Current Technology
THE #1 NAME IN SURGE SUPPRESSION

## Tech Notes Series

# Surge Protection Device (SPD) Fusing: What Works? What Doesn't?

If a manufacturer advertises a level of performance for its product, it is reasonable for the buyer to expect proof of that performance. An automobile may display its horsepower in shiny chrome letters, but its owner should expect to feel that horsepower in the pit of his stomach while accelerating from zero to 60 in five seconds. The engine, drivetrain and tires must all work in concert to deliver that sensation to the driver. A weakness in any of those components will limit performance to a disappointing level.

The performance of a Surge Protective Device (SPD) can also be limited by a single component. The electrical industry is increasingly aware that an SPD's fusing can greatly compromise its advertised single-pulse surge rating. Just talking about horsepower is one thing but what supports performance claims is how well the rubber meets the road.

**Why are SPDs fused?** Most SPDs use Metal Oxide Varistor (MOV) technology. Like all electronic components, misuse or stress can cause MOVs to fail. They normally fail as a short circuit. For safety reasons most electrical circuits are equipped with fuses or other protective devices to isolate shorted devices and prevent further damage. SPDs are no exception. Furthermore, to meet UL 1449 2$^{nd}$ Edition fusing is a must.

**Will just any fuse do?** To meet industry safety requirements it is convenient for SPD manufacturers to simply use off-the-shelf, general-purpose fuses. But let's think about something. Most fuses being applied in SPDs are for use in low-voltage power distribution and designed to protect loads and feeders from overloads and short circuits. They are also designed for use at 60 Hz and at some nominal AC voltage. Is an SPD considered an AC load? Does an SPD normally conduct AC current? No!

**What current does an SPD conduct?** SPDs are supposed to conduct surges! Surges shunted through an SPD are very brief current pulses lasting only microseconds. However, they can reach peak currents of tens or hundreds of thousands of amperes – especially in high lightning exposure applications. In between surge events the SPD is "invisible" to the power waveform and conducts only minute leakage current.

**How does an ordinary fuse behave during a surge?** Look at the $I^2T$ curve (Fig. 1) for a typical fuse used in an SPD. Now plot a surge event on that curve. The worst part of a surge occurs within 20 microseconds. The peak current during a surge can be in the range of tens of thousands of amperes. Hmmm. You mean you can't tell from the fuse curve what the fuse is going to do? Does the point you are trying to plot go off the page or fall into the "twilight zone" of the curve? To complicate matters more, the manufacturer's data is based on AC current measured in RMS Amperes. The surge is an 8 x 20 microsecond pulse expressed as a peak Amperes.

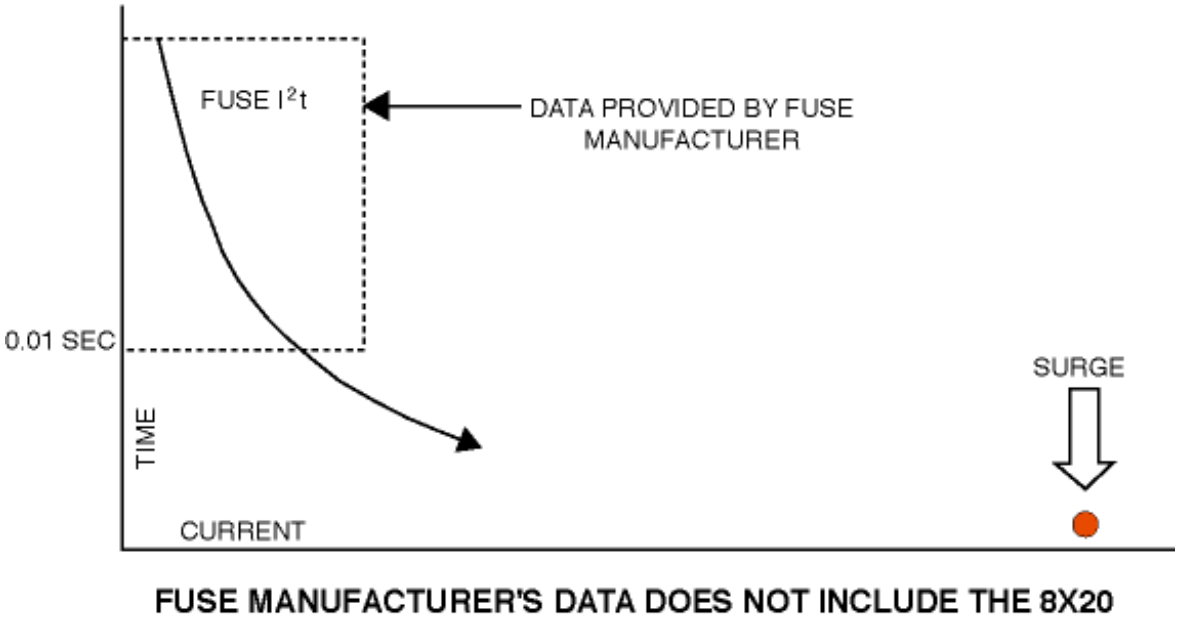


**Fig 1**

**A fuse's response to surges can be calculated and proven through testing.** A fuse manufacturer can provide the $I^2T$ melt value. This value is proportional to the amount of energy it takes to cause a fuse to open. When applied to the standard 8 x 20 microsecond pulse the $I^2T$ clearing value can be used to calculate the peak surge current that will open a fuse. This calculated value can be substantiated by testing.

Let's see how 10 popular SPD products are fused. The table below allows us to compare each product's published single-pulse surge capacity per mode to the calculated $I_p$ ratings of each product's fuse. Notice the disparity between the two numbers for each product.

| | | SURGE CAPACITY | | | Calculated |
|---|---|---|---|---|---|
| **MANUFACTURER** | **MODEL** | **per MODE (kA)** | **FUSE TYPE** | **Im²T** | **Ip(kA)** |
| C-H/TYCOR | PTY-S | **60** | KTK-R-30 | 2400 | **13.4** |
| C-H/TYCOR | PTY-M | **200** | FRS-R-60 | 23500 | **42.0** |
| C-H/TYCOR | CPS-S | **60** | KTK-R-30 | 2400 | **13.4** |
| C-H/TYCOR | CPS-M | **200** | FRS-R-100 | 64000 | **69.3** |
| INNOV TECH | PTE/PTX | **200** | VSP-40-2 | 19543 | **38.3** |
| APT | XGA | **80** | VSP-10 | 1541 | **10.8** |
| APT | XLHP | **240** | KTK-R-30 | 2400 | **13.4** |
| LEA | DS 40 | **225** | LPJ-60SP | 2700 | **14.2** |
| LEA | GB300 | **225** | LPJ-60SP | 2700 | **14.2** |

Which SPDs look like they can suppress a surge equal to their manufacturer's claimed single-pulse surge rating? Remember the automobile analogy in the first paragraph? How well does the rubber meet the road?

If a fuse's surge rating is less than the claimed single-pulse surge capacity of the product it is protecting then the product as a whole cannot possibly live up to its claims. One has to wonder how or if the various

products were tested. Were the products tested with the fuses? Did the MOVs but not the fuses survive the test?

**The Current Technology difference:** The Current Technology® TransGuard® (TG) and SELect® SPDs use a custom-designed fuse that will not limit the product's advertised surge capacity. Current Technology provides independent test data to prove this. The fact that our special fusing does not operate during a maximum surge is the key reason Current Technology products are able to pass the single-pulse surge test recommended by NEMA LS1-1992.

**How do we do it?** Through extensive research and development, Current Technology met the challenge and designed a unique fusing system that withstands a surge at least equal to the capacity of the product and is also able to clear a fault. Our design provides a fuse for each MOV. The multiple fuses are coordinated to conduct surges and only clear in the event of a fault. Multiple fuses allow MOVs to fail individually and be removed from the circuit individually. This leaves the remaining MOVs intact to provide continued protection. A conventionally fused SPD allows a single MOV failure to operate a single shared fuse and remove 100% of the MOVs in a single event. The result is 0% protection.

The Current Technology fuse has a surge rating 40% greater than the single-pulse rating of its associated MOVs. Additionally, the fuse is UL recognized with an interrupting rating of 200kAIC.

**If a fuse fails, how do you know?** Current Technology's unique fusing is provided with special circuitry to monitor the condition of each fuse. With either built-in or portable monitoring devices, the percentage of remaining surge capacity can be determined based on the number of intact fuses. You are always assured that your SPD is providing continuous protection. This is why Current Technology refers to this patented technology as the "Failure-Free Integrated Suppression Bus (ISB™ )."

**Proven performance:** The electrical industry routinely turns to the National Electrical Manufacturers Association (NEMA http://www.nema.org) to provide stability to the process of comparing competing electrical products. A NEMA document referred to as LS1-1992 provides guidance for specifying and comparing SPDs. The single-pulse surge test referred to in NEMA LS-1 1992 is fundamental to proving that an SPD performs to its advertised rating.

Current Technology products have been independently tested according to NEMA guidelines and can provide proof of single pulse performance – a claim few manufacturers can make.

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