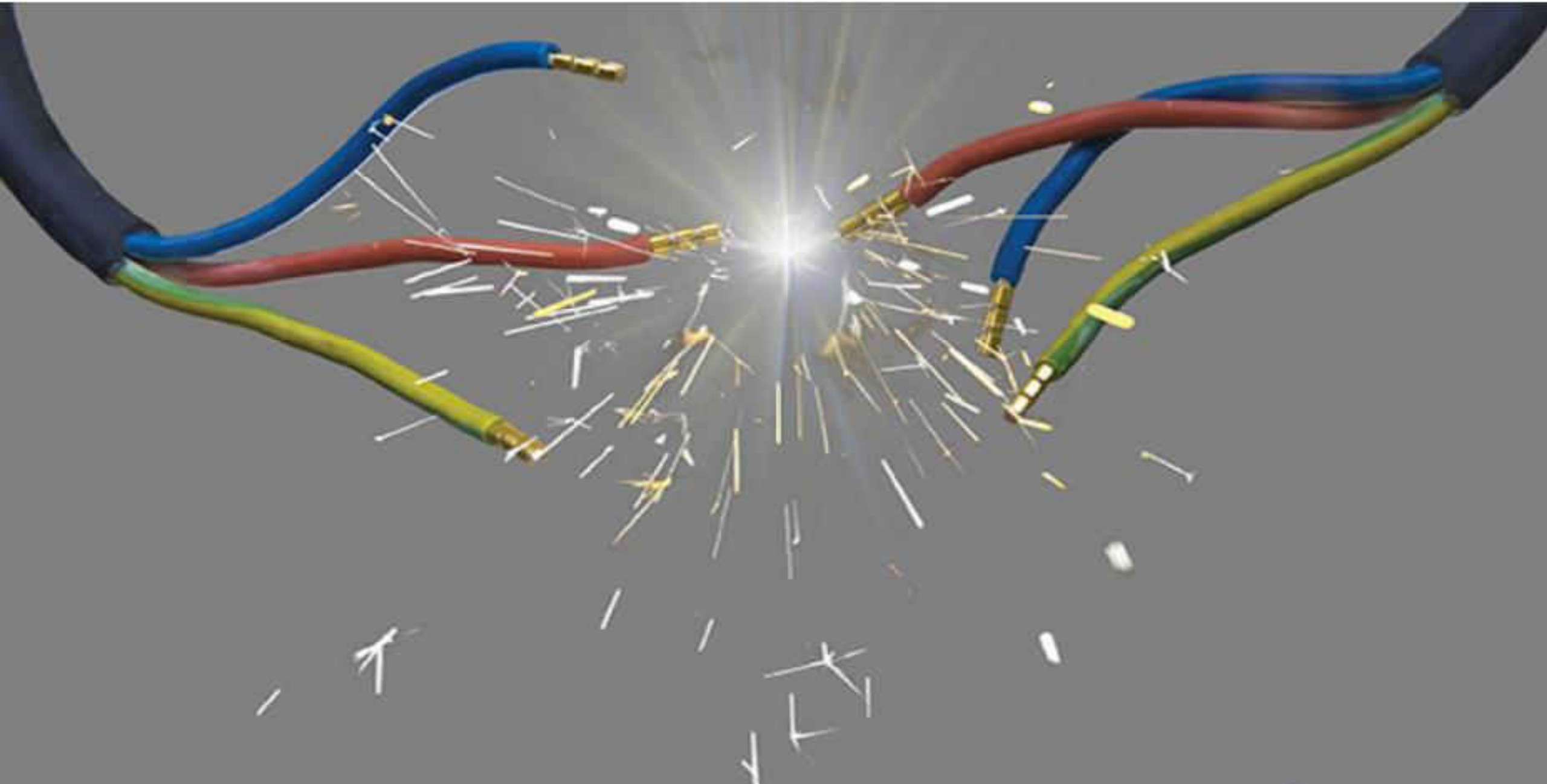
Lightning Overvoltage Protection (Surge Arrester), Transient Damage Equipment's Partially of Fully Shut down plant and Call for Maintenance only best perform with Earthing Value Maintained Ensure Effective Earthing Path

Common Causes of Electrical Problems in Your Home

Fire Accident Burj Khalifa Dubai
November 2022

- Overloading
- Electrical Surges
- Power Sags And Dips
- Uncovered Junction Box
- Light Switches Are Not Working
- Flickering Light
- Limited Outlets
- Lack Of GFCIs
- Overwired Panel
- Aluminum Wiring
- Backstabbed Wires
- Electric Shock

Joints should be handle by Experts



CABLE SIZING CALCULATION CRITERIA-1

when sizing low voltage (LV) cables, the minimum cross-section should be calculated using various criteria such as short-circuit current capacity, current-carrying capacity, and voltage drop of the cable. These criteria ensure the safe and efficient operation of the cable

Short Circuit Current Capacity: The short circuit current capacity determines the maximum current that the cable can safely carry without damage or failure due to overheating. The cable must be able to withstand the high short-circuit current that may occur in the event of a fault. This calculation considers the maximum fault current expected at the point of installation, the duration of the fault, and the cable's thermal withstand capability

$$A = \frac{Isc * \sqrt{t}}{k}$$

A	=	Cable cross-section area in Sq. mm
I_{sc}	=	Short circuit current
K	=	Constant, 143 for XLPE Cu. Cable
t	=	Duration of short-circuit in seconds

Current Carrying Capacity: The current carrying capacity calculation is based on the amount of current that the cable can continuously carry without exceeding its maximum operating temperature. This calculation considers factors such as the cable's insulation, the ambient temperature, and the cable's installation method, which can affect the heat dissipation of the cable.

$$\text{Full load current I} = \frac{P}{1.732 \times V \times Cos\emptyset}$$

CABLE SIZING CALCULATION CRITERIA -2

$$V_{(Running)} = \frac{1.732 \times I(R\cos\emptyset + X\sin\emptyset) \times L \times 100}{V \times n \times 1000}$$

L	=	Length of cable (m)
R	=	Cable resistance at 90°C – Ohm/km
X	=	Cable reactance at 50 Hz
I	=	Rated current (A)
n	=	No. of Parallel runs
cos ø	=	Power factor
I_{st}	=	Starting current
cos $ø_{st}$	=	Power factor at starting

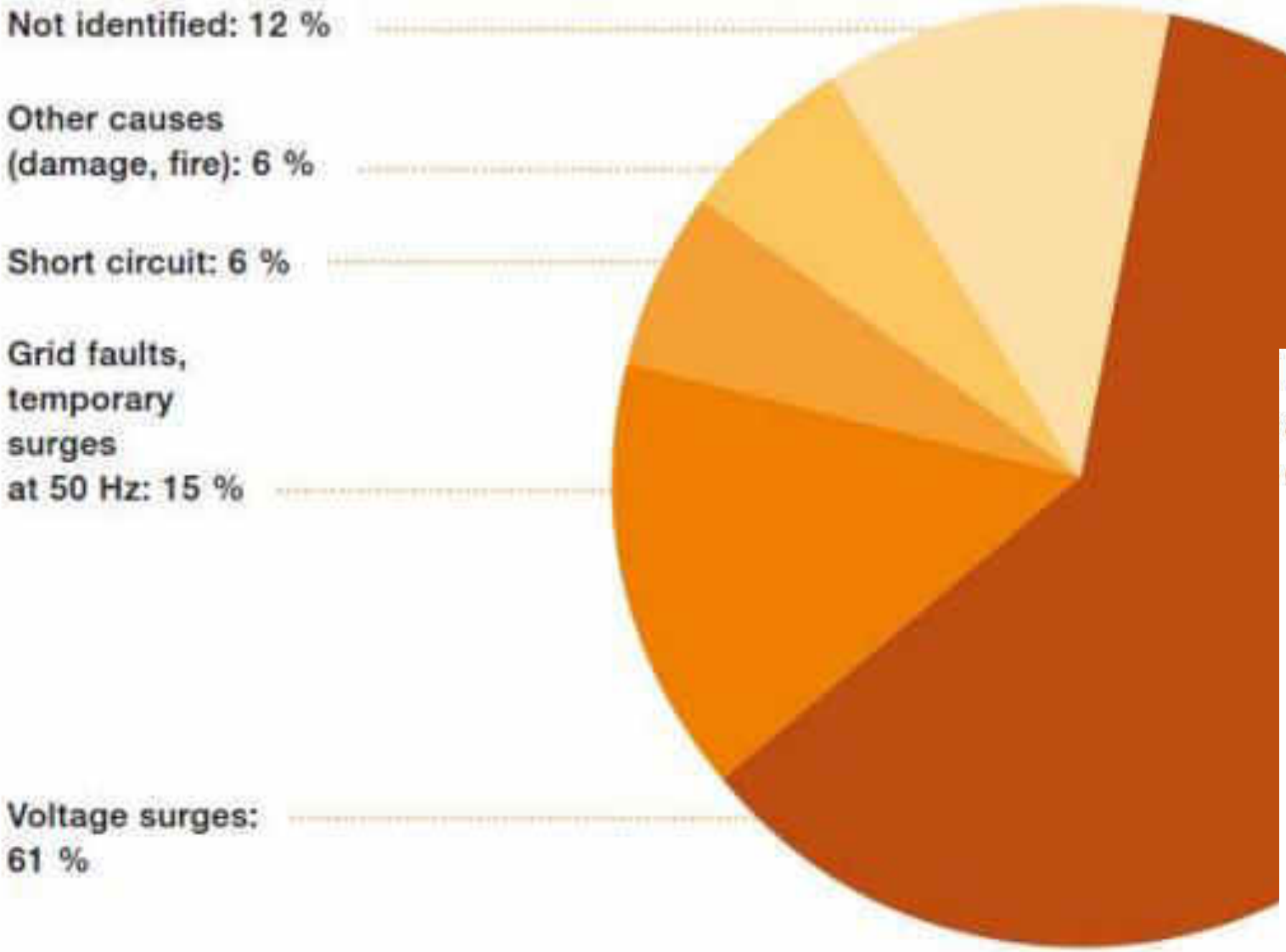
$$V_{(Starting)} = \frac{1.732 \times Ist(R\cos\emptyset st + X\sin\emptyset st) \times L \times 100}{V \times n \times 1000}$$

Voltage Drop of Cable: The voltage drop calculation determines the voltage drop along the length of the cable, which can affect the performance of the connected equipment. The voltage drop is calculated based on the cable length, the current flowing through the cable, and the cable's resistance

The voltage drop during running must be less than 3% (V(Running) < 3%)

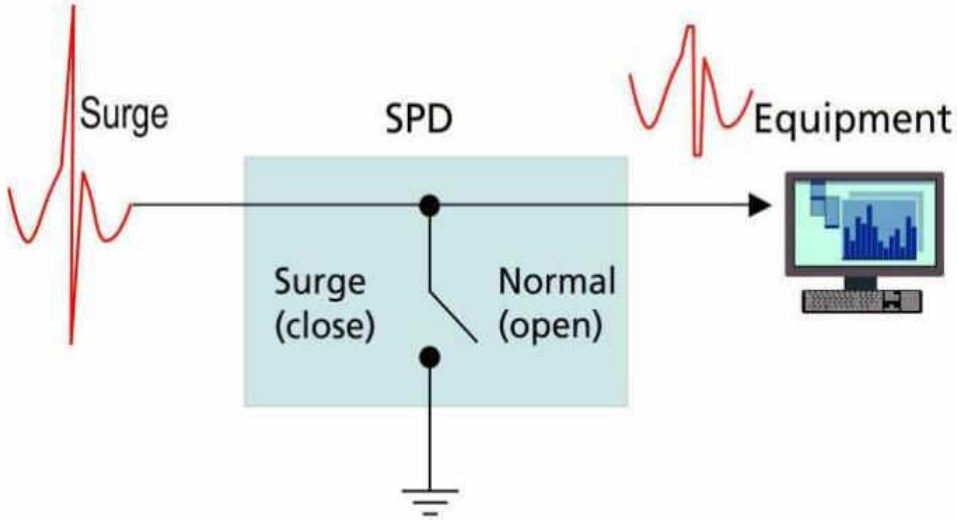
The voltage drop during starting must be less than 10 to 15% (V(Starting) <10-15%)

Surge Damage Your Systems It's Serious Topic Let Understand



Damage to electronic equipment. Analysis conducted in France for the residential segment by AVIVA, the sixth largest insurance company in the world (www.aviva.com)

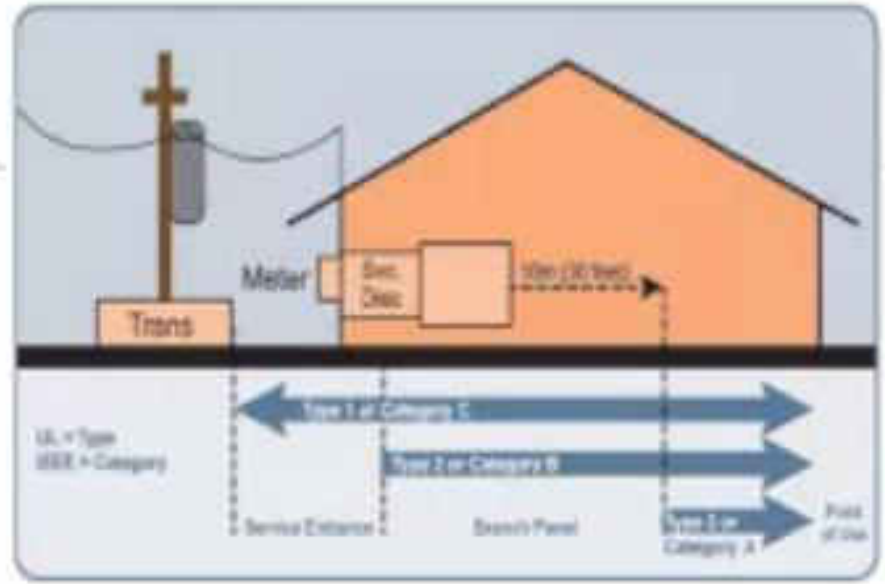
Divert surge currents and limit over-voltages, survive and repeatedly protect personnel, buildings and equipment

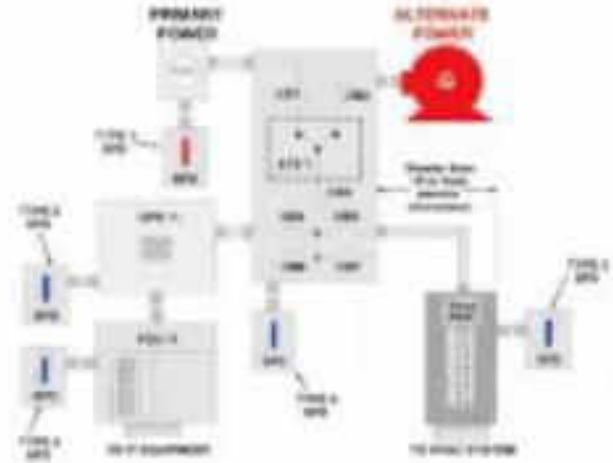


Types by Location – UL1449

Type 1	• **Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of service equipment** • **Installed without use of external overcurrent protective device**
Type 2	• Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device
Type 3	• Point-of-utilization SPDs • Installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel
Type 4	• The component assembly consisting of one or more Type 5 components (typically MOV or SASD) • Must comply with limited current tests and In • Not tested as standalone devices to intermediate and high current faults

Note Type 5 – Discrete component SPD (MOV or SASD)





UL / ANSI 1449 – Types by location

Products

Surge Protector

Type 1 SPD-lightning current arresters

Combined, spark gap and MOV
Iimp 25 kA / 100 kA Up ≤ 1.5 kV
No follow current, zero leakage current
Full coordination with Type 2 SPD

Type 2 SPD – surge arresters

Combined, spark gap and MOV
U c 75 to 760 V AC
In 20 kA / Imax 40 kA
Up ≤ 1.35 kV

Type 1 and 2 SPD -combined arresters B+C

Combined, spark gap and MOV
Iimp 12.5 kA / 50 kA
Up ≤ 1.5 kV
No follow current, zero leakage current

SPD PV - surge arrester

Combination of MOV and spark gap
PV Type 2 SPD
MOV surge arrester
UCPV 170 to 1500 V DC
In 15 to 20 kA
Imax 40 kA

TV Fridge guard and surge protector

TG-01

Universal / BS / Euro socket

FG-01

N1050 with surge

MCS: Mini-Columns Socket

FZ-551

Aluminum profile stand pole socket with base

FZ-531A/B

Single side 350/660mm aluminum profile

Acryl cover

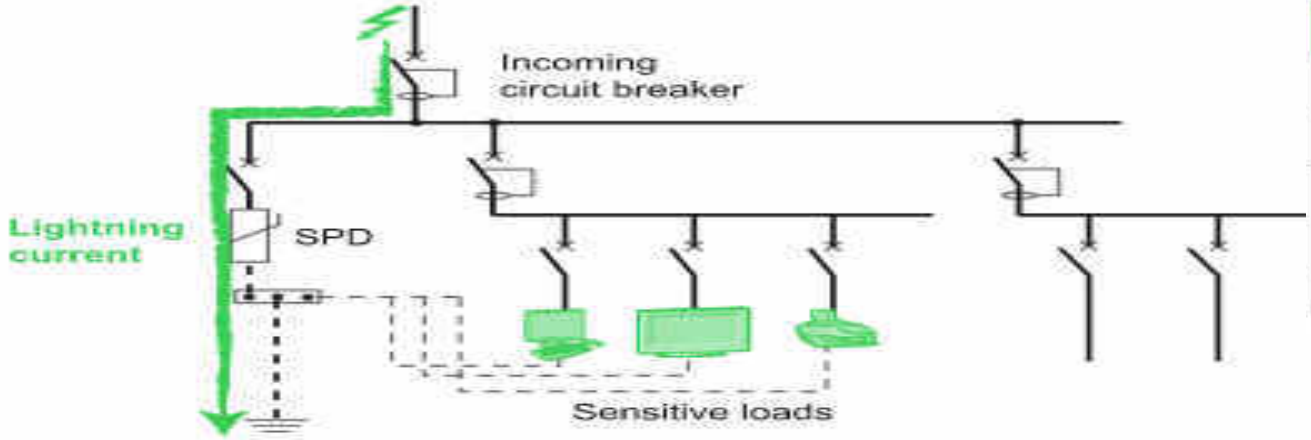
FZ-532A/B

Dual side 350/660mm aluminum profile

FZ-S66

FZ-A66

IP66 power painted stainless steel stand pole



	Direct lightning stroke	Indirect lightning stroke	
IEC 61643-1	Class I test	Class II test	Class III test
IEC 61643-11/2011	Type 1 : T1	Type 2 : T2	Type 3 : T3
EN/IEC 61643-11	Type 1	Type 2	Type 3
Former VDE 0675v	B	C	D
Type of test wave	10/350	8/20	1.2/50 + 8/20

Note 1: There exist T1 + T2 SPD (or Type 1 + 2 SPD) combining protection of loads against direct and indirect lightning strokes.

Note 2: some T2 SPD can also be declared as T3.

SPD is designed to limit transient overvoltages of atmospheric origin and divert current waves to earth, so as to limit the amplitude of this overvoltage to a value that is not hazardous for the electrical installation and electric switchgear and controlgear.

SPD eliminates overvoltages

- in common mode, between phase and neutral or earth;
- in differential mode, between phase and neutral.

In the event of an overvoltage exceeding the operating threshold, the SPD

- conducts the energy to earth, in common mode;
- distributes the energy to the other live conductors, in differential mode.

The three types of SPD

Type 1 SPD

The Type 1 SPD is recommended in the specific case of service-sector and industrial buildings, protected by a lightning protection system or a meshed cage.

It protects electrical installations against direct lightning strokes. It can discharge the back-current from lightning spreading from the earth conductor to the network conductors.

Type 1 SPD is characterized by a 10/350 µs current wave.

Type 2 SPD

The Type 2 SPD is the main protection system for all low voltage electrical installations. Installed in each electrical switchboard, it prevents the spread of overvoltages in the electrical installations and protects the loads.

Type 2 SPD is characterized by an 8/20 µs current wave.

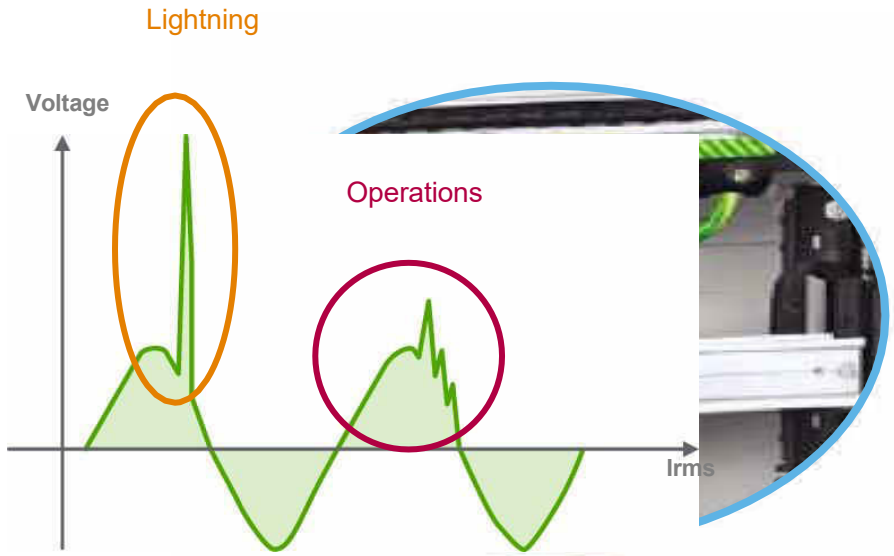
Type 3 SPD

These SPDs have a low discharge capacity. They must therefore mandatorily be installed as a supplement to Type 2 SPD and in the vicinity of sensitive loads.

Type 3 SPD is characterized by a combination of voltage waves (1.2/50 µs) and current waves (8/20 µs).

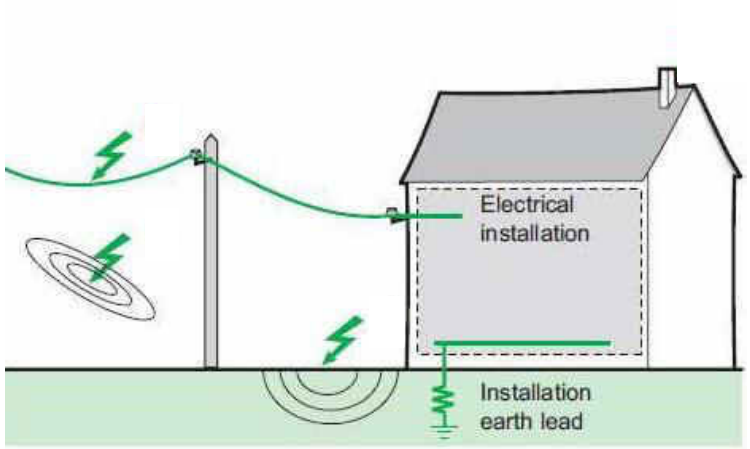
Electrical Overvoltage, Lightning and Transients

Sources	Characteristics
• Lightning	• Ultra-rapid transient phenomenon. Unit of measurement = kV/ μs • Highly destructive energy.
• Overvoltage generated by operations or incidents on the network.	• Repetitive phenomenon leading to premature aging. • Malfunction which may even result in permanent damage.



Lightning and its Consequences

- The main effect of lightning is **electrical overvoltage** which exposes the electrical installations to **a serious risk** of:

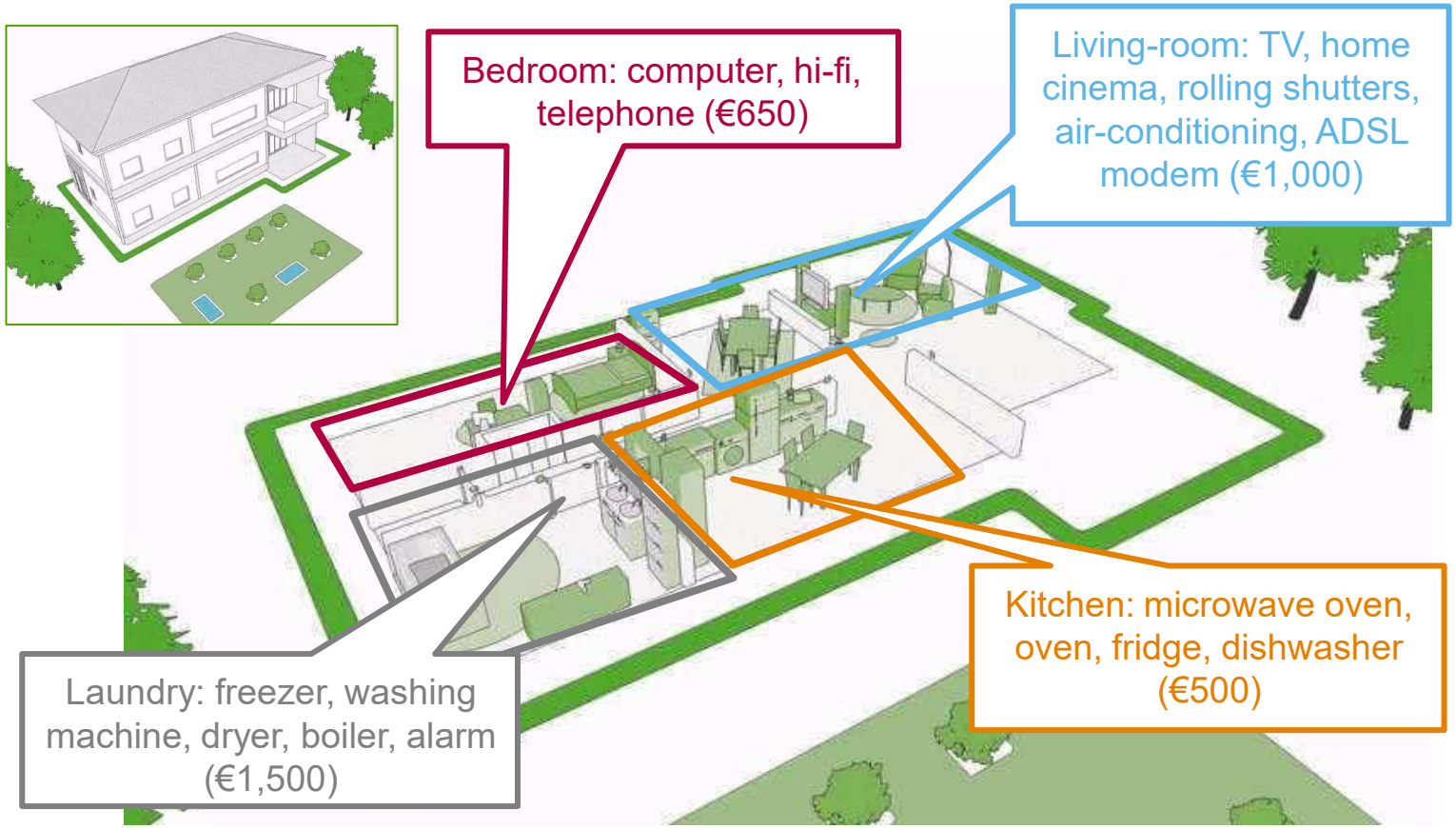


- malfunction,
- destruction of equipment,
- unavailability of production tools,
- etc.

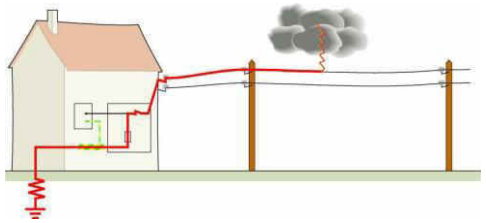
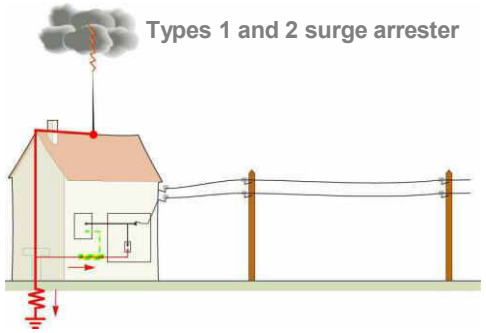
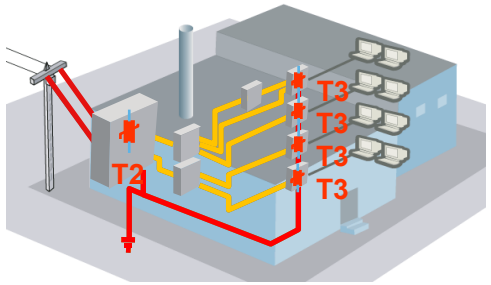
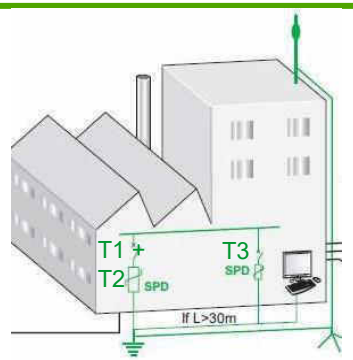
→ **The overvoltages come either from the electricity network or from the earth.**

The Damage Caused by Lightning

- **90%** of sockets power sensitive equipment and an overvoltage can damage them (Total values estimated amount



A means of Protection for Every Situation with and without Lightning Protection Installation at Permises

	No LPS*	With LPS*
Distance of the loads < 30m	Type 2 surge arrester 	Types 1 and 2 surge arrester 
Distance of the loads > 30m**	 Types 2 and 3 surge arrester	 Types 2, 1 and 3 surge arrester

Type of surge arrester

T1: only used when LPS is present

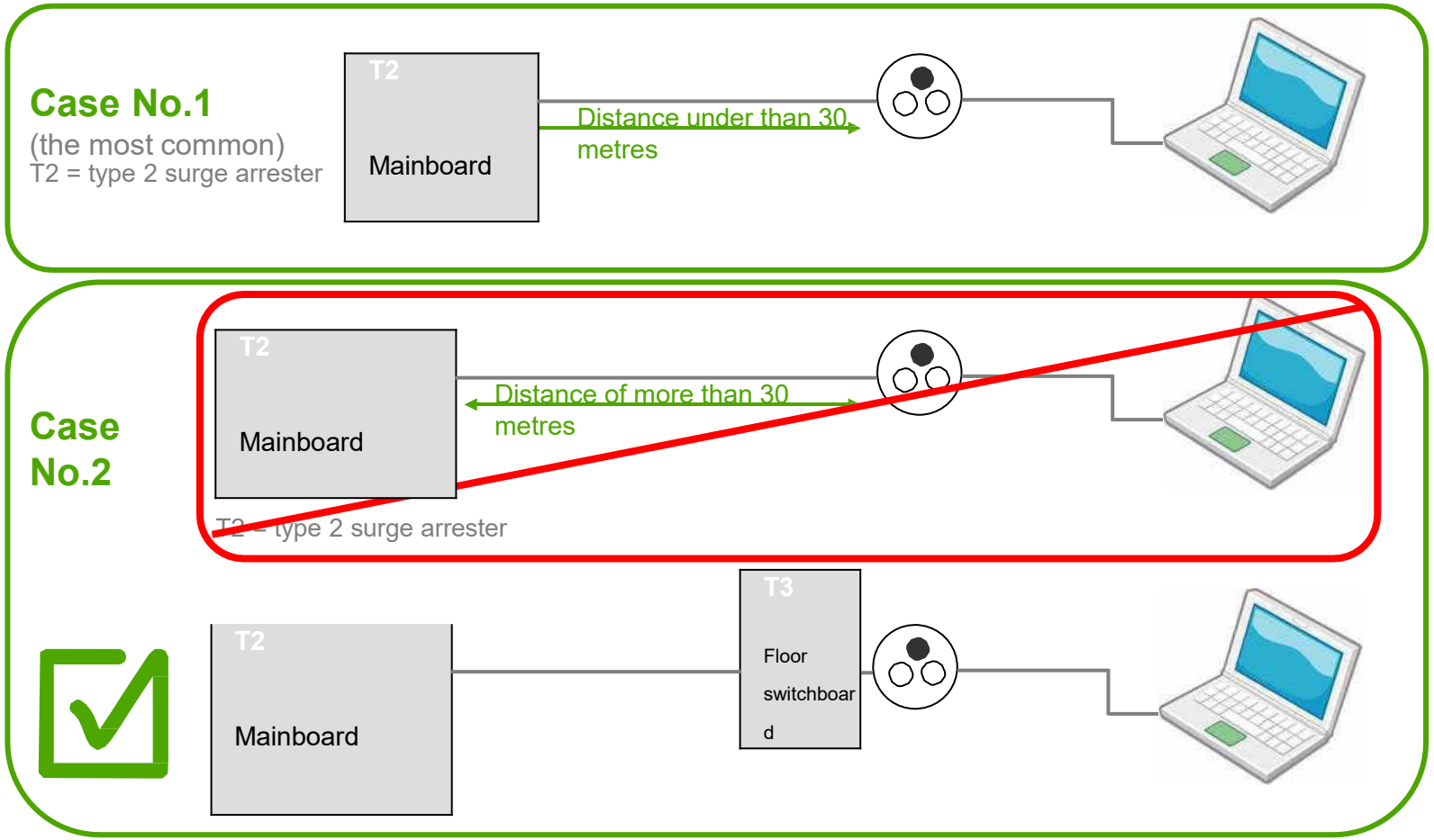
T2: used systematically.

T3: only used in addition to a T2 (as lower discharge capacity), if the loads are more than 30m from the incoming T2 surge arrester

** LPS (Lightning Protection System) = lightning rod, meshed cage on buildings)*

*** After 30m (between the surge arrester and the loads) lightning wave reflection phenomena appear in the cables.*

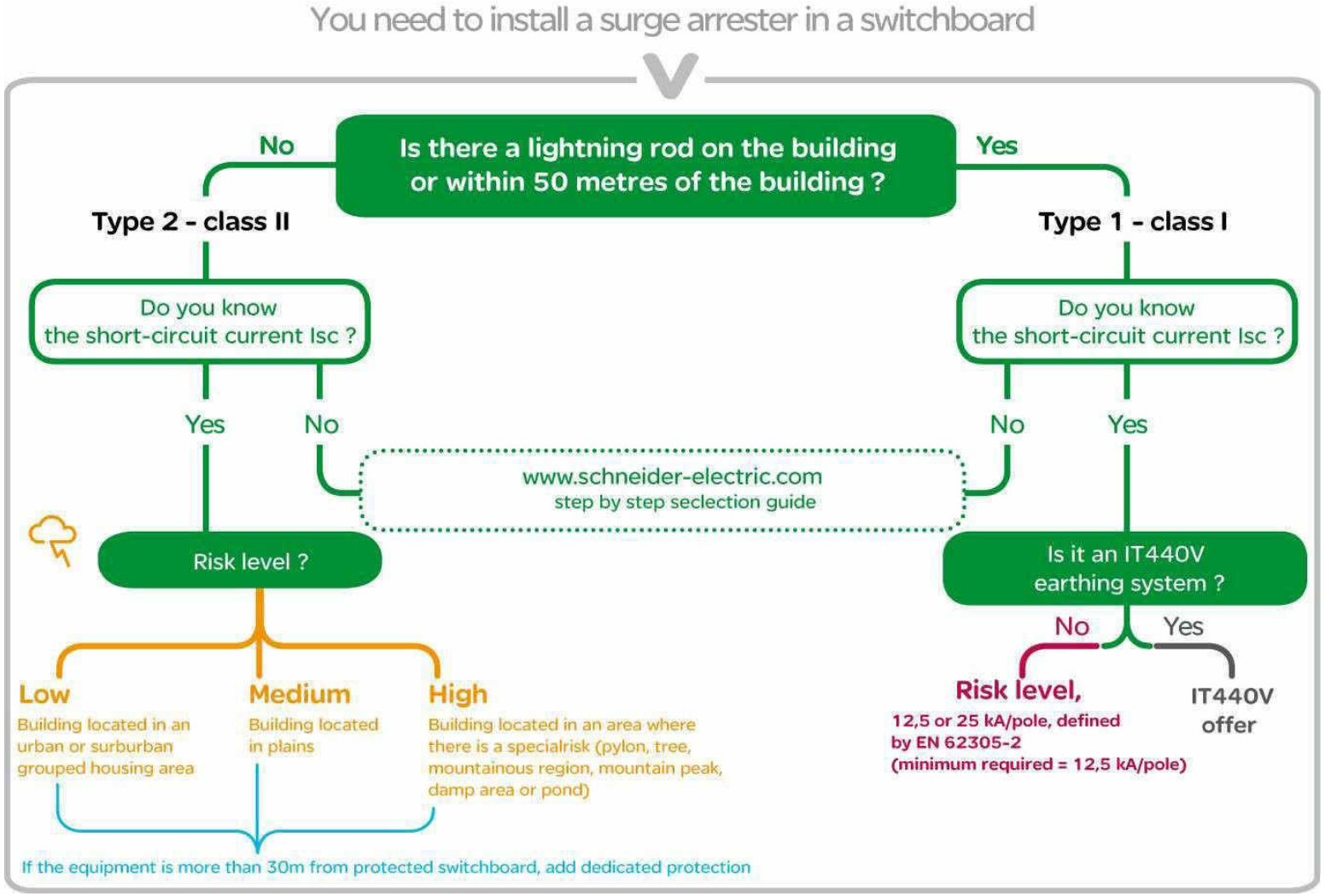
In practice: distance of Equipment's >30 Meters



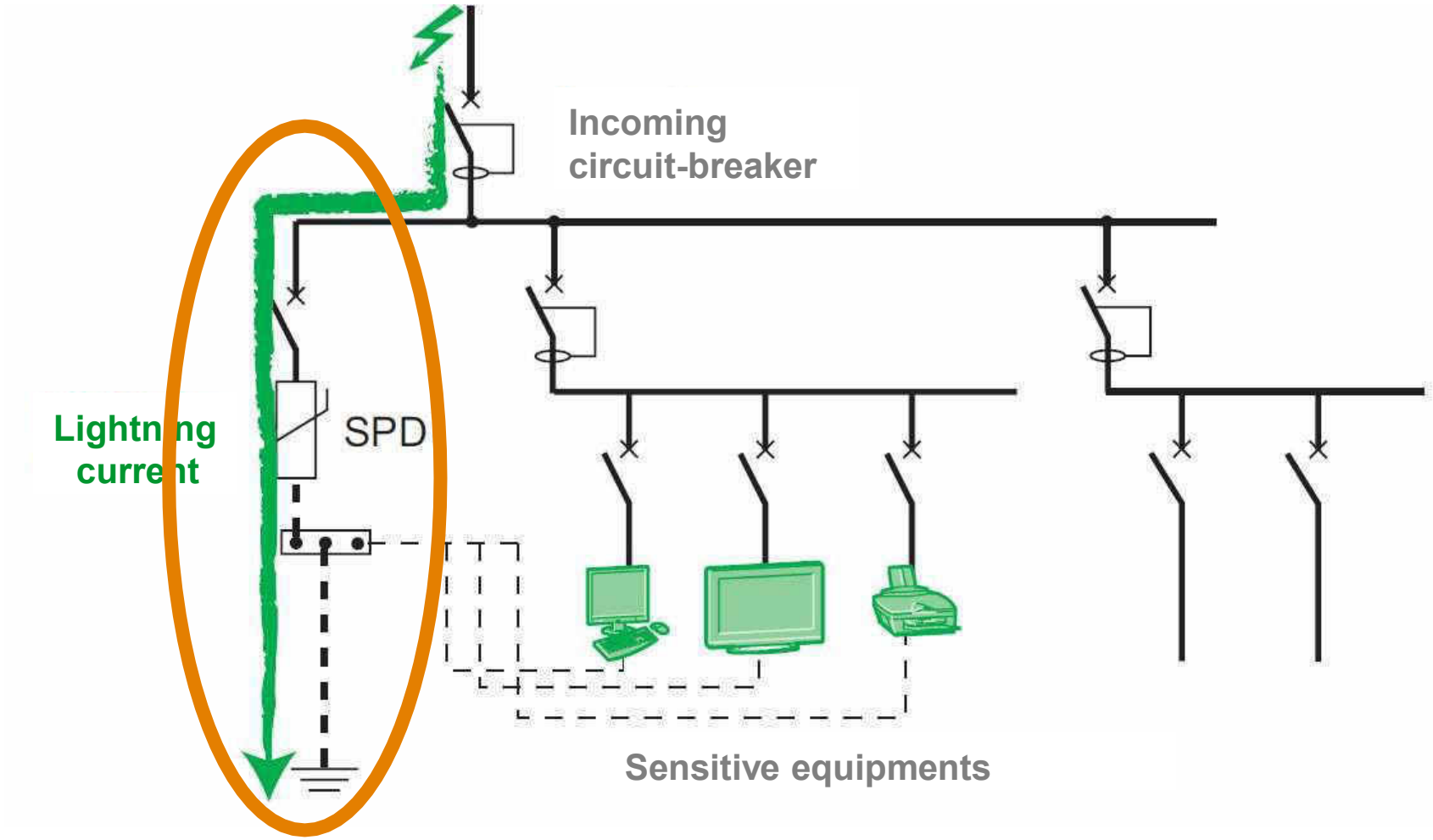
Install the surge arrester as close as possible to the sensitive equipment

** T2 = type 2 surge arrester, T3 = type 3 surge arrester.*

Surge Protection Important and Compulsory for all Incoming Power Line and Power Distribution Location before Power Entry into Equipment's



Location in the switchboard: in parallel

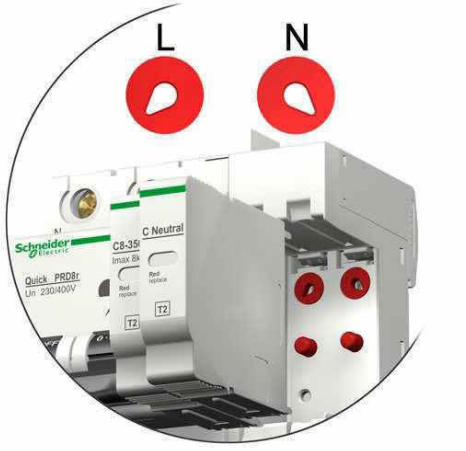


** SPD = Surge Protection Device.*

Lifetime of the surge arrester

- The surge arrester has the same lifetime as the **switchboard**.

- At the end of its life, a thermal protector integrated into the surge arrester:
  - isolate the surge arrester from the rest of the installation.
  - activates the red end-of-life warning light, indicating that the surge arrester needs to be changed.



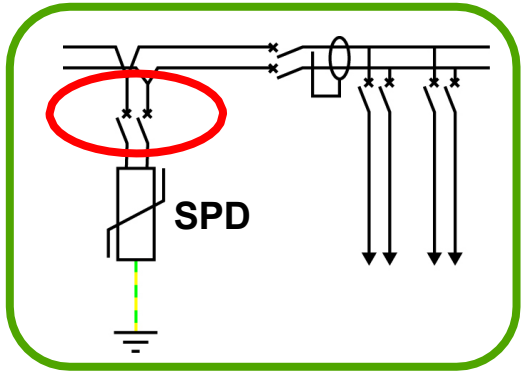
The Upstream Protection of the Surge Arrester

- The role of the surge arrester is to drive the lightning current to the earth in a **very short time** (< 350 microseconds).

- However, the surge arrester is not **intended to be exposed to a permanent overvoltage** (phase/neutral inversion, or neutral rupture). In this case, it would be short-circuited and may damage the switchboard.

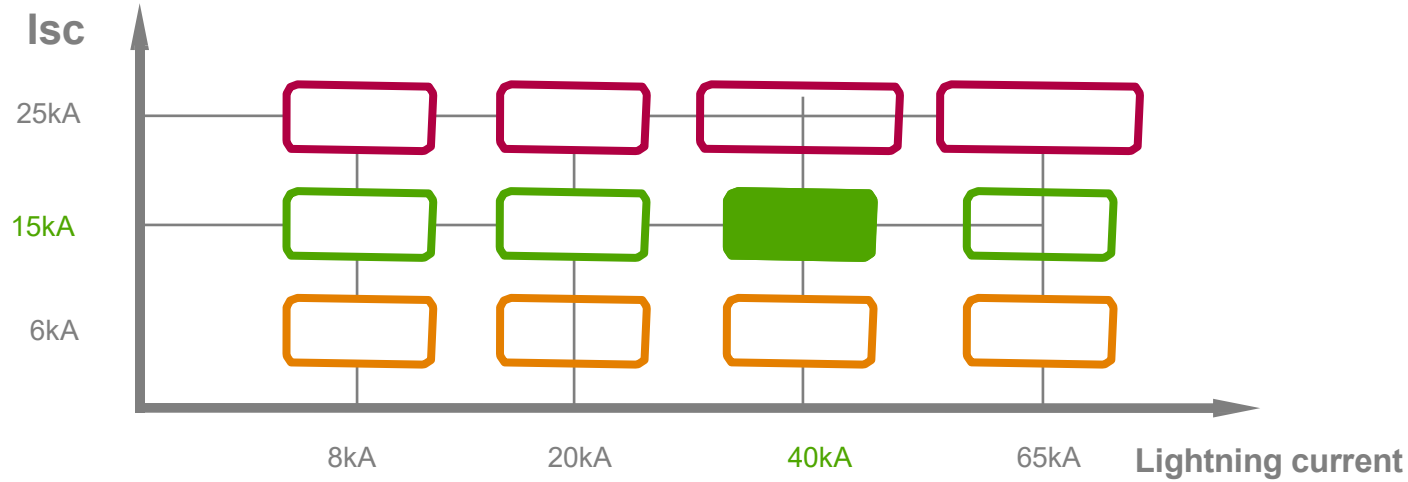
- A device protecting the surge arrester against short circuits is therefore required to ensure the safety of the electrical installation.

→ The surge arrester must be **protected upstream** by a **disconnection circuit breaker**.



2 Aspects Must be Taken into Account

- When making your choice, take into account:
  - lightning current withstand capacity (to avoid nuisance trpping),
  - short-circuit withstand capacity of the installation (Isc).

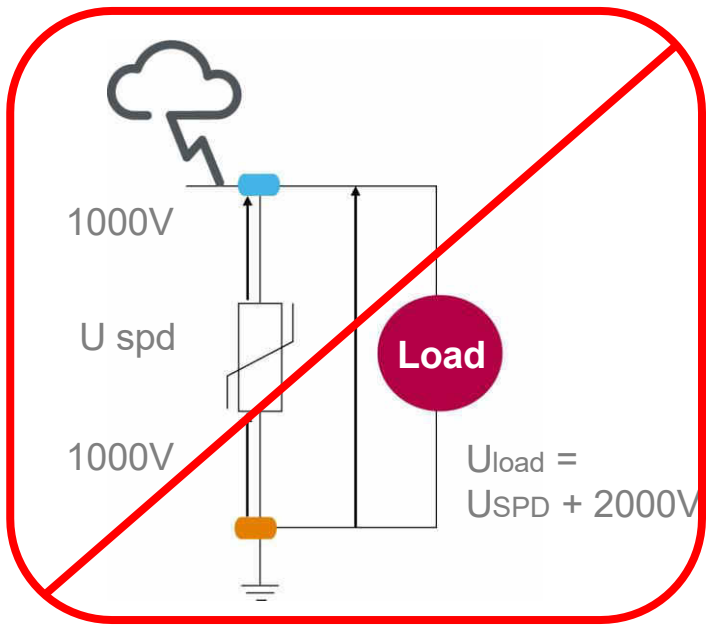


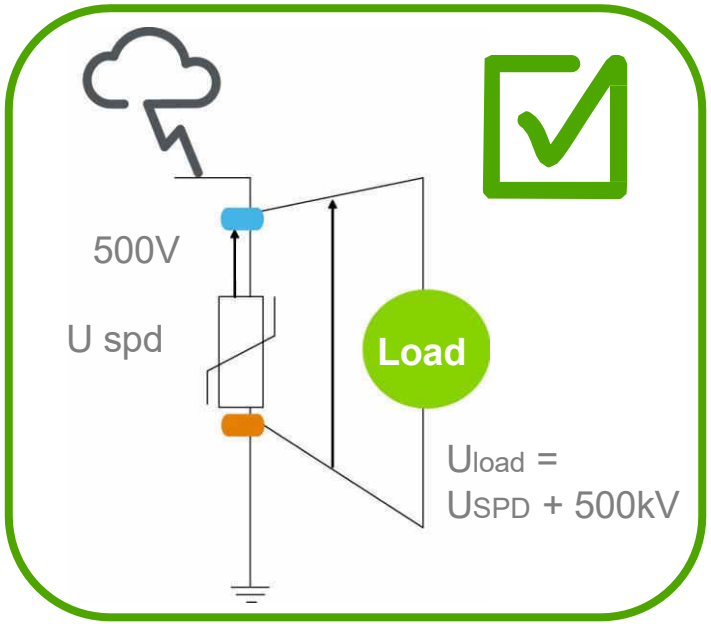
- E.g. the best disconnection circuit breaker for a breaking capacity of 15kA and Imax of 40kA is a C60H.

The Surge Arrester/Protection device as per Lightning Current May Enter into Equipment's /Systems Indoor Outdoor

Installing a Surge Arrester

- Lightning is a phenomenon that generates a high frequency voltage:
  - The **length of the cables** must be taken into account in cases of high frequency
- 1 Meter of cable crossed by a lightning current generates an overvoltage of 1,000V.

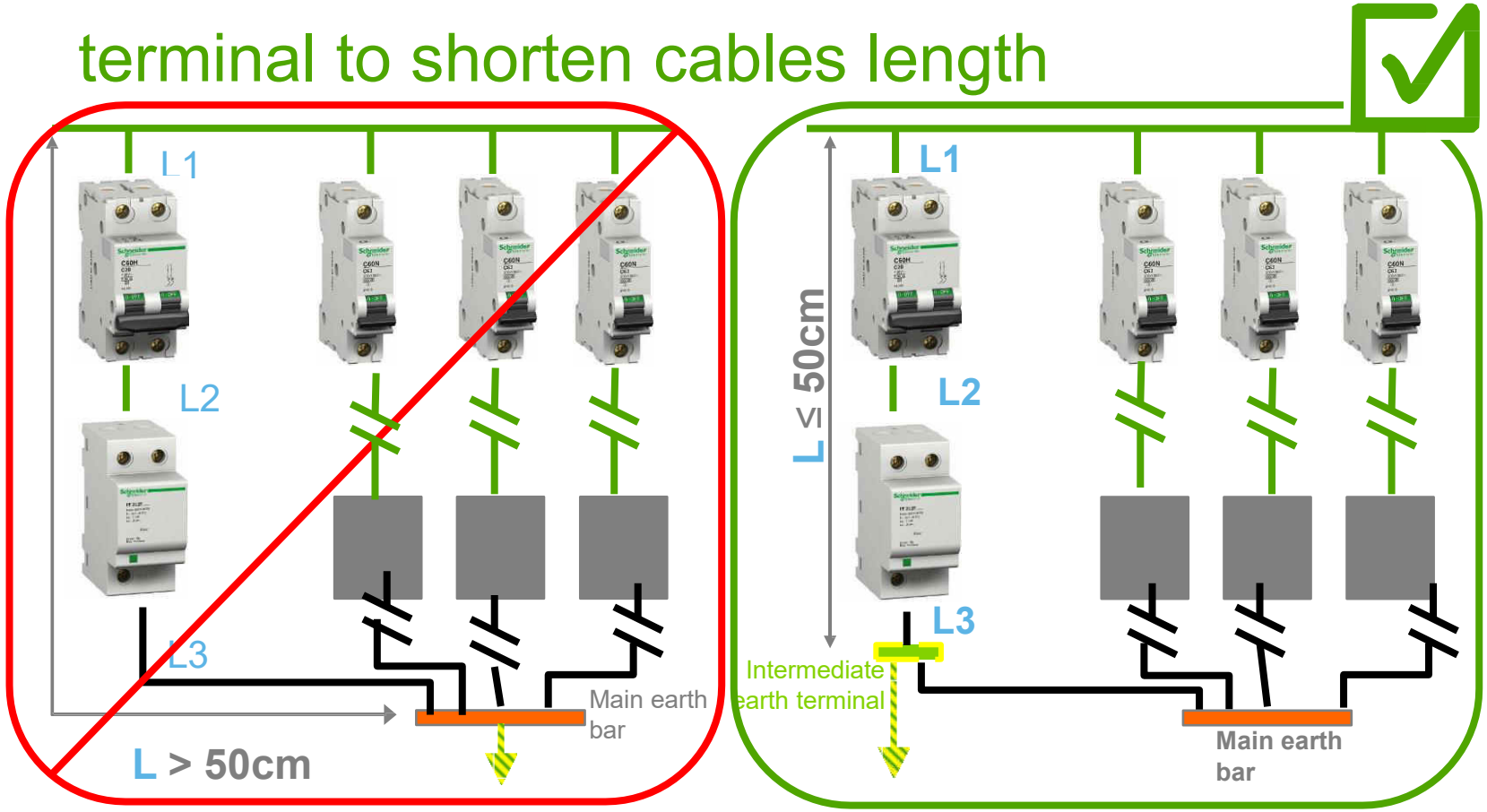




For an effective surge protection, shorten the length of cables.

In practice: Consider the Intermediate Earth

terminal to shorten cables length

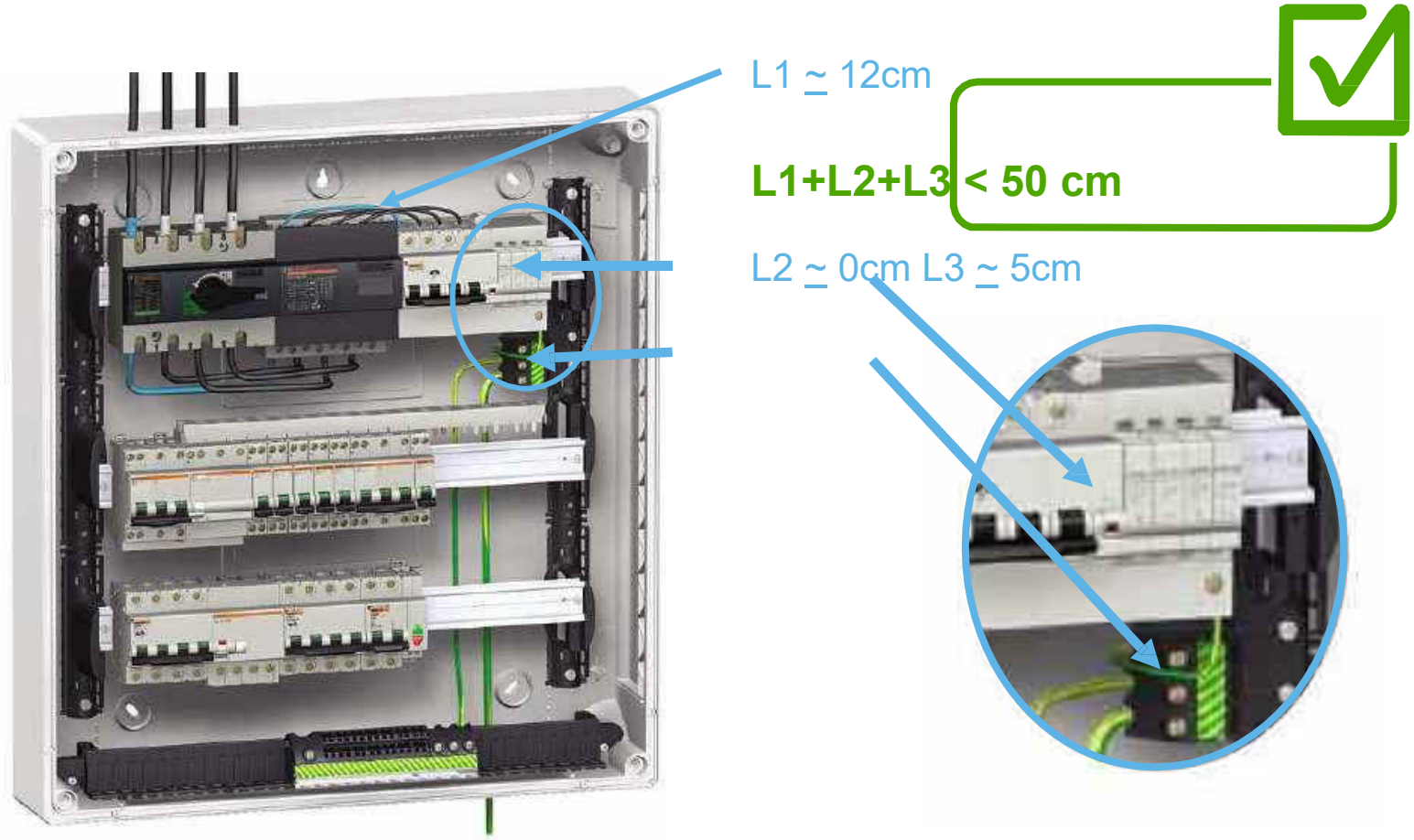


Mandatory in Standard IEC 60364-5-534:

- L (length of cables) < 50cm,
- cable cross-section S < 4mm²(Type 2) and S< 16mm² (Type 1).

L = L1 + L2 + L3

Installation in a plastic enclosure should be Avoid



Main incoming earth via the bottom
(main earth bar and intermediate earth terminal).

Installation in a plastic enclosure should be Avoid

Incoming earth cable via the top
(main earth bar and intermediate earth terminal).

Installation in a metal enclosure Preference Metal Body Junction Box

- Directly on "metal chassis".

- Use a lock washer to connect the cable to the chassis to give a good electrical contact.

→ The installation is possible only if the enclosure complies **with standard IEC 60439-1.**

ELECTRICAL DISTRIBUTION PROTECTION

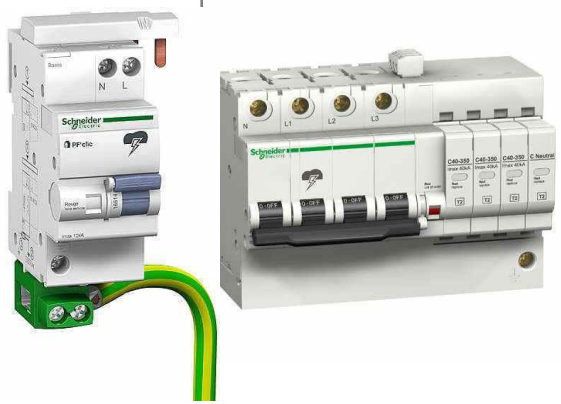
Protection of people

Circuit protection

Against permanent failure (due to overcurrent, overload, earth fault)

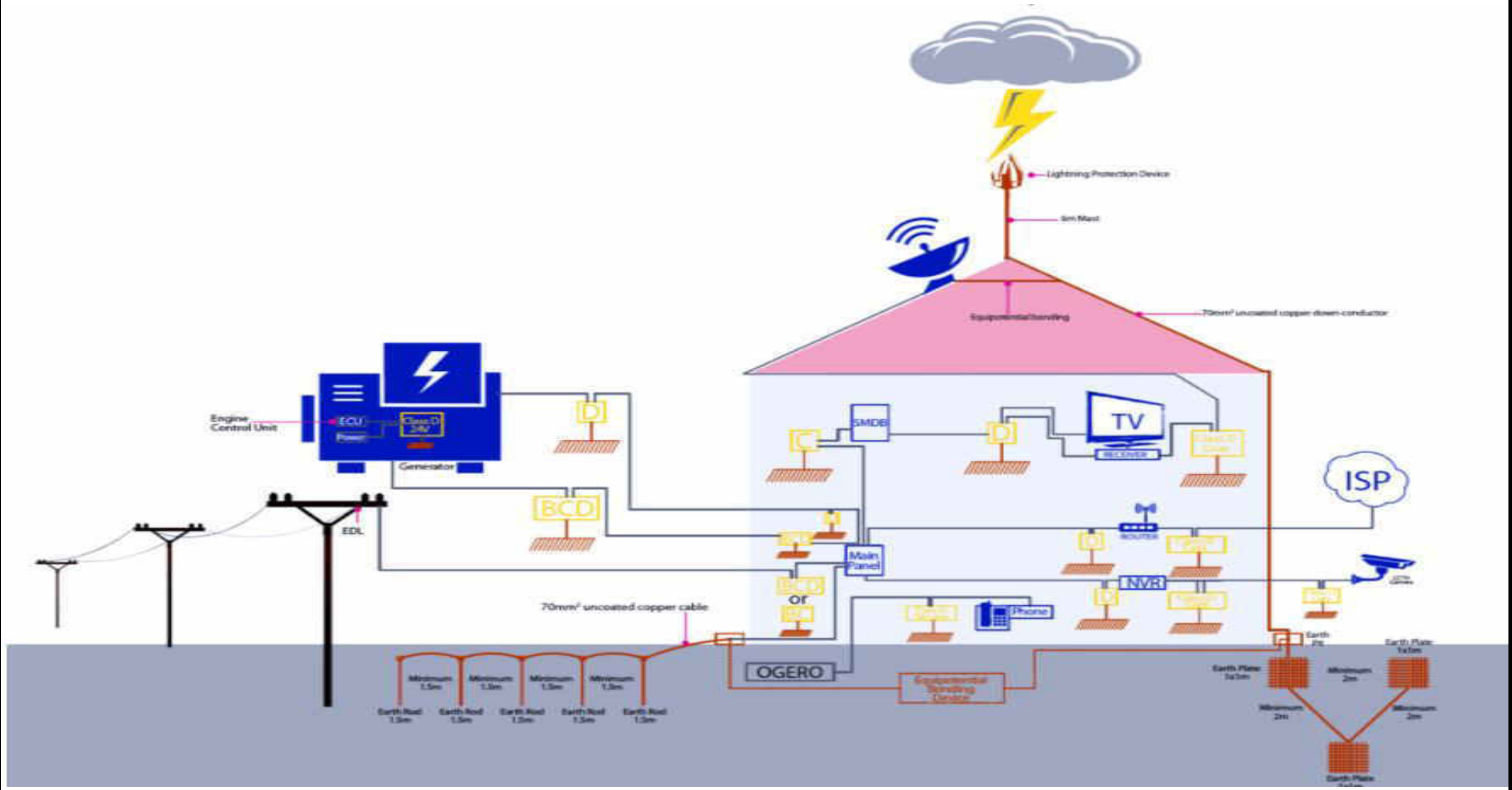
Protection of sensitive equipment

Against temporary failure (overvoltage, lightning)

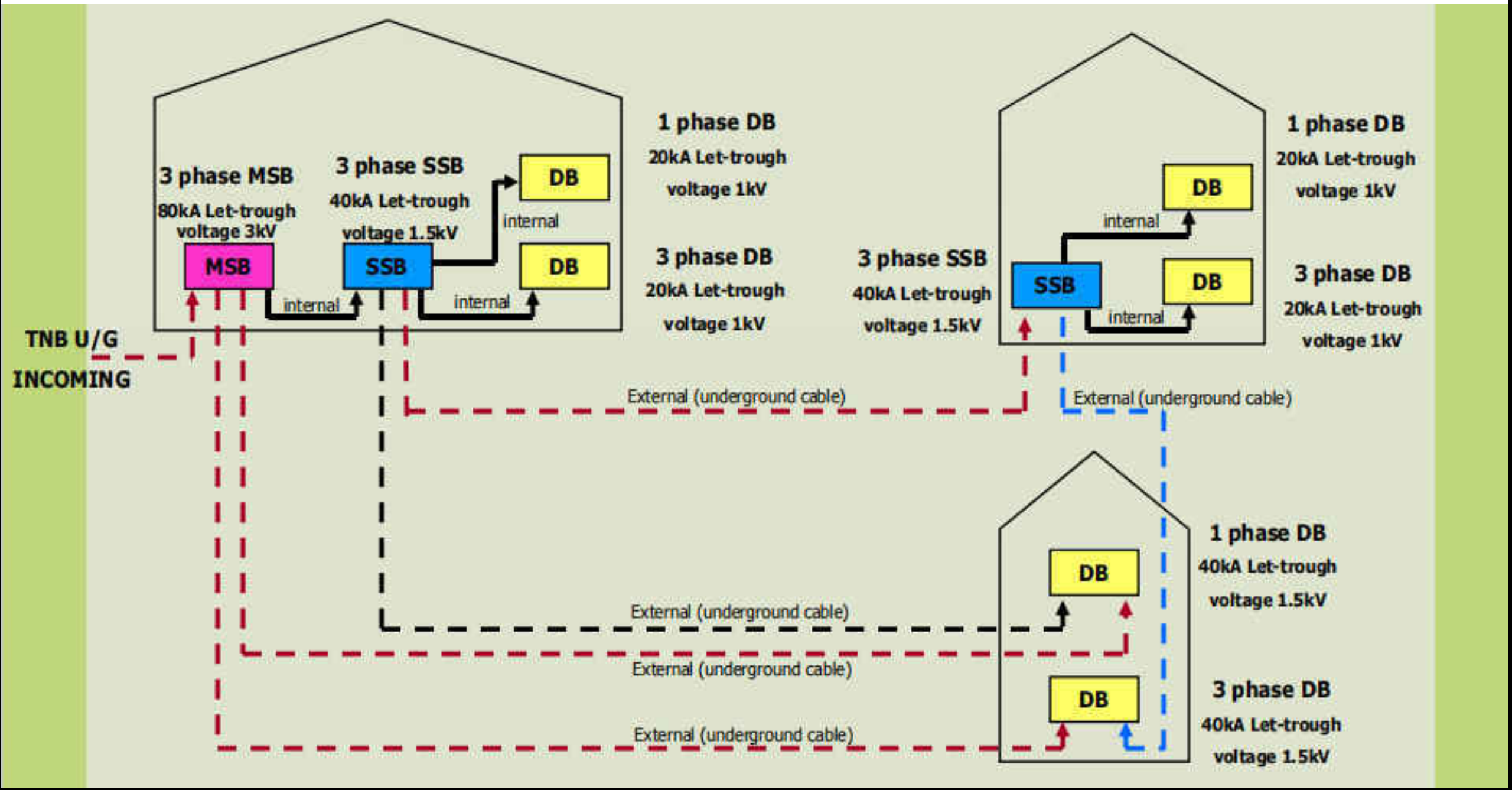


In the low-voltage system, the surge arrester is essential to **ensure complete protection**.

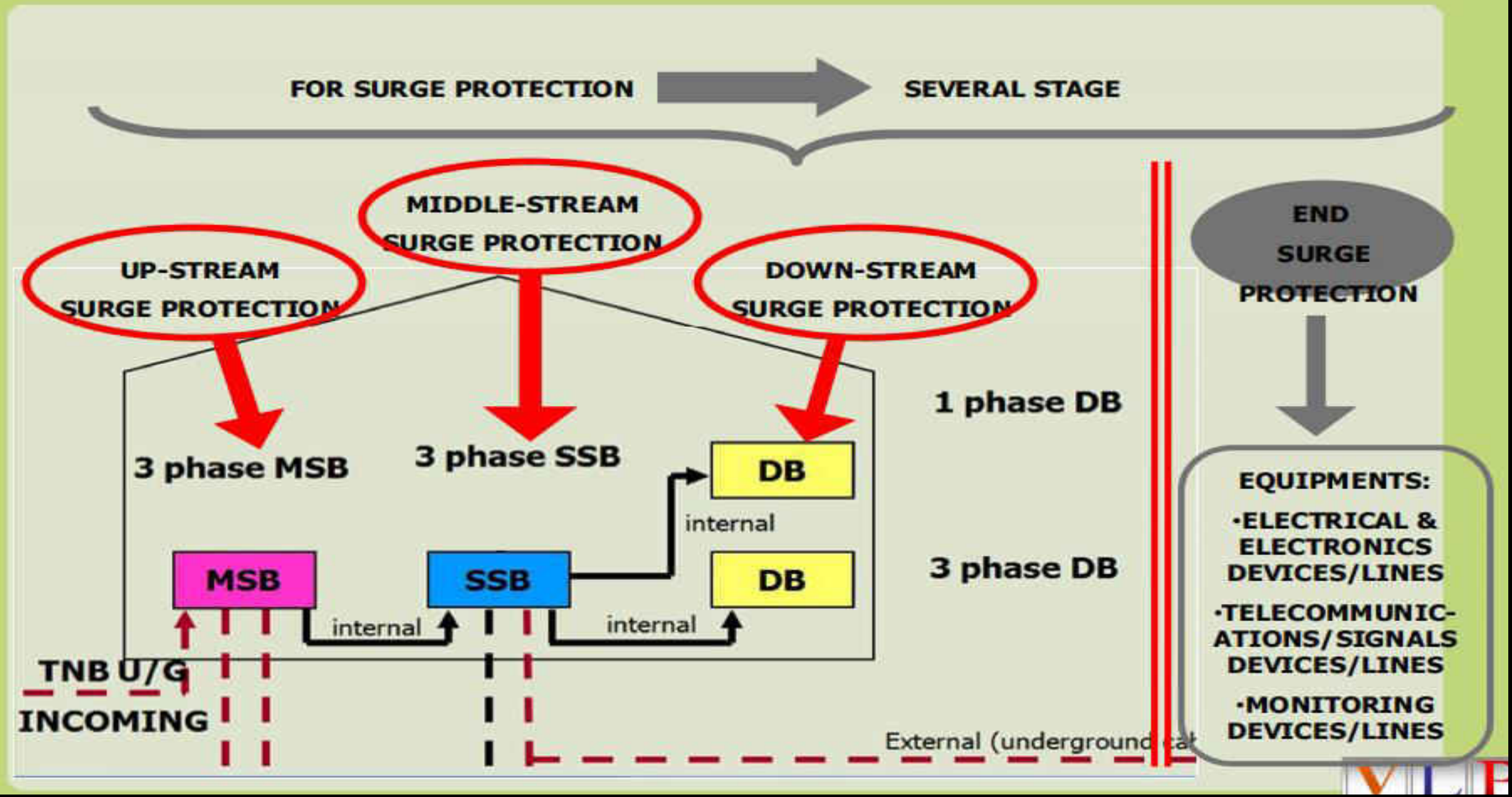
Surge Protection Class B C and D as per Equipment Category



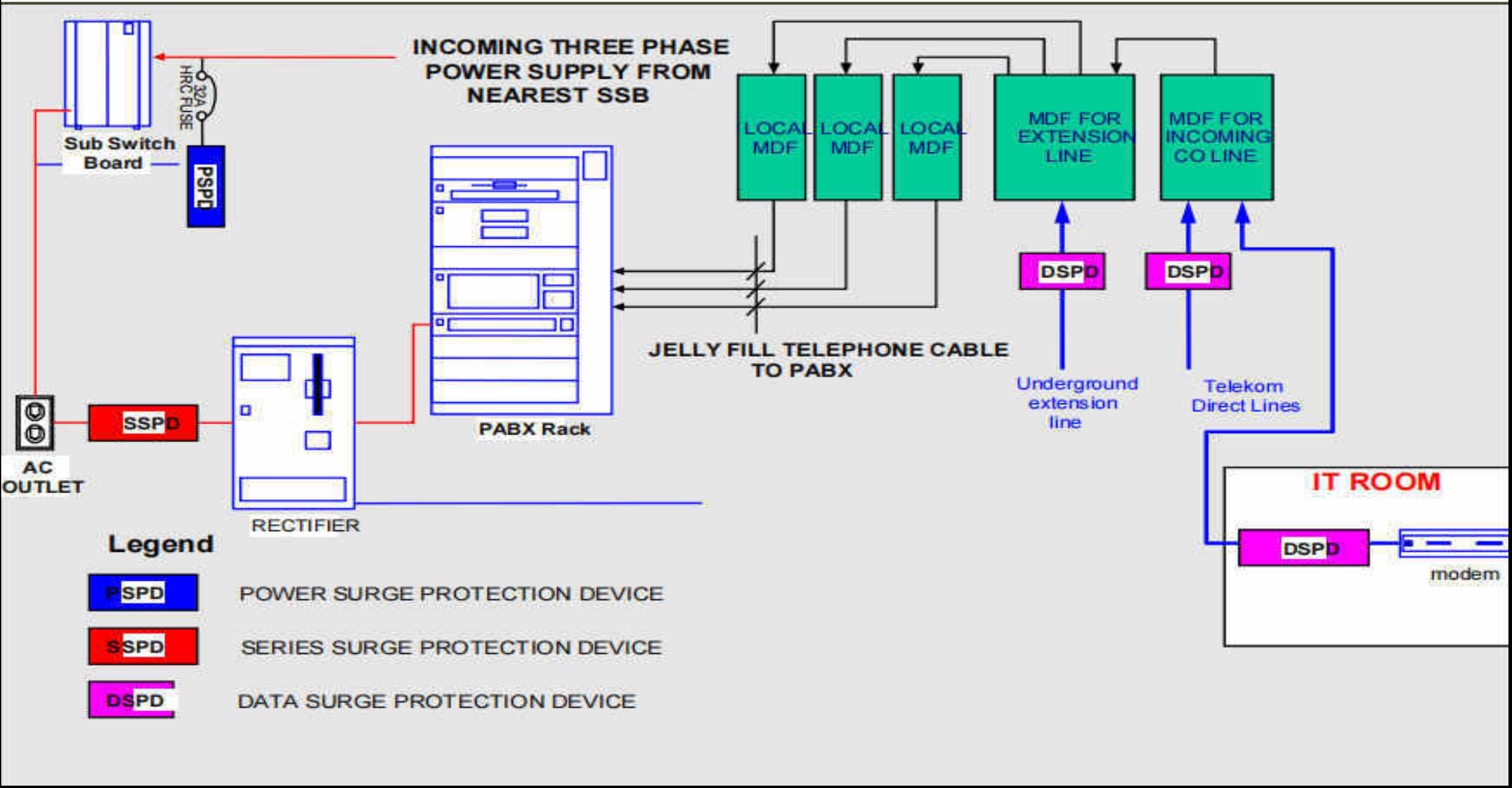
SURGE PROTECTION SELECTION FOR POWER SYSTEM



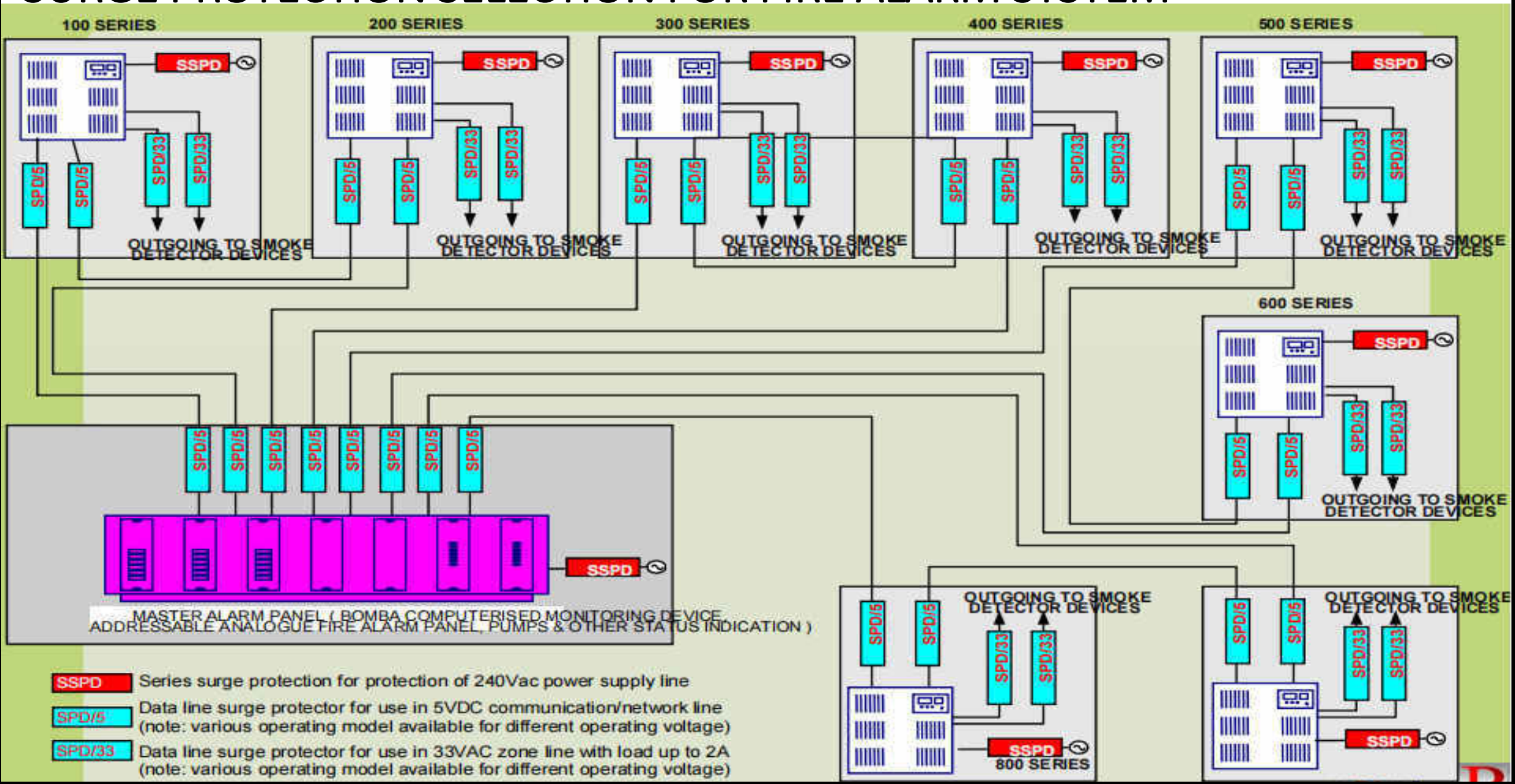
SURGE PROTECTION SELECTION



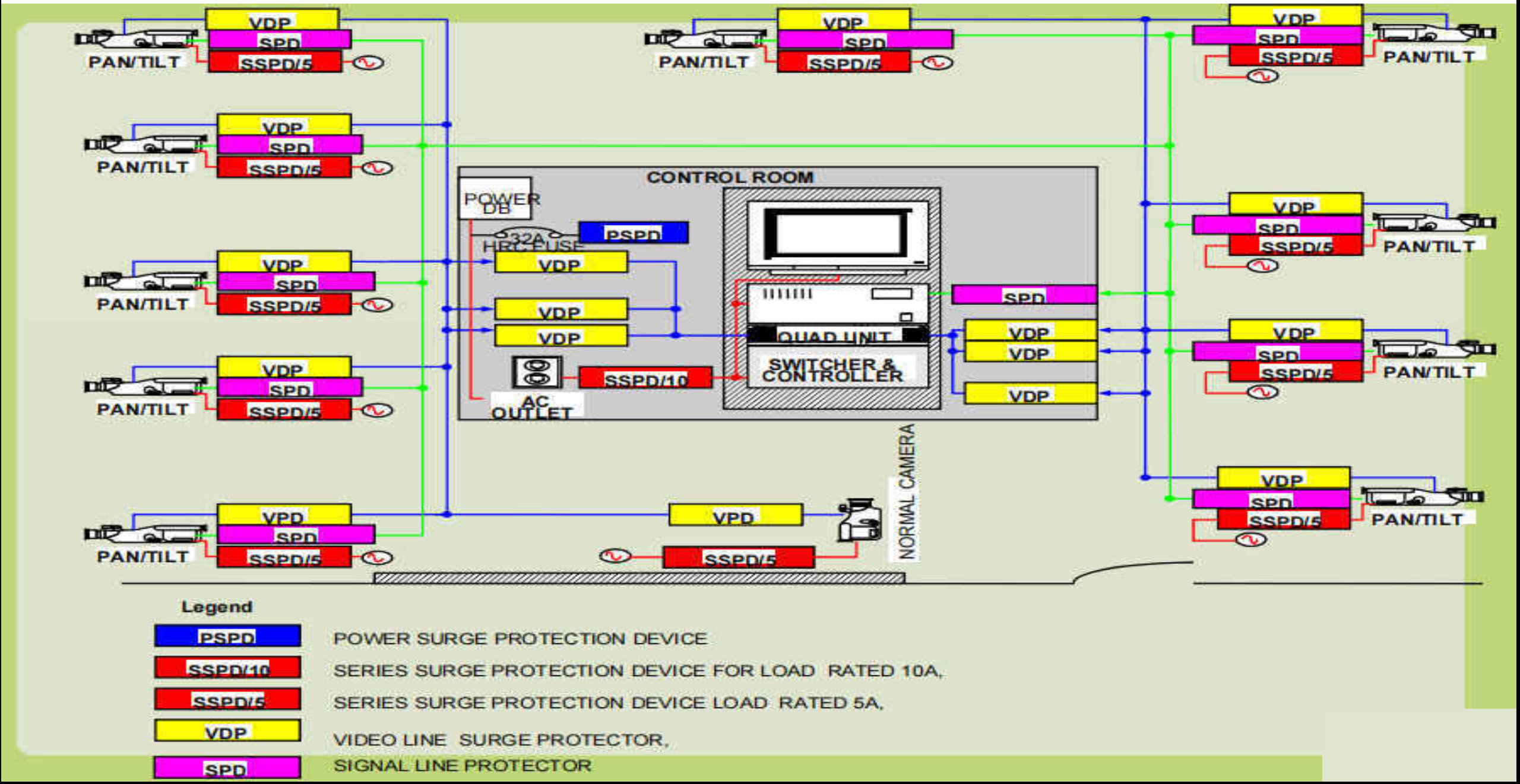
SURGE PROTECTION SELECTION FOR PABX SYSTEM



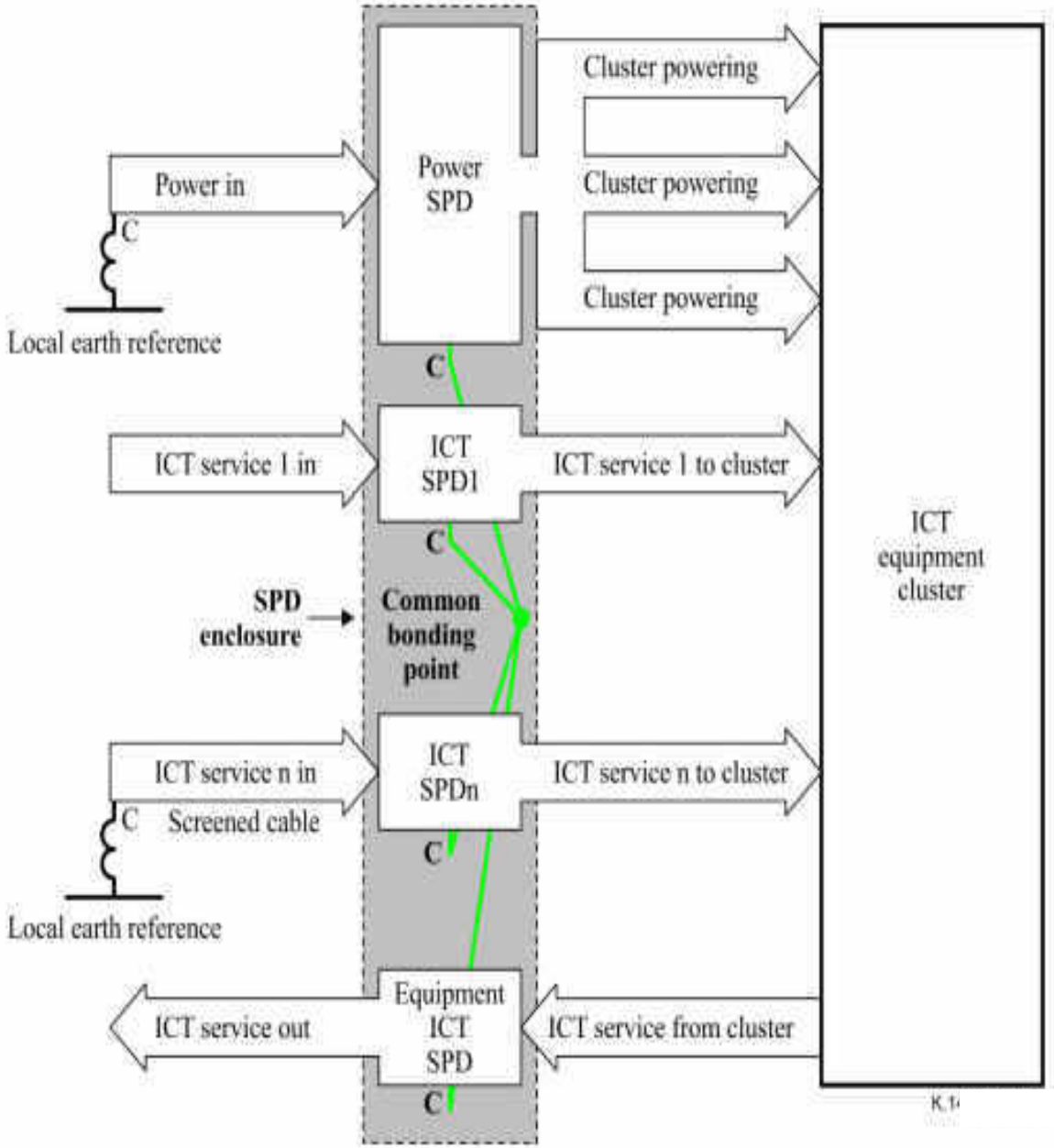
SURGE PROTECTION SELECTION FOR FIRE ALARM SYSTEM



SURGE PROTECTION SELECTION FOR CCTV SYSTEM

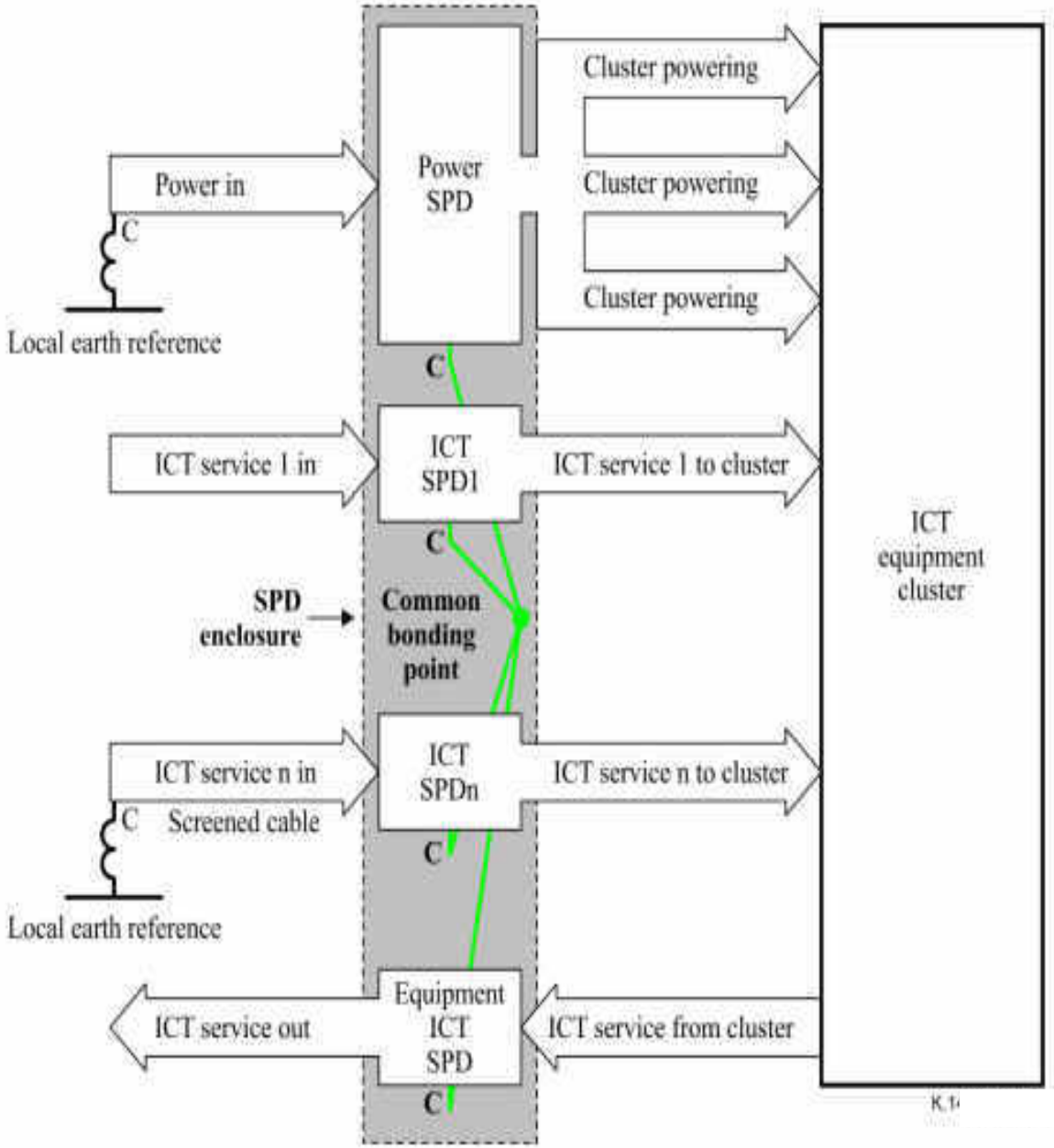


Surge Protection Installation for Multiple Equipments Safety



- A surge reference equaliser does two things; it brings together all the service SPDs by locating themin a single enclosure and provides a local earth reference for all the SPD "C" terminals to directly connect the common bonding point, or "star" connection has two external earth reference
- One from the power SPD mains plug/socket local earth reference and the other from the screened cable remote earth reference. This means that the diverted surge current can split between the power and screened cable earth references.to avoid earth loops in normal operation, one SPDn option is to make the screened cable "C"connection to the common bonding point via an SPD with a switching function, which maintains isolation during normal conditions but provides a bond during the occurrence of a surge.
- The surge reference equaliser is now called an MSPD, although there may not be any SPDs in it,only SPCs giving the equivalent surge functionality of the replaced SPDs.
- MSPD for protecting power, antenna, telephone and Ethernet services with warning lights for protection failure and missing earth connection.

Surge Protection Installation for Multiple Equipments Safety



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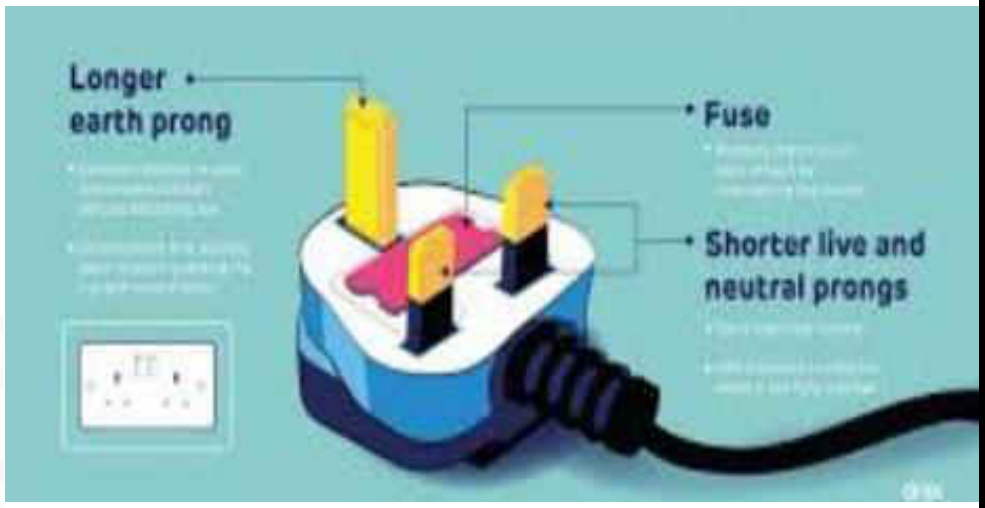
- MSPD for protecting power, antenna, telephone and Ethernet services with warning lights for protection failure and missing earth connection.

I am Power Plug I will be Marry with only My Right Partner
Make you Safety and Comfort



Freedom Connectors Safe Electric Wire Joints

- Electrical parameters: 250V/32A
- Product specifications: 12.4x20.5x14.5mm (LX W x H)
- Applicable wire: 0.75-2.5mm²"e+f" AGW28-14
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 2 digits
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC222-412

- Electrical parameters: 250V/32A
- Product specifications: 17x20.5x14.5mm (LX W x H)
- Applicable wire: 0.75-2.5mm²"e+f" AGW28-14
  0.75-4mm² "f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 3 digits
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FD222-413

- Electrical parameters: 250V/32A 600V/20A
- Product specifications: 40.2x21x14.5mm (LX W x H)
- Applicable wire: 0.08-2.5mm²"e+f" AGW28-14
  0.08-4mm² "f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 8digits
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC222-418

- Electrical parameters: 600V/32A
- Product specifications: 18.5x39.2x14.4mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 3 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC313

- Electrical parameters: 250V/32A
- Product specifications: 21.92x21x14.5mm (LX W x H)
- Applicable wire: 0.75-2.5mm²"e+f" AGW28-14
  0.75-4mm² "f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 4digits
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC222-414

- Electrical parameters: 250V/32A 600V/20A
- Product specifications: 26.6x21x14.5mm (LX W x H)
- Applicable wire: 0.75-2.5mm²"e+f" AGW28-14
  0.75-4mm² "f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 5digits
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC222-415

- Electrical parameters: 600V/32A
- Product specifications: 8.6x39.2x14.4mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 1 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC221

- Electrical parameters: 600V/32A
- Product specifications: 13.6x39.2x14.4mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 2 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC212

Freedom Connectors Safe Electric Wire Joints

- Electrical parameters: 600V/32A
- Product specifications: 25.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 2 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC223-2P

- Electrical parameters: 600V/32A
- Product specifications: 30.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 3 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC223-3P

- Electrical parameters: 600V/32A
- Product specifications: 35.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 4 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC223-4P

- Electrical parameters: 600V/32A
- Product specifications: 40.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 5 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC223-5P

- Electrical parameters: 600V/32A
- Product specifications: 60.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 10 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC223-10P

- Electrical parameters: 600V/32A
- Product specifications: 65.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 12 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: Gray + Orange, Yellow, Blue, Green (handle)
- Material: PA66

FC223-12P

- Electrical parameters: 600V/32A
- Product specifications: 45.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 6 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC223-6P

- Electrical parameters: 600V/32A
- Product specifications: 55.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 8 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC226-8P

Freedom Connectors Safe Electric Wire Joints

- Electrical parameters: 400V/32A
- Product specifications: 25.9x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 2into 4out
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange、blue (handle)
- Material: PA66

FC424

- Electrical parameters: 400V/32A
- Product specifications: 33.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 2into 6out
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange、blue (handle)
- Material: PA66

FC426

- Electrical parameters: 250V/24A 300V/20A⊛
- Product specifications: 20.5x8.5x15.5mm (LX W x H)
- Power supply side: 1.0-2.5mm²"s" AWG 14-12
- Lighting equipment measurement: 0.5-2.5mm²"s+f+st" AWG 20-16
- Can withstand instantaneous peak voltage: 4KV
- Stripping length: (9-11mm) /0.39in
- Connection method: plug-in
- Color: gray
- Material: PA66

FC224-101

- Electrical parameters: 600V/32A
- Product specifications: 35.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 3into 6out
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + blue、Yellow、orange (handle)
- Material: PA66

FC436

- Electrical parameters: 600V/32A
- Product specifications: 48.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 3into 9out
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + blue、Yellow、orange (handle)
- Material: PA66

FC439

- Electrical parameters: 600V/32A
- Product specifications: 18.5x39.2x14.4mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 3 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC313

- Electrical parameters: 600V/32A
- Product specifications: 43x30.8x8.2mm (LX W x H)
- Applicable wire:0.2-4mm² AWG 28-14
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 1 bit
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC121

TV Fridge guard and surge protector

TG-01

Universal / BS / Euro socket

FG-01

N1050 with surge

MCS: Mini-Columns Socket

FZ-551

Aluminum profile stand pole socket with base

FZ-531A/B

Single side 350/660mm aluminum profile

Acryl cover

FZ-532A/B

Dual side 350/660mm aluminum profile

FZ-S66

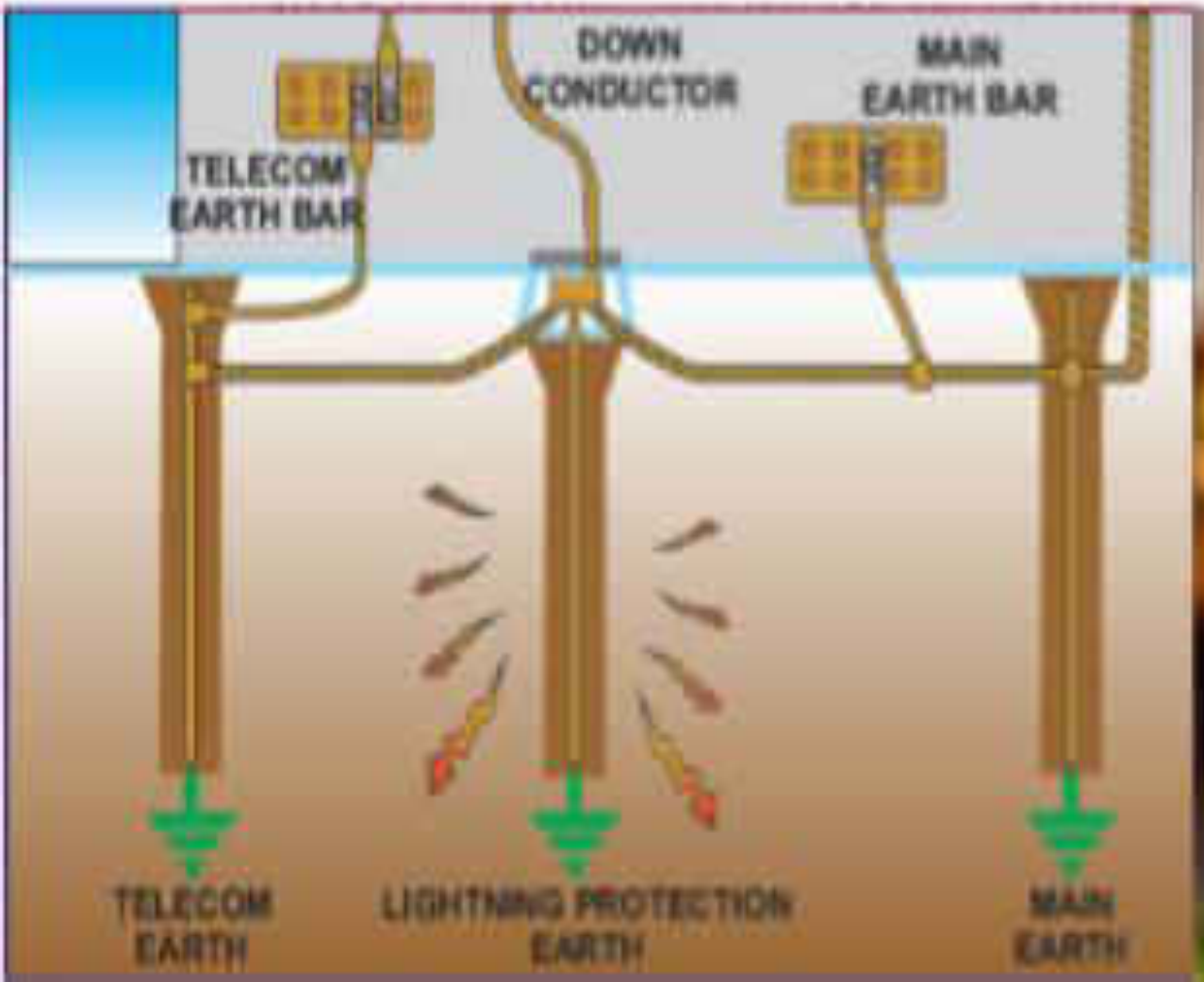
FZ-A66

IP66 power painted stainless steel stand pole

Earthing is Nothing less than Engineering Follow IS3043(2018),IEEE80,IEC62305

Earthing Distance Maximum 500mtr allowed for Electrical and
300mtrs allowed for Low Voltage Equipment's.

Shortest Discharge Path , Less Joints No Sharp Bend ,Round Conductor for routing Earthing up to Equipment's, all buried Joint should be Exothermic Weld



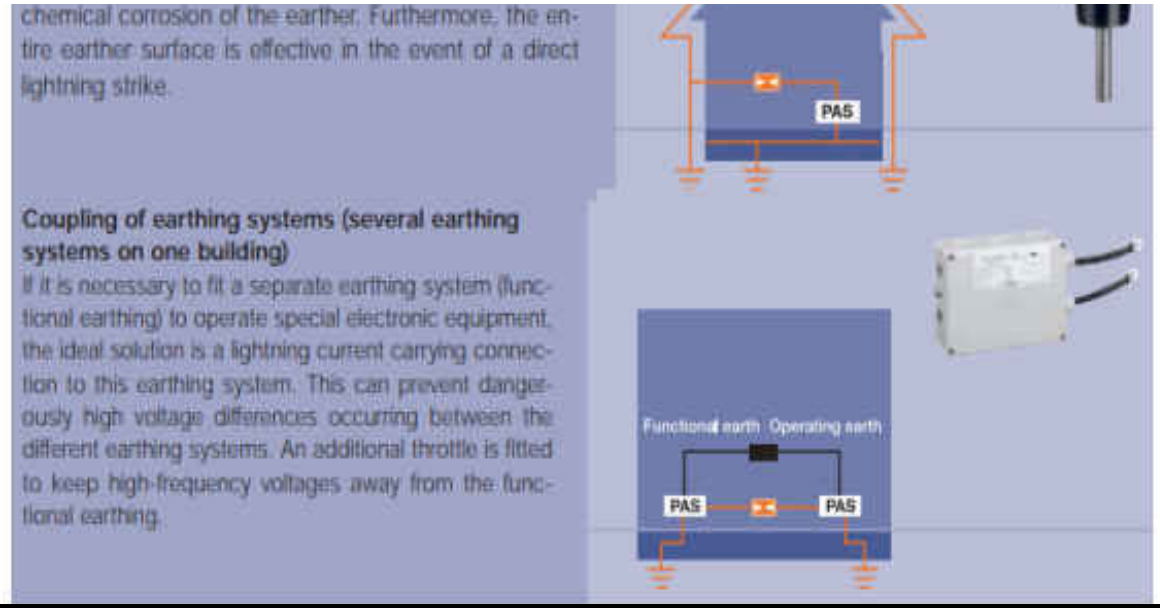
Sparkgap Protection

Spark gaps are intend to provide galvanic isolation between electrical installation parts where direct connections are not permitted. The galvanic isolation prevents not only electrochemical corrosion but provides also a connection capable of carrying lightning current. For connecting different earthing systems, the aim being to make optimum use of all earthers for lightning protection equipotential bonding.

Earthing Distance Maximum 500mtr allowed for Electrical and

300mtrs allowed for Low Voltage Equipment's.

Shortest Discharge Path , Less Joints No Sharp Bend ,Round Conductor for routing Earthing up to Equipment's, all buried Joint should be Exothermic Weld



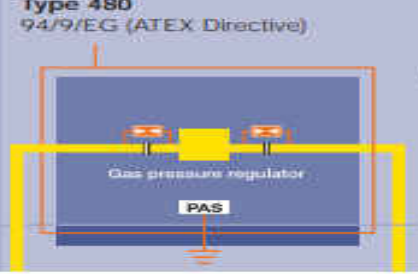
Spark Gap and Earthing One Step More Protection from Surge and Lightning

Spark gaps are intended to provide galvanic isolation between electrical installation parts where direct connections are not permitted. It's Provide Discharge of Earthing also a connection capable of carrying lightning current.

For connecting different Earthing Systems Structure, Grid and Equipotential Earthing, the aim being to make optimum use of all earthers for lightning protection equipotential bonding.

Isolating spark gaps for insulating flange (e.g. in a gas pressure control station)
(Isolating spark gap for the Ex-area) Type 480 isolating spark gap is highly suitable for the bridging of insulating flanges or insulating bolted connections (lightning current-carrying capable), especially in potentially explosive areas.

Type 480
94/9/EG (ATEX Directive)

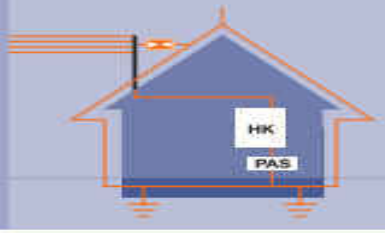


Isolating spark gaps for potential isolation (several earthing systems on one building)
If a building has two earthing systems – e.g. foundation earth electrode and earthing rod – these can be connected together via an isolating spark gap. In contrast to a direct electrical connection, this prevents electrochemical corrosion of the earther. Furthermore, the entire earther surface is effective in the event of a direct lightning strike.

Type 481

Over head connection (roof standard spark gaps for insulation)
With an over head line connection, the roof mast of a low-voltage open-wire line should have the largest possible distance to the lightning protection system. If this distance is less than half a metre, an enclosed protective spark gap must be integrated. The approval of the responsible energy supply company is required for the connection with the roof mast.

Type 482



Coupling of earthing systems (several earthing systems on one building)
If it is necessary to fit a separate earthing system (functional earthing) to operate special electronic equipment, the ideal solution is a lightning current carrying connection to this earthing system. This can prevent dangerously high voltage differences occurring between the different earthing systems. An additional throttle is fitted to keep high-frequency voltages away from the functional earthing.

Type FS-V20

Director:- Mr. Manish Khatri
Head Marketing & Sales:- Mr. Mahesh Chandra Manav

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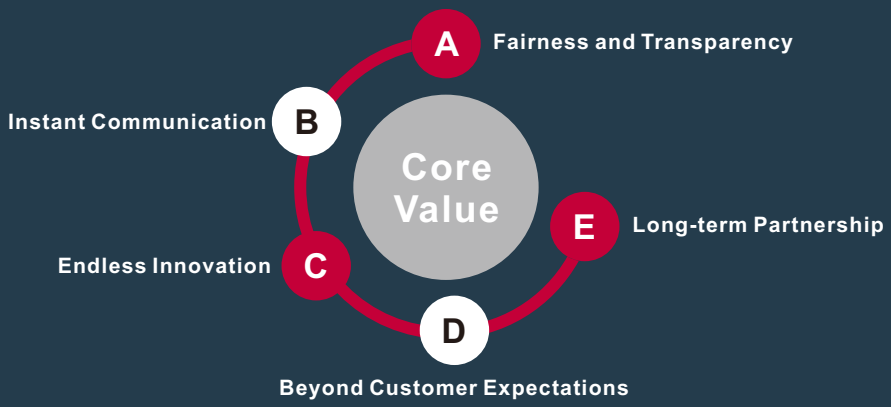
SURGEPROTEC

PRODUCT CATALOG

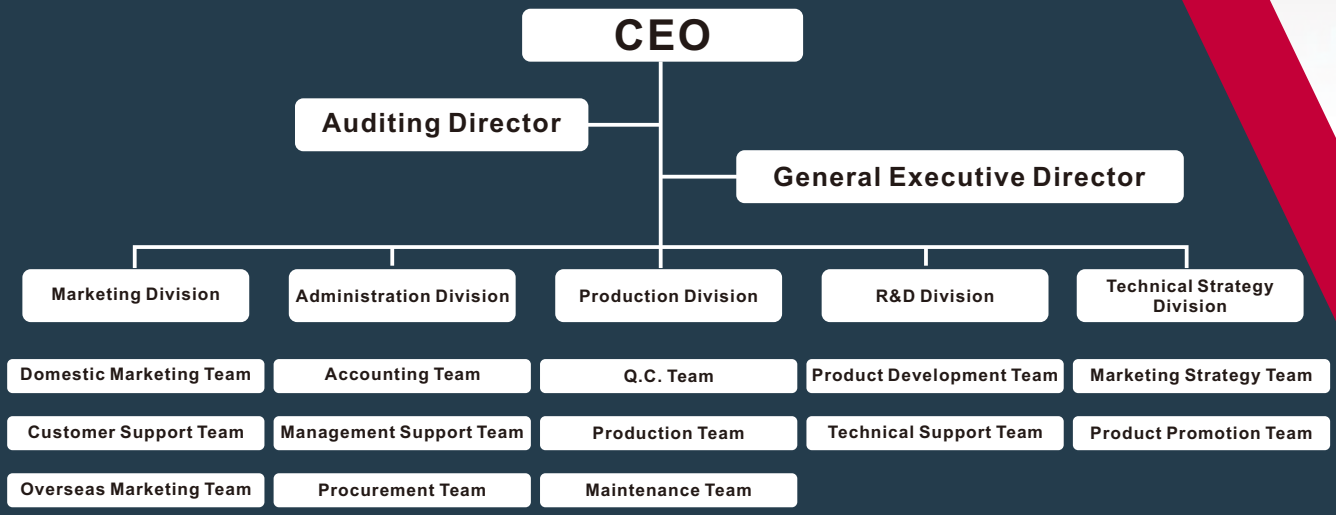
About our Company

COMPANY PROFILE

SPT (Surgeprotec Co., Ltd.) is a pioneering Korean company specialising in the development and production of surge protection devices. It offers a complex range of surge arresters, pursuant to EN 61643-11 standard and surge arresters for information technology, measurement and control, and telecommunications.
From the technical expertise to the operational deployment, we are passionate about all aspects and topics related to SPDs. Our teams are composed of engineers and SPD specialists who can bring forward the best insights and solutions. We support distributors, contractors and consultants with Sales Application Specialists.
We provide free A/S for 10 years for all surge protectors.



Organization Chart



About our
Services

SPT products provide complex solutions for surge protection devices for various applications.

Products

Surge Protector

Type 1 SPD-lightning current arresters

Combined, spark gap and MOV
Iimp 25 kA / 100 kA Up ≤ 1.5 kV
No follow current, zero leakage current
Full coordination with Type 2 SPD

SPD PV - surge arrester

Combination of MOV and spark gap
PV Type 2 SPD
MOV surge arrester
UCPV 170 to 1500 V DC
In 15 to 20 kA
Imax 40 kA

Type 2 SPD – surge arresters

Combined, spark gap and MOV
U c 75 to 760 V AC
In 20 kA / Imax 40 kA
Up ≤ 1.35 kV

Type 1 and 2 SPD -combined arresters B+C

Combined, spark gap and MOV
Iimp 12.5 kA / 50 kA
Up ≤ 1.5 kV
No follow current,
zero leakage current

>>>>>> Product Development <<<<<<

Quality	**Flexibility and Speed**	**R&D Department**	**Customers Requirements**
Safety, reliability and top quality of our products	**Flexible approach to the implementation of special solutions and products**	**Continuous innovation is the foundation of our further development**	**Customers are our everlasting inspiration**

1.SURGE PROTECTORS PARAMETERS

Uc (Maximum continuous operating Voltage)

Maximum effective voltage that can be applied permanently to the terminals of the protection device.

In (Nominal current)

Peak current in 8/20 μs waveform the protection device can withstand 20 times without reaching end of life.

Imax (Maximum discharge current)

Peak current with 8/20 μs waveform which the protection device can withstand.

Iimp (Impulse current)

Peak current with 10/350 μs waveform which the protection device can withstand without reaching end of life.

Up (Voltage protection level)

Maximum residual voltage between the terminals of the protection device during the application of a peak current.

Ures (Residual voltage)

Residual voltage of the surge protector during an 8/20μs current waveform injection at a determined rating.

TOV (Temporary Overvoltage)

The temporary overvoltage is the maximum AC voltage the surge protector can withstand during defined durations (5 seconds and 120 mn), without failure or with controlled disconnection. This parameter U T is greater to Uc. An additional test is required for TT AC system, to simulate a temporary ≪high voltage≫ overvoltages (TOV) between Neutral and PE (application of 1200 Vac, 300 A for 200 ms): the compliance with this test requires the use of the CT2 diagram (specific gas tube between N and PE)

2.CLASSIFICATION OF SURGE PROTECTORS

Protection devices are classified into types according to discharge capacity:

Type 1:

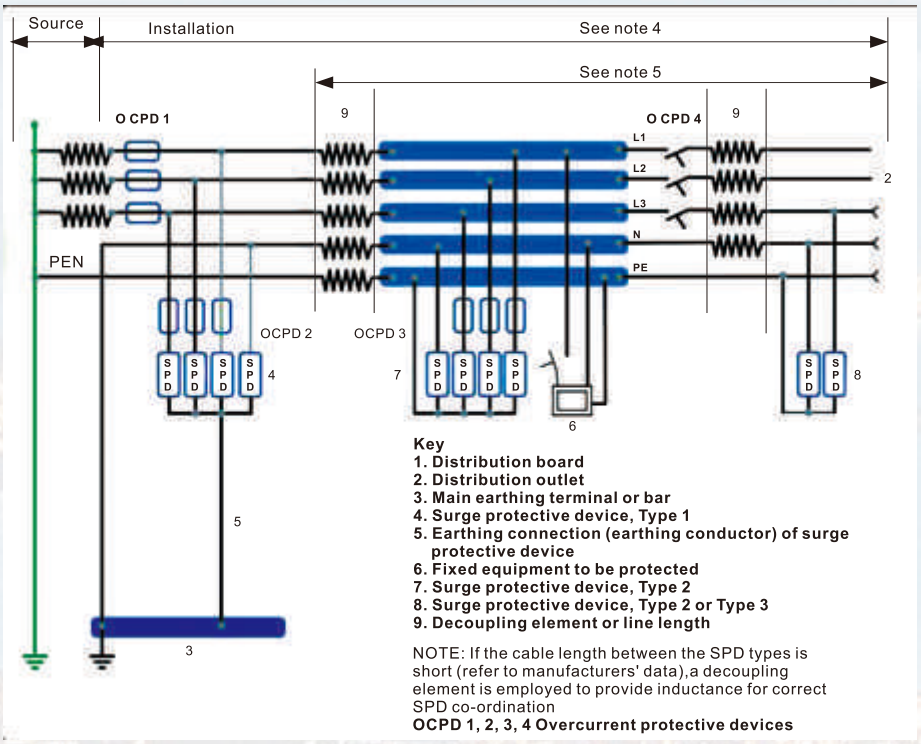
Tested with a 10/350 μs waveform (Class I test), which simulates the current produced by a direct lightning strike. Ability to discharge very high currents to earth, providing a high Up - voltage protection level. Must be accompanied by downstream Type 2 protectors. Designed for use in incoming power supply panels where the risk of lightning strike is high, for example in buildings with an external protection system.

Type 2:

Tested with a 8/20 μs waveform (Class II test), which simulates the current produced in the event of a switching or lightning strike on the distribution line or its vicinity. Ability to discharge high currents to earth, providing a medium Up - voltage protection level. Designed for use in distribution panels located downstream of Type 1 protectors or in incoming power supply panels in areas with low exposure to lightning strikes.

Type 3:

Tested with a combined 1.2/50 μs - 8/20 μs waveform (Class III test), which simulates the current and voltage that can reach the equipment to be protected. Ability to discharge medium currents to earth, providing a low Up - voltage protection level. Always installed downstream of a Type 2 protection, it is designed to protect sensitive equipment or equipment located more than 20m downstream of the Type 2 device.



3.SELECTION AND INSTALLATION OF SPDs

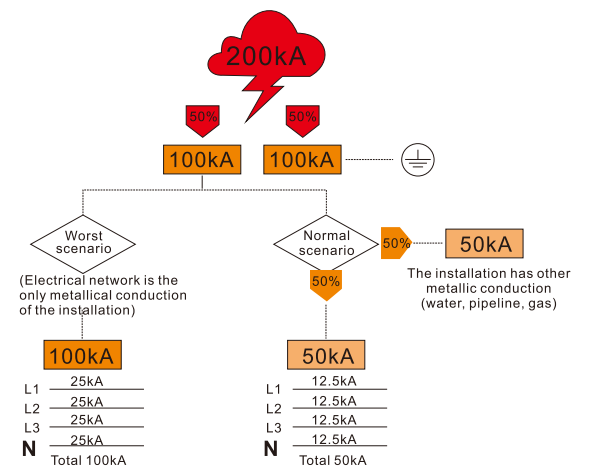
Type 1, Type 2 which one has to be selected?

The SPD protection design does not depend on the fault ratings given by the transformer, it only depends on the level of exposure in front of a surge. So, which SPD do we have to install in the main switchboard?

See the diagram below from IEC 63205-1 standard which displays the dispersion of the highest lightning considered: 200kA @ 10/350µs. In the worst case scenario, 50% of this energy is conducted away to earth leaving 100kA potential across the networks 3 phase and neutral. Here a 25kA @ 10/350µs (Iimp) Type 1 SPD is recommended for insulated installations in extreme exposed locations to lightning.

In the "Normal Scenario" it is assumed any direct lightning strike to the network will be at such a distance from the installation that another 50% of the energy is dispersed to earth via other conductors before entering your point of connection. In this scenario a device with 12.5kA @ 10/350µs (Iimp) Type 1 is recommended. Furthermore, based on the IEC 61643-12 standard, 12.5kA is the minimum kA rate when a Type 1 is needed. If the level of exposure of the installation is lower than above described scenarios

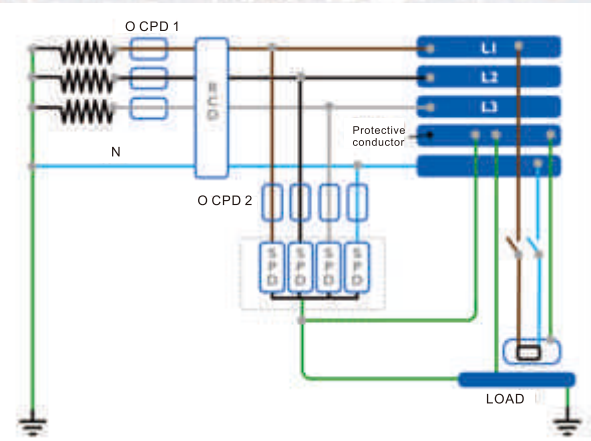
Type 2 SPD (Imax) may be considered along with risk and cost of equipment and downtime.



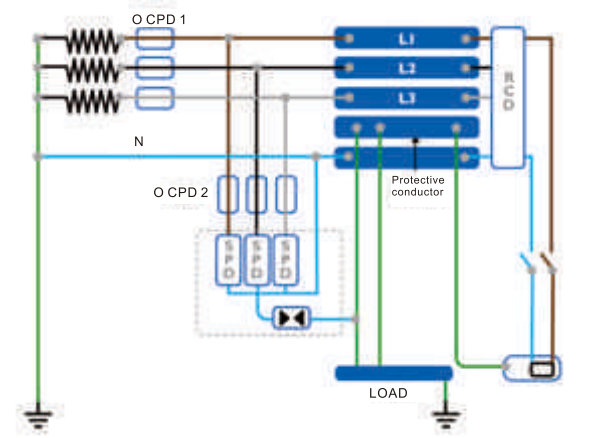
4.POWER SUPPLY NETWORKS

An SPD in power supply networks should be connected in two connection modes – mode x+0 (CT1) and mode x+1 (CT2).

The x+0 (CT1) connection mode is designated 3+0 (TN-C) or 4+0 (TN-S) for three-phase power supply and 1+0 (TN-C) or 2+0 (TN-S) for single-phase power supply. Such mode is beneficial in eliminating common mode of overvoltage.



The x+1 (CT2) connection mode is designated 3+1 for three -phase power supply and 1+1 for single-phase power supply. It cannot be used in the TN-C supply network. It is advantageous to use it to eliminate the differential mode of overvoltage.



Application

Smart Buildings

Construction & IDC
Telecommunication

Power Industries

Wind Power
Solar Power
Power Grid

Transportation Systems

EV Charging Station
Harbor Facilities
Expressway
Railway.

Monoblock Single-Pole SPD

SPT25-XXX/1(S)

Class I•Class II • Type 1•Type 2

Location of Use: Main Distribution Boards
Network Systems: TN-S, TN-C, TT
Mode of Protection: L-PE / N-PE
Surge Ratings: I_{imp} = 25 kA (10/350 µs)
I_n = 25 kA (8/20 µs)
IEC/EN Category: Class I+II / Type 1+2
Protective Elements: High Energy MOV
Housing: Monoblock Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012

Technical Data

SPT25-XXX/1(S)		150	275	320	385	440
IEC Electrical						
Nominal AC Voltage (50/60Hz)	U_o/ U_n	120 V	230 V	230 V	230 V	400 V
Maximum Continuous Operating Voltage (AC)	U_c	150 V	275 V	320 V	385 V	440 V
Nominal Discharge Current (8/20 µs)	I_n			25 kA		
Maximum Discharge Current (8/20 µs)	I_{max}			100 kA		
Impulse Discharge Current (10/350 µs)	I_{imp}			25 kA		
Specific Energy	W/R			156 kJ / Ω		
Charge	Q			12.5 As		
Voltage Protection Level	U_p	1000 V	1500 V	1600 V	1800 V	2000 V
Response Time	t_A			< 25 ns		
Back-Up Fuse (max)				315 A gL / gG		
Short-Circuit Current Rating (AC)	I_{SCCR}			50 kA		
TOV Withstand 5s	U_T	180 V	335 V	335 V	335 V	580 V
TOV 120min	U_T	230V	440V	440V	440V	765 V
Number of Ports				1		
Mechanical & Environmental						
Operating Temperature Range	T_a			-40 ºF to +158 ºF [-40 ºC to +70 ºC]		
Permissible Operating Humidity	RH			5%...95%		
Atmospheric pressure and altitude				80k Pa ... 106k Pa / -500 m ... 2000 m		
Terminal Screw Torque	M_{max}			26.5 lbf·in [3.0 Nm]		
Conductor Cross Section (max)				2 AWG (Solid, Stranded) / 4 AWG (Flexible)		
				35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)		
Mounting				35 mm DIN Rail, EN 60715		
Degree of Protection				IP 20 (built-in)		
Housing Material				Thermoplastic: Extinguishing Degree UL 94 V-0		
Thermal Protection				Yes		
Operating State / Fault Indication				Green ok / Red defect		
Remote Contacts (RC)				Optional		
RC Switching Capacity				AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A		
RC Conductor Cross Section (max)				16 AWG (Solid) / 1.5 mm^2(Solid)		

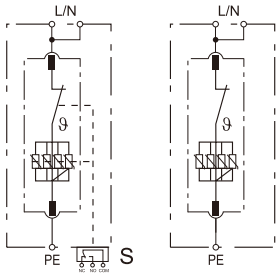
Order Information

Order Code	150	275	320	385	440
SPT25-XXX/1	2515011	2527511	2532011	2538511	2544011
SPT25-XXX/1S (with remote contacts)	2515012	2527512	2532012	2538512	2544012

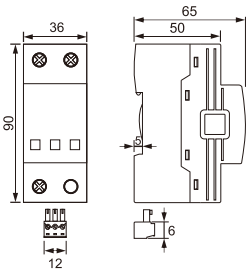
Internal Configuration

Legend

L Line
N Neutral
PE Protective Earth
S Signalling Contacts Optional



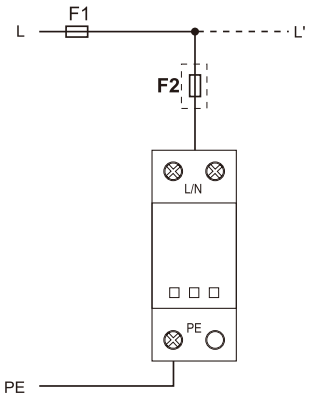
Dimensions & Packaging



Dimensions & Packaging					
SPT25-XXX/1(S)	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[260 × 230 × 320 mm]				
Minimum Order Quantity	42 Units				

Connection Diagram

TN-S, TN-C, TT (Single-phase, 1+0)



Monoblock Multi-Pole SPD

SPT25-XXX/2(S)

Class I•Class II • Type 1•Type 2

Location of Use: Main Distribution Boards
Network Systems: TN-S
Mode of Protection: L-PE / L-PE, N-PE / N-PE
Surge Ratings: I_{imp} = 25 kA (10/350 µs)
I_n = 25 kA (8/20 µs)
IEC/EN Category: Class I+II / Type 1+2
Protective Elements: High Energy MOV
Housing: Monoblock Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012

Technical Data

SPT25-XXX/2(S)		150	275	320	385	440
IEC Electrical						
Nominal AC Voltage (50/60Hz)	U_o/ U_n	120 V	230 V	230 V	230 V	400 V
Maximum Continuous Operating Voltage (AC)	U_c	150 V	275 V	320 V	385 V	440 V
Nominal Discharge Current (8/20 µs)	I_n			25 kA		
Maximum Discharge Current (8/20 µs)	I_{max}			100 kA		
Impulse Discharge Current (10/350 µs)	I_{imp}			25 kA		
Total Discharge Current (10/350 µs)	I_{total}			50 kA		
Specific Energy	W/R			156 kJ / Ω		
Charge	Q			12.5 As		
Voltage Protection Level	U_p	1000 V	1500 V	1600 V	1800 V	2000 V
Response Time	t_A			< 25 ns		
Back-Up Fuse (max)				315 A gL / gG		
Short-Circuit Current Rating (AC)	I_{SCCR}			50 kA		
TOV Withstand 5s	U_T	180 V	335 V	335 V	335 V	580 V
TOV 120min	U_T	230 V	440 V	440 V	440 V	765 V
Number of Ports				1		
Mechanical & Environmental						
Operating Temperature Range	T_a			-40 °F to +158 °F [-40 °C to +70 °C]		
Permissible Operating Humidity	RH			5%...95%		
Atmospheric pressure and altitude				80k Pa ... 106k Pa / -500 m ... 2000 m		
Terminal Screw Torque	M_{max}			26.5 lbf·in [3.0 Nm]		
Conductor Cross Section (max)				2 AWG (Solid, Stranded) / 4 AWG (Flexible)		
				35 mm² (Solid, Stranded) / 25 mm² (Flexible)		
Mounting				35 mm DIN Rail, EN 60715		
Degree of Protection				IP 20 (built-in)		
Housing Material				Thermoplastic: Extinguishing Degree UL 94 V-0		
Thermal Protection				Yes		
Operating State / Fault Indication				Green ok / Red defect		
Remote Contacts (RC)				Optional		
RC Switching Capacity				AC: 250V / 0.5 A;DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A		
RC Conductor Cross Section (max)				16 AWG (Solid) / 1.5 mm²(Solid)		

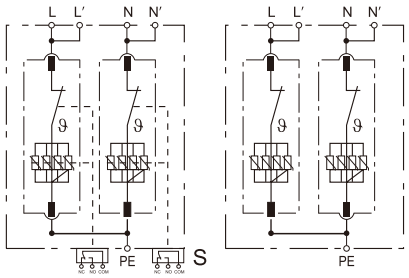
Order Information

Order Code	150	275	320	385	440
SPT25-XXX/2	2515021	2527521	2532021	2538521	2544021
SPT25-XXX/2S(with remote contacts)	2515022	2527522	2532022	2538522	2544022

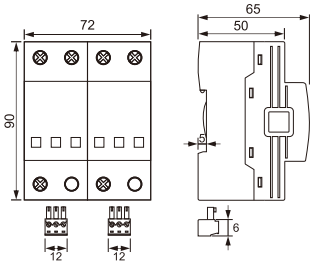
Internal Configuration

Legend

L/L′ Line
N/N′ Neutral
PE Protective Earth
S Signalling Contacts Optional



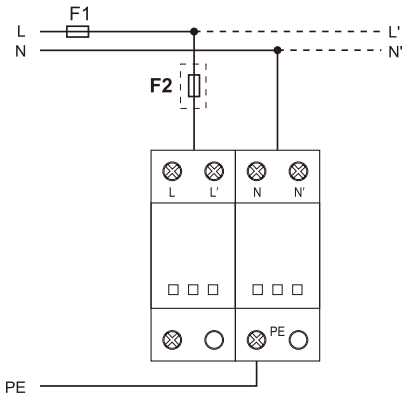
Dimensions & Packaging



Dimensions & Packaging					
SPT25-XXX/2(S)	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[260 × 230 × 320 mm]				
Minimum Order Quantity	24 Units				

Connection Diagram

TN-S (Single-phase, 2+0)



Monoblock Multi-Pole SPD

SPT25-XXX/3(S)

Class I•Class II • Type 1•Type 2

Location of Use: Main Distribution Boards
Network Systems: TN-C
Mode of Protection: L-PE / L'-PE
Surge Ratings: I_{imp} = 25 kA (10/350 µs)
I_n = 25 kA (8/20 µs)
IEC/EN Category: Class I+II / Type 1+2
Protective Elements: High Energy MOV
Housing: Monoblock Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012

Technical Data

SPT25-XXX/3(S)		150	275	320	385	440
IEC Electrical						
Nominal AC Voltage (50/60Hz)	U_o/ U_n	120 V	230 V	230 V	230 V	400 V
Maximum Continuous Operating Voltage (AC)	U_c	150 V	275 V	320 V	385 V	440 V
Nominal Discharge Current (8/20 µs)	I_n			25 kA		
Maximum Discharge Current (8/20 µs)	I_{max}			100 kA		
Impulse Discharge Current (10/350 µs)	I_{imp}			25 kA		
Total Discharge Current (10/350 µs)	I_{total}			75 kA		
Specific Energy	W/R			156 kJ / Ω		
Charge	Q			12.5 As		
Voltage Protection Level	U_p	1000 V	1500 V	1600 V	1800 V	2000 V
Response Time	t_A			< 25 ns		
Back-Up Fuse (max)				315 A gL / gG		
Short-Circuit Current Rating (AC)	I_{SCCR}			50 kA		
TOV Withstand 5s	U_T	180 V	335 V	335 V	335 V	580 V
TOV 120min	U_T	230 V	440 V	440 V	440 V	765 V
Number of Ports				1		
Mechanical & Environmental						
Operating Temperature Range	T_a			-40 ºF to +158 ºF [-40 ºC to +70 ºC]		
Permissible Operating Humidity	RH			5%...95%		
Atmospheric pressure and altitude				80k Pa ... 106k Pa / -500 m ... 2000 m		
Terminal Screw Torque	M_{max}			26.5 lbf·in [3.0 Nm]		
Conductor Cross Section (max)				2 AWG (Solid, Stranded) / 4 AWG (Flexible)		
				35 mm² (Solid, Stranded) / 25 mm² (Flexible)		
Mounting				35 mm DIN Rail, EN 60715		
Degree of Protection				IP 20 (built-in)		
Housing Material				Thermoplastic: Extinguishing Degree UL 94 V-0		
Thermal Protection				Yes		
Operating State / Fault Indication				Green ok / Red defect		
Remote Contacts (RC)				Optional		
RC Switching Capacity				AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A		
RC Conductor Cross Section (max)				16 AWG (Solid) / 1.5 mm²(Solid)		

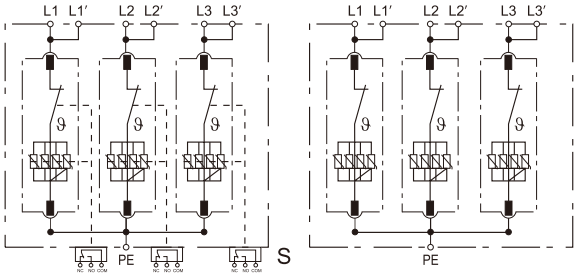
Order Information

Order Code	150	275	320	385	440
SPT25-XXX/3	2515031	2527531	2532031	2538531	2544031
SPT25-XXX/3S(with remote contacts)	2515032	2527532	2532032	2538532	2544032

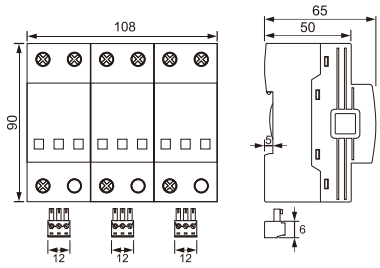
Internal Configuration

Legend

L / L′	Line
N / N′	Neutral
PE	Protective Earth
S	Signalling Contacts Optional

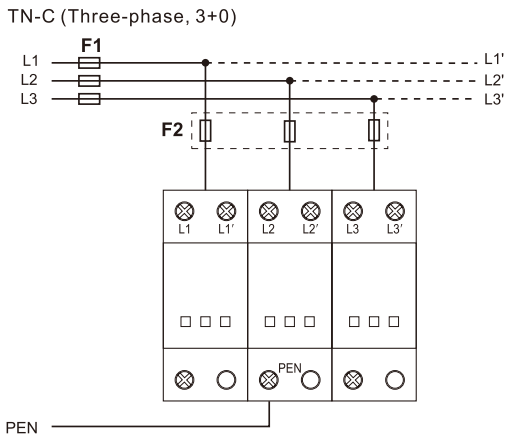


Dimensions & Packaging



Dimensions & Packaging					
SPT25-XXX/3(S)	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[260 × 230 × 320 mm]				
Minimum Order Quantity	12 Units				

Connection Diagram



Monoblock Multi-Pole SPD

SPT25-XXX/4(S)

Class I•Class II • Type 1•Type 2

Location of Use: Main Distribution Boards
Network Systems: TN-S
Mode of Protection: L-PE / L-PE, NPE / N-PE
Surge Ratings: I_{imp} = 25 kA (10/350 µs)
I_n = 25 kA (8/20 µs)
IEC/EN Category: Class I+II / Type 1+2
Protective Elements: High Energy MOV
Housing: Monoblock Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012

Technical Data

SPT25-XXX/4(S)		150	275	320	385	440
IEC Electrical						
Nominal AC Voltage (50/60Hz)	U_o/ U_n	120 V	230 V	230 V	230 V	400 V
Maximum Continuous Operating Voltage (AC)	U_c	150 V	275 V	320 V	385 V	440 V
Nominal Discharge Current (8/20 µs)	I_n			25 kA		
Maximum Discharge Current (8/20 µs)	I_{max}			100 kA		
Impulse Discharge Current (10/350 µs)	I_{imp}			25 kA		
Total Discharge Current (10/350 µs)	I_{total}			100 kA		
Specific Energy	W/R			156 kJ / Ω		
Charge	Q			12.5 As		
Voltage Protection Level	U_p	1000 V	1500 V	1600 V	1800 V	2000 V
Response Time	t_A			< 25 ns		
Back-Up Fuse (max)				315 A gL / gG		
Short-Circuit Current Rating (AC)	I_{SCCR}			50 kA		
TOV Withstand 5s	U_T	180 V	335 V	335 V	335 V	580 V
TOV 120min	U_T	230 V	440 V	440 V	440 V	765 V
Number of Ports				1		
Mechanical & Environmental						
Operating Temperature Range	T_a			-40 °F to +158 °F [-40 °C to +70 °C]		
Permissible Operating Humidity	RH			5%...95%		
Atmospheric pressure and altitude				80k Pa ... 106k Pa / -500 m ... 2000 m		
Terminal Screw Torque	M_{max}			26.5 lbf·in [3.0 Nm]		
Conductor Cross Section (max)				2 AWG (Solid, Stranded) / 4 AWG (Flexible)		
				35 mm²(Solid, Stranded) / 25 mm²(Flexible)		
Mounting				35 mm DIN Rail, EN 60715		
Degree of Protection				IP 20 (built-in)		
Housing Material				Thermoplastic: Extinguishing Degree UL 94 V-0		
Thermal Protection				Yes		
Operating State / Fault Indication				Green ok / Red defect		
Remote Contacts (RC)				Optional		
RC Switching Capacity				AC: 250V / 0.5 A;DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A		
RC Conductor Cross Section (max)				16 AWG (Solid) / 1.5 mm²(Solid)		

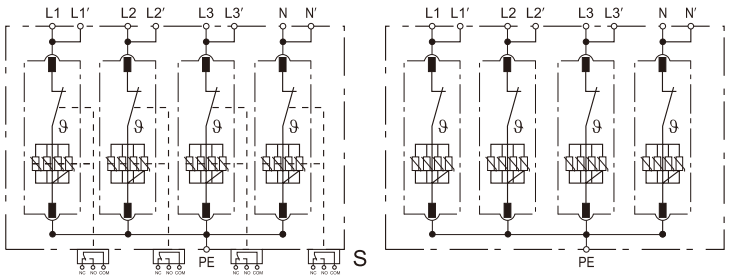
Order Information

Order Code	150	275	320	385	440
SPT25-XXX/4	2515041	2527541	2532041	2538541	2544041
SPT25-XXX/4S(with remote contacts)	2515042	2527542	2532042	2538542	2544042

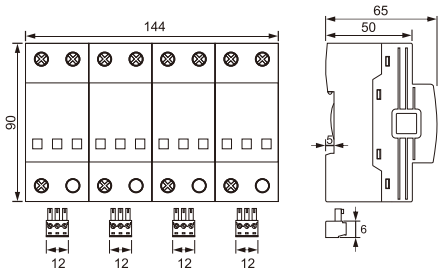
Internal Configuration

Legend

L / L′	Line
N / N′	Neutral
PE	Protective Earth
S	Signalling Contacts Optional

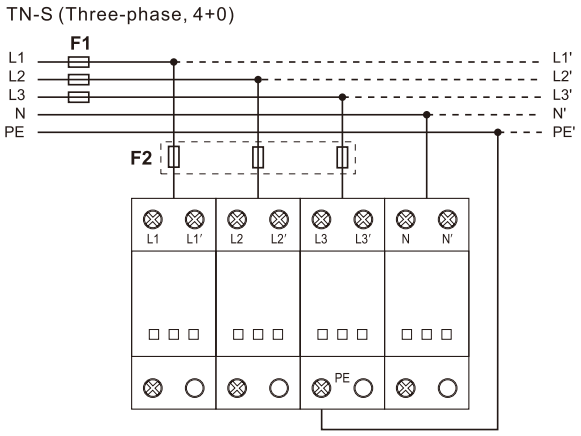


Dimensions & Packaging



Dimensions & Packaging					
SPT25-XXX/4(S)	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[260 × 230 × 320 mm]				
Minimum Order Quantity	12 Units				

Connection Diagram



Monoblock Multi-Pole SPD

SPT25-XXX/1(S)+1

Class I•Class II • Type 1•Type 2

Location of Use: Main Distribution Boards
Network Systems: TT, TN-S
Mode of Protection: L-N / L-N, N-PE
Surge Ratings: I_{imp} = 25 kA / 50 kA (10/350 µs)
I_n = 25 kA / 50 kA (8/20 µs)
IEC/EN Category: Class I+II / Type 1+2
Protective Elements: High Energy MOV and GDT
Housing: Monoblock Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012

Technical Data

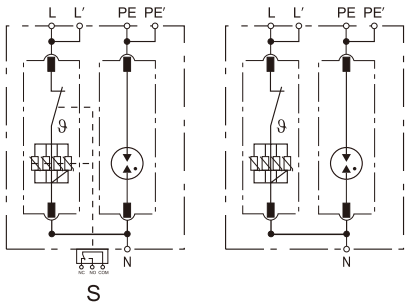
SPT25-XXX/1(S)+1			150	275	320	385
IEC Electrical						
Nominal AC Voltage (50/60Hz)			120 V	230 V	230 V	230 V
Maximum Continuous Operating Voltage	(L - N)	U_c	150 V	275 V	320 V	385 V
	(N - PE)	U_c	255 V	255 V	255 V	255 V
Nominal Discharge Current (8/20 µs)	(L - N) / (N - PE)	I_n	25 kA / 50 kA			
Maximum Discharge Current (8/20 µs)	(L - N) / (N - PE)	I_{max}	100 kA			
Impulse Discharge Current (10/350 µs)	(L - N) / (N - PE)	I_{imp}	25 kA / 50 kA			
Total Discharge Current (10/350 µs)		I_{total}	50 kA			
Specific Energy	(L - N) / (N - PE)	W/R	156 kJ / Ω / 625 kJ / Ω			
Charge	(L - N) / (N - PE)	Q	12.5 As / 25 As			
Voltage Protection Level	(L - N) / (N - PE)	U_p	1000 V/ 1500 V	1500 V/ 1500 V	1600 V/ 1500 V	1800 V/ 1500 V
Follow Current Interrupt Rating	(N-PE)	I_{fi}	100 A $_{RMS}$			
Response Time	(L - N) / (N - PE)	t_A	< 25 ns / < 100 ns			
Back-Up Fuse (max)			315 A gL / gG			
Short-Circuit Current Rating (AC)	(L - N)	I_{SCCR}	50 kA			
TOV Withstand 5s	(L - N)	U_T	180 V	335 V	335 V	335 V
TOV 120min	(L - N)	U_T	230 V	440 V	440 V	440 V
TOV Withstand 200ms	(N - PE)	U_T	1200 V			
Number of Ports			1			
Mechanical & Environmental						
Operating Temperature Range		T_a	-40 ºF to +158 ºF [-40 ºC to +70 ºC]			
Permissible Operating Humidity		RH	5%...95%			
Atmospheric pressure and altitude			80k Pa ... 106k Pa / -500 m ... 2000 m			
Terminal Screw Torque		M_{max}	26.5 lbf·in [3.0 Nm]			
Conductor Cross Section (max)			2 AWG (Solid, Stranded) / 4 AWG (Flexible)			
			35 mm² (Solid, Stranded) / 25 mm² (Flexible)			
Mounting			35 mm DIN Rail, EN 60715			
Degree of Protection			IP 20 (built-in)			
Housing Material			Thermoplastic: Extinguishing Degree UL 94 V-0			
Thermal Protection			Yes			
Operating State / Fault Indication			Green ok / Red defect			
Remote Contacts (RC)			Optional			
RC Switching Capacity			AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A			
RC Conductor Cross Section (max)			16 AWG (Solid) / 1.5 mm²(Solid)			

Order Information				
Order Code	**150**	**275**	**320**	**385**
SPT25-XXX/1+1	2515013	2527513	2532013	2538513
SPT25-XXX/1S+1(with remote contacts)	2515014	2527514	2532014	2538514

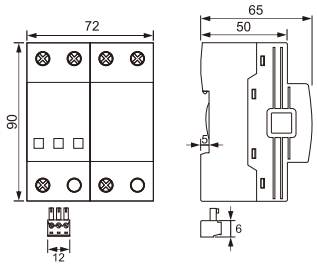
Internal Configuration

Legend

L / L′ Line
N Neutral
PE / PE′ Protective Earth
S Signalling Contacts Optional



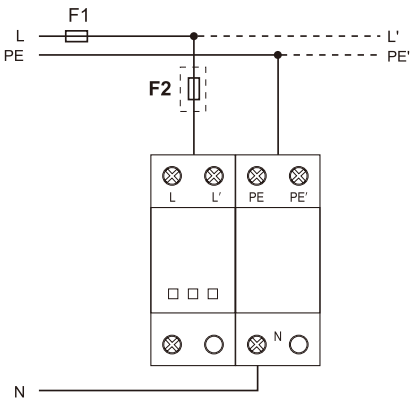
Dimensions & Packaging



Dimensions & Packaging					
SPT25-XXX/1(S)+1	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[260 × 230 × 320 mm]				
Minimum Order Quantity	24 Units				

Connection Diagram

TN-S,TT (Single-phase, 1+1)



Monoblock Multi-Pole SPD

SPT25-XXX/3(S)+1

Class I•Class II • Type 1•Type 2

Location of Use: Main Distribution Boards
Network Systems: TT, TN-S
Mode of Protection: L-N / L-N, N-PE
Surge Ratings: I_{imp} = 25 kA / 100 kA (10/350 µs)
I_n = 25 kA / 100 kA (8/20 µs)
IEC/EN Category: Class I+II / Type 1+2
Protective Elements: High Energy MOV and GDT
Housing: Monoblock Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012

Technical Data

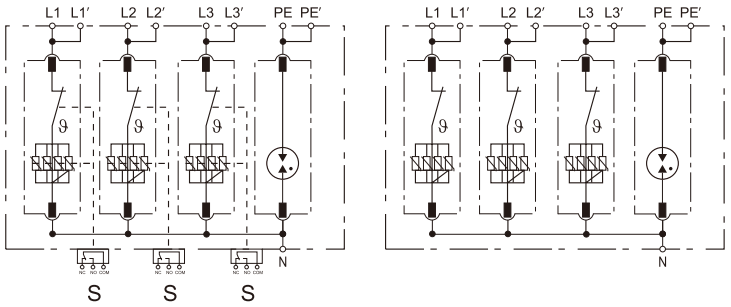
SPT25-XXX/3(S)+1			150	275	320	385
IEC Electrical						
Nominal AC Voltage (50/60Hz)			120 V	230 V	230 V	230 V
Maximum Continuous Operating Voltage	(L - N)	U_c	150 V	275 V	320 V	385 V
	(N - PE)	U_c	255 V	255 V	255 V	255 V
Nominal Discharge Current (8/20 µs)	(L - N) / (N - PE)	I_n	25 kA / 100 kA			
Maximum Discharge Current (8/20 µs)	(L - N) / (N - PE)	I_{max}	100 kA			
Impulse Discharge Current (10/350 µs)	(L - N) / (N - PE)	I_{imp}	25 kA / 100 kA			
Total Discharge Current (10/350 µs)		I_{total}	100 kA			
Specific Energy	(L - N) / (N - PE)	W/R	156 kJ / Ω / 2.5 M kJ / Ω			
Charge	(L - N) / (N - PE)	Q	12.5 As / 50 As			
Voltage Protection Level	(L - N) / (N - PE)	U_p	1000 V/ 1500 V	1500 V/ 1500 V	1600 V/ 1500 V	1800 V/ 1500 V
Follow Current Interrupt Rating	(N-PE)	I_{fi}	100 A_{RMS}			
Response Time	(L - N) / (N - PE)	t_A	< 25 ns / < 100 ns			
Back-Up Fuse (max)			315 A gL / gG			
Short-Circuit Current Rating (AC)	(L - N)	I_{SCCR}	50 kA			
TOV Withstand 5s	(L - N)	U_T	180 V	335 V	335 V	335 V
TOV 120min	(L - N)	U_T	230 V	440 V	440 V	440 V
TOV Withstand 200ms	(N - PE)	U_T	1200 V			
Number of Ports			1			
Mechanical & Environmental						
Operating Temperature Range		T_a	-40 ºF to +158 ºF [-40 ºC to +70 ºC]			
Permissible Operating Humidity		RH	5%...95%			
Atmospheric pressure and altitude			80k Pa ... 106k Pa / -500 m ... 2000 m			
Terminal Screw Torque		M_{max}	26.5 lbf·in [3.0 Nm]			
Conductor Cross Section (max)			2 AWG (Solid, Stranded) / 4 AWG (Flexible)			
			35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)			
Mounting			35 mm DIN Rail, EN 60715			
Degree of Protection			IP 20 (built-in)			
Housing Material			Thermoplastic: Extinguishing Degree UL 94 V-0			
Thermal Protection			Yes			
Operating State / Fault Indication			Green ok / Red defect			
Remote Contacts (RC)			Optional			
RC Switching Capacity			AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A			
RC Conductor Cross Section (max)			16 AWG (Solid) / 1.5 mm^2 (Solid)			

Order Information				
Order Code	**150**	**275**	**320**	**385**
SPT25-XXX/3+1	2515033	2527533	2532033	2538533
SPT25-XXX/3S+1(with remote contacts)	2515034	2527534	2532034	2538534

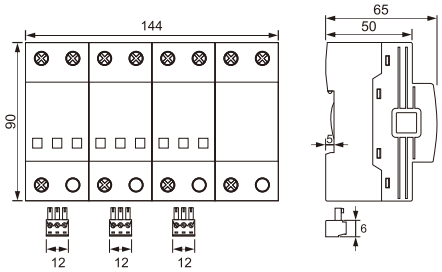
Internal Configuration

Legend

L / L′ Line
N Neutral
PE / PE′ Protective Earth
S Signalling Contacts Optional



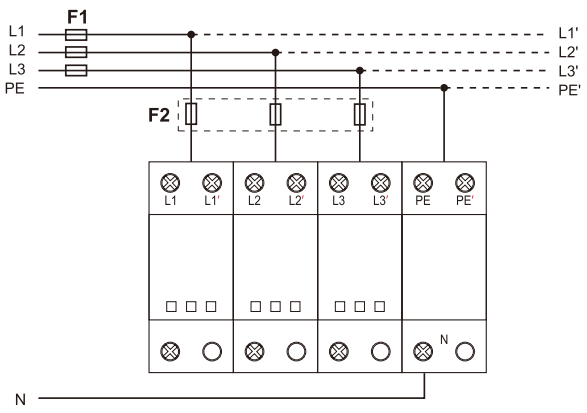
Dimensions & Packaging



Dimensions & Packaging					
SPT25-XXX/3(S)+1	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[260 × 230 × 320 mm]				
Minimum Order Quantity	12 Units				

Connection Diagram

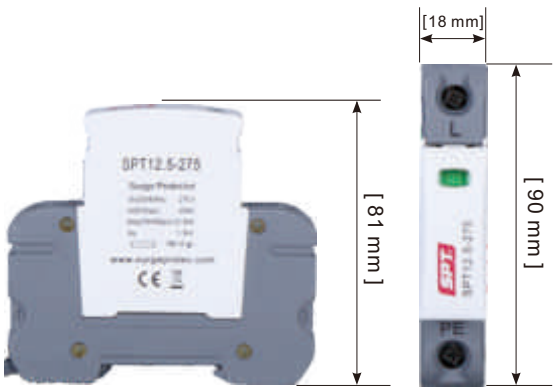
TN-S, TT (Three-phase, 3+1)



New Modular Single Pole & Multi-pole Surge Protective Devices

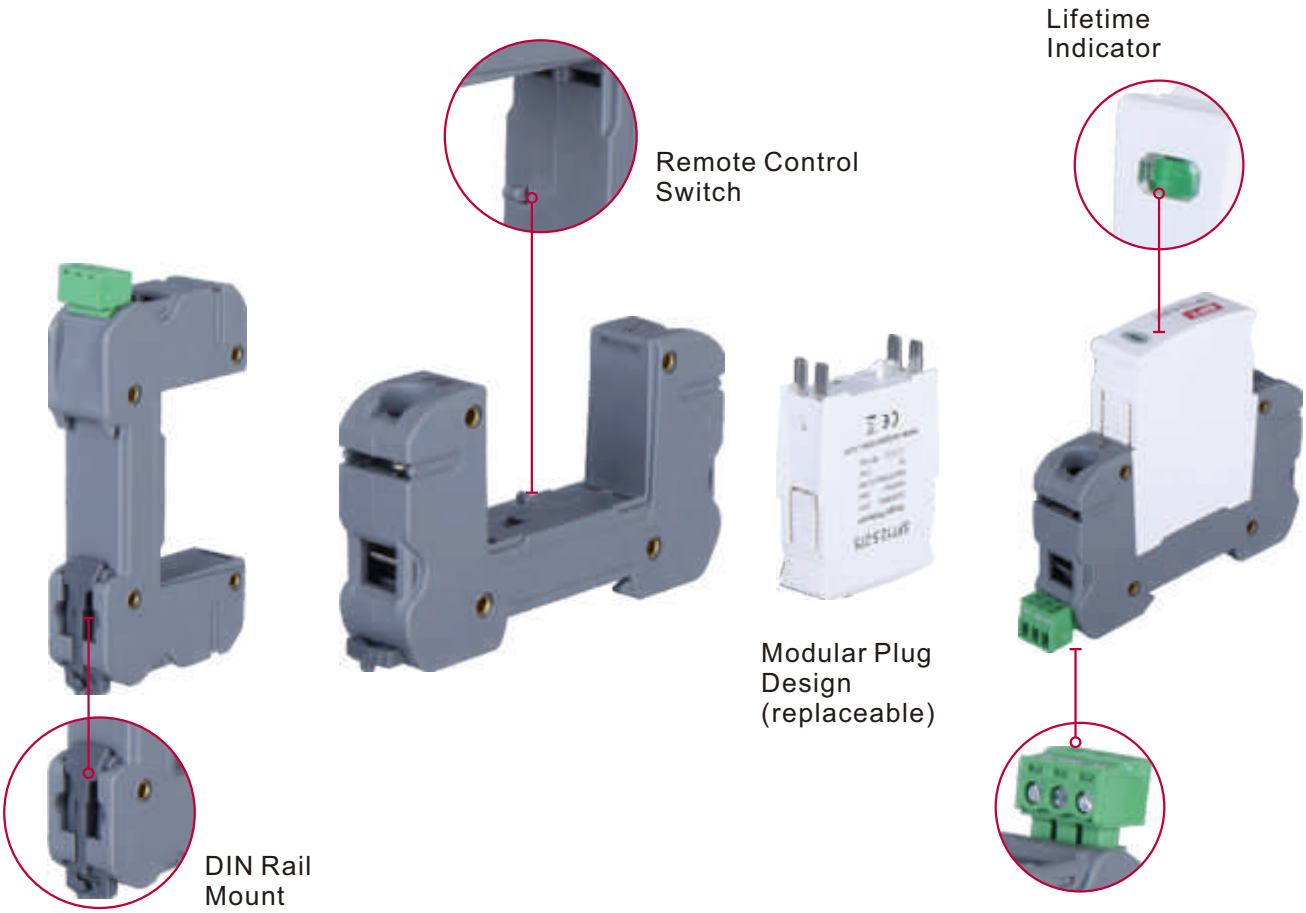
New Housing Design Features

- Contemporary design
- Low residual protection level
- Lifetime indicators
- Redesigned thermal disconnection
- Patented protection technologies
- No external back-up fuse required up to 315 A
- Vibration and shock withstand capability
- Space-saving design
- Easy replacement
- Patented module locking mechanism
- Meets IEC/EN and UL 1449 4th Edition



Modern Modular Space Saving Profile

SPT12.5-XXX/1



Type 1/Type 2 SPD

SPT12.5-XXX/1(S)

SPT12.5-XXX/2(S)

SPT12.5-XXX/3(S)

SPT12.5-XXX/4(S)

SPT12.5-XXX/1(S)+1

SPT12.5-XXX/3(S)+1

SPT12.5-PVXXX-(S)

Type 2 SPD

SPT40-XXX/1(S)

SPT40-XXX/2(S)

SPT40-XXX/3(S)

SPT40-XXX/4(S)

SPT40-XXX/1(S)+1

SPT40-XXX/3(S)+1

SPT40-PVXXX-(S)

Pluggable Single-Pole SPD

SPT12.5-XXX/1(S)

Class I•Class II • Type 1•Type 2•Type 1CA

Location of Use: Main Distribution Boards
Network Systems: TN-S, TN-C, TT (only L-N)
Mode of Protection: L-PE, N-PE (only TN-S), L-PEN, L-N
Surge Ratings: Iimp = up to 12.5 kA (10/350 µs)
In = up to 20 kA (8/20 µs)
IEC/EN/UL Category: Class I+II / Type 1+2 / Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

SPT12.5-XXX/1(S)		75	150	275	320	385	440
IEC Electrical							
Nominal AC Voltage (50/60Hz)	U_o/U_n	60V	120V	230V	230V	230V	400V
Maximum Continuous Operating Voltage (AC)	U_c	75V	150V	275V	320V	385V	440V
Nominal Discharge Current (8/20 µs)	I_n	20kA	20kA	20kA	20kA	10kA	10kA
Maximum Discharge Current (8/20 µs)	I_{max}	50kA	50kA	50kA	50kA	50kA	50kA
Impulse Discharge Current (10/350 µs)	I_{imp}	12.5kA	12.5kA	12.5kA	12.5kA	10kA	10kA
Specific Energy	W/R	39kJ/Ω	39kJ/Ω	39kJ/Ω	39kJ/Ω	25 kJ/Ω	25kJ/Ω
Charge	Q	6.25 As	6.25As	6.25As	6.25As	5As	5As
Voltage Protection Level	U_p	700V	1000V	1500V	1600V	1800V	2000 V
Response Time	t_A	<25 ns					
Back-Up Fuse (max)		315 A / 250 A gG					
Short-Circuit Current Rating (AC)	I_{SCCR}	25 kA / 50 kA					
TOV Withstand 5s	U_T	114V	180	335V	335V	335V	580V
TOV 120min	U_T	180V	230V	440V	440V	440V	765V
	Mode	Withstand	Safe Fail	Safe Fail	Safe Fail	Safe Fail	Safe Fail
Number of Ports		1					
UL Electrical							
Maximum Continuous Operating Voltage (AC)	MCOV	75V	150V	275V	320V	385V	440V
Voltage Protection Rating	VPR	330V	600V	900V	1200V	1350V	1500V
Nominal Discharge Current (8/20 µs)	I_n	20kA	20kA	20kA	20kA	20kA	20kA
Short-Circuit Current Rating (AC)	SCCR	100kA	200kA	150kA	150kA	150kA	200kA
Mechanical & Environmental							
Operating Temperature Range	T_a	-40 °F to +158 °F [-40 °C to +70 °C]					
Permissible Operating Humidity	RH	5%...95%					
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m					
Terminal Screw Torque	M_{max}	39.9 lbf·in [4.5 Nm]					
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)					
		35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)					
Mounting		35 mm DIN Rail, EN 60715					
Degree of Protection		IP 20 (built-in)					
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0					
Thermal Protection		Yes					
Operating State / Fault Indication		Green ok / Red defect					
Remote Contacts (RC)		Optional					
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A					
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm^2 (Solid)					

Order Information						
Order Code	**75**	**150**	**275**	**320**	**385**	**440**
SPT12.5-XXX/1	1207511	1215011	1227511	1232011	1238511	1244011
SPT12.5-XXX/1S(with remote contacts)	1207512	1215012	1227512	1232012	1238512	1244012
SPT12.5-XXX/0(spare modules)	1207501	1215001	1227501	1232001	1238501	1244001

Internal Configuration

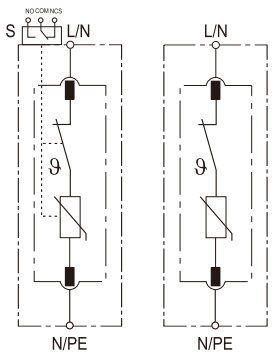
Legend

L Line

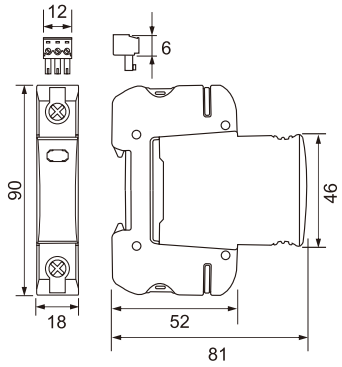
N Neutral

PE Protective Earth

S Signalling Contacts Optional

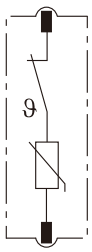


Dimensions & Packaging



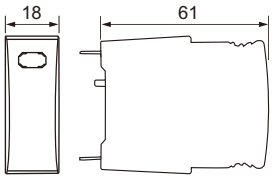
Dimensions & Packaging						
SPT12.5-XXX/1(S)	**75**	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN					
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]					
Minimum Order Quantity	64 Units					

SPT12.5-XXX/0



Plug Internal Configuration

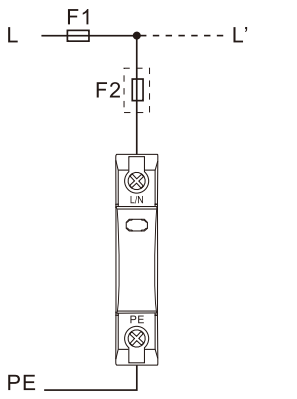
Dimensions & Packaging



Dimensions & Packaging						
SPT12.5-XXX/0	**75**	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN					
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]					
Minimum Order Quantity	64 Units					

Connection Diagram

TN-S, TN-C, TT (Single-phase, 1+0)



Pluggable Multi-Pole SPD

SPT12.5-XXX/2(S)

Class I•Class II • Type 1•Type 2•Type 1CA

Location of Use: Main Distribution Boards
Network Systems: TN-S
Mode of Protection: L-PE, N-PE
Surge Ratings: I_{imp} = up to 12.5 kA (10/350 µs)
I_n = up to 20 kA (8/20 µs)
IEC/EN/UL Category: Class I+II / Type 1+2 / Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

SPT12.5-XXX/2(S)		75	150	275	320	385	440
IEC Electrical							
Nominal AC Voltage (50/60Hz)	U_o/U_n	60V	120V	230V	230V	230V	400V
Maximum Continuous Operating Voltage (AC)	U_c	75V	150V	275V	320V	385V	440V
Nominal Discharge Current (8/20 µs)	I_n	20kA	20kA	20kA	20kA	10kA	10kA
Maximum Discharge Current (8/20 µs)	I_{max}	50kA	50kA	50kA	50kA	50kA	50kA
Impulse Discharge Current (10/350 µs)	I_{imp}	12.5kA	12.5kA	12.5kA	12.5kA	10kA	10kA
Specific Energy	W/R	39kJ/Ω	39kJ/Ω	39kJ/Ω	39kJ/Ω	25 kJ/Ω	25kJ/Ω
Charge	Q	6.25 As	6.25As	6.25As	6.25As	5As	5As
Voltage Protection Level	U_p	700V	1000V	1500V	1600V	1800V	2000 V
Response Time	t_A	<25 ns					
Back-Up Fuse (max)		315 A / 250 A gG					
Short-Circuit Current Rating (AC)	I_{SCCR}	25 kA / 50 kA					
TOV Withstand 5s	U_T	114V	180V	335V	335V	335V	580V
TOV 120min	U_T	114V	230V	440V	440V	440V	765V
	Mode	Withstand	Safe Fail	Safe Fail	Safe Fail	Safe Fail	Safe Fail
Number of Ports		1					
UL Electrical							
Maximum Continuous Operating Voltage (AC)	MCOV	75V	150V	275V	320V	385V	440V
Voltage Protection Rating	VPR	330V	600V	900V	1200V	1350V	1500V
Nominal Discharge Current (8/20 µs)	I_n	20kA	20kA	20kA	20kA	20kA	20kA
Short-Circuit Current Rating (AC)	SCCR	100kA	200kA	150kA	150kA	150kA	200kA
Mechanical & Environmental							
Operating Temperature Range	T_a	-40 °F to +158 °F [-40 °C to +70 °C]					
Permissible Operating Humidity	RH	5%...95%					
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m					
Terminal Screw Torque	M max	39.9 lbf·in [4.5 Nm]					
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)					
		35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)					
Mounting		35 mm DIN Rail, EN 60715					
Degree of Protection		IP 20 (built-in)					
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0					
Thermal Protection		Yes					
Operating State / Fault Indication		Green ok / Red defect					
Remote Contacts (RC)		Optional					
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A					
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm^2 (Solid)					

Order Information						
Order Code	**75**	**150**	**275**	**320**	**385**	**440**
SPT12.5-XXX/2	1207521	1215021	1227521	1232021	1238521	1244021
SPT12.5-XXX/2S(with remote contacts)	1207522	1215022	1227522	1232022	1238522	1244022
SPT12.5-XXX/0(spare modules)	1207501	1215001	1227501	1232001	1238501	1244001

Internal Configuration

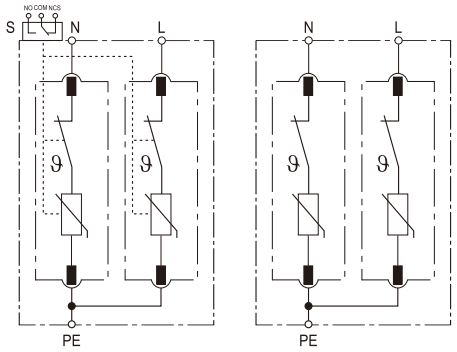
Legend

L Line

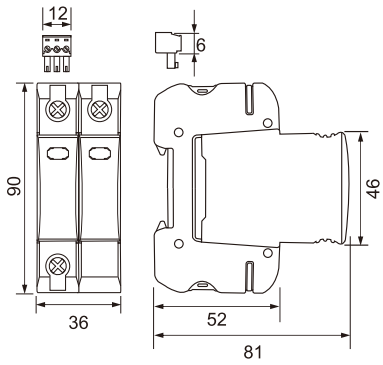
N Neutral

PE Protective Earth

S Signalling Contacts Optional



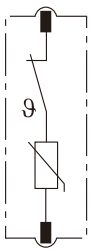
Dimensions & Packaging



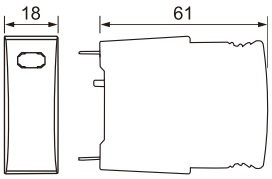
Plug Internal Configuration

Dimensions & Packaging						
SPT12.5-XXX/2(S)	**75**	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN					
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]					
Minimum Order Quantity	32 Units					

SPT12.5-XXX/0



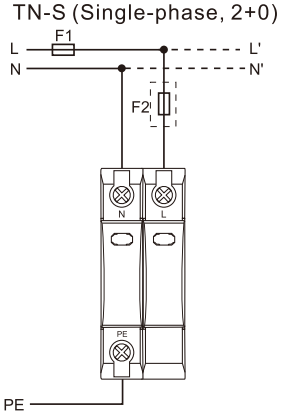
Dimensions & Packaging



Dimensions & Packaging						
SPT12.5-XXX/0	**75**	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN					
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]					
Minimum Order Quantity	64 Units					

Connection Diagram

TN-S (Single-phase, 2+0)



Pluggable Multi-Pole SPD

SPT12.5-XXX/3(S)

Class I•Class II • Type 1•Type 2•Type 1CA

Location of Use: Main Distribution Boards
Network Systems: TN-C
Mode of Protection: L-PEN
Surge Ratings: I_{imp} = up to 12.5 kA (10/350 µs)
I_n = up to 20 kA (8/20 µs)
IEC/EN/UL Category: Class I+II / Type 1+2 / Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

SPT12.5-XXX/3(S)

		150	275	320	385	440
IEC Electrical						
Nominal AC Voltage (50/60Hz)	U_o/U_n	120V	230V	230V	230V	400V
Maximum Continuous Operating Voltage (AC)	U_c	150V	275V	320V	385V	440V
Nominal Discharge Current (8/20 µs)	I_n	20kA	20kA	20kA	10kA	10kA
Maximum Discharge Current (8/20 µs)	I_{max}	50kA	50kA	50kA	50kA	50kA
Impulse Discharge Current (10/350 µs)	I_{imp}	12.5kA	12.5kA	12.5kA	10kA	10kA
Specific Energy	W/R	39kJ/Ω	39kJ/Ω	39kJ/Ω	25 kJ/Ω	25kJ/Ω
Charge	Q	6.25As	6.25As	6.25As	5As	5As
Voltage Protection Level	U_p	1000V	1500V	1600V	1800V	2000 V
Response Time	t_A	<25 ns				
Back-Up Fuse (max)		315 A / 250 A gG				
Short-Circuit Current Rating (AC)	I_{SCCR}	25 kA / 50 kA				
TOV Withstand 5s	U_T	180V	335V	335V	335V	580V
TOV 120min	U_T	230V	440V	440V	440V	765V
	Mode	Safe Fail	Safe Fail	Safe Fail	Safe Fail	Safe Fail
Number of Ports		1				
UL Electrical						
Maximum Continuous Operating Voltage (AC)	MCOV	150V	275V	320V	385V	440V
Voltage Protection Rating	VPR	600V	900V	1200V	1350V	1500V
Nominal Discharge Current (8/20 µs)	I_n	20kA	20kA	20kA	20kA	20kA
Short-Circuit Current Rating (AC)	SCCR	200kA	150kA	150kA	150kA	200kA
Mechanical & Environmental						
Operating Temperature Range	T_a	-40 °F to +158 °F [-40 °C to +70 °C]				
Permissible Operating Humidity	RH	5%...95%				
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m				
Terminal Screw Torque	M max	39.9 lbf·in [4.5 Nm]				
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)				
		35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)				
Mounting		35 mm DIN Rail, EN 60715				
Degree of Protection		IP 20 (built-in)				
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0				
Thermal Protection		Yes				
Operating State / Fault Indication		Green ok / Red defect				
Remote Contacts (RC)		Optional				
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A				
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm^2 (Solid)				

Order Information					
Order Code	**150**	**275**	**320**	**385**	**440**
SPT12.5-XXX/3	1215031	1227531	1232031	1238531	1244031
SPT12.5-XXX/3S(with remote contacts)	1215032	1227532	1232032	1238532	1244032
SPT12.5-XXX/0(spare modules)	1215001	1227501	1232001	1238501	1244001

Internal Configuration

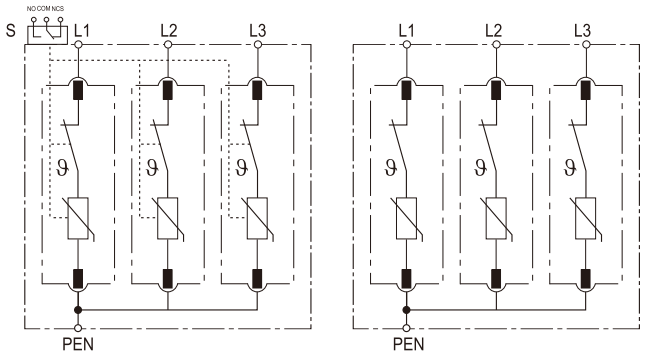
Legend

L Line

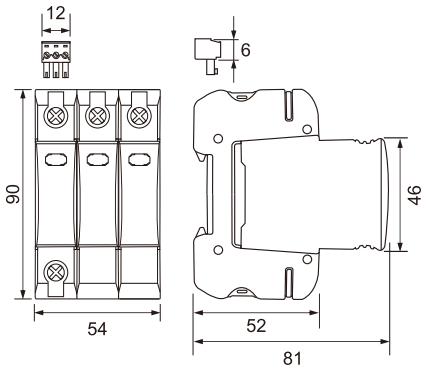
N Neutral

PE Protective Earth

S Signalling Contacts Optional

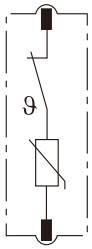


Dimensions & Packaging



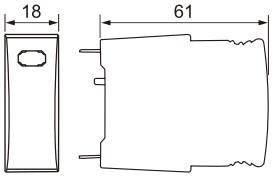
Dimensions & Packaging					
SPT12.5-XXX/3(S)	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]				
Minimum Order Quantity	16 Units				

SPT12.5-XXX/0



Plug Internal Configuration

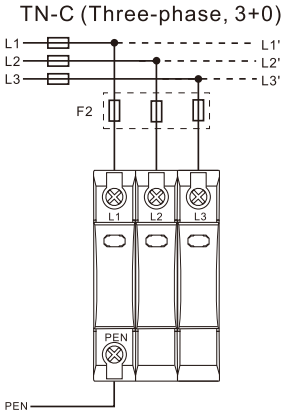
Dimensions & Packaging



Dimensions & Packaging					
SPT12.5-XXX/0	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]				
Minimum Order Quantity	64 Units				

Connection Diagram

TN-C (Three-phase, 3+0)



Pluggable Multi-Pole SPD

SPT12.5-XXX/4(S)

Class I•Class II • Type 1•Type 2•Type 1CA

Location of Use: Main Distribution Boards
Network Systems: TN-S
Mode of Protection: L-PE, N-PE
Surge Ratings: I_{imp} = up to 12.5 kA (10/350 µs)
I_n = up to 20 kA (8/20 µs)
IEC/EN/UL Category: Class I+II / Type 1+2 / Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

SPT12.5-XXX/4(S)

		150	275	320	385	440
IEC Electrical						
Nominal AC Voltage (50/60Hz)	U_o/U_n	120V	230V	230V	230V	400V
Maximum Continuous Operating Voltage (AC)	U_c	150V	275V	320V	385V	440V
Nominal Discharge Current (8/20 µs)	I_n	20kA	20kA	20kA	10kA	10kA
Maximum Discharge Current (8/20 µs)	I_{max}	50kA	50kA	50kA	50kA	50kA
Impulse Discharge Current (10/350 µs)	I_{imp}	12.5kA	12.5kA	12.5kA	10kA	10kA
Specific Energy	W/R	39kJ/Ω	39kJ/Ω	39kJ/Ω	25 kJ/Ω	25kJ/Ω
Charge	Q	6.25As	6.25As	6.25As	5As	5As
Voltage Protection Level	U_p	1000V	1500V	1600V	1800V	2000 V
Response Time	t_A	<25 ns				
Back-Up Fuse (max)		315 A / 250 A gG				
Short-Circuit Current Rating (AC)	I_{SCCR}	25 kA / 50 kA				
TOV Withstand 5s	U_T	180V	335V	335V	335V	580V
TOV 120min	U_T	230V	440V	440V	440V	765V
	Mode	Safe Fail	Safe Fail	Safe Fail	Safe Fail	Safe Fail
Number of Ports		1				
UL Electrical						
Maximum Continuous Operating Voltage (AC)	MCOV	150V	275V	320V	385V	440V
Voltage Protection Rating	VPR	600V	900V	1200V	1350V	1500V
Nominal Discharge Current (8/20 µs)	I_n	20kA	20kA	20kA	20kA	20kA
Short-Circuit Current Rating (AC)	SCCR	200kA	150kA	150kA	150kA	200kA
Mechanical & Environmental						
Operating Temperature Range	T_a	-40 °F to +158 °F [-40 °C to +70 °C]				
Permissible Operating Humidity	RH	5%...95%				
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m				
Terminal Screw Torque	M_{max}	39.9 lbf·in [4.5 Nm]				
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)				
		35 mm² (Solid, Stranded) / 25 mm² (Flexible)				
Mounting		35 mm DIN Rail, EN 60715				
Degree of Protection		IP 20 (built-in)				
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0				
Thermal Protection		Yes				
Operating State / Fault Indication		Green ok / Red defect				
Remote Contacts (RC)		Optional				
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A				
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm² (Solid)				

Order Information					
Order Code	**150**	**275**	**320**	**385**	**440**
SPT12.5-XXX/4	1215041	1227541	1232041	1238541	1244041
SPT12.5-XXX/4S(with remote contacts)	1215042	1227542	1232042	1238542	1244042
SPT12.5-XXX/0(spare modules)	1215001	1227501	1232001	1238501	1244001

Internal Configuration

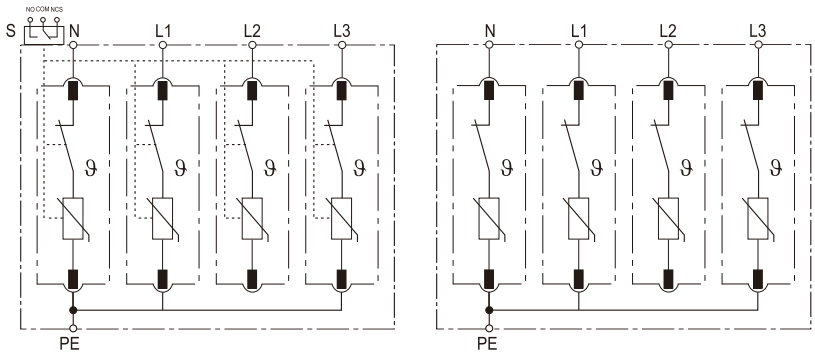
Legend

L Line

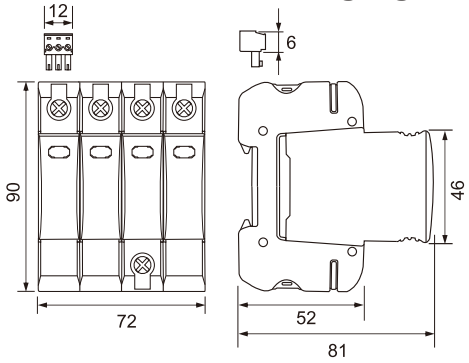
N Neutral

PE Protective Earth

S Signalling Contacts Optional

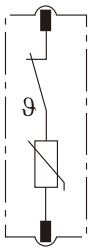


Dimensions & Packaging



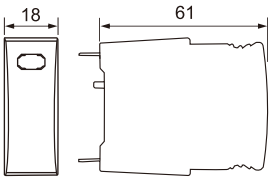
Dimensions & Packaging					
SPT12.5-XXX/4(S)	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]				
Minimum Order Quantity	16 Units				

SPT12.5-XXX/0



Plug Internal Configuration

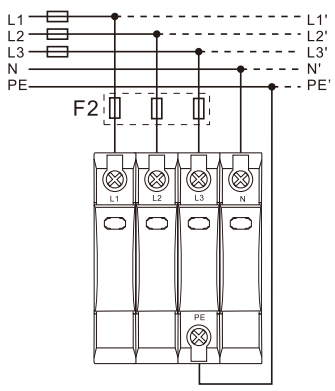
Dimensions & Packaging



Dimensions & Packaging					
SPT12.5-XXX/0	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]				
Minimum Order Quantity	64 Units				

Connection Diagram

TN-S (Three-phase, 4+0)



Pluggable Multi-Pole SPD

SPT12.5-XXX/1(S)+1

Class I•Class II • Type 1•Type 2 •Type 1CA

Location of Use: Main Distribution Boards
Network Systems: TT, TN-S
Mode of Protection: L-N,N-PE
Surge Ratings: I_{imp} =12.5 kA (10/350 μs)
I_n = 20 kA (8/20 μs)
IEC/EN/UL Category: Class I+II / Type 1+2 / Type 1CA
Protective Elements: High Energy MOV and GDT
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

SPT12.5-XXX/1(S)+1			75	150	275	320
IEC Electrical						
Nominal AC Voltage (50/60Hz)			60V	120V	230V	230V
Maximum Continuous Operating Voltage	(L- N)	U_c	75V	150V	275V	320V
	(N- PE)	U_c	255V	255V	255V	255V
Nominal Discharge Current (8/20 μs)	(L-N)/(N– PE)	I_n	20kA/ 25kA			
Maximum Discharge Current (8/20 μs)	(L-N)/(N- PE)	I_{max}	50kA/50kA			
Impulse Discharge Current (10/350 μs)	(L-N)/(N- PE)	I_{imp}	12.5 kA/25 kA			
Specific Energy	(L- N)/(N- PE)	W/R	39kJ/Ω/156kJ/Ω			
Charge	(L-N)/(N-PE)	Q	6.25As/12.5As			
Voltage Protection Level	(L-N)/(N– PE)	U_p	700V/1500V	1000V/1500V	1500V/1500V	1600V/1500V
Follow Current Interrupt Rating	(N-PE)	I_{fi}	100A_{RMS}			
Response Time	(L-N)/(N-PE)	t_A	<25ns/<100ns			
Back-Up Fuse (max)			315A/250AgG			
Short-Circuit Current Rating (AC)	(L- N)	I_{SCCR}	25kA/ 50kA			
TOV Withstand 5s	(L- N)	U_T	114V	180V	335V	335V
TOV 120min	(L- N)	U_T	114V	230V	440V	440V
		Mode	Withstand	Safe Fail	Safe Fail	Safe Fail
TOV Withstand 200ms	(N-PE)	U_T	1200V			
Number of Ports			1			
UL Electrical						
Maximum Continuous Operating Voltage (AC)	(L-N)/(N– PE)	MCOV	75V/255V	150V/255V	275V/255V	320V/255V
Voltage Protection Rating	(L-N)/(N- PE)	VPR	330V/1200V	600V/1200V	900V/1200V	1200V/1200V
Nominal Discharge Current (8/20 μs)	(L-N)/(– PE)	I_n	20kA /20kA	20kA /20kA	20kA /20kA	20kA /20kA
Short-Circuit Current Rating (AC)	(L- N)	SCCR	100kA	200kA	150kA	150kA
Mechanical & Environmental						
Operating Temperature Range	T_a		-40 °F to +158 °F [-40 °C to +70 °C]			
Permissible Operating Humidity	RH		5%...95%			
Atmospheric pressure and altitude			80k Pa ... 106k Pa / -500 m ... 2000 m			
Terminal Screw Torque	M_{max}		39.9 lbf·in [4.5 Nm]			
Conductor Cross Section (max)			2 AWG (Solid, Stranded) / 4 AWG (Flexible)			
			35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)			
Mounting			35 mm DIN Rail, EN 60715			
Degree of Protection			IP 20 (built-in)			
Housing Material			Thermoplastic: Extinguishing Degree UL 94 V-0			
Thermal Protection			Yes			
Operating State / Fault Indication			Green ok / Red defect			
Remote Contacts (RC)			Optional			
RC Switching Capacity			AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A			
RC Conductor Cross Section (max)			16 AWG (Solid) / 1.5 mm^2 (Solid)			

Order Information				
Order Code	**75**	**150**	**275**	**320**
SPT12.5-XXX/1+1	1207513	1215013	1227513	1232013
SPT12.5-XXX/1S+1(with remote contacts)	1207514	1215014	1227514	1232014
SPT12.5-XXX/0(spare modules)	1207501	1215001	1227501	1232001
SPT12.5-NPE/0(spare modules)	1225501	1225501	1225501	1225501

Internal Configuration

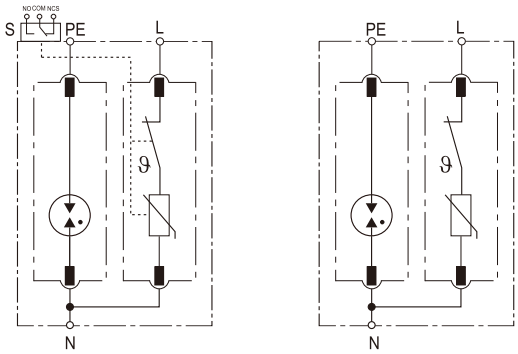
Legend

L Line

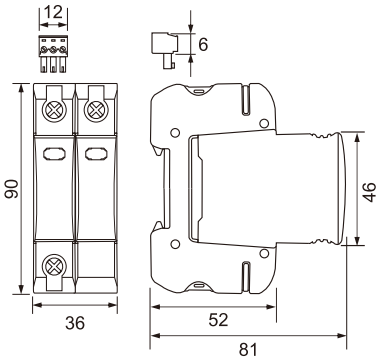
N Neutral

PE Protective Earth

S Signalling Contacts Optional

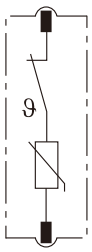


Dimensions & Packaging

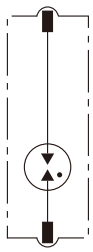


Dimensions & Packaging				
SPT12.5-XXX/1(S)+1	**75**	**150**	**275**	**320**
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]			
Minimum Order Quantity	32 Units			

SPT12.5-XXX/0

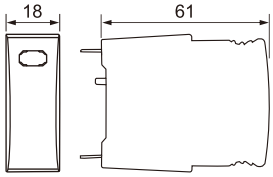


SPT12.5-NPE/0



Plug Internal Configuration

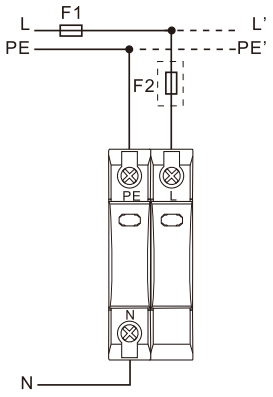
Dimensions & Packaging



Dimensions & Packaging				
SPT12.5-XXX/0	**75**	**150**	**275**	**320**
SPT12.5-NPE/0	**25**			
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]			
Minimum Order Quantity	64 Units			

Connection Diagram

TN-S,TT (Single-phase, 1+1)



Pluggable Multi-Pole SPD

SPT12.5-XXX/3(S)+1

Class I•Class II • Type 1•Type 2 •Type 1CA

Location of Use: Main Distribution Boards
Network Systems: TT, TN-S
Mode of Protection: N-PE, L-N
Surge Ratings: I_{imp} = 12.5 kA (10/350 µs)
I_n = 20 kA (8/20 µs)
IEC/EN/UL Category: Class I+II / Type 1+2 / Type 1CA
Protective Elements: High Energy MOV and GDT
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

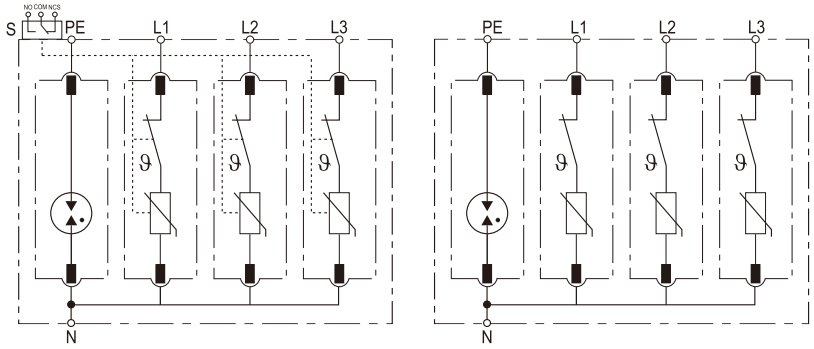
SPT12.5-XXX/2(S)+1			150	275	320
IEC Electrical					
Nominal AC Voltage (50/60Hz)			120V	230V	230V
Maximum Continuous Operating Voltage	(L- N)	U_c	150V	275V	320V
	(N– PE)	U_c	255V	255V	255V
Nominal Discharge Current (8/20 µs)	(L-N)/(N– PE)	I_n		20kA/50kA	
Maximum Discharge Current (8/20 µs)	(L-N)/(N– PE)	I_{max}		50kA/100kA	
Impulse Discharge Current (10/350 µs)	(L-N)/(N– PE)	I_{imp}		12.5kA/50kA	
Specific Energy	(L-N)/(N– PE)	W/R		39kJ/Ω/625kJ/Ω	
Charge	(L-N)/(N-PE)	Q		6.25As/25As	
Voltage Protection Level	(L-N)/(N– PE)	U_p	1000V/1500V	1500V/1500V	1600V/1500V
Follow Current Interrupt Rating	(N-PE)	I_{fi}		100A RMS	
Response Time	(L-N)/(N-PE)	t_A		< 25 ns / < 100 ns	
Back-Up Fuse (max)				315 A / 250 A gG	
Short-Circuit Current Rating (AC)	(L- N)	I_{SCCR}		25 kA / 50 kA	
TOV Withstand 5s	(L- N)	U_T	180V	335V	335V
TOV 120min	(L- N)	U_T	230V	440V	440V
		Mode	Safe Fail	Safe Fail	Safe Fail
TOV Withstand 200s	(N-PE)	U_T		1200V	
Number of Ports				1	
UL Electrical					
Maximum Continuous Operating Voltage (AC)	(L-N)/(N-PE)	MCOV	150V/255V	275V/255V	320V/255V
Voltage Protection Rating	(L-N)/(N-PE)	VPR	600V/1200V	900V/1200V	1200V/1200V
Nominal Discharge Current (8/20 µs)	(L-N)/(N-PE)	I_n	20kA/20kA	20kA/20kA	20kA/20kA
Short-Circuit Current Rating (AC)	(L- N)	SCCR	200kA	150kA	150kA
Mechanical & Environmental					
Operating Temperature Range	T_a	-40 °F to +158 °F [-40 °C to +70 °C]			
Permissible Operating Humidity	RH	5%...95%			
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m			
Terminal Screw Torque	M max	39.9 lbf·in [4.5 Nm]			
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)			
		35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)			
Mounting		35 mm DIN Rail, EN 60715			
Degree of Protection		IP 20 (built-in)			
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0			
Thermal Protection		Yes			
Operating State / Fault Indication		Green ok / Red defect			
Remote Contacts (RC)		Optional			
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A			
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm^2 (Solid)			

Order Information			
Order Code	**150**	**275**	**320**
SPT12.5-XXX/3+1	1215033	1227533	1232033
SPT12.5-XXX/3S+1 (with remote contacts)	1215034	1227534	1232034
SPT12.5-XXX/0 (spare modules)	121 5001	1227501	1232001
SPT12.5-NPE/0 (spare modules)	1225502	1225502	1225502

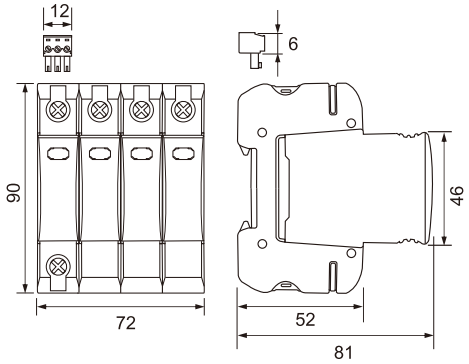
Internal Configuration

Legend

L Line
N Neutral
PE Protective Earth
S Signalling Contacts Optional



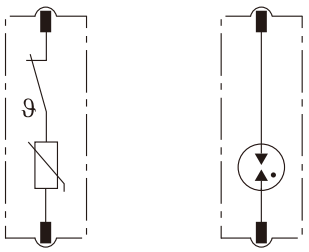
Dimensions & Packaging



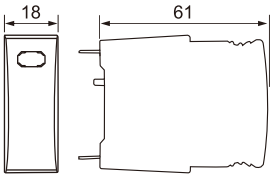
Dimensions & Packaging			
SPT12.5-XXX/3(S)+1	**150**	**275**	**320**
Single Unit DIN 43880 Dimension	1 CTN		
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]		
Minimum Order Quantity	16 Units		

Plug Internal Configuration

SPT12.5-XXX/0 SPT12.5-NPE/0

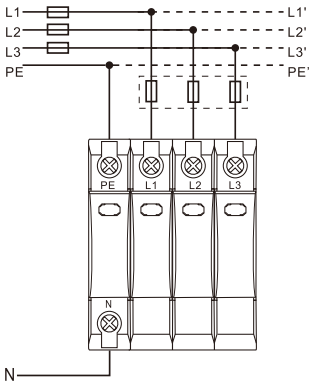


Plug Internal Configuration



Dimensions & Packaging			
SPT12.5-XXX/0	**150**	**275**	**320**
SPT12.5-NPE/0	**50**		
Single Unit DIN 43880 Dimension	1 CTN		
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]		
Minimum Order Quantity	64 Units		

Connection Diagram



Pluggable Multi-Pole SPD for Photovoltaic Systems

SPT12.5-PVXXX-(S)

Class I Class II • Type 1 Type 2 • Type 1CA

Location of Use: String box, Inverter
Mode of Protection: (DC+)- PE, (DC-)- PE, (DC+)- (DC-)
Surge Ratings: I_{total} = up to 12.5 kA (10/350 µs)
I_{total} = up to 40 kA (8/20 µs)
IEC/EN/UL Category: Class I+II / Type 1+2 / Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-31:2018
EN 50539-11:2013+A1:2014
UL 1449 4th Edition

Technical Data

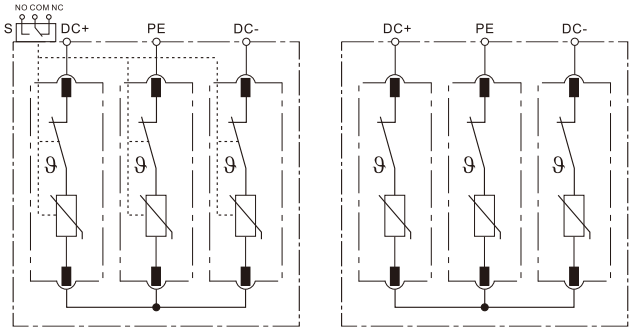
SPT12.5-PVXXX-(S)			600	1000	1200	1500
IEC Electrical						
Maximum Continuous Operating DC Voltage	(DC+) - PE, (DC-) - PE	U_{CPV}	600 V	1000 V	1200 V	1500 V
	(DC+) - (DC-)	U_{CPV}	600 V	1000 V	1200 V	1500 V
Nominal Discharge Current (8/20 µs)		I_n		20KA		
Impulse Discharge Current (10/350 µs)		I_{imp}		6.25kA		
Total Discharge Current (10/350 µs)		I_{Total}		12.5kA		
Total Discharge Current (8/20 µs)		I_{Total}		40kA		
Maximum Discharge Current (8/20 µs)		I_{max}		40kA		
Voltage Protection Level	(DC+) - PE, (DC-) - PE	U_p	2200 V	4000 V	4400 V	5200 V
	(DC+) - (DC-)	U_p	2200 V	4000 V	4400 V	5200 V
Response Time		t_A		< 25 ns		
Short-Circuit Current Rating		I_{SCPV}		2000A		
Number of Ports				1		
UL Electrical						
Maximum Permitted DC Voltage		V_{pvdc}	600 V	1000 V	1200 V	1500 V
Voltage Protection Rating	(DC+) - PE, (DC-) - PE	V_{PR}	1600 V	2500 V	3000 V	4000 V
	(DC+) - (DC-)	V_{PR}	1600 V	2500 V	3000 V	4000 V
Nominal Discharge Current (8/20 µs)		I_n		20 kA		
Short-Circuit Current Rating		SCCR	35 kA	50 kA	55 kA	65 kA
Mechanical & Environmental						
Operating Temperature Range		T_a		-40 °F to +158 °F [-40 °C to +70 °C]		
Permissible Operating Humidity		RH		5%...95%		
Atmospheric pressure and altitude				80k Pa ... 106k Pa / -500 m ... 2000 m		
Terminal Screw Torque		M_{max}		39.9 lbf·in [4.5 Nm]		
Conductor Cross Section (max)				2 AWG (Solid, Stranded) / 4 AWG (Flexible)		
				35mm² (Solid, Stranded) / 25mm² (Flexible)		
Mounting				35 mm DIN Rail, EN 60715		
Degree of Protection				IP 20 (built-in)		
Housing Material				Thermoplastic: Extinguishing Degree UL 94 V-0		
Thermal Protection				Yes		
Operating State / Fault Indication				Green ok / Red defect		
Remote Contacts (RC)				Optional		
RC Switching Capacity				AC: 250V / 0.5 A;DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A		
RC Conductor Cross Section (max)				16 AWG(Solid)/1.5 mm² (Solid)		

Order Information				
Order Code	600	1000	1200	1500
SPT12.5- PVXXX	0760025	0710235	0712231	0715231
SPT12.5- PVXXX-(S) (with remote contacts)	0760026	0710236	0712232	0715232
SPT12.5- PVXXX/0 (spare modules)	0760002	0710202	0712202	0715202

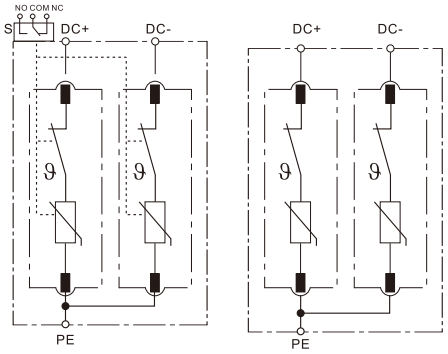
Internal Configuration

Legend
PE Protective Earth
S Signalling Contacts Optional

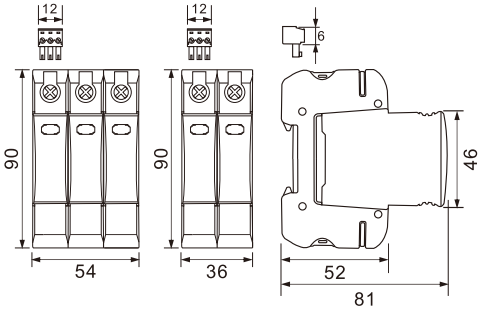
SPT12.5-PV1000-(S), SPT12.5-PV1200-(S), SPT12.5-PV1500-(S)



SPT12.5-PV600-(S)



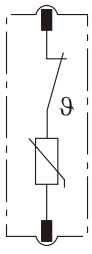
Dimensions & Packaging



SPT12.5-PV1500-(S)
SPT12.5-PV1200-(S)
SPT12.5-PV1000-(S)
SPT12.5-PV600-(S)

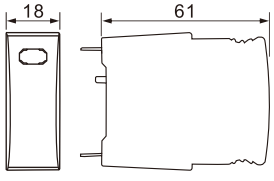
Dimensions & Packaging				
SPT12.5-PVXXX-(S)	600	1000	1200	1500
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[220 × 230 × 330 mm]			
Minimum Order Quantity	32 Units	16 Units	16 Units	16 Units

SPT12.5-PVXXX/0



Plug Internal Configuration

Dimensions & Packaging



Dimensions & Packaging				
SPT12.5-PVXXX/0	600	1000	1200	1500
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[220 × 230 × 330 mm]			
Minimum Order Quantity	64 Units			

Pluggable Single-Pole SPD

SPT40-XXX/1(S)

Class II • Type 2•Type 1CA

Location of Use: Sub-Distribution Boards
Network Systems: TN-S, TN-C, TT (only L-N)
Mode of Protection: L-PE, N-PE (only TN-S), L-PEN, L-N
Surge Ratings: I_n = 20 kA(8/20 µs)
IEC/EN/UL Category: Class II / Type 2 / Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

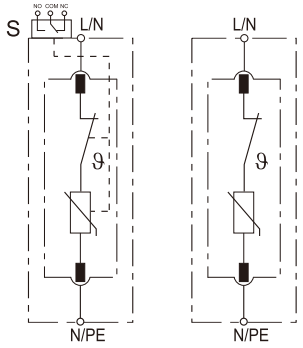
SPT40-XXX/1(S)		75	150	275	320	385	440
IEC Electrical							
Nominal AC Voltage (50/60Hz)	U_o/ U_n	60 V	120 V	230 V	230 V	230 V	400 V
Maximum Continuous Operating Voltage (AC)	U_c	75 V	150 V	275 V	320 V	385 V	440 V
Nominal Discharge Current (8/20 µs)	I_n	20 kA	20 kA	20 kA	20 kA	20 kA	20 kA
Maximum Discharge Current (8/20 µs)	I_{max}	40 kA	40 kA	40 kA	40 kA	40 kA	40 kA
Voltage Protection Level	U_p	400 V	1000 V	1500 V	1600 V	1750 V	2000 V
Response Time	t_A	< 25 ns					
Back-Up Fuse (max)		125 A gL / gG					
Short-Circuit Current Rating (AC)	I_{SCCR}	25 kA / 50 kA					
TOV Withstand 5s	U_T	90 V	180 V	335 V	335 V	335 V	580 V
	U_T	115 V	230 V	440 V	440 V	440 V	765 V
TOV 120min	mode	Withstand	Withstand	Safe Fail	Safe Fail	Safe Fail	Safe Fail
Number of Ports		1					
UL Electrical							
Maximum Continuous Operating Voltage (AC)	MCOV	75 V	150 V	275 V	320 V	385 V	440 V
Voltage Protection Rating	VPR	330 V	600 V	900 V	1000 V	1200 V	1500 V
Nominal Discharge Current (8/20 µs)	I_n	20 kA	20 kA	20 kA	20 kA	20 kA	20 kA
Short-Circuit Current Rating (AC)	SCCR	100 kA	200 kA	150 kA	150 kA	150 kA	200 kA
Mechanical & Environmental							
Operating Temperature Range	T_a	-40 ºF to +158 ºF [-40 ºC to +70 ºC]					
Permissible Operating Humidity	RH	5%...95%					
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m					
Terminal Screw Torque	M_{max}	39.9 lbf·in [4.5 Nm]					
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)					
		35 mm² (Solid, Stranded) / 25 mm² (Flexible)					
Mounting		35 mm DIN Rail, EN 60715					
Degree of Protection		IP 20 (built-in)					
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0					
Thermal Protection		Yes					
Operating State / Fault Indication		Green ok / Red defect					
Remote Contacts (RC)		Optional					
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A					
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm²(Solid)					

Order Information						
Order Code	**75**	**150**	**275**	**320**	**385**	**440**
SPT40-XXX/1	4007511	4015011	4027511	4032011	4038511	4044011
SPT40-XXX/1S (with remote contacts)	4007512	4015012	4027512	4032012	4038512	4044012
SPT40-XXX/0 (spare modules)	4007501	4015001	4027501	4032001	4038501	4044001

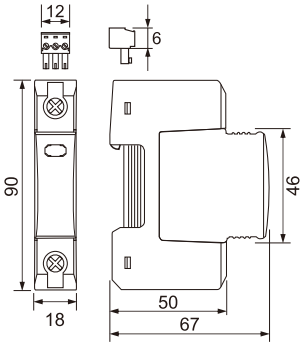
Internal Configuration

Legend

L Line
N Neutral
PE Protective Earth
S Signalling Contacts Optional

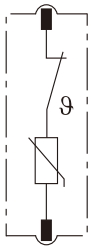


Dimensions & Packaging

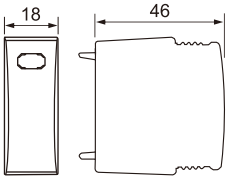


Dimensions & Packaging						
SPT40-XXX/1(S)	**75**	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN					
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]					
Minimum Order Quantity	72 Units					

SPT40-XXX/0



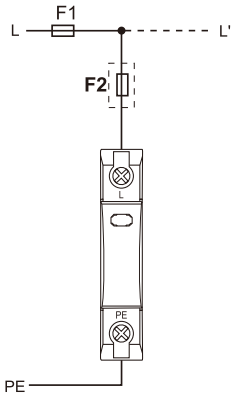
Dimensions & Packaging



Dimensions & Packaging						
SPT40-XXX/0	**75**	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN					
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]					
Minimum Order Quantity	96 Units					

Connection Diagram

TN-S, TN-C, TT (Single-phase, 1+0)



Pluggable Multi-Pole SPD

SPT40-XXX/2(S)

Class II • Type 2•Type 1CA

Location of Use: Sub-Distribution Boards
Network Systems: TN-S
Mode of Protection: L-PE, N-PE
Surge Ratings: I_n = 20 kA(8/20 μs)
IEC/EN/UL Category: Class II / Type 2 / Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

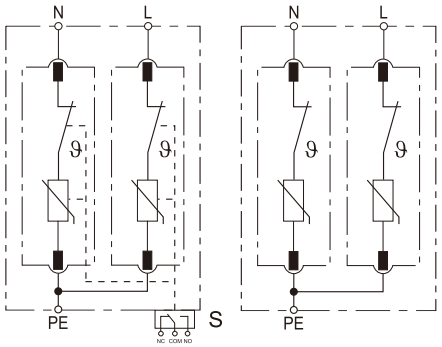
SPT40-XXX/2(S)		75	150	275	320	385	440
IEC Electrical							
Nominal AC Voltage (50/60Hz)	U_o/ U_n	60 V	120 V	230 V	230 V	230 V	400 V
Maximum Continuous Operating Voltage (AC)	U_c	75 V	150 V	275 V	320 V	385 V	440 V
Nominal Discharge Current (8/20 μs)	I_n	20 kA	20 kA	20 kA	20 kA	20 kA	20 kA
Maximum Discharge Current (8/20 μs)	I_{max}	40 kA	40 kA	40 kA	40 kA	40 kA	40 kA
Voltage Protection Level	U_p	400 V	1000 V	1500 V	1600 V	1750 V	2000 V
Response Time	t_A	< 25 ns					
Back-Up Fuse (max)		125 A gL / gG					
Short-Circuit Current Rating (AC)	I_{SCCR}	25 kA / 50 kA					
TOV Withstand 5s	U_T	90 V	180 V	335 V	335 V	335 V	580 V
TOV 120min	U_T	115 V	230 V	440 V	440 V	440 V	765 V
	mode	Withstand	Withstand	Safe Fail	Safe Fail	Safe Fail	Safe Fail
Number of Ports		1					
UL Electrical							
Maximum Continuous Operating Voltage (AC)	MCOV	75 V	150 V	275 V	320 V	385 V	440 V
Voltage Protection Rating	VPR	330 V	600 V	900 V	1000 V	1200 V	1500 V
Nominal Discharge Current (8/20 μs)	I_n	20 kA	20 kA	20 kA	20 kA	20 kA	20 kA
Short-Circuit Current Rating (AC)	SCCR	100 kA	200 kA	150 kA	150 kA	150 kA	200 kA
Mechanical & Environmental							
Operating Temperature Range	T_a	-40 ºF to +158 ºF [-40 ºC to +70 ºC]					
Permissible Operating Humidity	RH	5%...95%					
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m					
Terminal Screw Torque	M_{max}	39.9 lbf·in [4.5 Nm]					
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)					
		35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)					
Mounting		35 mm DIN Rail, EN 60715					
Degree of Protection		IP 20 (built-in)					
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0					
Thermal Protection		Yes					
Operating State / Fault Indication		Green ok / Red defect					
Remote Contacts (RC)		Optional					
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A					
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm^2(Solid)					

Order Information						
Order Code	**75**	**150**	**275**	**320**	**385**	**440**
SPT40-XXX/2	4007521	4015021	4027521	4032021	4038521	4044021
SPT40-XXX/2S(with remote contacts)	4007522	4015022	4027522	4032022	4038522	4044022
SPT40-XXX/0 (spare modules)	4007501	4015001	4027501	4032001	4038501	4044001

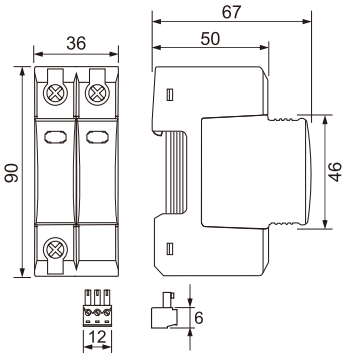
Internal Configuration

Legend

L Line
N Neutral
PE Protective Earth
S Signalling Contacts Optional

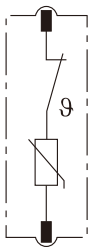


Dimensions & Packaging

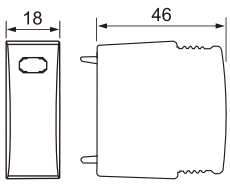


Dimensions & Packaging						
SPT40-XXX/2(S)	**75**	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN					
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]					
Minimum Order Quantity	42 Units					

SPT40-XXX/0



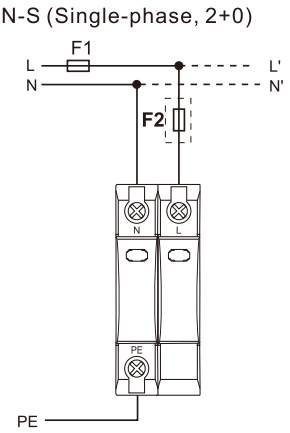
Dimensions & Packaging



Dimensions & Packaging						
SPT40-XXX/0	**75**	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN					
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]					
Minimum Order Quantity	96 Units					

Connection Diagram

TN-S (Single-phase, 2+0)



Pluggable Multi-Pole SPD

SPT40-XXX/3(S)

Class II • Type 2•Type 1CA

Location of Use: Sub-Distribution Boards
Network Systems: TN-C
Mode of Protection: L-PEN
Surge Ratings: I_n = 20 kA(8/20 μs)
IEC/EN/UL Category: Class II / Type 2 / Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

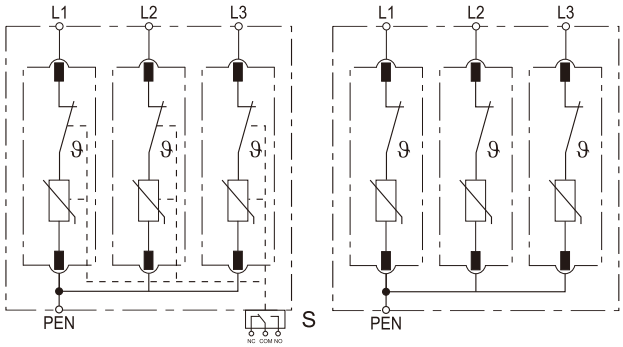
SPT40-XXX/3(S)		150	275	320	385	440
IEC Electrical						
Nominal AC Voltage (50/60Hz)	U_o/ U_n	120 V	230 V	230 V	230 V	400 V
Maximum Continuous Operating Voltage (AC)	U_c	150 V	275 V	320 V	385 V	440 V
Nominal Discharge Current (8/20 μs)	I_n	20 kA	20 kA	20 kA	20 kA	20 kA
Maximum Discharge Current (8/20 μs)	I_{max}	40 kA	40 kA	40 kA	40 kA	40 kA
Voltage Protection Level	U_p	1000 V	1500 V	1600 V	1750 V	2000 V
Response Time	t_A			< 25 ns		
Back-Up Fuse (max)				125 A gL / gG		
Short-Circuit Current Rating (AC)	I_{SCCR}			25 kA / 50 kA		
TOV Withstand 5s	U_T	180 V	335 V	335 V	335 V	580 V
TOV 120min	U_T	230 V	440 V	440 V	440 V	765 V
	mode	Withstand	Safe Fail	Safe Fail	Safe Fail	Safe Fail
Number of Ports				1		
UL Electrical						
Maximum Continuous Operating Voltage (AC)	MCOV	150 V	275 V	320 V	385 V	440 V
Voltage Protection Rating	VPR	600 V	900 V	1000 V	1200 V	1500 V
Nominal Discharge Current (8/20 μs)	I_n	20 kA	20 kA	20 kA	20 kA	20 kA
Short-Circuit Current Rating (AC)	SCCR	200 kA	150 kA	150 kA	150 kA	200 kA
Mechanical & Environmental						
Operating Temperature Range	T_a	-40 ºF to +158 ºF [-40 ºC to +70 ºC]				
Permissible Operating Humidity	RH	5%...95%				
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m				
Terminal Screw Torque	M_{max}	39.9 lbf·in [4.5 Nm]				
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)				
		35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)				
Mounting		35 mm DIN Rail, EN 60715				
Degree of Protection		IP 20 (built-in)				
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0				
Thermal Protection		Yes				
Operating State / Fault Indication		Green ok / Red defect				
Remote Contacts (RC)		Optional				
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A				
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm^2 (Solid)				

Order Information					
Order Code	**150**	**275**	**320**	**385**	**440**
SPT40-XXX/3	4015031	4027531	4032031	4038531	4044031
SPT40-XXX/3S (with remote contacts)	4015032	4027532	4032032	4038532	4044032
SPT40-XXX/0 (spare modules)	4015001	4027501	4032001	4038501	4044001

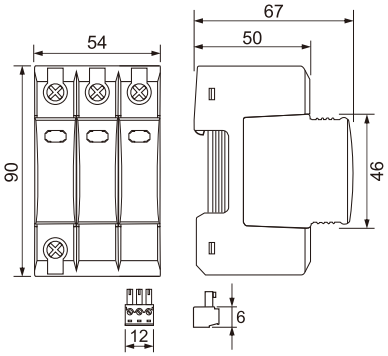
Internal Configuration

Legend

L Line
N Neutral
PE Protective Earth
S Signalling Contacts Optional

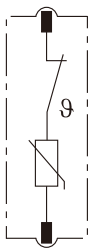


Dimensions & Packaging

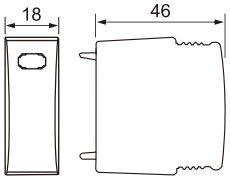


Dimensions & Packaging					
SPT40-XXX/3(S)	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]				
Minimum Order Quantity	30 Units				

SPT40-XXX/0



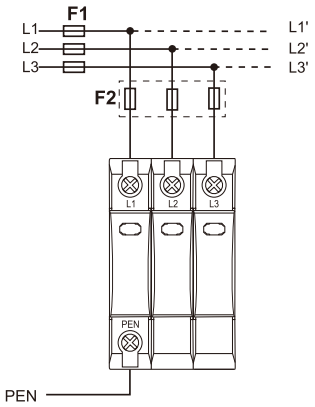
Dimensions & Packaging



Dimensions & Packaging					
SPT40-XXX/0	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]				
Minimum Order Quantity	96 Units				

Connection Diagram

TN-C (Three-phase, 3+0)



Pluggable Multi-Pole SPD

SPT40-XXX/4(S)

Class II • Type 2•Type 1CA

Location of Use: Sub-Distribution Boards
Network Systems: TN-S
Mode of Protection: L-PE, N-PE
Surge Ratings: I_n = 20 kA(8/20 μs)
IEC/EN/UL Category: Class II / Type 2 / Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

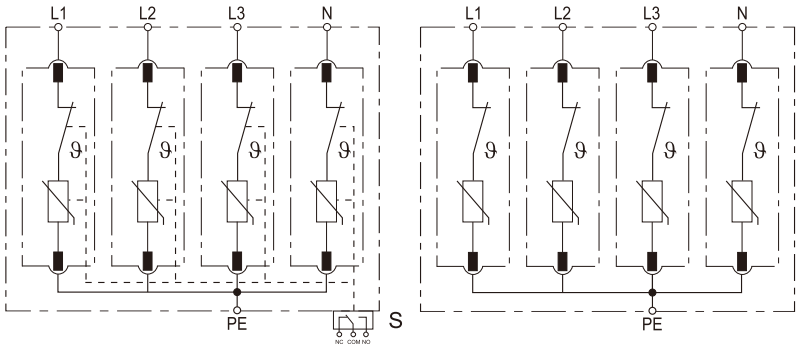
SPT40-XXX/4(S)		150	275	320	385	440
IEC Electrical						
Nominal AC Voltage (50/60Hz)	U_o/ U_n	120 V	230 V	230 V	230 V	400 V
Maximum Continuous Operating Voltage (AC)	U_c	150 V	275 V	320 V	385 V	440 V
Nominal Discharge Current (8/20 μs)	I_n	20 kA	20 kA	20 kA	20 kA	20 kA
Maximum Discharge Current (8/20 μs)	I_{max}	40 kA	40 kA	40 kA	40 kA	40 kA
Voltage Protection Level	U_p	1000 V	1500 V	1600 V	1750 V	2000 V
Response Time	t_A	< 25 ns				
Back-Up Fuse (max)		125 A gL / gG				
Short-Circuit Current Rating (AC)	I_{SCCR}	25 kA / 50 kA				
TOV Withstand 5s	U_T	180 V	335 V	335 V	335 V	580 V
TOV 120min	U_T	230 V	440 V	440 V	440 V	765 V
	mode	Withstand	Safe Fail	Safe Fail	Safe Fail	Safe Fail
Number of Ports		1				
UL Electrical						
Maximum Continuous Operating Voltage (AC)	MCOV	150 V	275 V	320 V	385 V	440 V
Voltage Protection Rating	VPR	600 V	900 V	1000 V	1200 V	1500 V
Nominal Discharge Current (8/20 μs)	I_n	20 kA	20 kA	20 kA	20 kA	20 kA
Short-Circuit Current Rating (AC)	SCCR	200 kA	150 kA	150 kA	150 kA	200 kA
Mechanical & Environmental						
Operating Temperature Range	T_a	-40 ºF to +158 ºF [-40 ºC to +70 ºC]				
Permissible Operating Humidity	RH	5%...95%				
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m				
Terminal Screw Torque	M_{max}	39.9 lbf·in [4.5 Nm]				
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)				
		35 mm² (Solid, Stranded) / 25 mm² (Flexible)				
Mounting		35 mm DIN Rail, EN 60715				
Degree of Protection		IP 20 (built-in)				
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0				
Thermal Protection		Yes				
Operating State / Fault Indication		Green ok / Red defect				
Remote Contacts (RC)		Optional				
RC Switching Capacity		AC: 250V / 0.5 A;DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A				
RC Conductor Cross Section		16 AWG (Solid) / 1.5 mm²(Solid)				

Order Information					
Order Code	**150**	**275**	**320**	**385**	**440**
SPT40-XXX/4	4015041	4027541	4032041	4038541	4044041
SPT40-XXX/4S(with remote contacts)	4015042	4027542	4032042	4038542	4044042
SPT40-XXX/0 (spare modules)	4015001	4027501	4032001	4038501	4044001

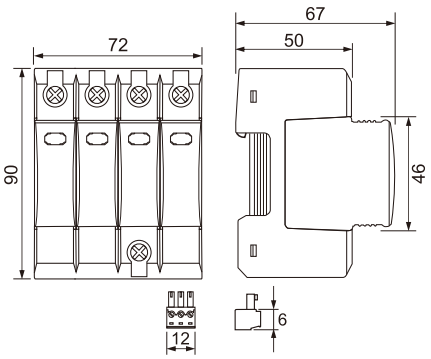
Internal Configuration

Legend

L Line
N Neutral
PE Protective Earth
S Signalling Contacts Optional

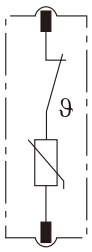


Dimensions & Packaging

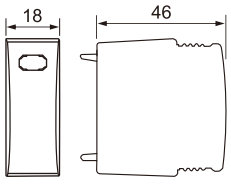


Dimensions & Packaging					
SPT40-XXX/4(S)	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]				
Minimum Order Quantity	24 Units				

SPT40-XXX/0



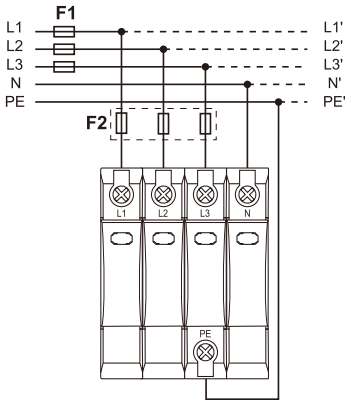
Dimensions & Packaging



Dimensions & Packaging					
SPT40-XXX/0	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]				
Minimum Order Quantity	96 Units				

Connection Diagram

TN-S (Three-phase, 4+0)



Pluggable Multi-Pole SPD

SPT40-XXX/1(S)+1

Class II • Type 2•Type 1CA

Location of Use: Sub-Distribution Boards
Network Systems: TT, TN-S
Mode of Protection: L-N, N-PE
Surge Ratings: I_n = 20 kA(8/20μs)
IEC/EN/UL Category: Class II / Type 2 / Type 1CA
Protective Elements: High Energy MOV and GDT
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

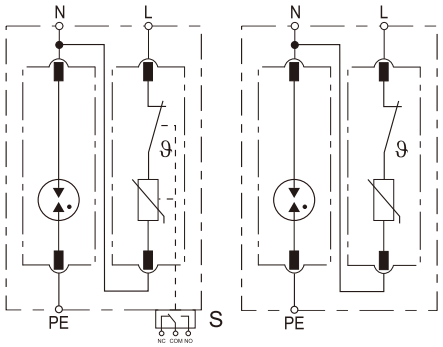
SPT40-XXX/1(S)+1			75	150	275	320
IEC Electrical						
Nominal AC Voltage (50/60Hz)			60 V	120 V	230 V	230 V
Maximum Continuous Operating Voltage	(L - N)	U_c	75 V	150 V	275 V	320 V
	(N - PE)	U_c	255 V	255 V	255 V	255 V
Nominal Discharge Current (8/20 μs)	(L - N) / (N - PE)	I_n	20 kA / 20 kA			
Maximum Discharge Current (8/20 μs)	(L - N) / (N - PE)	I_{max}	40 kA / 40 kA			
Voltage Protection Level	(L - N) / (N - PE)	U_p	400 V/ 1000 V	1000 V/ 1000 V	1500 V/ 1000 V	1600 V/ 1000 V
Follow Current Interrupt Rating	(N-PE)	I_{fi}	100 A_{RMS}			
Response Time	(L - N) / (N - PE)	t_A	< 25 ns / < 100 ns			
Back-Up Fuse (max)			125 A gL / gG			
Short-Circuit Current Rating (AC)	(L - N)	I_{SCCR}	25 kA / 50 kA			
TOV Withstand 5s	(L - N)	U_T	90 V	180 V	335 V	335 V
TOV 120min	(L - N)	U_T	115 V	230 V	440 V	440 V
		mode	Withstand	Withstand	Safe Fail	Safe Fail
TOV Withstand 200ms	(N - PE)	U_T	1200 V			
Number of Ports			1			
UL Electrical						
Maximum Continuous Operating Voltage (AC)	(L - N) / (N - PE)	MCOV	75 V / 255 V	150 V / 255 V	275 V / 255 V	320 V / 255 V
Voltage Protection Rating	(L - N) / (N - PE)	VPR	330 V / 1000 V	600 V / 1000 V	900 V / 1000 V	1000 V / 1000 V
Nominal Discharge Current (8/20 μs)	(L - N) / (N - PE)	I_n	20 kA / 20 kA	20 kA / 20 kA	20 kA / 20 kA	20 kA / 20 kA
Short-Circuit Current Rating (AC)	(L - N)	SCCR	100 kA	200 kA	150 kA	150 kA
Mechanical & Environmental						
Operating Temperature Range		T_a	-40 ºF to +158 ºF [-40 ºC to +70 ºC]			
Permissible Operating Humidity		RH	5%...95%			
Atmospheric pressure and altitude			80k Pa ... 106k Pa / -500 m ... 2000 m			
Terminal Screw Torque		M_{max}	39.9 lbf·in [4.5 Nm]			
Conductor Cross Section (max)			2 AWG (Solid, Stranded) / 4 AWG (Flexible)			
			35 mm^2 (Solid, Stranded) / 25 mm^2(Flexible)			
Mounting			35 mm DIN Rail, EN 60715			
Degree of Protection			IP 20 (built-in)			
Housing Material			Thermoplastic: Extinguishing Degree UL 94 V-0			
Thermal Protection			Yes			
Operating State / Fault Indication			Green ok / Red defect			
Remote Contacts (RC)			Optional			
RC Switching Capacity			AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A			
RC Conductor Cross Section (max)			16 AWG (Solid) / 1.5 mm^2(Solid)			

Order Information				
Order Code	**75**	**150**	**275**	**320**
SPT40-XXX/1+1	4007513	4015013	4027513	4032013
SPT40-XXX/1S+1 (with remote contacts)	4007514	4015014	4027514	4032014
SPT40-XXX/0 (spare modules)	4007501	4015001	4027501	4032001
SPT40-NPE/0 (spare modules)	4025501	4025501	4025501	4025501

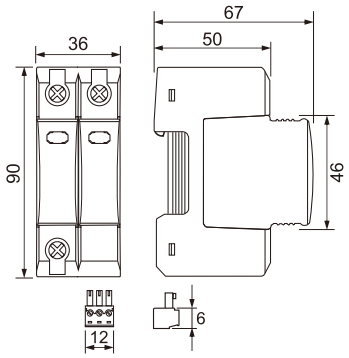
Internal Configuration

Legend

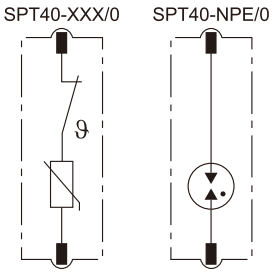
L Line
N Neutral
PE Protective Earth
S Signalling Contacts Optional



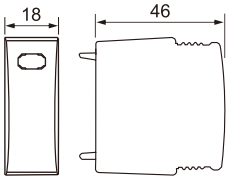
Dimensions & Packaging



Dimensions & Packaging				
SPT40-XXX/1(S)+1	**75**	**150**	**275**	**320**
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]			
Minimum Order Quantity	42 Units			



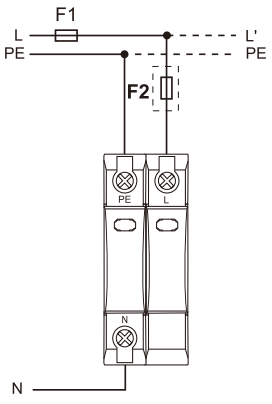
Dimensions & Packaging



Dimensions & Packaging				
SPT40-XXX/0	**75**	**150**	**275**	**320**
SPT40-NPE/0	**40**			
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]			
Minimum Order Quantity	96 Units			

Connection Diagram

TN-S,TT (Single-phase, 1+1)



Pluggable Multi-Pole SPD

SPT40-XXX/3(S)+1

Class II • Type 2•Type 1CA

Location of Use: Sub-Distribution Boards
Network Systems: TT, TN-S
Mode of Protection: L-N, N-PE
Surge Ratings: I_n = 20 kA(8/20 μs)
IEC/EN/UL Category: Class II / Type 2 / Type 1CA
Protective Elements: High Energy MOV and GDT
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

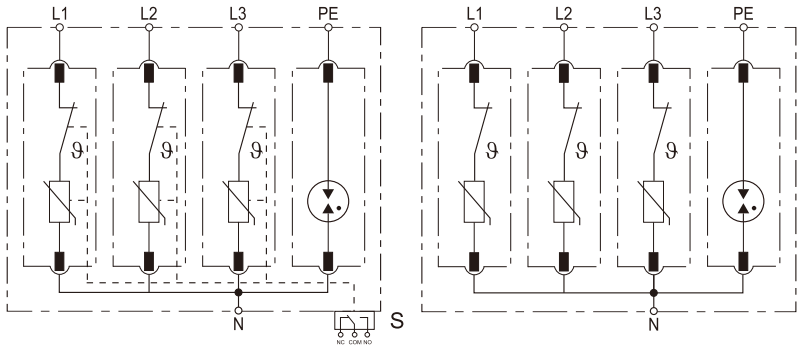
SPT40-XXX/3(S)+1			150	275	320	385
IEC Electrical						
Nominal AC Voltage (50/60Hz)			120 V	230 V	230 V	230 V
Maximum Continuous Operating Voltage	(L - N)	U_c	150 V	275 V	320 V	385 V
	(N - PE)	U_c	255 V	255 V	255 V	255 V
Nominal Discharge Current (8/20 μs)	(L - N) / (N - PE)	I_n	20 kA / 20 kA			
Maximum Discharge Current (8/20 μs)	(L - N) / (N - PE)	I_{max}	40 kA / 40 kA			
Voltage Protection Level	(L - N) / (N - PE)	U_p	1000 V/ 1000 V	1500 V/ 1000 V	1600 V/ 1000 V	1750 V/ 1000 V
Follow Current Interrupt Rating	(N-PE)	I_{fi}	100 A RMS			
Response Time	(L - N) / (N - PE)	t_A	< 25 ns / < 100 ns			
Back-Up Fuse (max)			125 A gL / gG			
Short-Circuit Current Rating (AC)	(L - N)	I_{SCCR}	25 kA / 50 kA			
TOV Withstand 5s	(L - N)	U_T	180 V	335 V	335 V	335 V
TOV 120min	(L - N)	U_T	230 V	440 V	440 V	440 V
		Mode	Withstand	Safe Fail	Safe Fail	Safe Fail
TOV Withstand 200ms	(N - PE)	U_T	1200 V			
Number of Ports			1			
UL Electrical						
Maximum Continuous Operating Voltage (AC)	(L - N) / (N - PE)	MCOV	150 V / 255 V	275 V / 255 V	320 V / 255 V	320 V / 255 V
Voltage Protection Rating	(L - N) / (N - PE)	VPR	600 V / 1000 V	900 V / 1000 V	1000 V / 1000 V	1200 V / 1000 V
Nominal Discharge Current (8/20 μs)	(L - N) / (N - PE)	I_n	20 kA / 20 kA	20 kA / 20 kA	20 kA / 20 kA	20 kA / 20 kA
Short-Circuit Current Rating (AC)	(L - N)	SCCR	200 kA	150 kA	150 kA	150 kA
Mechanical & Environmental						
Operating Temperature Range		T_a	-40 °F to +158 °F [-40 °C to +70 °C]			
Permissible Operating Humidity		RH	5%...95%			
Atmospheric pressure and altitude			80k Pa ... 106k Pa / -500 m ... 2000 m			
Terminal Screw Torque		M_{max}	39.9 lbf·in [4.5 Nm]			
Conductor Cross Section (max)			2 AWG (Solid, Stranded) / 4 AWG (Flexible)			
			35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)			
Mounting			35 mm DIN Rail, EN 60715			
Degree of Protection			IP 20 (built-in)			
Housing Material			Thermoplastic: Extinguishing Degree UL 94 V-0			
Thermal Protection			Yes			
Operating State / Fault Indication			Green ok / Red defect			
Remote Contacts (RC)			Optional			
RC Switching Capacity			AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A			
RC Conductor Cross Section (max)			16 AWG (Solid) / 1.5 mm^2 (Solid)			

Order Information				
Order Code	**150**	**275**	**320**	**385**
SPT40-XXX/3+1	4015033	4027533	4032033	4038533
SPT40-XXX/3S+1(with remote contacts)	4015034	4027534	4032034	4038534
SPT40-XXX/0(spare modules)	4015001	4027501	4032001	4038501
SPT40-NPE/0(spare modules)	4025501	4025501	4025501	4025501

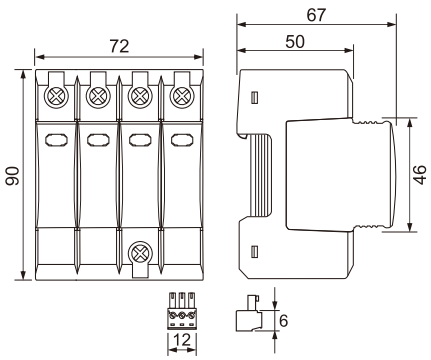
Internal Configuration

Legend

L Line
N Neutral
PE Protective Earth
S Signalling Contacts Optional

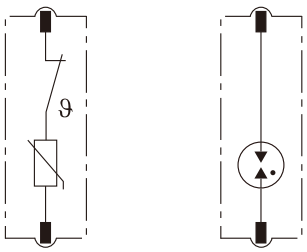


Dimensions & Packaging

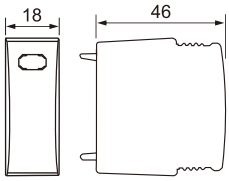


Dimensions & Packaging				
SPT40-XXX/3(S)+1	**150**	**275**	**320**	**385**
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]			
Minimum Order Quantity	24 Units			

SPT40-XXX/0 SPT40-NPE/0



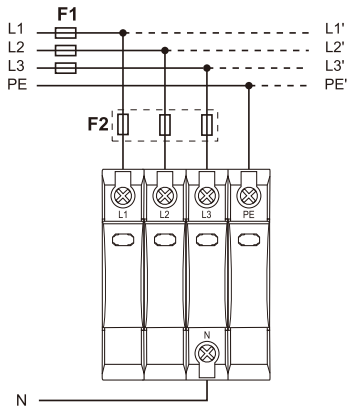
Dimensions & Packaging



Dimensions & Packaging				
SPT40-XXX/0	**150**	**275**	**320**	**385**
SPT40-NPE/0	**40**			
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]			
Minimum Order Quantity	96 Units			

Connection Diagram

TN-S, TT (Three-phase, 3+1)



Pluggable Multi-Pole SPD for Photovoltaic Systems

SPT40-PVXXX-(S)

Class II • Type 2•Type 1CA

Location of Use: String box, Inverter
Mode of Protection: (DC+)- PE, (DC-)- PE, (DC+)- (DC-)
Surge Ratings: I_n = 20kA (8/20μs)
I_{total} = up to 40kA (8/20μs)
IEC/EN/UL Category: Class II/ Type 2/ Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-31:2018
EN 50539-11:2013+A1:2014
UL 1449 4th Edition

Technical Data

SPT40-PVXXX-(S)			600	1000	1200	1500
IEC Electrical						
Maximum Continuous Operating DC Voltage	(DC+) - PE, (DC-) - PE	U_{cpv}	600 V	1000 V	1200 V	1500 V
	(DC+) - (DC-)	U_{cpv}	600 V	1000 V	1200 V	1500 V
Nominal Discharge Current (8/20 μs)		I_n		20 kA		
Total Discharge Current (8/20 μs)		I_{Total}		40 kA		
Maximum Discharge Current (8/20 μs)		I_{max}		40 kA		
Voltage Protection Level	(DC+) - PE, (DC-) - PE	U_p	2200 V	4000 V	4400 V	5200 V
	(DC+) - (DC-)	U_p	2200 V	4000 V	4400 V	5200 V
Response Time		t_A		< 25 ns		
Short-Circuit Current Rating		I_{scpv}		2000A		
Number of Ports				1		
UL Electrical						
Maximum Permitted DC Voltage		V_{pvdc}	600 V	1000 V	1200 V	1500 V
Voltage Protection Rating	(DC+) - PE, (DC-) - PE	VPR	1600 V	2500 V	3000 V	4000 V
	(DC+) - (DC-)	VPR	1600 V	2500 V	3000 V	4000 V
Nominal Discharge Current (8/20 μs)		I_n		20 kA		
Short-Circuit Current Rating		SCCR	35 kA	50 kA	55 kA	65 kA
Mechanical & Environmental						
Operating Temperature Range		T_a		-40 ºF to +158 ºF [-40 ºC to +70 ºC]		
Permissible Operating Humidity		RH		5%...95%		
Atmospheric pressure and altitude				80k Pa ... 106k Pa / -500 m ... 2000 m		
Terminal Screw Torque		M_{max}		39.9 lbf·in [4.5 Nm]		
Conductor Cross Section (max)				2 AWG (Solid, Stranded) / 4 AWG (Flexible)		
				35 mm² (Solid, Stranded) / 25 mm² (Flexible)		
Mounting				35 mm DIN Rail, EN 60715		
Degree of Protection				IP 20 (built-in)		
Housing Material				Thermoplastic: Extinguishing Degree UL 94 V-0		
Thermal Protection				Yes		
Operating State / Fault Indication				Green ok / Red defect		
Remote Contacts (RC)				Optional		
RC Switching Capacity				AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A		
RC Conductor Cross Section (max)				16 AWG (Solid) / 1.5 mm²(Solid)		

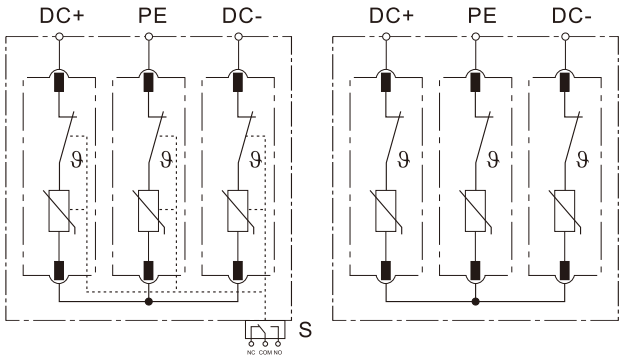
Order Information				
Order Code	**600**	**1000**	**1200**	**1500**
SPT40-PVXXX	4060025	4010235	4012231	4015231
SPT40-PVXXX-(S) (with remote contacts)	4060026	4010236	4012232	4015232
SPT40-PVXXX/0 (spare modules)	4060002	4010202	4012202	4015202

Internal Configuration

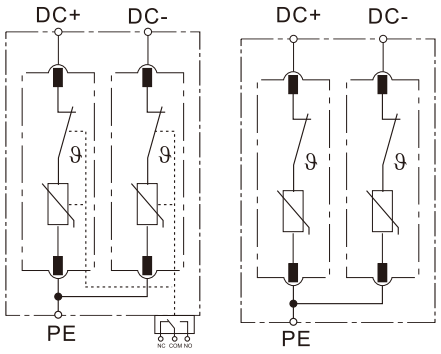
Legend

PE Protective Earth
S Signalling Contacts Optional

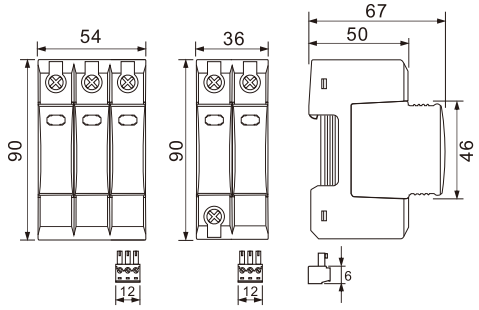
SPT40-PV1000-(S), SPT40-PV1200-(S), SPT40-PV1500-(S)



SPT40-PV600-(S)



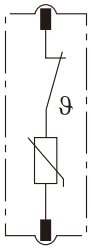
Dimensions & Packaging



SPT40-PV1500-(S) SPT40-PV600-(S)
SPT40-PV1200-(S)
SPT40-PV1000-(S)

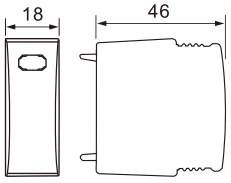
Dimensions & Packaging				
SPT40-PVXXX-(S)	**600**	**1000**	**1200**	**1500**
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]			
Minimum Order Quantity	42 Units	30 Units	30 Units	30 Units

SPT40-PVXXX/0



Plug Internal Configuration

Dimensions & Packaging



Dimensions & Packaging				
SPT40-PVXXX/0	**600**	**1000**	**1200**	**1500**
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]			
Minimum Order Quantity	96 Units			

In-line SPD for Coaxial & RF Systems

SPT CP BNC

C1 • C2 • C3

IEC/EN Category: C1/C2/C3
Protection: Impedance Matched
Maximum Operating:
Voltage: 70, 180, 280 V
Maximum Peak Power: 40, 125, 300 W
Frequency Range: DC – 2.6 GHz
Surge Discharge Ratings: I n : 10 kA, I max : 20 kA
Impedance: 50 Ω
Insertion Loss: < 0.4 dB
Return Loss: > 20 dB
Termination: BNC Type (F-F, M-F)
Housing: In-line Installation, Shielded Enclosure
Compliance: IEC/EN 61643-21

The SPT CP BNC Series of coaxial surge protectors is intended to protect RF antenna systems and is suitable for frequencies from DC to 2.6 GHz.
It is designed as an in-line unit allowing ease of installation. The careful design, low capacitance gas discharge arresters and high quality BNC-type termination connectors, ensures a minimum of insertion loss throughout the frequency band.
Transfer power is 40 W to 300 W continuous, depending on the coaxial cable protector voltage.
The CP coaxial cable protector is designed in accordance with IEC61643-21: 2012 standards and regulations.
A grounding stud is provided which should be connected to the system ground or coaxial feed-through bulkhead, as directly as possible.

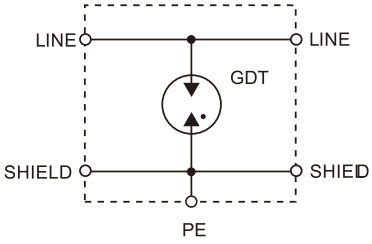
Technical Data

SPT CP BNC		70	180	280
IEC Electrical				
Maximum Continuous Operating Voltage	U_c	70V	180V	280V
Maximum Peak Power	P_{max}	40W	125 W	300W
C2 Nominal Discharge Current (8/20 µs)	I_n		10 kA	
Maximum Discharge Current (8/20 µs)	I_{max}		20 kA	
Residual Voltage at (1 kV/µs)	U_{res}	<600V	< 700V	<900V
Impedance	Z		500	
Insertion Loss	I_L		<0. 4dB ,	
Return Loss	R_L		>20dB	
Insulation Resistance of Protection	R_{iso}		>10GQ	
Frequency Range	f_G		0-2.6 GHz	
Mechanical				
Temperature Range		-40 ºF to +176 ºF [-40 ºC to +80 ºC]		
Connection		BNC Female/Female		BNC Male/Female
Degree of Protection IEC/EN 60529		IP 20 (built-in)		
Housing Material		Metal		
Order Information				
Order Code		**70**	**180**	**280**
SPT CP BNC-FF-xxx		800 850	800 851	800 852
SPT CP BNC-MF-xxx		800 853	800 854	800 855

Internal Configuration

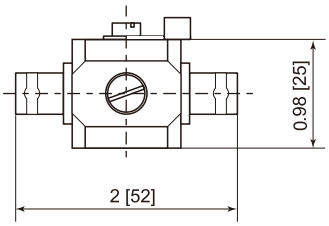
Legend

GDT Gas Discharge Tube
PE Ground

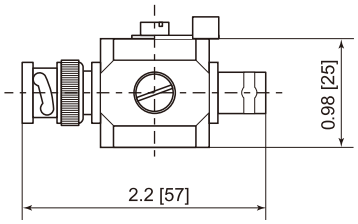


Dimensions & Packaging

SPT CP BNC-FF



SPT CP BNC-MF

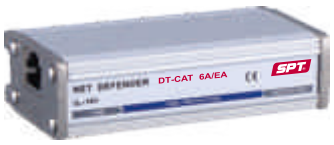


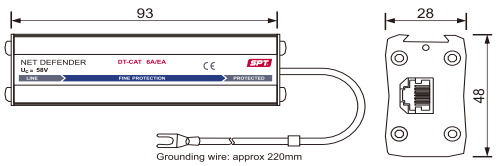
	SPT CP BNC-FF-xxx			SPT CP BNC-MF-xxx		
SPT CP BNC	**70**	**180**	**280**	**70**	**180**	**280**
Dimensions & Packaging						
Weight per Unit	3.74 oz [106 g]			4.02 oz [114 g]		
Packaging Dimensions (Single Unit)	2.9 × 1.2 × 1.2" [73 × 30 × 30 mm]					
Minimum Package Quantity	100 pieces					

SPTs for Telecommunication and Data Networks

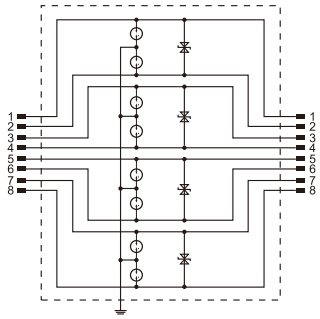
The "PoE Surge Protector" permits the use of Power over Ethernet with nominal currents of up to 1 A. It can be snapped directly onto the hat rail and uses it to create the necessary equipotential bonding. Alternatively, terminal protection using a separately connectable

- Support for Power over Ethernet + up to 1 A (PoE+ according to IEEE 802.3at)
- CAT 6A in the channel according to ANSI/TIA/EIA-568
- For installation in conformity with the lightning protection zone concept at the boundaries from 0 -2 and higher





Dimensions



Basic circuit diagram

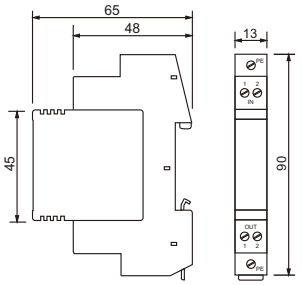
Type		DT-CAT 6A/EA
SPT according to EN 61643-21 / IEC 61643-21		type 2 / class II
Max. continuous operating a.c. voltage	U_c	41 V
Max. continuous operating d.c. voltage	U_c	58 V
Max. continuous operating d.c. voltage pair-pair (PoE)	U_c	57 V
Rated current	I_L	1 A
D1 Lightning impulse current (10/350 µs) per line	I_{imp}	1 kA
C2 Nominal discharge current (8/20 µs) line-line	I_n	150 A
C2 Nominal discharge current (8/20 µs) line-PG	I_n	2.5 kA
C2 Total nominal discharge current (8/20 µs) line-PG	I_n	10 kA
C2 Nominal discharge current (8/20 µs) pair-pair (PoE)	I_n	150 A
Voltage protection level line-line for In C2	U_P	< 190 V
Voltage protection level line-PG for In C2	U_P	< 600 V
Voltage protection level pair-pair for In C2 (PoE)	U_P	< 600 V
Voltage protection level line-line at 1 kV/µs C3	U_P	< 145 V
Voltage protection level line-PG at 1 kV/µs C3	U_P	< 500 V
Voltage protection level pair-pair at 1 kV/µs C3 (PoE)	U_P	< 600 V
Insertion loss at 250 MHz		< 2 dB
Capacitance line-line	C	< 165 pF
Capacitance line-PG	C	< 255 pF
Range of operating temperatures	T_U	-40/+80°C
Degree of protection		IP 20
Connection (input / output)		RJ45 / RJ45
Pinning		1/2, 3/6, 4/5, 7/8
Enclosure material		Aluminum housing
Earthing via		Connecting line
Transmission class according to ISO/IEC 11801		Cat. 6
Transmission class according to EN 50173-1		Class SPT
Transmission class according to ANSI/TIA/EIA-568		Cat. 6A in the channel

Modular SPD for Single Pair

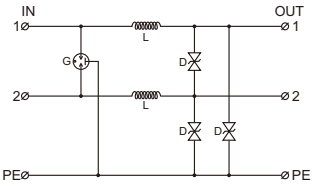
SPT-DC Series

D1•C1•C2•C3

IEC/EN Category: D1/C1/C2/C3
Mode of Protection: Longitudinal, Transverse
Coarse Protection: 3 Terminal GDT
Voltages: 5, 12, 15, 24, 30*, 48, 60, 110 V DC
Frequency Range: 30 MHz
Surge Discharge Ratings: I_n: 10 kA, I_{max}: 20 kA, I_{imp}: 2.5 kA
Series Load Current: 1 A
Enclosure: DIN 43880 2/3 TE, DIN Rail Mount
Terminals: Stranded to 4 mm2
Housing: Modular Design
Compliance: IEC/EN 61643-21
UL 497B 4th Edition



Dimensions



Basic circuit diagram

Technical Data

SPT-DC Series

		5	12	15	24	30*	48	60	110
Electrical									
Lines Protected		1							
Nominal Operating Voltage (DC)	U_n	5V	12 V	15 V	24 V	30 V	48 V	60 V	110 V
Maximum Continuous Operating Voltage (DC)	U_c	6V	15 V	18 V	28 V	33 V	52 V	64 V	170 V
Rated Load Current at 25°C	I_L	1A							
C2 Nominal Discharge Current (8/20 µs)	I_n	10 kA							
Maximum Discharge Current (8/20 µs)	I_{max}	20 kA							
D1 Impulse Current (10/350 µs)	I_{imp}	2.5 kA							
Residual Voltage at 5 kA (8/20 µs)	U_{res}	<22V	< 42 V	< 48 V	< 70 V	< 80 V	< 140 V	< 160 V	< 450 V
Rated Spark Overvoltage (Line-Ground)		7-10V	16-21 V	21-25 V	31-37 V	36-44 V	57-69 V	68-84 V	184-264 V
(Line-Line)		7-10V	16-21 V	21-25 V	31-37 V	36-44 V	57-69 V	68-84 V	184-264 V
Response Time Overvoltage Protection	t_A	< 1 ns							
Thermal Protection		Ye s							
Cut-off Frequency	f_G	30 MHz							
Mechanical									
Temperature Range		-40 °F to +176 °F [-40 °C to +80 °C]							
Terminal Cross Section Multi-strand (max.)		12 AWG [4 mm^2, 2.5 mm^2 Q Version]							
Degree of Protection IEC/EN 60529		IP 20 (built-in)							
Mounting IEC/EN 60715		35 mm DIN Rail							
Order Information									
Order Code		5	12	15	24	30*	48	60	110
SPT-DC-xxx		9086.33	9086.34	9086.35	9086.36	9082.80	9086.37	9086.38	9086.39
SPT-DC-xxxM (module)		9086.40	9086.41	9086.42	9086.43	9082.81	9086.44	9086.45	9086.46

STANDARDS FOR SURGE PROTECTORS

For almost 40 years, many worldwide organizations have developed standards that form the basis of our understanding of the surge environment and its effect on equipment. These surge protection working groups have been the catalyst for many of the advances that have been made related to the optimal performance, increased reliability and safety of surge protectors.
The most well-known reference standards are*:

Surge Protectors for Low-Voltage installations:

- UL1449 - AC and DC Power SPD (USA)
- CSA C22.2 (CANADA)
- NOM-001-SCFI (MEXICO)
- NOM-003-SCFI (MEXICO)
- IEC 61643-11 (International)
- NF EN 61643-11 (France)
- VDE 0675-6-11 (Germany)
- EN 61643-11 (Europe)

Surge Protectors for data and RF equipment:

- UL 497A - Primary Data SPD (USA)
- UL 497B - Secondary Data SPD (USA)
- UL 497E - RF Antenna SPD (USA)
- IEC 61643-21 (International)
- ITU-T recommendations K11, K12, K17, K20, K21, K36 (International)

Surge Protectors mandatory application:

- NFPA 70 - NEC - National Electric Code (USA)
- NFPA 79 - Electrical Standard for Industrial Machinery (USA)
- NFPA 780 - Guide on Electrical Inspections (USA)

Surge Protectors recommended guidelines:

- ANSI/IEEE C62.41 - Low-Voltage AC Power Circuits (USA)
- ANSI/IEEE C136.2 - Roadway & Area Lighting (USA)

Manufacutre and headquarter:
Surgeprotec Co., Ltd.
Business Registration: 637-88-01997
Address: NO 184 Jungbu-daero, Giheung-gu,
Yongin-si, Gyeonggi-do, 17095
Republic of Korea

Made in Korea

About our Company

COMPANY PROFILE

SPT (Surgeprotec Co., Ltd.) is a pioneering Korean company specialising in the development and production of surge protection devices. It offers a complex range of surge arresters, pursuant to EN 61643-11 standard and surge arresters for information technology, measurement and control, and telecommunications.
From the technical expertise to the operational deployment, we are passionate about all aspects and topics related to SPDs. Our teams are composed of engineers and SPD specialists who can bring forward the best insights and solutions. We support distributors, contractors and consultants with Sales Application Specialists.
We provide free A/S for 10 years for all surge protectors.

Authorized Distributor

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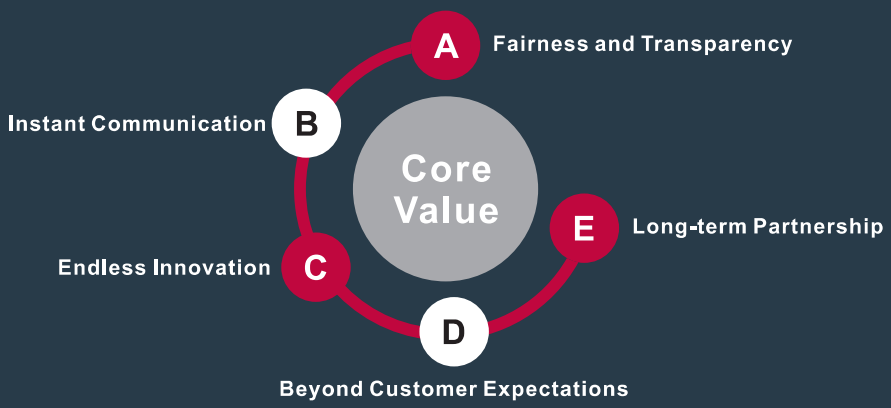
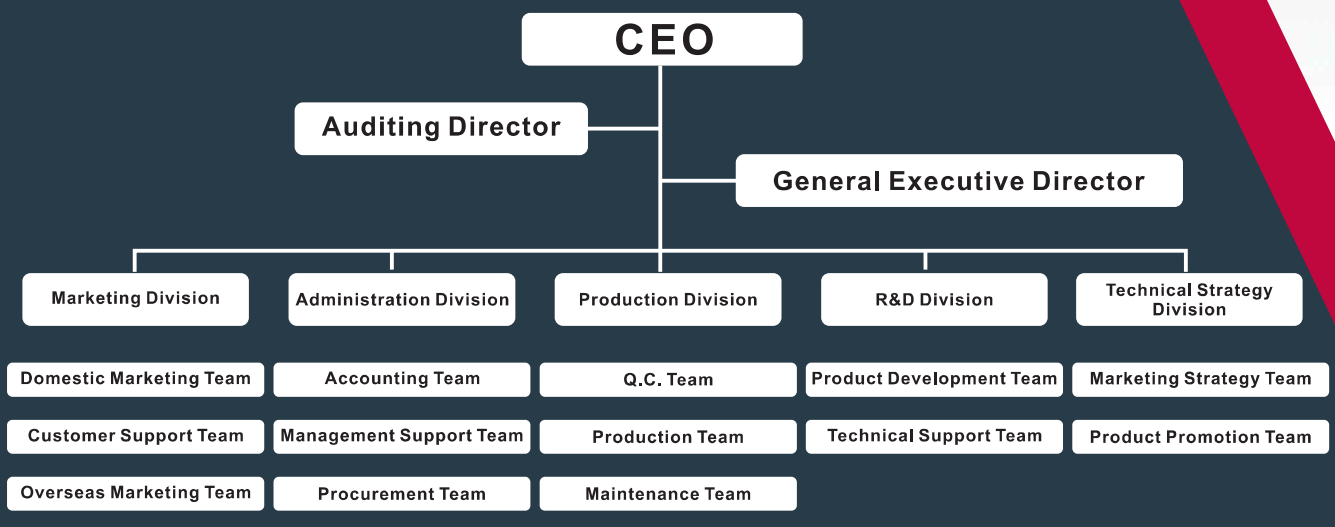


Organization Chart



About our
Services

SPT products provide complex solutions for surge protection devices for various applications.

Products

Surge Protector

Type 1 SPD-lightning current arresters

Combined, spark gap and MOV
Iimp 25 kA / 100 kA Up ≤ 1.5 kV
No follow current, zero leakage current
Full coordination with Type 2 SPD

SPD PV - surge arrester

Combination of MOV and spark gap
PV Type 2 SPD
MOV surge arrester
UCPV 170 to 1500 V DC
In 15 to 20 kA
Imax 40 kA

Type 2 SPD – surge arresters

Combined, spark gap and MOV
U c 75 to 760 V AC
In 20 kA / Imax 40 kA
Up ≤ 1.35 kV

Type 1 and 2 SPD -combined arresters B+C

Combined, spark gap and MOV
Iimp 12.5 kA / 50 kA
Up ≤ 1.5 kV
No follow current, zero leakage current

>>>>>> Product Development <<<<<<

Quality	**Flexibility and Speed**	**R&D Department**	**Customers Requirements**
Safety, reliability and top quality of our products	Flexible approach to the implementation of special solutions and products	Continuous innovation is the foundation of our further development	Customers are our everlasting inspiration

SURGE PROTEC
Surge Protection Total Solutions

SPT25-760/1S

Monoblock Single-Pole SPD

SPT25-XXX/1(S)

Class I•Class II • Type 1•Type 2

Location of Use: Main Distribution Boards
Network Systems: TN-S, TN-C, TT
Mode of Protection: L-PE / N-PE
Surge Ratings: I_{imp} = 25 kA (10/350 µs)
I_n = 30 kA(8/20 µs)
IEC/EN Category: Class I+II / Type 1+2
Protective Elements: High Energy MOV
Housing: Monoblock Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012

Technical Data

SPT25-XXX/1(S)		150	275	320	385	760
IEC Electrical						
Nominal AC Voltage (50/60Hz)	U_o/ U_n	120 V	230 V	230 V	230 V	690 V
Maximum Continuous Operating Voltage (AC)	U_c	150 V	275 V	320 V	385 V	760 V
Nominal Discharge Current (8/20 µs)	I_n			30kA		
Maximum Discharge Current (8/20 µs)	I_{max}			100 kA		
Impulse Discharge Current (10/350 µs)	I_{imp}			25 kA		
Specific Energy	W/R			156 kJ / Ω		
Charge	Q			12.5 As		
Voltage Protection Level	U_p	1000 V	1500 V	1600 V	1800 V	4000 V
Response Time	t_A			< 25 ns		
Back-Up Fuse (max)				315 A gL / gG		
Short-Circuit Current Rating (AC)	I_{SCCR}			50 kA		
TOV Withstand 5s	U_T	180 V	335 V	335 V	335 V	1050 V
TOV 120min	U_T	230V	440V	440V	440V	1350 V
Number of Ports				1		
Mechanical & Environmental						
Operating Temperature Range	T_a	-40 °F to +158 °F [-40 °C to +70 °C]				
Permissible Operating Humidity	RH	5%...95%				
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m				
Terminal Screw Torque	M_{max}	26.5 lbf·in [3.0 Nm]				
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)				
		35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)				
Mounting		35 mm DIN Rail, EN 60715				
Degree of Protection		IP 20 (built-in)				
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0				
Thermal Protection		Yes				
Operating State / Fault Indication		Red defect				
Remote Contacts (RC)		Optional				
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A				
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm^2(Solid)				

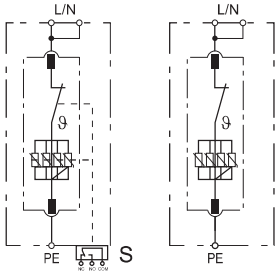
Order Information

Order Code	150	275	320	385	760
SPT25-XXX/1	2515011	2527511	2532011	2538511	9976011
SPT25-XXX/1S(with remote contacts)	2515012	2527512	2532012	2538512	9976012

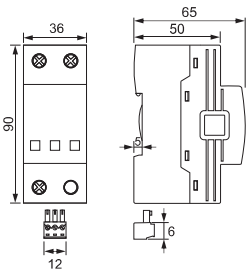
Internal Configuration

Legend

L Line
N Neutral
PE Protective Earth
S Signalling Contacts Optional

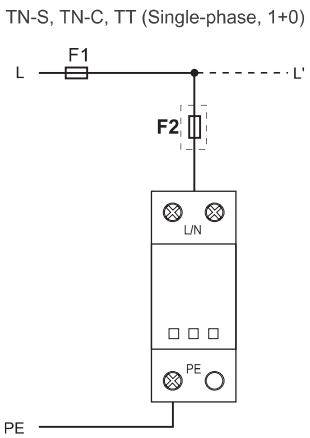


Dimensions & Packaging



Dimensions & Packaging					
SPT25-XXX/1(S)	**150**	**275**	**320**	**385**	**760**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[260 × 230 × 320 mm]				
Minimum Order Quantity	42 Units				

Connection Diagram



Surgeprotec Co., Ltd.
Minkyo Jeong / CEO

SURGE PROTEC
Surge Protection Total Solutions

SPT12.5-440/3S

Pluggable Multi-Pole SPD

SPT12.5-XXX/3(S)

Class I•Class II • Type 1•Type 2•Type 1CA

Location of Use: Main Distribution Boards
Network Systems: TN-C
Mode of Protection: L-PEN
Surge Ratings: I_{imp} = up to 12.5 kA (10/350 µs)
I_n = up to 20 kA (8/20 µs)
IEC/EN/UL Category: Class I+II / Type 1+2 / Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

SPT12.5-XXX/3(S)		150	275	320	385	440
IEC Electrical						
Nominal AC Voltage (50/60Hz)	U_o/U_n	120V	230V	230V	230V	400V
Maximum Continuous Operating Voltage (AC)	U_c	150V	275V	320V	385V	440V
Nominal Discharge Current (8/20 µs)	I_n	20kA	20kA	20kA	10kA	10kA
Maximum Discharge Current (8/20 µs)	I_{max}	50kA	50kA	50kA	50kA	50kA
Impulse Discharge Current (10/350 µs)	I_{imp}	12.5kA	12.5kA	12.5kA	10kA	10kA
Specific Energy	W/R	39kJ/Ω	39kJ/Ω	39kJ/Ω	25 kJ/Ω	25kJ/Ω
Charge	Q	6.25As	6.25As	6.25As	5As	5As
Voltage Protection Level	U_p	1000V	1500V	1600V	1800V	2000 V
Response Time	t_A	<25 ns				
Back-Up Fuse (max)		315 A / 250 A gG				
Short-Circuit Current Rating (AC)	I_{SCCR}	25 kA / 50 kA				
TOV Withstand 5s	U_T	180V	335V	335V	335V	580V
TOV 120min	U_T	230V	440V	440V	440V	765V
	Mode	Safe Fail	Safe Fail	Safe Fail	Safe Fail	Safe Fail

Mechanical & Environmental		
Operating Temperature Range	T_a	-40 °F to +158 °F [-40 °C to +70 °C]
Permissible Operating Humidity	RH	5%...95%
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m
Terminal Screw Torque	M max	39.9 lbf·in [4.5 Nm]
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)
		35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)
Mounting		35 mm DIN Rail, EN 60715
Degree of Protection		IP 20 (built-in)
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0
Thermal Protection		Yes
Operating State / Fault Indication		Green ok / Red defect
Remote Contacts (RC)		Optional
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm^2 (Solid)

Order Information					
Order Code	**150**	**275**	**320**	**385**	**440**
SPT12.5-XXX/3	1215031	1227531	1232031	1238531	1244031
SPT12.5-XXX/3S(with remote contacts)	1215032	1227532	1232032	1238532	1244032
SPT12.5-XXX/0(spare modules)	1215001	1227501	1232001	1238501	1244001

Internal Configuration

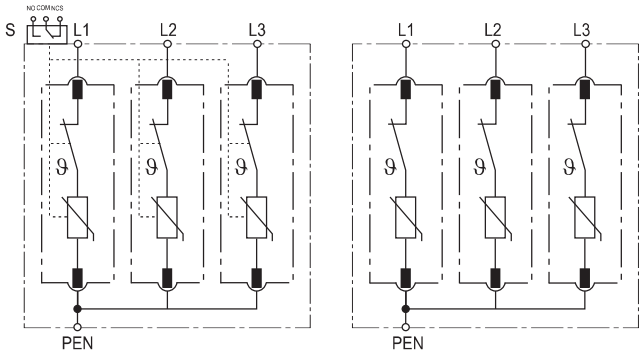
Legend

L Line

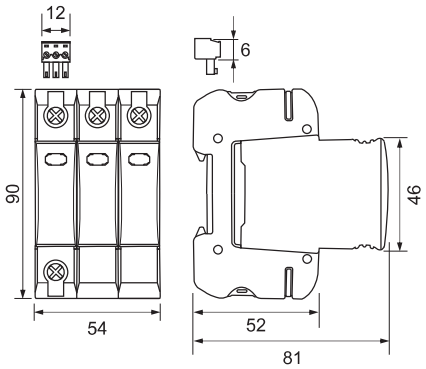
N Neutral

PE Protective Earth

S Signalling Contacts Optional

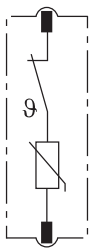


Dimensions & Packaging



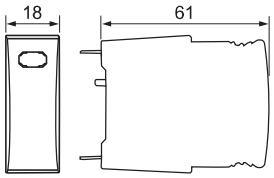
Dimensions & Packaging					
SPT12.5-XXX/3(S)	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]				
Minimum Order Quantity	16 Units				

SPT12.5-XXX/0



Plug Internal Configuration

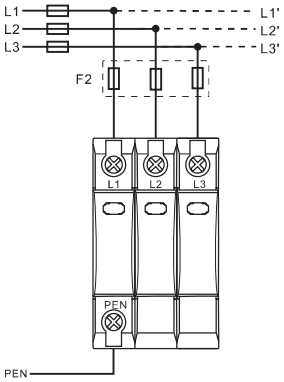
Dimensions & Packaging



Dimensions & Packaging					
SPT12.5-XXX/0	**150**	**275**	**320**	**385**	**440**
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[200 × 230 × 330 mm]				
Minimum Order Quantity	64 Units				

Connection Diagram

TN-C (Three-phase, 3+0)



Surgeprotec Co., Ltd.

Minkyo Jeong / CEO

SURGE PROTEC
Surge Protection Total Solutions

SPT30-750/3S

Pluggable Multi-Pole SPD

SPT40-XXX/3(S)

Class II • Type 2•Type 1CA

Location of Use: Sub-Distribution Boards
Network Systems: TN-C
Mode of Protection: L-PEN

IEC/EN/UL Category: Class II / Type 2 / Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

SPT40-XXX/3(S)		150	275	320	385	750
IEC Electrical						
Nominal AC Voltage (50/60Hz)	U_o/ U_n	120 V	230 V	230 V	230 V	690 V
Maximum Continuous Operating Voltage (AC)	U_c	150 V	275 V	320 V	385 V	750 V
Nominal Discharge Current (8/20 µs)	I_n	20 kA	20 kA	20 kA	20 kA	15 kA
Maximum Discharge Current (8/20 µs)	I_{max}	40 kA	40 kA	40 kA	40 kA	30 kA
Voltage Protection Level	U_p	1000 V	1500 V	1600 V	1750 V	3000 V
Response Time	t_A			< 25 ns		
Back-Up Fuse (max)				125 A gL / gG		
Short-Circuit Current Rating (AC)	I_{SCCR}			25 kA / 50 kA		

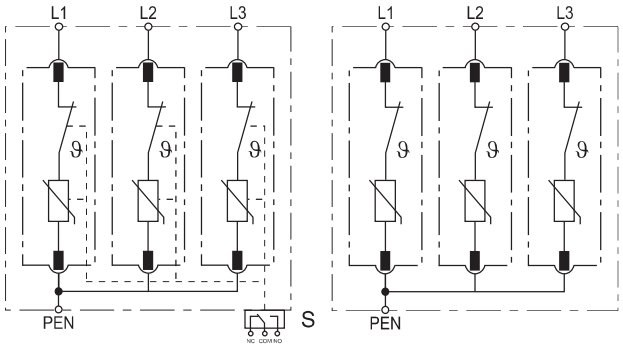
Mechanical & Environmental		
Operating Temperature Range	T_a	-40 °F to +158 °F [-40 °C to +70 °C]
Permissible Operating Humidity	RH	5%...95%
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m
Terminal Screw Torque	M_{max}	39.9 lbf·in [4.5 Nm]
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)
		35 mm² (Solid, Stranded) / 25 mm² (Flexible)
Mounting		35 mm DIN Rail, EN 60715
Degree of Protection		IP 20 (built-in)
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0
Thermal Protection		Yes
Operating State / Fault Indication		Green ok / Red defect
Remote Contacts (RC)		Optional
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm² (Solid)

Order Information					
Order Code	150	275	320	385	750
SPT40-XXX/3	4015031	4027531	4032031	4038531	9975031
SPT40-XXX/3S(with remote contacts)	4015032	4027532	4032032	4038532	9975032
SPT40-XXX/0(spare modules)	4015001	4027501	4032001	4038501	9975001

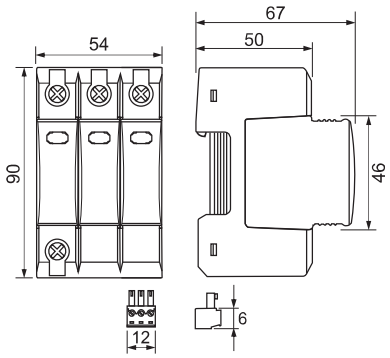
Internal Configuration

Legend

L Line
N Neutral
PE Protective Earth
S Signalling Contacts Optional

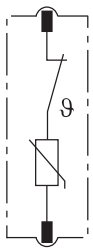


Dimensions & Packaging

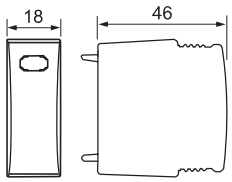


Dimensions & Packaging					
SPT40-XXX/3(S)	150	275	320	385	750
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]				
Minimum Order Quantity	30 Units				

SPT40-XXX/0

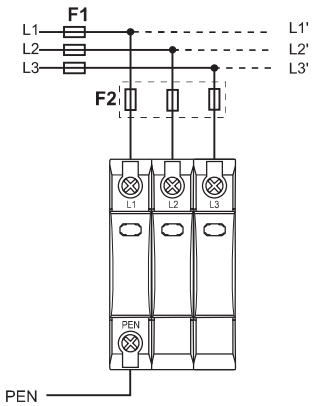


Dimensions & Packaging



Dimensions & Packaging					
SPT40-XXX/0	150	275	320	385	750
Single Unit DIN 43880 Dimension	1 CTN				
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]				
Minimum Order Quantity	96 Units				

TN-C (Three-phase, 3+0)



Connection Diagram

Surgeprotec Co., Ltd.
Minkyo Jeong / CEO

SURGE PROTEC
Surge Protection Total Solutions

SPT40-350/1S+1

Pluggable Multi-Pole SPD

SPT40-XXX/1(S)+1

Class II • Type 2•Type 1CA

Location of Use: Sub-Distribution Boards
Network Systems: TT, TN-S
Mode of Protection: L-N, N-PE
Surge Ratings: I_n = 20 kA(8/20μs)
IEC/EN/UL Category: Class II / Type 2 / Type 1CA
Protective Elements: High Energy MOV and GDT
Housing: Pluggable Design
Compliance: IEC 61643-11:2011
EN 61643-11:2012
UL 1449 4th Edition

Technical Data

SPT40-XXX/1(S)+1			75	150	275	350
IEC Electrical						
Nominal AC Voltage (50/60Hz)			60 V	120 V	230 V	240 V
Maximum Continuous Operating Voltage	(L - N)	U_c	75 V	150 V	275 V	350 V
	(N - PE)	U_c	255 V	255 V	255 V	255 V
Nominal Discharge Current (8/20 μs)	(L - N) / (N - PE)	I_n	20 kA / 20 kA			
Maximum Discharge Current (8/20 μs)	(L - N) / (N - PE)	I_{max}	40 kA / 40 kA			
Voltage Protection Level	(L - N) / (N - PE)	U_p	400 V/ 1000 V	1000 V/ 1000 V	1500 V/ 1000 V	1600 V/ 1000 V
Follow Current Interrupt Rating	(N-PE)	I_{fi}	100 A_{RMS}			
Response Time	(L - N) / (N - PE)	t_A	< 25 ns / < 100 ns			
Back-Up Fuse (max)			125 A gL / gG			
Short-Circuit Current Rating (AC)	(L - N)	I_{SCCR}	25 kA / 50 kA			
TOV Withstand 5s	(L - N)	U_T	90 V	180 V	335 V	415 V
TOV 120min	(L - N)	U_T	115 V	230 V	440 V	457 V
		mode	Withstand	Withstand	Safe Fail	Safe Fail
TOV Withstand 200ms	(N - PE)	U_T	1200 V			

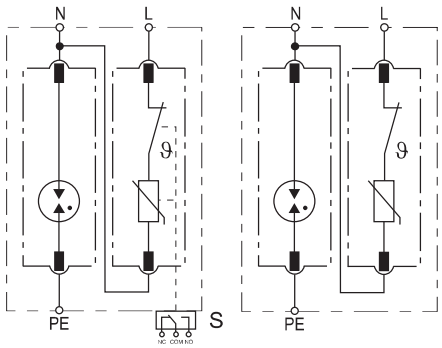
Mechanical & Environmental		
Operating Temperature Range	T_a	-40 °F to +158 °F [-40 °C to +70 °C]
Permissible Operating Humidity	RH	5%...95%
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m
Terminal Screw Torque	M_{max}	39.9 lbf·in [4.5 Nm]
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)
		35 mm^2 (Solid, Stranded) / 25 mm^2 (Flexible)
Mounting		35 mm DIN Rail, EN 60715
Degree of Protection		IP 20 (built-in)
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0
Thermal Protection		Yes
Operating State / Fault Indication		Green ok / Red defect
Remote Contacts (RC)		Optional
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm^2 (Solid)

Order Information				
Order Code	**75**	**150**	**275**	**350**
SPT40-XXX/1+1	4007513	4015013	4027513	9935013
SPT40-XXX/1S+1 (with remote contacts)	4007514	4015014	4027514	9935014

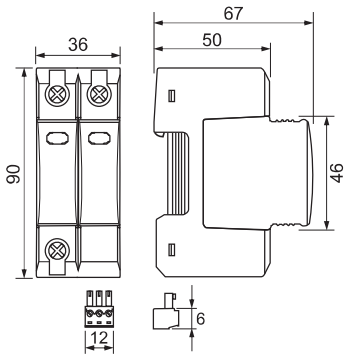
Internal Configuration

Legend

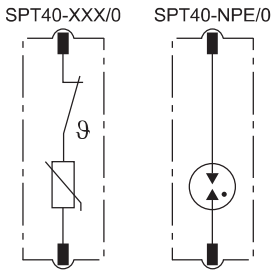
L Line
N Neutral
PE Protective Earth
S Signalling Contacts Optional



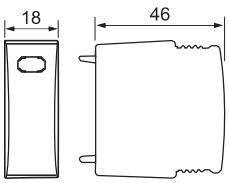
Dimensions & Packaging



Dimensions & Packaging				
SPT40-XXX/1(S)+1	**75**	**150**	**275**	**350**
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]			
Minimum Order Quantity	42 Units			



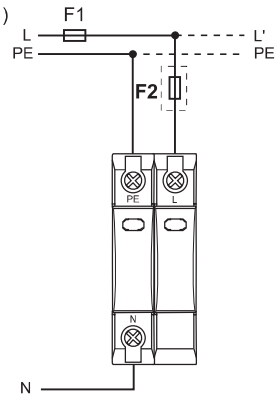
Dimensions & Packaging



Dimensions & Packaging				
SPT40-XXX/0	**75**	**150**	**275**	**350**
SPT40-NPE/0	**40**			
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]			
Minimum Order Quantity	96 Units			

Connection Diagram

TN-S,TT (Single-phase, 1+1)



Surgeprotec Co., Ltd.
Minkyo Jeong / CEO

SURGE PROTEC
Surge Protection Total Solutions

SPT40-PV1500-S

Pluggable Multi-Pole SPD for Photovoltaic Systems

SPT40-PVXXX-(S)

Class II • Type 2•Type 1CA

Location of Use: String box, Inverter
Mode of Protection: (DC+)- PE, (DC-)- PE, (DC+)- (DC-)
Surge Ratings: I_n = 20kA (8/20μs)
I_{total} = up to 40kA (8/20μs)
IEC/EN/UL Category: Class II/ Type 2/ Type 1CA
Protective Elements: High Energy MOV
Housing: Pluggable Design
Compliance: IEC 61643-31:2018
EN 50539-11:2013+A1:2014
UL 1449 4th Edition

Technical Data

SPT40-PVXXX-(S)			600	1000	1200	1500
IEC Electrical						
Maximum Continuous Operating DC Voltage	(DC+) - PE, (DC-) - PE	U_{cpv}	600 V	1000 V	1200 V	1500 V
	(DC+) - (DC-)	U_{cpv}	600 V	1000 V	1200 V	1500 V
Nominal Discharge Current (8/20 μs)		I_n	20 kA			
Total Discharge Current (8/20 μs)		I_{Total}	40 kA			
Maximum Discharge Current (8/20 μs)		I_{max}	40 kA			
Voltage Protection Level	(DC+) - PE, (DC-) - PE	U_p	2200 V	4000 V	4400 V	5200 V
	(DC+) - (DC-)	U_p	2200 V	4000 V	4400 V	5200 V
Response Time		t_A	< 25 ns			
Short-Circuit Current Rating		I_{scpv}	2000A			

Mechanical & Environmental		
Operating Temperature Range	T_a	-40 °F to +158 °F [-40 °C to +70 °C]
Permissible Operating Humidity	RH	5%...95%
Atmospheric pressure and altitude		80k Pa ... 106k Pa / -500 m ... 2000 m
Terminal Screw Torque	M_{max}	39.9 lbf·in [4.5 Nm]
Conductor Cross Section (max)		2 AWG (Solid, Stranded) / 4 AWG (Flexible)
		35 mm² (Solid, Stranded) / 25 mm² (Flexible)
Mounting		35 mm DIN Rail, EN 60715
Degree of Protection		IP 20 (built-in)
Housing Material		Thermoplastic: Extinguishing Degree UL 94 V-0
Thermal Protection		Yes
Operating State / Fault Indication		Green ok / Red defect
Remote Contacts (RC)		Optional
RC Switching Capacity		AC: 250V / 0.5 A; DC: 250V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A
RC Conductor Cross Section (max)		16 AWG (Solid) / 1.5 mm² (Solid)

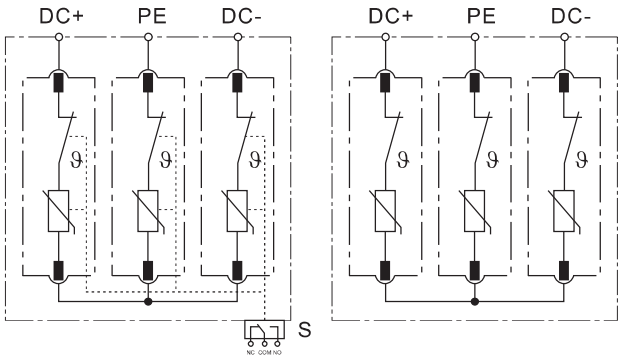
Order Information				
Order Code	**600**	**1000**	**1200**	**1500**
SPT40-PVXXX	4060025	4010235	4012231	4015231
SPT40-PVXXX-(S) (with remote contacts)	4060026	4010236	4012232	4015232
SPT40-PVXXX/0 (spare modules)	4060002	4010202	4012202	4015202

Internal Configuration

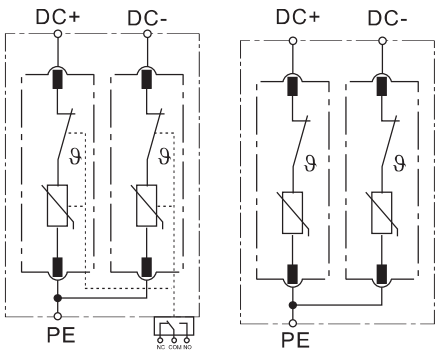
Legend

PE Protective Earth
S Signalling Contacts Optional

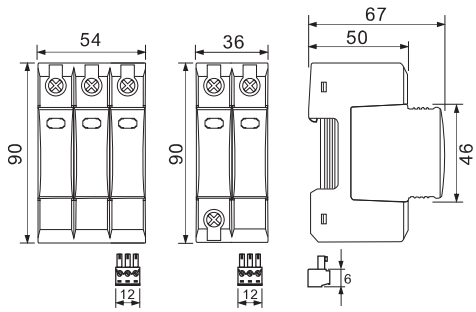
SPT40-PV1000-(S), SPT40-PV1200-(S), SPT40-PV1500-(S)



SPT40-PV600-(S)



Dimensions & Packaging

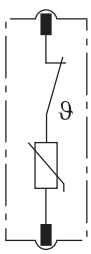


SPT40-PV1500-(S) SPT40-PV600-(S)
SPT40-PV1200-(S)
SPT40-PV1000-(S)

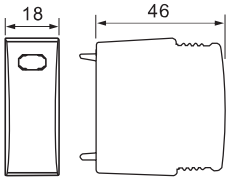
Dimensions & Packaging				
SPT40-PVXXX-(S)	**600**	**1000**	**1200**	**1500**
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]			
Minimum Order Quantity	42 Units	30 Units	30 Units	30 Units

Plug Internal Configuration

SPT40-PVXXX/0



Dimensions & Packaging



Dimensions & Packaging				
SPT40-PVXXX/0	**600**	**1000**	**1200**	**1500**
Single Unit DIN 43880 Dimension	1 CTN			
Packaging Dimensions (H x W x L)	[270 × 230 × 330 mm]			
Minimum Order Quantity	96 Units			

Surgeprotec Co., Ltd.
Minkyo Jeong / CEO

TRSS-RJ45/8 POE power/network integrated surge protector

- Cat6 and POE RJ45 network data protector
- Aluminum alloy shell, easy installation and replacement (DIN rail option)
- Built-in temperature control breaking technology and multiple protection technology
- Strong protection ability and high reliability
- High discharge capability and fast response time
- With a variety of protection functions: power and network signals
- The 48 Vdc power interface can be installed a according to the user's needs

TRSS-RJ45 series signal surge protective device are specially used for various computer network such as Ethernet network(LAN), its satisfied different types lightning –proof areas, the connector of its input and output is RJ45 female connector, which is easily connected and installed ,and it is main used in server equipment, working station(intranet)and router, HUB and board band RJ45 interface protection for protecting equipment, which will damaged by the over voltage of the earth or the line inductance.

Product capability parameter			
Product model			POE
			1 port
In accordance with			IEC 61643-21, EN61643-21
Normal Voltage (Vdc) : Un			48Vdc
Normal discharge current (8/20us) kA. : In			5
Max discharge current (8/20us) kA. : Imax			10
Lighting impulse current (10/350us)	Iimp		1
Voltage protection Level (V)	@1kV/us :Up		＜45V(LL);＜600V(LG)
	@5kV 10/700/us :Up		＜20V
Insertion loss			≤0.1dB
Response time			Instantaneous
Transmission Speed			1000Mbps
Type of connection In/Out			RJ45 (shielded) Female / Female
Ethernet cable Transmission performance			CAT 6
Connection Type			Series
Protective line			Data:1/2/3/6; PoE:4/5/7/8
Mounting			Inline / DIN rail
Material			Aluminum
Dimension (mm.)			94.5Wx25Lx25H
Weight (g.)			0.09
Operating temperature range			-40°C to +85°C
Environmental protection			IP20

LINK VUE SYSTEMS PTY LTD

TRSS-RJ45 POE power/network integrated surge protector

- Cat6 and POE RJ45 network data protector
- Aluminum alloy shell, easy installation and replacement
- Built-in temperature control breaking technology and multiple protection technology
- Strong protection ability and high reliability
- High discharge capability and fast response time
- With a variety of protection functions: power and network signals
- The 48 Vdc power interface can be installed a according to the user's needs

TRSS-RJ45 series signal surge protective device are specially used for various computer network such as Ethernet network(LAN), its satisfied different types lightning –proof areas, the connector of its input and output is RJ45 female connector, which is easily connected and installed ,and it is main used in server equipment, working station(intranet)and router, HUB and board band RJ45 interface protection for protecting equipment, which will damaged by the over voltage of the earth or the line inductance.

Product model	POE	
	16ports	24ports
In accordance with	IEC 61643-21, EN61643-21	
POE Voltage (Vdc) :	48Vdc	
Normal discharge current (8/20us) kA. : In	5	
Max discharge current (8/20us) kA. : Imax	10	
Residual pressure Up	60V	
Insertion loss	≤0.1dB	
Response time	Instantaneous	
Transmission Speed	1000M bps	
Type of connection In/Out	RJ45 (shielded) Female / Female	
Ethernet cable Transmission performance	CAT 6	
Connection Type	Series	
Mounting	Flange	
Material	Aluminum	
Dimension (mm.)	490Wx125Lx45 H	
Weight (Kgs.)	1.98	2.01
Operating temperature range	-40^{O}C to +85^{O}C	
Environmental protection	IP20	

LINK VUE SYSTEMS PTY LTD

Coaxial surge arrester

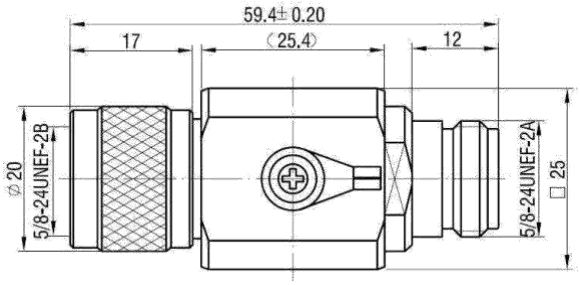
TRSW-N Coaxial Surge Arrester

Antenna feeder lightning arrester is a kind of surge protector, which is mainly used for lightning protection for feeder lines. Antenna-fed lightning arrester is also called antenna-fed signal lightning arrester, antenna-fed lightning arrester, antenna-fed line lightning arrester, and antenna-fed line lightning arrester. In the actual selection, the product's frequency range, insertion loss, maximum discharge current and other parameters are the primary considerations.

The coaxial antenna feeder lightning protector can prevent damage to the antenna and transceiver equipment caused by the feeder induced lightning overvoltage. It is suitable for the surge protection of the signal of the coaxial antenna feeder system such as satellite wireless communications, mobile base stations, microwave communications, and broadcast television. Installed in the lightning protection zone LPZ0A-1 and subsequent zones. The product is packaged in a shielded shell, built-in high-quality high-speed overvoltage protection devices, and has an efficient protection and defense function for the lightning high-voltage pulse induced on the antenna feeder line.

Features:

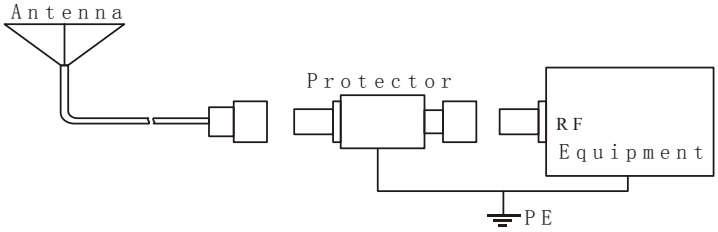
1. With replaceable integrated gas discharge tube.
2. Fast response without interruption.
3. Metal shell N type connection, easy to install.



Electrical Characteristics						
Type name	TRSW-N					
Interface type	Male to female					
Gas discharge tube arrester:	90V/230V/350V can be option					
Frequency range	DC-2.5GHz					
Operating current	none					
Max. discharge current (8/20μs) (Imax)	10KA					
Insertion loss	＜0.2dB					
Insulation resistance	≥5000 MΩ					
Impedance	50Ω					
Input Power	<20W	<50W	<100W	<200W	<400W	<500W
Initial Discharge Voltage	≥50V	≥70V	≥120V	≥190V	≥280V	≥280V
Protection mode(s)	Common mode					
Mechanical Characteristics						
Technology	GDT					
Connection to Network	Conntector male to female					
Mounting	freedthrough					
Housing material	Brass HPb59-1 GB4425-84					

Working temperature	-40℃-- +70℃
Degree of protection	IP20
Failsafe mode	short-ciruit
Disconnection indicator	transmission interrupt

Installation diagram:



Installation method of lightning protection device:

1. In order to reliably prevent lightning attacks, an antenna-fed lightning arrester can be connected in series to the antenna output end and the input end of the protected equipment. In areas with less lightning, if the antenna does not have an amplifier, you can also use only one antenna.

2. Weld the lug on the lightning arrester with the shortest possible grounding wire (the cross-sectional area of the wire is not less than 2.5mm), and the other end is reliably connected to the grounding bus of the lightning protection system, and the grounding resistance is not more than 4Ω.

3. When using the sky-fed lightning arrester outdoors, you must pay attention to rain protection, and must not allow rainwater to penetrate into it and cause corrosion damage.

4. This product does not require special maintenance. When the system fails, the lightning protector can be removed and then checked. If the system returns to normal after it is restored to the state before use, it means that the lightning protector has been damaged and must be replaced immediately.

Precautions for installation of lightning protection device:

1. This series of lightning arresters do not divide input and output terminals, and any port can be connected to the protected equipment.

2. Do not connect the positive and negative lines reversely or wrongly, and remember not to work with electricity.

3. The closer the lightning protection device is installed to the front end of the protected equipment, the better the effect.

Coaxial surge arrester

TRSW-SMA Coaxial Surge Arrester

Antenna feeder lightning arrester is a kind of surge protector, which is mainly used for lightning protection for feeder lines. Antenna-fed lightning arrester is also called antenna-fed signal lightning arrester, antenna-fed lightning arrester, antenna-fed line lightning arrester, and antenna-fed line lightning arrester. In the actual selection, the product's frequency range, insertion loss, maximum discharge current and other parameters are the primary considerations.

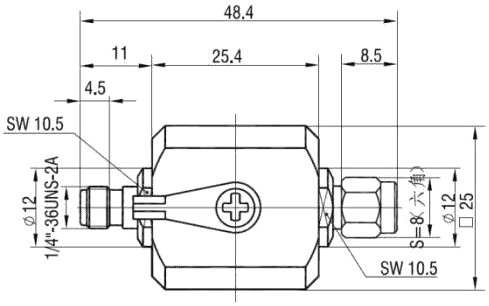
The coaxial antenna feeder lightning protector can prevent damage to the antenna and transceiver equipment caused by the feeder induced lightning overvoltage. It is suitable for the surge protection of the signal of the coaxial antenna feeder system such as satellite wireless communications, mobile base stations, microwave communications, and broadcast television. Installed in the lightning protection zone LPZ0A-1 and subsequent zones. The product is packaged in a shielded shell, built-in high-quality high-speed overvoltage protection devices, and has an efficient protection and defense function for the lightning high-voltage pulse induced on the antenna feeder line.

Features:

1. With replaceable integrated gas discharge tube.

2. Fast response without interruption.

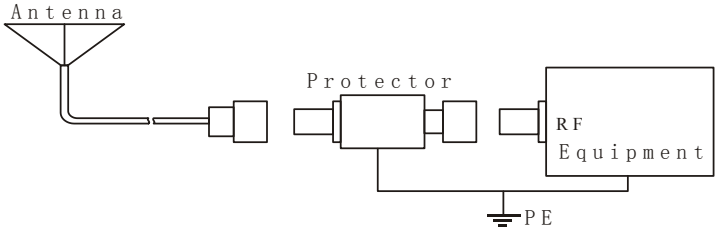
3. Metal shell SMA type connection, easy to install.



Electrical Characteristics						
Type name	TRSW-SMA					
Interface type	Male to female					
Gas discharge tube arrester:	90V/230V/350V can be option					
Frequency range	DC-2.5GHz					
Operating current	none					
Max. discharge current (8/20μs) (Imax)	10KA					
Insertion loss	＜0.2dB					
Insulation resistance	≥5000 MΩ					
Impedance	50Ω					
Input Power	<20W	<50W	<100W	<200W	<400W	<500W
Initial Discharge Voltage	≥50V	≥70V	≥120V	≥190V	≥280V	≥280V
Protection mode(s)	Common mode					
Mechanical Characteristics						
Technology	GDT					
Connection to Network	Conntector male to female					
Mounting	freedthrough					
Housing material	Brass HPb59-1 GB4425-84					

Working temperature	-40℃-- +70℃
Degree of protection	IP20
Failsafe mode	short-ciruit
Disconnection indicator	transmission interrupt

Installation diagram:



Installation method of lightning protection device:

1. In order to reliably prevent lightning attacks, an antenna-fed lightning arrester can be connected in series to the antenna output end and the input end of the protected equipment. In areas with less lightning, if the antenna does not have an amplifier, you can also use only one antenna.

2. Weld the lug on the lightning arrester with the shortest possible grounding wire (the cross-sectional area of the wire is not less than 2.5mm), and the other end is reliably connected to the grounding bus of the lightning protection system, and the grounding resistance is not more than 4Ω.

3. When using the sky-fed lightning arrester outdoors, you must pay attention to rain protection, and must not allow rainwater to penetrate into it and cause corrosion damage.

4. This product does not require special maintenance. When the system fails, the lightning protector can be removed and then checked. If the system returns to normal after it is restored to the state before use, it means that the lightning protector has been damaged and must be replaced immediately.

Precautions for installation of lightning protection device:

1. This series of lightning arresters do not divide input and output terminals, and any port can be connected to the protected equipment.

2. Do not connect the positive and negative lines reversely or wrongly, and remember not to work with electricity.

3. The closer the lightning protection device is installed to the front end of the protected equipment, the better the effect.

LINK VUE SYSTEMS PTY LTD

Coaxial surge arrester

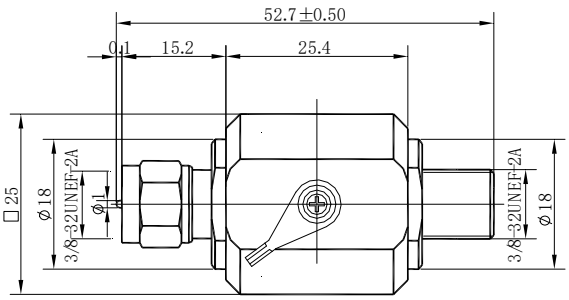
TRSW-F Coaxial Surge Arrester

Antenna feeder lightning arrester is a kind of surge protector, which is mainly used for lightning protection for feeder lines. Antenna-fed lightning arrester is also called antenna-fed signal lightning arrester, antenna-fed lightning arrester, antenna-fed line lightning arrester, and antenna-fed line lightning arrester. In the actual selection, the product's frequency range, insertion loss, maximum discharge current and other parameters are the primary considerations.

The coaxial antenna feeder lightning protector can prevent damage to the antenna and transceiver equipment caused by the feeder induced lightning overvoltage. It is suitable for the surge protection of the signal of the coaxial antenna feeder system such as satellite wireless communications, mobile base stations, microwave communications, and broadcast television. Installed in the lightning protection zone LPZ0A-1 and subsequent zones. The product is packaged in a shielded shell, built-in high-quality high-speed overvoltage protection devices, and has an efficient protection and defense function for the lightning high-voltage pulse induced on the antenna feeder line.

Features:

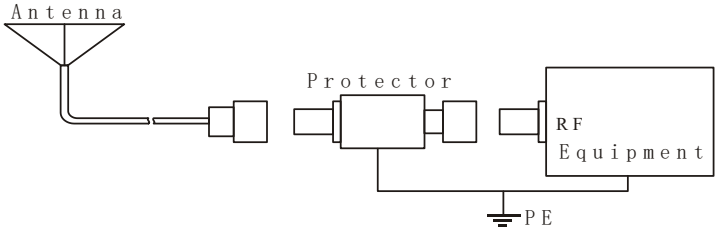
1. With replaceable integrated gas discharge tube.
2. Fast response without interruption.
3. Metal shell F type connection, easy to install.



Electrical Characteristics						
Type name	TRSW-F					
Interface type	Male to female					
Gas discharge tube arrester:	90V/230V/350V can be option					
Frequency range	DC-1GHz（other Frequency Range can be discussed.）					
Operating current	none					
Max. discharge current (8/20μs) (Imax)	10KA					
Insertion loss	＜0.2dB					
Insulation resistance	≥1000 MΩ					
Impedance	75Ω					
Input Power	<20W	<50W	<100W	<200W	<400W	<500W
Initial Discharge Voltage	≥50V	≥70V	≥120V	≥190V	≥280V	≥280V
Protection mode(s)	Common mode					
Mechanical Characteristics						
Technology	GDT					
Connection to Network	Conntector male to female					
Mounting	freedthrough					
Housing material	Brass HPb59-1 GB4425-84					

Working temperature	-40℃-- +85℃
Degree of protection	IP20
Failsafe mode	short-ciruit
Disconnection indicator	transmission interrupt

Installation diagram:



Installation method of lightning protection device:

1. In order to reliably prevent lightning attacks, an antenna-fed lightning arrester can be connected in series to the antenna output end and the input end of the protected equipment. In areas with less lightning, if the antenna does not have an amplifier, you can also use only one antenna.

2. Weld the lug on the lightning arrester with the shortest possible grounding wire (the cross-sectional area of the wire is not less than 2.5mm), and the other end is reliably connected to the grounding bus of the lightning protection system, and the grounding resistance is not more than 4Ω.

3. When using the sky-fed lightning arrester outdoors, you must pay attention to rain protection, and must not allow rainwater to penetrate into it and cause corrosion damage.

4. This product does not require special maintenance. When the system fails, the lightning protector can be removed and then checked. If the system returns to normal after it is restored to the state before use, it means that the lightning protector has been damaged and must be replaced immediately.

Precautions for installation of lightning protection device:

1. This series of lightning arresters do not divide input and output terminals, and any port can be connected to the protected equipment.

2. Do not connect the positive and negative lines reversely or wrongly, and remember not to work with electricity.

3. The closer the lightning protection device is installed to the front end of the protected equipment, the better the effect

LINK VUE SYSTEMS PTY LTD

Coaxial surge arrester

TRSW-SMA Coaxial Surge Arrester

Antenna feeder lightning arrester is a kind of surge protector, which is mainly used for lightning protection for feeder lines. Antenna-fed lightning arrester is also called antenna-fed signal lightning arrester, antenna-fed lightning arrester, antenna-fed line lightning arrester, and antenna-fed line lightning arrester. In the actual selection, the product's frequency range, insertion loss, maximum discharge current and other parameters are the primary considerations.

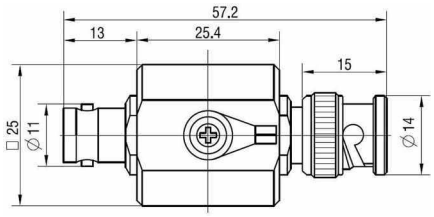
The coaxial antenna feeder lightning protector can prevent damage to the antenna and transceiver equipment caused by the feeder induced lightning overvoltage. It is suitable for the surge protection of the signal of the coaxial antenna feeder system such as satellite wireless communications, mobile base stations, microwave communications, and broadcast television. Installed in the lightning protection zone LPZ0A-1 and subsequent zones. The product is packaged in a shielded shell, built-in high-quality high-speed overvoltage protection devices, and has an efficient protection and defense function for the lightning high-voltage pulse induced on the antenna feeder line.

Features:

1. With replaceable integrated gas discharge tube.

2. Fast response without interruption.

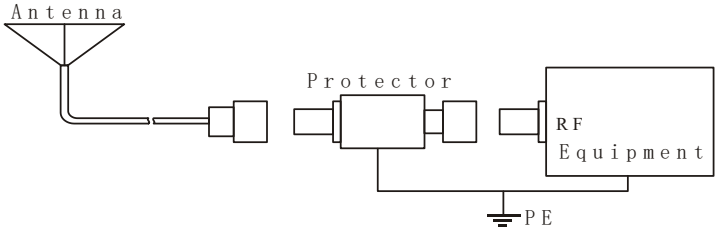
3. Metal shell SMA type connection, easy to install.



Electrical Characteristics						
Type name	TRSW-BNC					
Interface type	Male to female					
Gas discharge tube arrester:	90V/230V/350V can be option					
Frequency range	DC-2.5GHz					
Operating current	none					
Max. discharge current (8/20μs) (Imax)	10KA					
Insertion loss	＜0.2dB					
Insulation resistance	≥5000 MΩ					
Impedance	75Ω					
Input Power	<20W	<50W	<100W	<200W	<400W	<500W
Initial Discharge Voltage	≥50V	≥70V	≥120V	≥190V	≥280V	≥280V
Protection mode(s)	Common mode					
Mechanical Characteristics						
Technology	GDT					
Connection to Network	Conntector male to female					
Mounting	freedthrough					
Housing material	Brass HPb59-1 GB4425-84					

Working temperature	-40℃-- +70℃
Degree of protection	IP20
Failsafe mode	short-ciruit
Disconnection indicator	transmission interrupt

Installation diagram:



Installation method of lightning protection device:

1. In order to reliably prevent lightning attacks, an antenna-fed lightning arrester can be connected in series to the antenna output end and the input end of the protected equipment. In areas with less lightning, if the antenna does not have an amplifier, you can also use only one antenna.

2. Weld the lug on the lightning arrester with the shortest possible grounding wire (the cross-sectional area of the wire is not less than 2.5mm), and the other end is reliably connected to the grounding bus of the lightning protection system, and the grounding resistance is not more than 4Ω.

3. When using the sky-fed lightning arrester outdoors, you must pay attention to rain protection, and must not allow rainwater to penetrate into it and cause corrosion damage.

4. This product does not require special maintenance. When the system fails, the lightning protector can be removed and then checked. If the system returns to normal after it is restored to the state before use, it means that the lightning protector has been damaged and must be replaced immediately.

Precautions for installation of lightning protection device:

1. This series of lightning arresters do not divide input and output terminals, and any port can be connected to the protected equipment.

2. Do not connect the positive and negative lines reversely or wrongly, and remember not to work with electricity.

3. The closer the lightning protection device is installed to the front end of the protected equipment, the better the effect.

LINK VUE SYSTEMS PTY LTD

DIN Rail mounted SPD

TRSS-485/12V

RS485 DC surge protector. The surge protector is connected in series in front of the protected equipment, and is mainly suitable for communication lines, remote signaling, measurement and control systems, access control intercom systems, automatic control systems, security systems, etc., which can effectively absorb the energy generated by surges Impact, and introduce energy into the earth through the grounding cable.

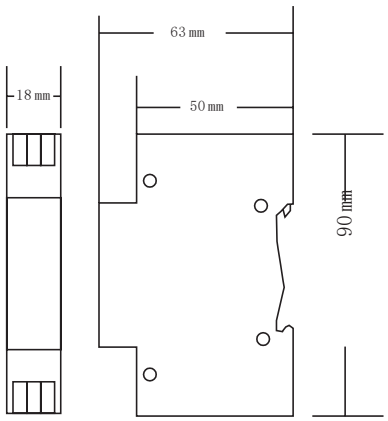
Features:

1. Protect a pair of signal lines from lightning surge.

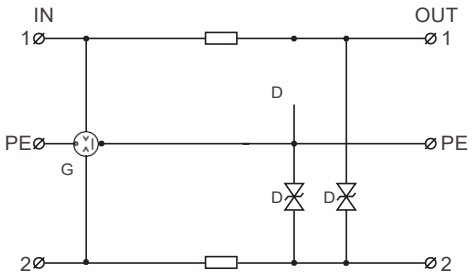
2. DIN rail installation saves a lot of space.

3. A variety of protection voltages are available, such as 12V 24V 36V 48V 110V.

4. The maximum discharge current is 10kA.



Dimensions



Basic circuit diagram

Type		TRSS-485/12V
Standards		EN 61643-21 / IEC 61643-21
Nominal voltage	U_n	12 V
Max. continuous operating voltage	U_c	15 V
Rated current	I_L	1 A
Nominal discharge current (8/20μs)	I_n	5 kA
Maximum discharge current (8/20μs)	I_{max}	10 kA
Voltage protection level line-line	U_p	30 V
Voltage protection level line-earth	U_p	600 V
Response time	ns	⩽1
Insertion loss		⩽0.5dB
Range of operating temperatures	T_U	40℃~+70℃
Cross-sectional area		0,14 - 2,5 mm^2solid /Dexible
For mounting on		35 mm DIN rail
Enclosure material		PA66
Place of installation		indoor installation
Degree of protection		IP 20
Connection type		Serial connection

Installation and notes:
1.Surge protective device is in series in front of protected equipment, and before installation should power off, and forbidden to operate with power.
2.When installation should make sure to wire according to surge protective device indication In, Out and PE. Output side is connected to protected equipment. Can't reverse, otherwise when lightning it will damage surge protective device, and can not protect the equipment properly.
3.When installing the ground wire, disconnect the device to avoid damage to the device due to the introduction of strong currents such as electric welding from the ground wire.
4.Connect the ground wire of the surge protector and the metal shell of the device to the grounding bar. It should test regularly during the surge protector using, if faults then should change or repair on time to ensure the safety of the protected equipment. 5.Non-professionals do not disassemble.

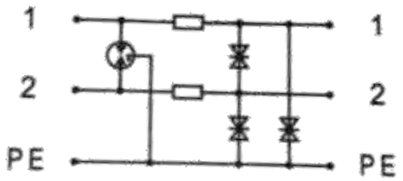
DIN Rail mounted SPD

TRSS-485

RS485 DC surge protector. The surge protector is connected in series in front of the protected equipment, and is mainly suitable for communication lines, remote signaling, measurement and control systems, access control intercom systems, automatic control systems, security systems, etc., which can effectively absorb the energy generated by surges Impact, and introduce energy into the earth through the grounding cable.

Features:

1. Protect a pair of signal lines from lightning surge.
2. DIN rail installation saves a lot of space.
3. A variety of protection voltages are available, such as 12V 24V 36V 48V 110V.
4. The maximum discharge current is 10kA.



Type		TRSS-485
Standards		EN 61643-21 / IEC 61643-21
Nominal voltage	U_n	12 V
Max. continuous operating voltage	U_c	15 V
Rated current	I_L	1 A
Nominal discharge current (8/20μs)	I_n	5 kA
Maximum discharge current (8/20μs)	I_{max}	10 kA
Voltage protection level line-line	U_p	30 V
Voltage protection level line-earth	U_p	600 V
Response time	ns	≤1
Insertion loss		≤0.5dB
Range of operating temperatures	T_U	40℃~+70℃
Cross-sectional area		0,14 - 2,5 mm²solid /Dexible
For mounting on		35 mm DIN rail
Enclosure material		PA66
Place of installation		indoor installation
Degree of protection		IP 20
Connection type		Serial connection

Installation and notes:
1.Surge protective device is in series in front of protected equipment, and before installation should power off, and forbidden to operate with power.
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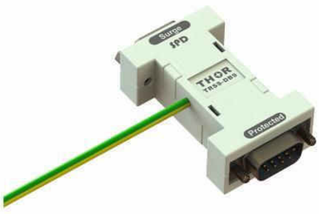
LINK VUE SYSTEMS PTY LTD

TRSS-DB9/DB25

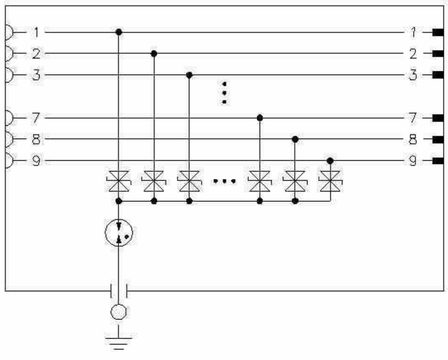


SPECIFICATION

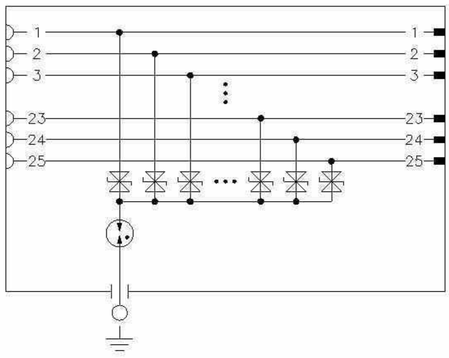
Type	TRSS-DB9	TRSS-DB25
Nominal working voltage （DC）U_N	12 V	12 V
Maximum continuous working voltage （DC）U_c	18 V	18 V
Rated current at 45℃ I_L	100 mA	100 mA
Nominal discharge current per line(C2, 8/20μs) I_n	0.1 kA	0.1 kA
Line-line voltage protection level(C2, 8/20 μs) U_p	60 V	60 V
Line-PE voltage protection level(C2, 8/20 μs) U_p	600 V	600 V
Line-line voltage protection level(C3, 1kV/μs) U_p	60 V	60 V
Line-PE voltage protection level(C3, 1kV/μs) U_p	600 V	600 V
Line-line voltage protection level(B2, 1kV@10/700μs) U_p	60 V	60 V
Line-PE voltage protection level(B2, 1kV@10/700μs) U_p	600 V	600 V
Line-line response time t_A	1 ns	1 ns
Line-PE response time t_A	100 ns	100 ns
Series resistance R	0 ohm	0 ohm
Enclosure rating	IP20	
Grounding method	Lead wire	
Shell material	ABS	
Body color	Beige/black	

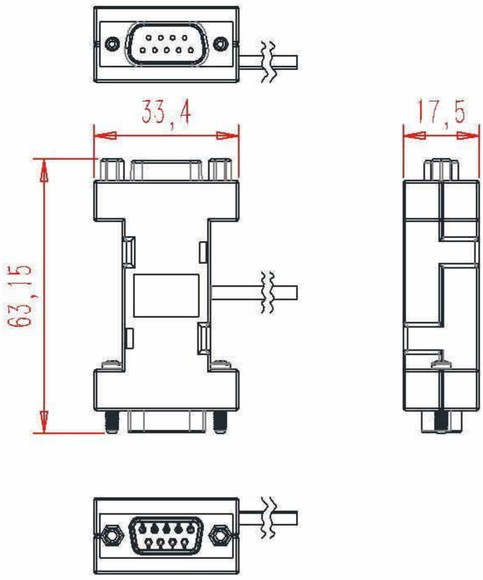
Circuit principle and dimensions

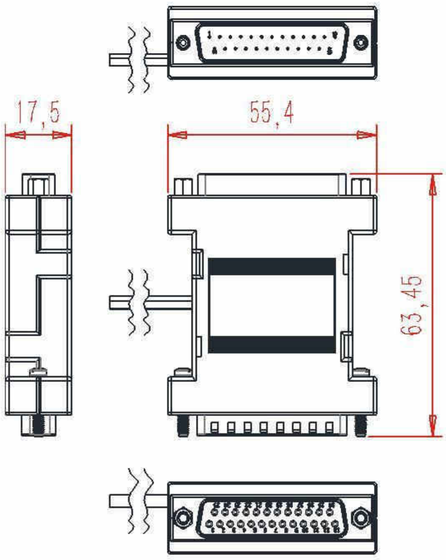
TRSS-DB9



TRSS-DB25







Link Vue System Pvt Ltd India

Ready to Grow and Fly our Wings

We are backup by our India office experience and profession Team of Technical believe to offer Genuine and Right Components Optimization of Customer Demand to Service and Trading along with System Design , Engineering Solution ,BOQ with Installation Support.

Focus Segments on Priority for Trading as per International Standard

1. Electrical Safety Products **Earthing , (ESE Type) Lightning Protection ,Surge Protection and Electrical Connectors PLUG Socket.**
2. **Online Lightning and Surge Monitoring System**

2. Networking Products **Ethernet SW ,Media Converter ,Wireless, Patch Cord ,LIU's**

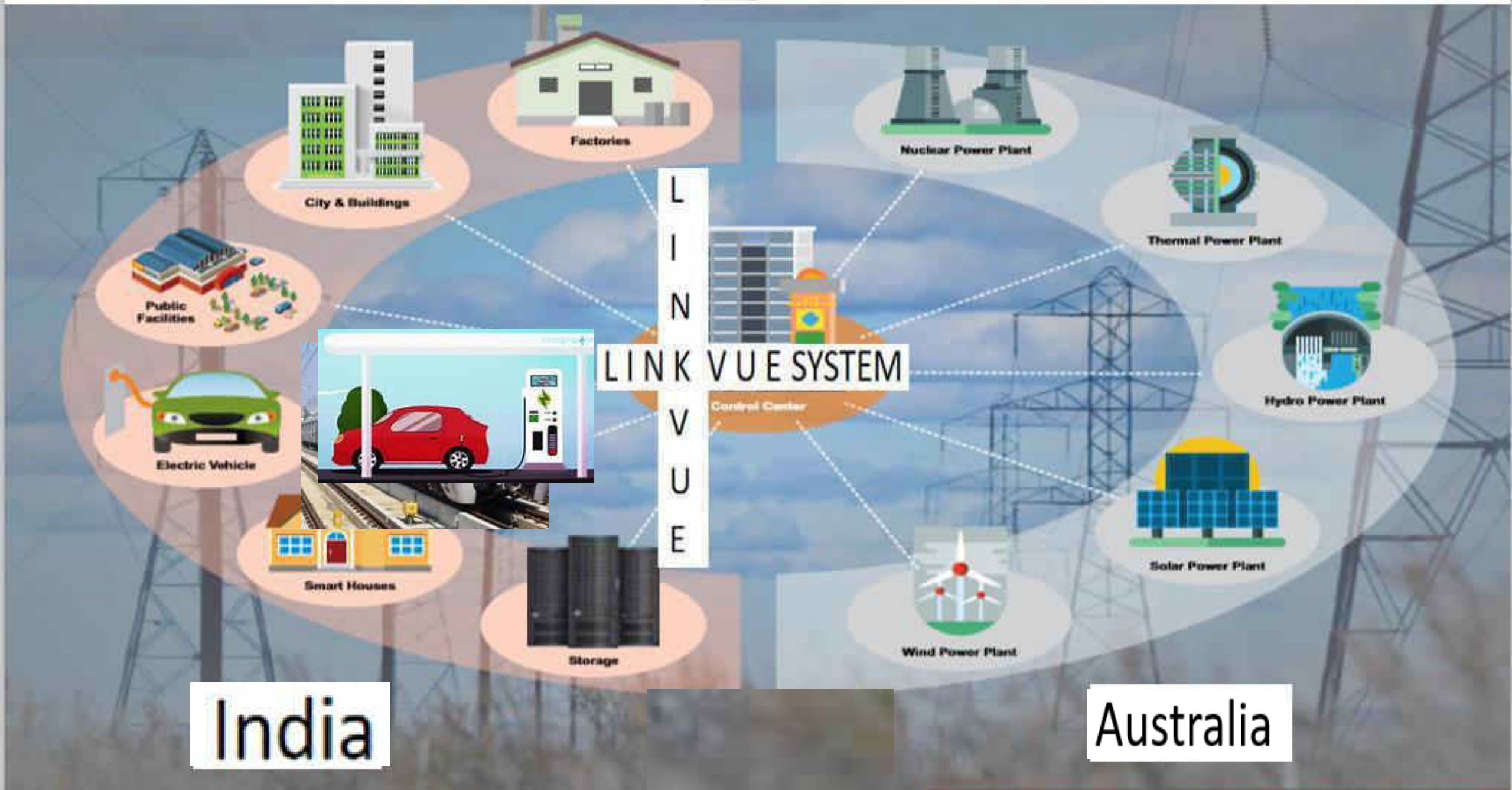
3. Automation Products **Smart Intelligent Data Loggers Protocol Converters , Protocol to FO Converters**

4. Special Products **Electric Vehicles and Charging Station AC/DC Power Socket for Vehicles and PLUG Gun Style for Charging Station also a Cable Harness Specify Length**.

5. Online Earthing and Surge Monitoring Systems

6. Our Focus Segment **: Large Building Infra , Data Centre,Railway Transportation, Airports , Railroad Tunnels, Solar PV, High Energy Battery Power , Green Hydrogen Plant and EV Charging Station Infra**

Right Solution Partner for your Problems LINK VUE A Genuine Approach Latest Technolgies Adoption



India

Australia


LINK VUE
Link Vue System Pvt Ltd
Electrical Safety
Earthing, Lightning & Surge Protection
Net Working Product Supply & Installation
Ethernet SW, Fiber Optics & Wire Less
Automation Products
Data Logger, RTU's Digital & Analog 1/0's
Protocol Converter, Media Converter,
Cables Connectors & LIU's
Perimeter Intrusion Detection System CCTV,
Fire Alarm, Access Controls & Security System
Cable & Connectors, Plug & Sockets for
Electrical Vehicles, Solar PV, Building Wiring
INDIA
AUSTRALIA

Human Can Sleep but System will be Monitor and Control Your Assets and Safety of Human Lives (Gaurd 24X7)

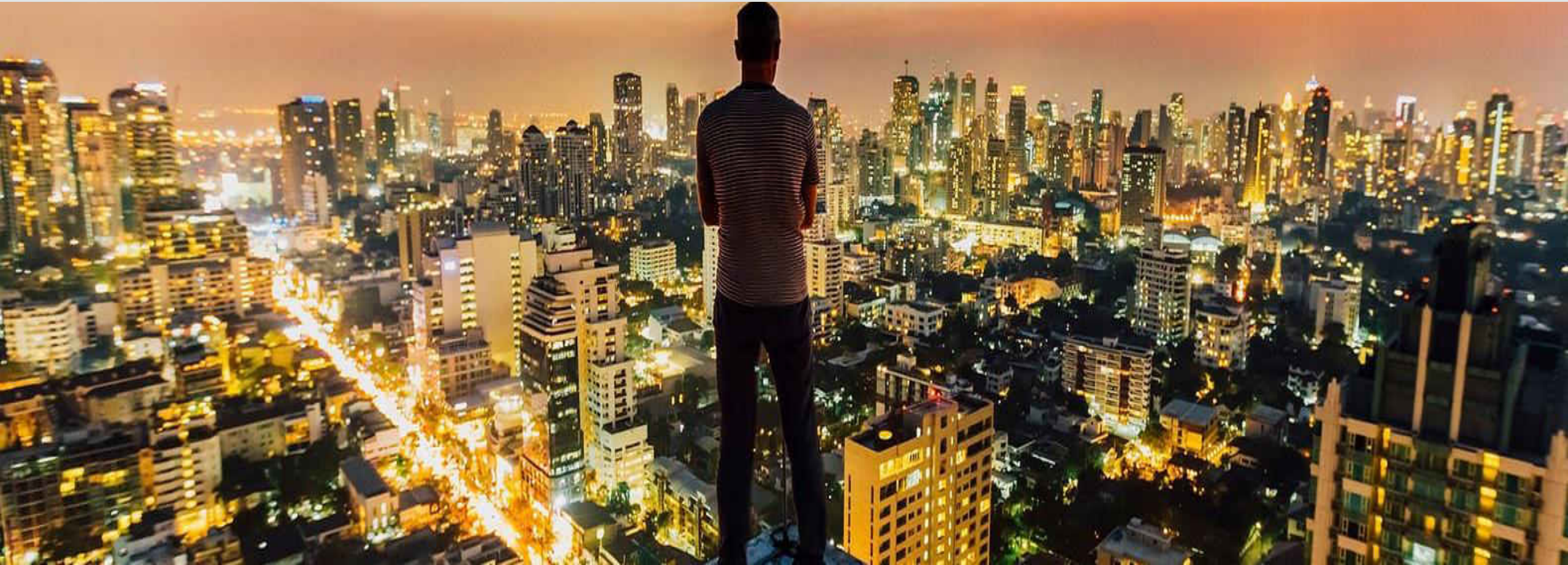
Access Control Systems

Intruder & Duress Alarm System

Video Surveillance

Integrated Security Systems

Video Verification Systems



LINKVUE - Industrial & Commercial Managed Gigabit PoE, Unmanaged Switches & Media Convertors Models Series

More than 100 different RJ45 copper & LC/ST/SC Fiber ports models available.

Physical Characteristics

Housing: Aluminium Alloy material with Ip40 Protection
Very light weight
Rack mount, wall mount & Din rail

Interfaces

Console Port: rs-232(RJ45 connector)
Web GUI Interfaces
Alarm Contact: 1 replay outputs, supports IP/MAC contact

Power

VAC Input: Rated voltage range ： 110-240V @2A /10 to 58 VDC Redundant dual inputs, Frequency ： 50/60Hz
Connection: 1 removable 6-pin terminal blocks
Protection Mechanism: overload protection, reverse connection protection, redundancy protection

Operating Environment

Operating Temperature: -40-85°C
Storage Temperature: -40-85°C
Ambient Relative Humidity: 5%-95% (non-condensing)
Rack Mount: 0-50 ℃ operation, -40-70 ℃ preservation, 0-90% no condensation

Industry Standards

EMI:FCC Part 15 Subpart B Class A, EN 55022 Class A
EMS:EN61000-4-2 (ESD), Level 4 at 15kV(Air), 8kV(Contact)
EN61000-4-3 (R/S), Level 3 at 10V/m
EN61000-4-4 (EFT), Level 4 at 4kV(Power Port), 2kV(Date Port)
EN61000-4-5 (Surge), Level 4 at 4kV
EN61000-4-6 (CS), Level 3 at 10V/m
EN61000-4-8, Level 5 at 100A/m
Shock:IEC 60068-2-27
Free Fall:IEC 60068-2-32
Vibration:IEC 60068-2-6

Certification

CE, FCC, RoHS

MTBF

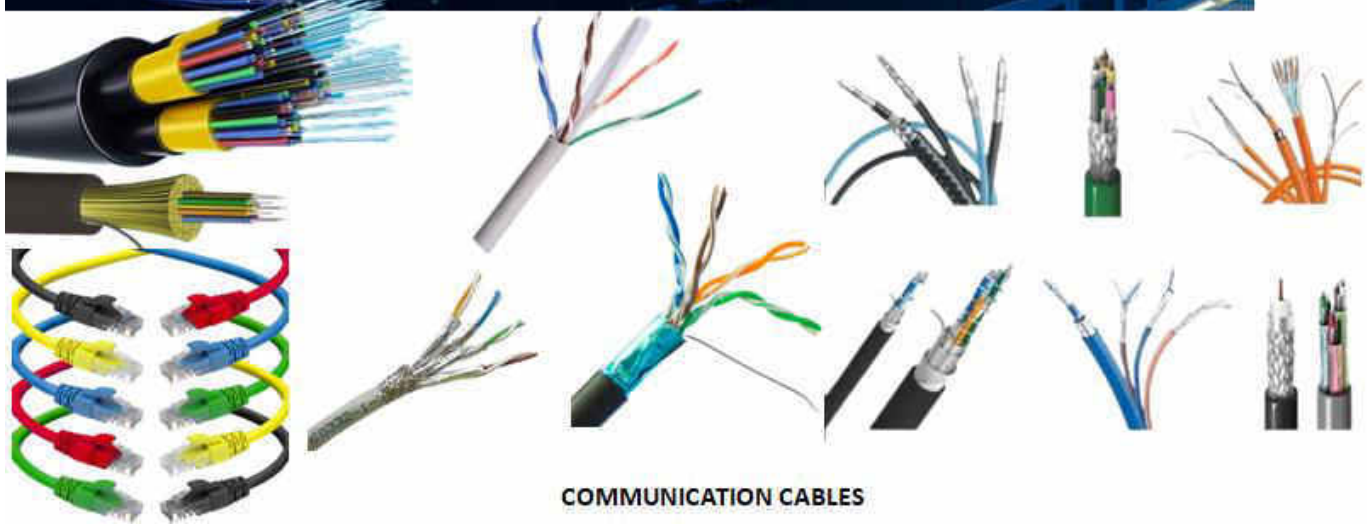
100,000 Hours

Warranty - 5-years

LINK-VUE BRAND FIBER OPTICS PASSIVE COMPONENTS TRADES AND SPLIICNG TERMINATIONS SERVICES

LIU

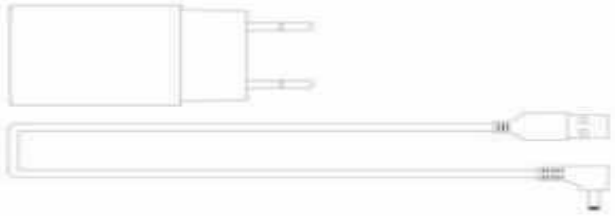
DIN RAIL LIU



COMMUNICATION CABLES

POE (POWER OVER ETHERNET) COMPONENTS

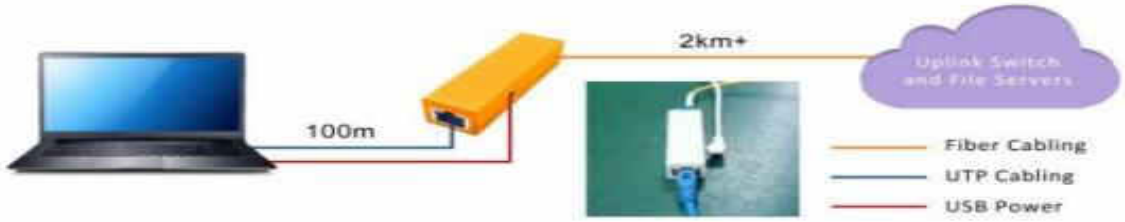
MINI
Media Converter



- 10/100/1000Base-T to 1000Base-X
- Auto-Negotiation, Auto-MDI/MDIX
- Operation Temp - 20~70°C
- AC-USB Adaptor & DC-USB Power
- AC/DC Power <1.2W
- Smallest Design 79*23*18mm

Fiber to the Laptop

Perfect solution to convert Ethernet link into a fiber link Portable ultra-compact size to use everywhere



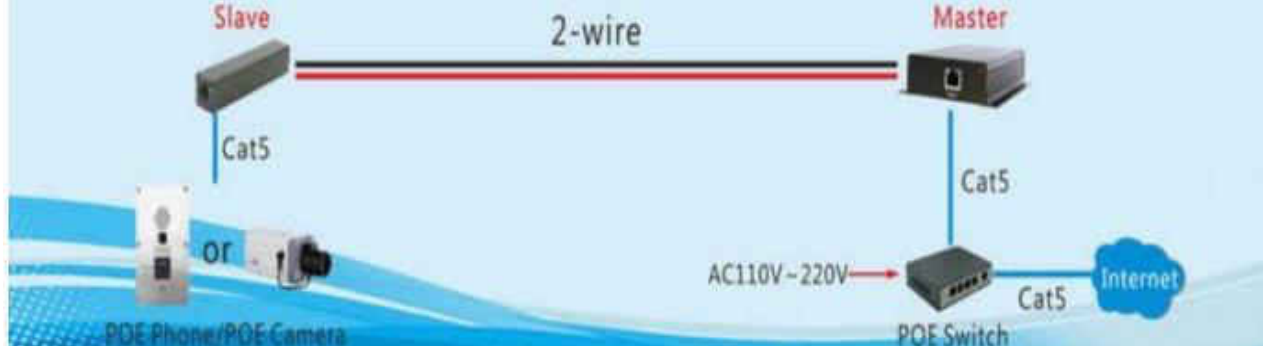
POE Ethernet Extender

Contact Mahesh Chandra Manav M-9811247237
manav.chandra@linkvuesystem.com www.linkvuesystem.com

Features :

- POE transmission up to 500m over any 2-wire/coaxial cable.
- Support power supply with POE switch/injector.
- Use any new or existing network infrastructure.
- Plug and play for easy installation.

POE Extender



INDUSTRIAL / COMMERCIAL GRADE PROTOCOL CONVERTERS.

Protocon-P7M: Modbus RTU to Modbus TCP/IP

SUNLUX TECHNOVATIONS

Protocon-P7M — A gateway for your Building Automation solution

Protocon-P7M is a cost effective solutions to connect equipment's with similar communication Protocols and physical Media.

Protocon-P7M is a product from Sunlux that allows users to integrate new and existing Modbus/RTU serial devices to TCP/IP network-based devices. The gateway server allows MODBUS/TCP based Controllers and applications to communicate and interoperate with serial MODBUS RTUs.

Supporting

- RJ45

nodes

Ethernet port

- 2 x RS485, 1 x RS232 port supports upto 30 nodes.

Protocols supported

- Modbus RTU, Modbus TCP/IP

Mapping data points Supported

- Maximum 500 data points

Applications

- Energy Management with Building Automation Systems
- Integrated metering of HVAC systems and chillers

PRODUCT ORDERING INFORMATION:

MODEL	INTE	ORDER CODE
Protocon-P7M: Modbus RTU to Modbus TCP/IP	1 x RS485	P7M-P1
	2 x RS485	P7M-P2
	2xRS485, 1 x RS232	P7M-P3

TeleMON™ - Telemetric Monitoring System

Key Features

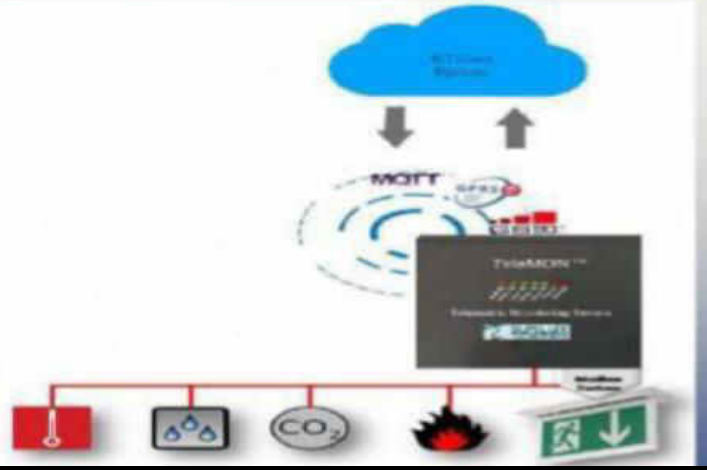
- ✓ MQTT support over 10/100 fast Ethernet (RJ45) or over built in 3G/4G Modem. Data encrypted with TLS
- ✓ Modbus RTU support on 2 x RS485 ports
- ✓ Modbus TCP support on 10/100 Fast Ethernet (RJ45)
- ✓ Device level security with TPM 2.0, Secure Boot
- ✓ Ruggedized (shock and vibration resistant) for challenging mobile and manufacturing environments
- ✓ Can be powered by 24V DC
- ✓ Provision for onboard data logging with real time stamp with configurable periodicity
- ✓ Configuration available through integrated web server

General Description

TeleMON™ is an industrial grade x86 based gateways. Telemon gateway provides two RS485 serial interface for Modbus RTU protocol, an ethernet interface for Modbus TCP and transfers the data to the cloud using MQTT (SSL/TLS) over 3G or 4G cellular modem or ethernet Interface. TeleMON gateway acquires data from legacy devices and modern sensors analyzes and make the data available at the cloud which would provide a platform for various applications like remote asset management, centralized monitoring etc.

TeleMON is specifically designed to implement data collection systems which operate according to the Internet of Things (IoT) paradigms; It allows bidirectional communication between field equipment and the Cloud software platform. All the data transferred to the cloud are encrypted with Transport Layer Security (TLS). It is possible to configure the MQTT message structure in order to better adapt to the different MQTT Brokers available (Amazon AWS, Mosquito etc.)

Typical Network Diagram



Protocol Specifications

Modbus

- ✓ TCP / RTU Support
- ✓ Holding Register, Input Register, Discrete Inputs, Coils supported
- ✓ Support for function code FC 0x01,0x02,0x03,0x04
- ✓ Serial Baud rate support from 9600 -115200

MQTT

- ✓ TLS 1.2 Certification supported
- ✓ MQTT using OpenSSL
- ✓ Connection and reconnection with configurable QOS level (0,1,2), DUP and Keep Alive Timer supported
- ✓ Publish and Subscribe support with configurable QOS levels (0,1,2)

Protocol Converters

Protocol	CAN Open	CC Link	DeviceNet	Ethernet IP	Modbus RTU	Modbus TCP	Profibus	Profinet
CAN open	✓	✓	✓	✓	✓	✓	✓	✓
DeviceNet	✓	✓	✓	✓	✓	✓	✓	✓
Ethernet IP	✓	✓	✓	✓	✓	✓	✓	✓
Modbus RTU	✓	✓	✓	✓	✓	✓	✓	✓
Modbus TCP	✓	✓	✓	✓	✓	✓	✓	✓
Profibus	✓	✓	✓	✓	✓	✓	✓	✓
Profinet	✓	✓	✓	✓	✓	✓	✓	✓
M-Bus	-	-	-	-	✓	-	-	-

CANopen M-Bus CC-Link Modbus Modbus EtherNet/IP DeviceNet

Electrical Safety

- Maintenance Free Earthing
- **Surge Protection** for Power , Signal & Data Serial Port ,Communication Port

Electrical Connectors

- Electrical Freedom Wiring Connectors Hanging, Panel Mounted and Channel Mounted Shorting , One 2 One and Distribution
- High Voltage PLUG-Sockets Cable 2 Cable ,Panel 2 Cable , Wall 2 Cable Outdoor IP 68 16Amps-450 Amps

Solar PV Connectors

- Solar PV MC4 Connectors , MC 4 Cable Harness ,Y Link , with and Without Fuses 1800VDC 30Amps
- Solar DC Fuses and Fuse Holders

Electric Vehicle Connectors

- Electric Vehicle Charging Connectors GBT ,CCS, CHAdeMO, CEE,SAE ,Tesla , Cable Harness for Male Vehicle Connectors and Female Gun Type PLUG

Electric Vehicle Protection Components

- RCD , RCBO EVSE Communication Products

Networking Products

- Ethernet SW Un Managed, Managed, Programmable
- Media Converter SM and MM Data Patch Cord, LIU's
- Communication Cables RS485, Modbus, Ethernet , FO , Profibus , Foundation Field Bus
- Communication Connectors Profibus , Modbus , Foundation Field Bus , ProfiNet

•Smart Intelligent Data Logger with Digital and Analogue I/0's

•Protocol Converter

- Master – Master
- Master- Slave
- Slave- Slave
- Profibus , Modbus RTU's Modbus TCP , CAN bus , ProfNet , Foundation Field Bus ,IEC61850 , Lon Works, Device Net BACnet
- Protocol to FO Converter

Electrical Power Must Follow Safety Connection & Trip Components for Equipment's & Human Protection

45 kW / 55 kW	Motor (PMSM)	31 kW
110 Nm / 114 Nm	Torque	110 Nm
6.2 sec / 5.7 sec	0-60 kmph	NA
250 km / 315 km	Range	230 km
19.2 kWh / 24 kWh	Battery	17.3 kWh
3.3 kW AC / 7.2 kW AC	Charging Options	3.3 kW
2.6 hrs / 3.6 hrs	0-80% (Charge)	5 hours

Earthing

Electrical Cable

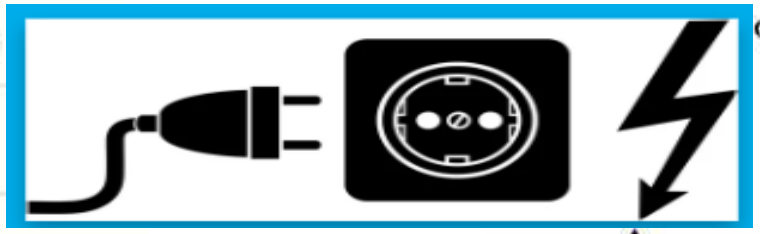
Termination Connectors

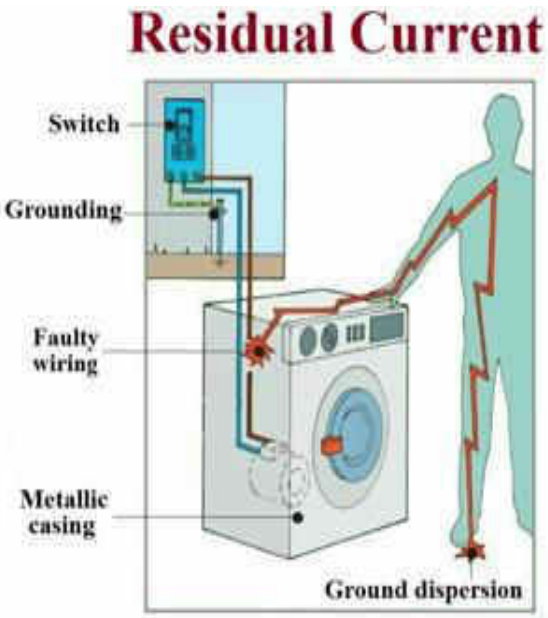
Fuse

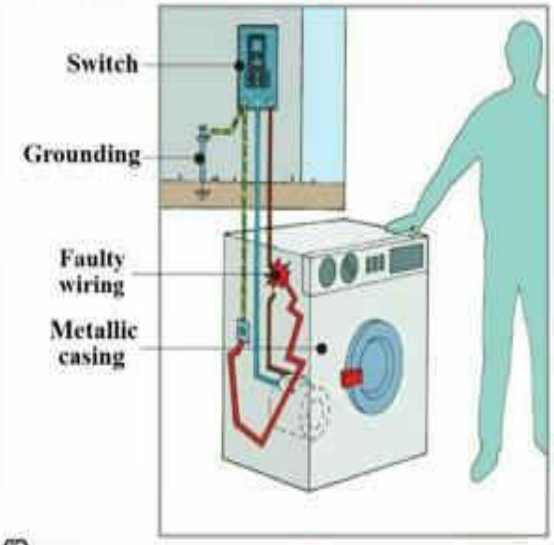
MCB

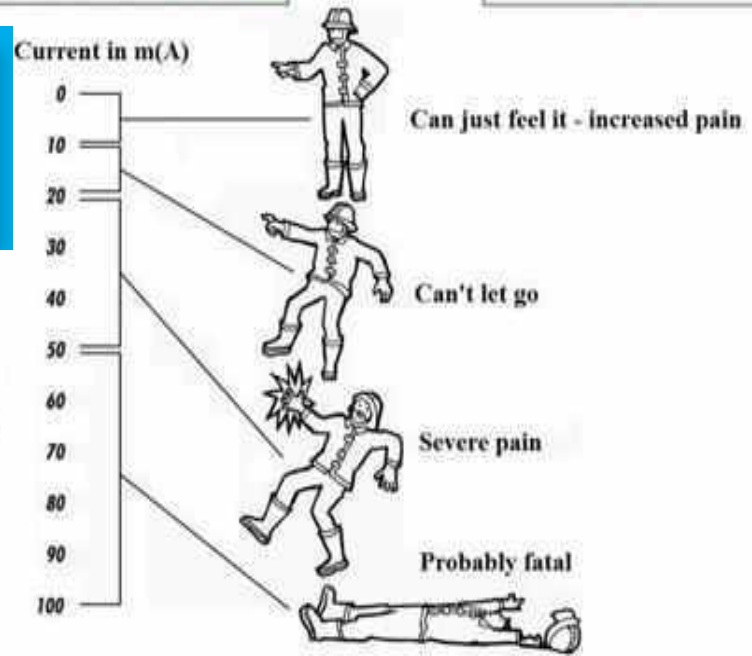
RCD/RCCB

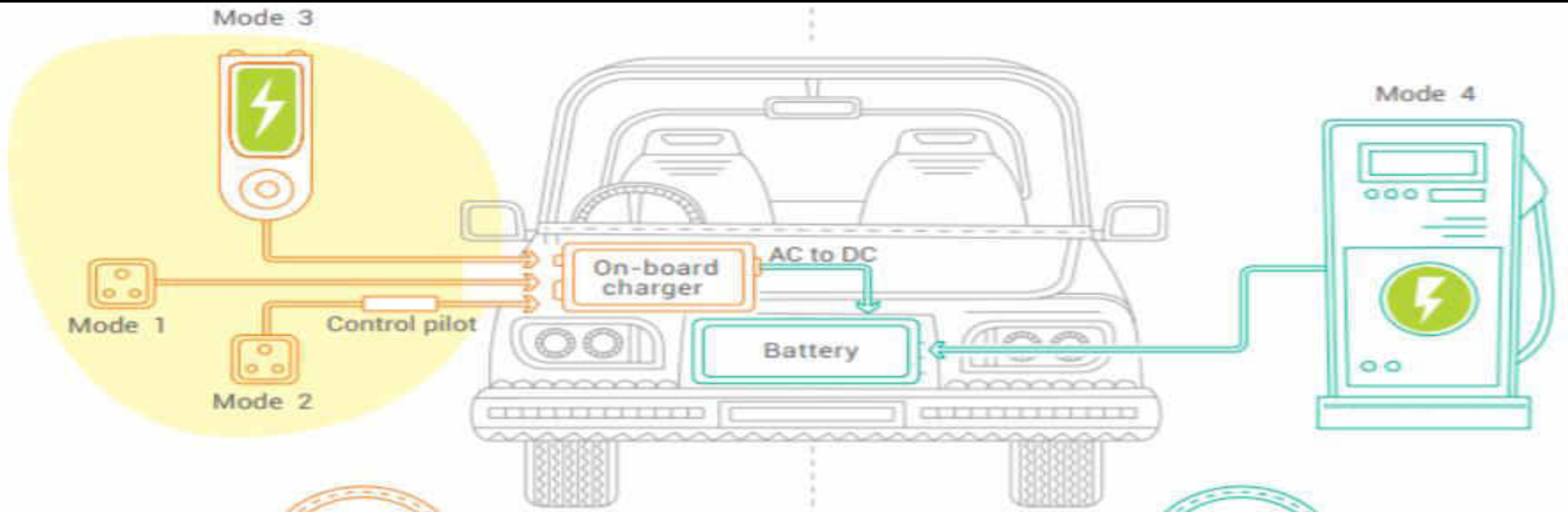
Surge Protection











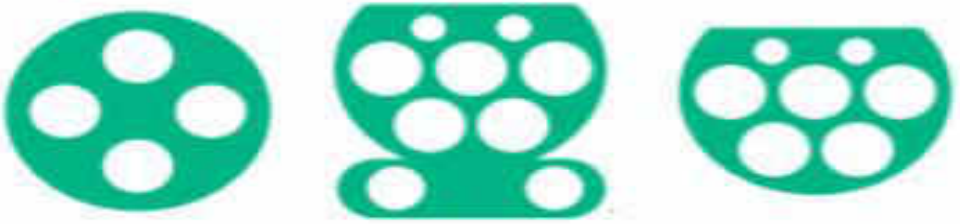
AC

(2kW TO 22kW)

DC

(2kW TO 200kW +) DC

3 PIN Type 1 Type 2



CHAdeMo Combo 2 Type 2

Electric Vehicle Charging Components

Similar Picture	Description
	Type2 plug with 5m long cable 32A, 3phase
	DC200A CCS2 connector
	AC 32A Type 2 female connector 1phase/3phase
	AC 63A type 2 female connector
	Type B RCD & RCCB 4Pole, 16A, 32A, 40A,63A
	Type B RCD & RCCB 4Pole, 80A,100A
	Type B RCBO 4Pole, 40A
	Type A RCD & RCCB 4Pole, 25A,40A,63A
	Type A RCD & RCCB 4Pole, 80A,100A

Similar Picture	Description
	Type A RCBO 4Pole, 40A
	**EVSE controller** 32A cable/socket version
	**EVSE controller with RFID card** 32A cable/socket version
	**EVSE Controller With RCMU** **32A, Cable version**
	DC Charging Module 20KW,1000V
	DC Charging Module 30KW,1000V


Type 1 EV Plug (SAE J1772)


Type 2 Female EV Plug


Type 2 Male EV Plug


CCS Combo 1 EV Plug


CCS Combo 2 EV Plug


CHAdeMO EV Plug

EV AC/DC Power Connectors for Vehicles & Charging Unit

AC EV Charger Connector

Type 1 EV Plug (SAE J1772)

Type 2 Female EV Plug

Type 2 Male EV Plug

AC EV Charger Socket

Type 1 EV Socket

Type 2 Male EV Socket

Type 2 Female EV Socket

DC EV Charger Connector

CCS Combo 1 EV Plug

CCS Combo 2 EV Plug

CHAdeMO EV Plug

DC EV Charger Socket

CCS Combo 1 Inlet Socket

CCS Combo 2 Inlet Socket

CHAdeMO Inlet Socket

EV PLUG Holder


J1772 Type 1 Plug Dummy Holder


J1772 Type 1 Plug Dummy Holder


J1772 Type 1 Plug Dummy Holder


Type 2 Female Plug Dummy Holder


Type 2 Female Plug Dummy Holder


Type 2 Female Plug Dummy Holder


CCS Combo 1 Plug Dummy Holder


CCS Combo 2 Plug Dummy Holder


CCS Combo 2 Plug Dummy Holder
With Micro Switch Detect

EV Cable Harness


Type 1 Inlet Socket With Cable


Type 2 Male Inlet Socket With Cable


Type 2 Male Inlet Socket For Motor


Type 2 to Type 1 EV Socket
EV Converter Cable


Type 1 to Type 2 Male Socket
EV Converter Cable


Type 1 to Type 1 EV Socket
EV Adapter Cable


CCS Combo 1 Inlet Socket With Cable


CCS Combo 2 Inlet Socket With Cable


CHAdeMO Inlet Socket With Cable


CCS Combo 1 Plug With Cable


CCS Combo 2 Plug With Cable


Japan CHAdeMO Plug With Cable

GBT

CCS2

Type2

CHAdeMO

SAE

TESLA

CEE

EV Charging Cable

TUV Standard EV Charging Cable

Product Introduction:

EV cable is a kind of flexible cable to connect electric vehicle with charging pile or power socket, high quality oxygen-free copper conductor ensures excellent conductive effect; TPE insulation material is soft and high strength; cable sheath is made from high-performance TPE, which possess characteristic as weatherability, high&low temperature resistance, rub resistance, ect.The cable is soft, elastic, flex index and won' t harden in low temperature. EV Cables for Electric vehicle conductive charging system are fit for Battery Electric Vehicle,Fuel Cell Vehicle(FCV) & Hybrid Electric Vehicle(HEV).They are widely used in charging connection beween electric vehicle and power supply; or used in Electric Vehicle charging facility & Charge interface.

AC EV Charging Cable

DC Fast Charger Cable

AC Single Phase (TUV)	3x2.5mm²+2x0.5mm²	16Amp	450V/750V	Black Orange Green
	3x6.0mm²+2x0.5mm²	32Amp		
	3x8.0mm²+2x0.5mm²	40A/50Amp		
	3x10mm²+2x0.5mm²	63Amp		
AC Single Phase (UL)	3x14AWG+1x18AWG	16Amp	600V	Black Orange Green
	3x10AWG+1x18AWG	32Amp		
	2x8AWG+1x10AWG+1x16AWG	40Amp		
	2x8AWG+1x10AWG+1x16AWG	50Amp		
AC Three Phase (TUV)	5x2.5mm²+2x0.5mm²	16Amp	450/750V	Black Orange Green
	5x6.0mm²+2x0.5mm²	32Amp		
	5x10mm²+2x0.5mm²	63Amp		
	5x13.3mm²+2x0.5mm²	70Amp		
DC Fast Charger (TUV)	2x16mm²+1x25mm²+6x0.75mm²	80Amp	750V/1000V	Black Orange Green
	2x35mm²+1x25mm²+6x0.75mm²	125Amp		
	2x50mm²+1x25mm²+6x0.75mm²	150Amp		
	2x70mm²+1x25mm²+6x0.75mm²	200Amp		
	2x80mm²+1x25mm²+6x0.75mm²	250Amp		

Product Description:

- Conductor: Soft annealed stranded Bare Copper
- Insulation: 125℃ halogen free TPE or TPU
- Filler: Cotton thread
- Cover: Non-woven fabrics
- Sheath: 125℃ halogen free TPE or TPU
- Color : Black,Orange,Green
- Rated Volatage: AC 450/750V,DC 1000V
- Rated temperature: -25℃ upto +125℃
- Voltage Test: 2.5KV AC /15min . No Breakdown
- Short circuit using temperature: +200℃ 5s
- Crush Resistance : 5kN ,8Km/h,220KPa,No Breakdown
- Flame Test: VW-1 test method comply with UL 2556

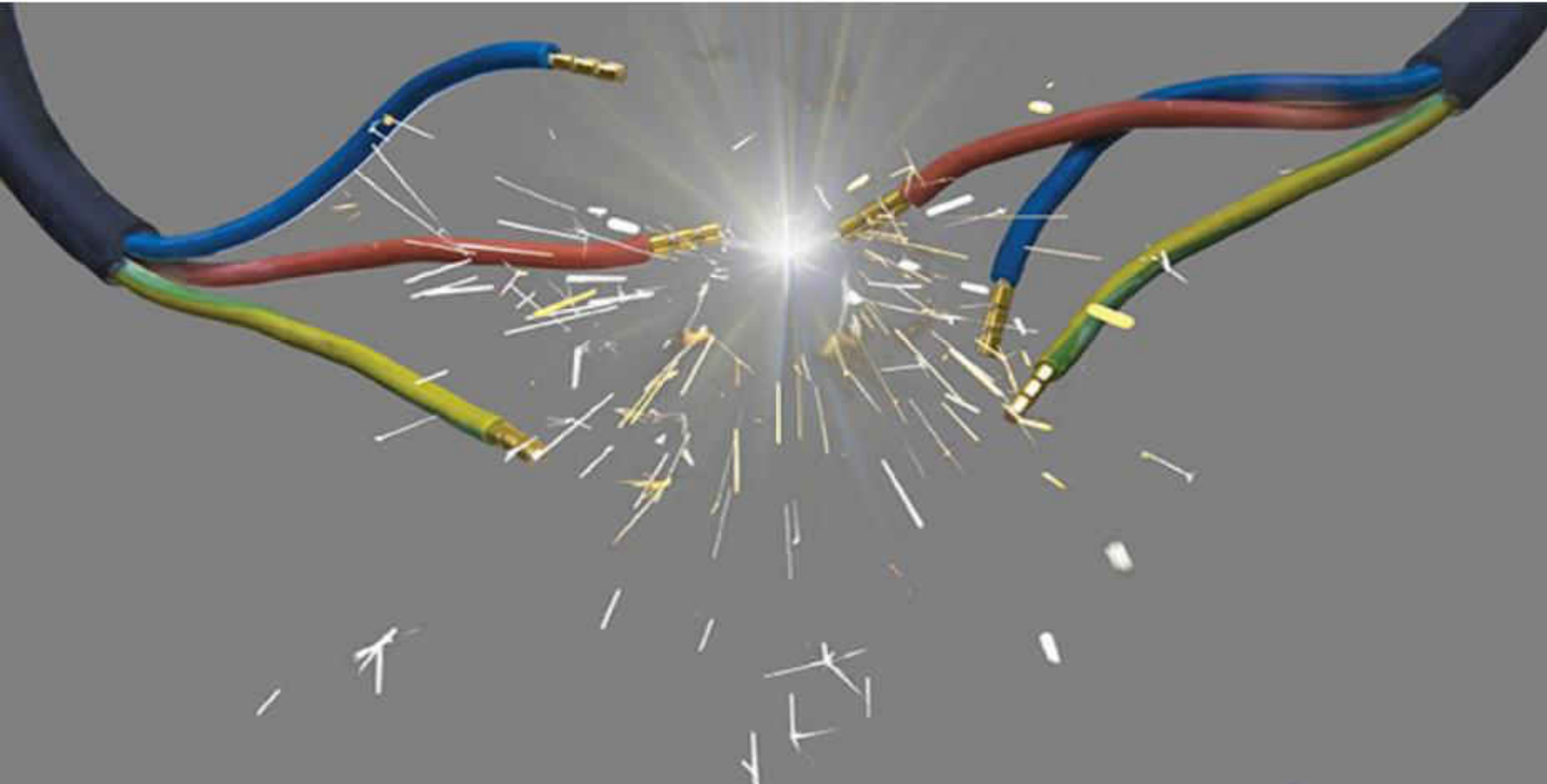
ELECTRICAL SAFETY TRADES FOR AUSTRALIA MARKET

Fire Accident Burj Khalifa Dubai
November 2022

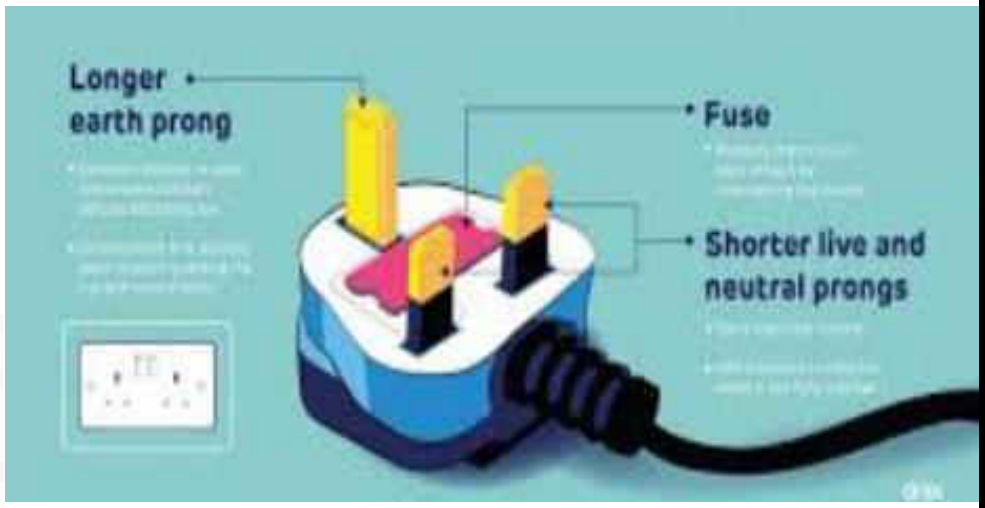
Common Causes of Electrical in Your Home

- Overloading
- Electrical Surges
- Power Sags And Dips
- Uncovered Junction Box
- Light Switches Are Not Working
- Flickering Light
- Limited Outlets
- Lack Of GFCIs
- Overwired Panel
- Aluminum Wiring
- Backstabbed Wires
- Electric Shock

Joints should be handle by Experts



I am Power Plug I will be Marry with only My Right Partner
Make you Safety and Comfort



MC 4 Solar PV DC Connector Family 1800V 30Amps

Freedom Connectors Safe Electric Wire Joints

- Electrical parameters: 250V/32A
- Product specifications: 12.4x20.5x14.5mm (LX W x H)
- Applicable wire: 0.75-2.5mm²"e+f" AGW28-14
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 2 digits
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC222-412

- Electrical parameters: 250V/32A
- Product specifications: 17x20.5x14.5mm (LX W x H)
- Applicable wire: 0.75-2.5mm²"e+f" AGW28-14
  0.75-4mm² "f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 3 digits
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FD222-413

- Electrical parameters: 250V/32A 600V/20A
- Product specifications: 40.2x21x14.5mm (LX W x H)
- Applicable wire: 0.08-2.5mm²"e+f" AGW28-14
  0.08-4mm² "f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 8digits
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC222-418

- Electrical parameters: 600V/32A
- Product specifications: 18.5x39.2x14.4mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 3 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC313

- Electrical parameters: 250V/32A
- Product specifications: 21.92x21x14.5mm (LX W x H)
- Applicable wire: 0.75-2.5mm²"e+f" AGW28-14
  0.75-4mm² "f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 4digits
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC222-414

- Electrical parameters: 250V/32A 600V/20A
- Product specifications: 26.6x21x14.5mm (LX W x H)
- Applicable wire: 0.75-2.5mm²"e+f" AGW28-14
  0.75-4mm² "f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 5digits
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC222-415

- Electrical parameters: 600V/32A
- Product specifications: 8.6x39.2x14.4mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 1 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC221

- Electrical parameters: 600V/32A
- Product specifications: 13.6x39.2x14.4mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 2 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC212

Freedom Connectors Safe Electric Wire Joints

- Electrical parameters: 600V/32A
- Product specifications: 25.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 2 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC223-2P

- Electrical parameters: 600V/32A
- Product specifications: 30.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 3 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC223-3P

- Electrical parameters: 600V/32A
- Product specifications: 35.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 4 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC223-4P

- Electrical parameters: 600V/32A
- Product specifications: 40.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 5 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC223-5P

- Electrical parameters: 600V/32A
- Product specifications: 60.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 10 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC223-10P

- Electrical parameters: 600V/32A
- Product specifications: 65.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 12 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: Gray + Orange, Yellow, Blue, Green (handle)
- Material: PA66

FC223-12P

- Electrical parameters: 600V/32A
- Product specifications: 45.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 6 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC223-6P

- Electrical parameters: 600V/32A
- Product specifications: 55.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 8 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC226-8P

Freedom Connectors Safe Electric Wire Joints

- Electrical parameters: 400V/32A
- Product specifications: 25.9x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 2into 4out
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange、blue (handle)
- Material: PA66

FC424

- Electrical parameters: 400V/32A
- Product specifications: 33.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 2into 6out
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange、blue (handle)
- Material: PA66

FC426

- Electrical parameters: 250V/24A 300V/20A⊛
- Product specifications: 20.5x8.5x15.5mm (LX W x H)
- Power supply side: 1.0-2.5mm²"s" AWG 14-12
- Lighting equipment measurement: 0.5-2.5mm²"s+f+st" AWG 20-16
- Can withstand instantaneous peak voltage: 4KV
- Stripping length: (9-11mm) /0.39in
- Connection method: plug-in
- Color: gray
- Material: PA66

FC224-101

- Electrical parameters: 600V/32A
- Product specifications: 35.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 3into 6out
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + blue、Yellow、orange (handle)
- Material: PA66

FC436

- Electrical parameters: 600V/32A
- Product specifications: 48.5x41.4x14.5mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 3into 9out
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + blue、Yellow、orange (handle)
- Material: PA66

FC439

- Electrical parameters: 600V/32A
- Product specifications: 18.5x39.2x14.4mm (LX W x H)
- Applicable wire:0.08-4mm²"f" AWG 28-12
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 3 lines
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC313

- Electrical parameters: 600V/32A
- Product specifications: 43x30.8x8.2mm (LX W x H)
- Applicable wire:0.2-4mm² AWG 28-14
- Can withstand instantaneous peak voltage: 4KV
- Number of channels: 1 bit
- Stripping length: (9-10mm) /0.37in
- Connection method: plug-in
- Color: gray + orange (handle)
- Material: PA66

FC121

Out Door IP 68 CEE Compliance Plug &Socket for Special Electrical Equipment's

2.7 CEE Plug,Socket & Coupler

2.7.1 Panel Mounted CEE Socket


3 pole


4 pole


5 pole

Ampere		3 pole	4 pole	5 pole
16A	IP44	SF1331	SF1431	SF1531
	IP67	SF1332	SF1432	SF1532
32A	IP44	SF3331	SF3431	SF3531
	IP67	SF3332	SF3432	SF3532
63A	IP44	SF6331	SF6431	SF6531
	IP67	SF6332	SF6432	SF6532
125A	IP67	SF5332	SF5432	SF5532

2.7.2 Panel side-mounted CEE Socket


3 pole


4 pole


5 pole

Ampere		3 pole	4 pole	5 pole
16A	IP44	SF1341	SF1441	SF1541
	IP67	SF1342	SF1442	SF1542
32A	IP44	SF3341	SF3441	SF3541
	IP67	SF3342	SF3442	SF3542
63A	IP44	SF6341	SF6441	SF6541
	IP67	SF6342	SF6442	SF6542
125A	IP67	SF5342	SF5442	SF5542

2.7.3 Wall mounted CEE Socket


3 pole


4 pole


5 pole

Ampere		3 pole	4 pole	5 pole
16A	IP44	SF1311	SF1411	SF1511
	IP67	SF1312	SF1412	SF1512
32A	IP44	SF3311	SF3411	SF3511
	IP67	SF3312	SF3412	SF3512
63A	IP44	SF6311	SF6411	SF6511
	IP67	SF6312	SF6412	SF6512
125A	IP67	SF5312	SF5412	SF5512

2.7.4 CEE Interlock Switch Socket


3 pole


4 pole


5 pole

Ampere		3 pole	4 pole	5 pole
16A	IP67	SF1372	SF1472	SF1572
32A	IP67	SF3372	SF3472	SF3572
63A	IP67	SF6372	SF6472	SF6572

Out Door IP 68 CEE Compliance Plug &Socket for Special Electrical Equipment's

Cable 2 Cable Plug &Sockets

2.7.5 CEE Coupler



3 pole 4 pole 5 pole

Ampere		3 pole	4 pole	5 pole
16A	IP44	SF1321	SF1421	SF1521
	IP67	SF1322	SF1422	SF1522
32A	IP44	SF3321	SF3421	SF3521
	IP67	SF3322	SF3422	SF3522
63A	IP44	SF6321	SF6421	SF6521
	IP67	SF6322	SF6422	SF6522
125A	IP67	SF5322	SF5422	SF5522

2.7.6 CEE plug



3 pole 4 pole 5 pole

Ampere		3 pole	4 pole	5 pole
16A	IP44	SF1301	SF1401	SF1501
	IP67	SF1302	SF1402	SF1502
32A	IP44	SF3301	SF3401	SF3501
	IP67	SF3302	SF3402	SF3502
63A	IP44	SF6301	SF6401	SF6501
	IP67	SF6302	SF6402	SF6502
125A	IP67	SF5302	SF5402	SF5502

2.7.7 CEE Concealed plug



3 pole 4 pole 5 pole

Ampere		3 pole	4 pole	5 pole
16A	IP44	SF1351	SF1451	SF1551
	IP67	SF1352	SF1452	SF1552
32A	IP44	SF3351	SF3451	SF3551
	IP67	SF3352	SF3452	SF3552
63A	IP44	SF6351	SF6451	SF6551
	IP67	SF6352	SF6452	SF6552
125A	IP67	SF5352	SF5452	SF5552

2.7.8 CEE Wall mounted plug



3 pole 4 pole 5 pole

Ampere		3 pole	4 pole	5 pole
16A	IP44	SF1361	SF1461	SF1561
	IP67	SF1362	SF1462	SF1562
32A	IP44	SF3361	SF3461	SF3561
	IP67	SF3362	SF3462	SF3562
63A	IP44	SF6361	SF6461	SF6561
	IP67	SF6362	SF6462	SF6562

TV Fridge guard and surge protector

TG-01

Universal / BS / Euro socket

FG-01

N1050 with surge

MCS: Mini-Columns Socket

FZ-551

Aluminum profile stand pole socket with base

FZ-531A/B

Single side 350/660mm aluminum profile

Acryl cover

FZ-532A/B

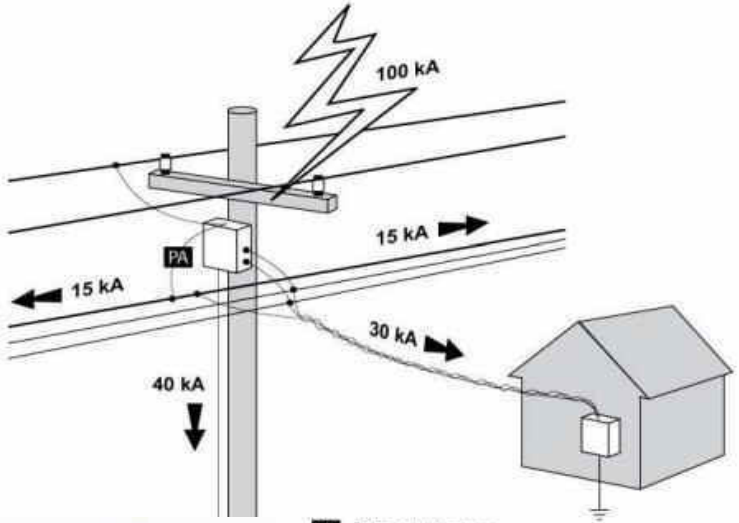
Dual side 350/660mm aluminum profile

FZ-S66

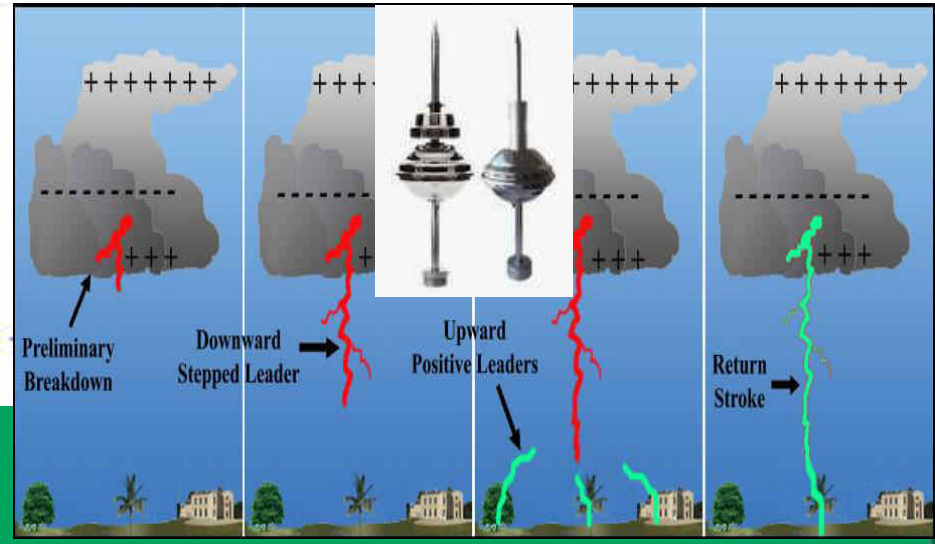
FZ-A66

IP66 power painted stainless steel stand pole

Link Vue System Electrical Safety (Surge Protection, Lightning Protection & Earthing)

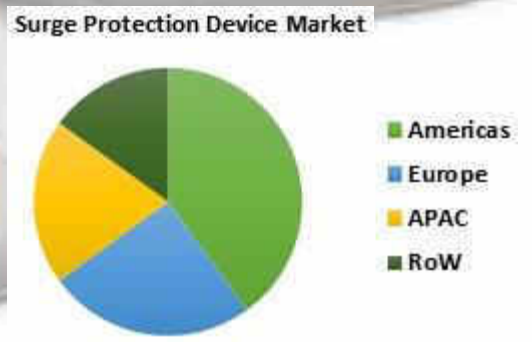


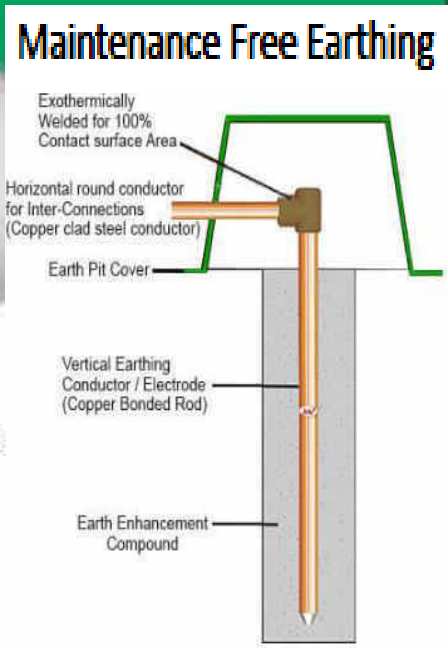
SPT



Lightning Equipotential Bonding Isolating Spark Gaps

Surge protection devices (SPDs) shall be provided for the main electrical distribution system including sub-switch boards and distribution boards, computers, electronic equipment, fire alarm panel, PABX equipment, UPS equipment, CCTV equipment, MATV equipment, card access equipment etc which are susceptible to lightning and switching surges.





Lightning Threat Measure Will Offer Prevention & Require Surge Protection

SPT-SC

Smart Surge Counter

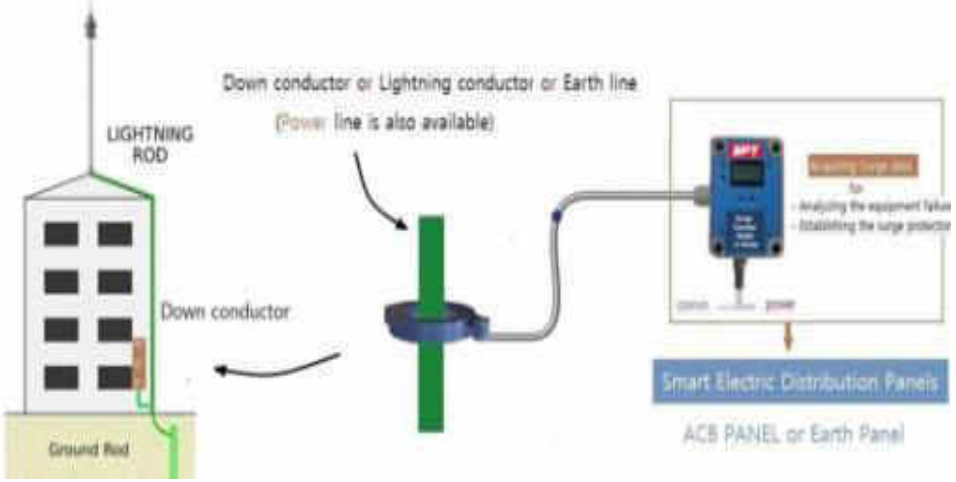
◆ Features

- Measures income Surge Amplitude value
- Records income Surge date and time
- Possible to Set ID NO. to each product
- All data is stored when burnout happens
- be able to Monitoring remotely Surge data From desk manager PC

◆ Technical Data

Electric specification	Models : MSC100/200_A , B
Minimum measurable current	0.3kA
Maximum measurable current	100kA
Operating Voltage	DC 9~15V
The number of storable data	200
Measurement error	+-10%
Operation temperature	-40 ℃ ~ + 60 ℃
IP protection degree	IP 67
Diameter of Surge sensor	55mm
Product body size (except surge sensor)	W*H*D =85*110*75

◆ Installation



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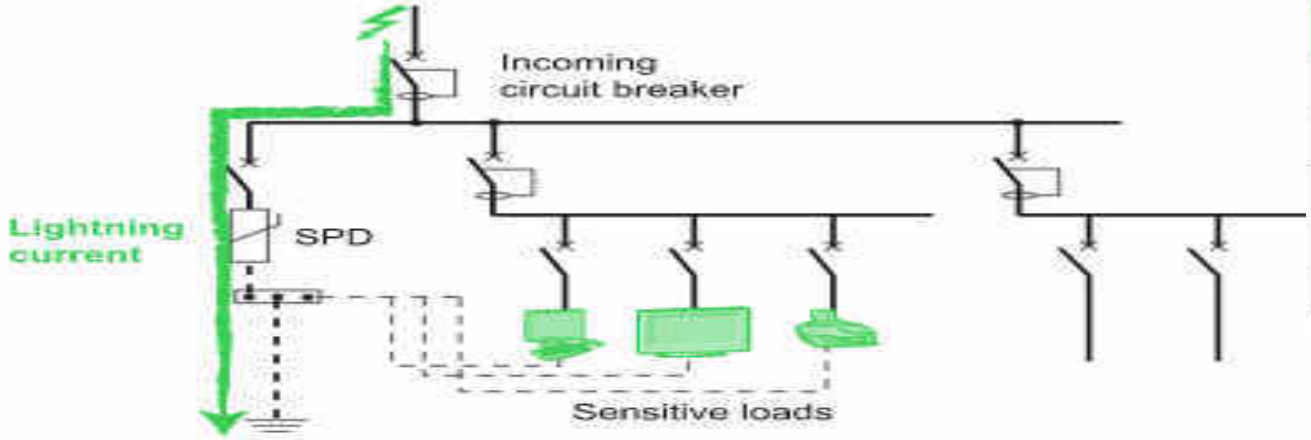
Surge Protection Now with Latest Selection and Installation Guideline

IEC 61643-32:2017 describes the principles for selection, installation and coordination of SPDs intended for use in Photovoltaic (PV) systems up to 1 500 V DC and for the AC side of the PV system rated up to 1 000 V rms 50/60 Hz. The photovoltaic installation extends from a PV array or a set of interconnected PV-modules to include the associated cabling and protective devices and the inverter up to the connection point in the distribution board or the utility supply point. This part of IEC 61643 considers SPDs used in different locations and in different kinds of PV systems:PV systems located on the top of a building. PV systems located on the ground like free field power plants characterized by multiple earthing and a meshed earthing system. The term PV installation is used to refer to both kinds of PV systems. The term PV power plant is only used for extended free-field multi-earthed power systems located on the ground. For PV installations including batteries additional requirements may be necessary.

IEC 61643-12:2020 describes the principles for the selection, operation, location and coordination of SPDs to be connected to 50/60 Hz AC power circuits, and equipment rated up to 1 000 V RMS. These devices contain at least one non-linear component and are intended to limit surge voltages and divert surge currents.



	Direct lightning stroke	Indirect lightning stroke	
IEC 61643-1	Class I test	Class II test	Class III test
IEC 61643-11/2011	Type 1 : T1	Type 2 : T2	Type 3 : T3
EN/IEC 61643-11	Type 1	Type 2	Type 3
Former VDE 0675v	B	C	D
Type of test wave	10/350	8/20	1.2/50 + 8/20

Note 1: There exist T1 + T2 SPD (or Type 1 + 2 SPD) combining protection of loads against direct and indirect lightning strokes.

Note 2: some T2 SPD can also be declared as T3.

SPD is designed to limit transient overvoltages of atmospheric origin and divert current waves to earth, so as to limit the amplitude of this overvoltage to a value that is not hazardous for the electrical installation and electric switchgear and controlgear.

SPD eliminates overvoltages

- in common mode, between phase and neutral or earth;
- in differential mode, between phase and neutral.

In the event of an overvoltage exceeding the operating threshold, the SPD

- conducts the energy to earth, in common mode;
- distributes the energy to the other live conductors, in differential mode.

The three types of SPD

Type 1 SPD

The Type 1 SPD is recommended in the specific case of service-sector and industrial buildings, protected by a lightning protection system or a meshed cage.

It protects electrical installations against direct lightning strokes. It can discharge the back-current from lightning spreading from the earth conductor to the network conductors.

Type 1 SPD is characterized by a 10/350 µs current wave.

Type 2 SPD

The Type 2 SPD is the main protection system for all low voltage electrical installations. Installed in each electrical switchboard, it prevents the spread of overvoltages in the electrical installations and protects the loads.

Type 2 SPD is characterized by an 8/20 µs current wave.

Type 3 SPD

These SPDs have a low discharge capacity. They must therefore mandatorily be installed as a supplement to Type 2 SPD and in the vicinity of sensitive loads.

Type 3 SPD is characterized by a combination of voltage waves (1.2/50 µs) and current waves (8/20 µs).

Products

Surge Protector

Type 1 SPD-lightning current arresters

Combined, spark gap and MOV
Iimp 25 kA / 100 kA Up ≤ 1.5 kV
No follow current, zero leakage current
Full coordination with Type 2 SPD

Type 2 SPD – surge arresters

Combined, spark gap and MOV
U c 75 to 760 V AC
In 20 kA / Imax 40 kA
Up ≤ 1.35 kV

Type 1 and 2 SPD -combined arresters B+C

Combined, spark gap and MOV
Iimp 12.5 kA / 50 kA
Up ≤ 1.5 kV
No follow current, zero leakage current

SPD PV - surge arrester

Combination of MOV and spark gap
PV Type 2 SPD
MOV surge arrester
UCPV 170 to 1500 V DC
In 15 to 20 kA
Imax 40 kA

Surge Protection for Serial and Co-Axial Communication Port

All data, control and telephone cables entering and leaving the communications building require protection. The protection must be placed at the protection boundary and the protective earth connected to station earth. The aim is to divert energy at the boundary.

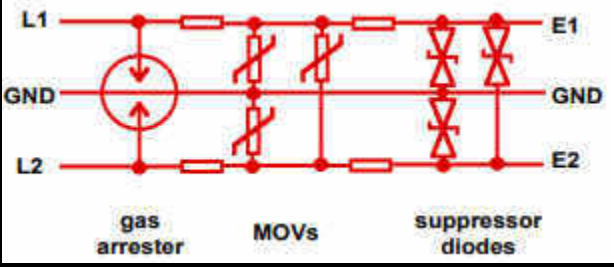
Data circuits require protection dependent upon their operating voltages and currents. Multistage series connected transient barriers should be employed. Figure 21 shows a typical schematic of Surge rating should be 20KA for an 8/20us impulse and the clamping voltage greater than the peak operating voltage.

Telephone lines require protection at the MDF. The protection should be multistage, when used with digital solid state telephone switches. Configuration will depend upon the termination method, eg KRONE®*, ADC, Reiche etc. Protect all incoming lines and external extensions. Generally internal extensions require no protection.

LAN systems require specialised protection specific to the LAN configuration. LAN line cards are particularly sensitive to transient overvoltage's and MUST be protected. Specialised protectors are available for the following protocols:

- RS232 in both DB9 and DB25 connector types
- RS485 and RS422 in DIN rail and DB9 configuration
- Thin Ethernet with in line and protected T BNC configuration
- Thick Ethernet with in line N type and DB15 AUI configuration
- RJ45 for UTP with hub protectors and individual terminal protectors

Ensure all LAN type protectors do not inhibit LAN performance. Only choose CAT5 UTP protectors.



As well as the outer conductors of coaxial feeders the inner conductors must also have protection applied to divert energy on the inner conductor to ground. The application of surge protection to UHF and microwave circuits is limited by frequency, return loss and insertion loss considerations. Typical coaxial surge protectors consist of a fast acting gas filled arrester connected between line and ground. Figure 19 shows a typical coaxial surge protector for type N connectors. This is a bulkhead mounting type.

Arrester flashover voltage should equal twice the peak line voltage. Example in a 50 ohm line with 50W transmitter, peak voltage = 70.7V. Minimum recommended gas arrester BV = 140V. Nearest value = 230V. Surge rating should be 20KA for an 8/20us impulse.

Gas filled arresters are unsuitable for high power HF and VHF transmitters (>= 1KW) unless the transmitters incorporate return power shutdown circuitry. A gas filled arrester once fired will remain in the conducting state by the presence of RF energy. This will destroy the arrester unless the transmitter has shutdown circuitry which detects the impedance discontinuity.

Alternatively utilise spark gap arresters with arc detection and shutdown circuitry.

For microwave link equipment an alternative and more effective solution is the quarter wave stub protector. These units must be tuned to the frequency in use but are capable of reasonably large bandwidth. For example a quarter wave stub protector centred on 2.4GHz has a usable bandwidth of +-100MHz. Figure 20 shows a typical unit.

Smart Earthing Condition Monitoring System

Monitoring the status of grounding system is essential to ensure safety and continuity of service.

SMART EARTHING MONITOR monitors the RESISTANCE and CONTINUITY of a grounding system by remotely sending the measurement data. The periodicity (hourly, daily, weekly) can be set to know in real time the status and proper functioning of the grounding system.

Data treatment through A.I and Deep Learning algorithms allows:

- Identifying degradation signs that may indicate the need for preventive or corrective maintenance.
- Identifying potential dangerous situations or even possible vandalism incidents.
- Optimizing both preventive and corrective maintenance tasks, reducing costs and labor risks
- Monitoring electrical activity in the grounding system according to customer requirements.

Information is sent via M2M communication to both web portal and other channels (e-mail or APP). **SMART EARTHING MONITOR** improves reliability and safety of the grounding system, optimizing its maintenance and periodic verifications in both cost and time.

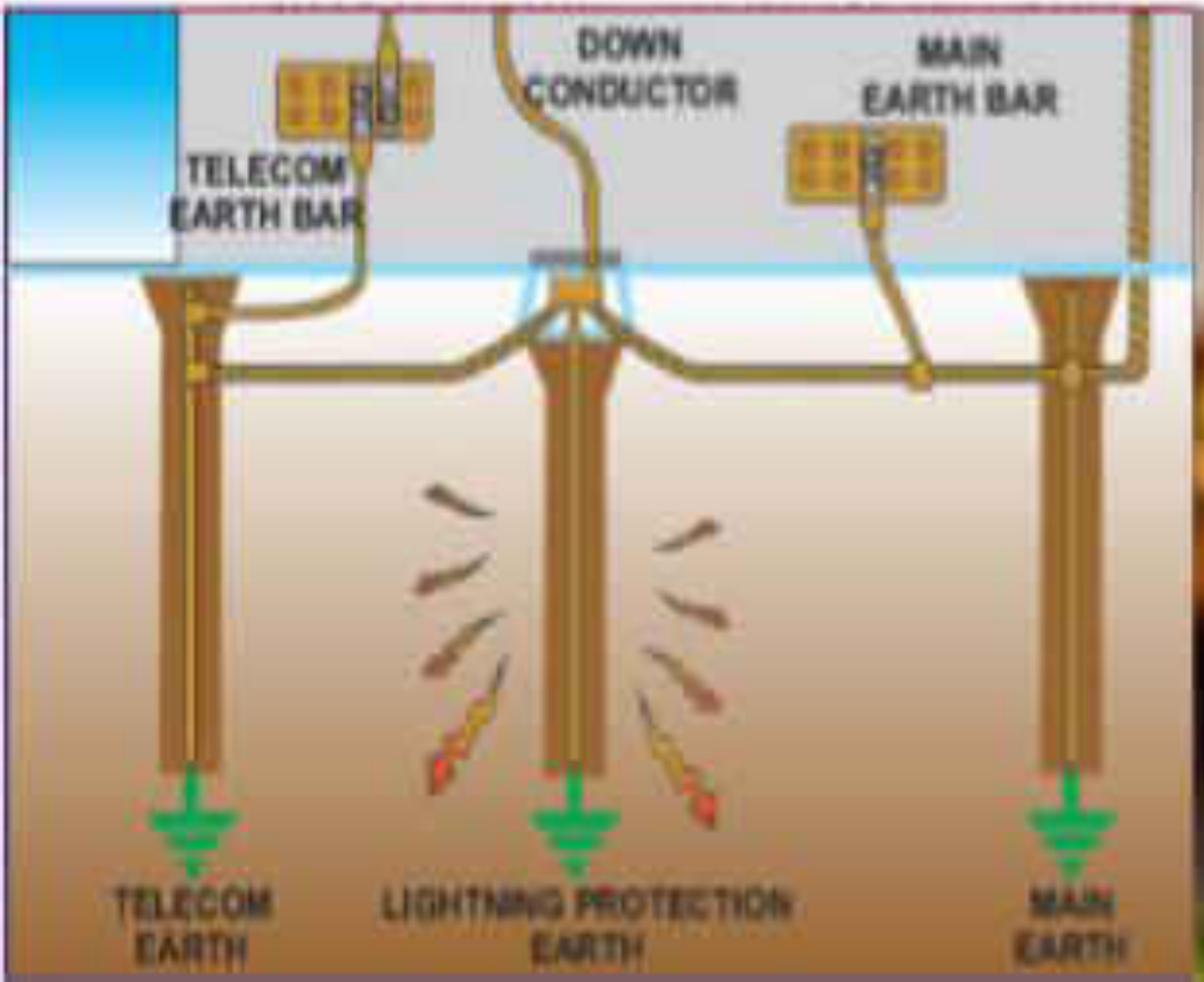
SMART EARTHING MONITOR provides the following advantages:

- Device managing both locally and remotely.
- Customizing warning and alarm criteria.
- Easy to install, without sectioning the down-conductor.
- It Allows to assign different profiles to users.

Earthing is Nothing less than Engineering Follow IS3043(2018),IEEE80,IEC62305

Earthing Distance Maximum 500mtr allowed for Electrical and
300mtrs allowed for Low Voltage Equipment's.

Shortest Discharge Path , Less Joints No Sharp Bend ,Round Conductor for routing Earthing up to Equipment's, all buried Joint should be Exothermic Weld



Sparkgap Protection

Spark gaps are intend to provide galvanic isolation between electrical installation parts where direct connections are not permitted. The galvanic isolation prevents not only electrochemical corrosion but provides also a connection capable of carrying lightning current. For connecting different earthing systems, the aim being to make optimum use of all earthers for lightning protection equipotential bonding.

Earthing Distance Maximum 500mtr allowed for Electrical and

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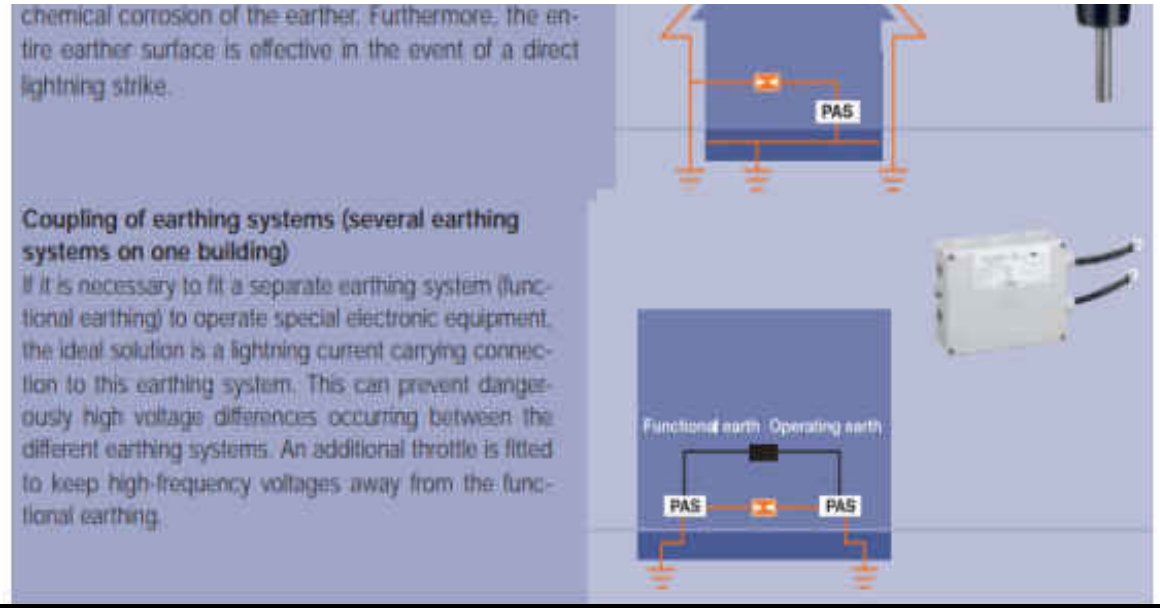


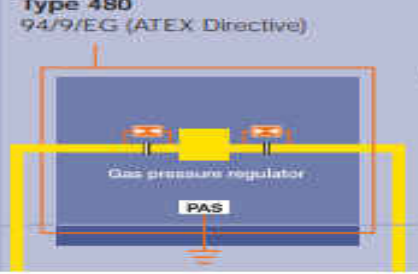
Spark Gap and Earthing One Step More Protection from Surge and Lightning

Spark gaps are intended to provide galvanic isolation between electrical installation parts where direct connections are not permitted. It's Provide Discharge of Earthing also a connection capable of carrying lightning current.

For connecting different Earthing Systems Structure, Grid and Equipotential Earthing, the aim being to make optimum use of all earthers for lightning protection equipotential bonding.

Isolating spark gaps for insulating flange (e.g. in a gas pressure control station)
(Isolating spark gap for the Ex-area) Type 480 isolating spark gap is highly suitable for the bridging of insulating flanges or insulating bolted connections (lightning current-carrying capable), especially in potentially explosive areas.

Type 480
94/9/EG (ATEX Directive)

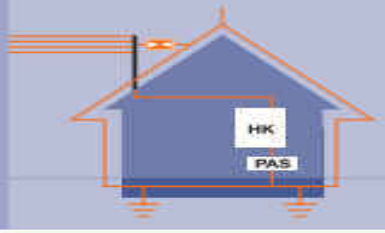


Isolating spark gaps for potential isolation (several earthing systems on one building)
If a building has two earthing systems – e.g. foundation earth electrode and earthing rod – these can be connected together via an isolating spark gap. In contrast to a direct electrical connection, this prevents electrochemical corrosion of the earther. Furthermore, the entire earther surface is effective in the event of a direct lightning strike.

Type 481

Over head connection (roof standard spark gaps for insulation)
With an over head line connection, the roof mast of a low-voltage open-wire line should have the largest possible distance to the lightning protection system. If this distance is less than half a metre, an enclosed protective spark gap must be integrated. The approval of the responsible energy supply company is required for the connection with the roof mast.

Type 482



Coupling of earthing systems (several earthing systems on one building)
If it is necessary to fit a separate earthing system (functional earthing) to operate special electronic equipment, the ideal solution is a lightning current carrying connection to this earthing system. This can prevent dangerously high voltage differences occurring between the different earthing systems. An additional throttle is fitted to keep high-frequency voltages away from the functional earthing.

Type FS-V20

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