



# Novaris

## Lightning and Surge Protection

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### To Filter or Divert?

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The difference  
between surge  
diverters and surge  
filters

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King

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One of the key differentiating factors when selecting surge protection devices is their let through voltage. The Australian Standard on Lightning Protection (AS/NZS 1768:2007) defines a standard combination waveform consisting of a 1.2/50us 6kV peak combined with an 8/20us 3kA peak. The let through voltage is the residual voltage exposed to the load past the surge protection device.

To get a better understanding of the let through voltages associated with higher energy surges, 1.2/50us 20kV, 8/20us 9kA surges have been included.

Lower let through voltages provide better protection for more sensitive equipment. Some surge protection manufacturers use lower voltage components to achieve a lower voltage let through at the expense of reliability. Novaris uses 275V MOVs for their 240V products to provide adequate headroom for tolerable voltage fluctuations. If lower let through voltages are required Novaris can provide a range of surge filters that offer excellent performance without sacrificing reliability.

## Surge Diverters

Surge diverters are connected in parallel. They consist of surge arresting components, usually metal oxide varistors (MOVs) and gas arresters. They work by diverting surge energy to ground. A typical let-through voltage waveform for a surge diverter is shown in Figure 1 below:

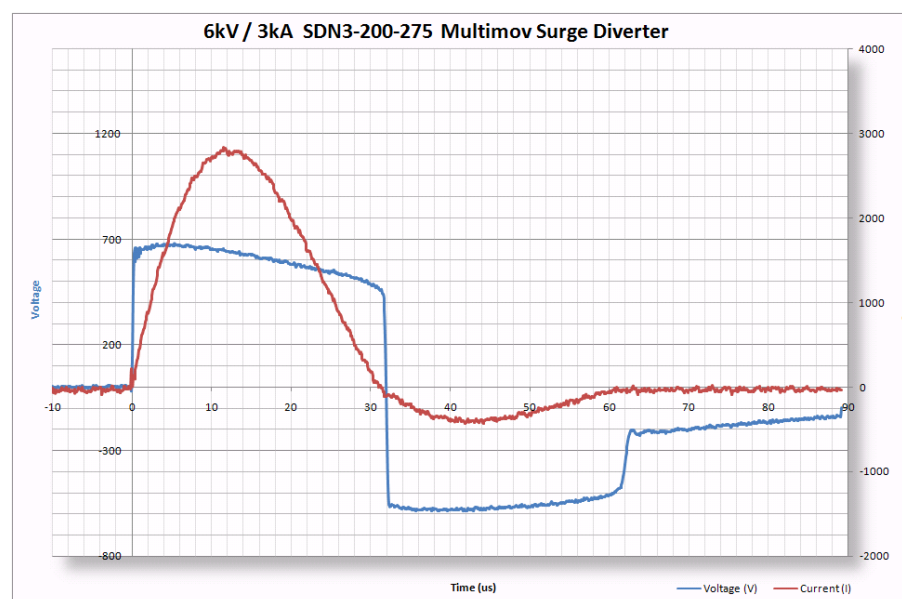


Figure 1 Typical let-through voltage of a surge diverter (6kV/3kA)

The let-through voltage shown here is just under 700V. Whilst this is low enough to protect most equipment, more sensitive electronic equipment would still be damaged by a surge of this magnitude. Surge diverters that employ other components such as Silicon Avalanche Diodes (SADs) can have lower let-through voltages (as low as 600V); however this is generally at the expense of the reliability and lifetime of the surge diverter.

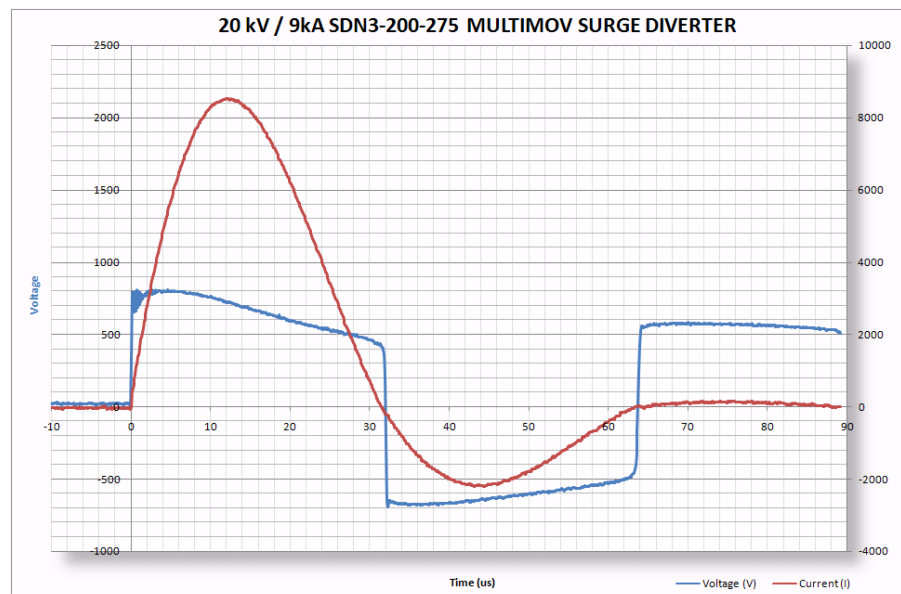


Figure 2 Typical let-through of a surge diverter (20kV/9kA)

As can be seen in Figure 2, the scaling for let through voltage is not linear based on the current applied. With a maximum surge current three times larger than the one defined in AS/NZS 1768:2007, at 9kA the let through voltage just over 800V.

## Surge Filters

Surge filters are connected in series. They employ three-stage protection consisting of surge diverters at the input and output, and a low-pass LC filter in the middle. The low pass filter not only suppresses surges, but also provides some filtering against harmonic noise. In the event of a surge, the majority of the surge energy is diverted to ground by the stage 1 surge diverter. As a result, the voltage at the input to stage 2 is clamped.

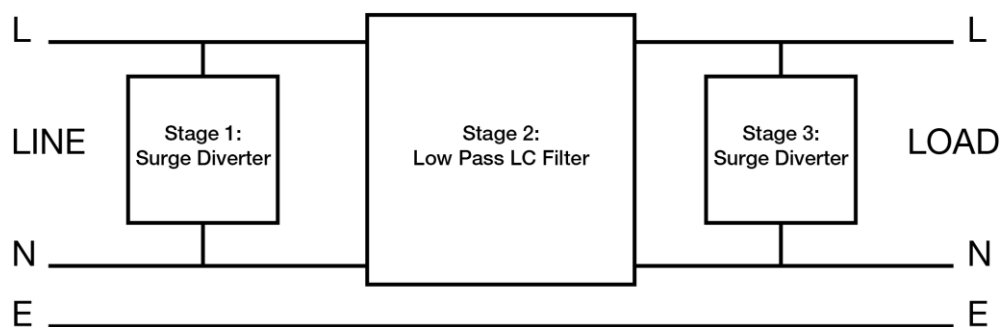


Figure 3 Surge filter configuration

The low-pass filter is high impedance which based on the signal frequency applied. This allows 50-60Hz power to pass through whilst heavily attenuating the high frequency surge. This leaves only a small surge for the stage 3 surge diverter to deal with. Typical values would be a 900V let-through voltage for stage 1 and a 600V drop across stage 2. This leaves only 300V ( $900 - 600 = 300$ ) at the output of the filter. Let-through voltages this low will protect even the most sensitive of electronic equipment. A typical let-through voltage waveform for a surge filter is shown in Figure 4 below:

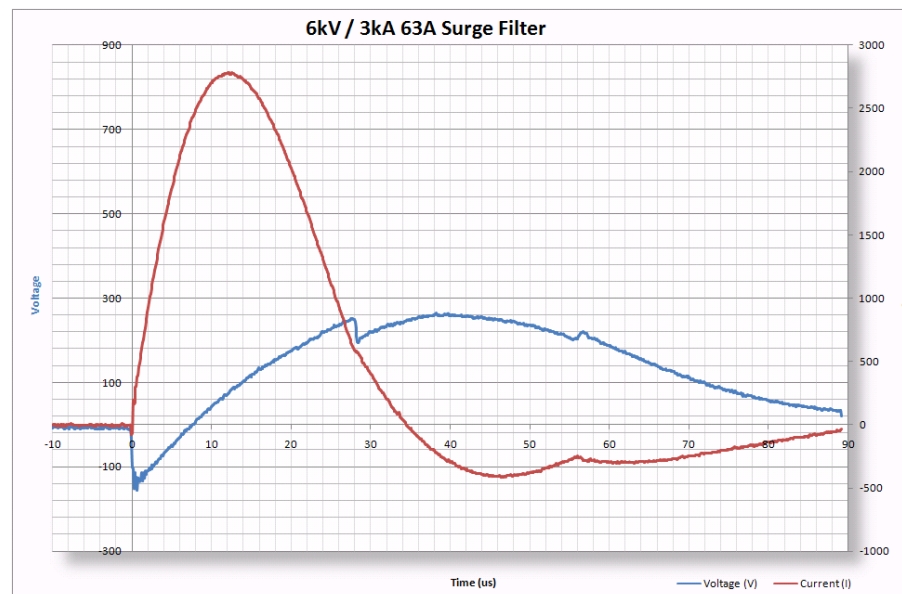


Figure 4 Typical let-through voltage of a surge filter (6kV/3kA)

With the 20kV / 9kA waveform in Figure 5 we can again see the non-linear characteristics of the MOVs. With three times the current the let through voltage has only increased by 170V.

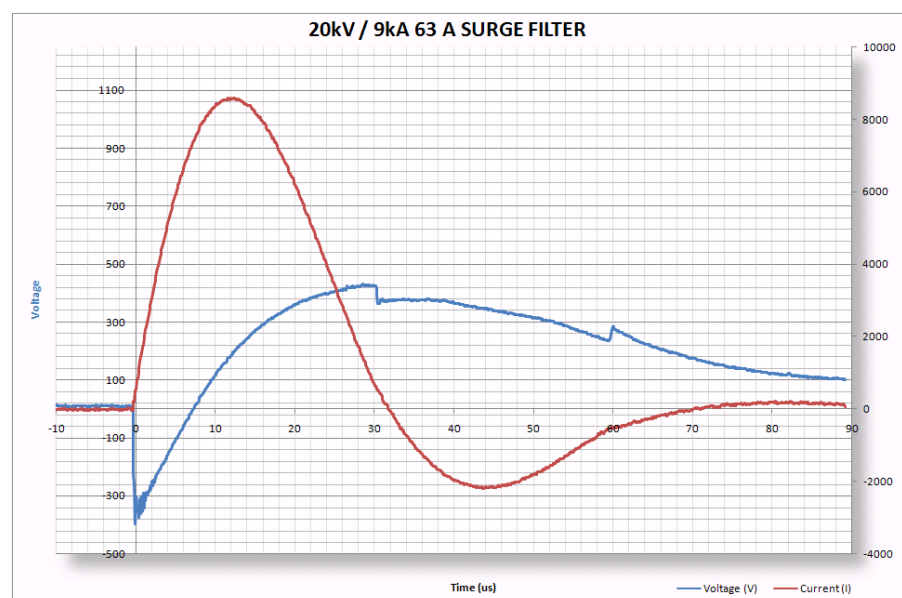


Figure 5 Typical let-through voltage of a surge filter (20kV/9kA)

## Advantages of Surge Filters

Beside the fact that surge filters have a remarkably lower let-through voltage, they have other advantages over surge diverters.

### Effect of shunt-connected leads

Because surge diverters are connected in parallel, the let-through voltage experienced by the connected equipment depends not only upon the performance of the surge diverter, but also on the inductance of the connecting leads.



Figure 6 illustrates this principle:

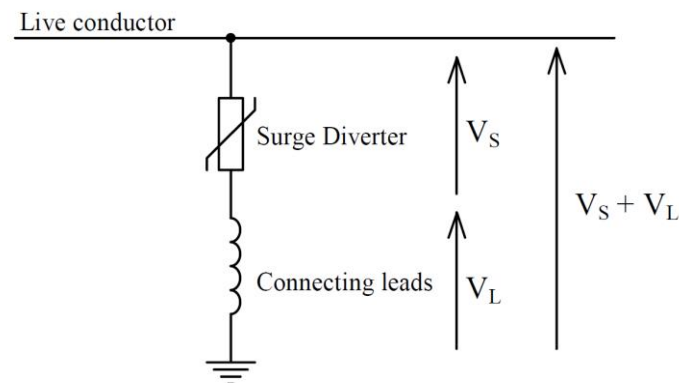


Figure 6 Effect of shunt-connected leads

Even if the inductance of the connecting leads is low, the extremely fast rise time of a lightning induced surge will create a very large voltage across them. Figure 7 (below) shows the let-through voltage of a surge diverter measured at its terminals, with 1m of connecting leads and with 2m of connecting leads. The total length of connecting leads includes the length from the main feed, through the disconnector to the line terminal, and from the neutral terminal back to the incoming feed.

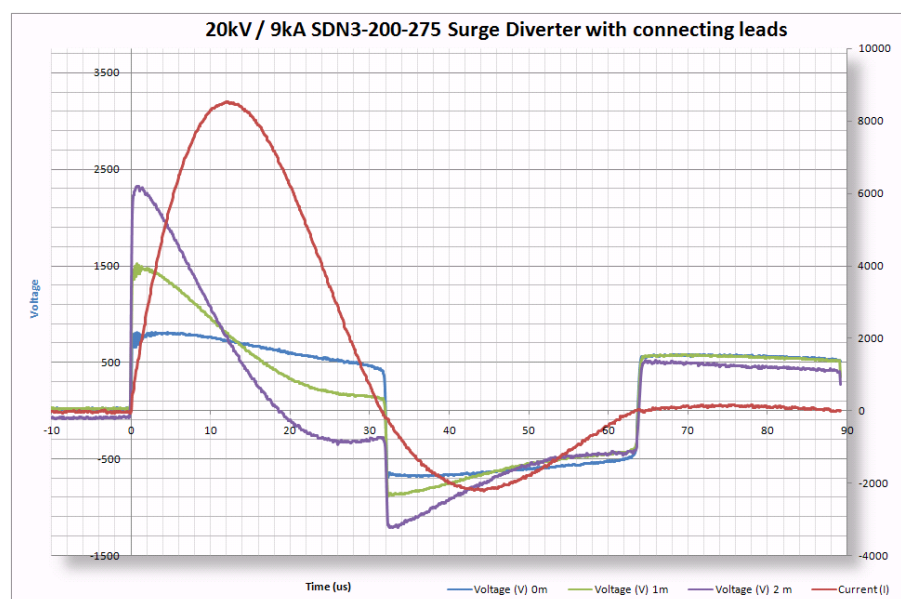


Figure 7 Let-through voltage of a surge diverter with and without connecting leads

This shows that in a practical situation, the actual let-through voltage experienced by connected equipment can be much greater than that stated in the technical specifications for the surge diverter. A larger the surge current causes a faster change in current which in turn increases the let through voltage due to wire inductance. This problem is not experienced with surge filters because they are connected in series. The manufacturer establishes the length of all shunt-connected leads. This means:

- The filter can be designed to minimise the lengths of connecting leads, therefore minimising the let-through voltage of the filter.
- The performance of the filter is not installation dependant.

- The let-through voltage experienced by connected equipment in practical situations is always the same as that stated in the technical specifications for the filter.

### Lifespan and reliability

Eventually, surge-diverting components are fatigued by repetitive and/or substantially sized surges. Because surge filters have three stages to a surge diverter's one, they tend to have a much longer lifespan, as well as increased reliability due to component redundancy. Novaris have performed extensive laboratory tests on surge filters that show the stage 1 surge diverter absorbs around 95% of the surge energy. This leaves only 5% of the surge energy for the stage 3 surge diverter to absorb. In all Novaris surge filters, the stage 3 surge diverter is generously rated. This provides a second line of defence should the stage 1 surge diverter fail. An additional advantage of the stage 3 surge diverter in a filter is that it protects against surges produced by connected equipment. This is particularly important when multiple loads are connected.

### Conclusion

Surge filters provide far superior protection against lightning induced surges on mains power lines. Unlike surge diverters, their performance is not installation dependant. On top of these points, they have a longer lifespan and are more reliable than surge diverters.