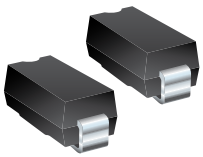
Comparing MLV vs. TVS Diode Circuit Protection Characteristics

WHITE PAPER

Bourns® Multilayer Varistors (MLVs)



Bourns® Transient Voltage Suppressor (TVS) Diodes

Introduction

Both Multilayer Varistors (MLVs) and Transient Voltage Suppressor (TVS) diodes are frequently used circuit protection components, but they differ in their operating principles and characteristics. In order to select the best option for a particular application, it is helpful to understand their differences. This white paper presents a comparison of the two devices covering each one's operating principles, advantages and the information designers need to consider when choosing the most optimal solution.

MLV Operating Principles

MLVs are non-linear resistors that exhibit a high resistance at low voltages, but rapidly decrease in resistance when subjected to high voltage transients. As the name implies, Multilayer Varistors are comprised of multiple layers of varistor, which are connected in parallel.

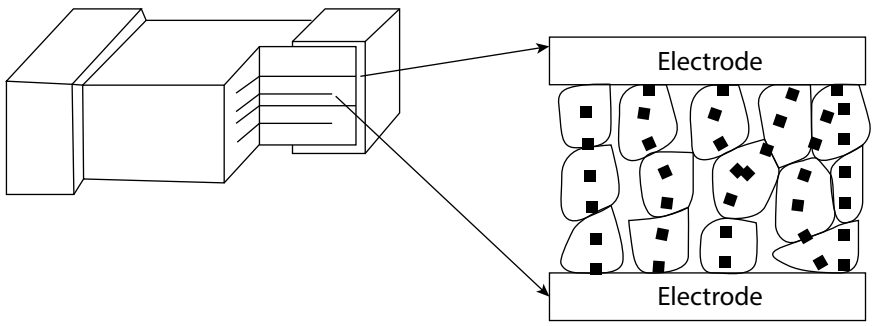
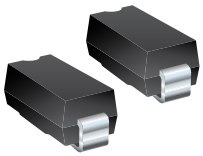


Figure 1. | *Diagram of a MLV*

Bourns® Multilayer Varistors (MLVs)



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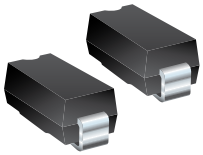
MLV Operating Principles (Continued)

This configuration offers several advantages:

- **Increased Surface Area:** The parallel arrangement significantly increases the total surface area available for thermal dissipation. This enhanced thermal capacity allows MLVs to handle larger surge currents and dissipate heat more efficiently, reducing the risk of overheating and failure.
- **Higher Surge Capacity:** The expanded surface area translates to a superior surge current capacity. MLVs can effectively absorb and clamp transient voltage spikes, safeguarding sensitive electronic components from damage. Bourns offers MLVs with surge capabilities that range from 100 A to 1200 A (8/20 µs).
- **Faster Response Time:** The parallel structure enables a faster response time to transient events. This is crucial for protecting against high-energy surges that can occur in various applications.
- **Improved Reliability:** The distributed nature of the parallel layers enhances the reliability of MLVs. If one layer experiences degradation or failure, the others can continue to function, providing a level of redundancy and ensuring continued protection.
- **Wide Voltage Range and Package Size:** The voltage range of Bourns® MLVs is from 11 V to 130 V, offered in compact surface mount package sizes from 0603 to 2220.

Bourns® Multilayer Varistors (MLVs)



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TVS Diode Operating Principles

TVS diodes are semiconductor devices that conduct current when the voltage across them exceeds a certain threshold.

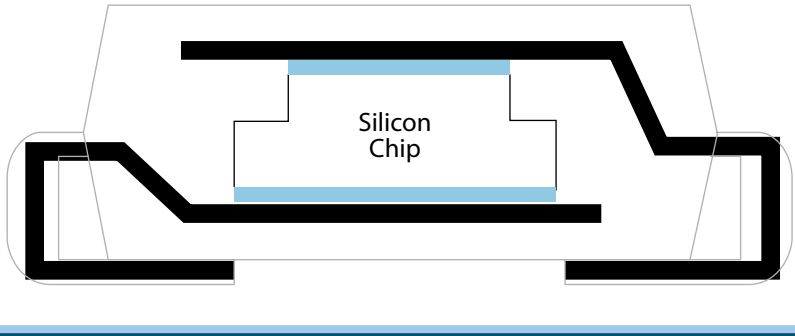

Figure 2. | *Diagram of a TVS Diode*

A TVS diode offers several advantages when compared to an MLV:

- **Faster Response Time:** Similar to MLVs, TVS diodes are capable of very rapid response times.
- **Wide Voltage Range and Package Size:** TVS diodes feature a significantly wider voltage range compared to MLVs. Bourns offer TVS diodes with voltages spanning from 5 V to 550 V. Although TVS diodes are available in compact packages, they are typically larger than those of MLVs.
- **Stable Clamping Voltage:** TVS diodes maintain a more consistent clamping voltage across a range of surge currents compared to MLVs, which experience an increase in clamping voltage as the surge current rises.
- **Longer Life:** Due to their semiconductor construction, TVS diodes are known to have a virtually unlimited lifespan when subjected to surges within their specified current ratings. In contrast, MLVs can degrade over time due to repeated exposure to high-energy transients.

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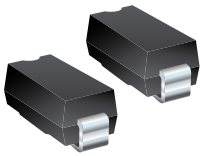

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Key Differences and Considerations:

Feature	MLV	TVS Diode
Surge Current Capability	High	Low
Response Time	Fast	Fast
Clamping Voltage	Variable, increases with current	Fixed
Power Dissipation	High	Low
Size	Compact	Large
Cost	Low	Medium

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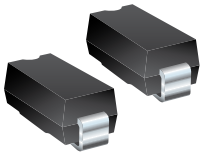

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Choosing the Right Device

The choice between MLVs and TVS diodes depends on specific application requirements, including:

- **Surge Energy Level:** For high-energy surges, MLVs are generally preferred due to their higher power handling capability.
- **ESD Suppression:** MLVs exhibit superior clamping performance for ESD events with peak voltages greater than 6 kV, compared to TVS diodes.

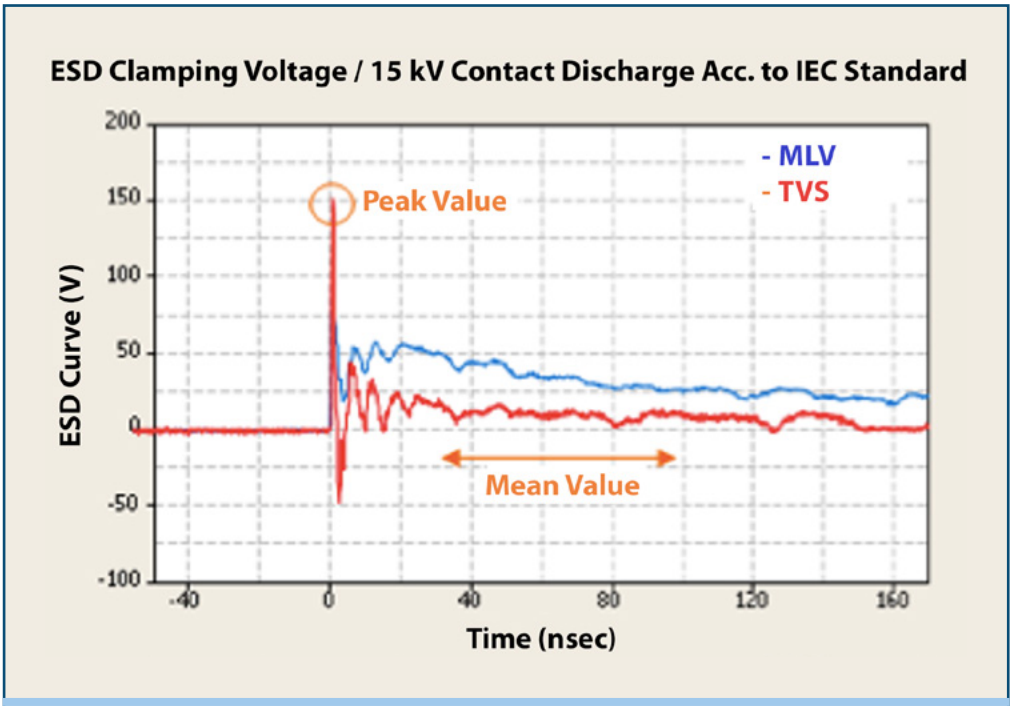

Figure 3. | *ESD clamping voltage*

- **Clamping Voltage:** TVS diodes offer precise clamping voltages, making them suitable for applications where voltage level control is critical.
- **Size and Cost:** MLVs are often more compact and less expensive than TVS diodes.

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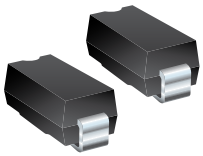

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Comparison Between Two Comparable Components:

Feature	MLV Part Numbr AV20K1210401NIR1	TVS Diode Part Number SMLJ33CA
Nominal Voltage	33 V @ 1 mA	33 V @ 1 mA
Surge Current Capability	400 A (8/20 µs)	281 A (8/20 µs)
Clamping Voltage at 281 A	93 V	69 V
Size: Length	3.2 mm	8 mm
Size: Width	2.5 mm	6 mm
Typical Cost	$	$$
Automotive grade available	Yes	Yes

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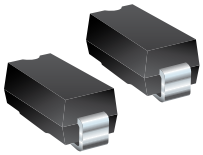

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Conclusion

Both MLVs and TVS diodes can be employed as essential components for circuit protection, each exhibiting its own unique strengths and weaknesses.

MLVs excel in handling high-energy surges due to their superior surge current capacity and efficient thermal dissipation. However, they may degrade over time with repeated exposure to high-energy transients. MLVs can also have variations in clamping voltage as the surge current increases.

TVS Diodes offer precise clamping voltages and longer lifespans, making them suitable for applications where voltage level control is a critical requirement. While they may have lower surge current capabilities compared to MLVs, the cost for TVS diodes is generally higher.
The optimal choice between MLVs and TVS diodes depends on a designer's specific application requirements. Design considerations when selecting between the two devices include the level of surge energy, desired clamping voltage, response time, size constraints, and cost considerations. In many cases, a combination of both devices can provide comprehensive protection for electronic circuits, leveraging the strengths of each technology.

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