White Paper

Surge Protection Device Technologies Compared

MOV Array vs SAD/MOV Hybrid Array

ASCO®

MOV ARRAY VS SAD/MOV HYBRID ARRAY

Lightning generated transients are diverse, with events that vary in polarity, currents, rise times, durations, and associated strokes per event. Transients can enter your electrical system at significant levels and can wreak havoc on your facility's sensitive electronic devices. A critical step in protecting your facility is to apply an appropriately sized surge protective device (SPD) at your service entrance and then cascade SPDs at critical points throughout your facility. But with the myriad of choices, technologies and features available, choosing the right device can be a difficult task. Obviously, the goal is to install a device that is both rugged enough to handle the impulses one would expect to see at its installed location, yet sensitive enough to respond in such a way that impulses are mitigated quickly and voltage "let-through" is minimized.

The end user has a few choices in the type of technologies they can select for this application. The two most prevalent are Metal Oxide Varistor (MOV) based SPDs and Silicon Avalanche Diode (SAD)/MOV hybrid SPDs. Both technologies provide a means by which to successfully suppress transient events, so the question often arises; "What exactly is the performance difference between an MOV and a SAD/MOV Hybrid SPD?"

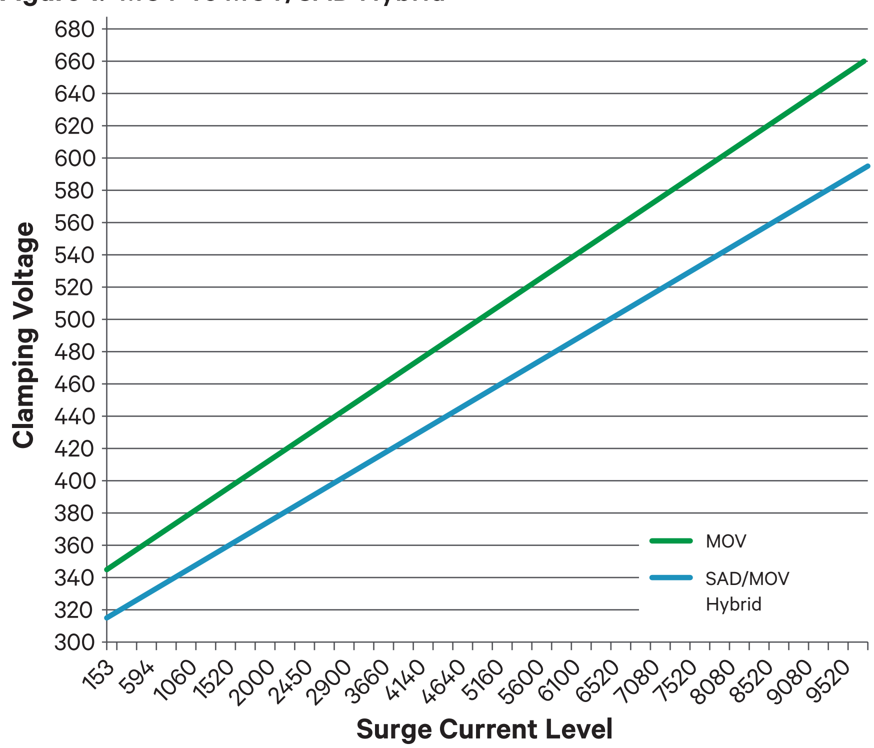
To figure this out, we performed a series of transient impulse tests that allowed us to examine the response of an MOV array and a SAD/MOV hybrid array. The results shown in **(Table 1)**, demonstrate that at lower current levels (1,000 amps or less) there is little difference in the actual clamping response between the two technologies. However, as we increased the current levels, we observed a larger gap, approximately a 20 volt difference at 1,000 amps growing to almost 80 volts at 10,000 amps. This trend continued as the applied current level increased. The advantage of the SAD/MOV hybrid array became clearer when we reached the peak test current level of 34,800 amps, where an improvement of 200 volts was recorded. Overall, an average of about 8.6% improvement was demonstrated "across the board" for the hybrid technology. Meaning that if we continued our test, we would expect to see differences far exceeding 200 volts **(Figure 1)**.

Table 1. Transient response test results of an MOV (only) array and an SAD/MOV array.

Surge Voltage (V)	Surge Current (A)	SAD/ MOV Clamp	MOV-Only Clamp	% Difference	In Volts
500	153	296	306	-3.27%	-10
1000	363	306	322	-4.97%	-16
3000	1280	342	364	-6.04%	-22
4500	2000	380	412	-7.77%	-32
6500	2900	420	456	-7.89%	-36
8000	3920	430	490	-12.24%	-60
8500	4140	430	490	-12.24%	-60
10000	4860	450	520	-13.46%	-70
19000	9280	560	640	-12.50%	-80
4500*	20400	1480	1540	-3.90%	-60
6500*	29600	2040	2220	-8.11%	-180
7500*	34800	2200	2400	-8.33%	-200

*Generator Switch: To achieve higher levels, switched generator from keytek to High Energy Lightning Simulator (HELS).

Figure 1. MOV vs MOV/SAD Hybrid



This information is extremely helpful when developing your facility's power protection scheme. When one considers the expected transient levels at high exposure locations within your building, such as the building's service entrance, the panels feeding rooftop condensers or outdoor "high-mast" lighting, the ideal first line of defense is an SPD that features a SAD/MOV hybrid array. Secondary panels to these locations can be protected by either technology, as the impulse levels will most likely be reduced to levels where the performance difference is negligible.

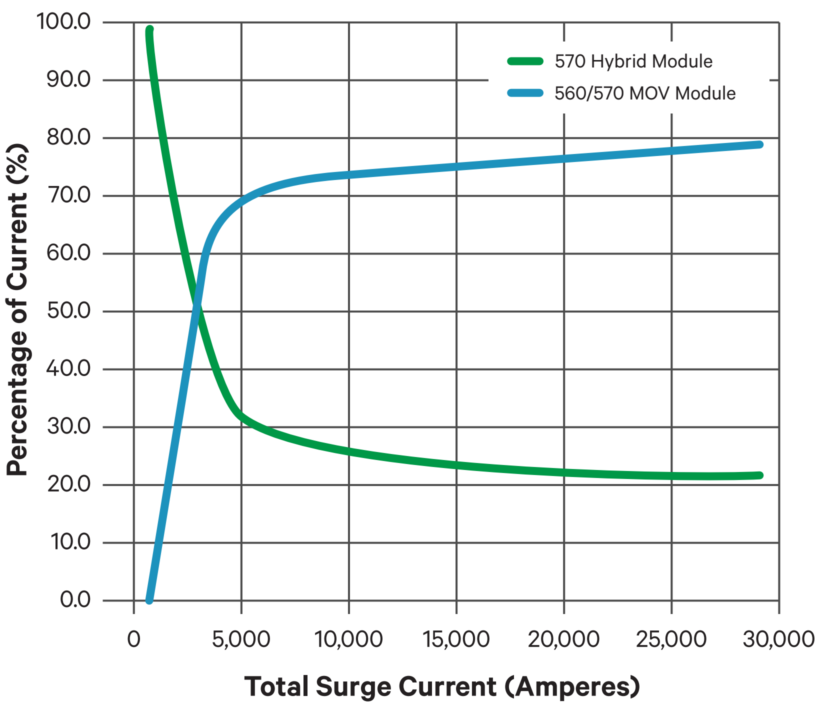
It is important to note that SADs in SPDs have a limited capacity for handling surge current. The SAD is typically used on PC board protection or in signal protection where impulse levels are expected to be rather low. Furthermore, most SPD manufacturers that employ SADs in their products market them as self-sacrificing elements or simply as SPDs to be placed in low exposure locations. However, as this test shows, the advantage of using the hybrid design is its response to high-energy events.

ASCO set out to solve this industry challenge, which led to the development of the **ASCO Model 570**. This SPD is unique in that it features a means by which an SAD will survive a high-energy event.

The Model 570 features a transition circuit that allows a closely regulated amount of energy to be transitioned between the primary SAD and the secondary MOV components. This design ultimately limits the amount of high-energy the SAD is required to divert. The graph in Figure 2, shows the current sharing feature of the Model 570. The 570's transition circuit ensures that the majority of the current at lower levels is diverted using the SAD technology. However, at higher levels (around 3,000 to 5,000 amps), the MOV "takes over" and handles most of the work; although never fully without the assistance of SAD technology **(Figure 2)**.

In summary; our testing demonstrates that the SAD/MOV hybrid approach is in fact the preferred SPD technology for high-energy locations. In addition, the **ASCO Model 570** is uniquely designed to survive in those locations, making it the ideal choice for high-risk locations; areas where we would expect to see the highest energy levels.

Figure 2. Typical Hybrid Surge Current Sharing Data



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