

## Why Not All Transient Voltage Surge Suppressors Are The Same

Mick Burgoyne, of Advance Electronics Ltd. examines the technology behind one of the most critical – and yet neglected – power chain devices.

It may seem surprising, but the majority of transient voltage surges are actually generated by an organisation's own equipment. Research indicates that up to 80% of voltage surges come from internal sources such as motors, fluorescent lights, photocopiers and other switching devices. Because modern mains powered electronic equipment is highly susceptible to sudden voltage variations, this makes voltage surge suppression an essential part of an organisation's power protection regime.

This is especially true over the last ten years, as more sophisticated microelectronics have been incorporated in everyday office devices such as computers, phone systems and servers. In fact, although the last decade has seen an improvement in the reliability of the mains power supply – at least as far as the incidence of outages is concerned – we are now experiencing a greater number of transient voltage surges than ever before, with consequent damage to all manner of equipment.

The remaining 20% of transients, generated externally, tend to receive more attention, because they are more dramatic. However, it is important to distinguish between internally and externally generated voltage surges, because they will frequently have differing effects on electrical equipment. For example, because internally generated transients will normally be of a lower peak voltage, they will usually not cause immediate equipment failure. However, they will often cause cumulative damage, leading to premature failure over a period of time. This, in turn, will result in data loss and corruption, with consequent downtime and increased costs.

On the other hand, externally generated transients often result in very high peak voltages over a very short duration. Take, for example, a typical lightning strike, which can lead to a voltage surge of well over 20,000 Volts being transmitted through the mains supply. Not surprisingly, this can cause instantaneous and catastrophic equipment failure, resulting in immediate operational shut down and long term disruption of business. Worse still, equipment replacement costs can run into thousands of pounds.

In essence, a Transient Voltage Surge Suppressor (TVSS) is a component that limits the amount of energy arising from a transient and, as a result, protects electrical equipment from damage.

However, although this definition is very straightforward, as with most things the reality is rather more complex. In fact, it is always worth bearing in mind that the motive for adding a TVSS to an individual piece of equipment is not always to protect it, but may also be to protect the rest of the system from equipment known to produce transients.

Because different parts of a commercial building or factory will be subject to different transient sources, we need to categorise these locations depending on the equipment they house. In a nutshell, BS 6651:1999 Annex C provides a zoned approach to transient protection. By classifying main and sub-distribution panels, sub and final distribution panels and individual hardware applications separately, the zoned approach allows us to match the perceived risk with the most suitable TVSS device.

Just as important as the rating of the surge suppressor is its actual design. There are three basic types of TVSS – the gas discharge tube (GDT), the metal oxide varistor (MOV) and the silicon avalanche diode (SAD). Each unit has its own characteristics but, as well as this, the manner in which the individual components are assembled also affects the efficiency of the device.

Briefly, the gas discharge tube uses specially designed electrodes, housed in a tube that contains one or more gases under pressure. By altering the mix of elements within the GDT, different breakdown voltages can be achieved. When activated, the GDT can reduce the applied voltage down to a few tens of volts in nanoseconds. However, there are a couple of considerations that need to be taken into account when using GDT devices, and which suggest that they are more effective when used in conjunction with other devices.

Even though a gas discharge tube might have a low breakdown rating, it will still need 600-800 Volts to fire when confronted by the sort of steep voltage waveform typified by a transient surge. It almost goes without saying that, while the GDT might be useful at absorbing very high peak voltages, it would have difficulty with controlling voltages that, although much lower, would still be capable of causing damage to sensitive equipment.

Additionally, in certain circumstances the arc within the tube may not be extinguished once the transient has passed. This effect can distort the normal waveform and, if the circuit can provide enough current, could destroy the tube.

MOV type voltage surge suppressors are manufactured from zinc oxide fragments, compressed under very high pressure. Although their response time is very swift, they have a non-linear resistance characteristic. In practice, this means that when an MOV is subjected to a large transient current surge, such as a lightning strike, the clamping voltage can increase to a level at which equipment damage could occur. Furthermore, longer duration current surges – as distinct from shorter transient peaks – will cause an MOV to destabilise.

However, because MOVs are inexpensive and can handle large currents, they are often used either exclusively or in conjunction with other devices within a TVSS module. This effectively overcomes the fact that MOVs have a finite design life, because the zinc oxide particles weaken after conducting a current.

Probably the ideal device to partner MOV is the silicon avalanche diode. SADs are semiconductors that can respond very rapidly to a transient voltage surge, and can be specified with clamping voltages that range from a few volts to several hundred. However, because their clamping voltage needs to be as close as possible to the peak value of the mains supply, it is necessary to use a number of SADs, so that the transient energy can be dissipated without sacrificing the device. Inevitably, this makes SADs more expensive than their MOV counterparts. However, silicon avalanche diodes will not degrade in use, provided their rated capacity is not exceeded.

A combination of SADs and MOVs provides the best solution to the opposing requirements of rapid response to transients and large total current capacity. Because the SADs react very quickly, they prevent the clamping voltage of the device rising as more current is dissipated by the MOVs. Nevertheless, it is advisable to use more than just a few SAD, to eliminate the potential damage caused by over current before the MOVs take effect.

However, just as important as the individual components within the TVSS device, is the way in which the TVSS is designed. Because of the self-sacrificing characteristics of the individual SAD and MOV components, the TVSS should be designed to allow true component redundancy, so that if an individual SAD or MOV fails, the device still continues to operate in accordance with its specification.

The ideal component structure for a TVSS device is the matrix configuration, for which Advance-Galatrek has made a patent application. In essence, the individual SADs and MOVs are arranged in separate assemblies, allowing individual components to self-sacrifice without compromising the performance of the TVSS as a whole. Because of this, the matrix solution offers all the advantages of SADs and MOVs as individual components, but provides additional reliability and crucial performance where they are most needed.

The beauty about the matrix configuration is that it works entirely passively, requiring no operator intervention whatsoever. Even if one of the SADs or MOVs should fail as a result of an unusually large voltage surge, the remaining components will continue to protect sensitive equipment from possible damage. In fact, TVSS devices using matrix technology have an anticipated survival time of 100,000 strikes, even allowing for individual component self-sacrifice. Even in the worst anticipated situation of the full transient surge being routed through a single component in the matrix, the life expectancy would be several hundred strikes.

And don't forget, just because you already have an Uninterruptible Power System (UPS) it doesn't mean that you can ignore the need for separate TVSS protection. Although most UPS devices now incorporate a basic form of transient surge protection, this usually only comprises a few MOVs. Consequently, unless the device provides some information on the level of protection and survivability, it can be ignored from the point of view of effective surge suppression. Furthermore, the UPS will not give any indication of whether the surge suppression components are still functioning, or have self-sacrificed. So, if the load is important enough to justify buying a UPS, it must also be worth adding proper protection against transient surges.

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