

Sine Wave Tracking

Getting the Most From Your Surge Protective Devices (SPDs)

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Sine wave tracking is a term that has been used throughout the surge industry for many years. In the early 1990's it was Schneider Electric™ who first introduced the sine wave tracking concept in their surge protection plug-strips with their Sine Wave Tracker™ technology. Since then many Surge Protective Device (SPD) manufacturers have followed with their own versions and trade marked names.

Over the years sine wave tracking has been misinterpreted and incorrectly specified. Many perceive sine wave tracking to relate to the noise attenuation and filtering characteristics of an SPD – which is not correct. The purpose of this document is to provide a clear understanding of what sine wave tracking is, the benefits it can provide, and where these SPDs should be installed.

What is sine wave tracking?

“Sine wave tracking” is a descriptive term commonly used by manufacturers to express a principle of operation. “Sine wave tracking” itself is not a recognized attribute of an SPD within the industry standards committees. Unlike other SPD performance values such as MCOV, VPR, In or SCCR which are clearly defined, there are no industry approved standard definitions or test procedures found within UL, IEEE, NEMA, IEC or other standards bodies for sine wave tracking and its performance characteristics.

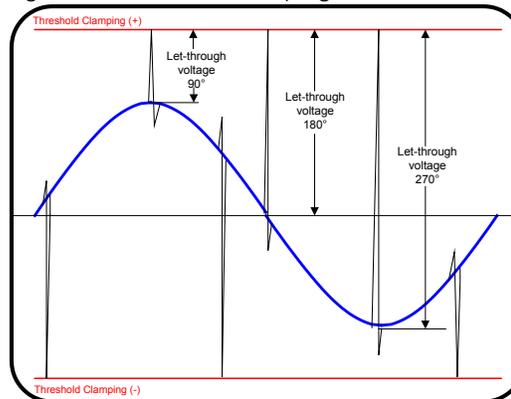
Schneider Electric, who first introduced the Sine Wave Tracker technology to the SPD industry, defines sine wave tracking as:

Sine wave tracking – The ability of an SPD to suppress high frequency, low-energy ring wave transients, providing uniform suppression around the fundamental voltage waveform regardless of the phase angle at which a surge is induced.

Not all SPDs provide this technology. SPDs that DO NOT incorporate sine wave tracking are referred to as threshold clamping SPDs.

Threshold clamping SPDs establish their clamping voltage irrespective of the instantaneous sine wave. Depending on the phase angle in which the transient is induced, the overall clamping or let-through voltage level will vary as the voltage must reach the set threshold before it starts to respond. The threshold is determined by the ratings of the Metal Oxide Varistors (MOVs) or other surge components that are utilized. Typically that threshold is set 15-25% above the nominal system voltage and is represented as the Maximum Continuous Operating Voltage (MCOV) of the device. (Figure 1)

Figure 1: Threshold Clamping



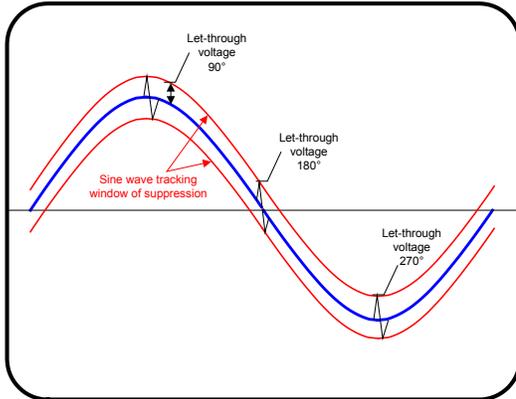
With a threshold clamping SPD a transient voltage must reach a pre-defined level before the SPD will react and start to suppress the transient.

Sine wave tracking SPDs incorporate hybrid circuitry to effectively suppress high frequency, low energy ring wave transients, at whatever phase angle they occur. Because of this, they provide better (lower) clamping or let-through levels than threshold clamping devices and create uniform protection levels, regardless of the phase angle of the transient. (Figure 2)

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Figure 2: Sine Wave Tracking



Laboratory testing on both threshold clamping, and sine wave tracking SPDs clearly show the benefits of the hybrid circuitry found within sine wave tracking SPDs.

When subjected to a Category A ring wave as defined in ANSI/IEEE C62.41-2002¹, the let-through voltage is measured at varying phase angles and compared against each other. (Table 1)

Let-through voltage is measured from the point of insertion (i.e. 90°, 180°, 270°) to the peak of the suppressed surge voltage.

Table 1: Let-through Voltage²

Phase Angle	Threshold clamping SPD	Sine wave tracking SPD
90°	194v	78v
180°	362v	78v
270°	524v	78v

As shown by the testing, the let-through voltages of the threshold clamping SPD range from 2.5 times up to 6.5 times the let-through voltage of the sine wave tracking SPD, depending on the induced phase angle. Sine wave tracking SPDs certainly provides the better and more uniform suppression against ring wave transients.

Ring Wave Transients – are they real?

There are two types of transients that have been described in ANSI/IEEE C62.41.2-2002: the impulse type transient and the ring wave type transient.

Impulse transients are typical of those transients

that are generated outside a facility. Lightning, utility switching, and other unexpected electrical events are some examples that may cause these impulse transients.

Ring wave transients are found internal to a facility. As loads are constantly being switched on and off many smaller transients are being induced into the distribution system. The inductance, capacitance, and resistance of the overall distribution systems cause these transients to take on a ringing shape.

Studies show that the majority of all transients (80%) are generated inside a facility while only 20% come externally from the utility side. However, as the impulse type transients progress through the distribution system they too will slowly take on ring wave characteristics.

Sine wave tracking SPDs are designed to respond to these high frequency, low energy ring wave transients. The hybrid technology used in sine wave tracking enabled SPDs is capable of sensing a sudden change of voltage (dv/dt) and will react to it immediately. By doing so it provides much better clamping performance over the threshold clamping SPDs. Lower clamping at the SPD level directly relates to lower surge voltages downstream at the sensitive equipment.

Getting the most out of your SPD

Threshold clamping SPDs do have their place and provide great surge suppression for electrical distribution systems. As with many products you buy today, there are optional features that can be added making a good thing even better. And, as with other products additional options and features, such as sine wave tracking, will typically increase the cost of an SPD.

When placing any SPD into service there are a number of factors that one should take into consideration. One of the most critical factors is location. At which locations should sine wave tracking SPDs be utilized?

As the hybrid technology is designed for ring wave type transients, it makes the most sense to place these SPDs within the distribution system where ring waves are being generated. One will get the most benefit from sine wave tracking SPDs when placed at the sub-panel levels of the distribution system, where they are more likely be exposed to ring wave transients.

Choosing the Right Level of Protection

IEEE category C locations, typically service entrance and outdoor locations, are most often subjected to impulse transients. Sine wave tracking provides little benefit with large impulse transients. If an SPD is intended only to mitigate large impulse transients, sine wave tracking may not provide much benefit. However, if switching components are located near a category C location, sine wave tracking can provide some benefit.

Specifying sine wave tracking

When specifying, referencing, or comparing performance criteria around sine wave tracking, the best way to evaluate its effectiveness is to measure the let through voltage at a number of phase angles such as 90°, 180° and 270°. These are good references and commonly used measurement points.

As described by NEMASurge.com in the FAQ section “All SPDs with capacitive RFI/EMI filtering exhibit sine wave tracking abilities”³. So specifying “sine wave tracking” simply means that an SPD contains hybrid circuitry in addition to threshold components.

However, a simple “Yes” to the question, “Does the SPD have sine wave tracking?” does not tell the full story. Two SPDs that both have sine wave tracking characteristics may have very different performance values when subjected to transients at various phase angles.

The let-through voltage of a sine wave tracking SPD is not a ‘set’ value. The type, size, design, number of components, and actual current effects how tight the “clamping window” is around the sine wave. It is up to the end user to determine what is sufficient for the application. The lower the let-through voltage, the better suppression the SPD is providing.

Many manufacturers describe their sine wave tracking performance in –dB of attenuation. This is a unit of measure used to characterize the performance of EMI/RFI filters. Circuitry used in providing sine wave tracking typically also provides EMI/RFI filtering. Typically, an SPD that has enhanced EMI/RFI filtering will also provide an increased level of sine wave tracking and vice versa. While the –dB of attenuation gives some indication of the filtering capability of the SPD,

–dB of attenuation should not be used to indicate the level of sine wave tracking. The best way to quantify the sine wave tracking capability of the SPD is the measurement of let-through voltages at various points of the sine wave.

Conclusion

Surge Protective Devices are installed into electrical distribution systems for one reason: to shunt and suppress the transient surge voltages that are being induced from both internal and external sources.

Many manufacturers have followed Schneider Electric by incorporating sine wave tracking technology into their SPDs to provide an added level of suppression against ring wave transients. This added level of suppression helps safeguard the electronics found deep inside a distribution system that could be sensitive to ringing or oscillations.

Things to remember:

- Sine wave tracking is most effective against ring wave transients.
- Sine wave tracking SPDs are most effective when placed at the sub-panel level of the distribution system where ring wave transients are being generated.
- Sine wave tracking SPDs provide uniform suppression against ring wave transients.
- Quantifying sine wave tracking capabilities of an SPD is the measurement of let-through voltages when the SPD is surged at various points of the sine wave. –dB of attenuation should not be used to indicate the level of sine wave tracking.

Having the proper understanding of what sine wave tracking truly is, will help you identify those applications where the technology should be used. Implementing sine wave tracking correctly will ensure you are getting the most from your SPD.

References

1. ANSI/IEEE C62.41.2-2002, Section 6.1.1
2. Table 1. Test results reflect 120v Schneider electric product when subjected to the Category A ring wave with a peak voltage of 2kV and a peak current of 67A.
3. nemasurge.com - Permission to reprint granted by NEMA.