



# Novaris

## Lightning and Surge Protection

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## Surge protection installation guide

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For electrical  
designers and  
installers

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The performance of a surge protection device (SPD) is governed by two main factors; the designed performance of the SPD and the installation practices used on site. The SPD performance can be gauged by the information provided by the supplier. The important parameters when selecting a surge protection device are:

- $I_{max}$ : The maximum surge current between any one phase and neutral that the SPD can withstand for a single strike, 8/20 $\mu$ s current.
- $I_n$ : The surge current the SPD can handle for 15 strikes, 8/20 $\mu$ s current.
- Voltage protection level,  $U_p$ : the residual voltage from the surge after passing the SPD.

### Effects of cable lengths on shunt connected SPDs

The most important factor necessary to ensure the voltage protection level is kept as close as possible to the manufacturer's specifications is the cable length. The inductance of shunt (parallel) connecting leads, although small (in the order of 1 microhenry per meter), has a significant effect upon  $U_p$ . The voltage developed along a length of conductor due to its inductance is given by the formula:

$$V = L \times di/dt$$

Although the inductance,  $L$ , is small, the rate of rise of current,  $di/dt$  is large and therefore the voltage developed across shunt connected leads is significant and adversely affects overall performance.

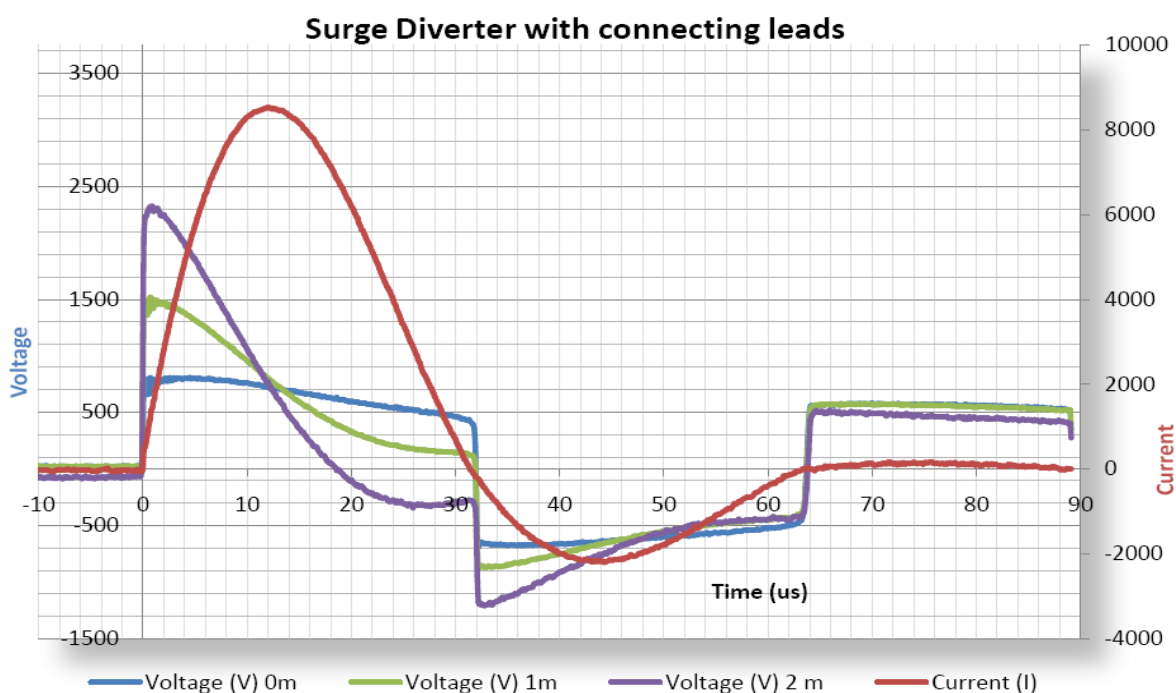


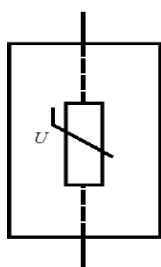
Figure 1 - Let through voltage for different cable lengths

The voltage protection levels for all SPD's are measured at the terminals for a given surge current. Figure 1 gives the example of a Novaris SDD1-100-275 surge diverter measured at the terminals, with 1m of cable and with 2m of cable. The length is split between each side of the device, i.e. half on the line side and half on the neutral side.

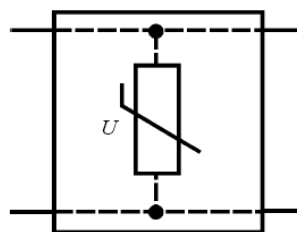


The reason for the large potential difference along the cable has little to do with the resistance and far more to do with the inductance.

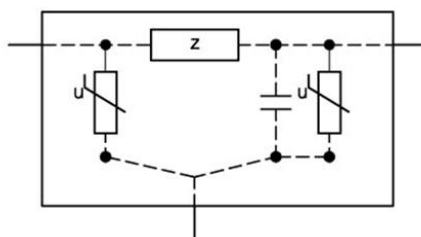
In figure 1 with a current rise time of  $1.5\text{kA}/\mu\text{s}$  and a cable inductance of 1 microhenry per meter, the increase in the voltage protection level is 750V/meter. An SDD1-100-275 located 500mm away from the incoming feed connection, with an overall length of 1m of wiring including the SPD fuse connection, will have a let through voltage of 1500V.



Shunt Connected SPD (Novaris SD, SDD, SDN)



Series Connected SPD (Novaris SSP)



Series Connected Surge Filter (Novaris SFH, SFM, SFD)

Figure 2 – Typical SPD configurations

Series connected SPDs incorporate the shunt connection internally, eliminating the detrimental effects of shunt connected leads. Unlike shunt connected surge diverters, load current is a factor when selecting a series device. Series connected surge filters provide superior performance in terms of voltage protection level and are particularly useful for protecting sensitive electronic loads.

## Backup Fuse Rating for Surge Protection Devices

Shunt type SPDs are given a maximum backup fuse rating which is marked on the device. This fuse rating is selected to allow the  $I_{\text{max}}$  surge current to reach the device whilst protecting the device from short circuit failures. The fuse rating for series connected SPDs is solely determined by the load current rating of the device.

Selecting an appropriate fuse for a protection installation is extremely important to ensure maximum performance of the SPD. The maximum fuse rating may not always be appropriate.

There are two different approaches when selecting fuse ratings for SPDs which are dependent upon the services provided by the site and their required uptime.

### Power loss tolerant sites

At a power loss tolerant site it is acceptable to lose the incoming power feed. In this situation the SPD will be exposed to the maximum surge current and provide the best protection for the site.

### Incoming feeder is smaller or equal to the SPD maximum fuse rating

In this situation utilising the incoming supply fuses for service and SPD protection will ensure the protection device is exposed to the entire surge current. If the surge is larger than the supply fuse can handle the site is still protected. The drawback is if the SPD enters failure mode then the supply fuse can trip and de-energise the site.

### Non power loss tolerant sites

At a non power loss tolerant site it is not acceptable to lose the incoming power feed. In this situation, careful selection of the SPD fuse while maintaining discrimination will ensure maximum surge current exposure whilst de-energising the SPD if it enters failure mode.

### Incoming feeder is larger than the SPD maximum fuse rating

If the incoming fuse rating is more than  $1/3^{\text{rd}}$  greater than the SPD maximum fuse rating then generally the SPD fuse will trip before the incoming feed fuse. In this situation simply use the recommended maximum fuse for the SPD. This will allow the protection device to provide the highest level of protection as the selected fuse will be exposed to  $I_{\text{max}}$  surges.

### Incoming feeder is smaller than the SPD maximum fuse rating

If the incoming fuse is smaller than the SPD maximum fuse rating then the device will not be exposed to its full  $I_{\text{max}}$  rating. The effects of this problem are not entirely harmful as the incoming feed wire will also restrict the surge. Table 1 provides a guide to selecting fuses and CBs (circuit breakers) for fuse co-ordination. Novaris products can be provided with an active alarm to monitor the SPD fuse and its protection level.

If the incoming feeder is much smaller than the recommended fuse rating it is recommended to place the SPD fuse before the incoming feeder to utilise the upstream breaker for co-ordination.

Table 1 – Fuse/CB co-ordination chart

Incoming feeder fuse rating (A)	Incoming feeder CB Rating (A)	SPD fuse rating (A)	SPD CB rating (A)
16	6	10	4
25	10	16	6
32	16	20	10
40	20	25	16
63	32	40	20
80	40	50	25
125	63	80	40
160	80	100	50
250	125	160	80
500	250	320	160

Fuses are recommended for SPD and upstream use as CB impulse current tolerances may vary.

SPD maximum fuse ratings are marked on the product. Do not install fuses with a rating higher than the maximum fuse rating.

## Typical Connections

At a main switchboard the SPD is installed after the main switch and prior to any RCD. Novaris configures its SPDs as shown in figure 3. This provides all mode protection with the N-PE gas discharge tube firing to create a momentary short circuit between neutral and protective earth.

This configuration may be used universally on any TN wiring system whether at a main switchboard or sub-distribution board. For a TN-C-S system where the neutral and protective earth are connected together at the main switchboard the N-PE gas discharge tube becomes redundant.

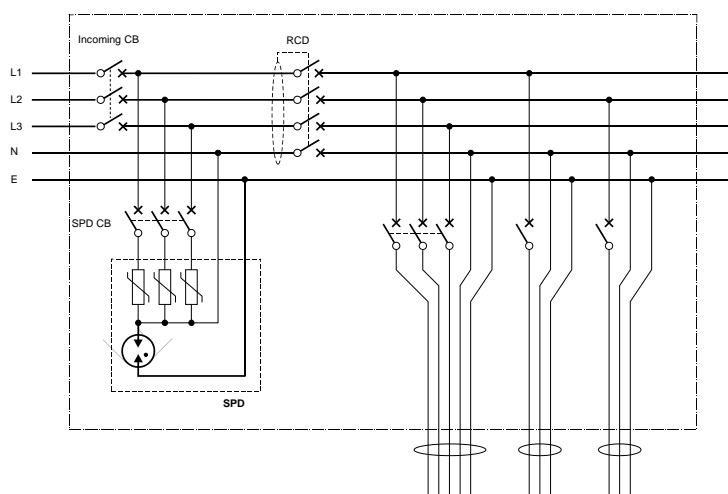


Figure 3 – One port shunt connected SPD

A two port SPD or surge filter should be installed as per figure 4. This single phase example shows a TN-C-S system with the multiple earth neutral link (MEN). In this case the N-PE GDT is redundant. With other TN wiring systems the GDT is necessary. The secondary SPD neutral bar provides a through connection for the neutral avoiding the added inductance of an otherwise shunt connection to the main neutral bar.

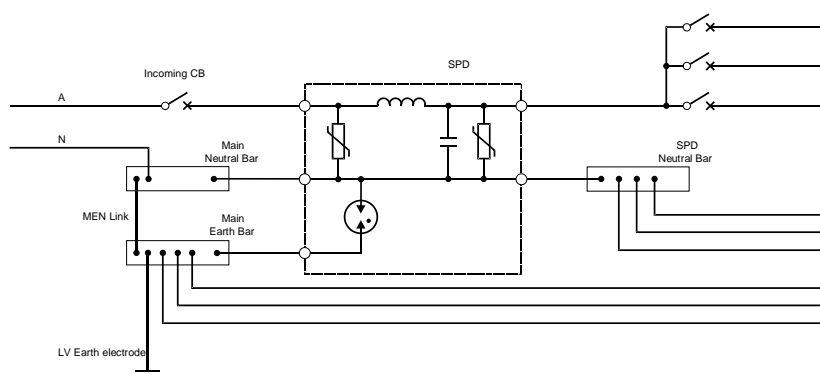


Figure 4 – Two port series connected SPD

At a sub-distribution board or at the input to an equipment rack a small 2 port SPD or surge filter provides effective protection for electronic equipment. This can be wired as shown in figure 5.

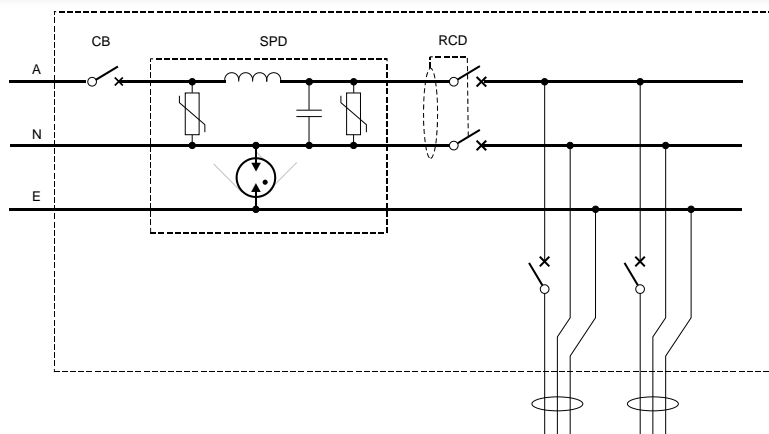


Figure 5 – Two port series connected SPD

## Define a surge protection boundary

The point of defining a surge protection boundary is to identify which services need protection and to ensure that surges cannot be induced to parallel cables.

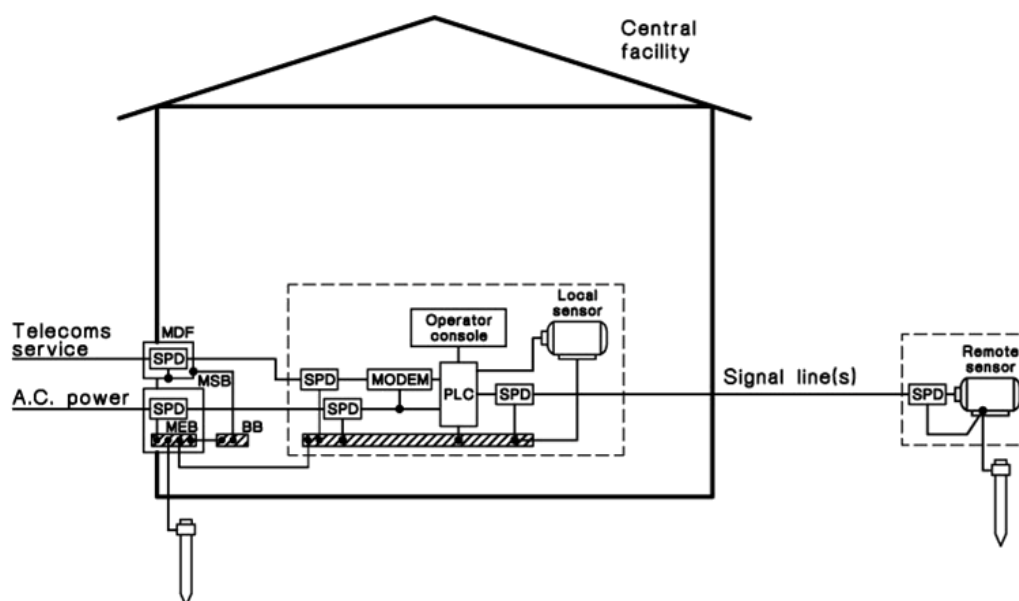


Figure 6 - Surge protection boundary example

Figure 6 shows an example of a site with multiple services entering the building. Within the building a protected boundary has been defined and within it all incoming services have surge protection applied. A remote boundary is also shown with a remote sensor contained. Often signal and RF cables are overlooked when a surge protection system is designed. If these services are exposed to lightning or use a different earth then they can introduce surges.

The protection boundary also helps identify clean (surge protection applied) and dirty (no surge protection applied) service cables. It is important to make sure clean and dirty cables are separated so surge currents cannot be induced on parallel lines. It is also possible for the voltage from a surge to overload the insulation of a cable causing the surge to be introduced to adjacent services.

All SPDs within a given boundary must be referenced to the same earth as figure 6 shows.

## Earth Bonding

It is important for energy dissipation to ensure a site has a low resistance earth but it is more important to make sure all services within a lightning protection boundary are bonded together.

Potential differences are a major cause of damage to electronic components. If all services are bonded together there is no potential difference between services and all will rise to the same potential.

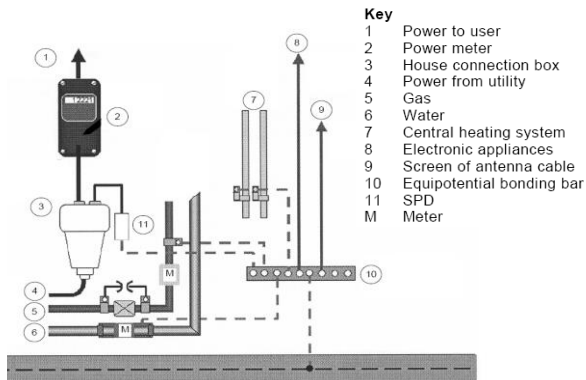


Figure 7 – Bonded services example

Services that can not be bonded together and use a different earth require surge protection at both ends of the service run to prevent potential differences from reaching equipment.

## Conclusion

By following these principles both designers and installers can maximise the potential of their surge protection devices.

The protected site will:

- Minimise residual voltage
- Maximise SPD exposure to surge current
- Reduce voltage potential difference between devices
- Minimise risk of induced voltages in clean cables