Surge Protection Devices

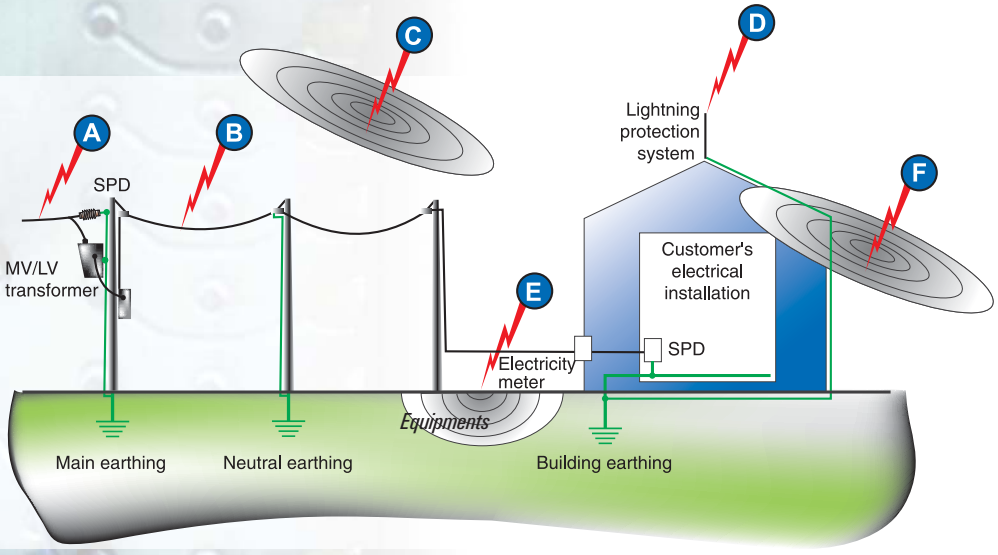
Low voltage Networks

Indelec
lightning protection

Transient Overvoltages

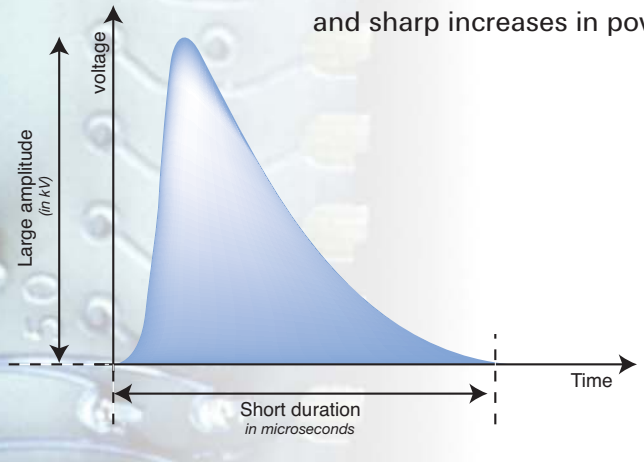
The origins of overvoltages

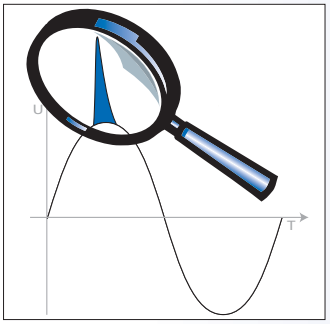
- **A** Direct impact on overhead High Voltage lines
- **B** Direct impact on overhead Low Voltage lines
- **C** Electromagnetic radiation on overhead lines
- **D** Direct impact on external Lightning Protection System
- **E** Rise of ground potential
- **F** Electromagnetic radiation on lightning protection systems conductors

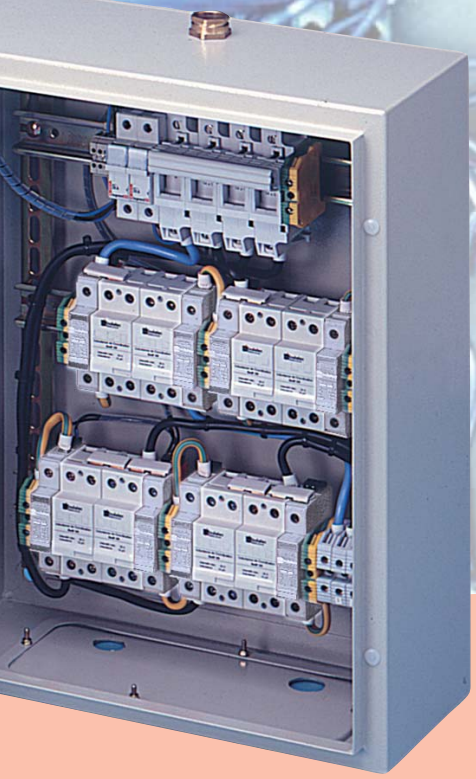


Definition of transient overvoltages

Transient Overvoltages are defined as short duration and sharp increases in power line voltage.

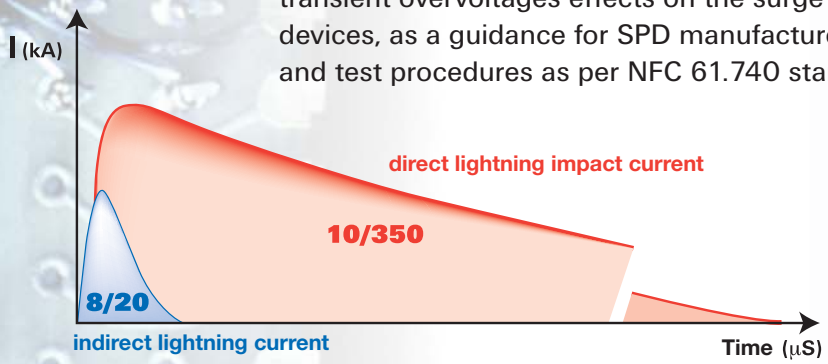






Standardized wave forms

The standardized wave forms aim to represent transient overvoltages effects on the surge protection devices, as a guidance for SPD manufacturers design and test procedures as per NFC 61.740 standard.



- **8/20 µs waveform :**
  simulation of indirect lightning discharge and switching operations
- **10/350 µs waveform :**
  simulation of a direct lightning discharge
- **Open circuit voltage 1.2/50 µs wave form**
  Equipment overvoltage load

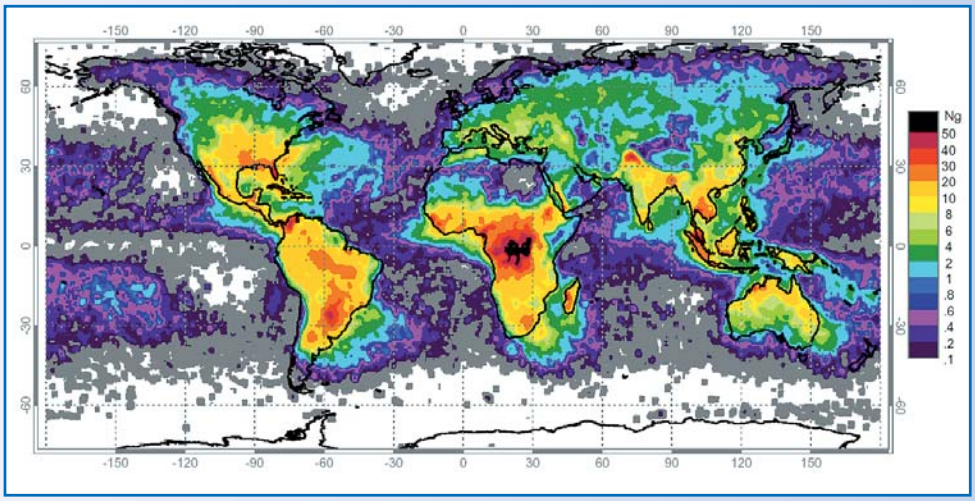
Transient currents consequences for the equipment

- **Destruction (partial or complete)**
- **Interference with normal operation**
- **Premature ageing**
- **Latent degradation**

Worsening factors

> increasing number of sensitive equipment
> electronic equipment increasing sensibility to transient currents
> uninterruptible service requirement
> costs of service interruption
> standard requirements for SPD installation

World lightning density map (Ng)



Choosing Surge Protection Devices

Case N°1 : **Building equipped with an external lightning protection system**

Type 1 surge arrester is mandatory.

Type 1 SPD technical characteristics requirements:

- 10/350 µs waveform test
- Iimp > 12.5 kA
- Up < 2.5kV

Case N°2 : **Building not equipped with an external lightning protection system**

- **If the lightning density Ng > 2.5** - *Type 1* or *Type2* SPD are required at the main switchboard.
- **If lightning density Ng < 2.5** - installation of *Type 1* or *Type2* SPD are recommended.

Building and power supply specifications	Lightning density (Ng) Keraunic Level (Nk)	
	Ng ≤ 2,5 *Nk* ≤ 25	*Ng* > 2,5 *Nk* > 25
Building equipped with an external lightning protection system	Mandatory	Mandatory
Building connected to completely or partially overhead low voltage power line	Recommended [2]	Recommended
Building connected to underground low voltage power line	Recommended [2]	Recommended
Personal safety may be endangered by service interruption [1]	Based on risk assessment survey	Mandatory

UTE C15-443 table

[1] For example, buildings equipped with medical equipment, fire safety equipment, alarms...

[2] SPD may be required depending on the type of equipment (sensitivity, costs...) or the consequences of service interruption (downtime costs, ...).

Installation

Coordination of INDELEC low voltage Surge Protection Devices (SPD)

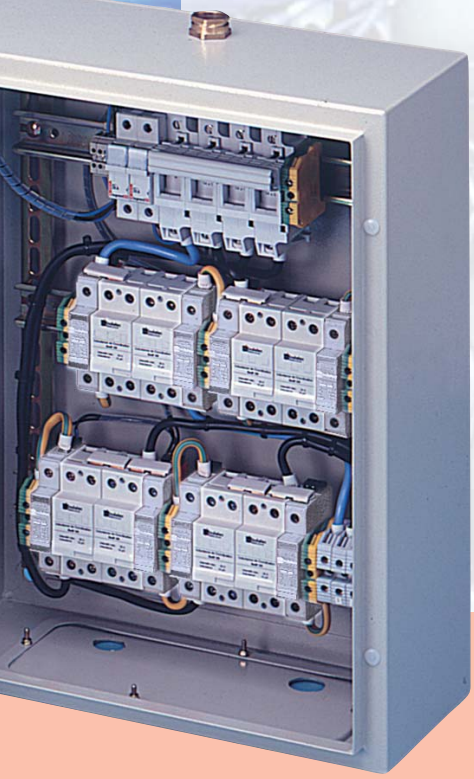
In order to gain maximum protection efficiency, it may be necessary to create a "coordination diagram" indicating / requiring a primary SPD level at the main switchboard panel and a secondary SPD level at the nearest electrical panel to the sensitive equipment.

Coordination is required in both of following cases:

- Highly sensitive equipment:
  - improvement of the protection level Up
- Extended distance (greater than 30m) of wire between equipment to be protected and the primary level of SPD within the main panel:
  - limitation of ringing voltages created during the surge transmission.

Efficient SPD coordination is achieved by including the following (between primary and secondary SPD levels):

- either a minimum length of wire (greater than 10m)
- or a coordination inductor unit. This type of wiring is recommended in a reduced space (such as electrical panels). The coordination inductor unit is connected in series. The inductor unit must then be adapted to the line maximum current (35A and 63A inductors are available).



Recommended coordination diagrams

Recommended coordination

Not required

Impossible

Primary SPD	Secondary SPD: DGV	Secondary SPD: DGA	Secondary SPD: DGT	Secondary SPD: DGX
DGV		L>10m or inductor units	L>10m or inductor units	L>30m or inductor units
DGA			L>10m or inductor units	L>10m or inductor units
DGT				L>10m or inductor units
DGX				

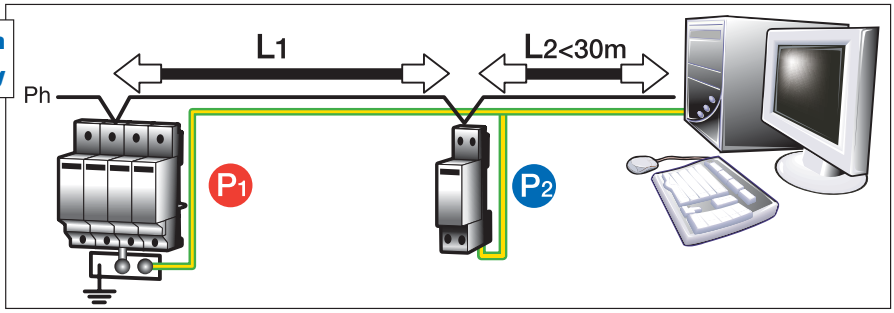
L : minimum length of wires between primary/secondary SPD

Surge Protection Device coordination

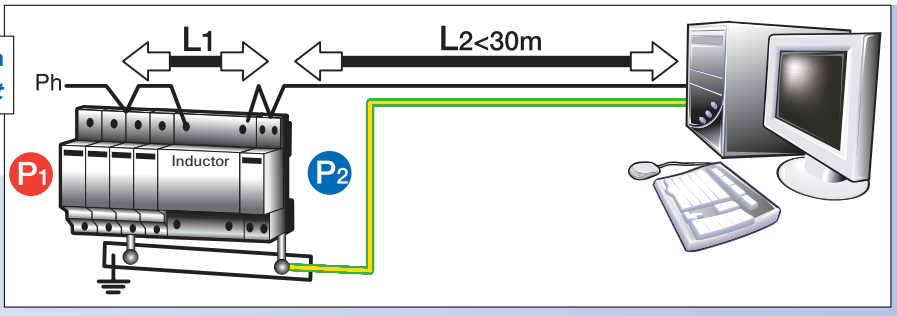
Coordination *by wiring*

P1 Primary SPD

P2 Secondary SPD (close to the sensitive equipment)

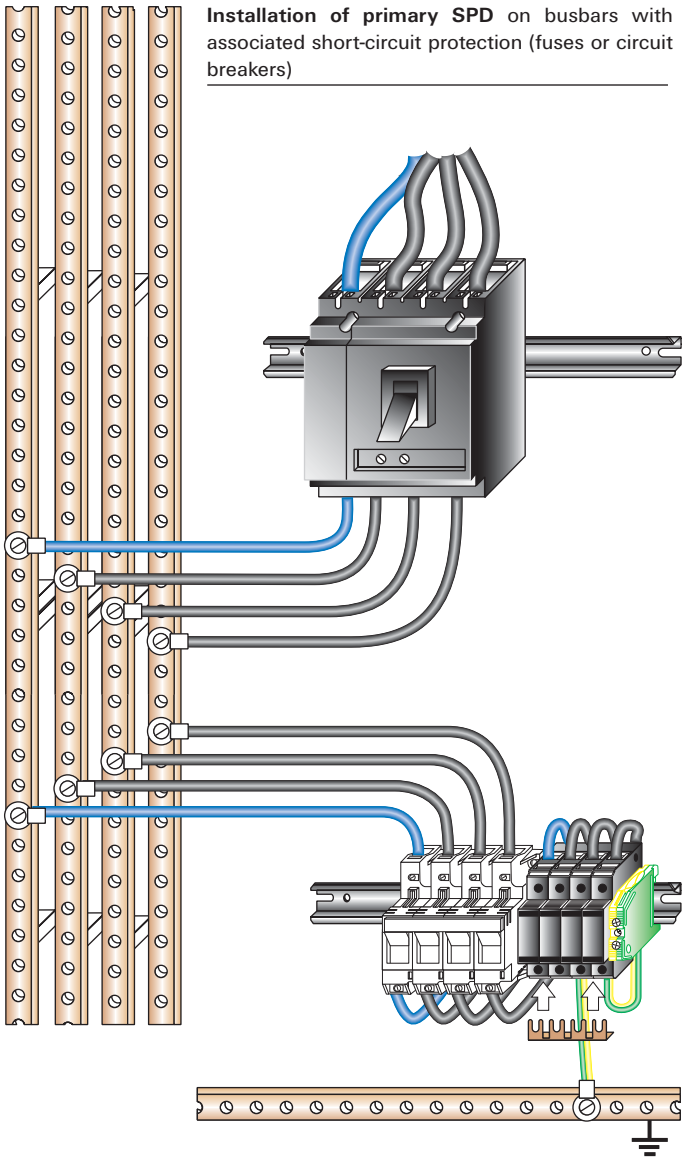


Coordination *by inductor unit*

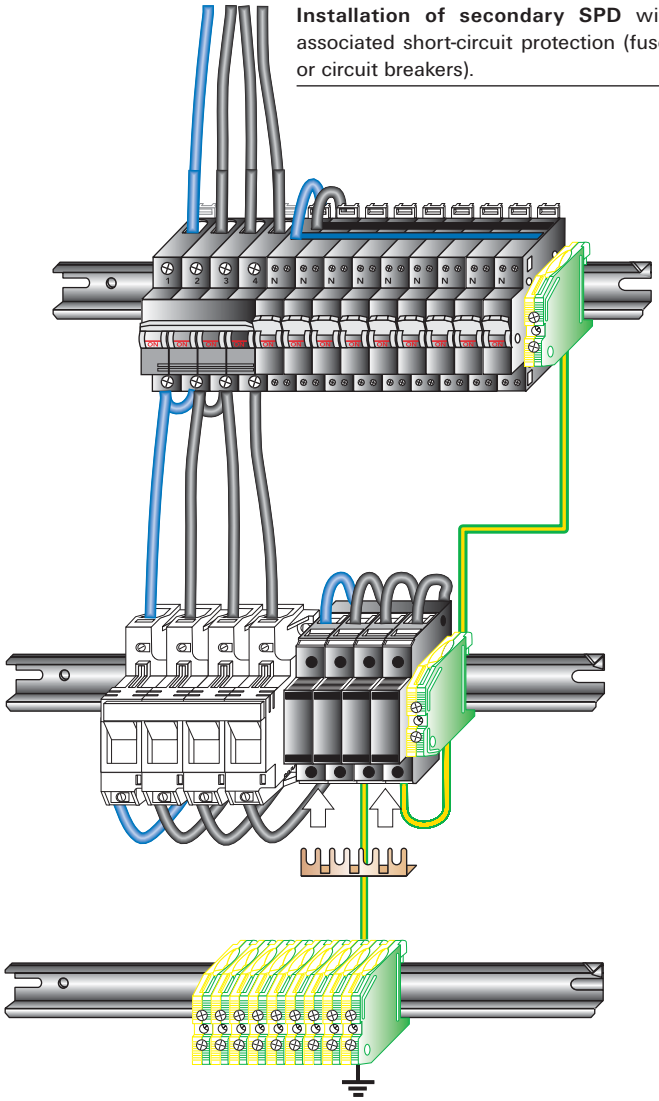


Surge Protection Devices: wiring

Installation of primary SPD on busbars with associated short-circuit protection (fuses or circuit breakers)



Installation of secondary SPD with associated short-circuit protection (fuses or circuit breakers).



Low voltage surge protection devices and associated short circuit protection

The following tests are required for these protective devices:

- short-circuit current tests
- overload current tests (industrial surges caused by switching power sources)

Choosing short circuit protectors:

The protective device must operate:

The SPD associated with short circuit protection device must operate as fast as possible to interrupt fault conditions with appropriate current rating.

The protective device must not operate:

The short circuit protection device must not operate under nominal discharge current (In) load.

The SPD short circuit protection device could be a fuse or circuit-breaker.
The following table compares the two solutions based on the required specifications.

Parameters	Fuses	Circuit breaker
Voltage decrease (Up improvement)	+	-
Lightning impulse current behaviour	+	- Contacts wear
Icc	+	-
Reduced dimensions	-	+
Cost	+	-
Remote failure control	+	+

In conclusion,
fuses provide a more suitable solution as short circuit protection for SPD.

Associated short circuit protections

SPD type	Fuses rating	Icc
DGV	125 A gG	100 kA
DGA	100 A gG	100 kA
DGT	50 A gG	100 kA
DGX	20 A gG	100 kA

Conductor Cross Sectional Area (C.S.A.)

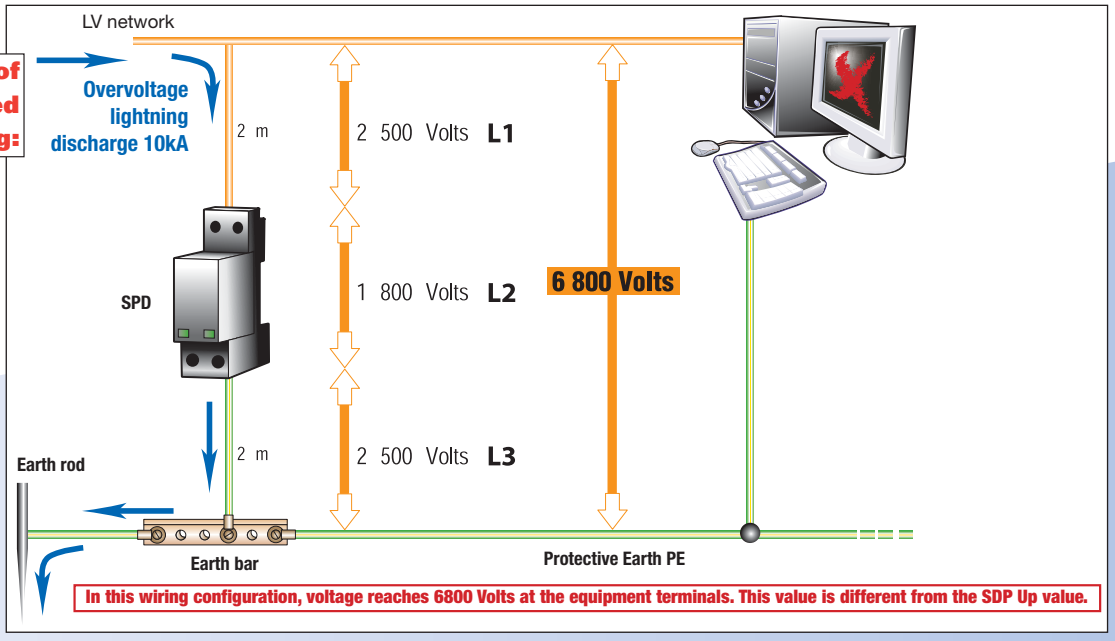
	Without external lightning protection system	With external lightning protection system
Active conductors	Mini : 4 mm^2	Mini : 10 mm^2
Protective Earth cable (PE)	Identical section to the active conductor Mini : 4 mm^2	Identical section to the active conductor Mini : 10 mm^2

Max conductor C.S.A. per type of SPD:
Type1 (DGV) 35 mm^2 max
Type 2 (DGA, DGT, DGX) 25 mm^2 max

The 50cm rule

The total length of L1, L2 and L3 must be less than 50cm long, in order to keep Up (residual voltage) value as low as possible. ***In cases where the length exceeds 50 cm, it is possible to:***

- reduce L3 length by relocating the earth bar;
- select another type of SPD with a lower Up value;
- use coordinated wiring.



Two protection modes

Two wiring diagrams are available:

Common mode protection (C1)

The SPD is wired between Phases and Earth in addition to Neutral and Earth. In this configuration, all the SPD are similar: DGV, DGA, DGT or DGX according to the required protection level.

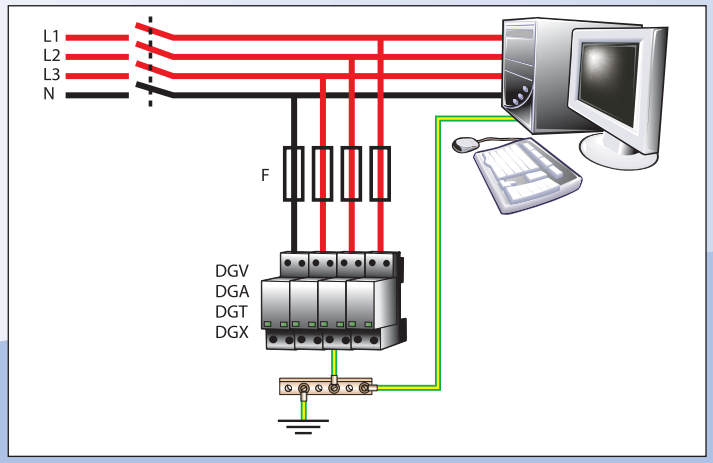
Common and Differential protection (C2 or "3+1 mode")

Enhanced protection can be achieved with this type of wiring:

- For type 1 SPD, DGV modules are wired between Phases and Neutral and a DE module is wired between Neutral and Earth.
- For type 2 SPD, DGA, DGT or DGX modules are wired between Phases and Neutral, and a DGE module is wired between Neutral and Earth.

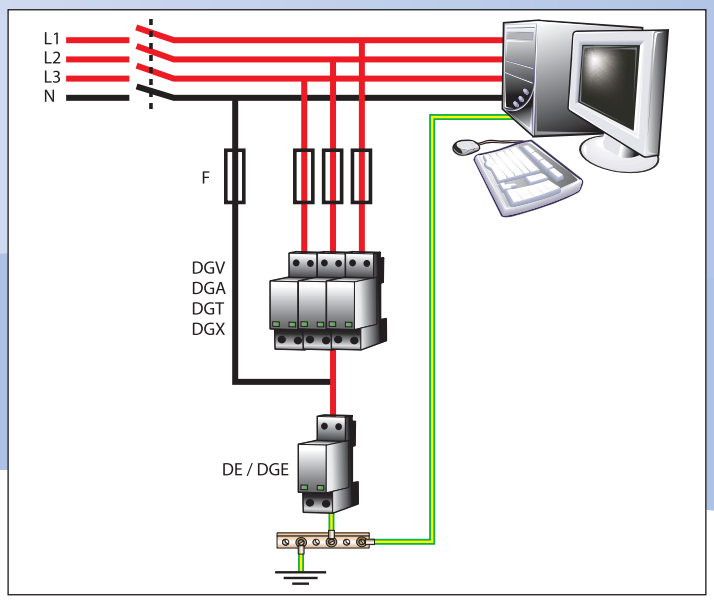
Common mode protection

C1



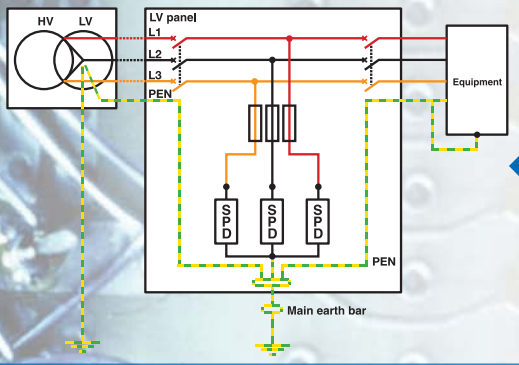
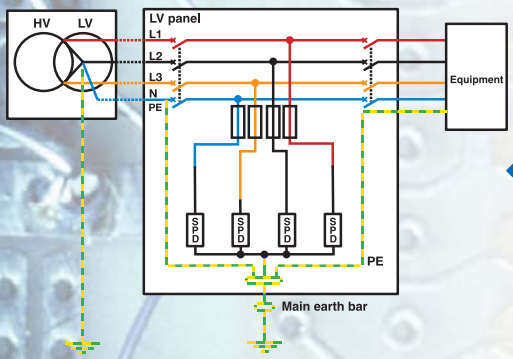
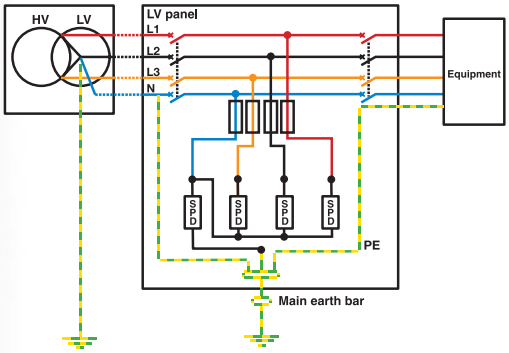
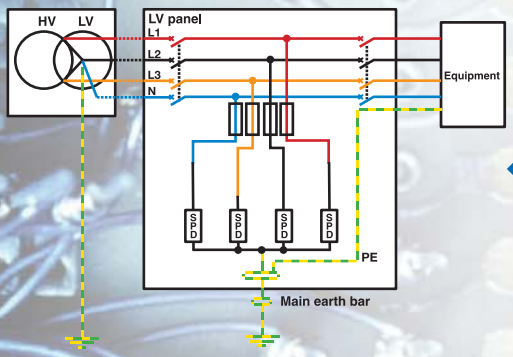
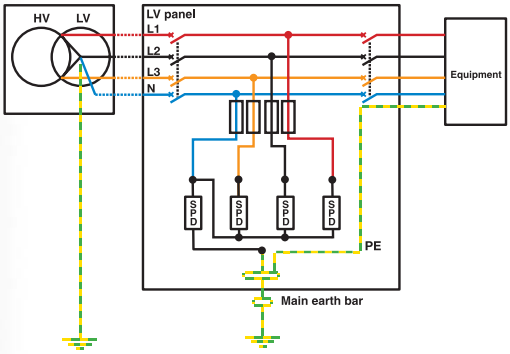
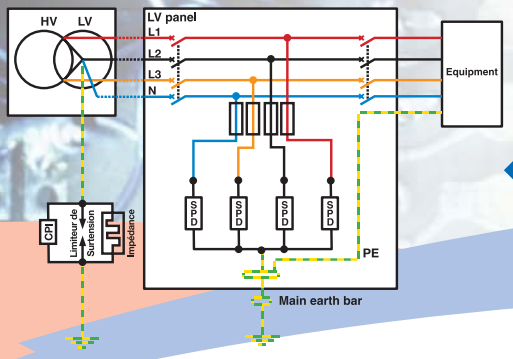
Common and Differential mode protection

C2



Wiring diagrams

Mountings according to different neutral systems

	Common Mode Protection (C1)	Common and Differential Mode Protection (C2) (scheme "3+1")
TNC		✕
TNS		
TT		
IT		✕

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