

Surge Protective Device Response Time

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With today's electronics it is critical that you provide surge suppression from both power line and internally generated transients. A Surge Protective Device (SPD) does just that, but how fast must an SPD respond to these transients in providing the needed suppression to equipment?

The purpose of this document is to clear up some of the confusion that exists with specifying surge protective devices and their response time ratings.

"Response time" is a term that carries many different meanings depending on the industry referenced. For the purpose of this document the following general definition will be used:

Response Time: The time a system or functional unit takes to react to a given input.

Specifying Response Time

Many specifying engineers reference response time as "critical" performance criteria when qualifying an SPD. It is not uncommon for these specified response times to be extremely fast, e.g. <1 nanosecond (10^{-9}).

Much of the confusion that leads to extremely fast specified response times stems from SPD manufacturers who publish <1 nanosecond response time claims. Of these claims it is important to ask, how is this value determined? Does the claimed response time provide any real value? And is that level of response time possible?

Surge Component Vs. Surge Device

Varying suppression component technologies are available on the market today (MOVs, SADs,

and other suppression elements). Each has its own set of performance characteristics. The manufacturers of these discrete components test and provide their response time characteristics, typically in the sub-nanosecond region.

However, these response times represent performance when testing the component material at the substrate level. As discrete components are packaged for different mounting methods, the inductance associated with the mounting and lead lengths, even at the component level, result in a much slower response time.

A reputable MOV manufacturer states:

"The response time of the actual varistor ceramics is in the picosecond region. In the case of leaded varistors, the inductance of the connecting leads causes the response time to increase to values of several nanoseconds."¹

This would also be true of the other surge suppression components. The response times specified by manufacturers for their leaded components will be measured in the several nanosecond time frame. This value is much slower than the market specified one nanosecond.

Using the same reasoning, the added inductance of an installed SPD with its attached wires, would slow the response time of the unit even more.

Therefore, it is not common practice today for an SPD manufacturer to measure and publish

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the response time of a complete system. Instead, the response times reflected on SPD data sheets are typically the values provided at the component level within the design and are not representative of the complete system.

What Do Industry Standards Say?

The industry standards committees that provide direction, recommendations and safety standards, such as IEEE, NEMA and UL, have yet to include response time in their publications as a key product performance or specification criteria. As a result, there hasn't been an industry standard test procedure, or defined pass/fail response criteria to determine how fast is fast enough. Therefore, without defined procedures and expected results, many SPD manufacturers do not publish response times of their complete systems.

Information that is available comes from the IEEE definition for industry standard test waveforms within C62.41.2, "Characterization of Surges in Low-Voltage AC Power Circuits." This waveform, used throughout the industry, has a rise time measured at 8 microseconds, 1000 times slower than the several nanosecond response times of the individual components.

Surge suppression devices employing common MOV, SAD or comparable technologies are capable of responding within the microsecond region.

IEEE, NEMA, and UL standards committees agree that response time should not be used as performance criteria when comparing SPDs.

Conclusion

Response time, though important to understand, should not be used by itself in specifying or comparing one SPD to another. There are several factors involved with the installation of a complete unit that affect the overall response rate and its effectiveness that should be considered. Things such as the size of wire used, the amount of wire used, and overall installation method have a greater effect on the performance and level of suppression any SPD can provide.

How fast is fast enough? The commonly specified <1 nanosecond response time for a complete SPD is not realistic. Unfortunately, this value has become a marketing tool that some manufacturers use in an attempt to elevate their products.

Instead, it is important to focus on the measured let-through voltage, or UL's Voltage Protection Rating (VPR) that takes into account many variables including the initial response of the components and the added inductance of the system. This industry-defined test provides a better representation of the overall level of suppression an installed SPD will provide.

References

1. EPCOS AG, a member of TDK-EPC Corporation, "*SIOV metal oxide varistors*", General Technical Information, (April 2011), p. 5.