

Coordination of Surge protection devices

> Design guide

Surge arresters for commercial
and industrial buildings

**Surge protection devices:
how to choose them?**



How to choose surge protection devices?

As everyone knows, surge protection devices or surge protective devices (SPD) protect electrical equipment against over-voltages caused by lightning. That said, it is not always easy to know which to choose. Choosing the right surge arrester and protective circuit breakers involves a wide range of parameters related to types of surge protection devices, circuit breaker arrangements and risk assessment.

Let's try to see things more clearly...

First of all, current standards define three categories of surge protective devices for low-voltage electrical installations:

Type 1	Install in the main switchboard in buildings with lightning protection systems. Can discharge very powerful lightning currents.	Should be used as part of lightning protection systems i.e. when lightning rods or meshed cages are installed
Type 2	Install in the main power distribution switchboard. Discharge currents from indirect lightning strikes, inductive and conductive overvoltages, and switching transients.	Should always be used.
Type 3	Dedicated to the protection of specific devices. Very low discharge capacity.	Supplementary surge protective devices: <ul style="list-style-type: none"> • Used in Types 1+2+3 combinations in industrial facilities where a lightning protection systems is in place • Used in Types 2+3 combinations when there is no lightning protection systems

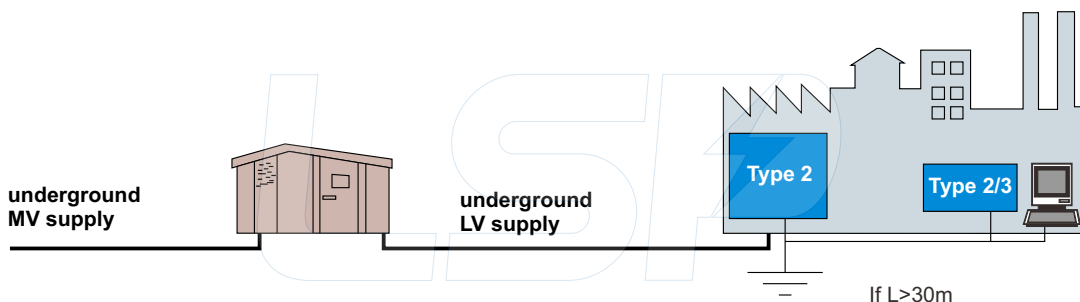
What surge protective devices should be chosen and where should they be installed?

Lightning protection should be approached from an overall viewpoint. Depending on the application (large industrial plants, data centers, hospitals, etc.), a risk assessment method must be used to guide in choosing optimal protection (lightning protection system, surge protective devices). National regulations, moreover, may make it compulsory to use the EN 62305-2 standard (Risk assessment).

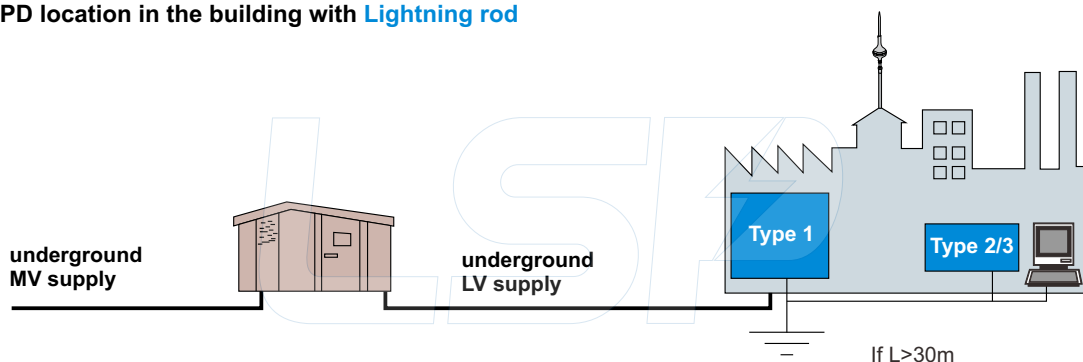
In other cases (housing, offices, buildings not sensitive to industrial risks), it is easier to adopt the following protection principle:

In all cases a Type 2 surge protective device will be installed in the electrical installation's incoming-end switchboard. Then, the distance between that surge protective device and the equipment to be protected should be assessed. When this distance exceeds 30 meters, an additional surge protective device (Type 2 or Type 3) should be installed near the equipment.

SPD location in the building without **Lightning rod**



SPD location in the building with Lightning rod



And the sizing of surge protective devices?

Then, the sizing of Type 2 surge protective devices depends mainly on the exposure zone (moderate, medium, high): there are different discharge capacities for each of these categories ($I_{max} = 20, 40, 60 \text{ kA}$ (8/20 μs)).

For Type 1 surge protective devices, the minimum requirement is a discharge capacity of $I_{imp} = 12.5 \text{ kA}$ (10/350 μs). Higher values may be required by the risk assessment when the latter is requested.

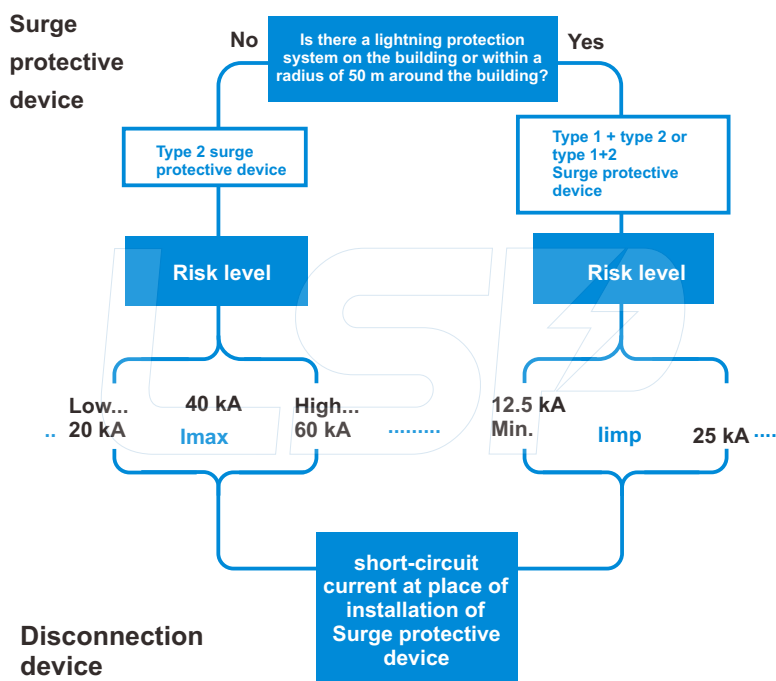
How to choose the protection devices associated with the surge protective devices?

Finally, the protection device associated with the surge protective device (circuit breaker or fuse) will be chosen according to the short-circuit current at the place of installation. In other words, for a residential electrical switchboard, a protection device with an $I_{sc} < 6 \text{ kA}$ will be chosen.

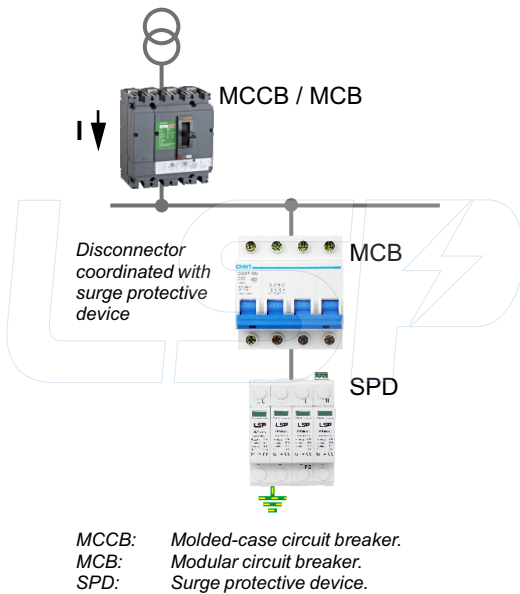
For office applications, the I_{sc} is generally $< 20 \text{ kA}$.

Manufacturers must provide the table for coordination between the surge protective device and the associated protection device. More and more surge protective devices already incorporate this protection device in the same enclosure.

Simplified selection principle (excluding full risk assessment)

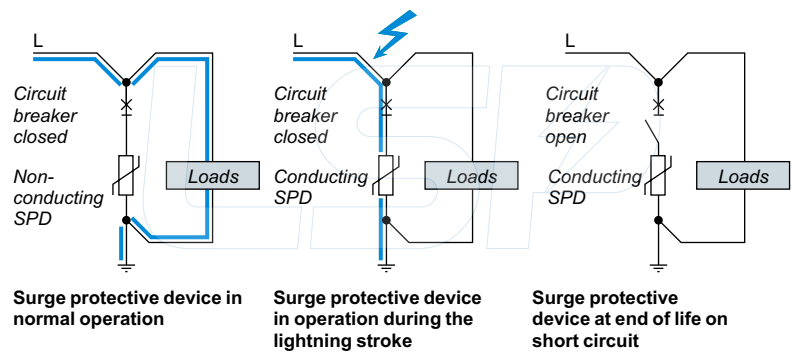


➤ Coordination between the surge protective device and its disconnect circuit breaker



An external disconnecting device must be coordinated with a surge protective device in order to achieve:

- continuity of service:
 - do not trip due to surge current,
 - do not increase (U_p) voltage protection level.
- effective protection against all types of overcurrents:
 - overload due to SPD aging,
 - short circuit of low intensity (impedant) due to temporary overvoltages,
 - short circuit of high intensity due to SPD degradation.



The disconnecting device must be coordinated with the surge protective device. It is designed to meet the following two constraints:

Resistance to lightning current

The resistance to lightning current is an essential characteristic of the surge protective device's external disconnecting device.

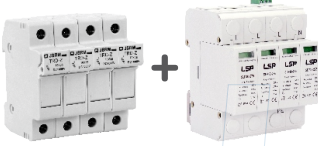

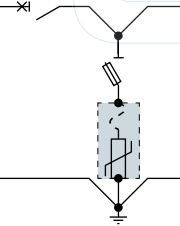
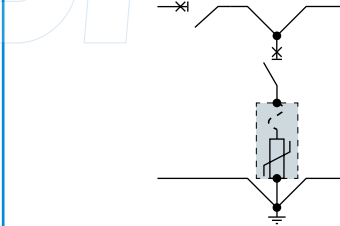
The device must be capable of passing the following standardized tests: not trip upon 15 successive impulse currents at I_n .

Resistance to short-circuit current

The breaking capacity is determined by the installation rules (IEC 60364 standard):

- the external disconnecting device must have a breaking capacity equal to or greater than the presumed short-circuit current I_{sc} at the point of installation.
- when this device is integrated into the surge protective device, conformity with product standard IEC 61643-11 naturally ensures protection.

Surge protective device coordination (cont.)

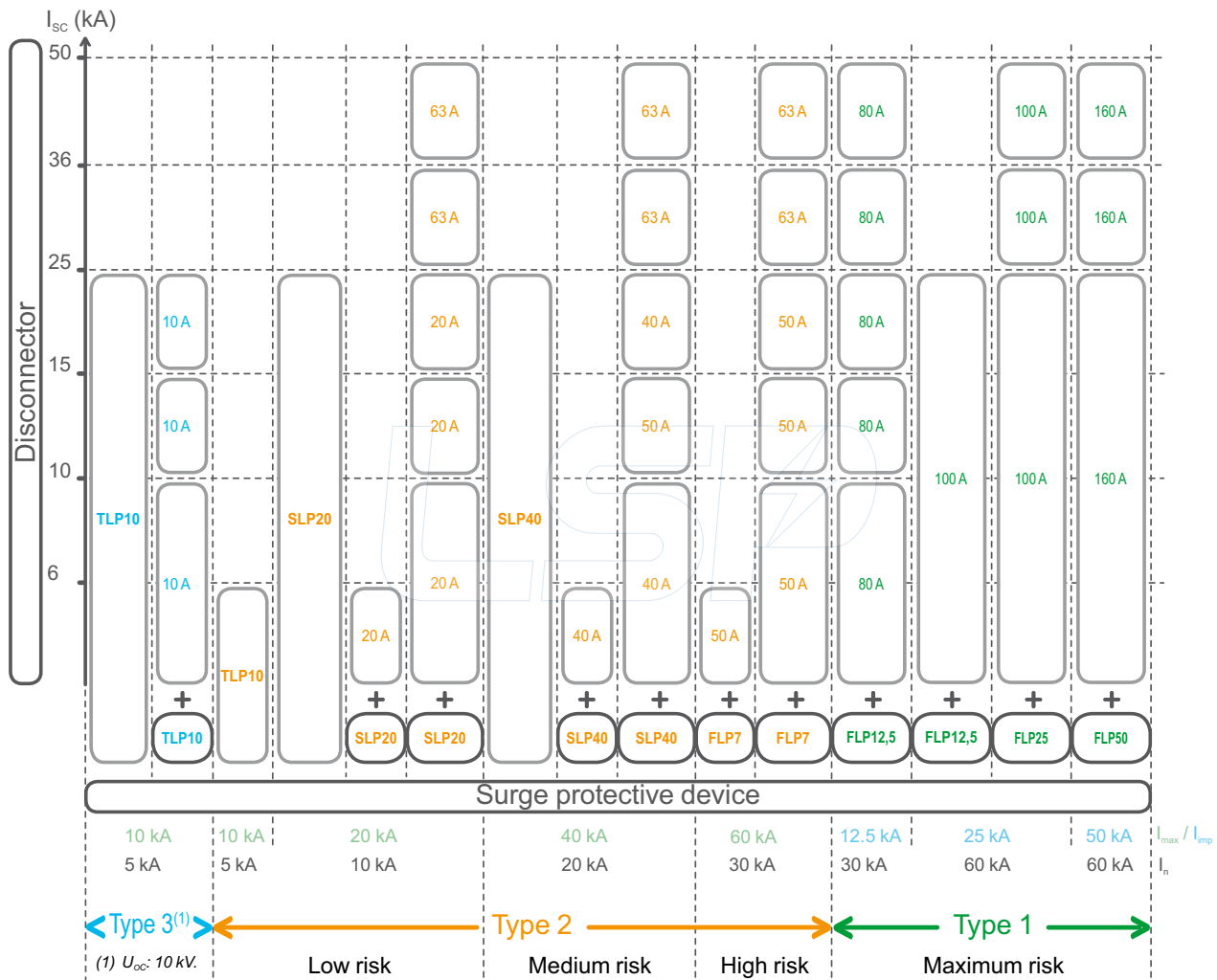
			
	External disconnecting device	Fuse protection combined with the SPD	Circuit breaker protection combined with the SPD
			
Lightning protection of equipment	=	=	=
Protection of installation (at end of the surge protective device's life)	All types of disconnecting devices protect the equipment satisfactorily	=	+
Continuity of service (at end of the surge protective device's life)	Achieved if compliance with the MCB/SPD coordination table	Protection from (impedant) short circuits of low intensity not well ensured	Protection against (impedant) short circuits of low intensity
Maintenance (at end of the surge protective device's life)	+	Only the surge protective device circuit is shut down	+
	=	Change of fuses	+
			Immediate resetting

Main reasons why the disconnecting device recommended by the manufacturer should be used:

- if the disconnecting device's rating is lower than the recommended rating: risk of the disconnecting device opening in normal operation.
- if the disconnecting device's rating is higher than the recommended rating: risk of non-disconnection during a temporary voltage surge.

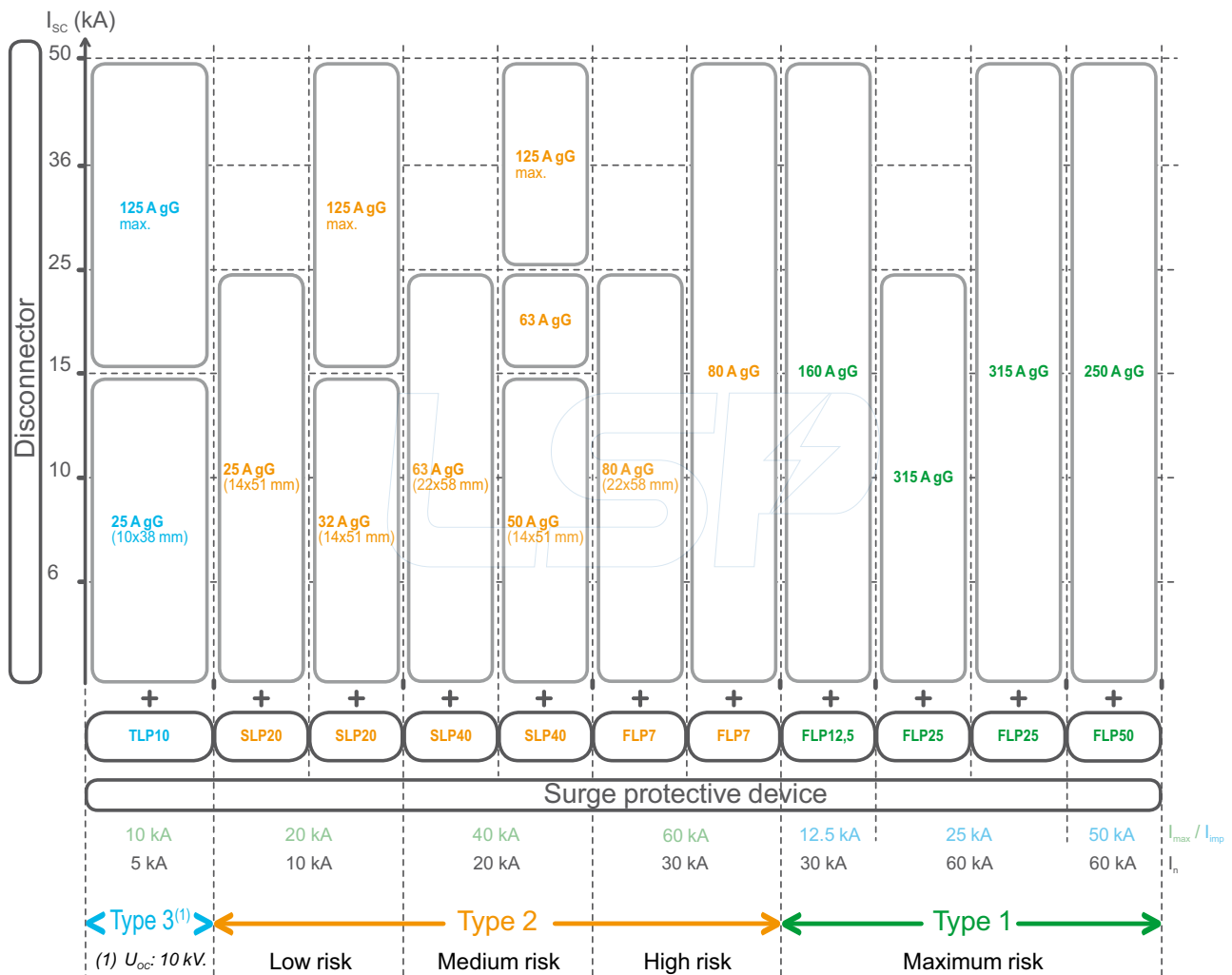
➤ Coordination between the surge protective device and its disconnect circuit breaker in the event of a short circuit

This table shows: the rating, curve and short circuit current level of the disconnector coordinated with the surge protective device.



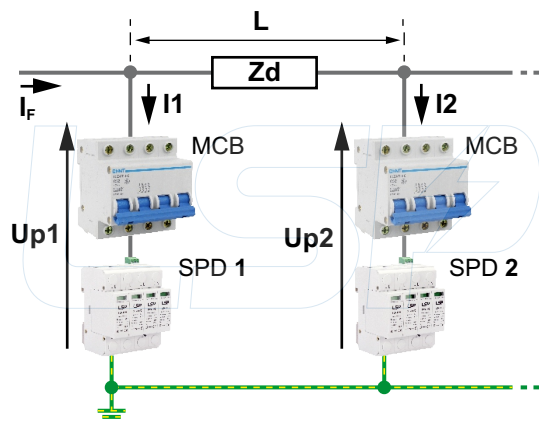
(*) For lightning impulse current withstand

➤ Coordination between the surge protective device and its disconnect fuse in the event of a short circuit



> Coordination between two surge protective devices, upstream/downstream

When two surge protective devices are installed in an electrical installation, coordination is needed according to IEC 61643-12 to obtain an acceptable stress distribution between the two surge protective devices according to their permissible energy "E".



L and Z_d represent the cable length and impedance respectively between the 2 surge protective devices.

U_{p2} : level of protection of surge protective device SPD2.

U_w : impulse withstand voltage of the equipment to be protected.

I_{max} : maximum discharge current.

I_F : lightning current:

$\leq I_{max}$ of SPD1

$= I_1 + I_2$

E : permissible energy.

MCB: modular circuit breaker.

SPD: surge protective device.

For coordination between two surge protective devices, a minimum cable length between these 2 surge protective devices is needed to ensure that:

@ $I_2 < I_{max}$ SPD2.

@ $U_{p2} < U_w$.

@ $E_2 < E_{max}$ SPD2.

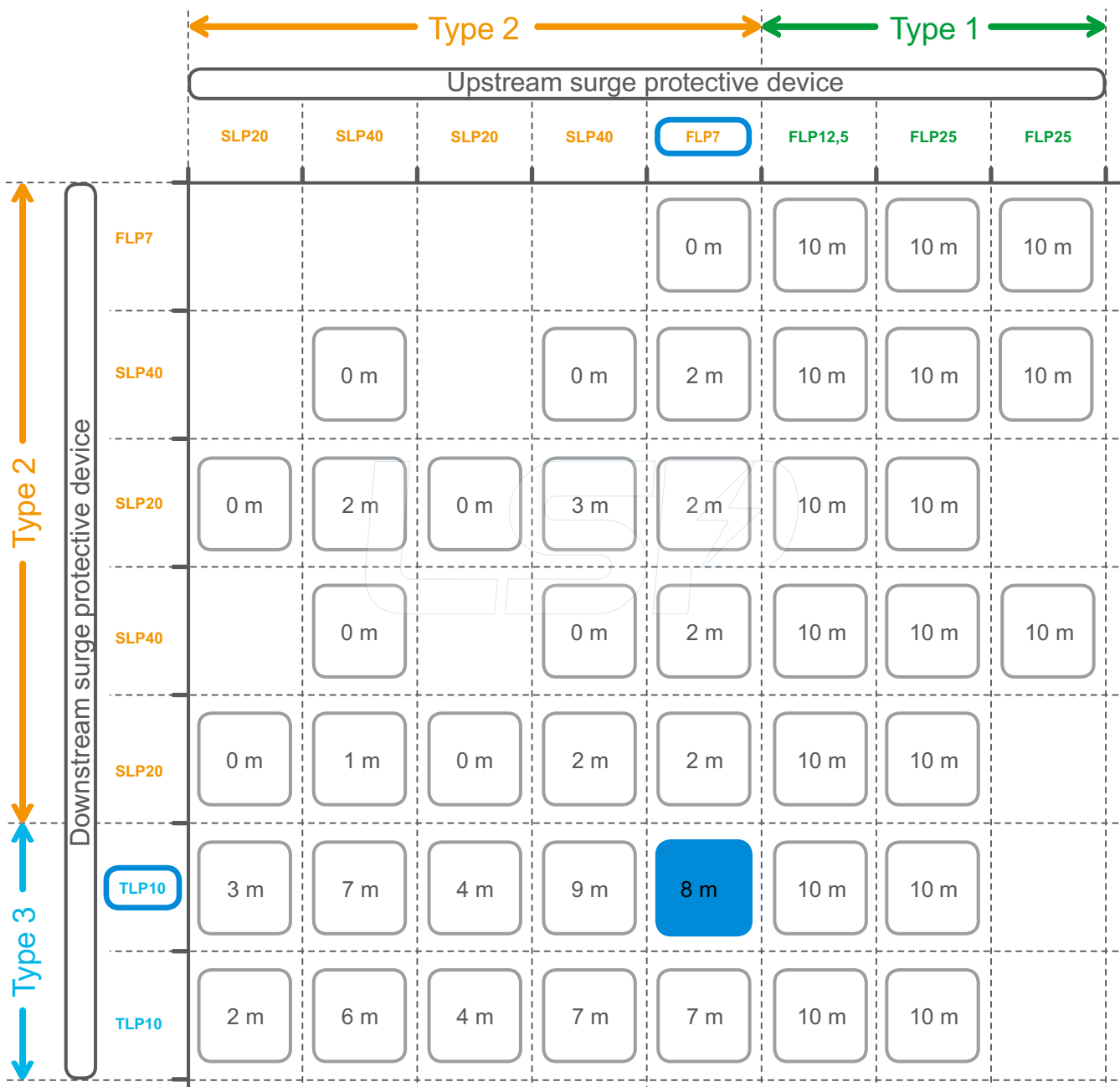
Surge protective device coordination (cont.)

Minimum distance between two surge protective devices, upstream/downstream

For a cable section of 16 mm² and an impulse current equal to the maximum discharge current (I_{max}) of the upstream surge protective device.

Example

If FLP7 is installed in the incoming panelboard, the second SPD TLP10 must be installed at a cable length of 8 meters from the first one.





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