

# Coordination of Surge Protective Devices



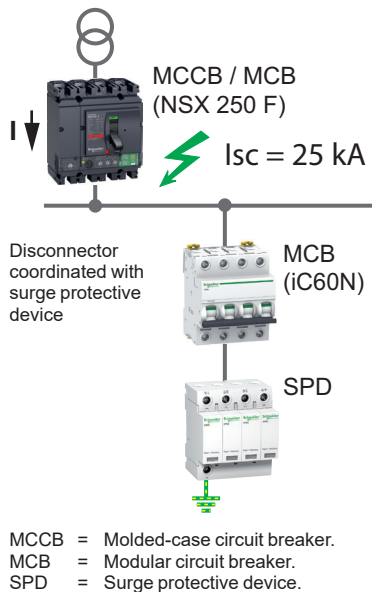
## > Design guide

Surge arresters for commercial and industrial buildings



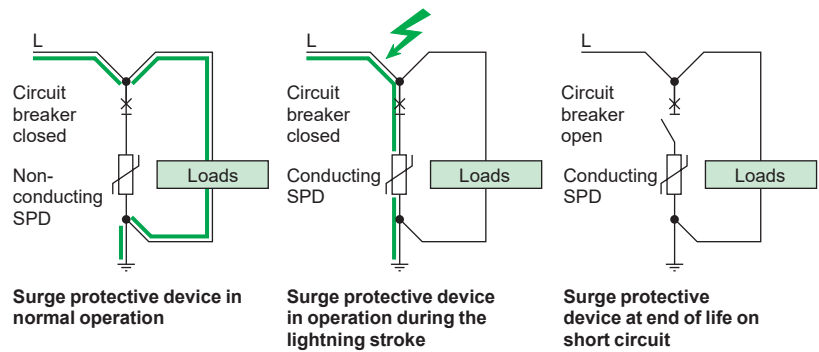
# Surge protective device coordination

## > 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 (Up) 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.




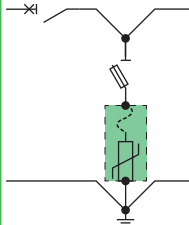
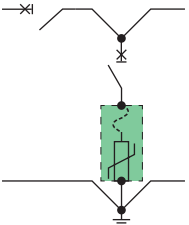
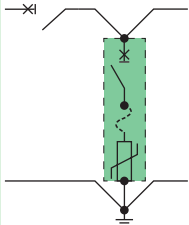
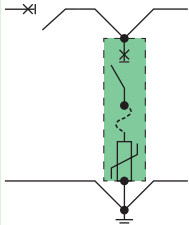
The device must be capable of passing the following standardized tests: not trip upon 15 successive impulse currents at  $I_n$ .

### 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.)

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

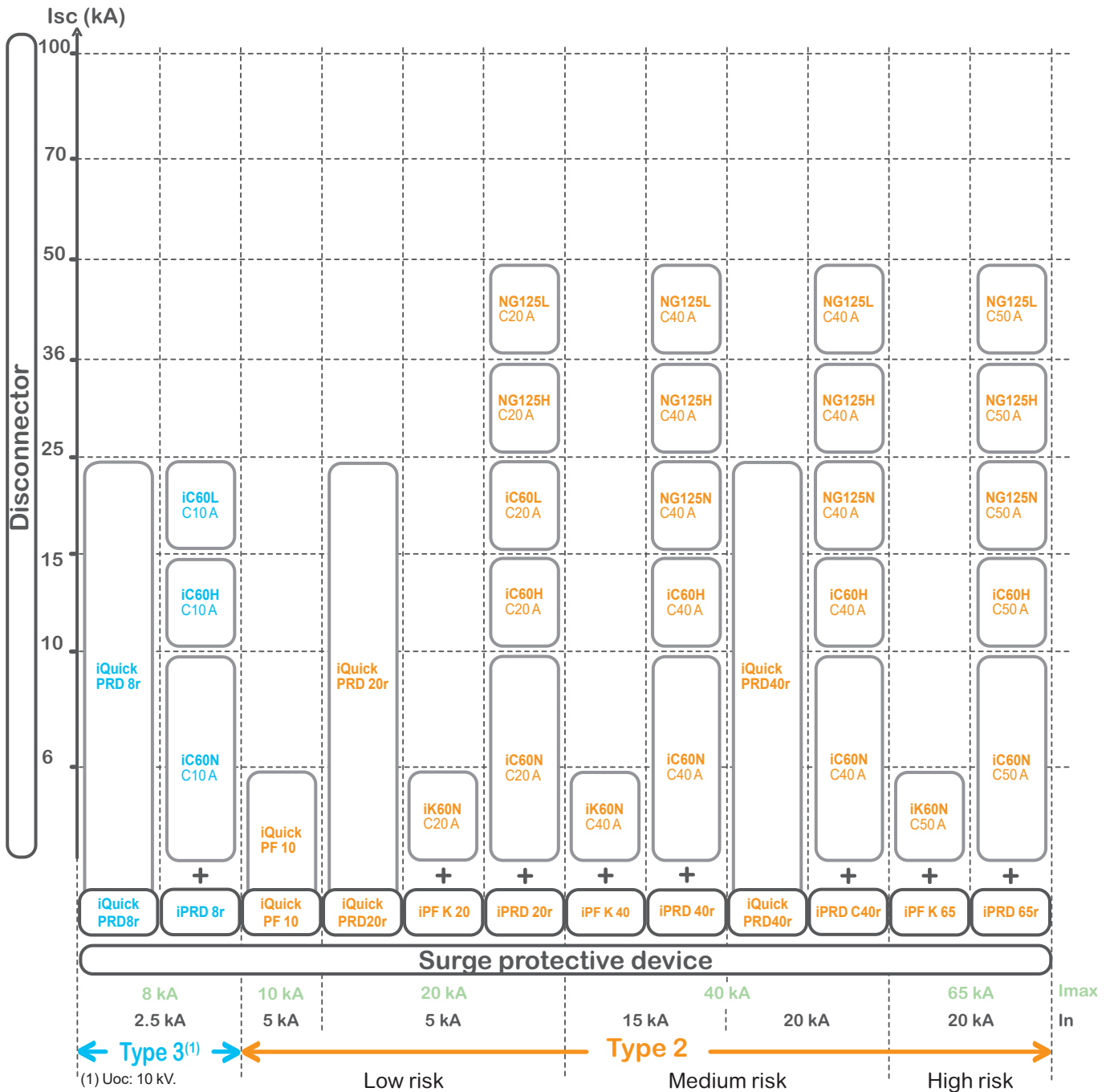
Main reasons why the disconnecting device recommended by the manufacturer should be used:

- 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.

# Surge protective device coordination (cont.)

## > Coordination between the surge protective device Type 2 and Type 3 and its disconnect circuit breaker in the event of a short circuit

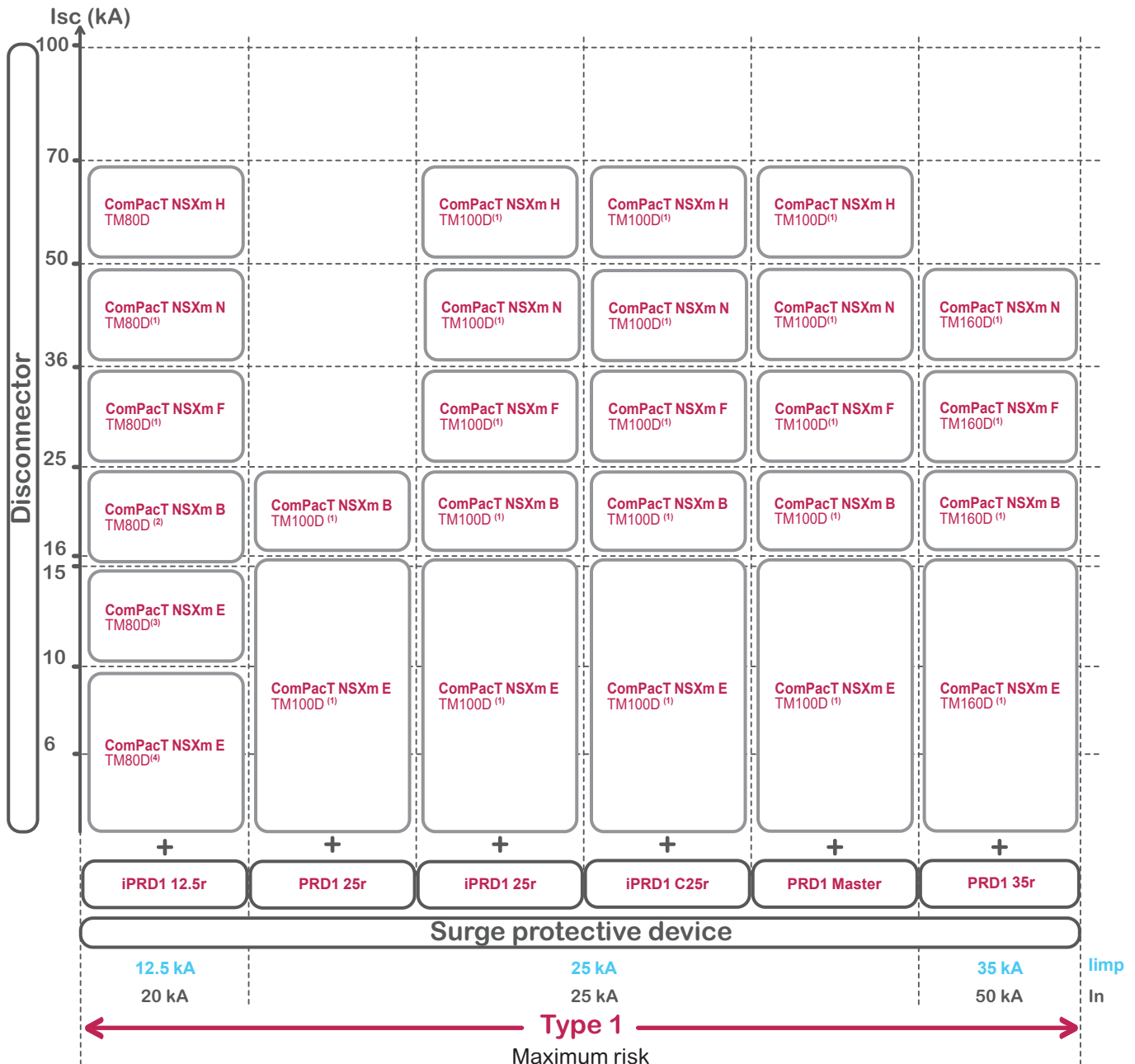
This table shows: the rating, curve and short circuit current level of the disconnector coordinated with the surge protective device.



# Surge protective device coordination (cont.)

## ➤ Coordination between the surge protective device Type 1 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.



(1): Equivalence table ComPacT NSXm - ComPacT NSX100 / NSX160

(2): For all applications where the Type 1 current wave (10/350 μs) ≤ 10 kA [limp ≤ 10 kA], the Acti9 NG125N C80 A can be used

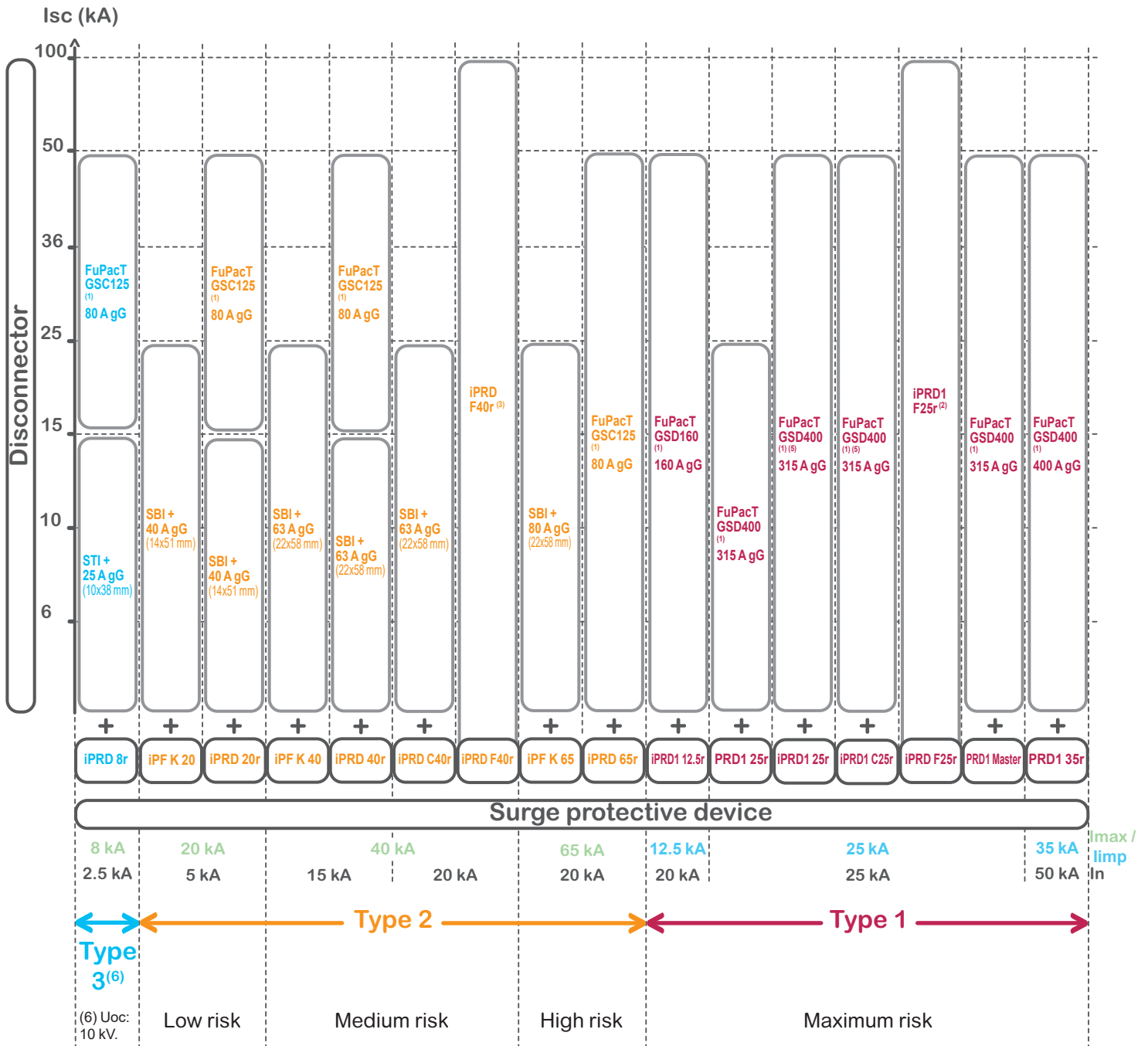
(3): For all applications where the Type 1 current wave (10/350 μs) ≤ 10 kA [limp ≤ 10 kA], the Acti9 C120H C80 A can be used

(4): For all applications where the Type 1 current wave (10/350 μs) ≤ 10 kA [limp ≤ 10 kA], the Acti9 C120N C80 A can be used

NSXm	NSX	NSXm	NSX	NSXm	NSX
NSXm F TM80D	NSX100 F TM100D	NSXm B TM100D	NSX100 B TM100D	NSXm B TM160D	NSX160
NSXm N TM80D	NSX100 N TM100D	NSXm E TM100D	NSX100 E TM100D	NSXm E TM160D	NSX160
		NSXm F TM100D	NSX100 F TM100D	NSXm F TM160D	NSX160
		NSXm N TM100D	NSX100 N TM100D	NSXm N TM160D	NSX160
		NSXm H TM100D	-		

# Surge protective device coordination (cont.)

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



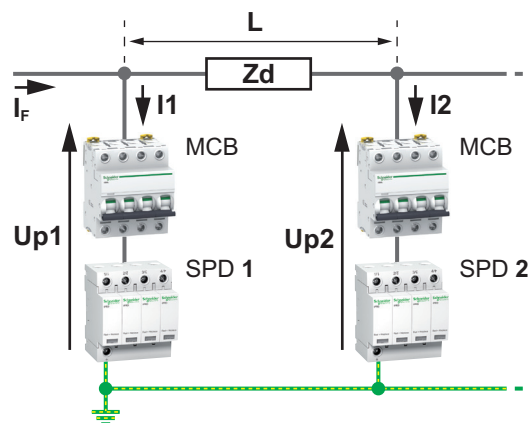
Note:

- (1): GSC and GSD are fuse switch disconnectors for DIN and NFC fuse. You can use BS fuse inside GSB fuse switch disconnector (cf catalog LVPED216031EN)
- (2): Total Selectivity if the upstream fuse  $\geq 315$  A; declared for  $I_{sc} = 75$  kA, tested and validated up to  $I_{sc} = 100$  kA (declaration of conformity on request)
- (3): Total Selectivity if the upstream fuse  $\geq 63$  A; tested and validated up to  $I_{sc} = 100$  kA
- (4): Total Selectivity if the upstream fuse  $\leq 100$  A. If upstream fuse  $> 100$  A, use 100 A gG fuse for disconnector
- (5): Total Selectivity if the upstream fuse  $\leq 315$  A. If upstream fuse  $> 315$  A, use 315 A gG fuse for disconnector

## Surge protective device coordination (cont.)

### > 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.  
 $Up_2$ : 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.
- $Up_2 < U_w$ .
- $E_2 < E_{max}$  SPD2.

# Surge protective device coordination (cont.)

Minimum distance between two surge protective devices, upstream/downstream

For a cable section of 16 mm<sup>2</sup> and an impulse current equal to the maximum discharge current (I<sub>max</sub>) of the upstream surge protective device.

**Example**

If iPRD65r is installed in the incoming panelboard, the second SPD iPRD8r must be installed at a cable length of 8 meters from the first one.

		Upstream surge protective device																		
		Type 2							Type 1											
		Low risk			Medium risk				High risk	Maximum risk										
		5 kA	15 kA	20 kA		20 kA	20 kA	25 kA	25 kA											
In		I <sub>max</sub> / I <sub>imp</sub>																		
		20 kA			40 kA				65 kA	12.5 kA	25 kA									
		iQuick PRD 20r	iPRD 20r	iPRD 40r	iQuick PRD 40r	iPRD C40r	iPRD F40r	iPRD 65r	iPRD1 12.5r	PRD1 25r	iPRD1 25r	iPRD1 C25r	iPRD1 F25r	PRD1 Master						
Downstream surge protective device	High risk	20 kA	65 kA	iPRD 65r						0 m	10 m	10 m	(2)	(2)	(2)	10 m				
		Medium risk	20 kA	40 kA	iPRD F40r			- (1)	0 m	0 m	0 m	- (1)	- (1)	- (1)	0 m	0 m	0 m	- (1)		
	iPRD C40r						- (1)	0 m	0 m	0 m	- (1)	- (1)	- (1)	1 m	0 m	0 m	- (1)			
	iQuick PRD 40r						0 m	0 m	0 m	0 m	2 m	10 m	10 m	(2)	(2)	(2)	10 m			
	Low risk	15 kA		iPRD 40r						0 m	0 m	(2)	(2)	2 m	10 m	10 m	(2)	(2)	(2)	10 m
		5 kA	20 kA	iPRD 20r	0 m	0 m	3 m	2 m	(2)	3 m	2 m	10 m	10 m	(2)	(2)	(2)	(2)	- (1)		
	iQuick PRD 20r			0 m	0 m	2 m	1 m	(2)	3 m	2 m	10 m	10 m	(2)	(2)	(2)	(2)	- (1)			
	Uoc: 10 kV	2.5 kA	8 kA	iPRD 8r	3 m	4 m	9 m	7 m	5 m	2 m	8 m	10 m	10 m	(2)	(2)	(2)	(2)	- (1)		
				iQuick PRD 8r	2 m	4 m	7 m	6 m	5 m	2 m	7 m	10 m	10 m	(2)	(2)	(2)	(2)	- (1)		

Note:  
 (1): Forbidden configuration.  
 (2): Validation in progress, value will come in next release of the document.

## Surge protective device coordination (cont.)

### > Cascading in the event of a short circuit between the surge protective device disconnect and the upstream circuit breaker

#### What is cascading?

Cascading means using the circuit breakers' limiting power, which allows circuit breakers of lower performance to be installed downstream.

The upstream circuit breakers then act as a barrier for major short-circuit currents. They thus enable circuit breakers of breaking capacity lower than the presumed short-circuit current (at their point of installation) to be loaded in their normal breaking conditions.

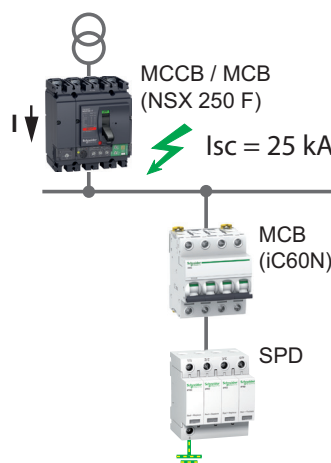
Since current limiting takes place all along the circuit controlled by the upstream current-limiting circuit breaker, cascading concerns all the devices located downstream of that circuit breaker.

It is not restricted to two consecutive devices.

#### Case 1

#### Disconnect circuit breaker not integrated into the surge protective device.

For this type of study, refer to the existing coordination tables.  
> see 548E4205 catalogue module.

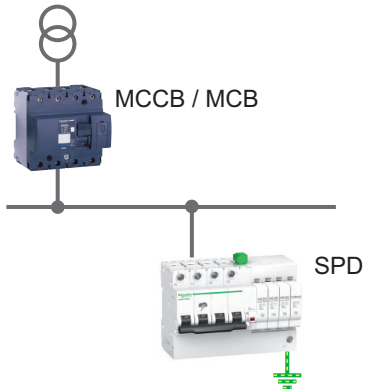


MCCB = Molded-case circuit breaker.  
MCB = Modular circuit breaker.  
SPD = Surge protective device.

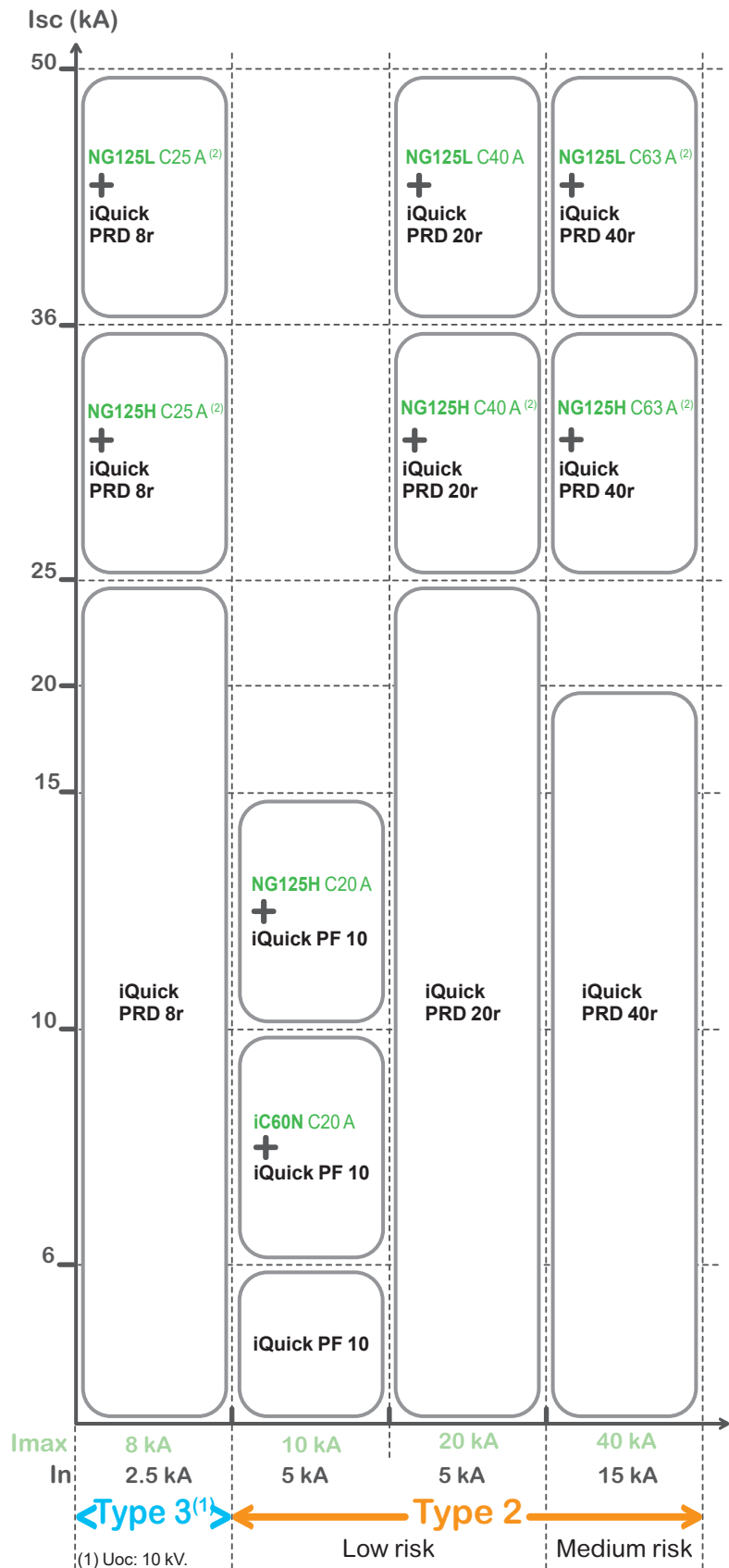
# Surge protective device coordination (cont.)

## Case 2

Disconnect circuit breaker integrated into the surge protective device.



- MCCB = Molded-case circuit breaker.
- MCB = Modular circuit breaker.
- SPD = Surge protective device.



(2): rating up to 80 A is validated

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