

Control Panel Technical Guide

How to prevent machine
malfunctions and electronic
damage due to voltage surges?



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Machines face surges every In case of failure, is the right

Surges are hardly observable, they have multiple consequences on machines and process. Some are serious with risks of injury, others are only material. In many cases the users have difficulties to investigate the causes.

Some relevant situations...

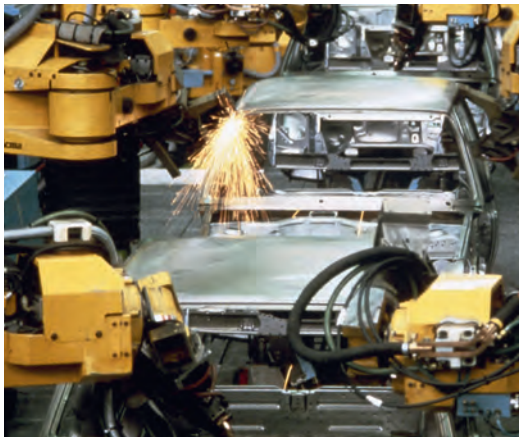


Unexpected stops

- Stops of ventilation, elevator, lighting causing risks for people.
- Stops of other equipments causing overheating, overcooling, flooding with damage to the installation, the building.
- Stops on machines causing production loss, etc.

Strange behavior

The appropriate machine controls are sometimes unpredictable causing erratic information on alphanumeric display, engine runaway with mechanical breakdown as worse consequences.



Electrical and electronic breakdown

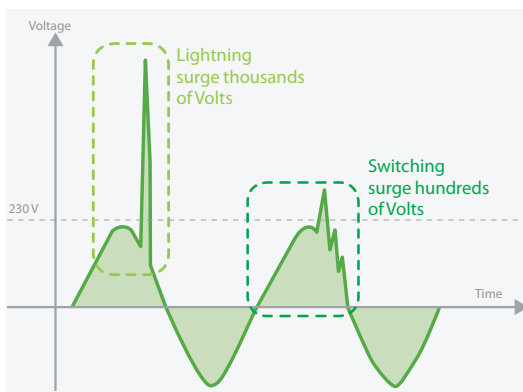
- Electronic devices are usually sensitive to surges conducted by supply lines, sensors and communication lines.
- Overvoltage can destroy electronic components or cause flashes between tracks of printed circuits.
- In some situation destruction can degenerate into a fire.



Every day. Is diagnostic always done?

They are invisible and transient: surges cause malfunctions and damages

> Their difference is a matter of energy.



Atmospheric surges

In a surge due to a lightning, the energy is great.

It is sufficient to destroy electronic components, even vaporize conductors.



Example: Damage on a modem motherboard due to atmospheric surge carried by the telecom line.



Industrial surges

> They are caused by:

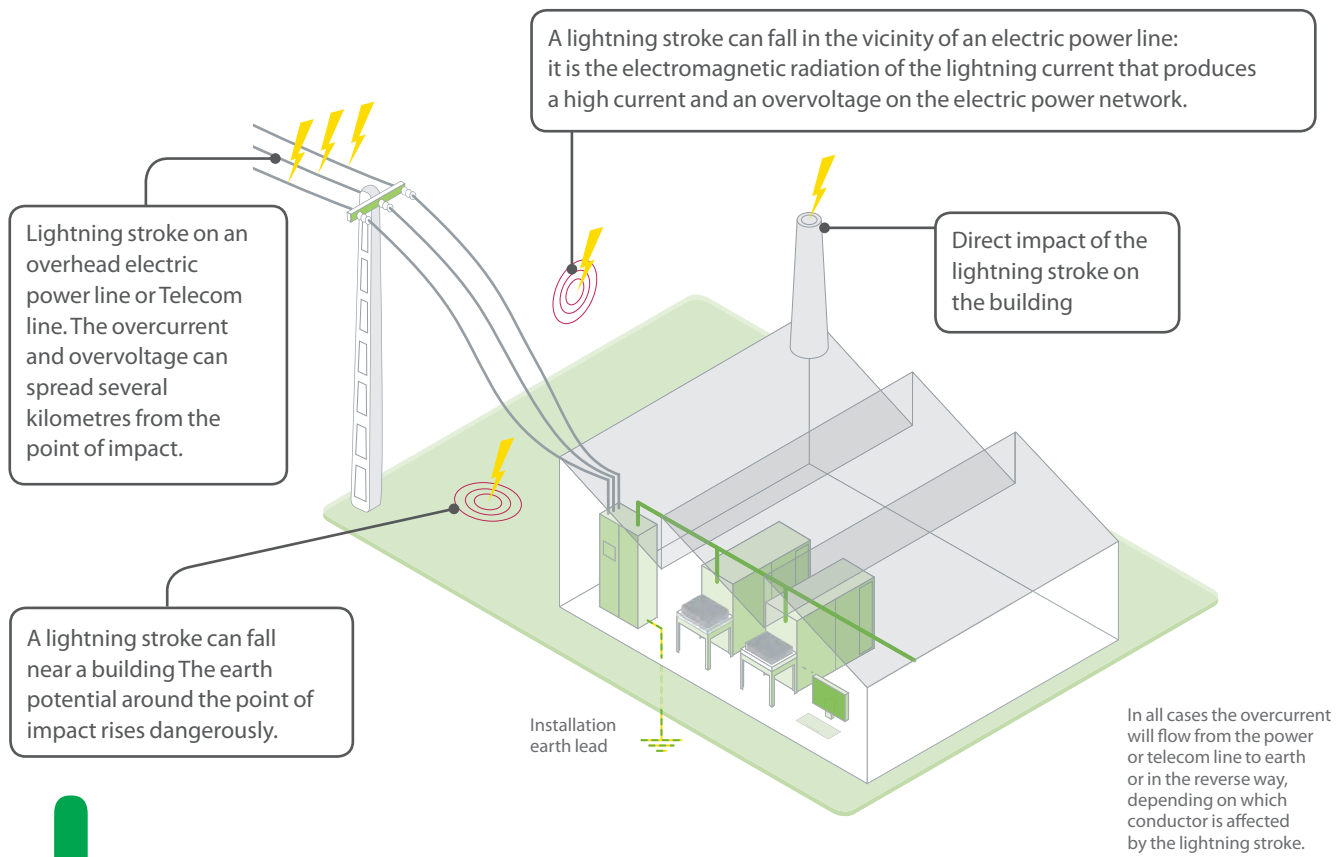
- capacitor banks switching, contactor coils or other inductive loads switching
- motor drives.

> Their consequences:

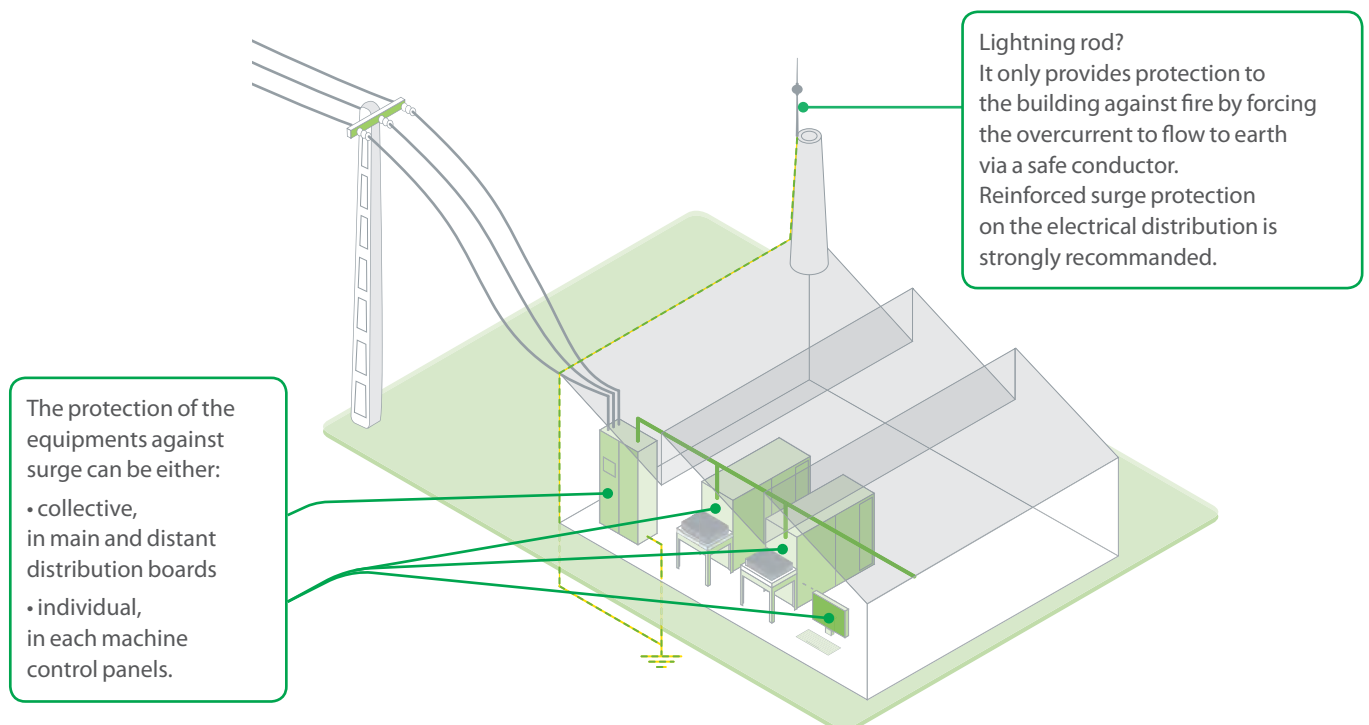
- superposition of noise on analog signals that generate false indications (eg wrong temperature)
- data change in memories
- lower transmission speed due to repetitions
- system reset, etc.

The energy coming from industrial surges is lower but still a cause of nuisance.

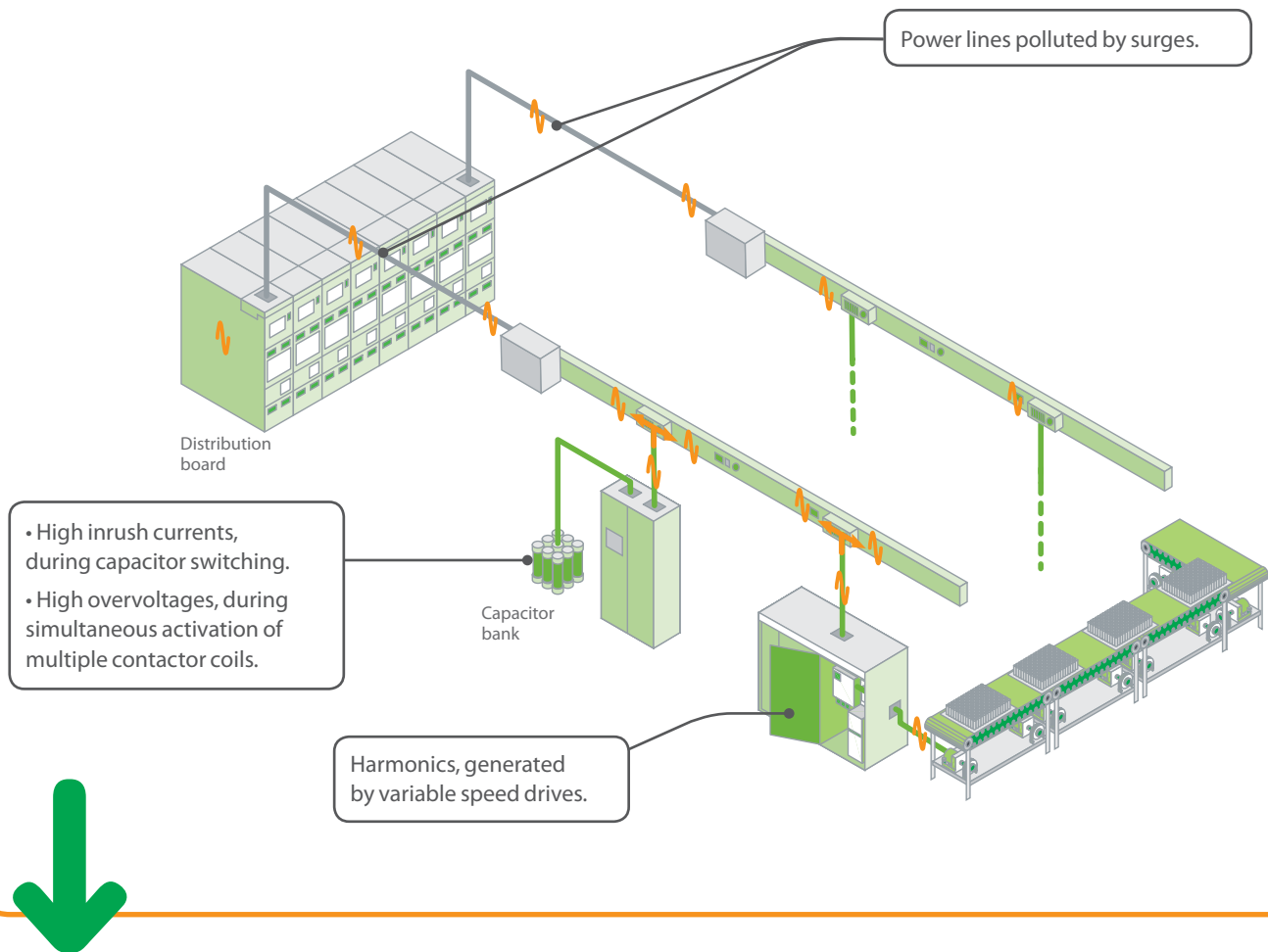
How atmospheric surges are generated?



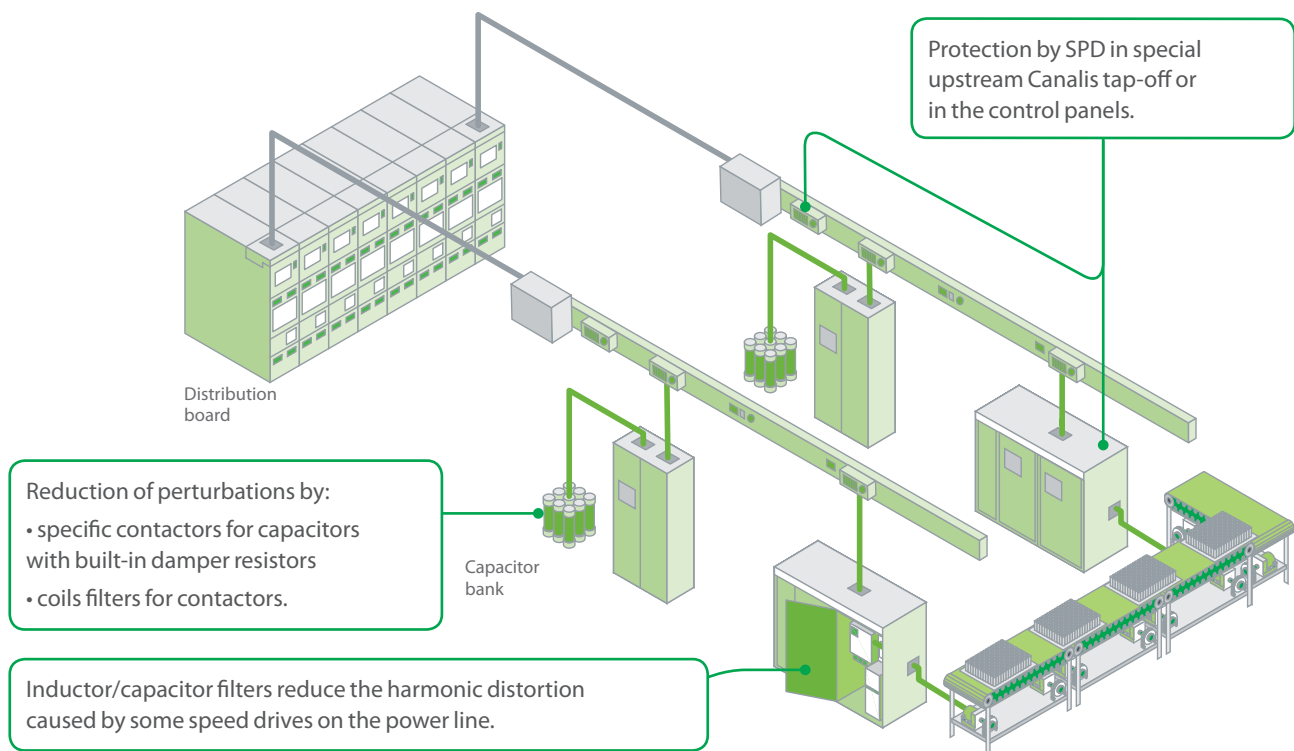
Where should the protection be installed?



How industrial surges are generated?



Where should the protection be installed?



The Surge Protection Devices (SPD)



What does an SPD look like?



Cartridge-type PRD 3P+N

• Cartridge-type SPD:

They have their varistors incorporated into pluggable cartridges for easier maintenance.



Combi Quick'PRD 3P+N

• Combi-SPD technology:

The built-in circuit-breaker (disconnecter) automatically isolates to the SPD when its cartridges need replacement.

Thus, the disconnecter offers continuity of service to the rest of the installation.

Zoom on:

Cartridge technology
The SPD is composed of a varistor or a gas tube.

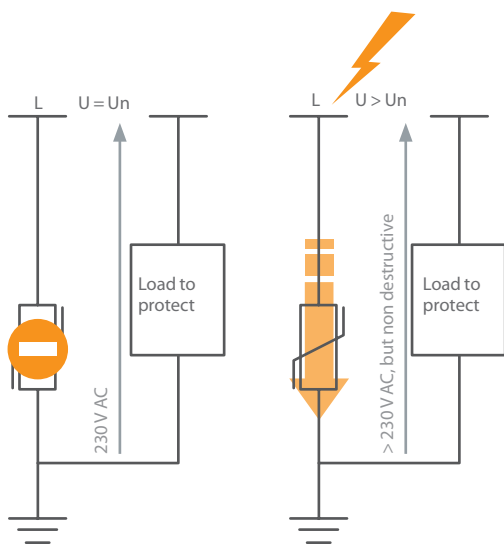


Varistor: its resistance decreases when the voltage increases.



Gas tube: a conductive arc appears between electrodes above a certain voltage.

How does an SPD work?

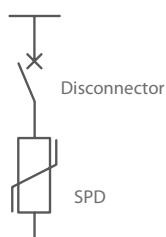


The SPD acts as a valve:

- It is closed (high impedance) when the voltage is normal ($U = U_n$).
- It is opened (conductive) in case of surge.

What happens when the main voltage exceeds the “maximum permanent voltage” (U_c of SPD)?

The surge current is derivated directly to earth thus the surge voltage is dropped to a non-destructive value for the electrical installation which is cabled in parallel.



A disconnecter is a dedicated circuit breaker which isolates the SPD circuit when the varistor cartridge has come to its end of life or during maintenance.

After a certain number of shocks depending on their intensity, the varistor will be short-circuited and need to be replaced. The information is usually given by a mechanical indicator.

Surge Protection Devices applications

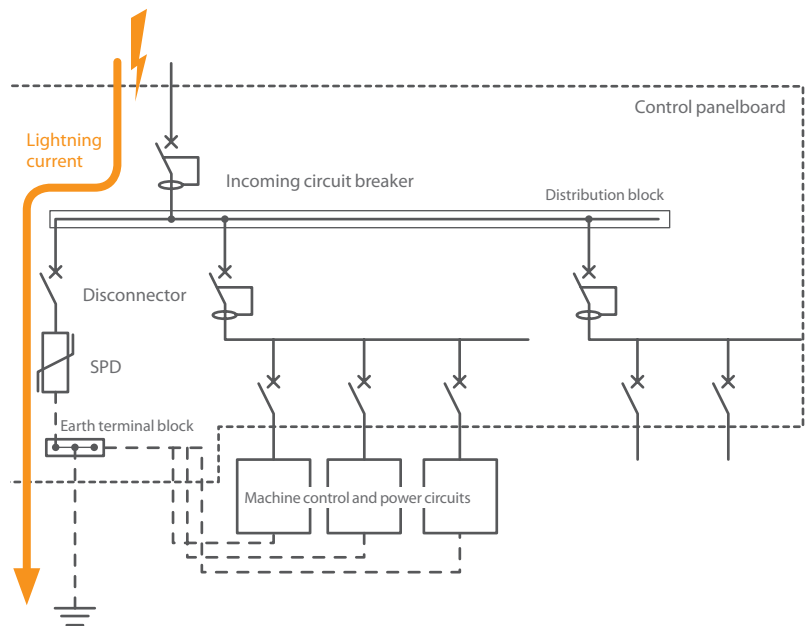


1 AC power circuits

Implementation

The SPD and its disconnecter are connected between the incoming circuit breaker (usually to the distribution block) and the earth terminal block.

As the voltage surge will be limited between these 2 points, the machine circuits will be protected.



Expert's tip

The impedance of the disconnecter + SPD circuit must be as low as possible. Cable liaisons must be as short as possible to ensure the lowest residual surge voltage during the current flow. 50 cm of cable per phase ensure a residual voltage ≤ 500 V. Which is acceptable.

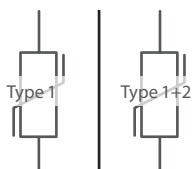


Choice of...

AC SPD types according to the risk

Very exposed area or building equipped with a lightning-rod (even in the case of an underground power line).

> Very strong risk



SPD Type 1 / 1+2



Preferably install SPD in the main distribution board.

Building with totally or partially overhead power line.

> Common risk



SPD Type 2



Alone or as a complement of a SPD type 1. Install SPD in main distribution board or remote panel board.

Against self re-generated residual surges which appear over 20-30 meters of a cable connected to an already protected panel board.

> Very strong & common risk



SPD Type 3



As a complement of a SPD Type 1+2 or Type 2. To be placed close to the load to be protected.

SPD disconnecter



It is chosen in the range prescribed by the SPD manufacturer in order to ensure its electrical coordination with the known or presumed upstream protection. Thus, main tripping during lightning will be avoided.

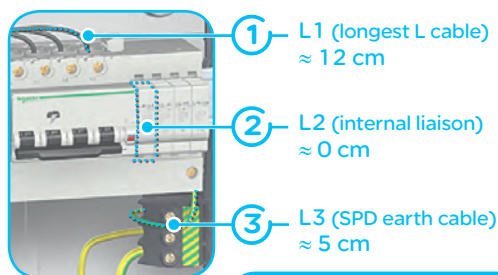
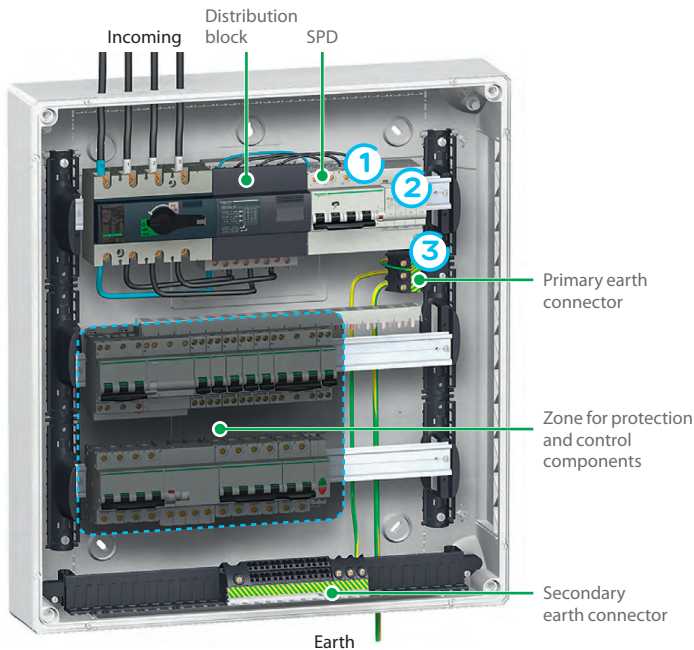
Thanks to Combi SPD technology the choice of a separate disconnecter is no longer needed.

Focus on...

Cabling rules of AC SPD in a machine control panel

Example in a:

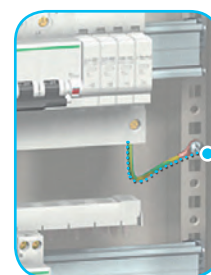
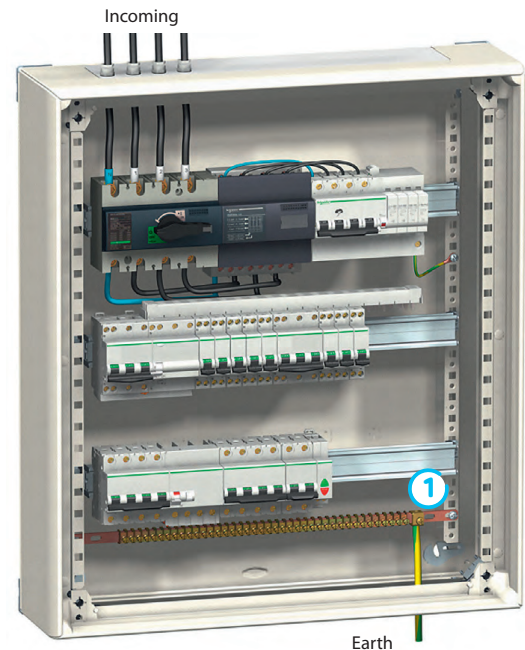
Pragma plastic enclosure



✓ $L1 + L2 + L3 < 50 \text{ cm}$

Example in a:

Prisma Plus metallic enclosure



The metallic chassis is used as a conductor

Connect the cable with a lock washer to ensure a perfect contact.

This solution is only possible with enclosures complying to the IEC 60439-1 standard.



The Surge Protection Devices for AC applications by Schneider Electric

- Perfect electrical coordination between the disconnector and the SPD.
- Faster cabling.
- Safety is preserved as the disconnector is tripped in case of faulty or missing cartridge.
- Quick disconnection of the SPD before dielectric test of the distribution or the control board.

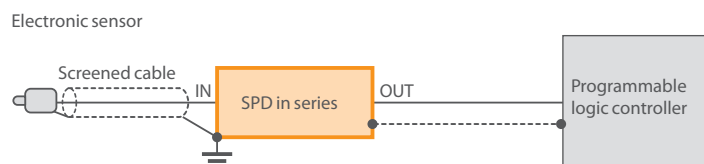


iQuickPRD 40r 3P+N
(ref. A9L16294)

QuickPRD 40r
Combi technology
offers better
performances
than traditional
technology.

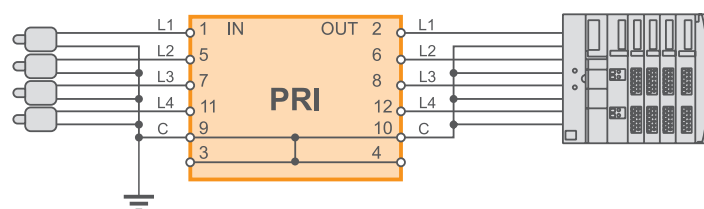
2 Very low voltage circuits

4 channels PRI SPD protecting the inputs of a controller:



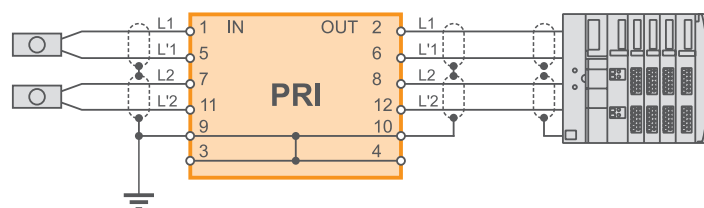
①

Cabling principle of an SPD for use in series.



②

4 binary sensors with common polarity are protected by a 4 channels iPRI SPD.



③

2 analog sensors or data lines without common polarity are protected by a 4 channels iPRI SPD.



iPRI – 4 channels
(ref. A9L16339)

Expert's tip

Place the SPD in the control panel board, close from the sensor terminal block.



Selection guides



To select:

➤ The SPD according to circuit voltage

AC Power

Type 1+2 (+ disconnecter)		Type 2		Type 3	
High risk, for single machine in an isolated and exposed shelter (pump, wind turbine...).		Common risk, for machine protection.		For complementary machine protection when a global Type 1 or 2 protection is already provided by the electrical distribution.	
Icc max: 10 kA		Icc max: 10 kA		Icc max: 10 kA	
					
C120N - 80 A	iPRF1 12.5r	iQuick PRD 20r	Common surge protection tap-off	iQuick PRD 8r	Common surge protection tap-off
	1P+N (ref. A9L16632) 3P (ref. A9L16633) 3P+N (ref. A9L16634)	1P+N (ref. A9L16295) 3P (ref. A9L16296) 3P+N (ref. A9L16297)	Canalis KN (ref. KNBQPRD) Canalis KS (ref. KSBQPRD)	1P+N (ref. A9L16298) 3P (ref. A9L16299) 3P+N (ref. A9L16300)	Canalis KN (ref. KNBQPF) Canalis KS (ref. KSBQPF)

Very low voltage AC/DC

	Series SPD for supply, sensor or data cables running along high voltage conductors or outdoor.
Max permanent voltage: 53 V DC – 37 V AC Max line current: 300 mA	
iPRI	iPRC
4 channels (ref. A9L16339)	1 channel (ref. A9L16337)

High voltage DC

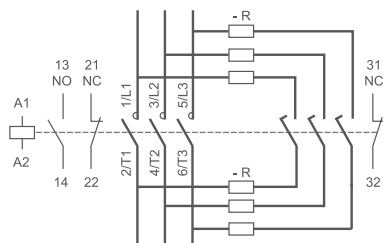
	DC SPD for photovoltaic generator
Max. permanent voltage: 600 V DC for 16434 – 1000 V DC for 16436.	
iPRD40r 600DC	iPRD40r 1000DC
(ref. A9L16434)	(ref. A9L16436)

➤ Contactors and suppressors for attenuation of switching surge

Contactors for capacitor banks



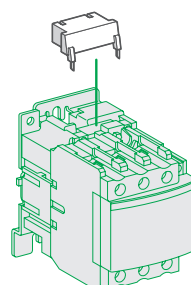
LC1D.K series:
3 poles contactors for capacitor switching



The capacitors are commutated in 2 phases:

- Phase 1: auxiliary contacts closed, the damp resistors (resistive white cables) limit the inrush current.
- Phase 2: less than 1 second later, the main contacts are closed shorting the damp resistors. The full current flows.

Suppressor modules for contactor coils



LA4D..., LAD4...
suppressor modules for TeSys D contactors

Contactor coil generates transients during commutation. They can be absorbed by a suppressor module connected in parallel.

Several types of suppressors (RC, varistors, flywheel diodes) to choose according AC or DC voltage and acceptable increase of contactor drop – out time.

Useful links

Understanding the protection principles, designing protection systems



http://www.electrical-installation.org/wiki/Protection_against_voltage_surges_in_LV

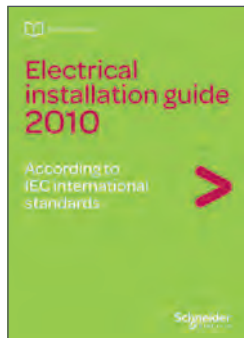
Choosing the appropriate SPD



<http://www.schneider-electric.com>

Useful Documents

Designing a distribution network according to IEC standards



Order:

<http://www.order.engineering.schneider-electric.com>

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www.schneider-electric.com

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