SURGE PROTECTION
APPLICATION MANUAL 3

INDUSTRIAL

HOSPITAL

TERTIARY

PHOTOVOLTAIC

WIND POWER PLANT

CELLULAR DATA

EV CHARGING STATION

ZOTUP®
INNOVATIVE SURGE PROTECTION

MADE IN ITALY

ZOTUP® INNOVATIVE SURGE PROTECTION

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WHO WE ARE

THE COMPANY

ZOTUP is our company. Since 1986 we focus our efforts on the development of solutions for surge protection and on the production of Surge Protective Devices. We strive to serve our customers with highest quality products and services.

ZOTUP's values are pure and simple.

SAFETY	Our ambition and goal is to provide products that **protect people, their property and their working environment.**
QUALITY	Only through the **quality of our products** we can meet our promise.
INNOVATION	Continuous further development is the heartbeat of **ZOTUP**. Cutting -edge products are the answer to our customers needs.

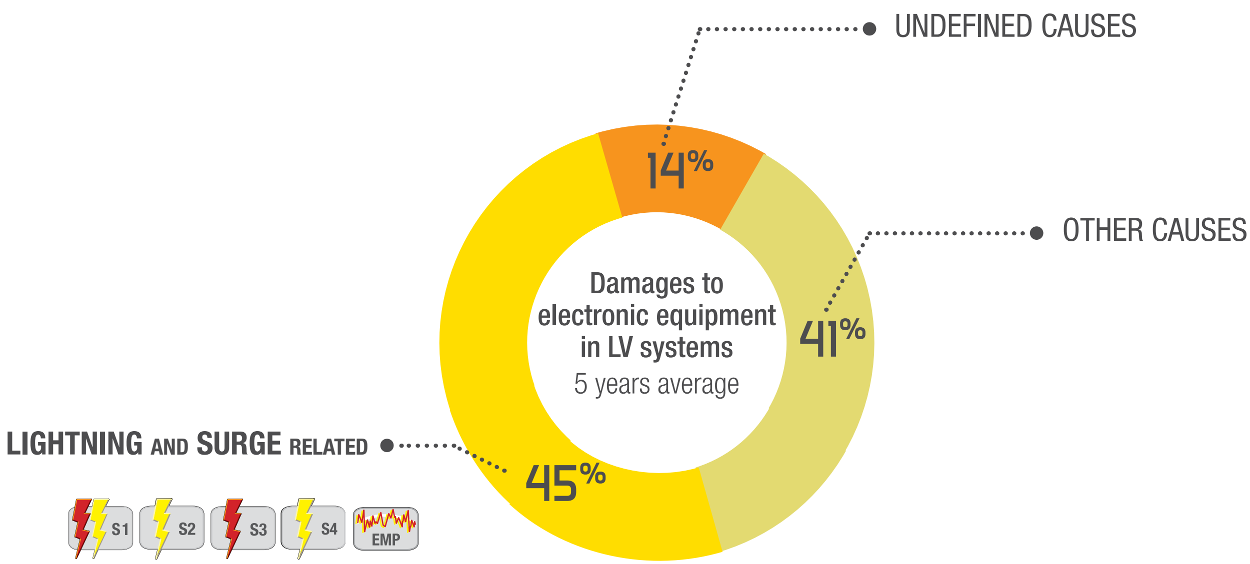
By means of these values, we at **ZOTUP** want to keep track with the market, today and tomorrow.

YOUR SAFETY, OUR GOAL

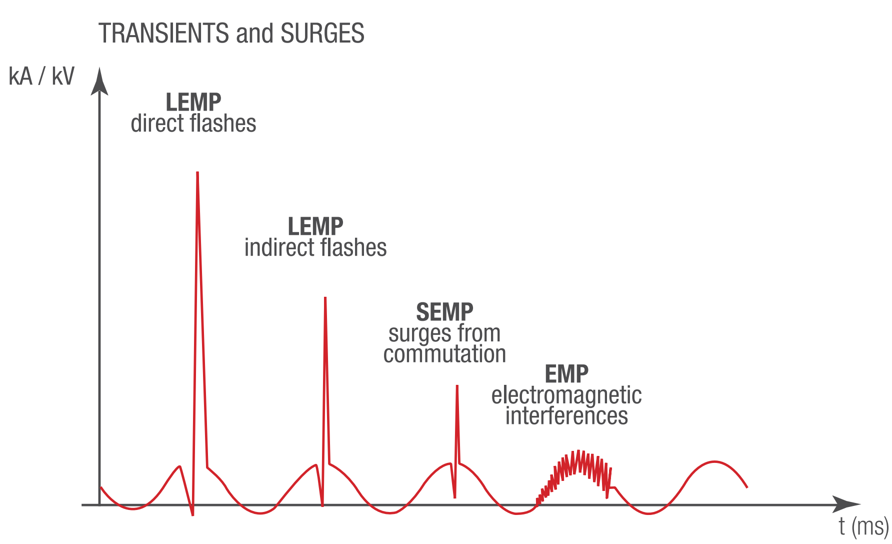
SURGE PROTECTIVE DEVICES - WHY?

REQUIRED BY HD 60364-4-443 AND BY THE EN 62305 SERIES OF STANDARDS FOR PROTECTION AGAINST TRANSIENT OVERVOLTAGES OF ATMOSPHERIC ORIGIN.

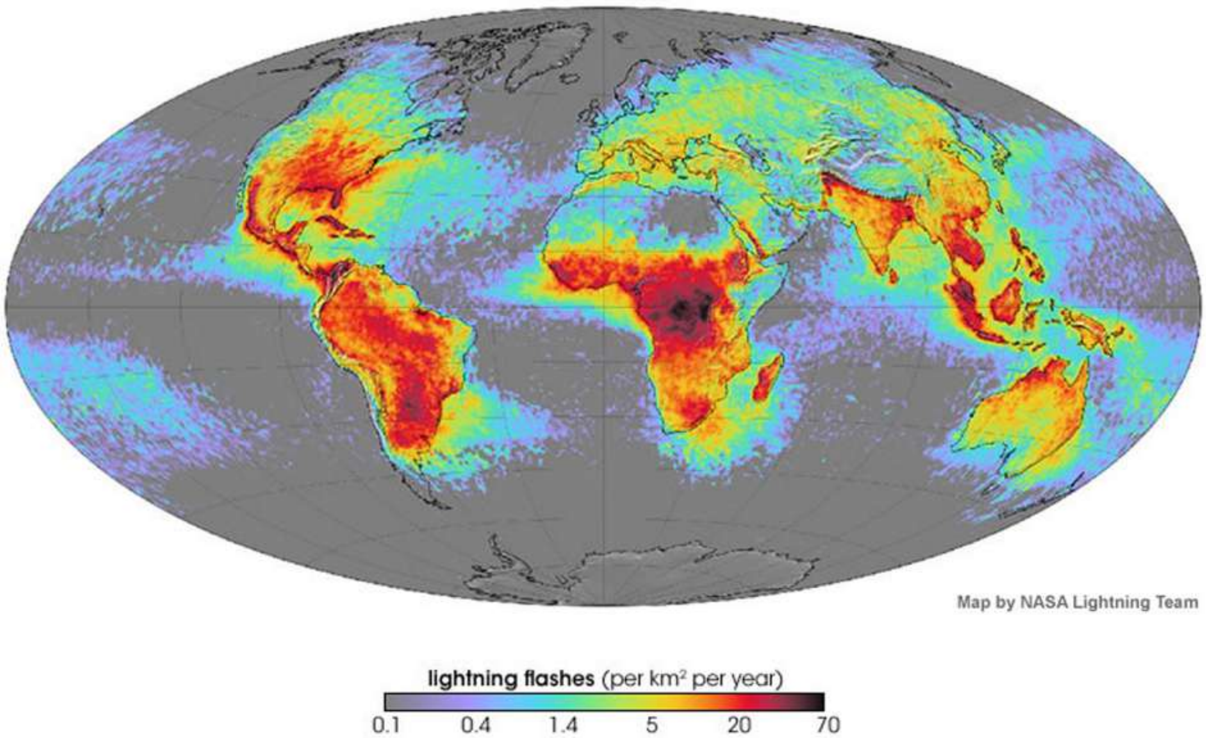
In the Internet era and with the exponentially increasing use of electrical and electronic equipment containing sensitive integrated circuits and semi-conductors with high cost implication in case of damage, increasing attention to transient phenomena of atmospheric origin and to the resulting surges within the electric distribution systems and installations is required. The statistical analysis of damages published by insurance companies irrefutably demonstrates the dimension of the problem. The costs of damage and downtime due to these transient effects has the same order of magnitude as the costs of civil crime.
To prevent damages to people and equipment, to ensure continuity of the electrical supply and of communication services and to avoid the corresponding economic loss due to presence of such interferences, the realisation of highly effective protection measures for structures and buildings in the public, industrial and tertiary care infrastructure as well as for private premises is essential.



source: German Insurance Association (GDV); Berlin - 2009.



LIGHTNING GROUND FLASH DENSITY



Source: Article by Hobart M. King.

NASA has satellites orbiting the Earth with sensors designed to detect lightning and collect data, which is transmitted to Earth, plotted geographically and used to construct a geographic record of lightning activity over time. The map above shows the average yearly counts of lightning per square kilometer based on data collected by NASA's Lightning Imaging Sensor on the Tropical Rainfall Measuring Mission satellite between 1995 and 2002. Places where less than one lightning occurred (on average) each year are gray or light purple; places with the largest number of lightning flash are deep red, grading to black.
Globally, there are about 40 to 50 lightning every second, or nearly 1.4 billion of lightning per year. These electrical discharges are powerful and deadly. Each year, lightning not only kill people and wildlife but are also responsible for billions of dollars in damage to buildings, communication systems, power lines, electrical equipment and billions of dollars per year in flight rerouting and delays. Thus, maps showing the distribution of lightning across the Earth – which is far from uniform - are important for economic, environmental and safety reasons. The ideal conditions for the appearance of lightning and associated thunderstorms occur where warm, moist air rises and mixes with cold air above: the heated land surface warms the air above it, and that warm air rises to encounter cold air aloft. The interaction between air masses of different temperature stimulates thunderstorms and lightning. These conditions occur almost daily in many regions on Earth, but only rarely in other regions. Moreover, much more lightning occurs over land than over the ocean because daily sunshine heats the land surface faster than the ocean. More lightning occurs near the equator than at the poles because not only the latter's frozen surfaces are not effectively warmed by the sun to produce convection but also there is very little moisture in polar air.

DENSITY OF LIGHTNING FLASHES TO THE GROUND N_G

The ground flash density N_G is the number of lightning flashes per km^2 per year. These values are provided by recording of all the flashes detected by the corrresponding lightning location system (LLS) that covers the territory. The detection data registered by the LLS must be collected and processed, in order to calculate the annual number of dangerous events N_x according to EN 62305-2. It is sufficient to provide the geographical coordinates (latitude/longitude) to retrieve the corresponding value of N_G. The ground flash density values are drawn from National databases where available. Where no such database is available, the standard IEC 62858 Ed.2 (2019-10) recommends to obtain the N_G by multiplying the N_t (total density of optical recorded flashes per km^2 per year from NASA website) by 0,25.

REFERENCE STANDARDS

Awareness, that transient surges are the main influencing factor of the MTBF (Mean Time Between Failures) of systems and equipment, is driving all manufacturers in the area of surge protection to continuously develop new overvoltage protective devices with increasing features and in compliance with the actual national and International standards.
The following is a list of the key standards involved:

IEC 61643-11 Ed. 1 (2011-03)
EN 61643-11 (2012-10)

Low-voltage surge protective devices:

Part 11: Surge protective devices connected to low-voltage power systems.

Requirements and test methods.

IEC 61643-12 Ed. 3 (2020-05)
CLC/TS 61643-12 (2009)

Surge protective devices connected to low-voltage power systems. Selection and application principles.

IEC 61643-21 Ed. 1.2 (2012-07)
EN 61643-21 +A1 +A2 (2001/2009/2013)

Low-voltage surge protective devices.

Part 21: Surge protective devices connected to telecommunications and signalling networks. Performance requirements and testing methods.

IEC 61643-22 Ed. 2 (2015-06)
CLC/TS 61643-22 (2016)

Surge protective devices connected to telecommunications and signalling networks. Selection and application principles.

IEC 61643-31 Ed. 1 (2018-01)
EN 61643-31 (2019-10)

Surge protective devices.

Part 31: SPDs connected to the d.c. side of photovoltaic applications. Requirements and tests methods.

IEC 61643-32 (2017-09)
CLC/TS 51543-32 (2020)

Low-voltage surge protective devices connected to the d.c. side of photovoltaic installations. Selection and application principles.

IEC 62305 series Ed. 2 (2010-12)
EN 62305 series (2011/2012)

Protection against lightning.

Part 1: General principles;
Part 2: Risk management;
Part 3: Physical damage to structures and life hazard;
Part 4: Electrical and electronic systems within structures.

IEC 60364-5-534 (2015-09)
HD 60364-5-534 (2016-02)

Low-voltage electrical installations.

Part 5-53: Selection and erection of electrical equipment. Isolation, switching and control. Clause 534: Devices for protection against transient overvoltages.

IEC 61000-4-5 Ed. 3 (2014-05)
EN 61000-4-5 (2014)

Electromagnetic compatibility (EMC).

Part 4-5: Testing and measurement techniques. Surge immunity test.

IEC 61439 series
EN 61439 series

Low-voltage switchgear and controlgear assemblies.

IEC 61439-1(2020) / EN 61439-1 (2011)
Part 1: General rules.

IEC 61439-2 (2011) / EN 62439-2 (2011)
Part 2: Power switchgear and controlgear assemblies.

IEC 61439-3 (2012) / EN 62439-3 (2012)+AC (2019)
Part 3: Distribution boards intended to be operated by ordinary persons (DBO).

IEC 61439-4 (2012) / EN 62439-4 (2013)
Part 4: Particular requirements for assemblies for construction sites (ACS).

IEC 61439-7 (2018) / EN IEC 61439-7 (2020)
Part 7: Assemblies for specific applications such as marinas camping sites, market squares, electric vehicle charging stations.


IEC 61643-31
Edition 1.0 2018-01
IEC
INTERNATIONAL STANDARD
NORME INTERNATIONALE
colour inside
Low-voltage surge protective devices –
Part 31: Requirements and test methods for SPDs for photovoltaic installations
IEC 61643-11
Edition 1.0 2011-03
IEC
INTERNATIONAL STANDARD
NORME INTERNATIONALE
colour inside
Low-voltage surge protective devices –
Part 11: Surge protective devices connected to low-voltage power systems –
Requirements and test methods
NORMA ITALIANA CEI
Norma Italiana
CEI 64-8/1
La seguente Norma è identica a: HD 60364.1:2008-08.
Data Pubblicazione
2021-08
Titolo
Impianti elettrici utilizzatori a tensione nominale non superiore a 1 000 V in corrente alternata e a 1 500 V in corrente continua
Parte 1: Oggetto, scopo e principi fondamentali
Title
Low-voltage electrical installations
Part 1: Fundamental principles

Knowledge of some basic technical terms and definitions associated with SPDs will facilitate an understanding of the contents of this catalogue.
Please find below a selection of the most important.

TT System

Technique for the protection of persons: the exposed conductive parts are earthed and residual current devices (RCDs) are used.

TN System

Technique for the protection of persons: interconnection and earthing of exposed conductive parts and the neutral are mandatory.

IT System

Technique for the protection of persons:
- Interconnection and earthing of exposed conductive parts;
- Indication of the first fault by an insulation monitoring device (IMD);
- Interruption for the second fault using overcurrent protection (circuit-breakers or fuses).

SPD test class I (IEC) or Type 1 (EN)

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

SPD test class II (IEC) or Type 2 (EN)

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

SPD test class III (IEC) or Type 3 (EN)

SPD tested with combination wave.

Voltage switching type SPD (GAP)

SPD that has a high impedance when no surge is present, but can have a sudden change in impedance to a low value in response to a voltage surge. Common examples of components used in such SPDs are spark gaps, gas tubes and thyristors.

Voltage limiting type SPD

SPD that has a high impedance when no surge is present, but will reduce it continuously with increased surge current and voltage.
Common examples of components used in such SPDs are varistors and avalanche diodes.

Combination type SPD

SPD that incorporates both, voltage switching components and voltage limiting components.
The SPD may exhibit voltage switching, limiting or both.

N-PE SPD

SPD intended exclusively for application between N and PE conductors in an installation.

Mode of protection (of a SPD)

An intended current path, between terminals that contains protective components, e.g. line-to line, line-to-earth, line-to-neutral, neutral-to-earth.

Multipole SPD

SPD with more than one mode of protection, or a combination of electrically interconnected SPDs offered as a unit.

Maximum Continuous Operating Voltage (U_c)

Maximum r.m.s. voltage, which may be continuously applied to the SPD's mode of protection. This is comparable to the nominal voltage of other installation devices.

Impulse discharge current (I_{imp})

Crest value of a discharge current through the SPD with specified charge transfer Q and specified energy W/R in the specified time.
This characterises an SPD as test class I or type 1. The characteristic waveform is 10/350 µs.

Nominal discharge current (I_n)

Crest value of the current through the SPD with a current waveshape of 8/20 µs.This characterises an SPD as test class II or type 2.

Maximum discharge current (I_{max})

Crest value of a current through the SPD having an 8/20 µs waveshape and magnitude according to the manufacturers specification.
Imax is an optional parameter.
This parameter should not be considered for the selection of SPDs.

Discharge current (I_d)

Presumed maximum crest value of the current through the SPD when subjected to a combination wave with an open circuit voltage equal to U_{oc}.
The real current through the SPD will always be lower than I_{SC}.

Total discharge current (I_{Total})

Current which flows through the PE or PEN terminal of a multipole SPD during the total discharge current test.

Short-circuit current rating (I_{sccr})

Maximum prospective short-circuit current from the power system for which the SPD, in conjunction with the disconnector specified, is rated.

Follow current (I_f)

Peak current supplied by the electrical power system and flowing through the SPD after a discharge current impulse.

Follow current interrupt rating (I_{fi})

Prospective short-circuit current that an SPD is able to interrupt without operation of a disconnector.

No Follow Current® (NFC)

An SPD design not causing any follow current.
SPDs with NFC-technology avoid any undesired current stress to disconnectors and protective devices upstream the SPD.

Open circuit voltage (U_{OC})

Open circuit voltage of the combination wave generator at the point of connection of the device under test.

(Voltage) protection Level (U_p)

Maximum voltage to be expected at the SPD terminals due to an impulse stress with defined voltage steepness and an impulse stress with a discharge current with given amplitude and waveshape.

Noise level attenuation (dB)

Reduction of the noise caused by electromagnetic interferences, both in common and differential mode.

Temporary Overvoltage (TOV)

Power frequency overvoltage of relatively long duration. A temporary overvoltage is undamped or weakly damped.

SPD behaviour in case of Temporary Overvoltages TOV (U_T)

- Withstand without damage: withstand (W);
- or fail in a safe way, maintaining its IP degree: safe (S).

Status Indicator

Device that indicates the operational status of an SPD or a part of an SPD. Such indicator may be local visual and may have remote signalling and output contact capability. Intermediate stages of the status indicator may also be provided e.g. for preventive maintenance, before it has reached its end of life.

Pollution Degree (PD)

Numeral characterizing the expected pollution of the relevant environment.

P.D. 1: No pollution or only dry, non-conductive pollution.

P.D. 2: Only non-conductive pollution, except an occasionally temporary conductivity caused by condensation.

P.D. 3: Conductive pollution or dry non-conductive pollution which becomes conductive due to expected condensation.

PARAMETERS FOR SPD SELECTION

The parameters to be considered for SPD selection are many. The main ones are:

- Suitability for the power distribution system (TN, TT, IT);
- Maximum Continuous Operating Voltage (U_c);
- Behaviour in case of TOV (U_T);
- SPD Type (and impulse current / voltage) T1 T2 T3;
- Short circuit current rating (I_{sccr});
- Back-up protection OCPD (fuse);
- Follow current interrupt rating (I_{fi});
- Voltage protection level (U_p);
- Pollution Degree;
- Response time (t_a).

Maximum Continuous Operating Voltage U_c:
This is the maximum r.m.s. voltage, which may be continuously applied to the SPD's mode of protection.
It is selected depending on:

- the nominal voltage of the circuit to be protected;
- the low voltage distribution system (TN, TT, IT);
- the required modes of protection (phase to earth; phase to neutral; neutral to earth).

Recommended U_c values for 230/400 V plants in the different power distribution systems.
By respecting these values, the behaviour of failure mode in caso of TOV improves.

SPD	TN-system	TT-system	IT-systems
phase to neutral	Uc ≥ 335 V	Uc ≥ 335 V	Uc ≥ 335 V (1)
phase to earth	Uc ≥ 335 V	Uc ≥ 400 V	Uc ≥ 400 V
neutral to earth	-	Uc 255 V (2)	Uc 255 V (2)

(1) only for systems with distribuited neutral - (2) tested for a TOV of 1200 V for 200 ms

Behaviour in case of Temporary Overvoltage TOV (U_T), in accordance with IEC 61643-11:

Application	Test parameters of the TOV		
SPDs connected to:	For t_T = 5 s (Faults within the LV-system in the consumer installation) (requirements in 7.2.8.1 and test in 8.3.8.1)	For t_T = 120 min (Faults within the LV-system in the distribution system) (requirements in 7.2.8.1 and test in 8.3.8.1)	For t_T = 200 ms (Faults within the HV system) (requirements in 7.2.8.2 and test in 8.3.8.2)
	Withstand* mode required	**Withstand*** mode or **safe**** failure mode	**Withstand*** mode or **safe**** failure mode
	Test values of the TOV U_T (V)		
TN Systems			
Connected L-(PE)N o L-N	1,32 x U_{REF}	√ 3 x U_{REF}	-
Connected N-PE	-	-	-
Connected L-L	-	-	-
TT Systems			
Connected L-PE	√ 3 x U_{REF}	1,32 x U_{REF}	1200 + U_{REF}
Connected L-N	1,32 x U_{REF}	√ 3 x U_{REF}	-
Connected N-PE	-	-	1200
Connected L-L	-	-	-
IT Systems			
Connected L-PE	-	-	1200 + U_{REF}
Connected L-N	1,32 x U_{REF}	√ 3 x U_{REF}	-
Connected N-PE	-	-	1200 + U_{REF}
Connected L-L	-	-	-

* **Withstand mode (W):** the SPD withstands without being damaged! This is the optimal condition.

** **Safe failure mode (S):** the SPD is damaged and behaves in a safe way, without burning and maintaining its IP degree. This is the minimum acceptable condition, which involves the loss of the protection.

SPD test classes I, II, III / Types T1 T2 T3

Surge protective devices are tested in accordance with the classification and parameters provided by the manufacturer. Depending on the intended application, according to HD 60364-5-534 or the EN 62305 series, there are three different test classes corresponding to three types of SPDs:

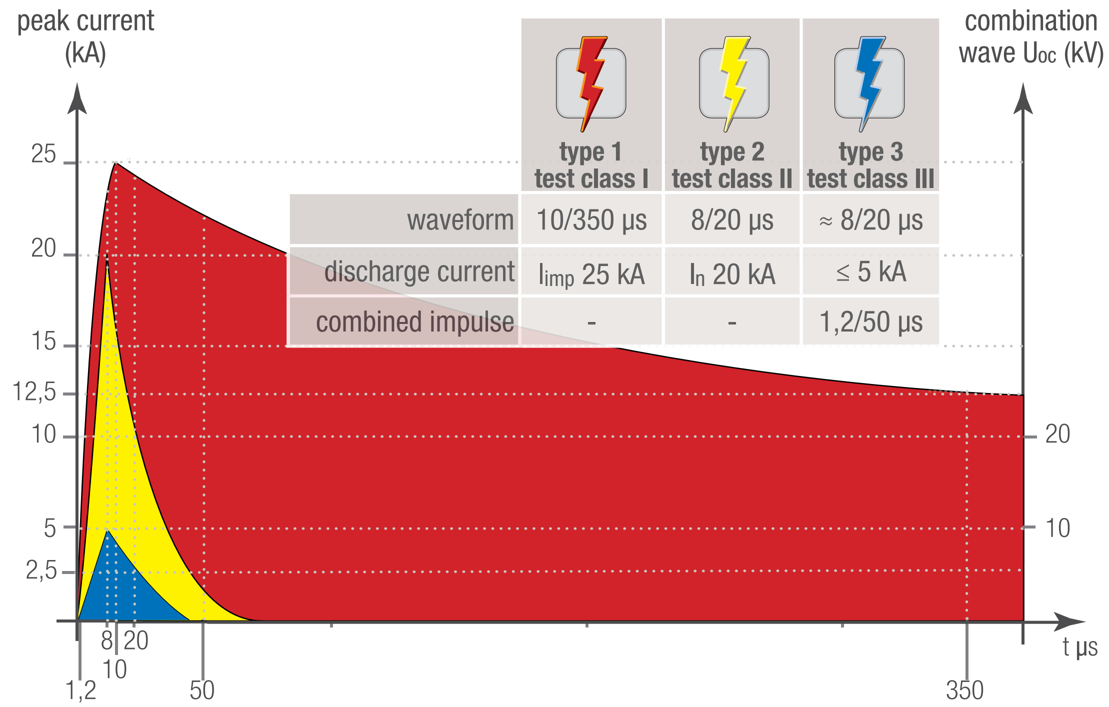
Type of SPD	*IEC 61643-11 (2011-03)*	*EN 61643-11 (2012-10)*	*SPD icon*
SPD for lightning equipotential bonding	SPD test class I	SPD type 1 T1	
SPDs for protection against transient overvoltages	SPD test class II	SPD type 2 T2	
SPDs for protection against transient overvoltages and for equipment protection	SPD test class III	SPD type 3 T3	
SPDs with filter for enhanced equipment protection	IEC 61000-4-5	EN 61000-4-5	

- SPD type 1: tested with the impulse discharge current I_{imp} (typically 10/350 µs) and with 8/20 µs current impulses;

- SPD type 2: tested with the nominal discharge current I_n (8/20 µs) and optional with the maximum discharge current I_{max} (8/20 µs). *Imax should not be considered for choosing an SPD.* When containing any voltage switching components SPDs type 1 and type 2 are additionally tested with 1,2/50 µs voltage impulses;

- SPD type 3: tested with a combination wave generator providing an open circuit voltage U_{oc} (1,2/50 µs) and a defined short circuit current I_{cw} (8/20 µs) with a fictive nominal output impedance of 2 Ω.

Maximum preferred discharge current values for type 1, type 2 and type 3 SPDs in accordance with EN 61643-11



Short circuit withstand capability (short circuit current rating I_{sccr}):
During the normal operation of overvoltage protectiove devices, the SPD provides a high impedance at nominal system voltage and rated frequency. In case an SPD reaches its end-of-life in a low impedance state, the resulting short-circuit current must be interrupted. This interruption may be provided by an SPD internal disconnector or in conjunction with an external disconnector, e.g. a fuse.
When the SPD manufacturer provides information about a maximum allowed backup fuse rating, any alternative overcurrent protective device, like e.g. MCBs or circuit breakers, must be considered very carefully, because such devices may not provide the required impulse withstand, specifically in applications where type 1 SPDs are required and partial lightning currents are to be expected.
If other kinds overcurrent protective devices than the ones recommended by the SPD manufacturer are used, this is under the full responsibility of the installer. Furthermore the higher internal impedance of such other devices compared to a fuse may add to the voltage drop under surge conditions and may therefore worsen the effective voltage protection level for the installation and equipment.

Follow current interrupt rating I_{fi}:
This rating only exists in the IEC 61643-11 and relates to SPD constructions, which generally cause a follow current from the power supply after discharge current flow, and describes the ability of such SPDs to self-extinguish such follow current without operation or alteration of any disconnector. Important for correct understanding is, that this parameter does not provide a real current value that gets interrupted by the SPD, but the maximum prospective short circuit current that may be available at the SPD's point of installation, at which any expected follow current will be self-extinguished by the SPD.
While IEC 61643-11 allows this follow current interrupt rating I_{fi} to be lower than the short-circuit current rating I_{sccr}, EN 61643-11requires this rating to be equal to the short-circuit current rating I_{sccr}. But both installation rules, IEC 60364-5-534 as well as HD 60364-5-534, require that the follow current interrupt rating must be equal or higher than the maximum available short circuit current from the power system at the SPD's point of installation.

NFC No Follow Current®:
Thanks to their design characteristics, SPDs with **No Follow Current®** technology **(NFC)**, completely avoid the flow of follow currents from the power system at all, and therefore also limit the impulse stress to disconnectors (e.g. fuses) and upstream protective devices in the installation to a minimum. Thus resulting in a lower risk of supply outages.

Voltage Protection level U_p:
This parameter is defined as the maximum instantaneous voltage value at the SPD's terminals during its intended operation under defined impulse stress conditions. Depending on the construction and the type of components used in the SPD this protection level corresponds to:

- for voltage Limiting SPDs: the residual voltage at nominal discharge current (8/20 µs) for type 2 SPDs or the residual voltage at a discharge current (8/20 µs), with a crest value of I_{imp} for type 1 SPDs;
- for voltage switching and combination SPDs: the limiting voltage at 1,2/50 µs voltage impulses and the residual voltage as above, whatever is higher, or the limiting voltage at hybrid generator impulses.

The protection level provided by SPDs must be compared to the impulse voltage withstand of the equipment to be protected, also taking into consideration the distances between these SPDs and the equipment.

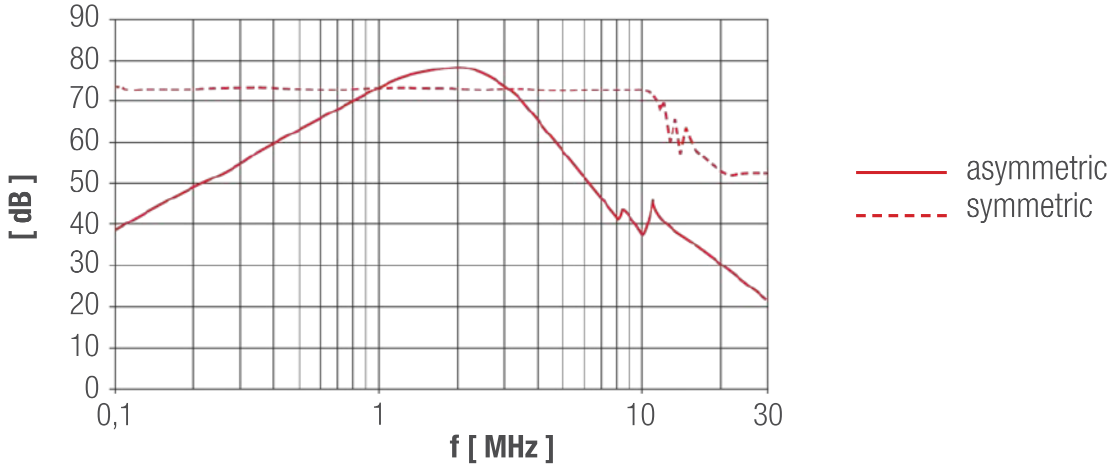
Response time t_a:
In EN 61643-11 the response time of SPDs is not directly addressed, but only an implicit factor when testing for the limiting voltage of voltage switching or combination SPDs. However, for semiconductors even very short peaks can be harmfull and therefore the response time of SPDs is not of secondary importance. The phenomena of transient overvoltages in equipment is usually in the order of some ten **µs**, the response time of voltage limiting SPDs is in the order of some to some ten **ns**, but the time before damage may occur to some categories of semiconductors is in the order of **ps**.
This leads to the simple statement: the shorter the SPDs response time is, the better is the overall protection function the SPD provides.

Coordination of SPDs:
The best effectiveness of SPDs can only be ensured through appropriate coordination of all SPDs with regard to the voltage protection level and the energy absorption. The necessary information to enable such coordination of SPDs can only be provided by the manufacturer, because the specific SPD design and construction may have a significant influence here. The larger an electrical system is, the more difficult and complex it is to achieve proper coordination because of the increasing distances, and therefore increasing conductor length and impedances, between the SPDs and the parts of the installation and the equipment to be protected, which may cause the various SPDs installed to operate independently from each other.

Total discharge current (I_{total} 10/350 and I_{total} 8/20):
This parameter is intended to specify and test for the maximum surge current stress in the terminal and related components of a multipole SPD, which are connected to PE. This is necessary to check for the accumulating effects and stress factors when several or even all modes of protection of an SPD are operated, because all other tests are performed on single modes of protection, only I_{total} is particularly important for SPDs of type 1 as the stresses expected in a lightning equipotential bonding system are common mode, meaning impulse currents flowing simultaneously in all active conductors, as indicated in EN 62305-1 and -4.

Noise level attenuation:
This is realised by filters for limiting the electromagnetic interferences in the range of 150 kHz – 30 MHz, both in common and line to line mode, which show a specific characteristic to reach that protective behaviour. Such filters are added as an additional feature to advanced SPD designs for providing extensive protection against transients and all kinds of conducted interferences, with the aim of reaching electromagnetic compatibility (EMC) in a wide frequency range.

Filter characteristics showing the asymmetric and the symmetric attenuation curve



Pollution Degree:
The basic safety publication EN 60664-1 for insulation coordination for equipment within low voltage systems specifies and classifies four pollution degrees, whereby the micro-environmental conditions of the insulation must be taken into account for construction. Micro environment in this context means the immediate environment of the insulation, as compared to the macro environment, which describes the environment of the room or location where the equipment is installed. The micro environment often depends primarily on the macro environment and they are essentially identical.
Classification of pollution degrees (PDs):
PD 1: No pollution or only dry, non-conductive pollution.
PD 2: Only non-conductive pollution, except an occasionally temporary conductivity caused by condensation.
PD 3: Conductive pollution or dry non-conductive pollution which becomes conductive due to expected condensation.
This design parameter of an SPD should be thoroughly checked to determine its suitability for a specific application. As a general guideline for domestic applications pollution degree 2 applies and for industrial applications pollution degree 3 applies. It may require particular attention in outdoor locations or under severe environmental conditions. e.g. for photovoltaic installations, public lighting and wind farms, industrial environments such as steel mills, cement factories.

SELECTION OF SPDS ACCORDING TO THE EXPECTED IMPACT

The standard series IEC and EN 62305 defines lightning flashes to various points as so called sources of damage. Such damage may e.g. be to a structures, to services, to installations or equipment. The installation of SPDs within the electric distribution system can significantly reduce the risk of such damages to services, to installations or equipment. Electromagnetic interferences are also a potential source of damage, the risk of which can be reduced by the installation of SPDs with additional filter.

Source of damage	*Source of damage*	*Effect Icon*	*Selection of SPD*
Flash to the structure	S1		T1 and T2
Flash near the structure	S2		T2 and/or T3
Direct flash to the service	S3		T1 and T2
Indirect flash to the service	S4		T2 and/or T3
Interference on the service	EMP		T1 and /or T2 and /or T3 +FILTER

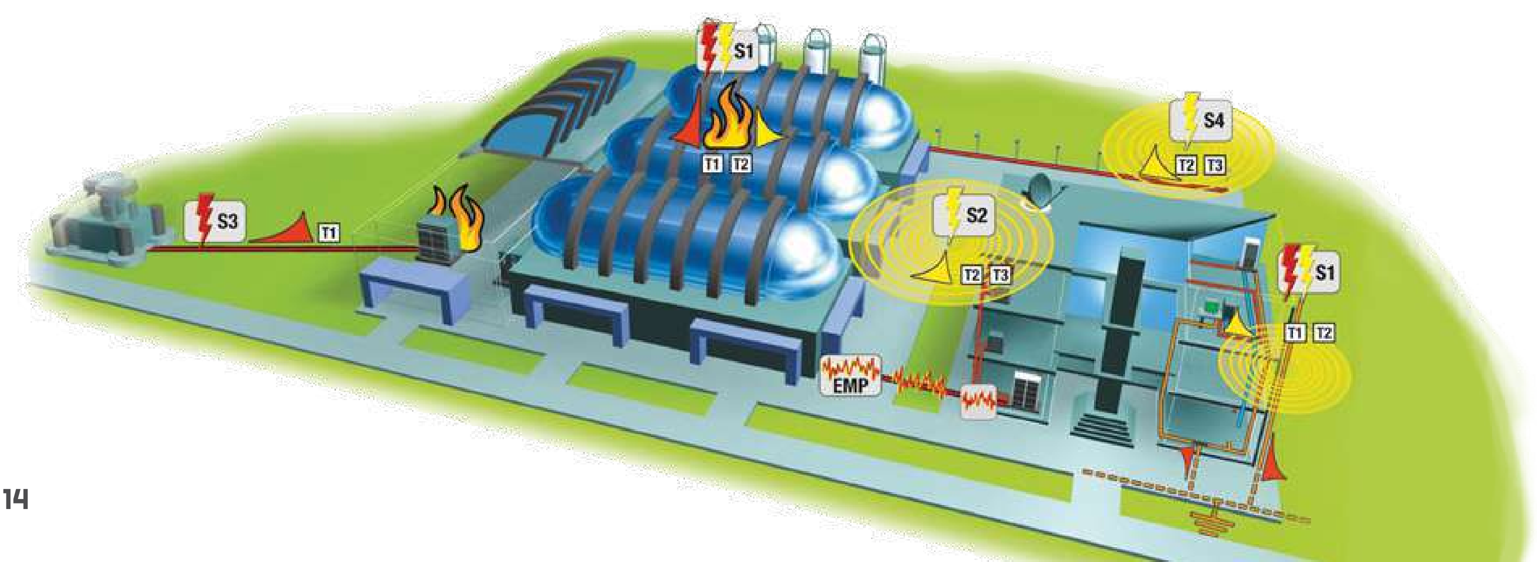
SPD type

SPD Type 1 and 2 T1 T2

SPD Type 2 T2

SPD Type 3 T3

SPD with additional filter



SELECTION OF SPDS ACCORDING TO THE EXPECTED IMPACT IN ACCORDANCE WITH IEC AND EN 62305-2

Lightning flash to the structure - direct flash (source of damage S1):

The lightning current flowing to earth is subdivided directly and via SPDs between the earthing system and all metal structures entering, including any electric services. A representative current waveform is a unipolar 10/350 µs impulse (I_{imp}). In the event of a direct lightning flash to a structure there will also be induced currents represented by an 8/20 µs impulse (I_n). Required SPDs are T1 and **T2 .**

Lightning flash near the structure - indirect flash (Source of damage S2):

The impulses caused by induction effects from magnetic fields generated by the lightning current are represented by an 8/20 µs impulse (I_n).
Required SPDs are T2 and/or T3**.**

Lightning flash to a service - direct flash (Source of damage S3):

The lightning current is subdivided to both directions of the service and insulation breakdown needs to be considered. A representative current waveform is a unipolar 10/350 µs impulse (I_{imp}). Required SPDs are T1 and T2.

Lightning flash close to a service - indirect flash (Source of damage S4):

The impulses caused by induction effects from magnetic fields generated by the lightning current are represented by an 8/20 µs impulse (I_n).
Required SPDs are T2 and/or T3.

SELECTION OF SPDS ACCORDING TO THE EXPECTED IMPACT IN ACCORDANCE WITH HD 60364-4-443

Lightning flash to a service - direct flash (Source of damage S3):

The lightning current is subdivided to both directions of the service and insulation breakdown needs to be considered. A representative current waveform is a unipolar 10/350 µs impulse (I_{imp}). Required SPDs are T1 and T2.

Lightning flash close to a service - indirect flash (Source of damage S4):

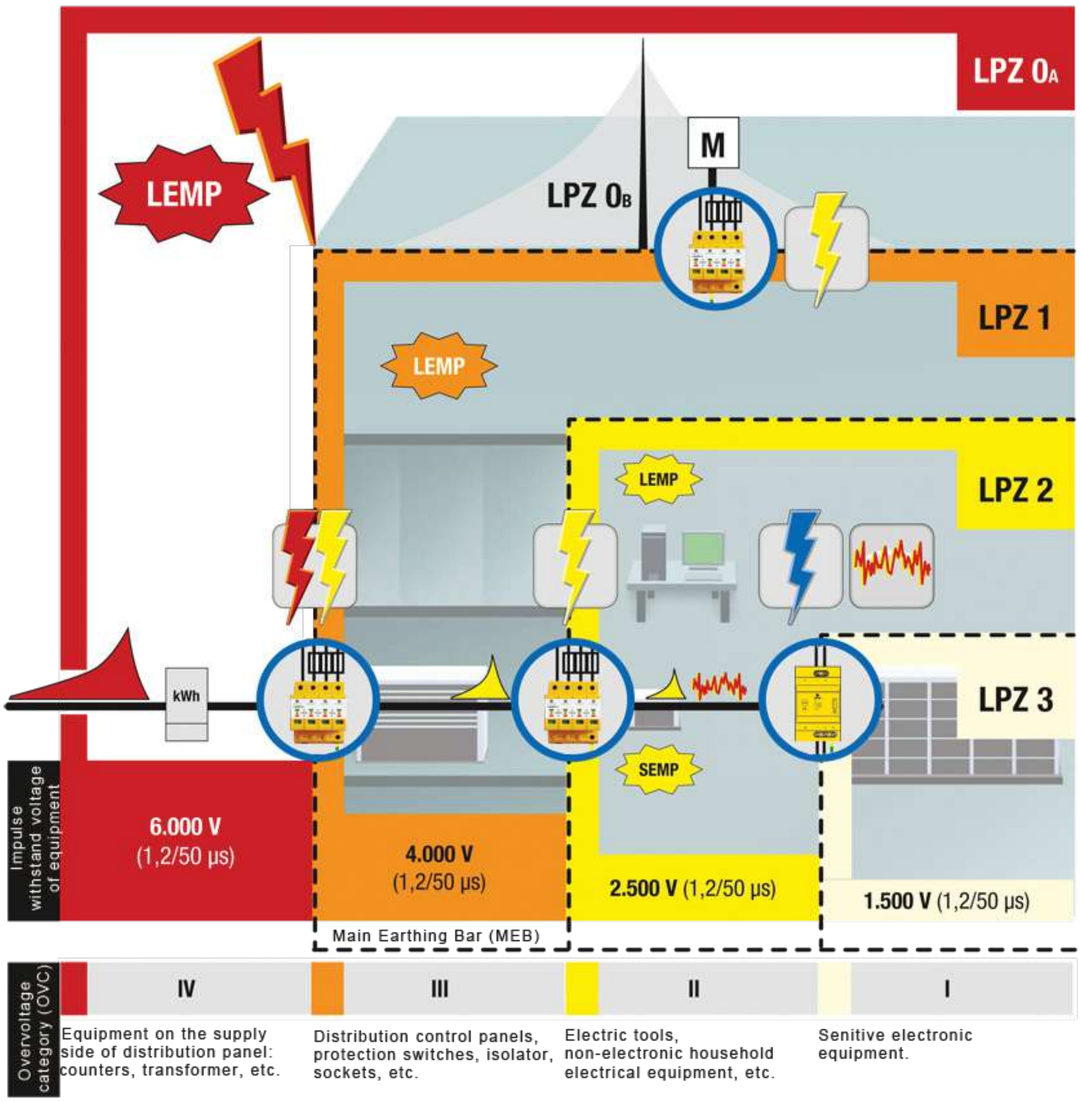
The impulses caused by induction effects from magnetic fields generated by the lightning current are represented by an 8/20 µs impulse (I_n).
Required SPDs are T2 and/or T3.

Electromagnetic interferences conducted by the service:

Conducted electromagnetic interferences may appear in common mode (all active conductors versus earth) or in differential mode (between active conductors) and are mostly in the range of 150 kHz to 30 MHz.
Such interferences can cause damage to equipment and service outage.
It is recommended to apply SPDs with interference filter. The required discharge capability is determined depending on the source of damage to be expected (S2 and S4) and the filter characteristic and mitigation level is determined by the expected interference level.

SELECTION OF SPDs ACCORDING TO THE LIGHTNING PROTECTION ZONE (LPZ) CONCEPT

SPDs shall be selected and installed in accordance with the requirements of the HD 60364-4-443 and the IEC and EN 62305 series of standards respectively, and the HD 60364-5-534. The primary SPDs shall be located as close as possible to the origin of the installation. In many cases this will be the Main Distribution Board (MDB). Further SPDs will most likely be located in Sub Distribution Boards (SDBs).
Following the philosophy of the lightning protection zone concept right from the planning phase of an installation, it is first necessary to define and separate into areas (so called zones) within a structure, which require a certain level of protection, depending on the resistivity and immunity of the equipment installed and used there. The higher the protection requirements are, the higher is the corresponding Zone number.
Based on that the progressive attenuation of transients and electromagnetic inteferences is achieved through the installation of coordinated SPDs at the boundaries of the zones defined.
The objective is to reach a fully compatible system, where all electric and electronic equipment is sufficiently protected not to face any transients or interference it is not able to withstand. By doing this service continuity and the integrity of equipment should be guaranteed.



Classification of LPZs:

LPZ 0_A Zone where the threat is due to the direct lightning flash and the full lightning electromagnetic field. The internal system may be subjected to full or partial lightning surge current;

LPZ 0_B Zone protected against direct lightning flashes but where the threat is the full lightning electromagnetic field. The internal system may be subjected to partial lightning surge current;

LPZ 1 Zone where the surge current is limited by current sharing and by isolating interfaces and/or SPDs at the boundary. Spatial shielding may attenuate the lightning electromagnetic field;

LPZ 2, ..., n Zone where the surge current may be further limited by current sharing and by isolating interfaces and/or additional SPDs at the boundary. Additional spatial shielding may be used to further attenuate the lightning electromagnetic field.

LIGHTNING PROTECTION LEVELS (LPLs) AND SPD DISCHARGE CAPABILITY

The Standard series EN 62305 classifies a set of four Lightning Protection Levels with decreasing efficiency. The table below briefly outlines the details and threat parameters for these levels.

Lightning protection level LPL	Total efficiency	Capture efficiency	Dimensioning efficiency	Values of protection parameters chosen for LPS dimensioning					
				I_{max} (kA)	I_{min} (kA)	$\Delta i/\Delta t$ (kA/µs)	Q_{tot} (C)	Q_{imp} (C)	E_{sp} (kJ/Ω)
I	98%	99%	**99%**	**200**	3	200	300	100	10.000
II	95%	97%	**98%**	**150**	5	150	225	75	5.600
III	90%	95%	**95%**	**100**	7	100	150	50	2.500
IV	80%	85%	**95%**	**100**	16	100	150	50	2.500

• Discharge capability requirements according to IEC and EN 62305

In order to choose the correct value for the SPD discharge capability, it is necessary to determine the expected impulse current at the SPDs point of installation. This value depends on the strike point of the lightning flash and on the current sharing and distribution within the structure and the electric system and wiring.

The EN 62305 series of standards provides the information necessary to calculate these parameters for source of damage S1. For sources of damage S2, S3 and S4, the standard provides the values to be applied. The standard also provides appropriate information for telecommunication systems, because discharge parameters are an important factor there as well.

According to EN 62305-2 (Risk Analysis) the SPDs discharge capability is quite important and provides an indication for the overall protection level of the SPD system installed (see table beside).

In some cases, the standard recommends the choice of SPDs with very high capabilities in order to reduce the risk of explosion (increase of I_{imp}, I_n capabilities corresponding to LPL I requirements).

Choosing SPDs with a high discharge capability (I_{imp}) is important, but it should be considered that other SPD parameters, like the protection level (U_p), must be superior too then.

LPL + SPD Rating	*P_{SPD} 1)*
none / no coordinated SPD	1
III-IV + SPD with I_n/I_{imp}	0,05
II + SPD with I_n/I_{imp}	0,02
I + SPD with I_n/I_{imp}	0,01
I + SPD with 1,5 x I_n/I_{imp}	0,005
I + SPD with 2 x I_n/I_{imp}	0,002
I + SPD with 3 x I_n/I_{imp}	0,001

1) probability that an overvoltage damages an apparatus protected by an SPD system, expressed in %

• Discharge capability requirements according to HD 60364-5-534

The standard HD 60364-5-534 provides some minimum requirements regarding the discharge capability of SPDs in case of indirect lightning, but also in case of direct lightning when there is not sufficient data available to calculate the parameters based on IEC and EN 62305-2. Depending on the mode of protection, these minimum requirements are:

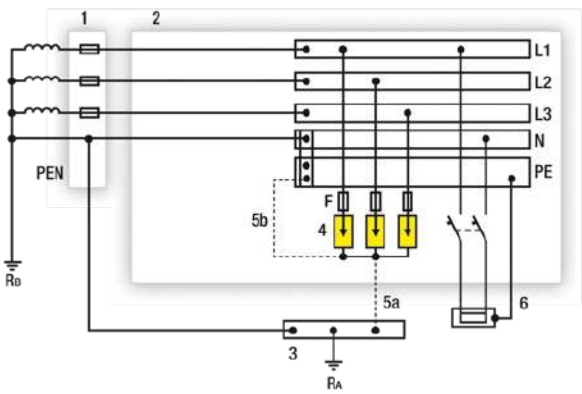
- For indirect lightning a nominal discharge current $I_n \geq 5$ kA 8/20 µs, and, when connection type CT2 is applied (3+1 or 1+1 connection), a nominal discharge current $I_n \geq 20$ kA 8/20 µs for the SPD mode connected N to PE in three-phase systems, and 10 kA 8/20 µs in single-phase systems. Nevertheless we recommend to use SPDs with a nominal discharge current of at least 10 kA 8/20 µs.

- For direct lightning an impulse current $I_{imp} \geq 12{,}5$ kA 10/350 µs for LPL III and IV, and, when connection type CT2 is applied (3+1 or 1+1 connection), an impulse current $I_{imp} \geq 50$ kA 10/350 µs for the SPD mode connected N to PE in three-phase systems, and 25 kA 10/350 µs in single-phase systems.

INSTALLATION OF SPDS IN TN-, TT-, AND IT-SYSTEMS ACCORDING TO HD 60364-5-534

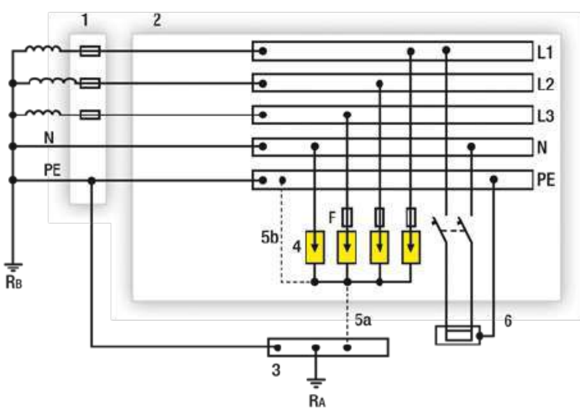
The installation of SPDs in a specific power distribution system must be coordinated with the protective measures against indirect contact (fault protection) and with the corresponding protective devices and their capability to withstand impulse currents.
This coordination depends on the type and earthing arrangement of the power system, as there are TN-, TT- and IT-systems according to HD 60364-1 and the corresponding protective devices may be:

- overcurrent protective devices;
- residual current protective devices;
- insulation monitoring devices.



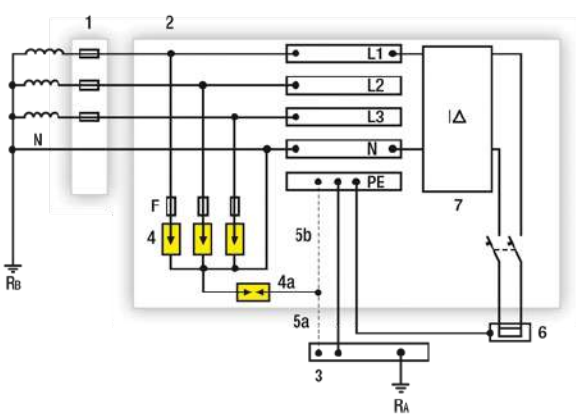
Installation of SPDs in a TN-C-system

Connection type CT1 (3+0 connection)



Installation of SPDs in a TN-S-system

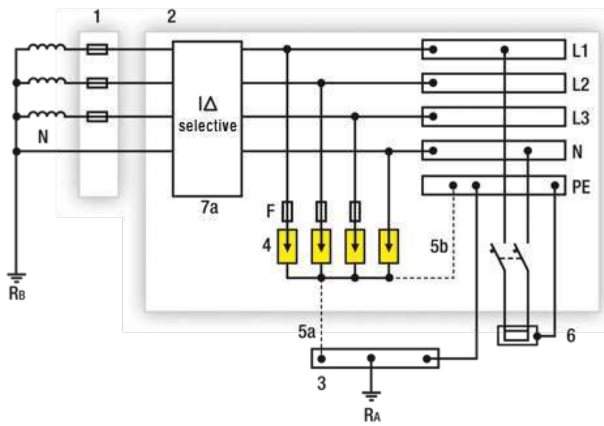
Connection type CT1 (4+0 connection)



Installation of SPDs in a TT-system upstream the main residual current device

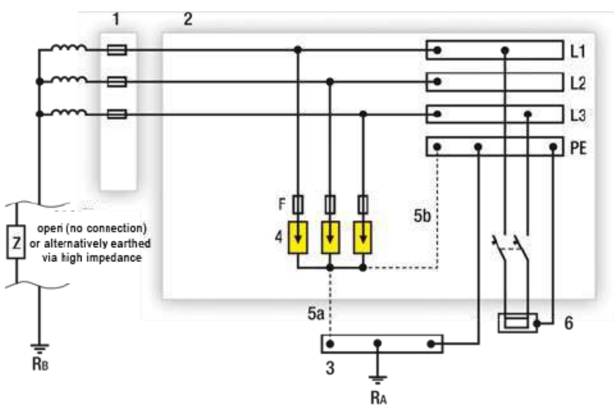
Connection type CT2 (3+1 connection)

1: OCPD 1 OverCurrent Protective Device at the origin of the installation (e.g. in the main distribution board)
2: Main Distribution Board (MDB)
3: Main Earthing Terminal
4: Surge Protective Device(s) (SPDs)
4a: Surge Protective Device connected N to PE (N-PE SPD) when connection type CT2 (3+1 connection) is applied
5a/5b: Alternative connections to PE (preferably the shortest route, or even both connections as required in some countries)
6: Equipment to be protected
7: Residual Current Device (RCD) (in most cases this will be a RCCB or a RCBO)
7a: Selective Residual Current Device (e.g. type S RCD)
F: OCPD 2 OverCurrent Protective Device required by the SPD manufacturer
RA: Earthing resistance of the (consumers) installation
RB: Earthing resistance of the power supply system



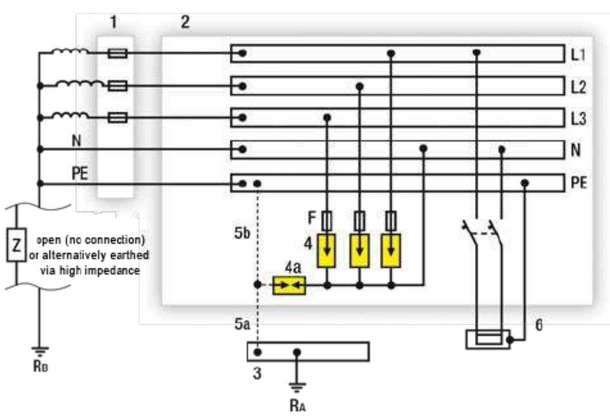
Installation of SPDs in a TT-system downstream the main residual current device

Connection type CT1 (4+0 connection)



Installation of SPDs in an IT-system without distributed neutral

Connection type CT1 (3+0 connection)



Installation of SPDs in an IT-system with distributed neutral

Connection type CT2 (3+1 connection)

ICONS FOR A QUICK SPD SELECTION

Protection against direct and indirect lightning effects (combined Type 1 and 2)

Protection against indirect lightning effects (Type 2)

Protection against induced overvoltages (Type 3)

Protection against electro-magnetic interferences on the line including transient surge suppression

ZOTUP SPD GLOSSARY

L - ZOTUPLIMITER

Varistor based SPDs:

- **NFC No Follow Current®**
- very short response time (t_a): ≤ 25 ns;
- very good voltage protection level even at certain impulse overcurrent;
- high impulse current rating: (I_{imp}) up to 25 kA/pole, 10/350 µs; (I_{max}) up to 100 kA/pole 8/20 µs.

The wide range of **limiting SPDs** with **NFC No Follow Current®** technology allows optimum protection in most applications, also in large installations, where SPDs often operate independent from each other, and where reliable protection and high performance are required.

IL - ZOTUPCOMB

Combined Voltage Limiting and Switching SPD with varistor and GDT connected in series:

- **NFC No Follow Current®** as a result of the combination;
- short response time (t_a): ≤ 100 ns;
- good voltage protection level;
- no leakage currents.

Combined SPDs make use of GDT and varistor elements, with voltage switching and with voltage limiting function. In our production range, these SPDs have been optimized for those applications where no really high discharge capability is required, as for example residential applications.

IA - I - G - ZOTUPGAP

- **Type IA - Voltage Switching Spark gap based SPDs with trigger technology:**
  - high impulse current rating: (I_{imp}) 25 kA/pole 10/350 µs; 100 kA/4 poles 10/350 µs);
  - short response time (t_a): ≤ 100 ns;
  - good voltage protection level;
  - no leakage currents.

SPDs with spark gap and trigger technology are intended for primary protection applications where the prospective short circuit current of the power distribution system at the installation point of the SPDs is lower than or equal to I_{fi} and for installations where coordinated SPDs with very short response time are provided for secondary protection. A typical application is e.g. in a TT system of a medium plant size comprising a main distribution board feeding first and second level subdistribution boards.

- **Type I - Voltage Switching GDT based SPDs:**
  - the typical application for this device is in the N-PE mode of protection in TT distribution systems (1+1 or 3 + 1 construction, connection type CT 2 according to HD 60364-5-534);
  - high impulse current rating (I_{imp}) and (I_{max}) up to 100 kA, 10/350 µs.

- **Type G - Isolating Spark Gap ISG SPDs:**

These devices are used to indirectly connect an LPS to nearby metal structures which cannot be directly connect for functional reasons.

- Monolithic explosion proof protection;
- Good protection level;
- High insulation resistance;
- High discharge capability (I_{imp}).

ILF - ZOTUPFILTER

Combined Voltage Limiting and Switching SPD plus Filter with varistor and GDT comprising an additional filter:

- effective noise level attenuation by use of additional high frequency bandpass filters;
- high level interference protection for sensitive equipment with limited resistivity and immunity characteristics;
- high discharge capabilty (combination wave test at U_{oc} 10 kV 1,2/50 µs, I_{cw} 5 kA 8/20 µs).

Combined SPDs with additional filter are used where high continuity of service is required like data centers, DCS (distributed control systems), etc.. These SPDs do not only protect against transients due to lightning, but also against high frequency conducted interferences. They are applied where Electromagnetic Compatibility (EMC) is an issue and requires improvement of the system immunity.

ZOTUPBOX

Protection boxes with an IP65 enclosure which provide a compact and preinstalled solution for applications in Power Centers.

ZOTUPACCESSORIES

CPs are fork-type busbars with 2 up to 8 connection points. Typical application: to provide a common PE connection for several SPDs.

LLP - ZOTUPLED

SPD LED Lighting Protection Systems
A ready to install assembly of a voltage limiting and a voltage switching SPD providing two modes of protection.

S - ZOTUPSIGNAL

SPDs for Signalling, telecommunication and data transmission.
These SPDs are connected in series with low resistivity electronic equipments, like analog interfaces and data networks.

C - ZOTUPCOAX

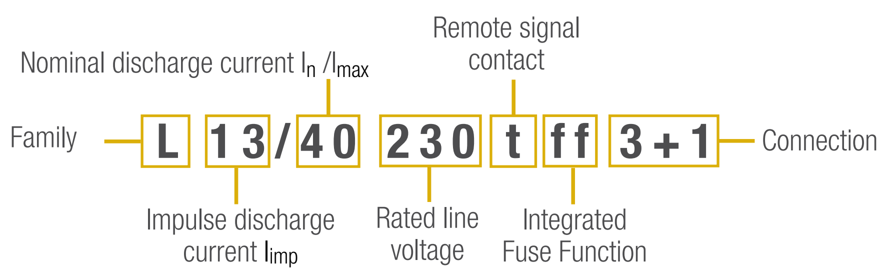
Specific SPDs with coaxial connectors for protecting TV switchboards, satellite antenna or wideband transmission equipment and remote systems.
Particularly suitable for applications with long coaxial cables which are exposed to electromagnetic interference.

ZU - ZOTUPHV

Surge Arresters for high voltage systems (HV) with typical applications: protection of transformers, switchgears and transmission lines in HV systems.

- Surge Arresters with silicone rubber housing providing big internal and external creepage distances suitable for all applications with high level of pollution.
- Surge Arresters available with disconnector device, which is activated by and increase in internal preassure with a reliable operating mechanism and stable characteristic even over long time.
- Additional lightning strike counters and lightning strike counters with measurement for indication of the total leakage current (internal and external dispersion) are also available.
- Surge Arresters with a higher thermal energy rating than 4,5 kJ/kV are available upon request.

Ordering code Example for Low Voltage SPDs:



ZOTUP SPDs FOR LOW VOLTAGE SYSTEMS

SPDs FOR LOW VOLTAGE ALTERNATING CURRENT (AC) APPLICATIONS

- L ... – ZOTUPLIMITER
- IA ... – ZOTUPGAP (SPARK GAPS WITH TRIGGER TECHNOLOGY)
- I ... – ZOTUPGAP (SPARK GAPS N-PE)
- IL ... – ZOTUPCOMB
- PB ... – ZOTUPBOX
- CP ... – ZOTUPACCESSORIES

SPDs FOR ALTERNATING CURRENT (AC) WITH ADDITIONAL FILTER

- ILF ... – ZOTUPFILTER

SPDs FOR DIRECT CURRENT (DC) AND PHOTOVOLTAIC APPLICATIONS

- L 7/30 DC … ff – ZOTUPLIMITER
- L 13/60 PVY … ff – ZOTUPLIMITER
- L 3/40 PVY … ff – ZOTUPLIMITER

SPDs FOR LED LIGHTING

- LLP ... – ZOTUPLED
- IL 1/10 2P LED – ZOTUPCOMB

ZOTUP SPDs FOR SIGNALLING, TELECOMMUNICATION AND DATA TRANSMISSION

SPDs FOR SIGNALLING AND TELECOMMUNICATION NETWORKS

- S (S-ASI L/R; S-AS2; S-N) – ZOTUPSIGNAL
- C ... – ZOTUPCOAX

SPDs FOR DATA TRANSMISSION

- S (S-ASI B/G; S-F; S ADSL) – ZOTUPSIGNAL

ZOTUP ISOLATING SPARK GAPS

ISOLATING SPARK GAPS

- G ... – ZOTUPGAP

ZOTUP SURGE ARRESTERS FOR HIGH VOLTAGE SYSTEMS (HV)

SURGE ARRESTERS FOR HIGH VOLTAGE SYSTEMS

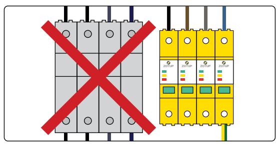
- ZU ... – ZOTUPHV

THE INNOVATIVE FEATURES OF OUR NEW PRODUCTS

MAIN FEATURES

ZOTUP brings to the market a new technology after 4,5 years of intensive research and development activities. These new products are supported by more than 330 laboratory tests and the technology behind is protected by four international patents. Herewith **ZOTUP** is standing for new state of the art surge protection for low voltage power systems. **ZOTUP** products represent an outstanding innovation on the market of surge protection with regard to performance, safety, easiness of installation and reliability. All these quality attributes are now available in a single product.

The unique technical features putting our products to the top are:



- ## Integrated Fuse Function (ff)

in case the SPD reaches its end of life in a short circuit state.
According to the product standard EN 61643-11 SPDs are classified according to their behavior when reaching end of life.
<u>There are two types of failure modes:</u>

- OCFM (Open Circuit Failure Mode);
- SCFM (Short Circuit Failure Mode).

An SPD with OCFM must disconnect from the power supply when reaching end of life. The disconnection operation can be performed by an internal or an external disconnector, or by a combination of these two.

<u>The standard differentiates between two distinct processes:</u>

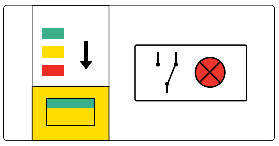
a) **a "slow" process** that depends on the degradation of voltage limiting components, e.g. in MOV-based SPDs, leading to thermal runaway. In such case the disconnection is generally ensured by an internal thermal operated disconnector.

b) **a "quick" or even "instant" process** that depends on the overcurrent caused by a very low remaining impedance of the SPD, which causes a short circuit on the supply. The interruption of such short-circuit current is managed by an internal or external disconnector with appropriate breaking capability, preferrably a fuse. The innovative feature from **ZOTUP** is a patented combined internal disconnector, which is able to disconnect in both of the above mentioned cases, the "slow" and the "quick" or "instant" process. This means that the disconnector used in **ZOTUP** products provides an Integrated Fuse Function (ff). Therefore, as long as certain short circuit current values are not exceeded, our products do not require any additional external disconnector.

Advantages:

- Maintaining the full discharge capability of the SPD. An external fuse or disconnector may influence/limit this capability;
- The overall voltage drop across the SPD branch circuit and therefore the effective voltage protection level for the installation and equipment is kept to a minimum, as there are no additional devices and the wiring can be kept very short;
- No additional costs for external disconnectors, less time for cabling and a smaller ecologic footprint.

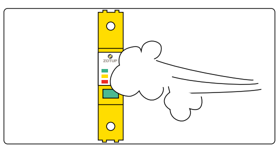
If the short circuit current at the point of installation exceeds the breaking capability of that internal disconnector an additional external fuse is required. In such case the fuse is intrinsically selective with the internal disconnector, safeguarding the integrity of the SPD in case of a very low impedance or even short circuit state.



- **Progressive performance indication**

The new design of ZOTUP makes regular checks of the SPDs status and system verification very easy. Periodic verification is generally required by regulations on national level. The new **ZOTUP** SPD range displays its performance status by a change of color in the Status Indicator window. The transition from the initial green color (full performance) to the totally yellow (minimum performance) is **progressive/analog**. The colour in the window indicates the actual remaining performance of the SPD, thus providing comprehensive information rather than a simple good versus out of order message for attention.
After that a red indication follows, showing the SPD has reached its end of life.

Advantages:
- **Progressive indication** of the reduction in performance of the SPD allows preventive maintenance and optimization of replacement decisions;
- **Remote indication** for SPDs incorporating a changeover contact is activated when the performance reaches its minimum state (totally yellow). Therefore the remote alarm is preventive, because the SPD is still operational and still able to protect at minimum performance level.



- **For applications with high pollution (PD 3) and for extended temperature range (-40°/+80°C)**

The increasing application of SPDs under "heavy" environmental conditions (such as traffic light controls, cellular radio and mobile phone stations, outdoor public lighting and street lighting systems) has highlighted the need for more stringent requirements on resistivity to pollution.

Installation of SPDs in costal areas with a high rate of salinity and/or in locations with increased condensation effects due to rapid changes in temperature, e.g. in photovoltaic (PV) installations and power plants or in Wind Turbines, has shown that increased distances are necessary to sufficiently prevent from electric tracking on insulating materials on a long term view.

ZOTUP deals with the issue of pollution and uses firm materials and applies adequate design features to achieve Pollution Degree 3 for all internal and external creepage distances and clearances.
Keeping an emphasis on environmental aspects our products are designed and classified for the highest level of temperature range, which goes even beyond the so called extended range in the product standard.

Advantages:
- Improved reliability when installed in "heavy" environments;
- Enabling applications that cannot be covered with a lower pollution degree or normal temperature range.

THE WEBAPP

SIZE YOUR SYSTEM WITH THE FREE APP BY ZOTUP. INSTALL IT ON YOUR SMARTPHONE OR ON YOUR PC DESKTOP.

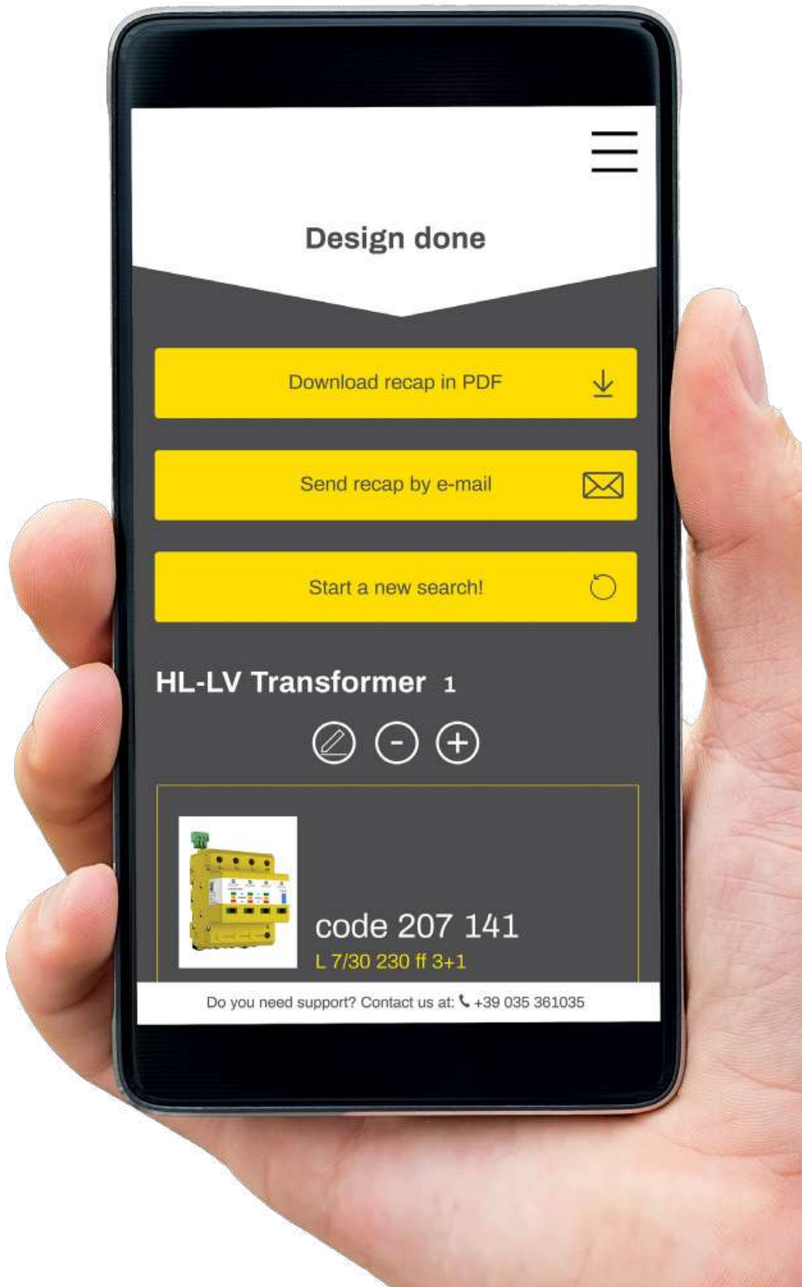
HOW TO DOWNLOAD IT

Free of charge through a simple link: **webapp.zotup.it**
Since this is a webapp, it does not require a store **(Google Play or App Store).**
You will only need to register when you first login.

HOW IT WORKS

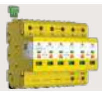
Simple multiple-choice questions will guide the user in choosing the right SPD. The most suitable SPD for the protection needs will be indicated, with all the technical info.
There is also the option to save and/or download report.

webapp.zotup.it



ZOTUP SURGE ARRESTERS

SPDs FOR LOW VOLTAGE ALTERNATING CURRENT (AC) APPLICATIONS

SPD	Model	Application icon	Test class/Type	Modes of protection	Impulse discharge current I_{imp}	Nominal discharge current I_n
	L 25/100 230 t ff		I e II / T1 e T2	1	25 kA	60 kA
	L 25/100 230 t ff 2		I e II / T1 e T2	2	25 kA	60 kA
	L 25/100 230 t ff 3		I e II / T1 e T2	3	25 kA	60 kA
	L 25/100 230 t ff 4		I e II / T1 e T2	4	25 kA	60 kA
	L 25/100 230 t ff 1+1		I e II / T1 e T2	2	25 kA	60 kA
	L 25/100 230 t ff 3+1		I e II / T1 e T2	4	25 kA	60 kA
	IA 25 230		I e II / T1 e T2	1	25 kA	25 kA
	IA 25 230 2		I e II / T1 e T2	2	25 kA	25 kA
	IA 25 230 4		I e II / T1 e T2	4	25 kA	25 kA
	IA 25 230 1+1		I e II / T1 e T2	2	25 kA	25 kA
	IA 25 230 3+1		I e II / T1 e T2	4	25 kA	25 kA
	I 100 N-PE		I e II / T1 e T2	1	100 kA	100 kA
	L 13/40 230 ff		I e II / T1 e T2	1	13 kA	35 kA
	L 13/40 230 ff 2		I e II / T1 e T2	2	13 kA	35 kA
	L 13/40 230 ff 3		I e II / T1 e T2	3	13 kA	35 kA
	L 13/40 230 ff 4		I e II / T1 e T2	4	13 kA	35 kA
	L 13/40 230 ff 1+1		I e II / T1 e T2	2	13 kA	35 kA
	L 13/40 230 ff 3+1		I e II / T1 e T2	4	13 kA	35 kA
	I 52 N-PE		I e II / T1 e T2	1	52 kA	52 kA

SPD	Model	Application icon	Test class/Type	Modes of protection	Impulse discharge current I_{imp}	Nominal discharge current I_n
	Prot. Box TN 40 ff		I e II / T1 e T2	4	10 kA	40 kA
	Prot. Box TT 40 ff			4		
	L 7/30 230 ff		I e II / T1 e T2	1	8 kA	30 kA
	L 7/30 400 ff		I e II / T1 e T2	1	7 kA	30 kA
	L 7/30 1000 ff		I e II / T1 e T2	1	2 kA	20 kA
	L 7/30 230 ff 2		I e II / T1 e T2	2	8 kA	30 kA
	L 7/30 230 ff 3		I e II / T1 e T2	3	8 kA	30 kA
	L 7/30 230 ff 4		I e II / T1 e T2	4	8 kA	30 kA
	L 7/30 230 ff 1+1		I e II / T1 e T2	2	8 kA	30 kA
	L 7/30 230 ff 3+1		I e II / T1 e T2	4	8 kA	30 kA
	L 3/30 60 ff		II /T2	1	-	20 kA
	L 3/30 120 ff		II /T2	1	-	20 kA
	L 3/30 230 ff		II /T2	1	-	30 kA
	L 3/30 400 ff		II /T2	1	-	30 kA
	L 3/30 230 ff 2		II /T2	2	-	30 kA
	L 3/30 230 ff 3		II /T2	3	-	30 kA
	L 3/30 230 ff 4		II /T2	4	-	30 kA
	L 3/30 230 ff 1+1		II /T2	2	-	30 kA
	L 3/30 230 ff 3+1		II /T2	4	-	30 kA
	L 2/10 230 ff		II /T2	1	-	10 kA

ZOTUP SPDs FOR LOW VOLTAGE APPLICATION
FOR AC APPLICATION

SPD	Model	Application icon	Test class/Type	Modes of protection	Impulse discharge current I_{imp}	Nominal discharge current I_n
	L 2/10 230 ff 2		II /T2	2	-	10 kA
	L 2/10 230 ff 4		II /T2	4	-	10 kA
	L 2/10 230 ff 1+1		II /T2	2	-	10 kA
	L 2/10 230 ff 3+1		II /T2	4	-	10 kA
	L 2/10 230 ff 2 TT		II /T2	2	-	10 kA
	L 2/10 230 ff 4 TT		II /T2	4	-	10 kA
	I 12 N-PE		I e II / T1 e T2	1	12,5 kA	40 kA

FOR BASIC AC APPLICATION

SPD	Model	Application icon	Test class/Type	Modes of protection	Impulse discharge current I_{imp}	Nominal discharge current I_n
	IL 1/10 2P 230		II / T2	3	-	10 kA
	L 2/20 230 e		II / T2	1	-	20 kA
	L 2/20 230 1+1		II / T2	2	-	20 kA
	L 2/20 230 3+1		II / T2	4	-	20 kA
	IL 1/3 2P		III / T3	3	-	3 kA
	IL 1/10 2P M		II / T2	3	-	10 kA

FOR WIND TURBINE APPLICATIONS IN AC

SPD	Model	Application icon	Test class/Type	Modes of protection	Impulse discharge current I_{imp}	Nominal discharge current I_n
	L 7/30 600 ff		I e II / T1 e T2	1	5 kA	25 kA
	L 7/30 750 ff		I e II / T1 e T2	1	5 kA	20 kA
	L 7/30 750 ff 3		I e II / T1 e T2	3	5 kA	20 kA

ACCESSORIES

SPD	Model	Application icon	Test class/Type	Modes of protection	Impulse discharge current I_{imp}	Nominal discharge current I_n
	CP 1	-	-	-	-	-
	CP 2	-	-	-	-	-
	CP 3	-	-	-	-	-
	CP 4	-	-	-	-	-
	CP 5	-	-	-	-	-
	CP 6	-	-	-	-	-
	CP 7	-	-	-	-	-
	CP 8	-	-	-	-	-

ZOTUP SPDs FOR ALTERNATING CURRENT (AC) WITH ADDITIONAL FILTER

SPD	Model	Application icon	Test class/Type	Modes of protection	Impulse discharge current I_{imp}	Nominal discharge current I_n
	ILF 4P 250		I, II e III / T1, T2 e T3	4	12,5 kA	25 kA
	ILF 4P 400		I, II e III / T1, T2 e T3	4	12,5 kA	25 kA
	ILF 4P 40		III / T3	4	-	3 kA
	ILF 4P 63		III / T3	4	-	3 kA
	ILF 4P 80		III / T3	4	-	3 kA
	ILF 4P 125		III / T3	4	-	3 kA
	ILF 2P 40		III / T3	2	-	3 kA
	ILF 2P 63		III / T3	2	-	3 kA
	ILF 2P 80		III / T3	2	-	3 kA
	ILF 2P 10 DIN		III / T3	2	-	3 kA
	ILF 2P 16 DIN		III / T3	2	-	3 kA
	ILF 2P 25 DIN		III / T3	2	-	3 kA

ZOTUP SPDs FOR DIRECT CURRENT (DC) IN LOW VOLTAGE SYSTEM

SPD	Model	Application icon	Test class/Type	Modes of protection	Impulse discharge current I_{imp}	Nominal discharge current I_n
	L 7/30 DC 60 ff		II / T2	1	-	20 kA
	L 7/30 DC 110 ff		II / T2	1	-	20 kA
	L 7/30 DC 230 ff		I e II / T1 e T2	1	8 kA	30 kA
	L 7/30 DC 600 ff		I e II / T1 e T2	1	7 kA	30 kA
	L 7/30 DC 1000 ff		I e II / T1 e T2	1	5 kA	20 kA

ZOTUP SPDs FOR LOW VOLTAGE APPLICATION AND PHOTOVOLTAIC APPLICATIONS

SPD	Model	Application icon	Test class/Type	Modes of protection	Impulse discharge current I_{imp}	Nominal discharge current I_n
	L 13/60 PV Y 600 ff		I e II / T1 e T2	3	7 kA	20 kA
	L 13/60 PV Y 1000 ff		I e II / T1 e T2	3	5 kA	20 kA
	L 3/40 PV Y 600 ff		II / T2	3	-	20 kA
	L 3/40 PV Y 1000 ff		II / T2	3	-	20 kA

ZOTUP SPDs FOR LED LIGHTNING IN LOW VOLTAGE SYSTEM

SPD	Model	Application icon	Test class/Type	Modes of protection	Impulse discharge current I_{imp}	Nominal discharge current I_n
	LLP 7/30 230 ff 1+1		I e II / T1 e T2	2	8 kA	30 kA
	LLP 2/10 230 ff 1+1		II / T2	2	-	10 kA
	IL 1/10 2P LED		II / T2	2	-	10 kA

ZOTUP SPDs FOR SIGNALLING AND TELECOMMUNICATION NETWORKS

SPD	Model	Application icon	Impulse rating/ Category	Category D1 Impulse discharge current (10/350 μs) per wire	Category C2 Nominal discharge current (8/20 μs) per wire	Connection technique
	S-ASI 1 L 6		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 1 L 12		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 1 L 24		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 1 L 48		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 2 L 6		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 2 L 12		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 2 L 24		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 2 L 48		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 1 R 6		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 1 R 12		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 1 R 24		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 1 R 48		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 2 R 6		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 2 R 12		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 2 R 24		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite
	S-ASI 2 R 48		C1, C2, C3, D1	2,5 kA	15 kA	morsetti a vite

SPD	Model	Application icon	Impulse rating/ Category	Category D1 Impulse discharge current (10/350 µs) per wire	Category C2 Nominal discharge current (8/20 µs) per wire	Connection technique
	S-AS 2 24/1		C2, C3	-	1 kA	morsetti a vite
	S-AS 2 48/1		C2,C3	-	1 kA	morsetti a vite
	S-N 24 RJ/RJ tel		C2, C3	-	2,5 kA	RJ 45
	S-N 24 LSA/RJ tel		C2, C3	-	2,5 kA	LSA/RJ 45
	S-N 24 C		-	-	-	-

SPECIFIC SPDs WITH COAXIAL CONNECTORS

SPD	Model	Application icon	Impulse rating/ Category	Category D1 Impulse discharge current (10/350 µs) per wire	Category C2 Nominal discharge current (8/20 µs) per wire	Connection technique
	C 5		C2, C3, D1	2 kA	5 kA	F
	C 6		C2, C3	-	1 kA	BNC
	C 7		C2, C3, D1	2 kA	10 kA	7/16 M/F
	C 8		C2, C3, D1	2 kA	5 kA	7/16 M/F

SPDs FOR DATA TRASMISSION

SPD	Model	Icon app.	Impulse rating/ Category	Transmission rating	Impulse discharge urrent D1 (10/350 µs) per wire	Nominal discharge current C2 (8/20 µs) per wire	Connection technique
	S-ASI 1 B 6		C1, C2, C3, D1	-	2,5 kA	15 kA	screw type terminals
	S-AS 1 B 12		C1, C2, C3, D1	-	2,5 kA	15 kA	screw type terminals
	S-ASI 1 B 24		C1, C2, C3, D1	-	2,5 kA	15 kA	screw type terminals
	S-ASI 1 B 48		C1, C2, C3, D1	-	2,5 kA	15 kA	screw type terminals
	S-ASI 2 B 6		C1, C2, C3, D1	-	2,5 kA	15 kA	screw type terminals
	S-ASI 2 B 12		C1, C2, C3, D1	-	2,5 kA	15 kA	screw type terminals
	S-ASI 2 B 24		C1, C2, C3, D1	-	2,5 kA	15 kA	screw type terminals
	S-ASI 2 B 48		C1, C2, C3, D1	-	2,5 kA	15 kA	screw type terminals
	S-ASI 1 G 48		C1, C2, C3, D1	-	2,5 kA	15 kA	screw type terminals
	S-ASI 1 G 110		C1, C2, C3, D1	-	2,5 kA	20 kA	screw type terminals
	S-ASI 2 G 48		C1, C2, C3, D1	-	2,5 kA	15 kA	screw type terminals
	S-ASI 2 G 110		C1, C2, C3, D1	-	2,5 kA	20 kA	screw type terminals
	S-F 1/6		C2, C3	6	-	1kA	RJ 45
	S-F 1/48 PoE +		C2, C3	6 A	-	1kA	RJ 45
	S-F 1/48 PoE + b		C2, C3	6 A	-	1kA	RJ 45
	S ADSL		C2, C3	-	-	2,5 kA	RJ 45

Alternate Current System (AC)

	Model	Application Icon	System Voltage kV	Rated Voltage kV	Line discharge class (IEC 60099-4 Ed. 2.2; 2009)	Max. thermal energy absoption capability kJ per kV of Ur (IEC 60099-4 Ed. 3.0; 2014)	Nominal discharge current In kA (8/20 µs)	Location
	ZU HV 12.2		10	12	2	4,5	10	indoor + outdoor
	ZU HV 18.2		15	18	2	4,5	10	indoor + outdoor
	ZU HV 24.2		20	24	2	4,5	10	indoor + outdoor
	ZU HV 30.2		24	30	2	4,5	10	indoor + outdoor
	ZU HV 36.2		30	36	2	4,5	10	indoor + outdoor

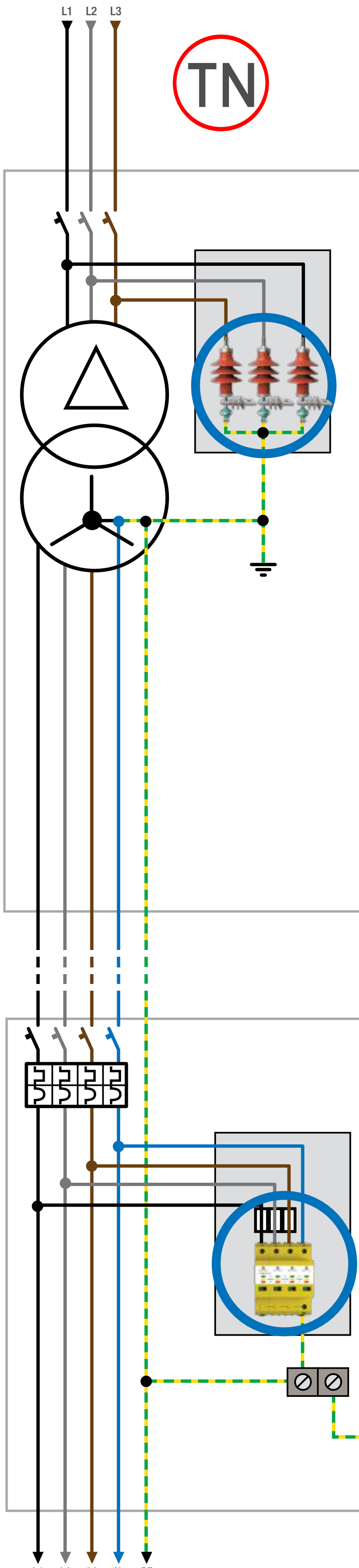
Direct Current System (DC)

	Model	Application Icon	System Voltage V	Continuos DC operating voltage Uc	Line discharge class (IEC 60099-4 Ed. 2.2; 2009)	Max. thermal energy absorption capability kJ per kV per Ur (IEC 60099-4 Ed. 3.0; 2014)	Nominal discharge current In kA (8/20 µs)	Location
	ZU HV DC-1 1/10		-	1,0	DC-B (4)	28	20	indoor + outdoor
	ZU HV DC-1 1,5/10		-	1,5	DC-B (4)	28	20	indoor + outdoor
	ZU HV DC-1 2/10		-	2,0	DC-B (4)	28	20	indoor + outdoor
	ZU HV DC-1 3/10		-	3,0	DC-B (4)	28	20	indoor + outdoor
	ZU HV DC-1 4/10		-	4,0	DC-B (4)	28	20	indoor + outdoor
	ZU HV DC-1 4,5/10		-	4,5	DC-B (4)	28	20	indoor + outdoor

APPLICATION EXAMPLES

Surge arresters:
ZOTUP Typical installation example in a TN-S System

Tertiary / Industrial
(large size in a single structure)

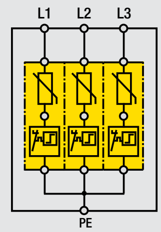


to secondary panelboards

Trasform Cabin

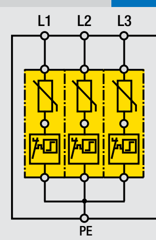
MV System 15,000 V

TYPE	QUANTITY	CODE
ZU HV 18.2	3	120 418
ZU 7	3	107 000
ZU 4	3	104 000



MV System 20,000 V

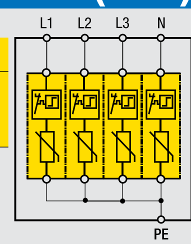
TYPE	QUANTITY	CODE
ZU HV 24.2	3	120 424
ZU 7	3	107 000
ZU 4	3	104 000



General Swithcboard / Power Center

AC 230/400 V voltage typical diagram CT1 (4+0)

TYPE	QUANTITY	CODE
L 13/40 230 t ff 4	1	214 140

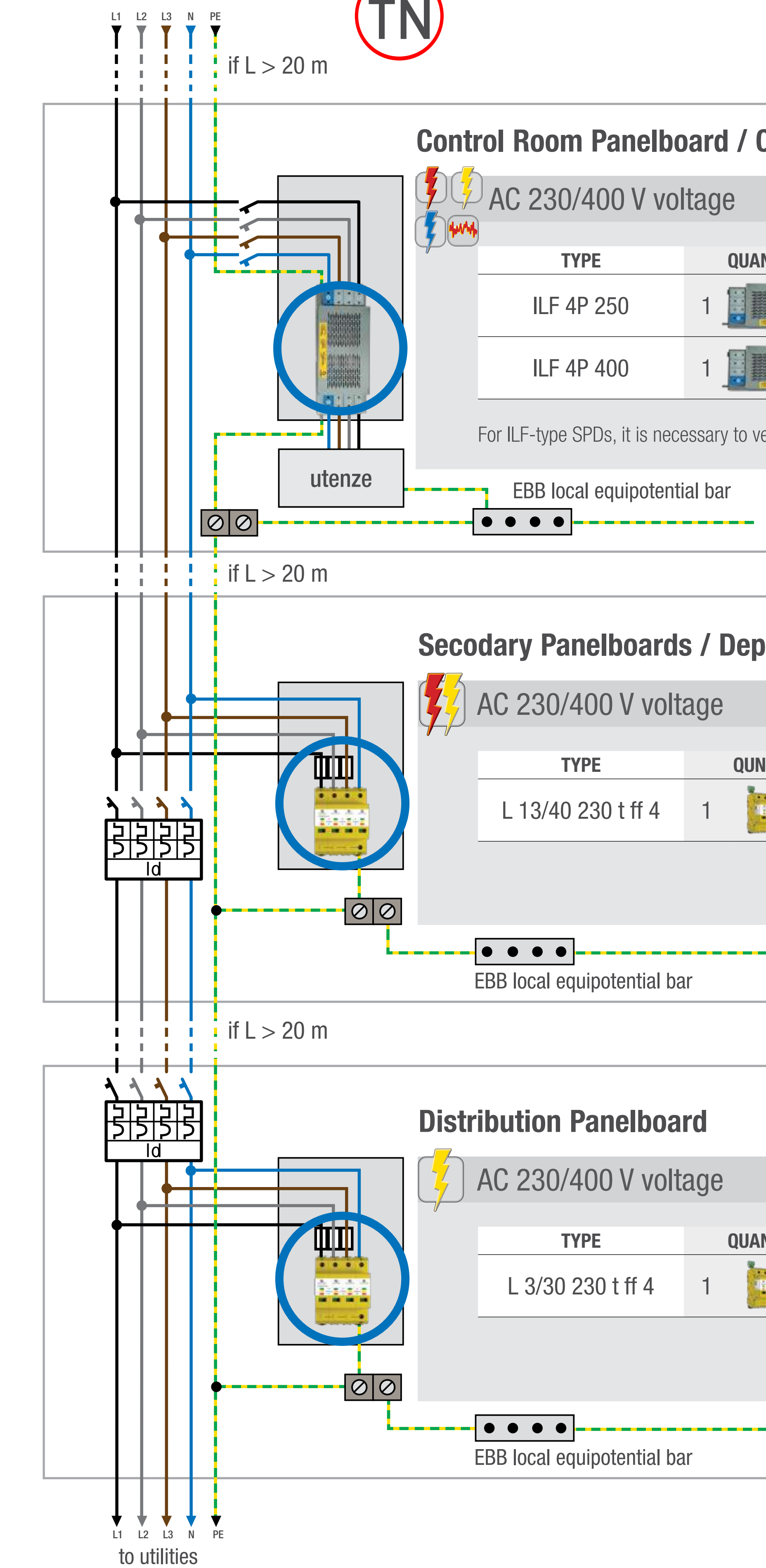


MEBB main equipotential bar

EBB local equipotential bar

ZOTUP Typical installation example in a TN-S system

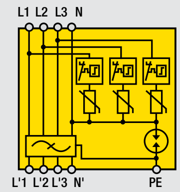
Tertiary / Industrial
(large-scale in a single facility)



Control Room Panelboard / CED

AC 230/400 V voltage — typical diagram **CT2 (3+1)**

TYPE	QUANTITY	CODE
ILF 4P 250	1	219 374
ILF 4P 400	1	219 344

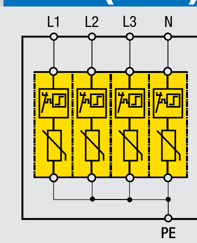


For ILF-type SPDs, it is necessary to verify the current carrying capacity of the load.

Secodary Panelboards / Department Panelboards

AC 230/400 V voltage — typical diagram **CT1 (4+0)**

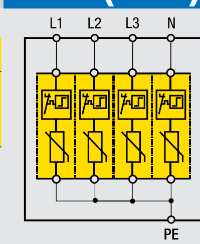
TYPE	QUNTITY	CODE
L 13/40 230 t ff 4	1	214 140



Distribution Panelboard

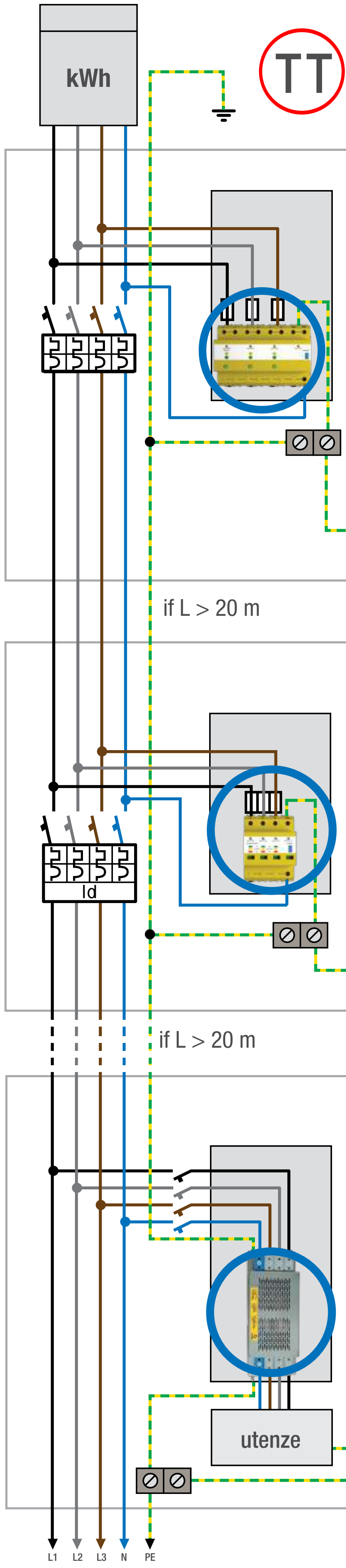
AC 230/400 V voltage — typical diagram **CT1 (4+0)**

TYPE	QUANTITY	CODE
L 3/30 230 t ff 4	1	210 140



Surge arresters:
ZOTUP Typical example of installation in a TT system

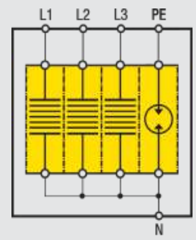
Tertiary / Industrial
(medium-sized with meter panel in suburban or rural area)



Meter Panel

AC 230/400 V voltage — typical diagram **CT2 (3+1)**

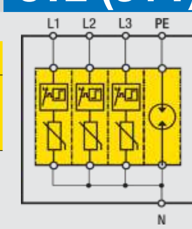
TYPE	QUANTITY		CODE
IA 25 3+1	1		203 141



General Panelboard

AC 230/400 V voltage — typical diagram **CT2 (3+1)**

TYPE	QUANTITY		CODE
L 13/40 230 t ff 3+1	1		214 141

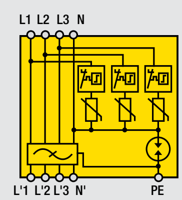


Control Room Panelboard / CED

AC 230/400 V voltage — typical diagram **CT2 (3+1)**

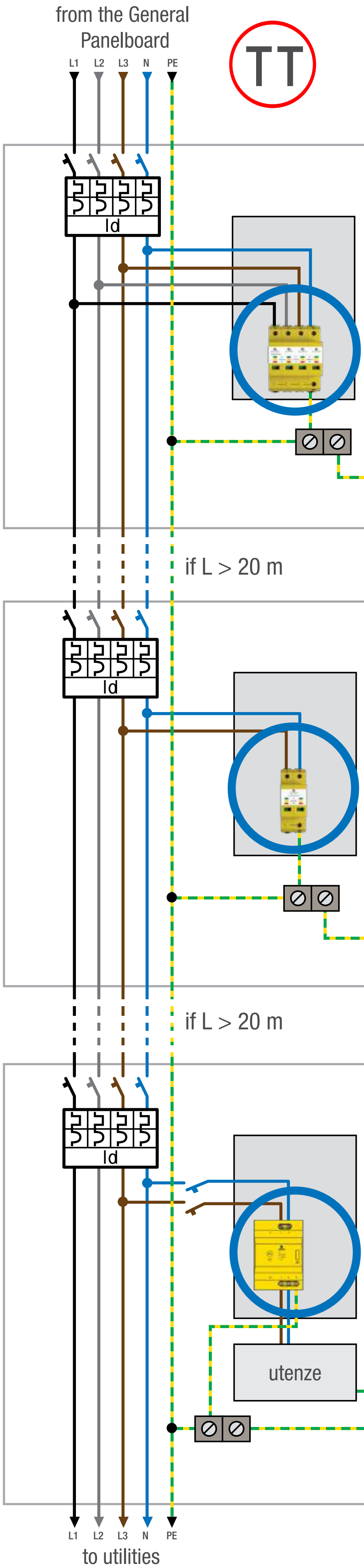
TYPE	QUANTITY		CODE
ILF 4P 250	1		219 374
ILF 4P 400	1		219 344

Per gli SPD tipo ILF è necessario verificare la portata in corrente del carico.



Surge arresters:
ZOTUP Typical example of installation in a TT system

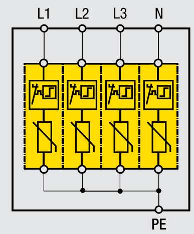
Tertiary / Industrial
(medium-sized with meter panel in suburban or rural area)



Three-phase Zone Panelboard

AC 230/400 V voltage — typical diagram **CT1 (4+0)**

TYPE	QUANTITY	CODE
L 2/10 230 t ff 4 TT	1	212 240



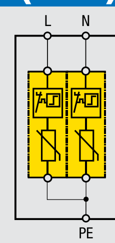
EBB local equipotential bar

if L > 20 m

Single-phase Zone Panelboard

AC 230/400 V voltage — typical diagram **CT1 (2+0)**

TYPE	QUANTITY	CODE
L 2/10 230 t ff 2 TT	1	212 220



EBB local equipotential bar

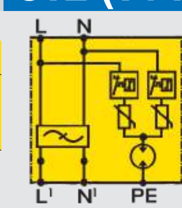
if L > 20 m

Machine Side Panelboard

AC 230/400 V voltage — typical diagram **CT2 (1+1)**

TYPE	QUANTITY	CODE
ILF 2P 25 DIN	1	209 325

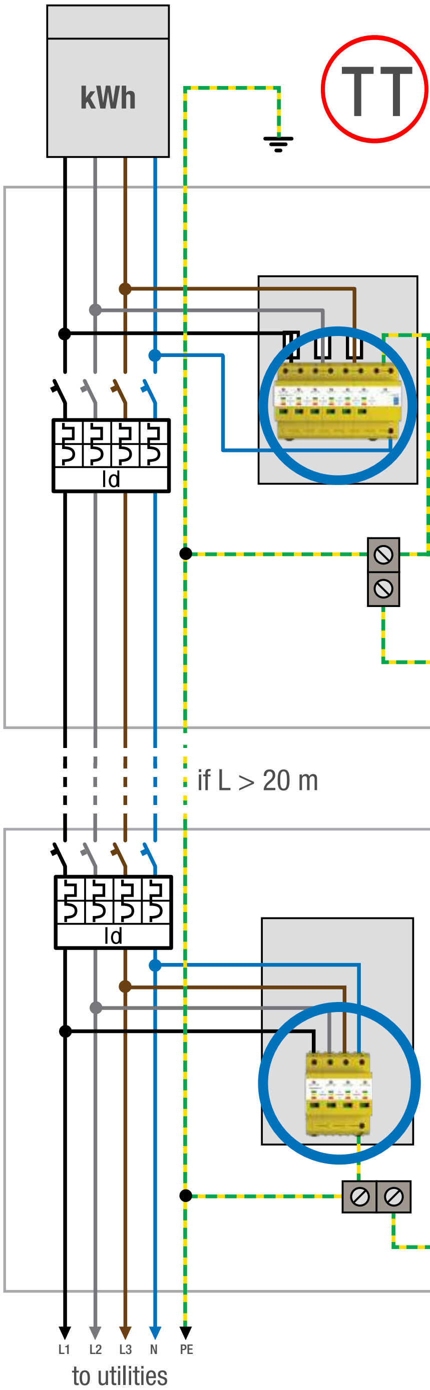
For ILF-type SPDs, it is necessary to verify the rating (A) depending on the load. Three-phase designs are also available.



EBB local equipotential bar

Surge arresters:
ZOTUP Typical example of installation in a TT system

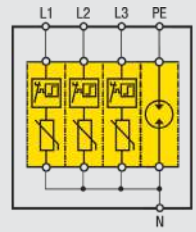
Tertiary / Industrial
(medium/small size with no meter panel in a suburban or rural area)



General Panelboard

AC 230/400 V voltage — typical diagram **CT2 (3+1)**

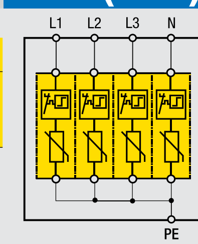
TYPE	QUANTITY		CODE
L 25/100 230 t ff 3+1	1		215 141



Three-phase Zone Panelboard

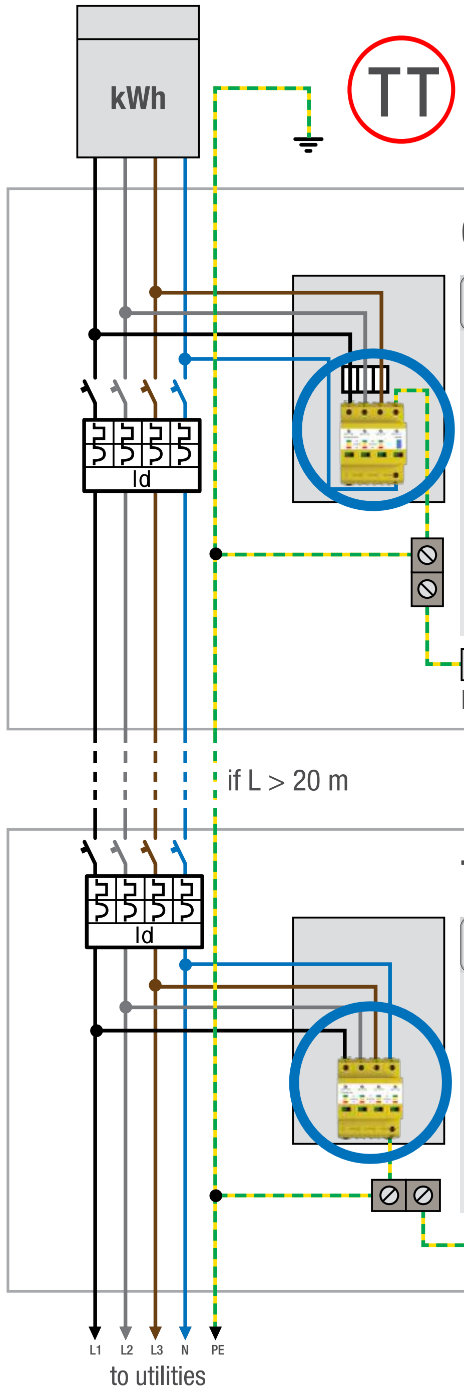
AC 230/400 V voltage — typical diagram **CT1 (4+0)**

TYPE	QUANTITY		CODE
L 2/10 230 t ff 4 TT	1		212 240



ZOTUP Typical example of installation in a TT system

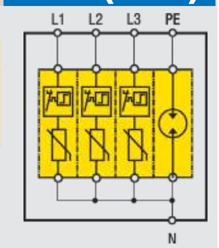
Tertiary / Handicraft
(small in suburban or rural area)



General Panelboard

AC 230/400 V voltage typical diagram **CT2 (3+1)**

TYPE	QUANTITY	CODE
L 13/40 230 ff 3+1	1	204 141



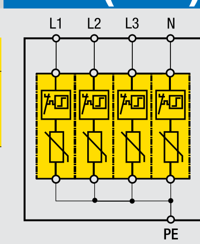
MEBB main equipotential bar

EBB local equipotential bar

Three-phase Zone Panelboard

AC 230/400 V voltage typical diagram **CT1 (4+0)**

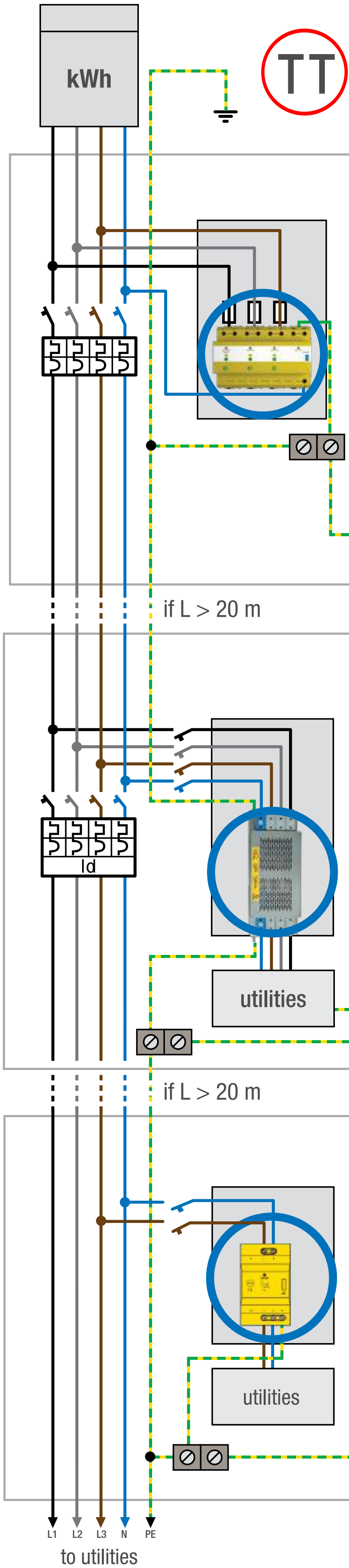
TYPE	QUANTITY	CODE
L 2/10 230 ff 4 TT	1	202 240



EBB local equipotential bar

ZOTUP Typical example of installation in a TT system

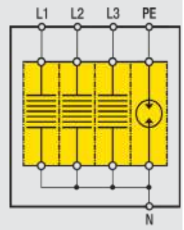
Tertiary / Data Center



Meter Panel

AC 230/400 V voltage — typical diagram **CT2 (3+1)**

TYPE	QUANTITY		CODE
IA 25 3+1	1		203 141



MEBB main equipotential bar

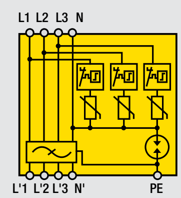
EBB local equipotential bar

Control Panel Room / CED

AC 230/400 V voltage — typical diagram **CT2 (3+1)**

TYPE	QUANTITY		CODE
ILF 4P 250	1		219 374
ILF 4P 400	1		219 344

For ILF-type SPDs, it is necessary to verify the current carrying capacity of the load.



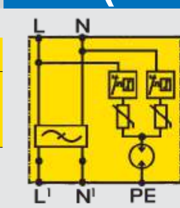
EBB local equipotential bar

Structured Wiring Rack

AC 230/400 V voltage — typical diagram **CT2 (1+1)**

TYPE	QUANTITY		CODE
ILF 2P 16 DIN	1		209 320

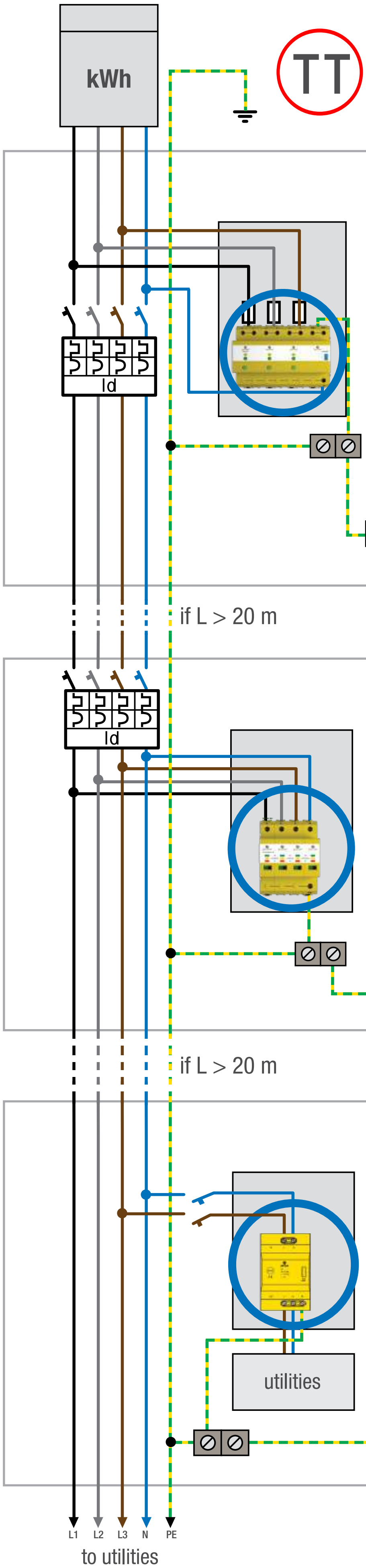
Maximum protection load: 16 A



EBB local equipotential bar

ZOTUP Typical example of installation in a TT system

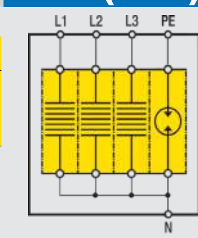
Tertiary / Open-space offices
(large/medium size)



Meter Panel

AC 230/400 V voltage — typical diagram **CT2 (3+1)**

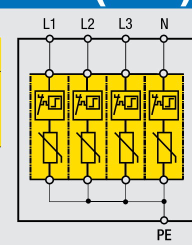
TYPE	QUANTITY	CODE
IA 25 3+1	1	203 141



General Panelboard

AC 230/400 V voltage — typical diagram **CT1 (4+0)**

TYPE	QUANTITY	CODE
L 2/10 230 t ff 4 TT	1	212 240

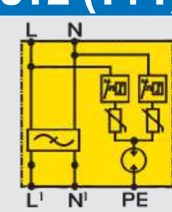


Structured Wiring Rack

AC 230/400 V voltage — typical diagram **CT2 (1+1)**

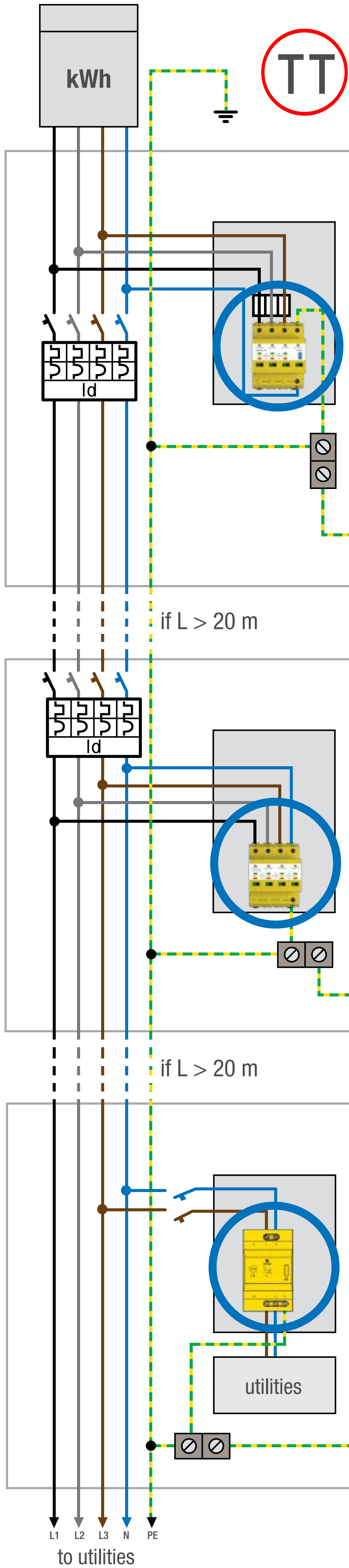
TYPE	QUANTITY	CODE
ILF 2P 16 DIN	1	209 320

Maximum load of the protection: 16 A



Surge arresters:
ZOTUP Typical example of installation in a TT system

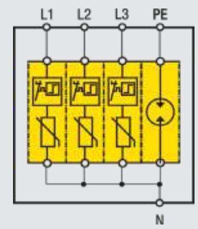
Tertiary / Offices
(small size in urban area)



Meter Panel

AC 230/400 V voltage — typical diagram **CT2 (3+1)**

TYPE	QUANTITY	CODE
L 7/30 230 ff 3+1	1	207 141



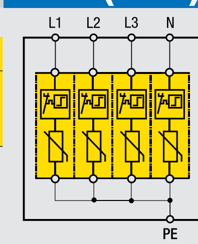
MEBB main equipotential bar

EBB local equipotential bar

General Panelboard

AC 230/400 V voltage — typical diagram **CT1 (4+0)**

TYPE	QUANTITY	CODE
L 2/10 230 ff 4 TT	1	202 240



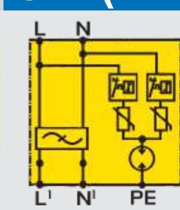
EBB local equipotential bar

Structured Wiring Rack

AC 230/400 V voltage — typical diagram **CT2 (1+1)**

TYPE	QUANTITY	CODE
ILF 2P 16 DIN	1	209 320

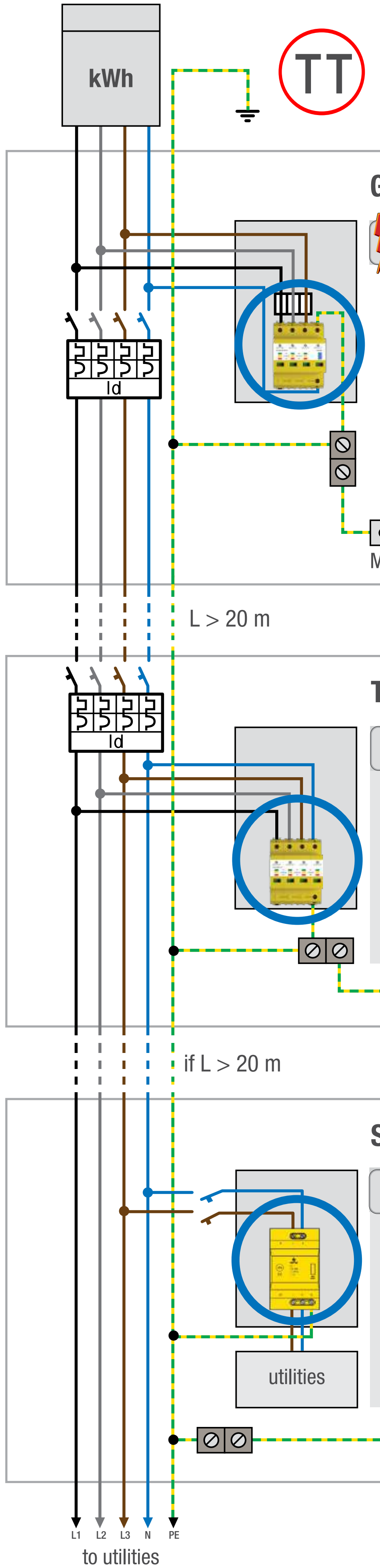
Maximum load of the protection: 16 A



EBB local equipotential bar

ZOTUP Typical example of installation in a TT system

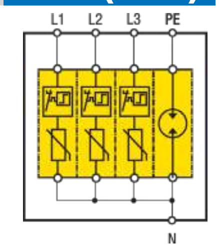
Tertiary / Supermarket
(in suburban or rural area)



General Panelboard

AC 230/400 V voltage — typical diagram **CT2 (3+1)**

TYPE	QUANTITY	CODE
L 13/40 230 t ff 3+1	1	214 141



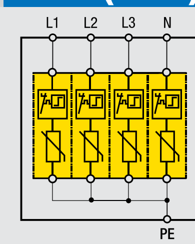
MEBB main equipotential bar

EBB local equipotential bar

Three-phase Zone Panelboard

AC 230/400 V voltage — typical diagram **CT1 (4+0)**

TYPE	QUANTITY	CODE
L 2/10 230 t ff 4 TT	1	212 240



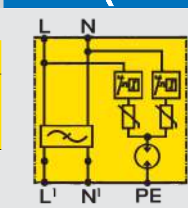
EBB local equipotential bar

Structured Wiring Rack

AC 230/400 V voltage — typical diagram **CT2 (1+1)**

TYPE	QUANTITY	CODE
ILF 2P 16 DIN	1	209 320

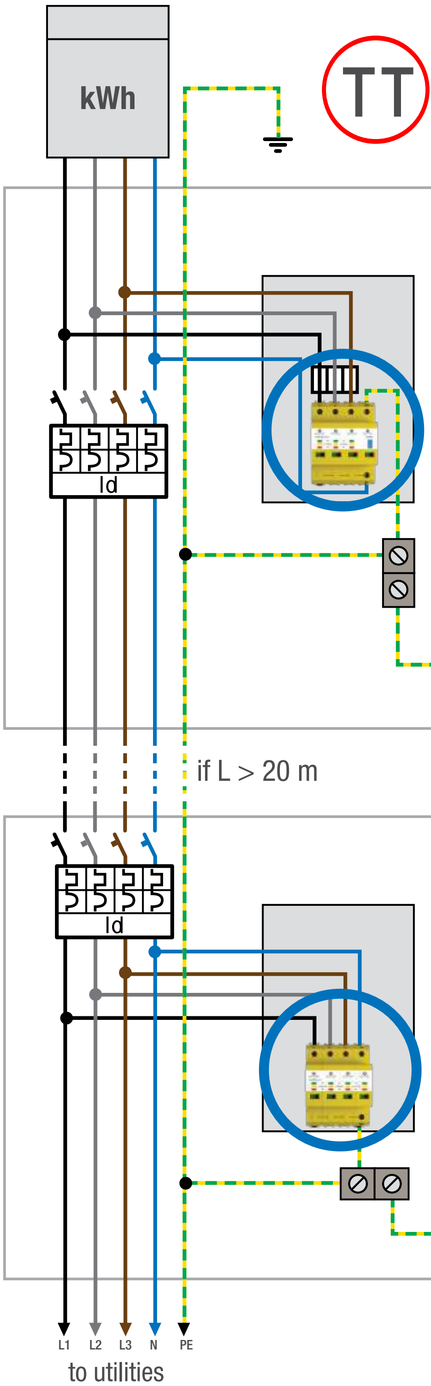
Maximum load of the protection: 16 A



EBB local equipotential bar

ZOTUP Typical example of installation in a TT system

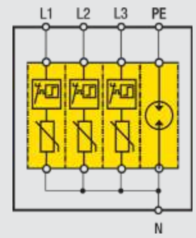
Tertiary / Shopping Center
(aggregate of stores)



Meter Panel

AC 230/400 V voltage — typical diagram **CT2 (3+1)**

TYPE	QUANTITY	CODE
L 13/40 230 ff 3+1	1	204 141



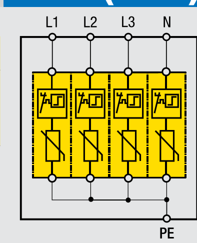
MEBB main equipotential bar

EBB local equipotential bar

Three-phase Zone Panelboard

AC 230/400 V voltage — typical diagram **CT1 (4+0)**

TYPE	QUANTITY	CODE
L 2/10 230 ff 4 TT	1	202 240

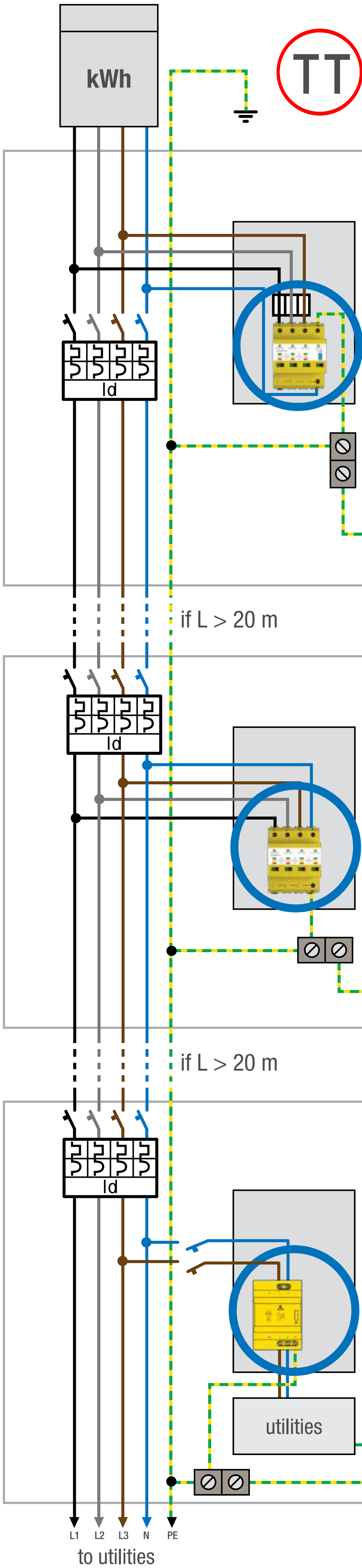


EBB local equipotential bar

ZOTUP Typical example of installation in a TT system

Residential
(large villa in suburban or rural area)

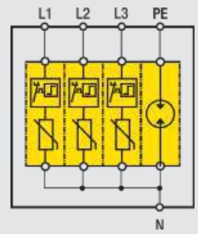
CEI 64-8 Ed. 8



General Panelboard

AC 230/400 V voltage — typical diagram **CT2 (3+1)**

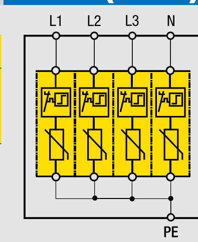
TYPE	QUANTITY	CODE
L 13/40 230 ff 3+1	1	204 141



Three-phase Zone Panelboard

AC 230/400 V voltage — typical diagram **CT1 (4+0)**

TYPE	QUANTITY	CODE
L 2/10 230 ff 4 TT	1	202 240

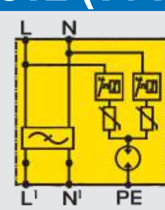


Sensitive Utility Panelboard (home automation)

AC 230/400 V voltage — typical diagram **CT2 (1+1)**

TYPE	QUANTITY	CODE
ILF 2P 25 DIN	1	209 325

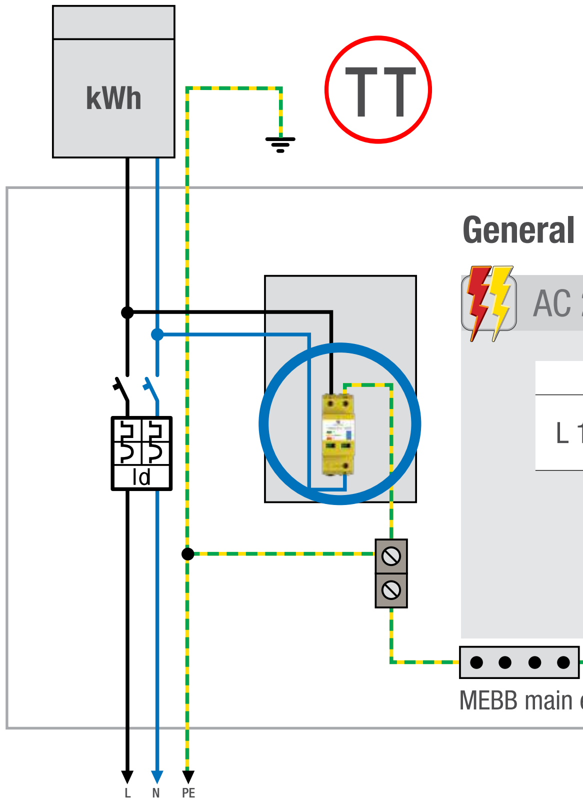
For ILS-type SPDs, it is necessary to verify the rating (A) depending on the load.



ZOTUP Typical example of installation in a TT system

Residential
(Small Villa in suburban/rural area)

CEI 64-8 Ed. 8

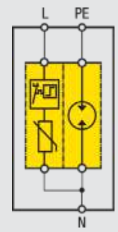


to utilities

General Panelboard

AC 230 V voltage typical diagram **CT2 (1+1)**

TYPE	QUANTITY	CODE
L 13/40 230 ff 1+1	1	204 121

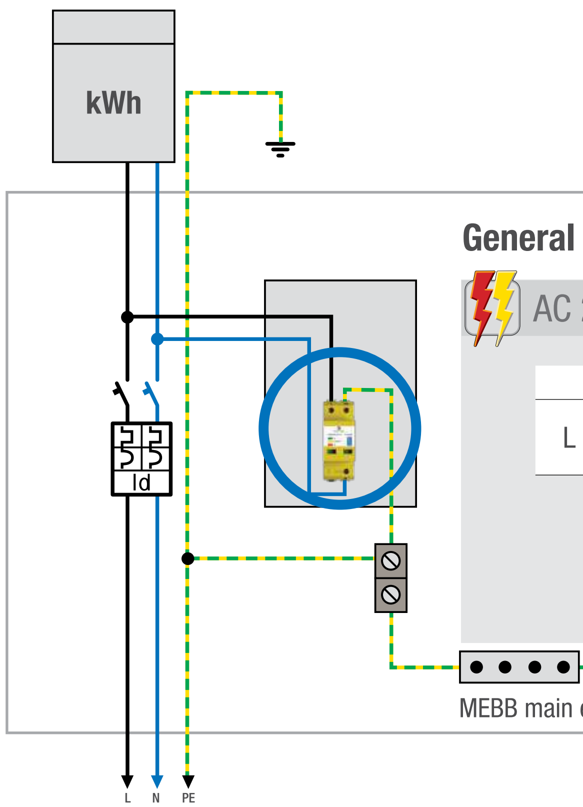


MEBB main equipotential bar

EBB local equipotential bar

Residential
(Small-scale villa in urban area)

CEI 64-8 Ed. 8

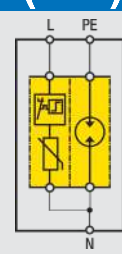


to utilities

General Panelboard

AC 230 V voltage typical diagram **CT2 (1+1)**

TYPE	QUANTITY	CODE
L 7/30 230 ff 1+1	1	207 121

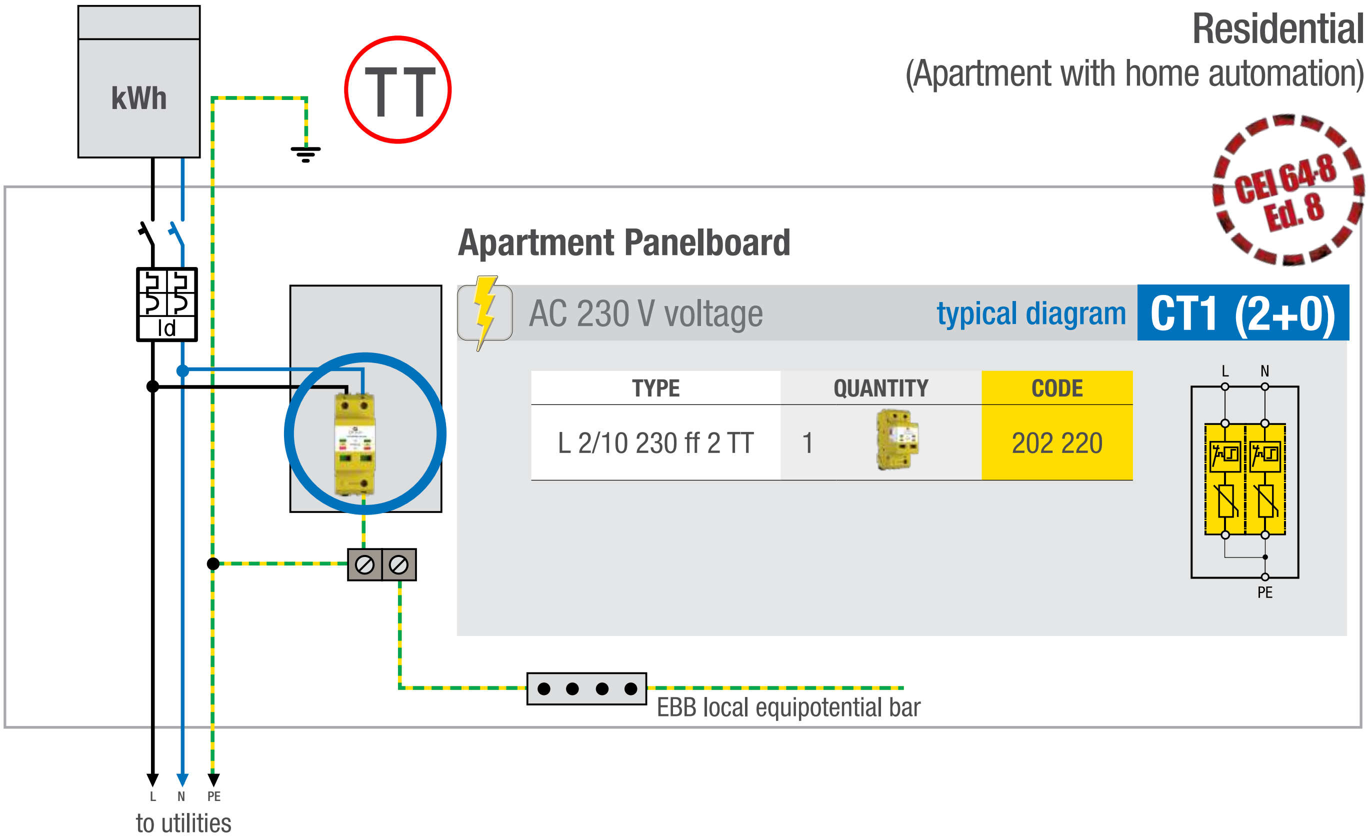


MEBB main equipotential bar

EBB local equipotential bar

ZOTUP Typical example of installation in a TT system

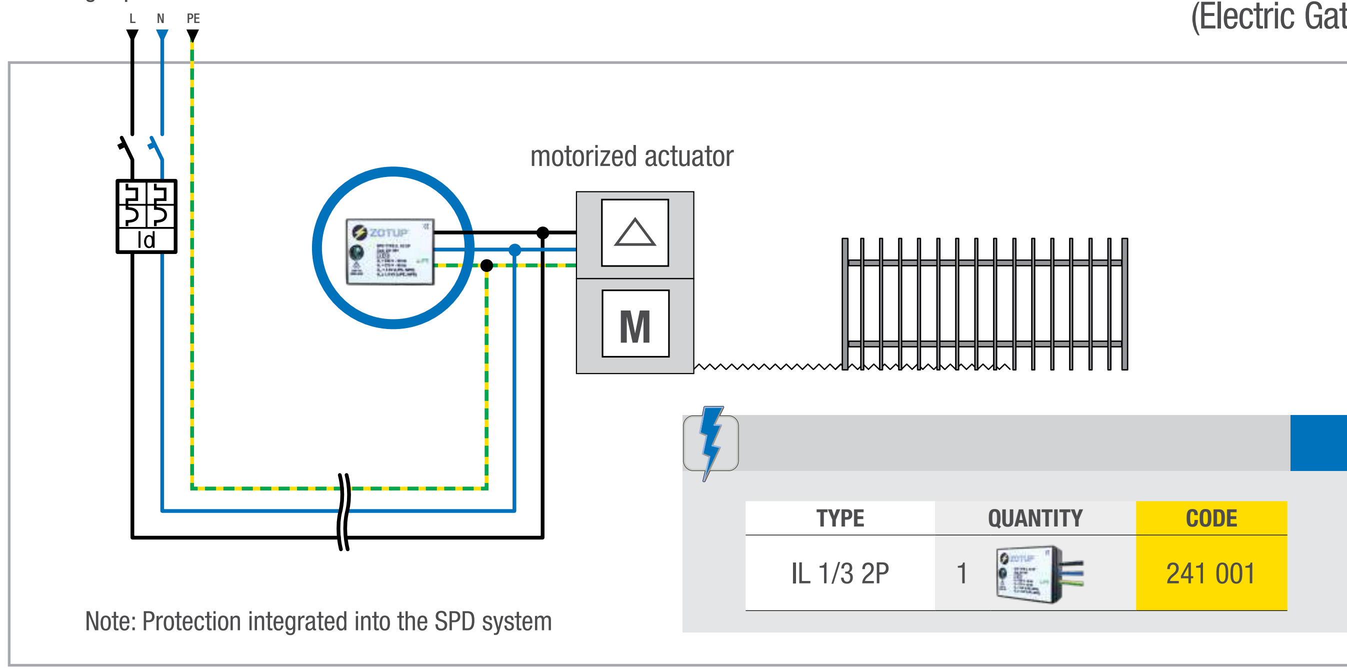
Residential
(Apartment with home automation)



AC 230 V voltage — typical diagram **CT1 (2+0)**

TYPE	QUANTITY	CODE
L 2/10 230 ff 2 TT	1	202 220

Residential
(Electric Gate)

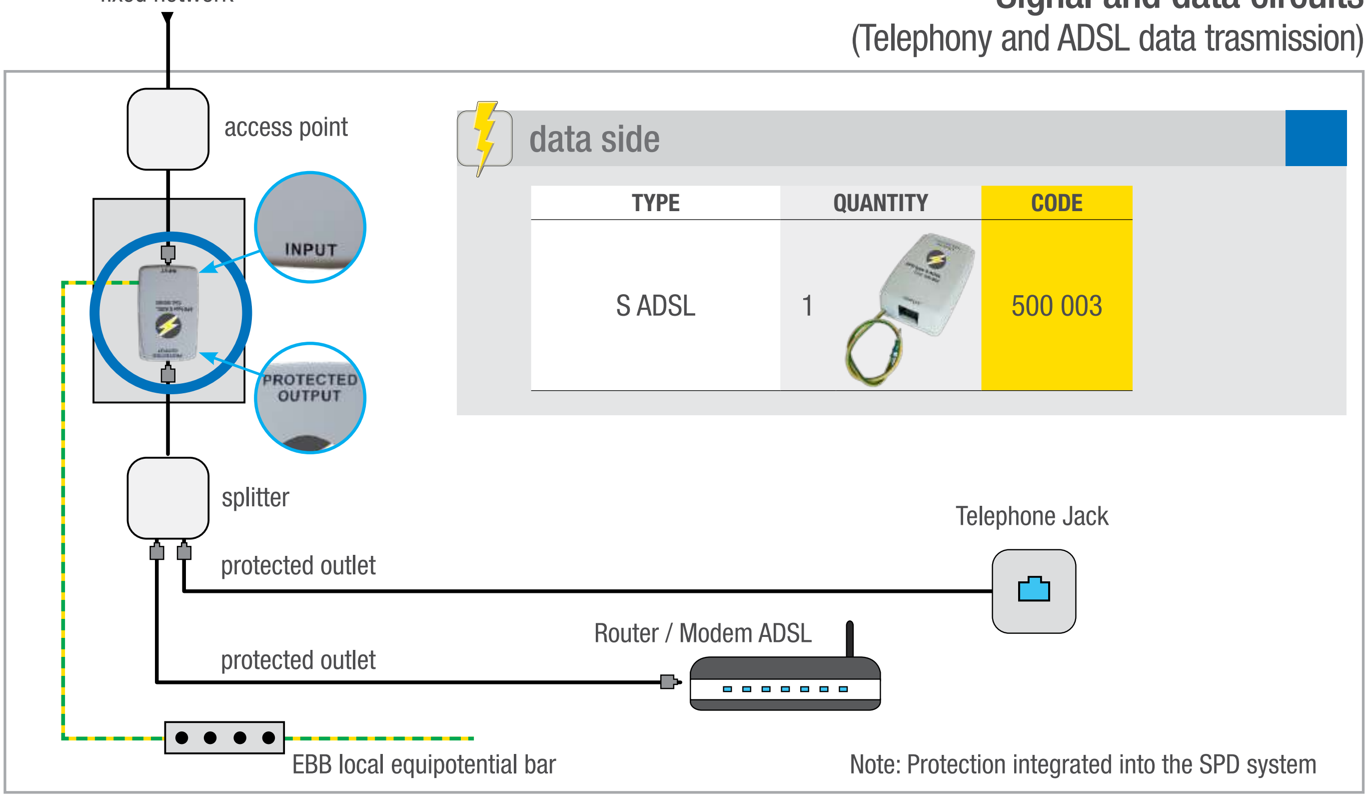


TYPE	QUANTITY	CODE
IL 1/3 2P	1	241 001

Note: Protection integrated into the SPD system

ZOTUP Typical installation example for signal and data circuits

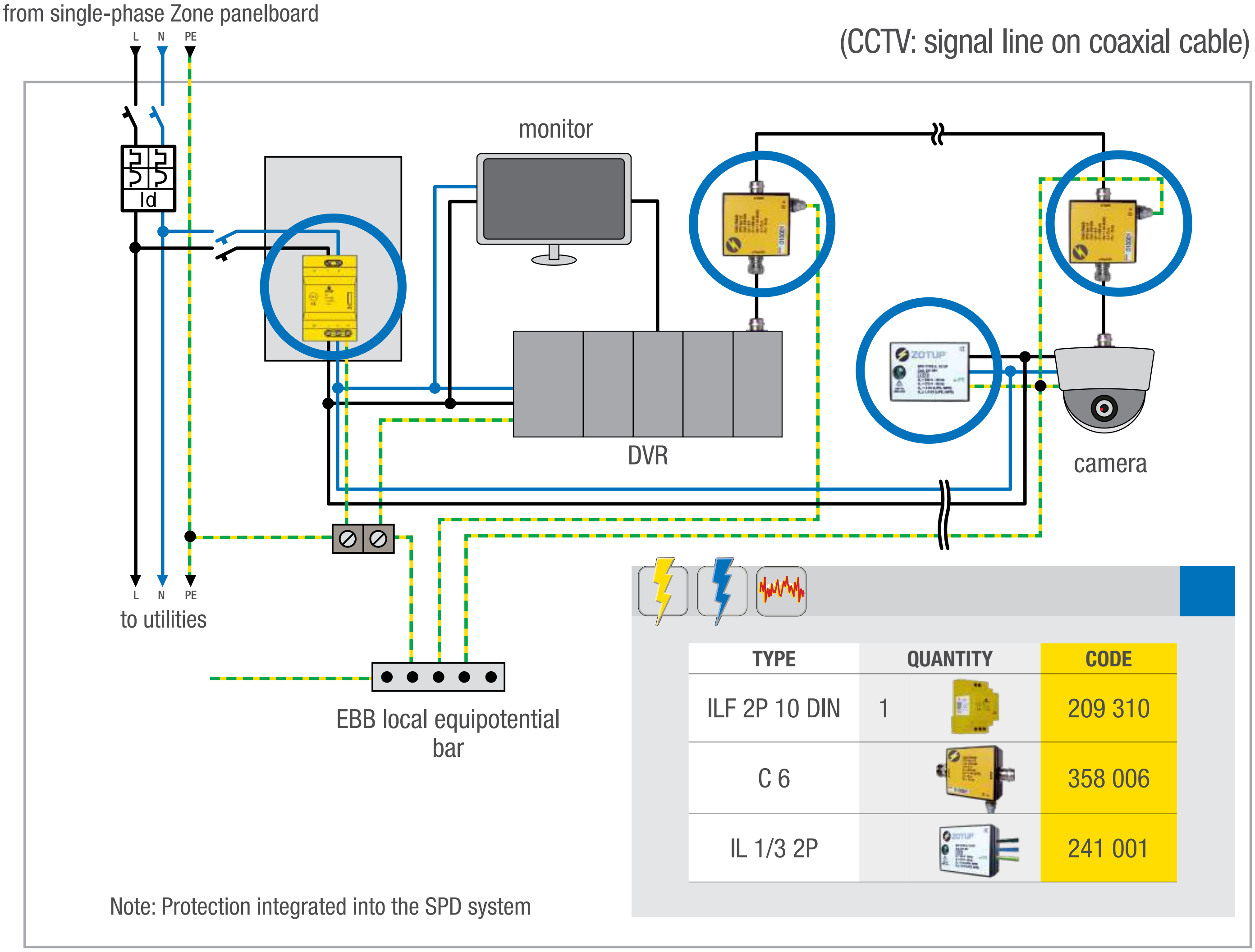
Signal and data circuits
(Telephony and ADSL data trasmission)



TYPE	QUANTITY	CODE
S ADSL	1	500 003

Note: Protection integrated into the SPD system

(CCTV: signal line on coaxial cable)

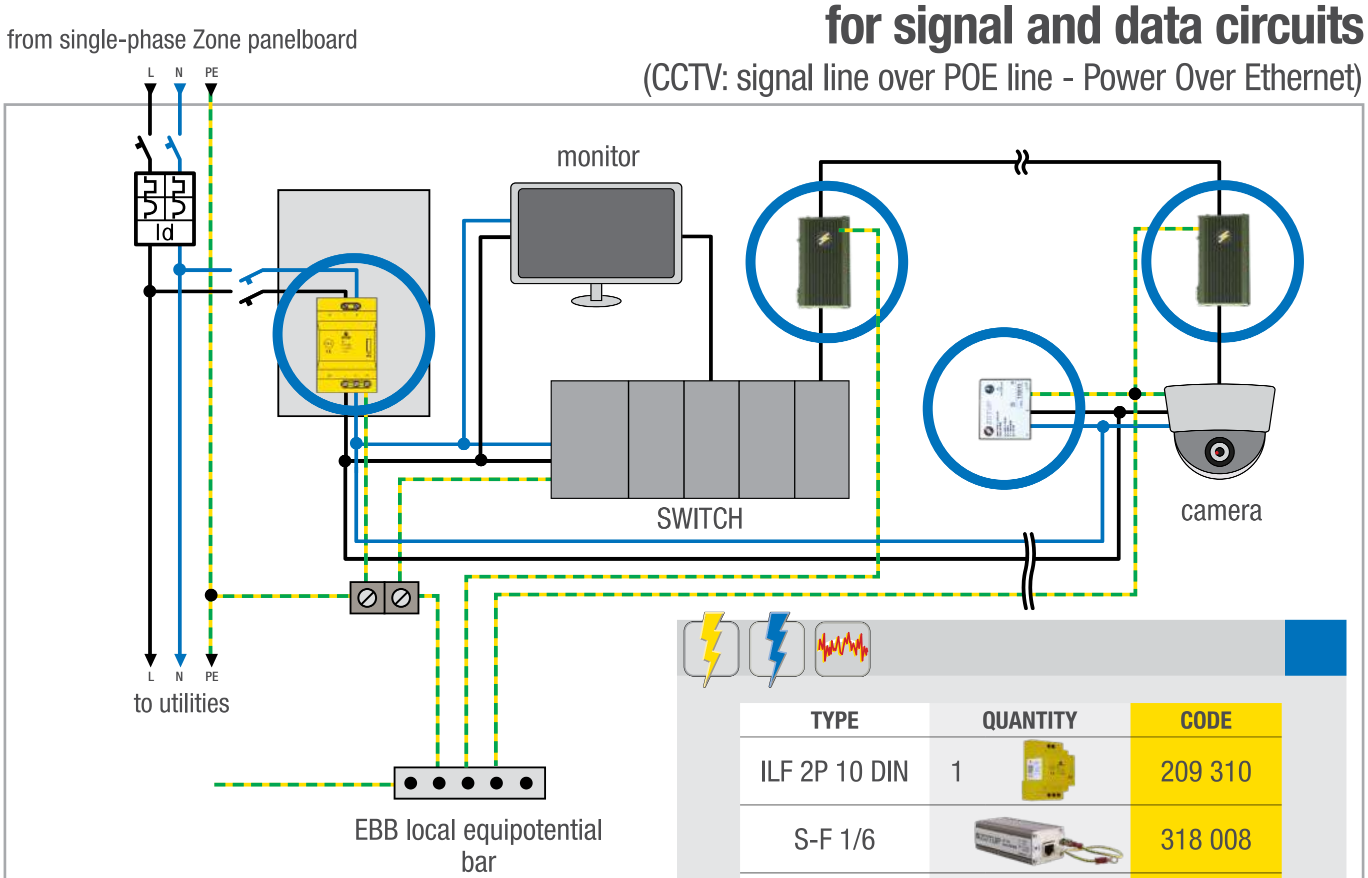


TYPE	QUANTITY	CODE
ILF 2P 10 DIN	1	209 310
C 6		358 006
IL 1/3 2P		241 001

Note: Protection integrated into the SPD system

Surge arresters:
ZOTUP Typical installation example for signal and data circuits

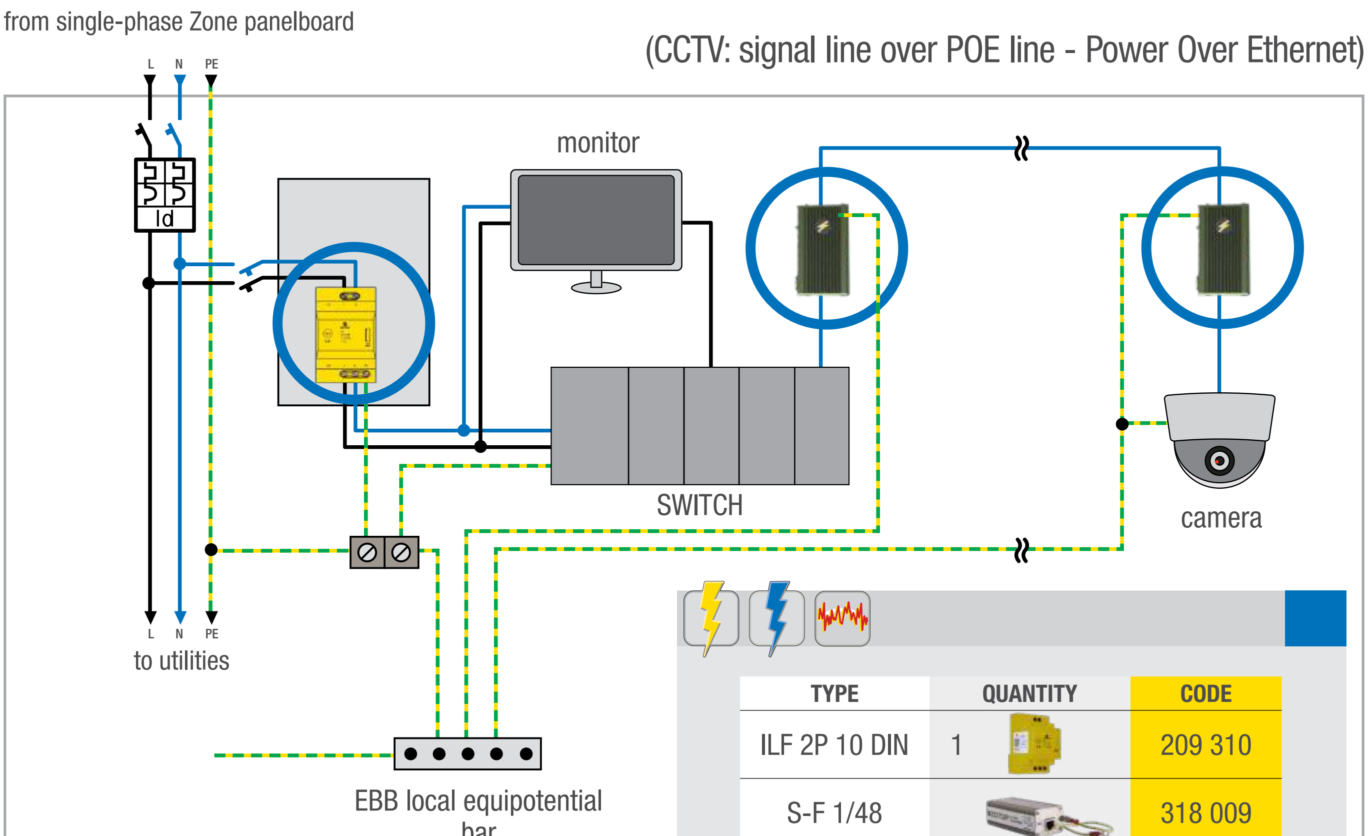
(CCTV: signal line over POE line - Power Over Ethernet)



Note: Protection integrated into the SPD system

TYPE	QUANTITY	CODE
ILF 2P 10 DIN	1	209 310
S-F 1/6		318 008
IL 1/10 2P M		241 002

(CCTV: signal line over POE line - Power Over Ethernet)

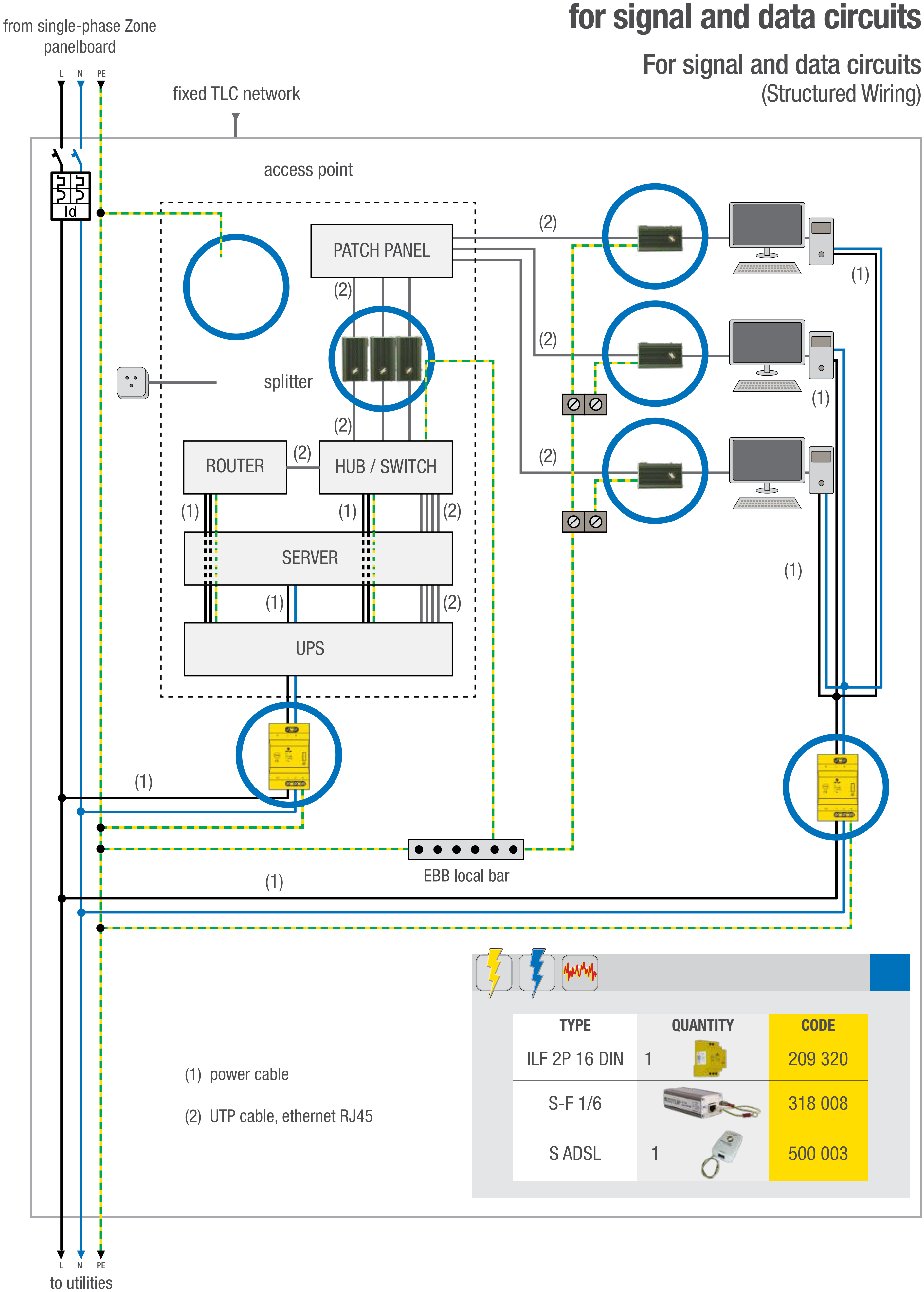


Note: Protection integrated into the SPD system

TYPE	QUANTITY	CODE
ILF 2P 10 DIN	1	209 310
S-F 1/48		318 009

Surge arresters:
ZOTUP Typical installation example for signal and data circuits

For signal and data circuits
(Structured Wiring)



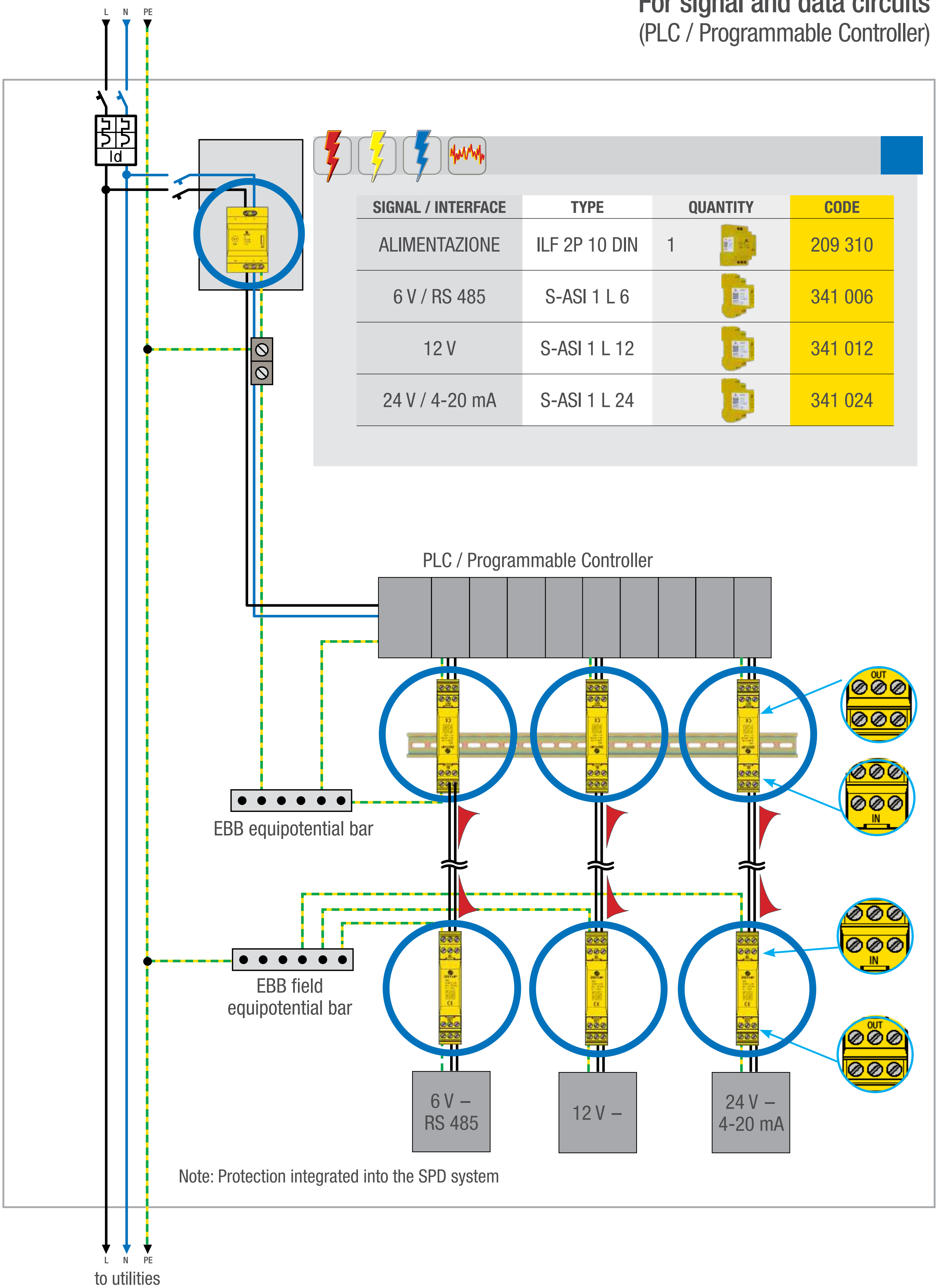
(1) power cable

(2) UTP cable, ethernet RJ45

TYPE	QUANTITY	CODE
ILF 2P 16 DIN	1	209 320
S-F 1/6		318 008
S ADSL	1	500 003

Surge arresters:
ZOTUP Typical installation example for signal and data circuits

For signal and data circuits
(PLC / Programmable Controller)



SIGNAL / INTERFACE	TYPE	QUANTITY	CODE
ALIMENTAZIONE	ILF 2P 10 DIN	1	209 310
6 V / RS 485	S-ASI 1 L 6		341 006
12 V	S-ASI 1 L 12		341 012
24 V / 4-20 mA	S-ASI 1 L 24		341 024

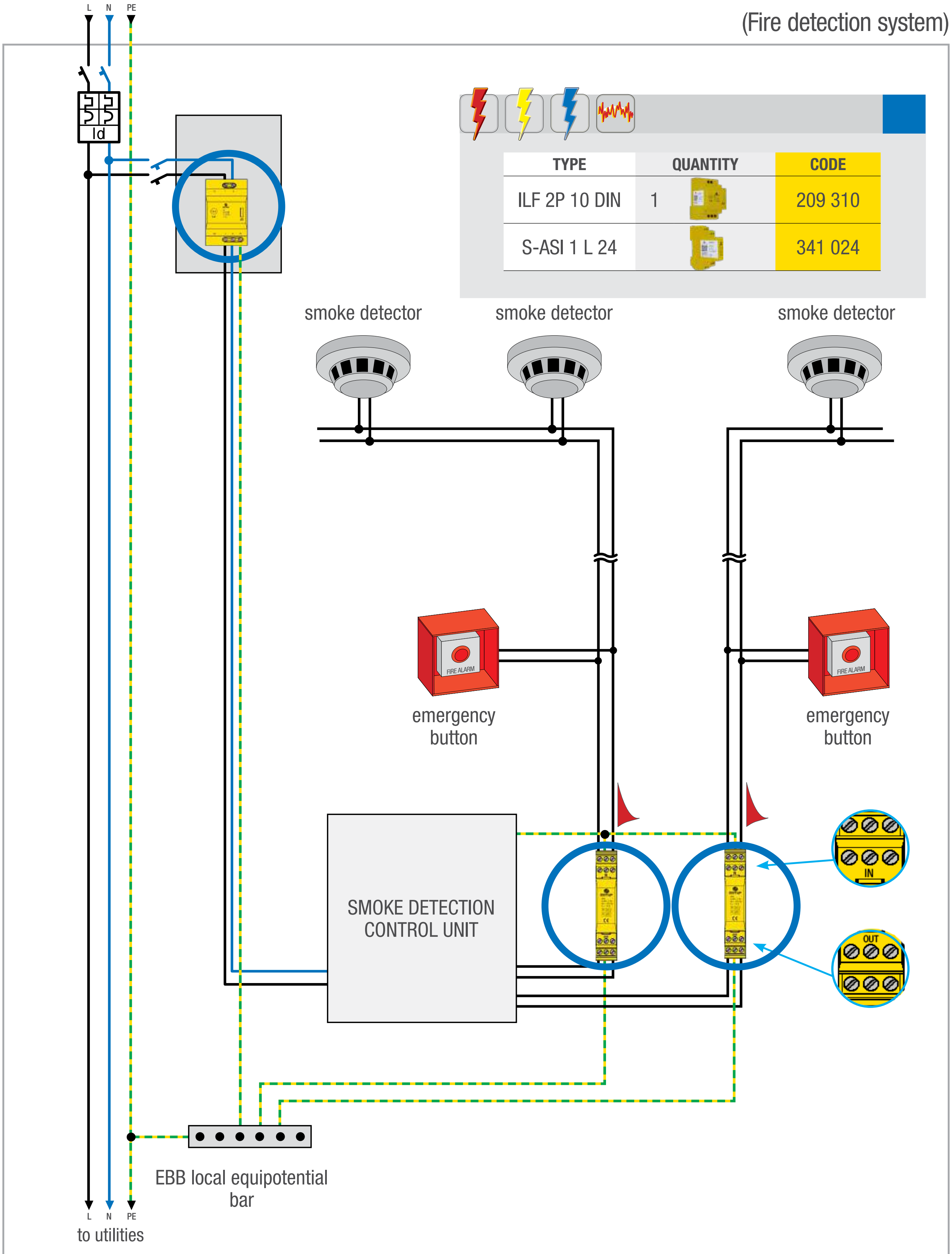
Note: Protection integrated into the SPD system

ZOTUP Typical installation example for signal and data circuits

(Fire detection system)

from single-phase Zone panelboard

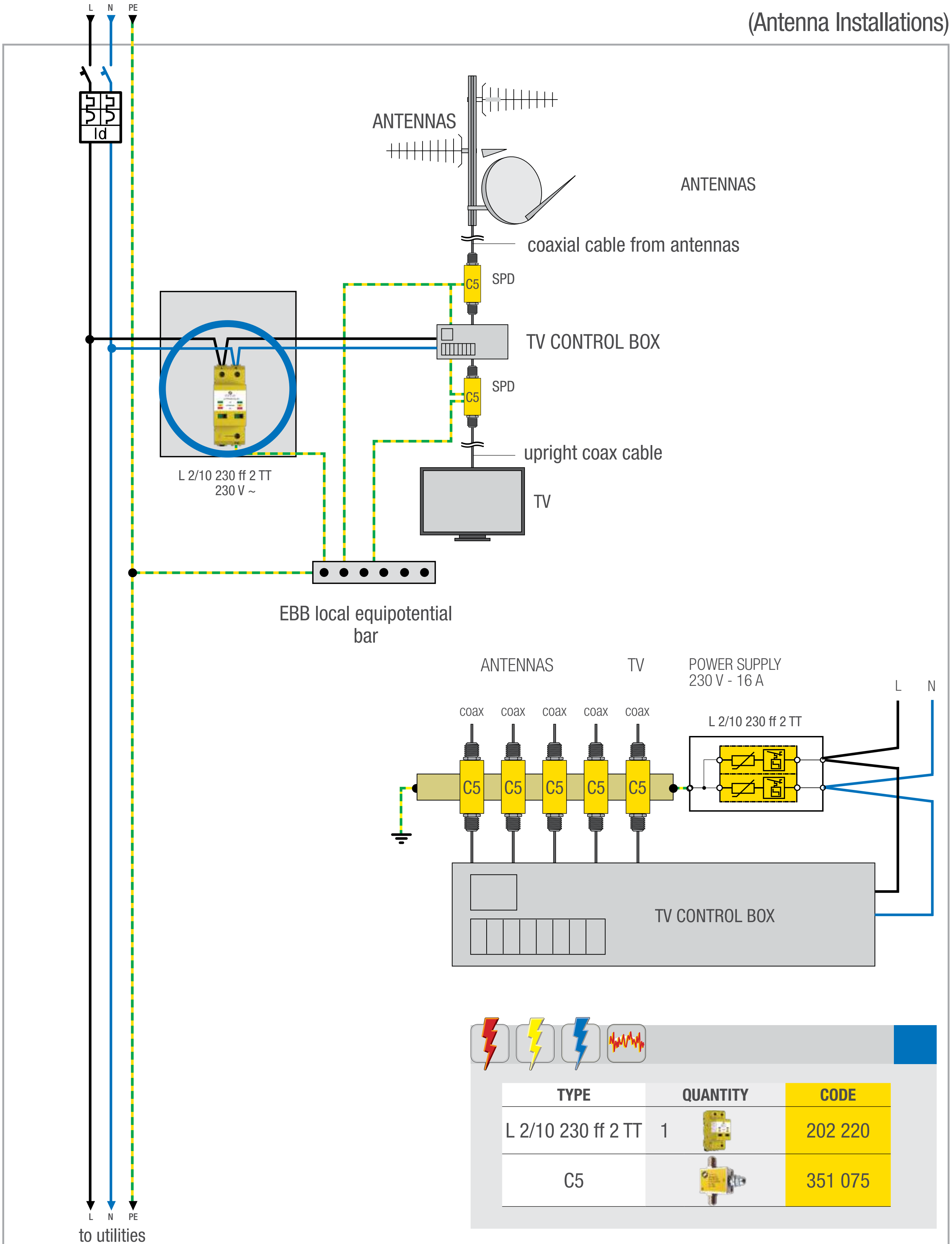
TYPE	QUANTITY	CODE
ILF 2P 10 DIN	1	209 310
S-ASI 1 L 24		341 024



Note: Protection integrated into the SPD system

Surge arresters:
ZOTUP Typical installation example for signal and data circuits

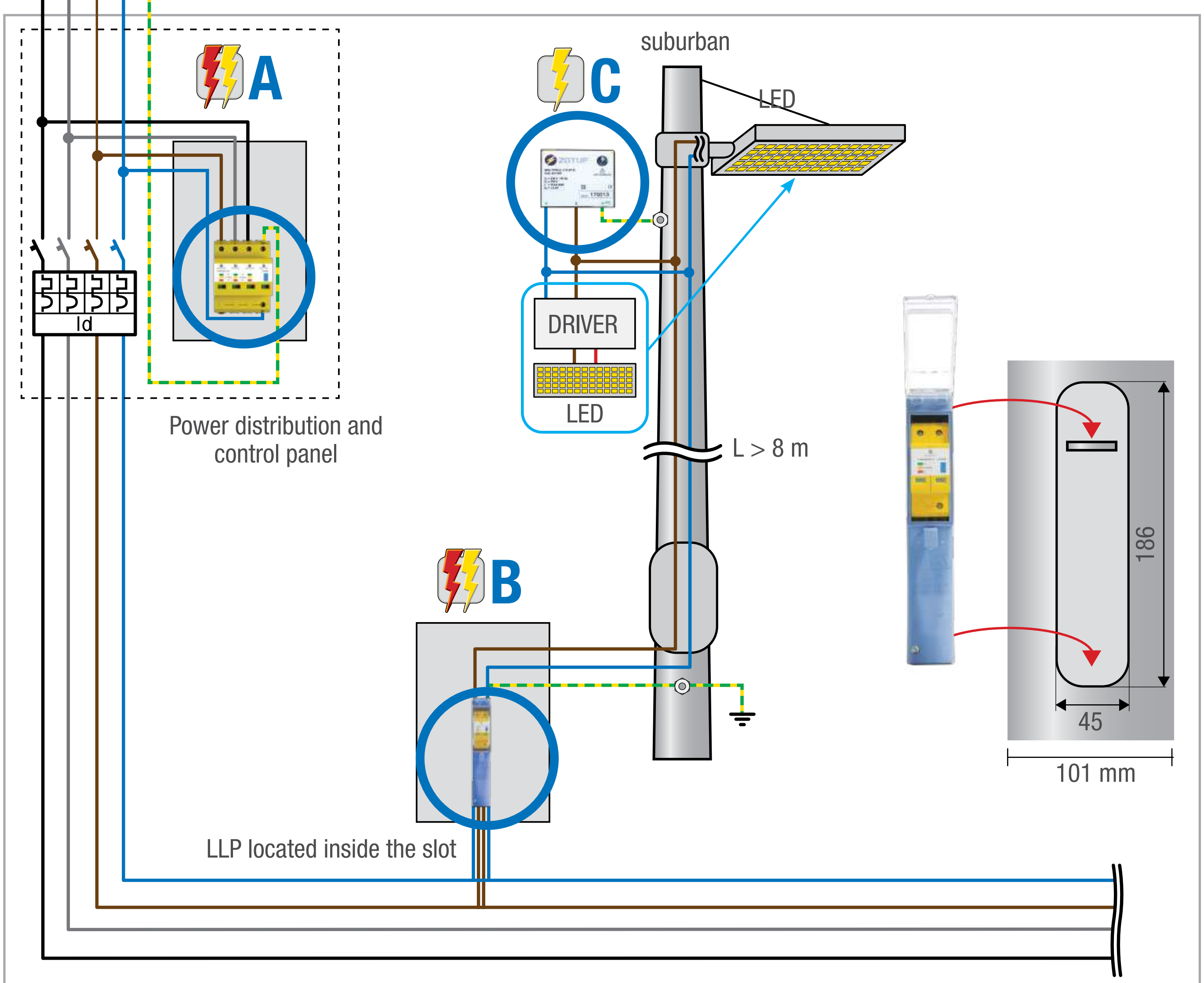
(Antenna Installations)

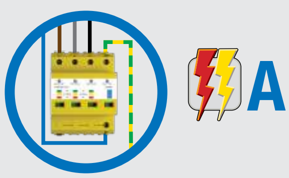


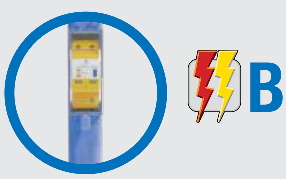
TYPE	QUANTITY	CODE
L 2/10 230 ff 2 TT	1	202 220
C5		351 075

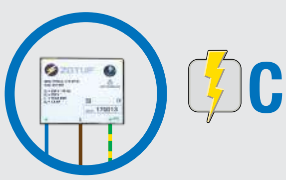
Surge arresters:
ZOTUP Typical installation example for LED street lightning

LED street lightning
(In suburban environment - poles L > 8 m
DRIVER on board LED light fixture)







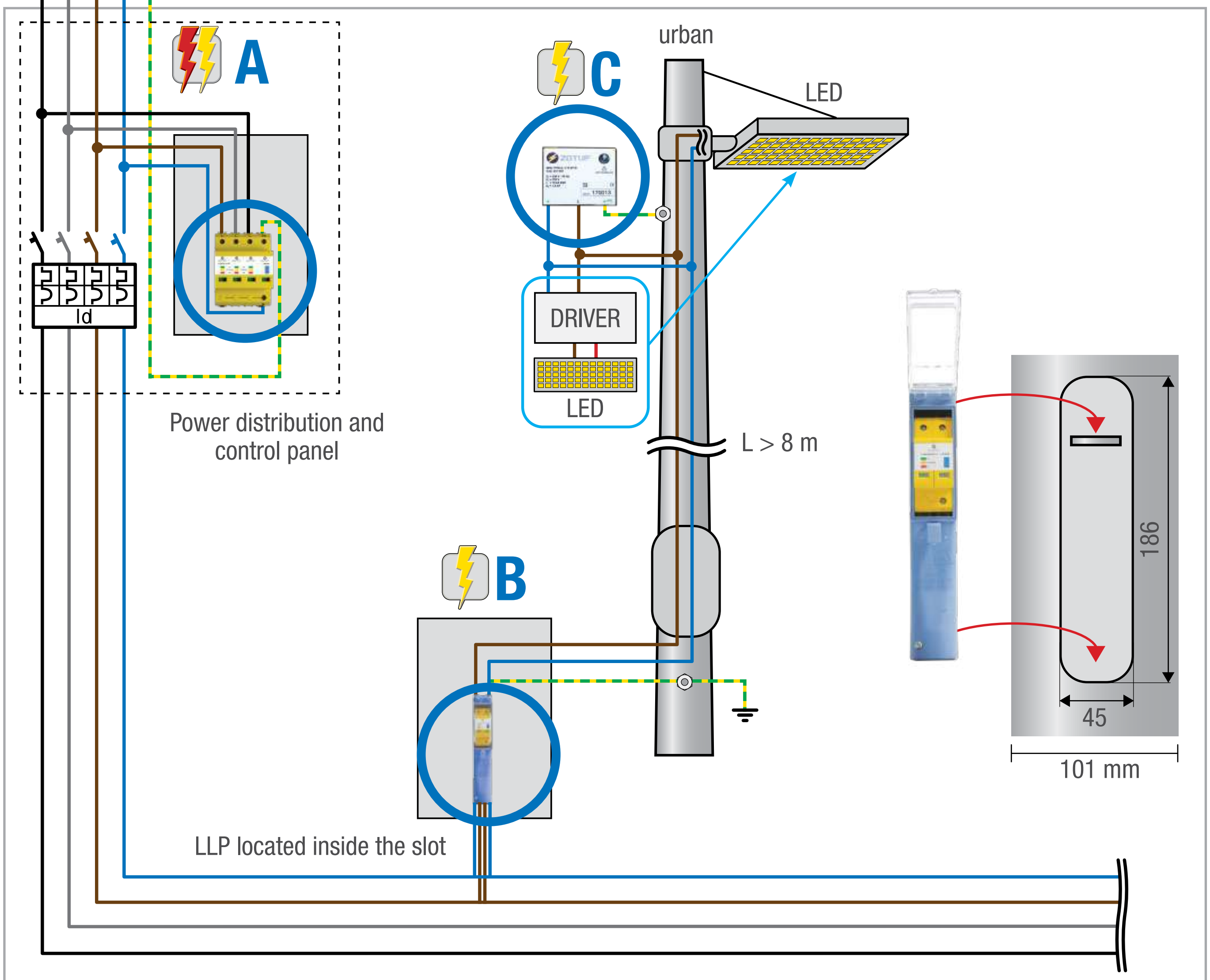


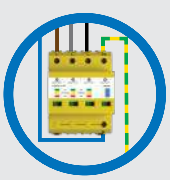
TYPE	QUANTITY		CODE
L 13/40 230 t ff 3+1	1		214 141
LLP 7/30 230 ff 1+1	1		242 191
IL 1/10 2P M	1		241 002

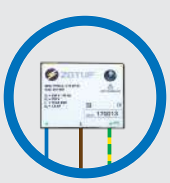
ZOTUP Typical installation example for LED street lightning

LED street lightning

(In urban environment - poles L > 8 m
DRIVER on board LED light fixture)

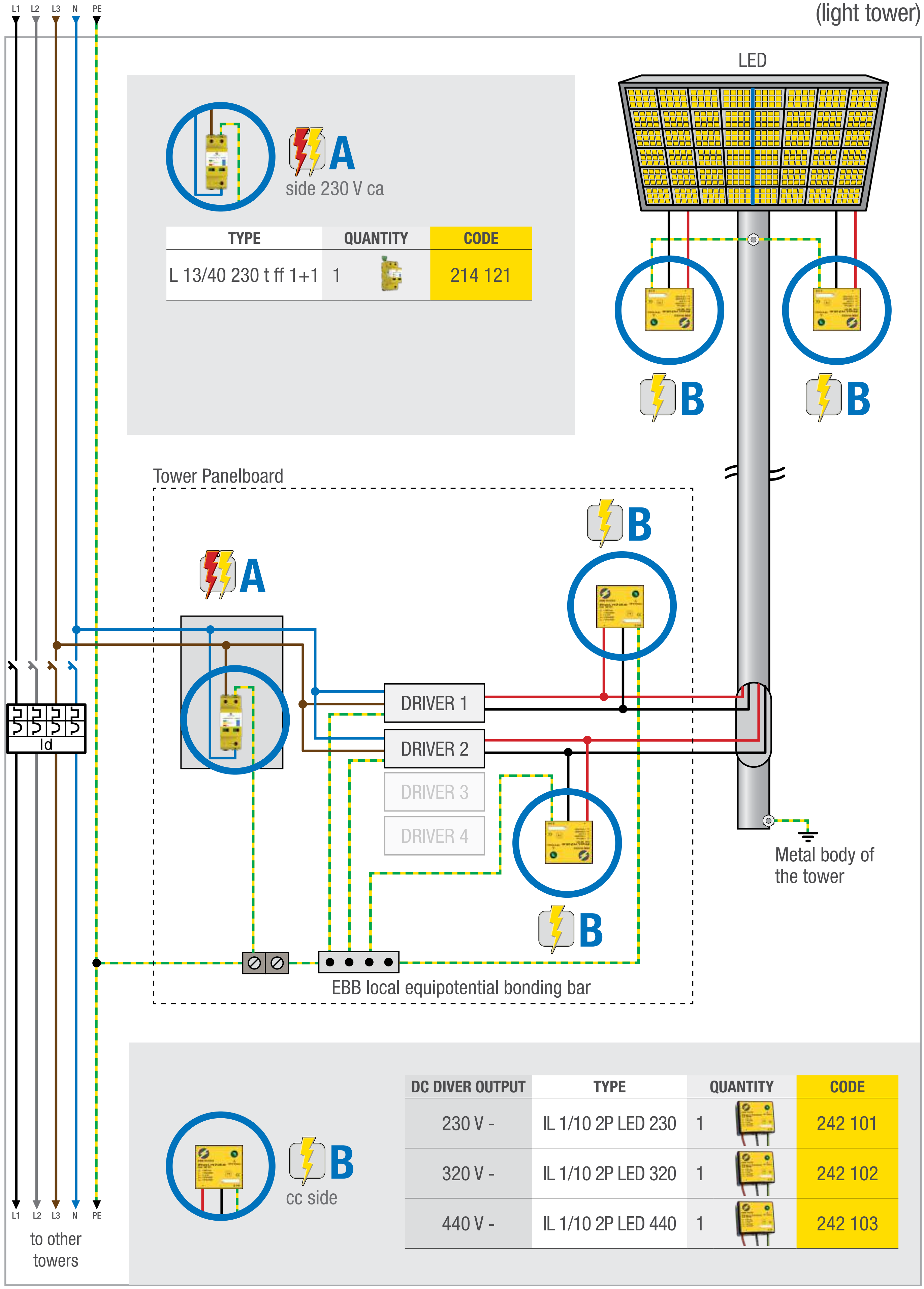






TYPE	QUANTITY		CODE
L 7/30 230 t ff 3+1	1		217 141
LLP 2/10 230 ff 1+1	1		242 190
IL 1/10 2P M	1		241 002

Surge arresters:
ZOTUP Typical installation example for LED street lightning
(light tower)

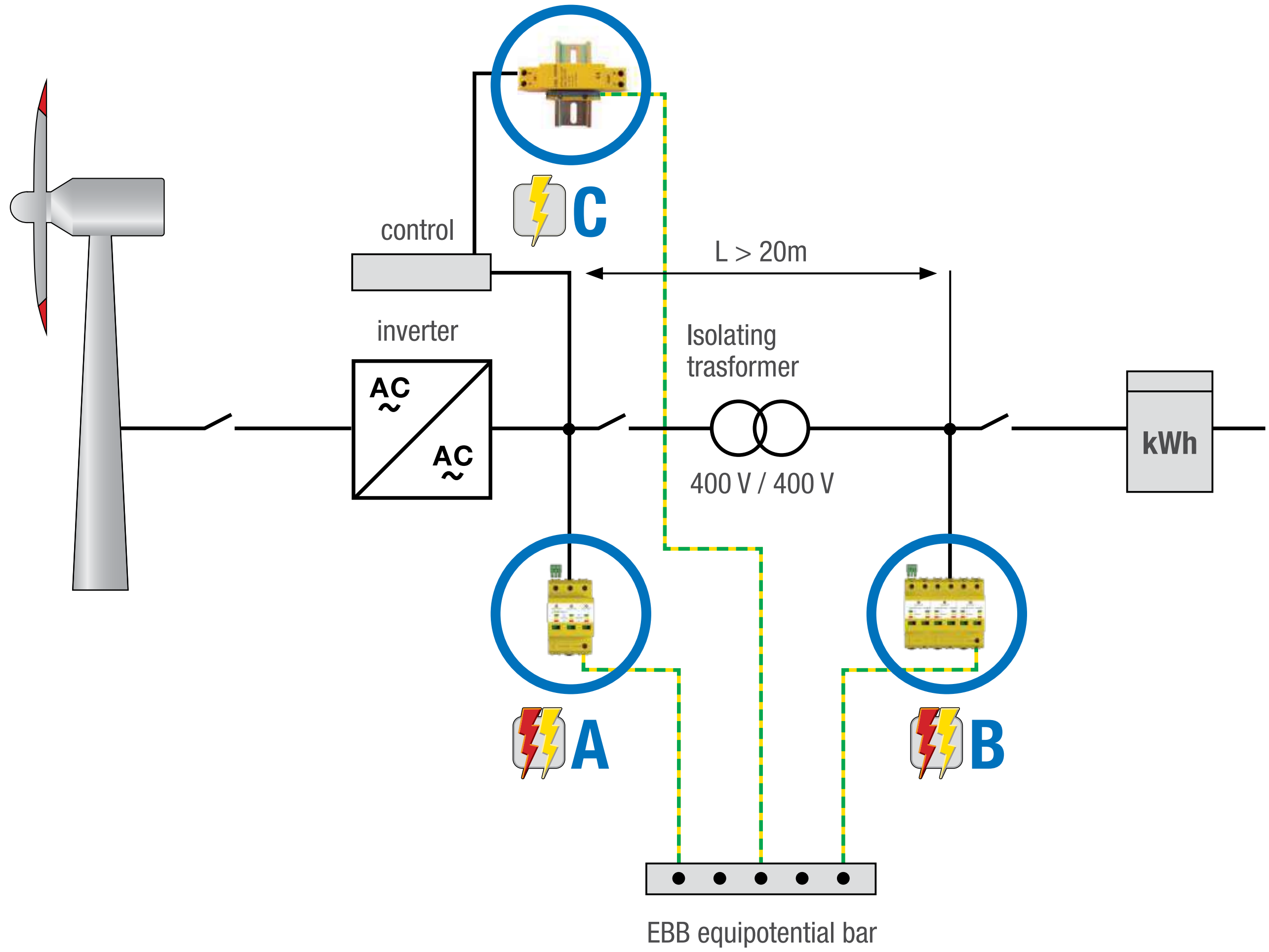


TYPE	QUANTITY	CODE
L 13/40 230 t ff 1+1	1	214 121

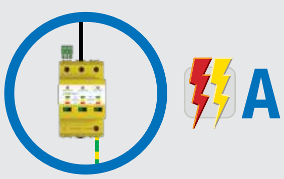
DC DIVER OUTPUT	TYPE	QUANTITY	CODE
230 V -	IL 1/10 2P LED 230	1	242 101
320 V -	IL 1/10 2P LED 320	1	242 102
440 V -	IL 1/10 2P LED 440	1	242 103

ZOTUP Typical example in wind power plants

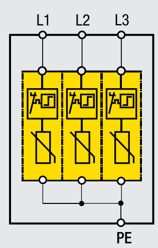
Small wind power plants
(Power below 200 kW)



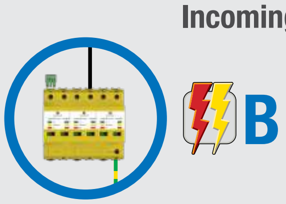
Inverter protection



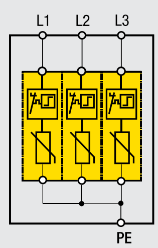
TYPE	QUANTITY	CODE
L 7/30 750 t ff 3	1	217 137



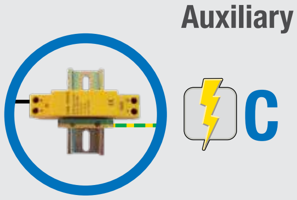
Incoming line protection



TYPE	QUANTITY	CODE
L 25/100 230 t ff 3	1	215 130



Auxiliary circuit protection



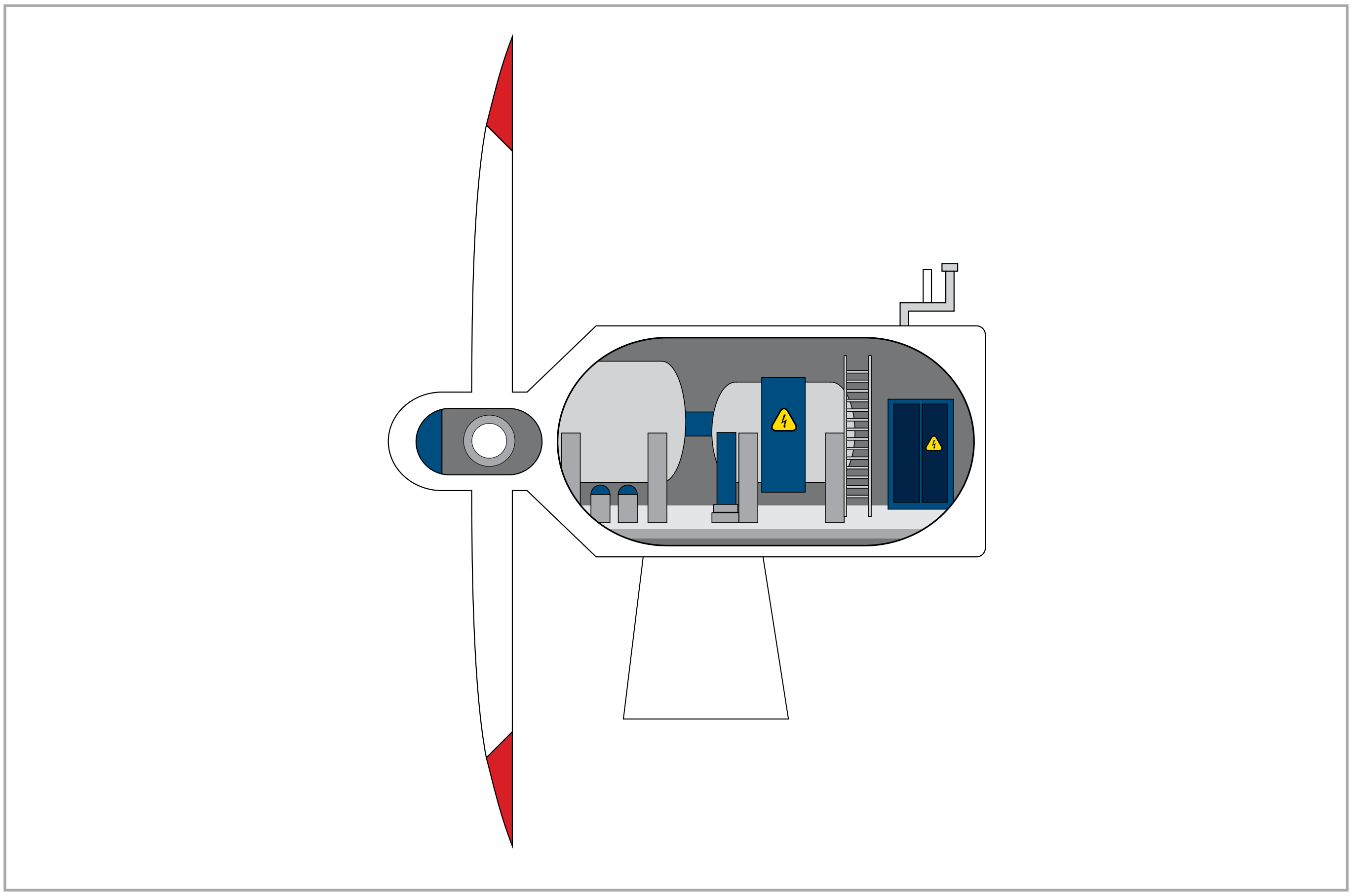
TYPE	QUANTITY	CODE
S-AS 2 24/1	1	302 524

Reference: Standards EN-IEC 61400-24 (2010-08); CLC/TS 50539-22 (2012-08).

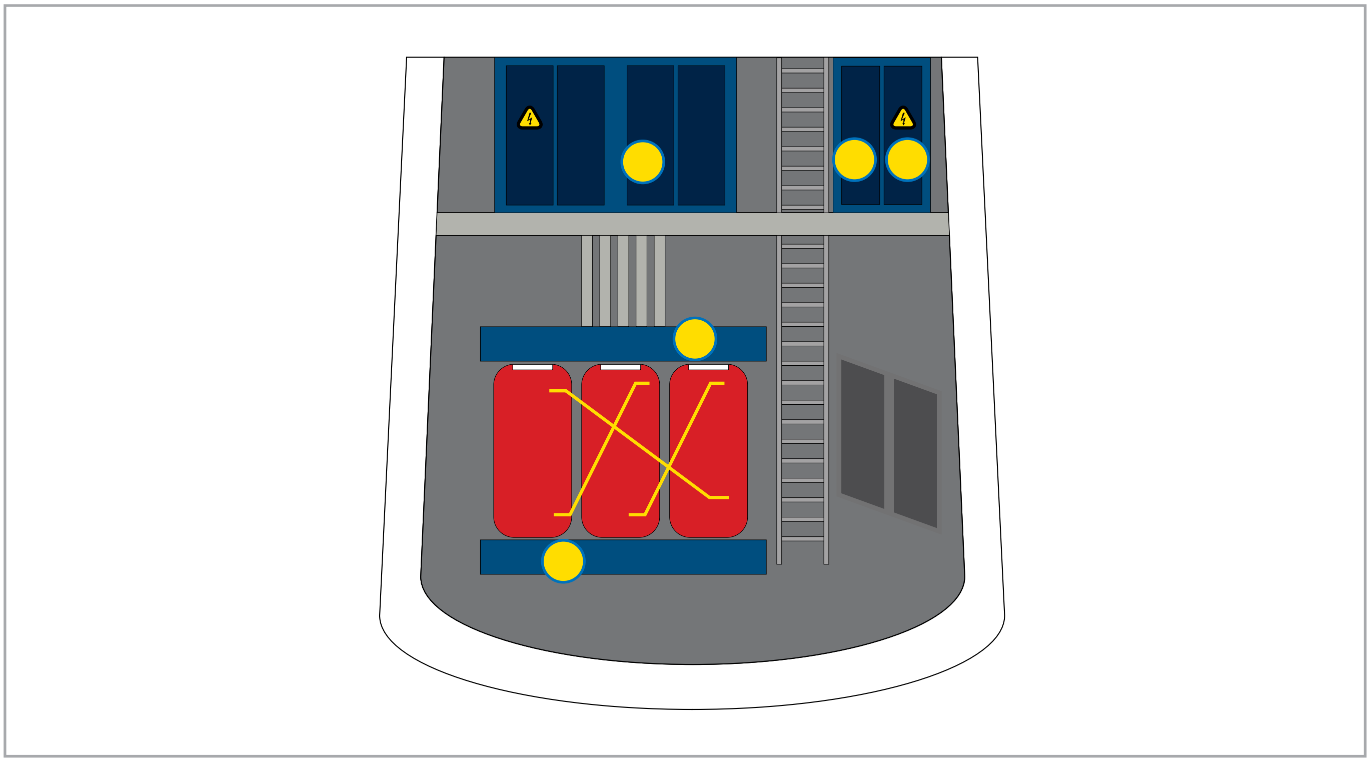
ZOTUP Typical example in wind power plants

Powerful wind power plants
(Power higher than 200 kW)

Turbine



Tower base

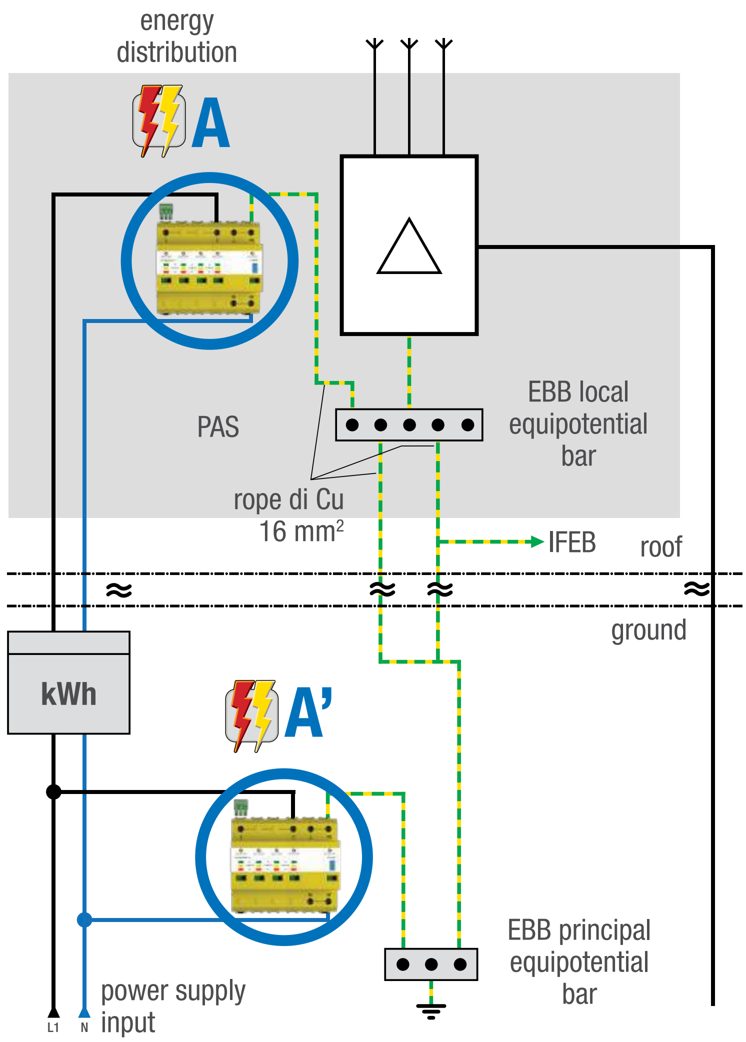


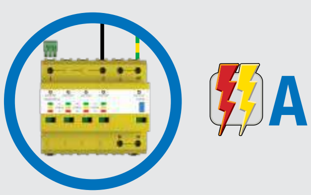
		TYPE	QUANTITY	CODE
1	**Pitch controller, blade and rotor sensor**	L 7/30 230 t ff 2	1 	217 120
		S-ASI 1 L 24		341 024
		S-F 1/48		318 009
2	**Blade signalling lights**	L 13/40 230 t ff 2	1 	214 120
3	**Anemometer**	S-ASI 1 L 24	1 	341 024
4	**Power supply to the nacelle system**	L 7/30 230 t ff 3	1 	217 130
5	**Generator, rotor protection**	L 7/30 1000 t ff	3 	217 110
6	**Power supply to the systems at the base of the tower**	L 3/30 230 t ff	1 	210 130
7	**Low-voltage side trasformer**	L 7/30 400 t ff	4 	217 104
		CP 4	1 	249 594
8	**Generator, stator and inverter protection**	L 7/30 750 t ff 3	1 	217 137
9	**Signals, buses and control lines**	S-ASI 1 L 24	1 	341 024
10	**Medium-voltage side trasformator (20 kV / 690 V)**	ZU HV 24.2	3 	120 424
		ZU 7	3 	107 000
		ZU 4	3 	104 000

References: Standards EN-IEC 61400-24 (2010-08); CLC/TS 50539-22 (2012-08).

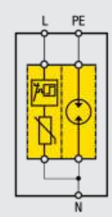
ZOTUP Typical installation example for TV stations / broadcasting

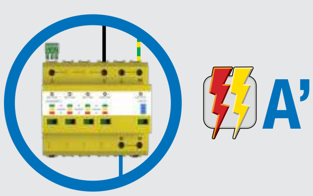
Single-phase





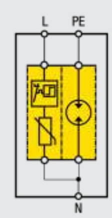
TYPE	QUANTITY		CODE
L 50/100 230 t ff 1+1	1		218 121





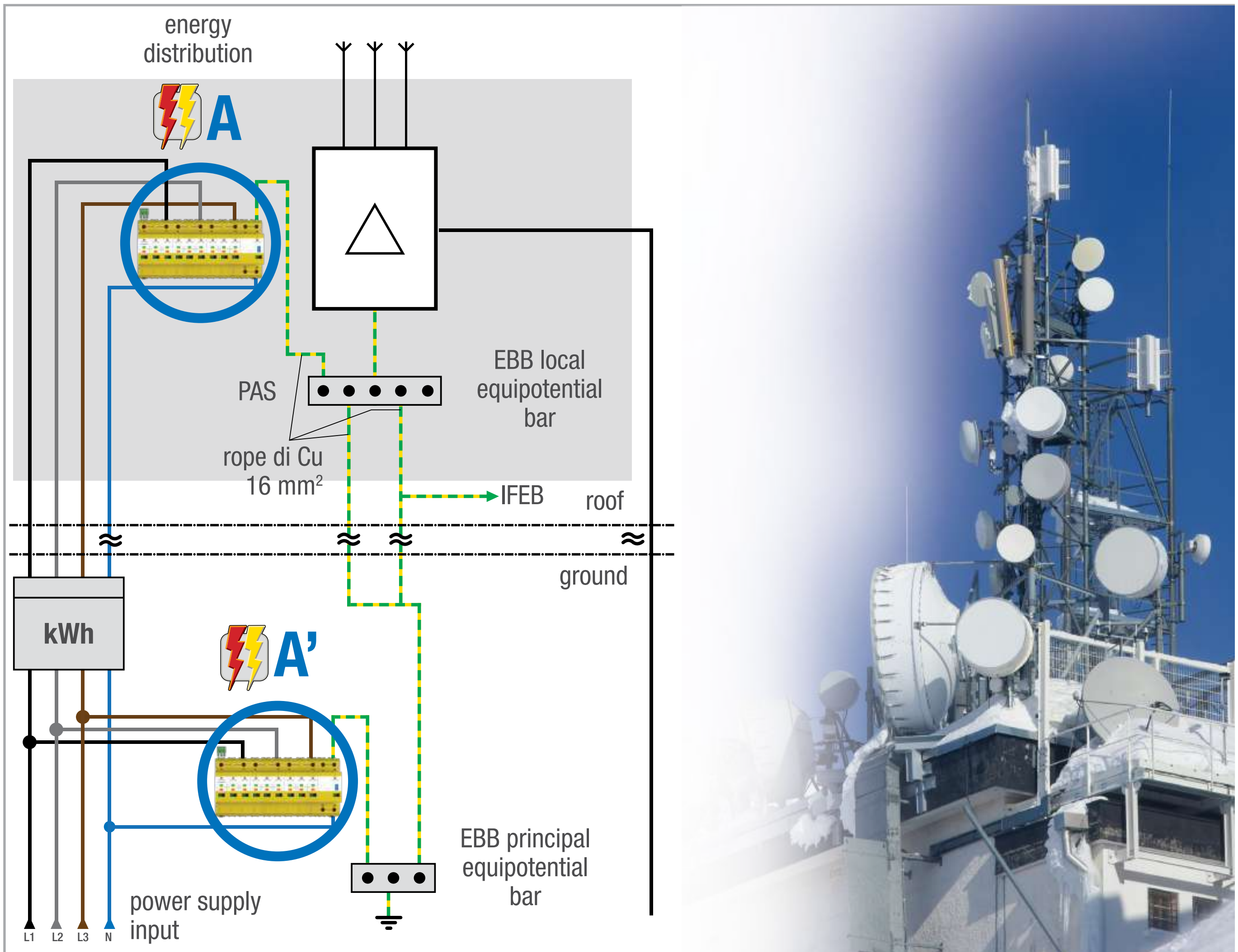
(SUBJECT TO AGREEMENT WITH DISTRIBUTOR)

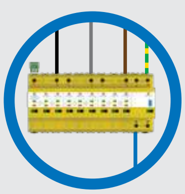
L 50/100 230 t ff 1+1	1		218 121



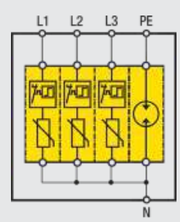
Surge arresters:
ZOTUP Typical installation example for TV stations / broadcasting

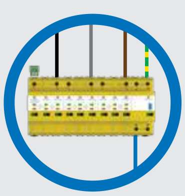
Three-phase




A

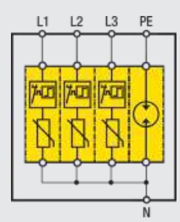
TYPE	QUANTITY		CODE
L 40/100 230 t ff 3+1	1		216 141




A'

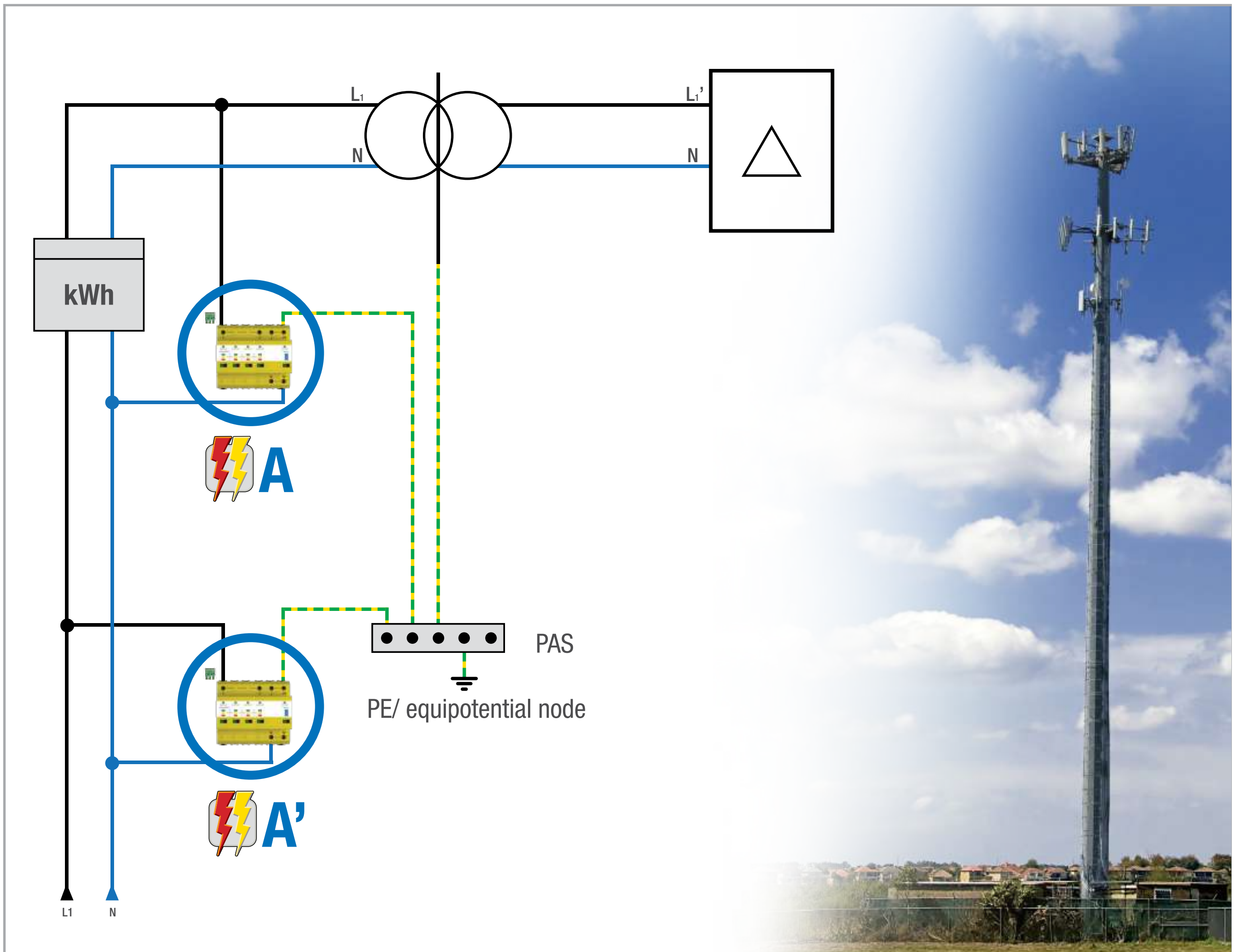
(SUBJECT TO AGREEMENT WITH DISTRIBUTOR)

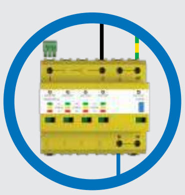
L 40/100 230 t ff 3+1	1		216 141



ZOTUP Typical installation example for communication tower

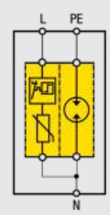
Single-phase

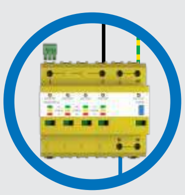




A

TYPE	QUANTITY	CODE
L 50/100 230 t ff 1+1	1 	218 121

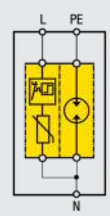




A'

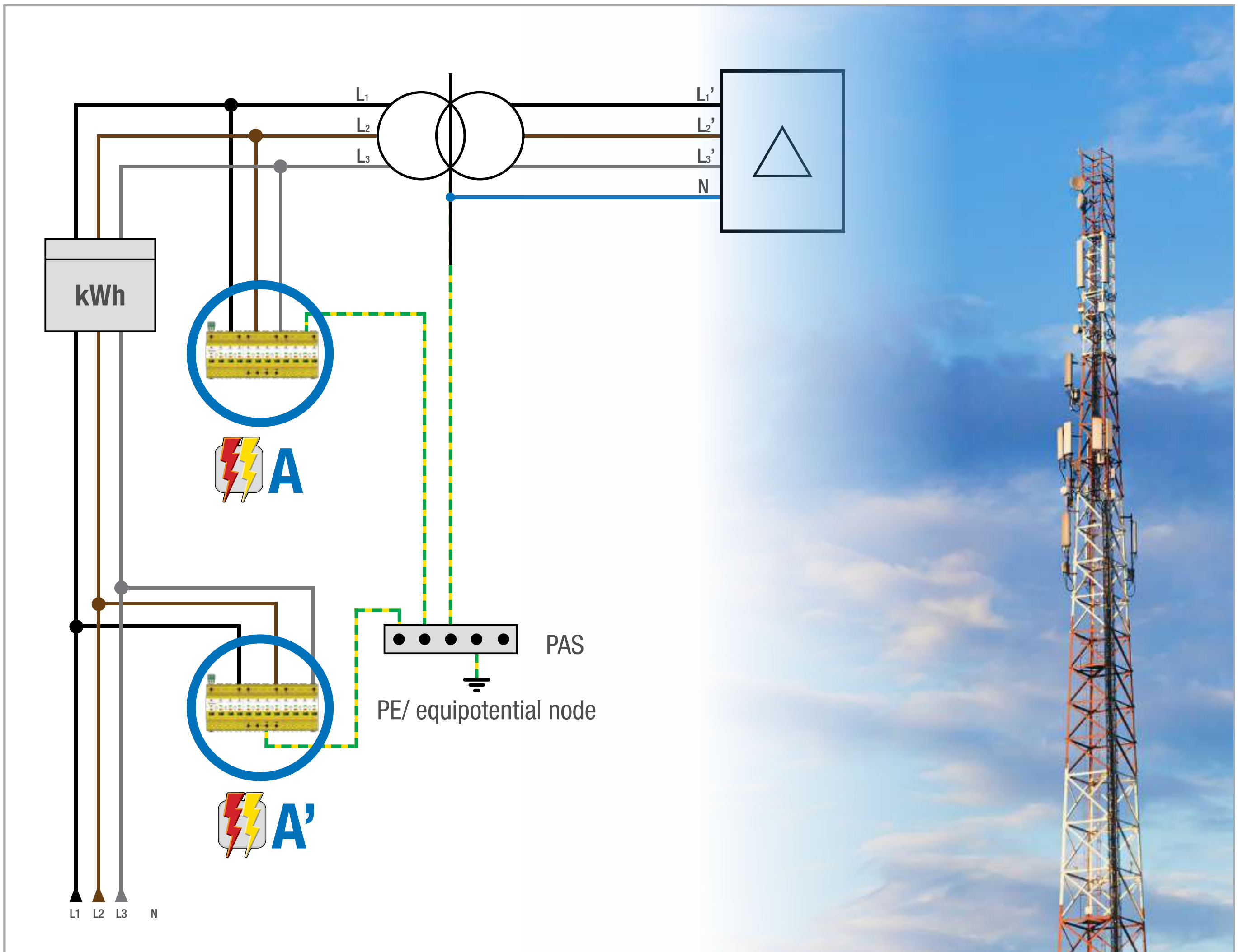
(SUBJECT TO AGREEMENT WITH DISTRIBUTOR)

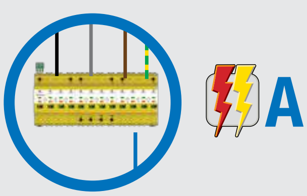
L 50/100 230 t ff 1+1	1 	218 121



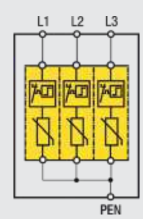
Surge arresters:
ZOTUP Typical installation example for communication tower

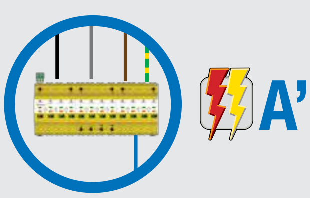
Three-phase





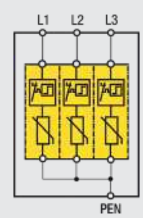
TYPE	QUANTITY	CODE
L 45/100 230 t ff 3+1	1	216 141



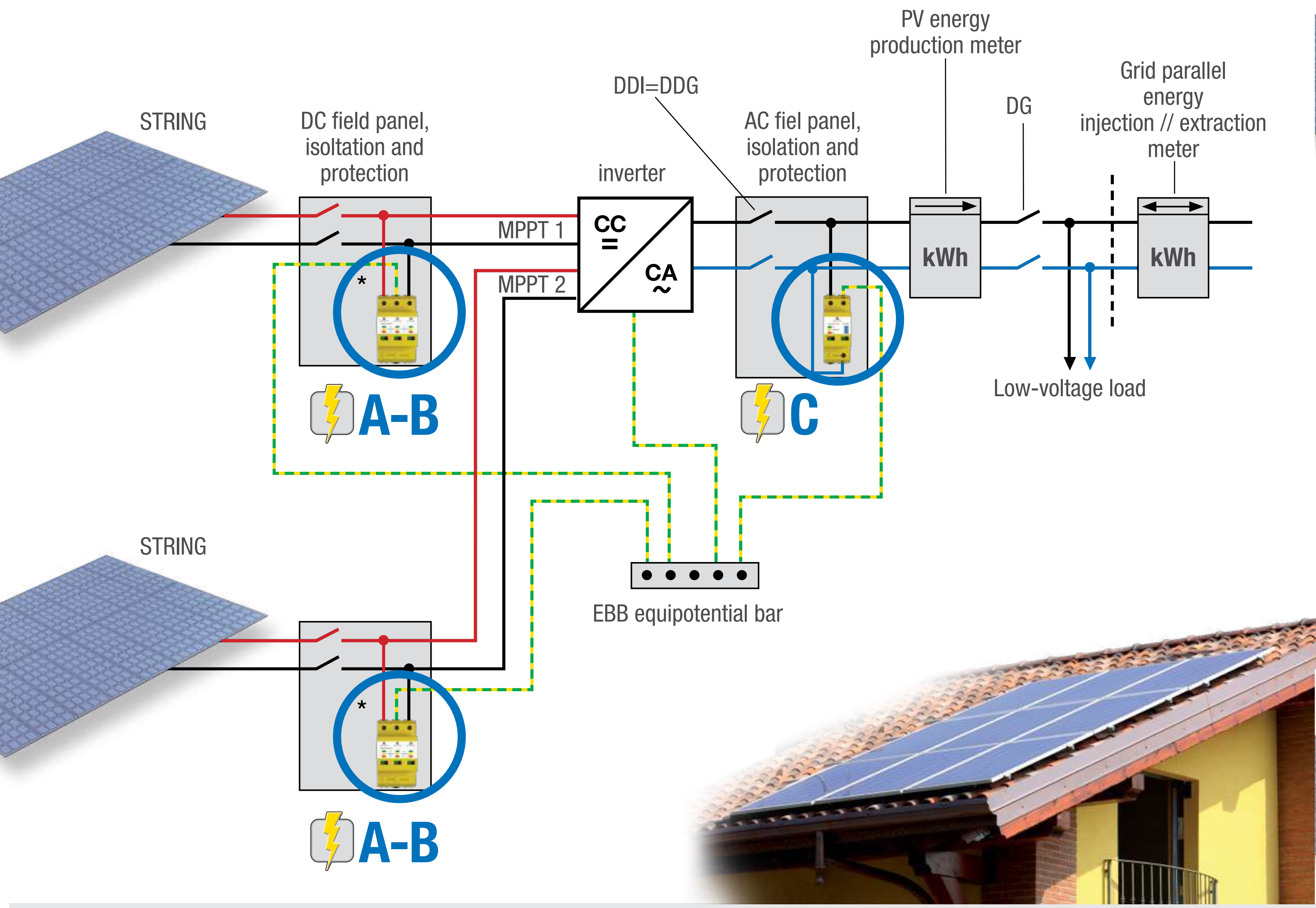


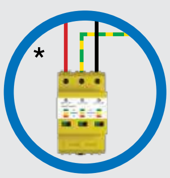
(SUBJECT TO AGREEMENT WITH DISTRIBUTOR)

L 45/100 230 t ff 3+1	1	216 141

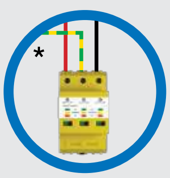


Surge arresters:
ZOTUP Typical installation example for PV system for indirect discharge
Photovoltaic Systems
(Small photovoltaic system - parallel to the low-voltage grid with an inverter)

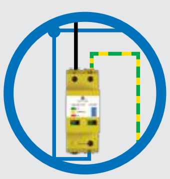




A DC side
UCPV ≤ 600 V cc

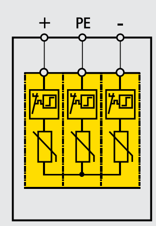


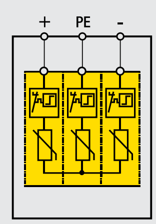
B DC side
UCPV ≤ 1000 V cc

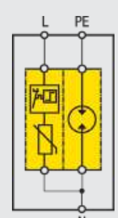


C AC side
Uc (SPD) = 335 V ca

TYPE	QUANTITY	CODE
L 3/40 PV Y 600 ff	1	210 106
L 3/40 PV Y 600 t ff	1	210 116
L 3/40 PV Y 1000 ff	1	210 110
L 3/40 PV Y 1000 t ff	1	210 126
L 3/30 230 ff 1+1	1	200 121



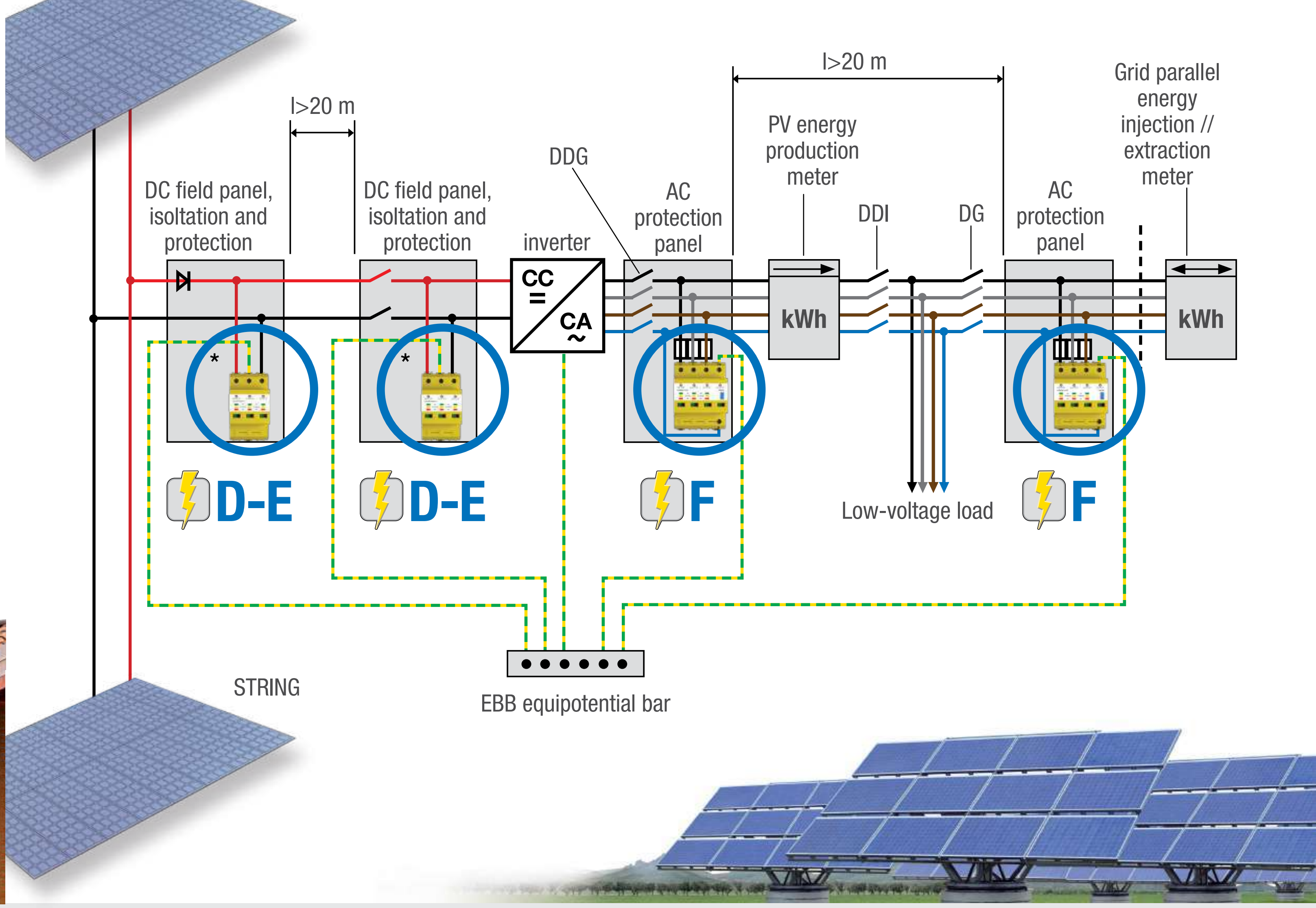


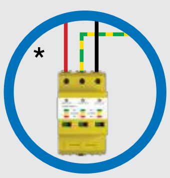


Surge arresters:
ZOTUP Typical installation example for PV system for indirect discharge

Photovoltaic Systems

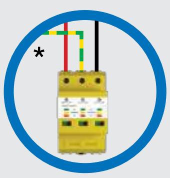
(Medium photovoltaic system - parallel to the low-voltage grid with an inverter)





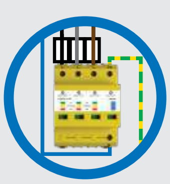
D DC side

$U_{CPV} \leq 600$ V cc



E DC side

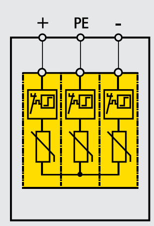
$U_{CPV} \leq 1000$ V cc

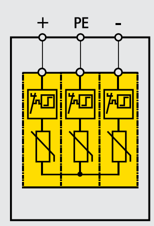


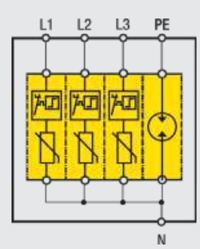
F AC side

U_C (SPD) = 335 V ca

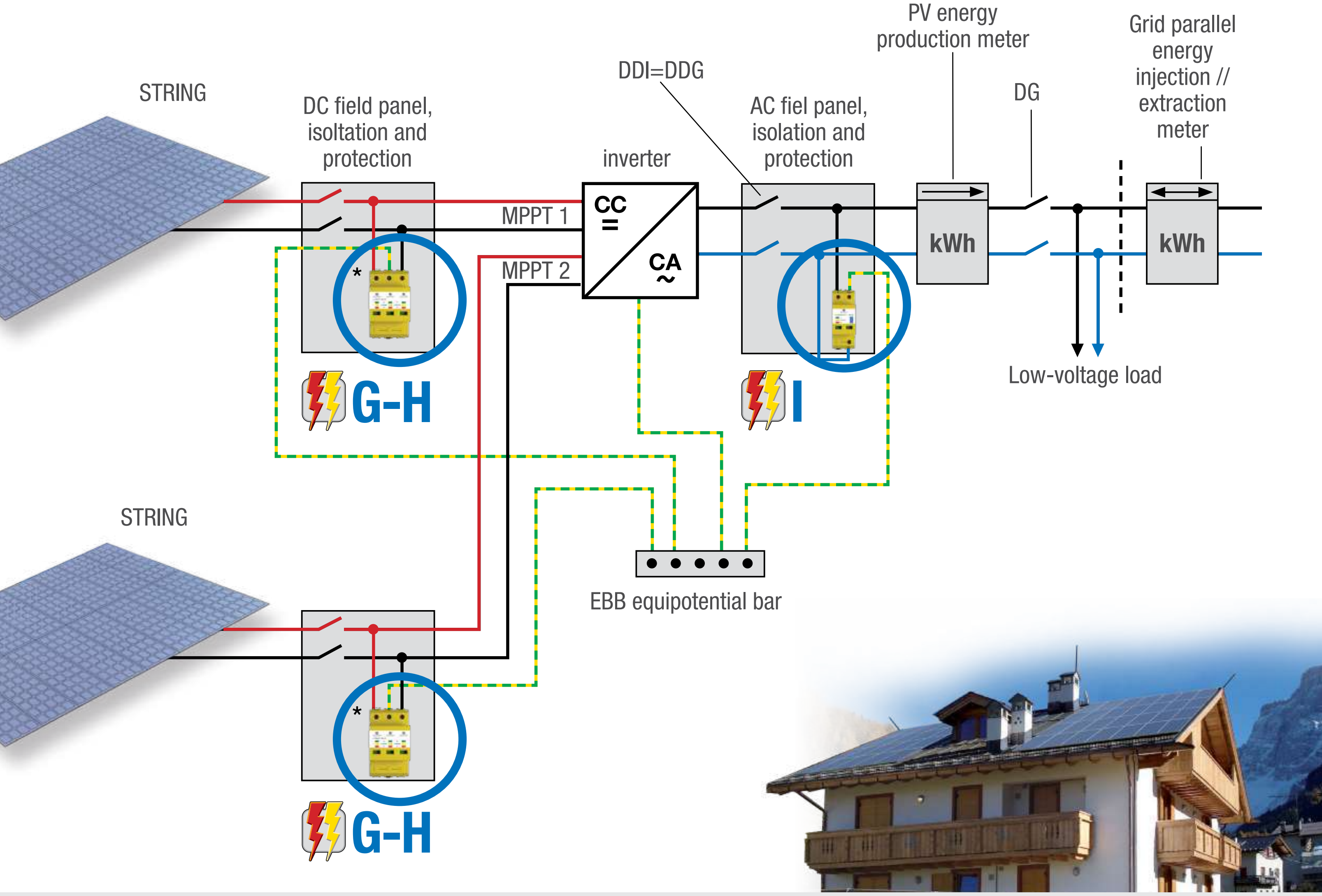
TYPE	QUANTITY		CODE
L 3/40 PV Y 600 ff	1		210 106
L 3/40 PV Y 600 t ff	1		210 116
L 3/40 PV Y 1000 ff	1		210 110
L 3/40 PV Y 1000 t ff	1		210 126
L 3/30 230 ff 3+1	1		200 141

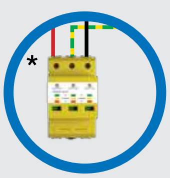






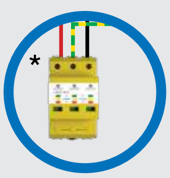
Surge arresters:
ZOTUP Typical installation example for PV system for indirect discharge
Photovoltaic Systems
(Small photovoltaic system - parallel to the low-voltage grid with an inverter)





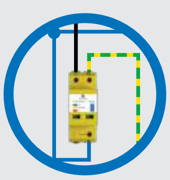
G DC side

$U_{CPV} \leq 600$ V cc



H DC side

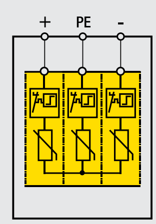
$U_{CPV} \leq 1000$ V cc

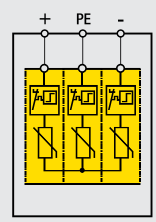


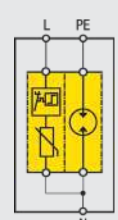
I AC side

U_{C} (SPD) $= 335$ V ca

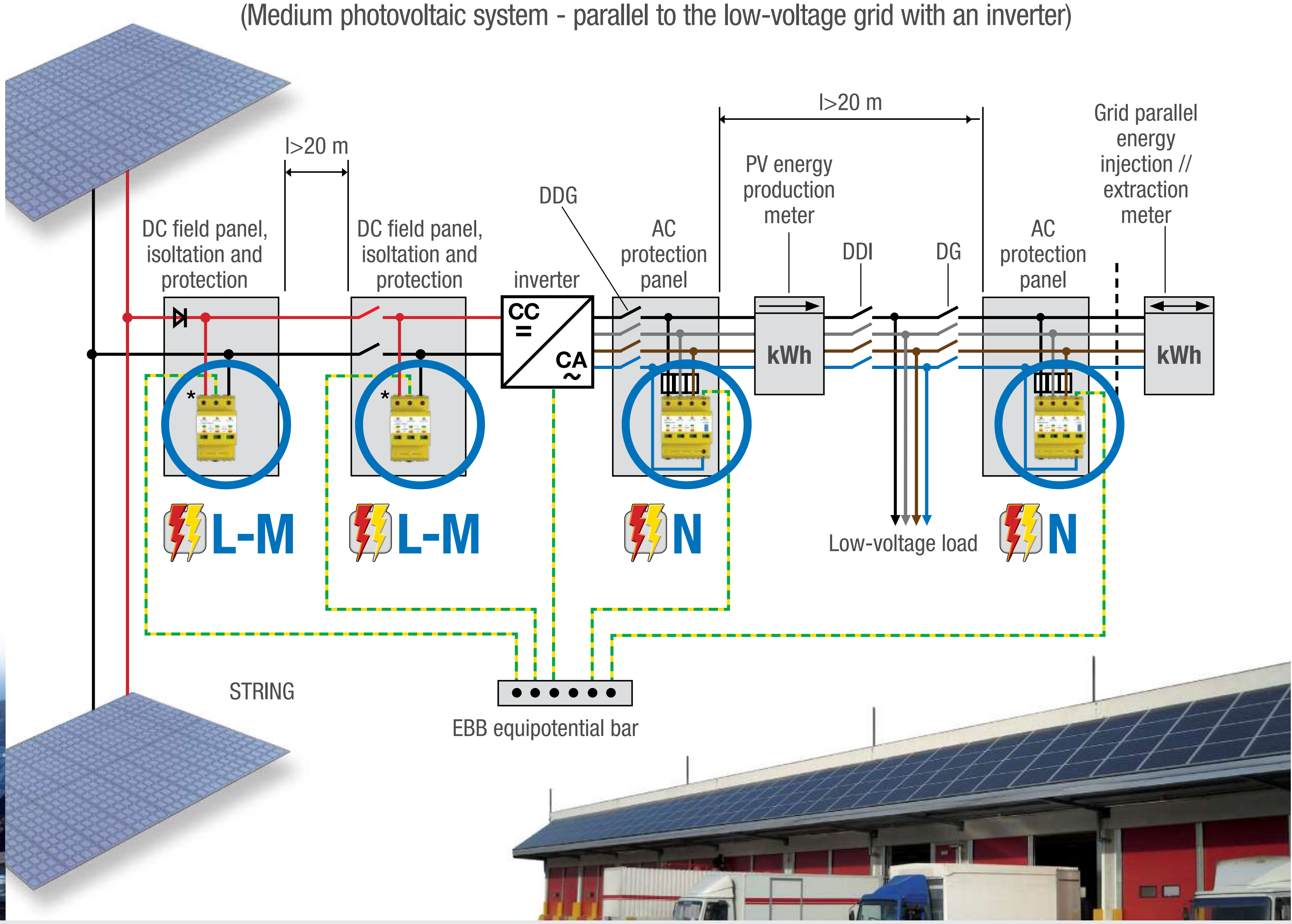
TYPE	QUANTITY		CODE
L 13/60 PV Y 600 ff	1		216 106
L 13/60 PV Y 600 t ff	1		216 116
L 13/60 PV Y 1000 ff	1		216 110
L 13/60 PV Y 1000 t ff	1		216 126
L 13/40 230 ff 1+1	1		204 121

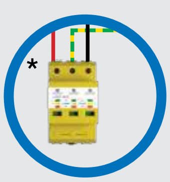




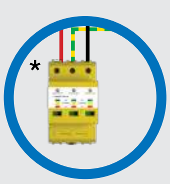


Surge arresters:
ZOTUP Typical installation example for PV system for indirect discharge
Photovoltaic Systems
(Medium photovoltaic system - parallel to the low-voltage grid with an inverter)

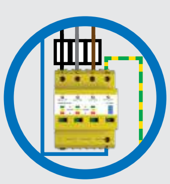




L DC side
UCPV ≤ 600 V cc

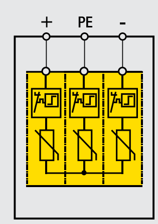


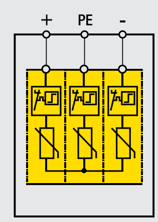
M DC side
UCPV ≤ 1000 V cc

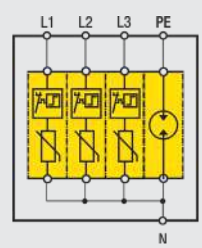


N AC side
Uc (SPD) = 335 V ca

TYPE	QUANTITY		CODE
L 13/60 PV Y 600 ff	1		216 106
L 13/60 PV Y 600 t ff	1		216 116
L 13/60 PV Y 1000 ff	1		216 110
L 13/60 PV Y 1000 t ff	1		216 126
L 13/40 230 t ff 3+1	1		214 141



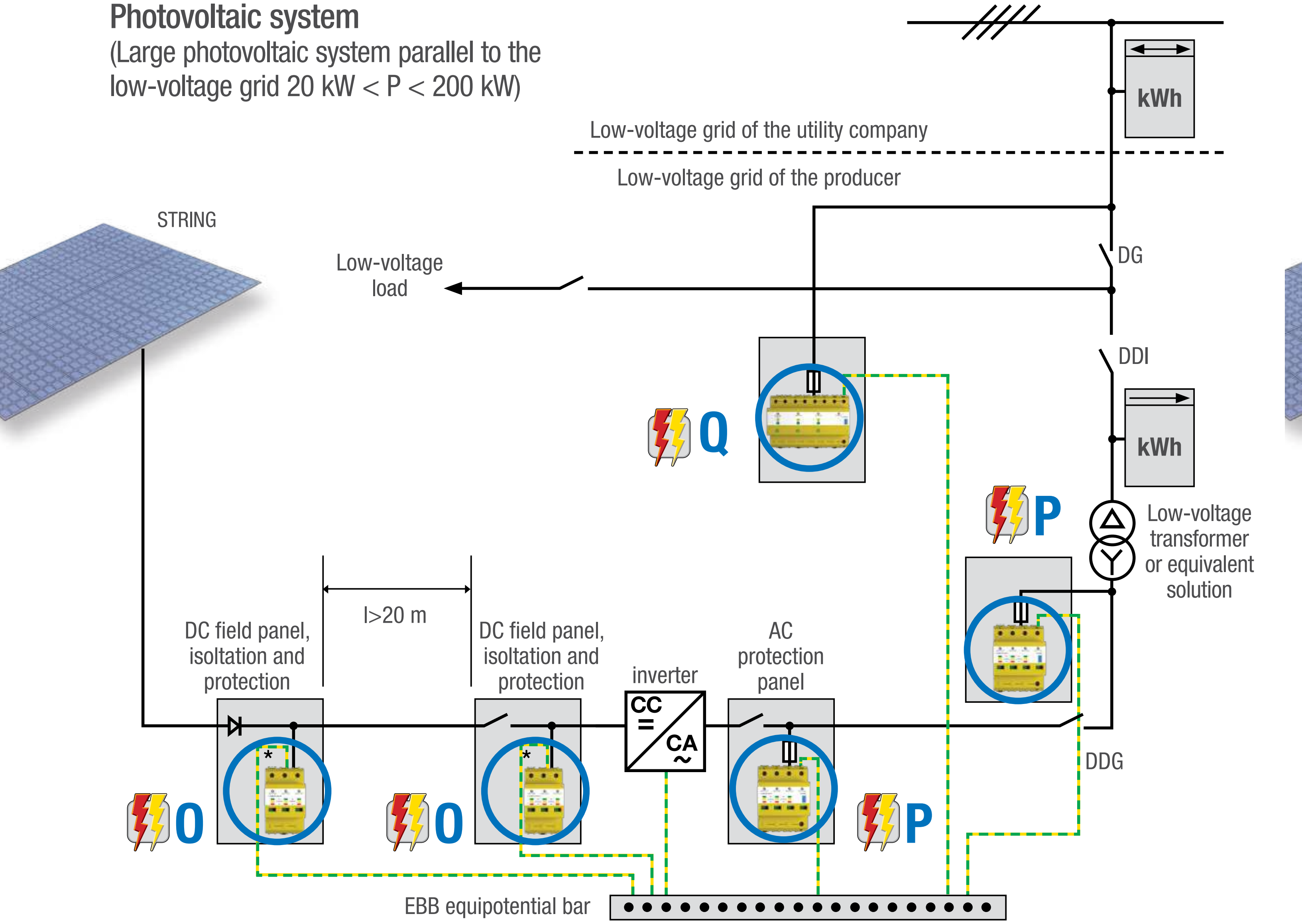


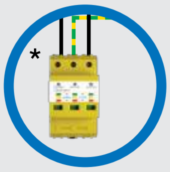


Surge arresters:
ZOTUP Typical installation example for PV system for indirect discharge

Photovoltaic system

(Large photovoltaic system parallel to the low-voltage grid 20 kW < P < 200 kW)



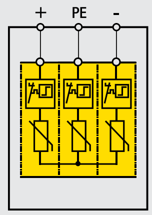


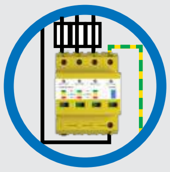
O DC side

$U_{CPV} \leq 600$ V cc

$U_{CPV} \leq 1000$ V cc

TYPE	QUANTITY		CODE
L 13/60 PV Y 600 t ff	1		216 116
L 13/60 PV Y 1000 t ff	1		216 126

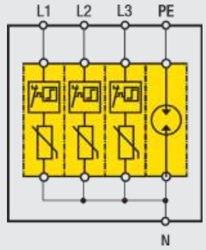


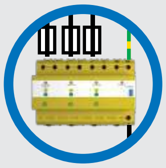


P AC side

U_{c} (SPD) = 335 V ca

TYPE	QUANTITY		CODE
L 13/40 230 ff 3+1	1		204 141

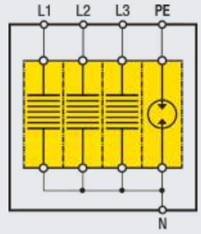




Q AC side

U_{c} (SPD) = 255 V ca

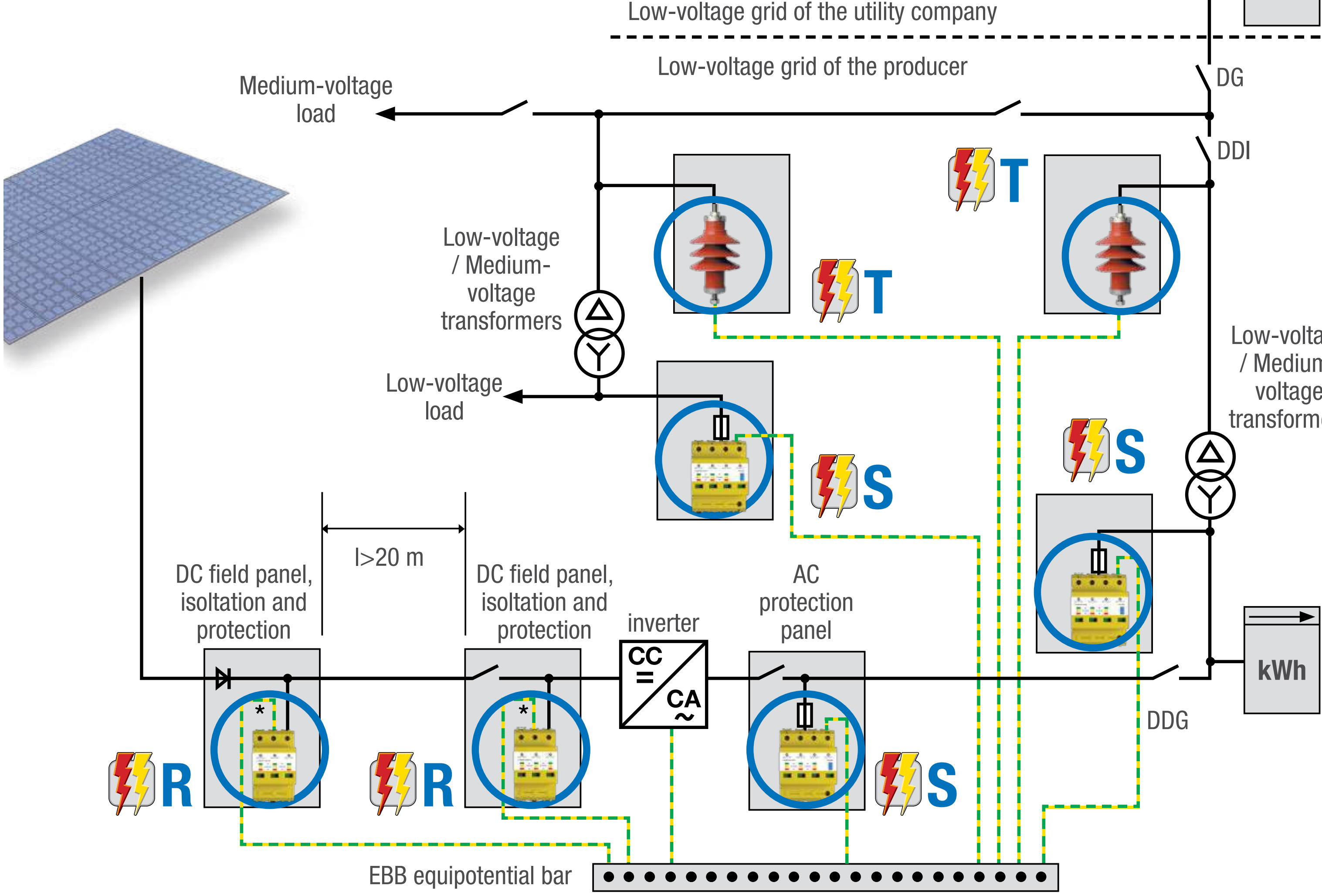
TYPE	QUANTITY		CODE
IA 25 3+1	1		203 141

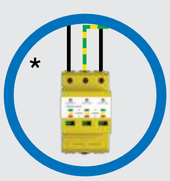


ZOTUP Typical installation example for PV system for indirect discharge

Photovoltaic system

(Large photovoltaic system parallel to the low-voltage grid 20 kW P > 200 kW)



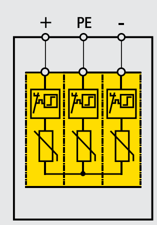


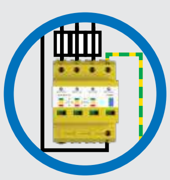
R DC side

$U_{CPV} \leq 600$ V cc

$U_{CPV} \leq 1000$ V cc

TYPE	QUANTITY	CODE
L 13/60 PV Y 600 t ff	1	216 116
L 13/60 PV Y 1000 t ff	1	216 126

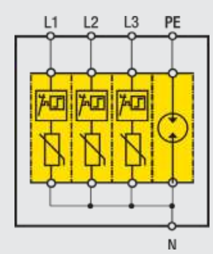


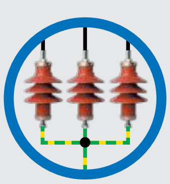


S AC side

U_c (SPD) = 335 V ca

TYPE	QUANTITY	CODE
L 13/40 230 t ff 3+1	1	214 141

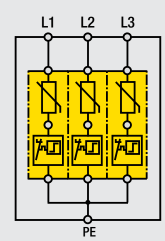




T MV side

20.000 V

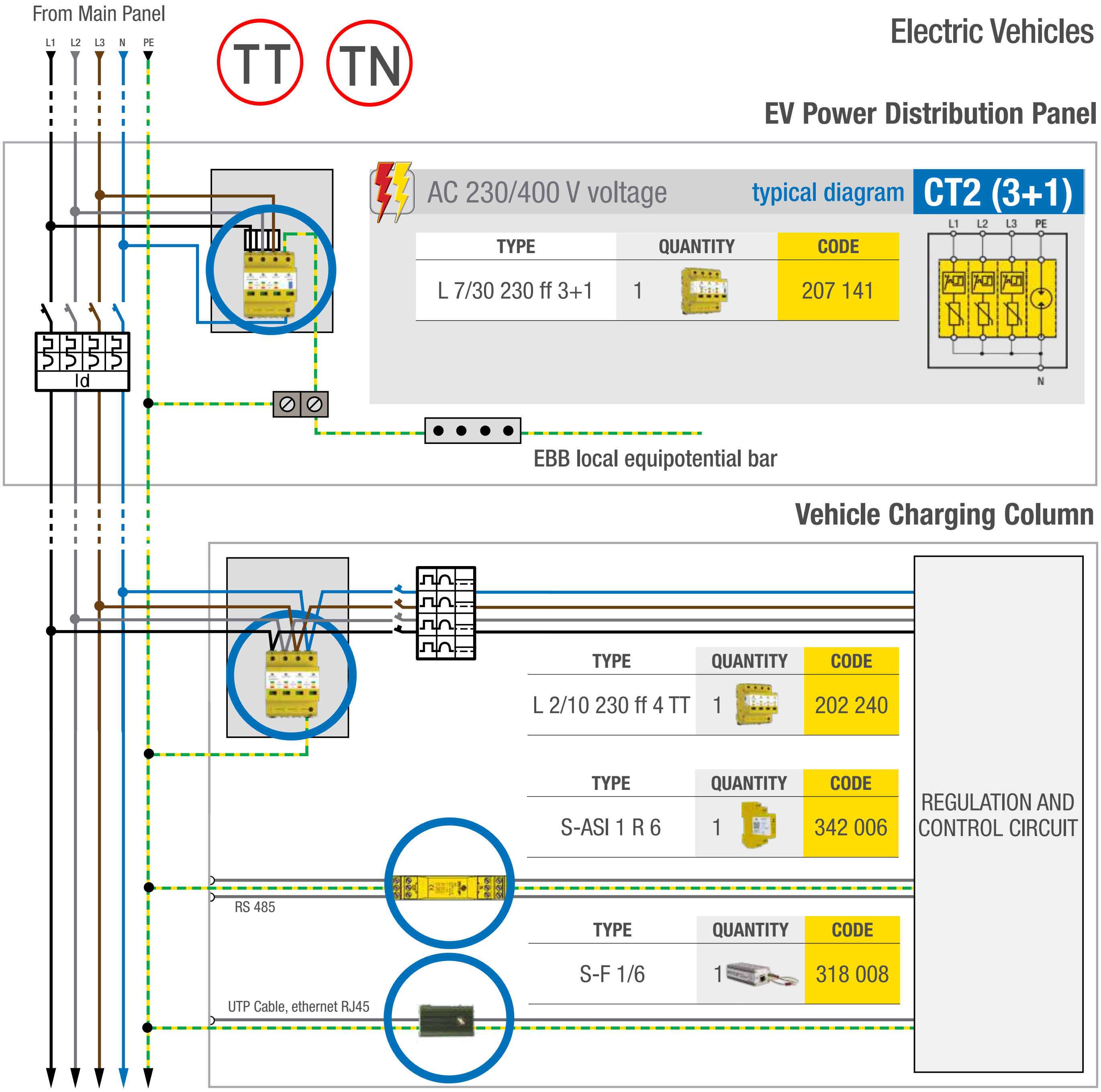
TYPE	QUANTITY	CODE
ZU HV 24.2	3	120 424
ZU 7	3	107 000
ZU 4	3	104 000



Surge arresters:
ZOTUP Typical installation example for EV charging stations in TT and TN-S systems

Electric Vehicles

EV Power Distribution Panel



TYPE	QUANTITY	CODE
L 7/30 230 ff 3+1	1	207 141

TYPE	QUANTITY	CODE
L 2/10 230 ff 4 TT	1	202 240

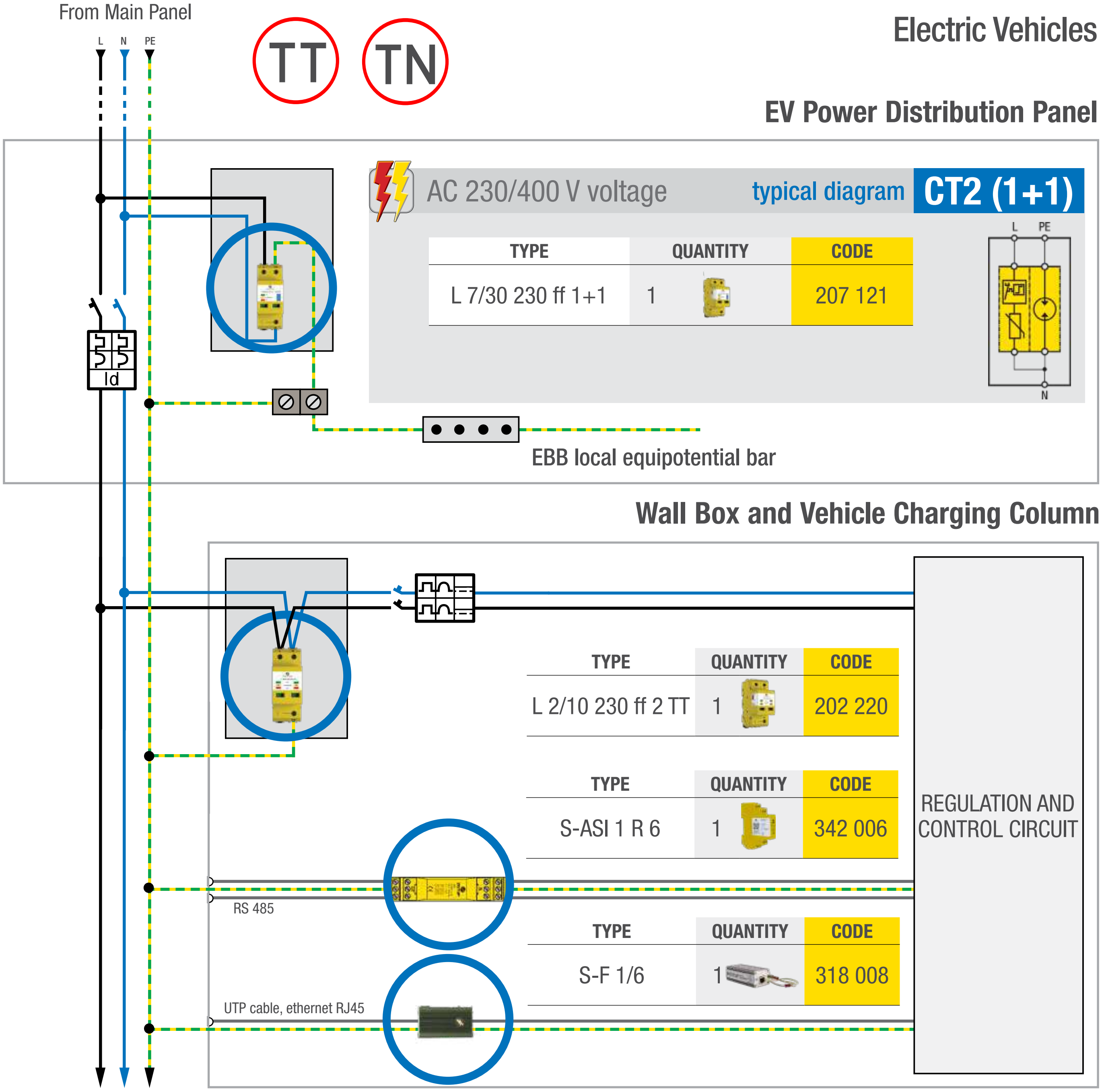
TYPE	QUANTITY	CODE
S-ASI 1 R 6	1	342 006

TYPE	QUANTITY	CODE
S-F 1/6	1	318 008

Surge arresters:

ZOTUP Typical installation example for EV charging stations in TT and TN-S systems

Electric Vehicles



EV Power Distribution Panel — AC 230/400 V voltage — typical diagram CT2 (1+1)

TYPE	QUANTITY	CODE
L 7/30 230 ff 1+1	1	207 121

Wall Box and Vehicle Charging Column

TYPE	QUANTITY	CODE
L 2/10 230 ff 2 TT	1	202 220

TYPE	QUANTITY	CODE
S-ASI 1 R 6	1	342 006

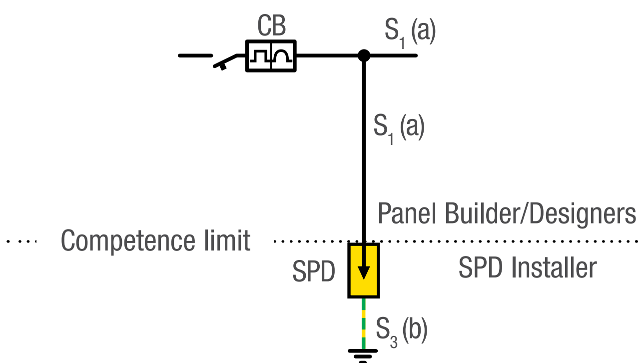
TYPE	QUANTITY	CODE
S-F 1/6	1	318 008

ZOTUP When overcurrent limitation is necessary

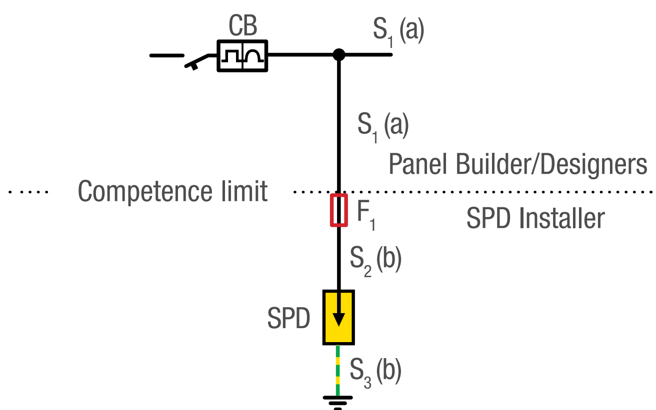
If the short-circuit current at the ZOTUP installation point exceeds its breaking capacity, it is necessary to provide a backup fuse in series with the surge arrester. The interaction between the overcurrent limitation measures present in the system and the SPD (Surge Protective Device) must be evaluated during the design and installation phases. The standards HD 60364-5-534 (2016-02), EN 64-8/4 443.2.2 Ed.7 (2012-06), and CEI EN 62305 Ed.2 series should be taken into consideration. Depending on the line conductor's section S1 and the line protection (circuit breaker or fuse), it is necessary to follow the indications provided in the following tables.

Principle diagram WITH MAIN SWITCH

WITHOUT FUSE



WITH FUSE F_1



CB = Circuit Breaker
F_1 = Protective Fuse (backup fuse/supporting fuse with gG characteristic).
SPD = Surge Protective Device.
Icc = Short-circuit current at the SPD installation point.
S_1 = Conductor section in the installation.
S_2 = Conductor section branching toward the SPD (downstream of the backup fuse).
S_3 = Grounding conductor section.

CONNECTION OF THE SPD WITHOUT FUSE

For Icc	SPD type	L 25/100 ff	IA 25	L 13/40 ff	L 7/30 ff	L 3/30 ff	L 2/10 ff
≤ 100 kA	I_n main switch	≤ 160 A	-	≤ 160 A	≤ 160 A	≤ 160 A	≤ 160 A
≤ 50 kA	I_n main switch	≤ 160 A	-	≤ 160 A	≤ 160 A	≤ 160 A	≤ 160 A
≤ 16 kA	I_n main switch	≤ 160 A	≤ 160 A	≤ 160 A	≤ 160 A	≤ 160 A	≤ 160 A
	Section S_1 (mm^2)	(a)	(a)	(a)	(a)	(a)	(a)
	Section S_3 (mm^2)	(b)	(b)	(b)	(b)	(b)	(b)

CONNECTION OF THE SPD WITH FUSE F_1[1]

For Icc	SPD type	L 25/100 ff	IA 25	L 13/40 ff	L 7/30	L 3/30 ff	L 2/10 ff
≤ 100 kA	I_n main switch	> 160 A	-	> 160 A	> 160 A	-	-
	I_n fuse F_1	125/160* A	-	125/160* A	125 A	-	-
≤ 50 kA	I_n main switch	> 160 A	-	> 160 A	> 160 A	> 160 A	> 160 A
	I_n fuse F_1	125/250* A	-	125/160* A	125 A	125 A	125 A
≤ 16 kA	I_n main switch	> 160 A	> 160 A	> 160 A	> 160 A	> 160 A	> 160 A
	I_n fuse F_1	125/250 A	125/315 A	125/160 A	125 A	125 A	125 A
	Section S_1 (mm^2)	(a)	(a)	(a)	(a)	(a)	(a)
	Section S_2 (mm^2)	16	16	16	16	(b)	(b)
	Section S_3 (mm^2)	16	16	16	16	(b)	(b)

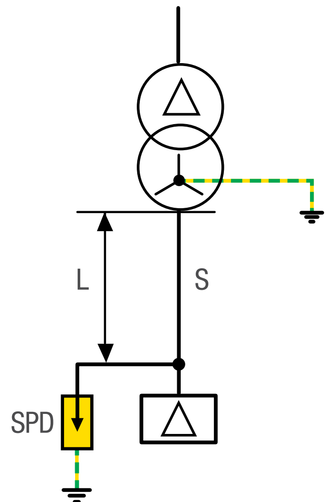
(a) Definition of the sections within the competence of the switchboard builder or designer.
(b) Section equal to S_1, with a minimum of 6 mm^2 and a maximum of 16 mm^2.
* Recommended fuses: ETI NV, characteristic gG, reference voltage 500 V. Breaking capacity 120 kA.

ZOTUP When overcurrent limitation is not necessary

The interaction between the overcurrent limitation measures present in the system and connected in series to the SPD must be evaluated during the design and installation phase. In this regard, the CEI 64-8 (2012) and CEI EN 62305 1-4 standards should be taken into consideration.

The ZOTUP range of SPDs has a specific short-circuit current breaking capacity that occurs at the end of life of the overload arrester. When the plant's short-circuit current is below this value, the installation of backup/support overcurrent limitation in series with the SPD can be avoided, with all the resulting advantages.
In order to simplify the evaluation of this opportunity, the following table is provided, which allows for a cautious and quick definition of the cable length above which the backup/support fuse is not required. The cable length is a function of the rated power of the MV/LV transformer and the cable section. By performing an accurate calculation of Icc, considering the actual conductor sections, the cable length that allows for the avoidance of the backup fuse installation is smaller than the one indicated in the table (as the table assumes a constant cable section in a cautious manner).

Schematic diagram

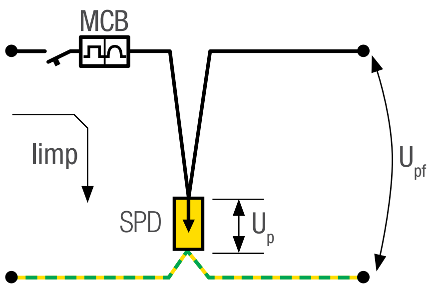


Transformer MV / LV (400 V) (Vcc = 6 %)		CABLE LENGHT BEYOND WHICH THE BACKUP FUSE IS NOT NECESSARY Cable Lenght L [m] ; Cable Section S [mm^2]											
Rated Power [kVA]	**Short circuit current [kA]**	**S = 6**	**S = 10**	**S = 16**	**S = 25**	**S = 35**	**S = 50**	**S = 70**	**S = 95**	**S = 120**	**S = 150**	**S = 185**	**S = 240**
160	4	Backup fuse not necessary											
250	6	5	7	11	16	22	28	37	46	54	60	67	74
315	8	7	12	18	27	37	48	66	84	100	113	129	145
400	10	9	15	23	35	48	63	86	112	134	153	177	201
500	12	10	17	26	40	54	71	99	130	157	180	209	240
630	15	11	18	28	43	59	78	109	144	174	201	235	271
800	19	11	19	29	45	62	82	116	154	187	217	255	296
1.000	24	12	19	30	47	64	86	121	161	196	228	269	313
1.250	30	12	20	31	48	67	90	124	166	203	236	280	327
1.600	38	12	20	31	49	67	90	127	170	208	243	288	338
2.000	48	12	20	32	49	68	91	129	173	212	248	295	347
2.500	60	12	20	32	50	68	92	130	175	215	252	300	353
3.150	76	12	20	32	50	69	92	131	177	217	255	304	358
4.000	96	13	21	32	50	69	93	132	178	219	258	307	363

Cable Lenght L

Surge arresters:
ZOTUP Tips for the installation of SPDs

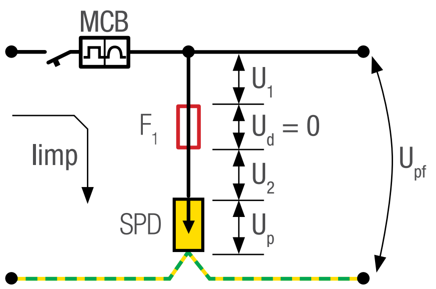
The insertion of SPDs into the system can be undermined, in whole or in part, by incorrect wiring. The IEC 60364-5-534 standard provides important guidelines regarding connections, aimed at minimizing dynamic voltage drops that occur across cables. To understand the importance of this aspect, it is necessary to remember that the impulse current of lightning has a growth dynamics of approximately 10 kA/µs. In this context, the inductive components of the wiring take precedence over the resistive ones, and it is easy to experience voltage drops on the order of 1 kV per meter. The simple connection precautions outlined below help optimize the insertion of SPDs.



WITHOUT BACKUP FUSE

$U_{pf} = U_p$

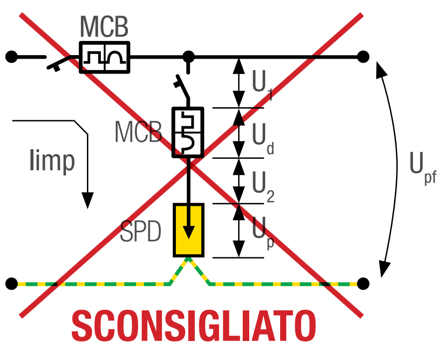
In the event of end-of-life of the SPD, network protection intervenes by interrupting the service.



WITH BACKUP FUSE

$U_{pf} = U_1 + U_2 + U_p$ $\qquad$ $U_{pf} > U_p$

In the event of end-of-life of the SPD, the fuse comes into play, ensuring service continuity as well.

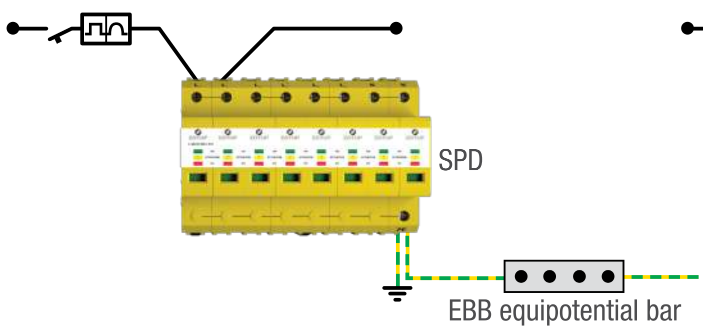


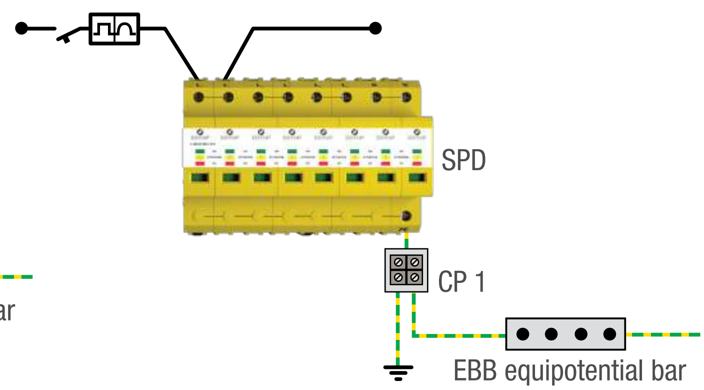
WITH MCB BACKUP

$U_{pf} = U_1 + U_d + U_2 + U_p$ $\qquad$ $U_{pf} >> U_p$

The level of protection is heavily influenced by the voltage drop Ud. The discharge capacity of the SPD is limited by the presence of the MCB. There may also be a potential issue of selectivity between the two MCBs.

The connection to V is facilitated in many SPDs by the presence of double terminals. However, in seveal instances, it may not be feasible due to high currents involved and subsequent cable sections. Through the use of accessories from the CP series (see page 65), the wiring can often be optimized regardless.

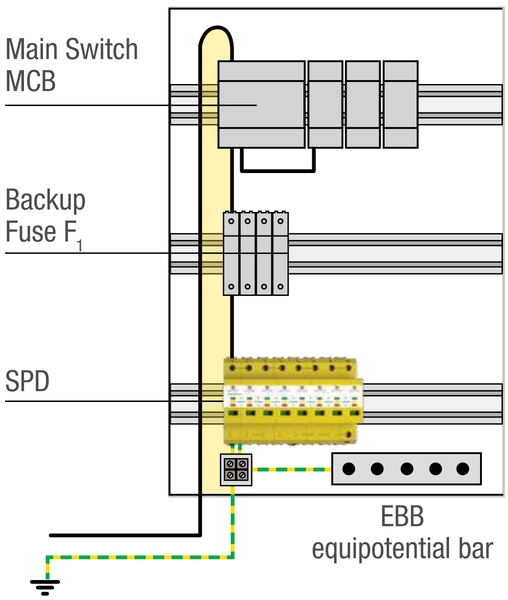




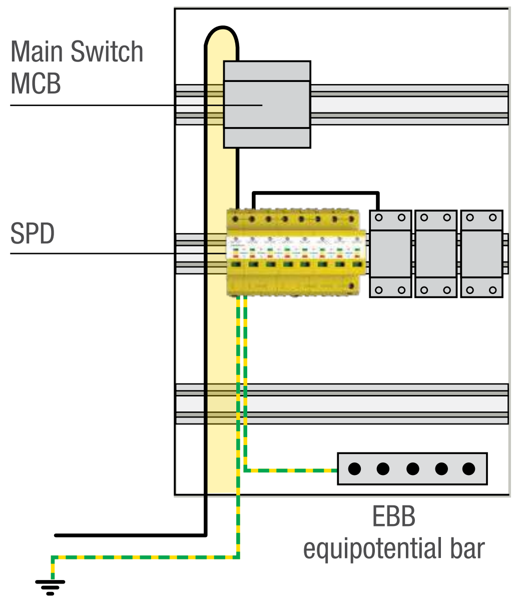
Surge arresters:
ZOTUP Tips for the installation of SPDs

The lightning impulse current, when passing through the wiring cables, also generates an electromagnetic field capable of inducing overvoltages in adjacent circuits. By reducing the loops inside the panel, as indicated in the figure below (light yellow area), the wiring can be optimized.

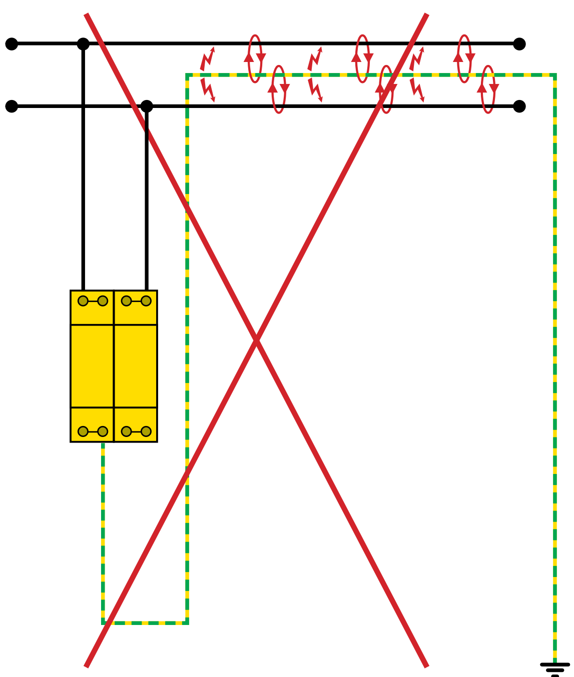
Panel with high currents



Panel with limited currents

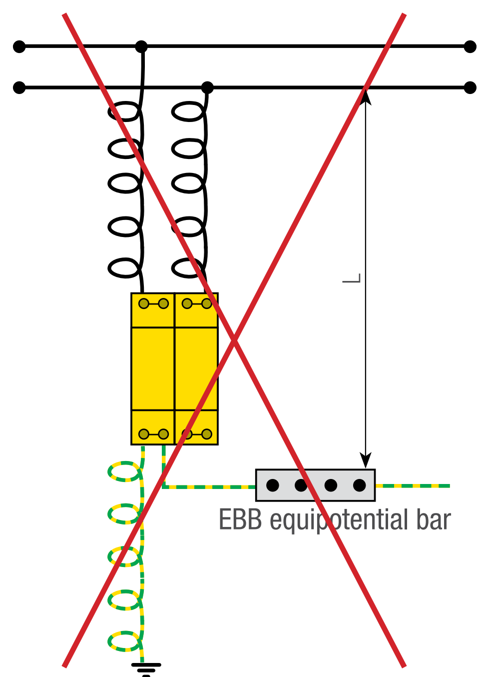


Note: During the measurement of insulation resistance, the SPDs must be disconnected



INCORRECT

The earth conductor should not be placed togheter with the protected conductors as it generates inductive coupling.



INCORRECT

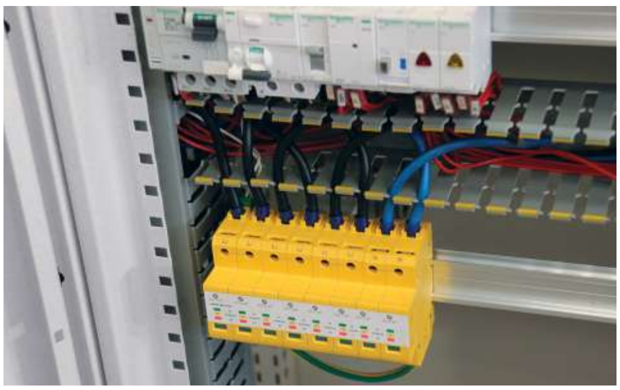
Connections should not be made too long as it causes voltage drops across the cables.
Maximum allowable lenght L ≤ 0,5 m.

Gallery of installations examples

Example of protections for the MV system of the MV/LV transformer with ZU HV 24.2 surge arresters.

Example of protection with line CB > 160 A.

Example of protection with line CB ≤ 160 A.



Example of protection for signal circuits and a power supply with ILF 2P 32 e S-ASI 24 surge arresters.

Example of protection for an existing medium.sized power distribution panel with ILF 4P 250 surge arrester.

Example of protection for telephony and transmission with S ADLS surge arrester.

Example of protection for an existing large-sized power distribution panel with ILF 4P 400 surge arrester.

Example of protection in a terminal block for public LED lightning.

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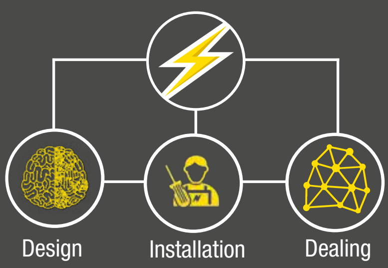

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