# Surface Mount Power TVS Diodes Deliver Optimal Protection for Power Supplies

## APPLICATION NOTE

PTVS
Through-Hole
Series

PTVS
Surface Mount Series

AC and DC power supplies used in telecom and other exposed applications often require protection against hostile events such as power line surges and indirect lightning strikes. Avoiding damage to the power supply by limiting the peak surge voltage to an acceptable level without short-circuiting the line for an extended period of time is crucial to minimizing the downtime of critical systems and avoiding costly maintenance calls. Power TVS diodes uniquely meet the demands of these applications.

Other voltage limiting technologies, such as Metal Oxide Varistors (MOVs), exhibit a response where the voltage across the device continues to rise as the current through it increases. The peak voltage at its maximum rated current could be as much as three times its breakdown voltage at low current. In contrast, after an initial short duration peak, the voltage across a Power TVS diode folds back to a lower level and then remains relatively constant as the current through the device continues to increase. This difference in response is shown in figure 1, which compares a Model PTVS3-076C-TH Power TVS diode with a typical breakdown voltage ($V_{BR}$) of 90 V to a Model MOV-10D101K 10 mm MOV with a typical $V_{BR}$ of 100 V. Note the voltage foldback characteristic of the diode compared to the rising voltage of the MOV. At the peak current of 2500 A, the diode voltage is almost 200 V lower than that of the MOV. In addition to a lower clamp voltage, the Power TVS diode is a semiconductor device which provides better reliability and increased durability against repetitive surges when compared to a typical Metal Oxide Varistor.

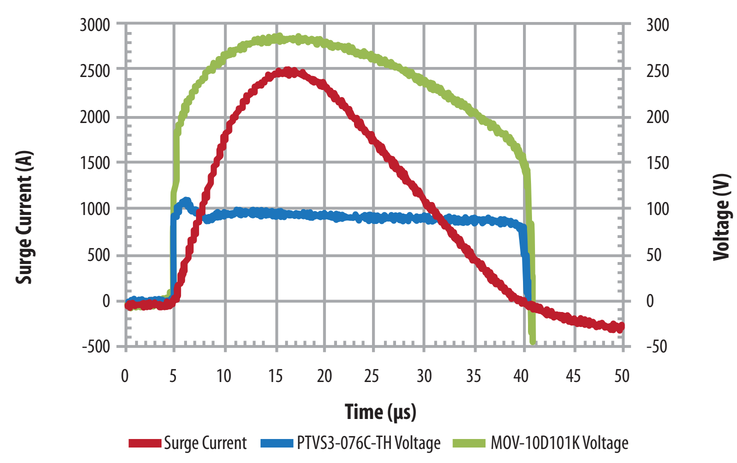


*Figure 1. | Comparison of a PTVS Diode and a Metal Oxide Varistor*

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One factor that can significantly compromise the performance of lower voltage Power TVS diodes at high currents is the lead inductance of the packaged device. The contribution of the lead inductance to the voltage response of the device is given by the equation V = L di/dt. Knowing that the voltage contribution is directly proportional to the rate of change of the surge current (di/dt), we realize that the voltage drop across the inductance will increase for waveforms with faster rise and decay times as well as at higher peak currents for the same waveform. It also tells us that this voltage drop will be less significant at lower peak surge currents for the same waveform and for slower waveforms since the rate of change of the surge current (di/dt) will be reduced.

Figure 2 shows the simulated effect of the lead inductance on a PTVS diode when it is subjected to a 15kA, 8/20 µs surge current waveform.  The simulation shows the response of a diode with 0, 8 and 20 nH of lead inductance. Just 20 nH of lead inductance increases the peak voltage by over 60 V.  The lead inductance of a low voltage (58 or 76 V), 15 kA PTVS diode with a lead pitch of 24 mm is about 20 nH, which means that this is a very realistic scenario. We know we can't reduce the lead inductance to zero, but Figure 2 shows that we can significantly improve the performance of the diode if we reduce the lead inductance to 8 nH. Fortunately, we can achieve this lower lead inductance by using a surface mount package.

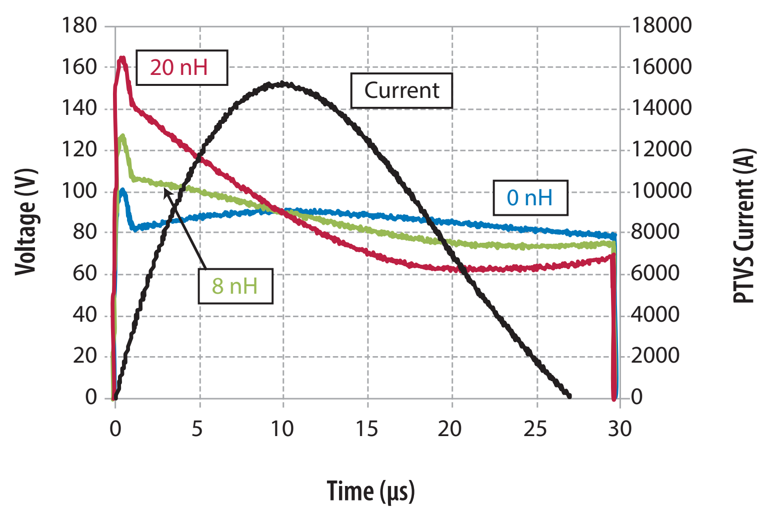


*Figure 2. | Simulated Effect of Lead Inductance on the Performance of a PTVS Diode*

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Bourns has developed two families of Power TVS diodes in Surface Mount (SM) packaging – Model PTVSx-xxxC-M, and PTVSx-xxx-SH The PTVSx-xxxC-M high temperature models are available with standoff voltages of 58 V and 76 V. In addition to improved surge response which is due to their low lead inductance, they also eliminate an extra assembly step in cases where they would have been the only through-hole device(s) used on the PCB assembly. The graph in figure 3 compares the voltage waveforms of surface mount devices (Model PTVS10-076C-M and PTVS10-076C-SH) and an axial lead (Model PTVS10-076C-TH) 10 kA Power TVS diode with identical voltage and peak current ratings. The lower inductance of the –M surface mount package reduces the peak voltage by 26 V when tested using the 1.2/50 us, 8/20 us combination wave with a peak current of 10 kA. This is a significant improvement in protection performance given that limiting the peak surge voltage to an acceptable level is critical in most power line applications.

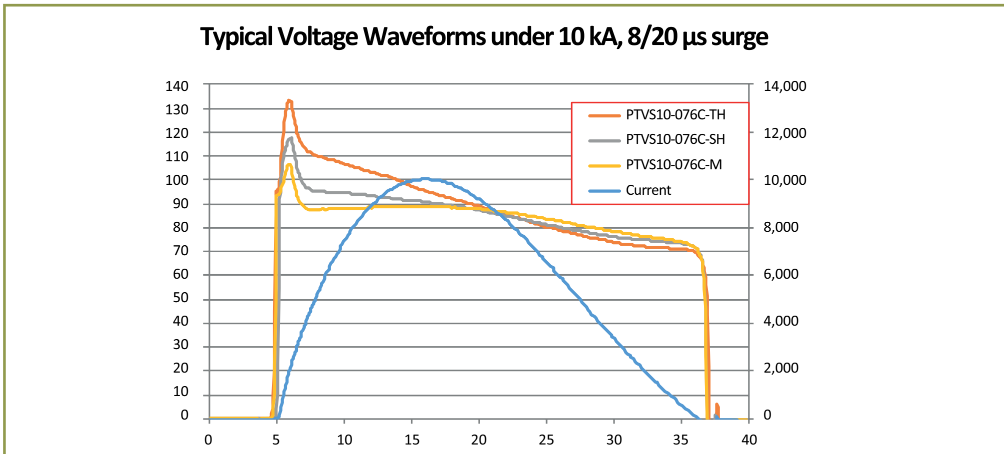


*Figure 3.* | *Comparison of 1Surface Mount and Axial Lead Devices*

## SUMMARY

In conclusion, Power TVS diodes offer superior protection for AC and DC power line applications with the best overall protection being achieved by a Power TVS diode in a surface mount package. Power TVS diodes offer superior protection compared to other devices, such as MOVs. Bourns offers a wide voltage range of devices with surge current ratings of 3, 6, 10 and 15 kA.

## ADDITIONAL RESOURCES

For more information and further technical support, visit Bourns online at:

**www.bourns.com**



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