help desk

DMX Isolation and Protection | By Wayne Howell

"There are two approaches to surge protection … block the surge [or] divert the fault. A combination of the two techniques provides optimal results . . ."

Last month, I discussed the problems associated with common mode voltages and how isolation helps. This month, I'd like to look at the related subject of electrical protection. Protection is the term used to describe a method of stopping or limiting damage from an electrical problem or disturbance. Clearly this is relevant to all electronic equipment, but I shall focus on protection of DMX512. The subject is generally referred to as 'surge protection'. Surges have three primary routes into your control system . . .

Galvanic coupling: This means there is a direct electrical connection. Examples include a direct lightning strike or accidental connection to the mains. A direct lightning strike can involve surge voltages in the million volts range with currents over 1000A. The faults we hear about on the Help Desk cover a huge range of voltages. It may be an accidental connection of the DMX cable to a DC LED power supply. Or, because some manufacturers of LED fixtures combine DMX and mains in one cable, a cable fault can easily cause an AC connection to the DMX signal.

In architectural applications, particularly metal structures, lightning strike is a real problem with the potential of very high voltage and energy being fed into the DMX cable.

Capacitive coupling: This includes faults caused by indirect lightning strikes and by also operating near electrical disturbances such as overhead power lines or dimmer racks.

Inductive coupling: This is largely cable-to-cable, for example where control cables and dimming cables run parallel for a significant distance. The cables can operate as an inefficient transformer. Faults from inductive coupling are a particular concern for architectural installations in transport infrastructure such as subways where very high current switching operates near the control systems.

APPROACHES TO SURGE PROTECTION

Isolation may be able to stop electrical faults propagating between equipment via the DMX512 cable (which is another key reason to use isolation), but it is unlikely that it will provide any protection to equipment in the direct path of the fault.

There are two approaches to surge protection: one is to block the surge, the other is to divert the fault. A combination of the two techniques provides optimal results, and this underlies the concept of primary, secondary and tertiary protection. There are many types of components for protecting the DMX cable, offering varying degrees of protection at different costs.

Sadly, there is no standardisation for terminology to describe different levels of fault, let alone to describe levels of protection. This makes it very difficult for the end user to make objective comparisons between products. Rather, an understanding of the components is needed.

Primary protection (diversion) - the gas discharge tube (GDT): The GDT is probably the best-known form of primary protection from lightning strike. Humphry Davy discovered the principles of the spark gap: the concept that with enough potential difference between two conductors, the gas around them will ionise and provide a conduction path. The resultant arc conducts away the energy of the lightning to ground.

Secondary protection (diversion or blocking): After a lightning strike or mains short, dangerous voltages will have propagated beyond the GDTs and must be stopped. Secondary protection can be implemented in both block and divert methods.

Diversion: Diversion protection is usually implemented in such a way that, once triggered, it will force a protective device such as a fuse to trip. This approach is often called crow bar protection and is implemented with devices such as the Metal Oxide Varistor (MOV), the Zener or the Thyristor.

Secondary protection using diversionary tactics does have its downsides. The approaches generally use a fuse which may be destroyed after a protection event (a so-called 'one-shot' or 'sacrificial' scenario).

Alternatively, there exist 'self-healing' protection circuits which continue to function after a diversion event. But these can bring other compromises such as adding signal capacitance, which will degrade the signal and reduce the maximum attainable cable length and number of fixtures per cable.

Blocking: Blocking is a more modern approach to protection. Traditionally, Positive Temperature Coefficient (PTC) devices are used. When a surge occurs, they heat up and their resistance increases. PTCs are widely used for resettable fuses, but are of limited value for protecting the data. They are slow to react and have an adverse effect on the signal. The Transient Blocker is a newer approach; the devices can respond in a few billionths of a second to both over-voltage and over-current events. They actually disconnect the fault signal and so do not suffer from the limitations of PTC devices.

Tertiary protection - belt and braces: In principle, if the DMX line has good primary and secondary protection, tertiary protection should not be required. In reality, it's an inexpensive way to provide that final layer of defence - it only takes a few tens of volts to damage electronics.

Most tertiary protection techniques use components that divert dangerous voltages. The difference to secondary protection is that, by the tertiary stage, the protection can simply conduct away the fault rather than trigger a fuse. The generic term used for these devices is Transient Voltage Suppressor (TVS) - essentially Zener diodes which conduct a small fault voltage to ground. Some line drivers also provide built-in transient suppression.

CONCLUSION

When protection against lightning is required, GDT protection on the front end of the DMX distribution equipment is the only solution. If protection against accidental mains connection is required then primary or secondary TB (Transient Blockers) are best. If the installation is in a very low risk area, then TVS of intrinsic driver protection can be used. As would be expected, the cost scales with the protection level . . .

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