



Innovative Technology
TVSS Products

Technical Document

**WHY SILICON AVALANCHE
DIODES ARE NOT RECOMMENDED
FOR AC POWERLINE
SUPPRESSORS**

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A Surge Protection Device (SPD), also called a Transient Voltage Surge Suppressor (TVSS), is used to protect semi-conductor loads from powerline transients. SPDs are installed in the ac power system at the service entrance and panelboards, and sometimes at the load. SPDs are also required on data communication lines to prevent ground loops and induced surges, which can damage equipment.

In ac power applications, over 95% of SPDs use Metal Oxide Varistors (MOV) because of their high-energy capability and reliable clamping performance. For added performance, hybrid designs (MOVs and capacitive filter) are typically specified.

A small number of SPD manufacturers still promote the use of Silicon Avalanche Diodes for ac applications. These companies attempt to scare customers into buying a premium priced unit by publishing misleading information about MOV surge components. The following Tech Note summarizes the marketing claims and technical insights regarding SADs suppressors.

SAD Myths and Reality

“SADs have a faster response time (e.g. 5 picosecond compared to 1 nanosecond for MOVs). The faster SAD response time results in improved SPD performance.”

1. NEMA LS-1 and IEEE committees do not mention the use of response time as a SPD specification. All SPDs have sufficient response time to “turn on” and shunt surges. The response time of an MOV is 1000 times faster than the time it takes for a surge to reach full current (i.e. 8 microseconds). Response time is not an appropriate criteria to use when specifying SPDs.

2. The response time for a SAD device is equivalent to that of an MOV device. Response time of the device is affected more by the internal wiring/connection than the speed of the SAD (or MOV). For example, a SAD may react in 1 picosecond but the internal wiring and connecting leads within the SPD add inductance (about 1 to 10 nanohenrys per inch). This inductive effect is the dominating factor in overall response time - not the SAD reaction time.

3. Note that hybrid filters (MOVs combined with capacitive filtering) react the fastest because the capacitors activate instantaneously to any high frequency surge.

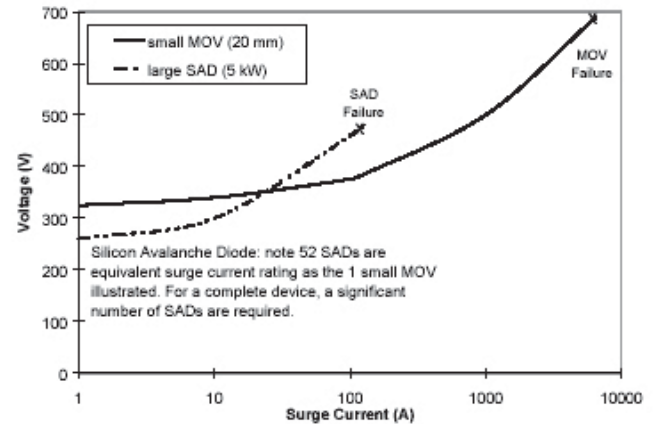
MOVs degrade resulting in short life expectancy of the SPD and unsafe failures. SADs do not degrade and are safer to use.

4. Life expectancy of SADs is much lower than that of an MOV (see Figure 1). A single SAD will be damaged by a surge under 1000 A. Given that IEEE C62.41 requires SPDs to withstand 10,000 Amp surges, SADs do not have sufficient energy capabilities for service entrance or

branch panel applications. To hide this weakness, SAD devices often publish Joule ratings or Wattage instead of publishing Surge Current Capacity per Phase (a more reflective performance criteria).

Note: IEEE and NEMA do not recommend the use of Joule ratings for SPD comparison.

Figure 1: SADs have limited energy capability



MOVs are rated from 6500 A to 40,000 A, making them more reliable for ac power systems.

Quality SPDs often parallel MOVs to achieve Surge Current ratings in excess of 300,000 A per phase. These results can be verified through independent testing at lightning labs. At these ratings, the SPD will operate effectively for over 25 years in IEEE classified high exposure environments.

Paralleling SADs is more difficult than with MOVs. Suppressors using parallel SADs require a significant amount of components, which reduce the overall device reliability.

Given the limited energy ratings of SADs, these devices are not recommended for panelboard or switchboard applications. Similarly, hybrid designs using MOVs and SADs do not achieve component synergies. In high-energy applications for example, the SADs are the weak link because the SADs and MOVs cannot be coordinated to work together.

5. Failure mode. SAD manufacturers claim that their units do not degrade. Rather than degrade, the SAD fails in a short circuit mode at much lower energy levels than a MOV. A properly constructed MOV suppressor will not degrade, even when exposed to thousands of high-energy strikes.

Degradation problems do exist with the very inexpensive surge bars. These devices are usually manufactured offshore and are poorly constructed utilizing under-rated MOVs. These low quality devices should not be compared to the SPDs typically used at panelboards or service entrance locations.

“SADs Provide Tighter Clamping than MOVs”

When exposed to IEEE defined test waveforms and UL 1449 test results, both MOV and SAD devices have the same Suppression Voltage Ratings. Accordingly, UL does not regard SAD devices as providing any better clamping than MOV based SPDs.

Summary

There are a number of myths in the SPD industry. When evaluating SPDs, it is important to evaluate the performance of the suppressor unit and not compare individual internal elements. In other words, SPD construction methods and internal wiring/fusing limitations are critical to overall performance. Independent testing is essential when comparing the performance of these units.

Based on the proven track record of performance, MOV based suppressors are highly reliable. That is why almost all suppressors employ MOV components. For service entrance or panelboard locations, SADs are not recommended because of their limited energy capability. SADs are primarily used to protect dataline and communication wires.

Figure 2: Comparison of Components Used in Surge Protection Devices

SPD Component	Advantages and Disadvantages
Metal Oxide Varistor (MOV)	Highest energy capability, excellent reliability and consistent performance, better mechanical connectivity for paralleling multiple components. Non-linear clamping curve gradually degrades over repeated use (only at high surge levels), moderate capacitance.
Silicon Avalanche Diode(SAD)	Flatter clamping curve, excellent reliability and consistent performance. Very low energy capability, expensive.
Selenium Cells	Moderate to high-energy capability. Very high leakage current, high clamping voltage, bulky, expensive, obsolete components.
Gas Tubes	High-energy capability, very low capacitive (requirement for data line applications). Unpredictable and unstable repetitive behavior, “crow-bar” to ground (unsuitable for AC systems), expensive.
Hybrid SPD	MOV/Filter is most common hybrid; incorporates the advantages of other components while overcoming the problems associated with each individual component (achieves long life expectancy, faster response, better clamping performance). Inherent problems with hybrid SPDs using MOV and SAD, or devices using selenium cells (inability to have the various components “work together”).

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Eaton Corporation
1000 Cherrington Parkway
Moon Township, PA 15108-4312
United States
tel: 1-800-525-2000
www.eatonelectrical.com



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