

How a New Varistor Design Improves Circuit Protection Performance and Saves Space

WHITE PAPER



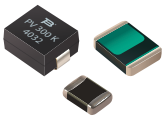
[Bourns® Through-Hole Metal Oxide Varistors \(MOV\)](#)



[Bourns® EdgMOV™ Components](#)



[Bourns® Through-Hole Multilayer Varistors \(MLVs\)](#)



[Bourns® Surface Mount Multilayer Varistors \(MLVs\)](#)

INTRODUCTION

[Varistor technology](#) dates back as far as the 1920s. Researchers at that time found that copper-oxide exhibited a varying resistance dependent on the polarity and magnitude of an applied voltage. Hence, the word varistor was born – alluding to the material’s variable resistance dependent on the applied voltage. Up until 1970, Japanese researchers recognized the properties of zinc oxide (ZnO) as being useful in a ceramic sintering process. This type of device became the preferred method for protecting circuits and it came to be known as the metal-oxide varistor (MOV). The manufacturing process today remains largely the same, with many companies producing MOVs across a billion-dollar global market.

MOVs are bidirectional, non-linear surge suppression devices that are widely used for limiting voltage during a surge or transient event across a broad spectrum of applications. These overvoltage protection devices are available in multiple form factors and surge protection ranges. As a non-linear device, an MOV’s characteristics will not vary gradually. Rather, their resistance changes suddenly when the applied voltage reaches or exceeds the device’s rated parameters. An MOV also features non-ohmic current-voltage characteristics similar to a diode. In contrast to a diode, however, an MOV has the same characteristic for both directions of traversing current.

This white paper outlines the advantages and benefits of a new varistor design from Bourns. The improved design provides multiple options that give designers the flexibility to specify a higher surge rating with lower clamping voltage or the same surge rating with a smaller diameter protection solution. The paper also presents how designers can choose a higher MOV voltage while maintaining the same clamping voltage, which, in turn, helps reduce the potential of MOV leakage current to minimize or avoid premature failures.

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MOV CONSTRUCTION BASICS

Many companies have tried to improve the MOV by mixing new powders, creating new material compositions, changing granulate processes, adding dopants, increasing density control, and modifying manufacturing methods. Some companies also use copper electrodes to help with the thermal dissipation and improve surge current, with the negative side effect of significant cost increases having to be passed on to their customers. While designing the Company's innovative IsoMOV™ Hybrid Protection Components, Bourns discovered through simulation testing that thermal dissipation does not spread evenly when a surge event occurs. The majority of the heat tends to spread outward. That's why most MOVs tend to incur failure modes on or near the edge of the electrode. Figure 1 demonstrates this phenomenon.



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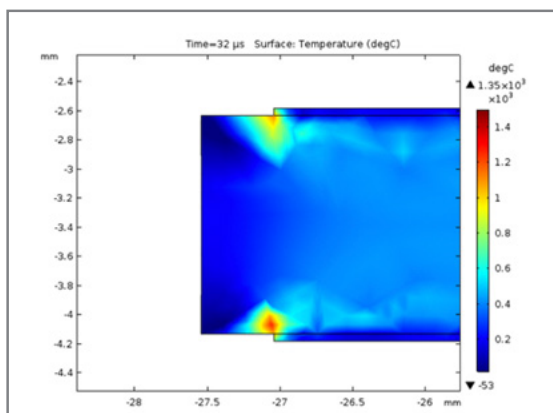


Figure 1 - Heat accumulation can be seen near the edge of the disc

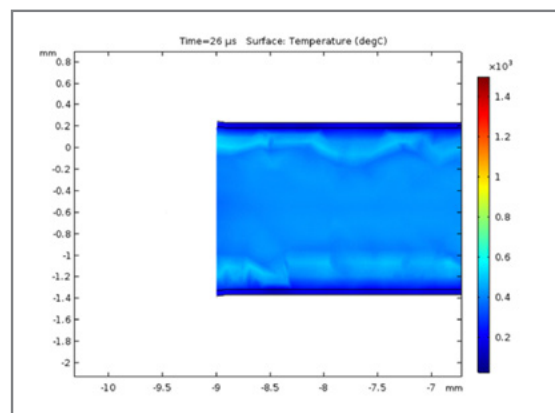


Figure 2 - Heat dissipation evenly across the disc

Learning from the simulation testing and replicating the test results, Bourns engineers developed a new formulation and process to control heat dissipation and reduce the failure frequently experienced at the edge of the MOV. Hence, the Bourns® EdgMOV™ High Surge Disc Varistor was created.

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LEVERAGING THE DESIGN BENEFITS

Offered in four model family sizes; 7 mm, 10 mm, 14 mm, and 20 mm, with nominal current ratings of 1.5 kA, 3 kA, 5 kA and 8 kA, respectively, EdgMOV™ disc varistors are designed to match common MOV footprints, allowing for drop-in replacement without any PCB redesign. This approach provides designers with two distinct value propositions as the surge ratings of EdgMOV™ protectors are comparable to the surge ratings of the next larger size of conventional MOV components, allowing for board space savings or higher performance from the same board space.

As an example of board space saving, a 10 mm Bourns® EdgMOV™ high surge protector is rated for 3 kA nominal current (15 operations), which is comparable to a typical 14 mm standard MOV (typically also rated at 3 kA nominal current). Conversely, if a designer is looking to enhance the performance of their primary protector without increasing size, a similarly sized EdgMOV™ protector can be selected to replace the existing MOV, providing enhanced performance in the same package size. For example, a 14 mm MOV (typically rated at 3 kA nominal current) can be replaced with a 14 mm EdgMOV™ disc varistor with its performance rated at 5 kA nominal current for a 66 % increase without re-spinning or re-layout of the PCB.

This dual benefit offers designers the flexibility of choosing an equally-rated EdgMOV™ high surge protector that is smaller than their current MOV selection or choosing a higher-rated EdgMOV™ protector of the same size as their current MOV selection and enhancing the surge capability of their protection scheme.



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LEVERAGING THE DESIGN BENEFITS (Continued)



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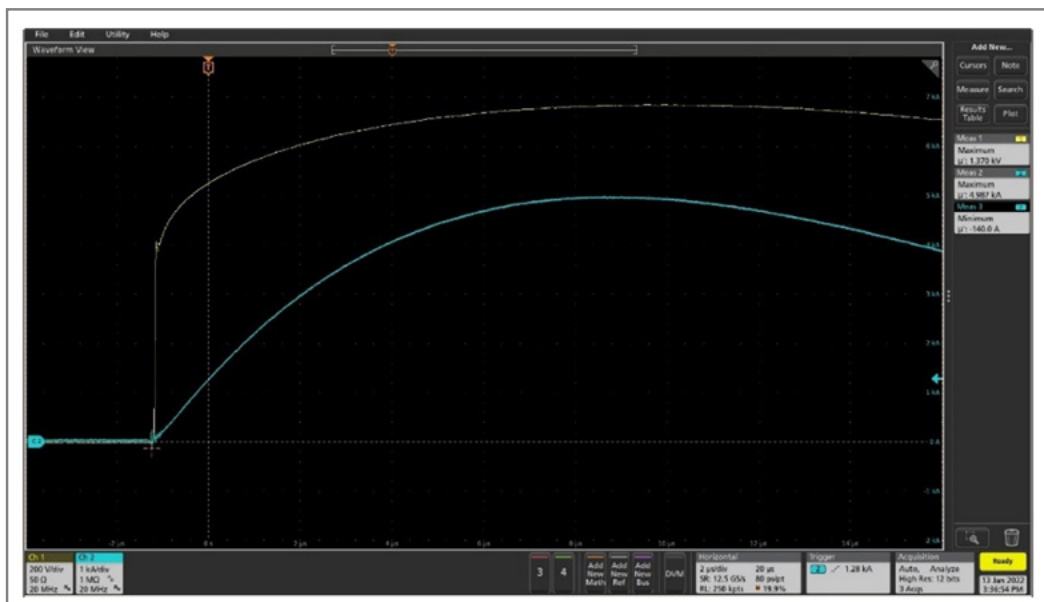


Figure 3 - Here is an example of a 14 mm MOV experiencing a 5 kA surge

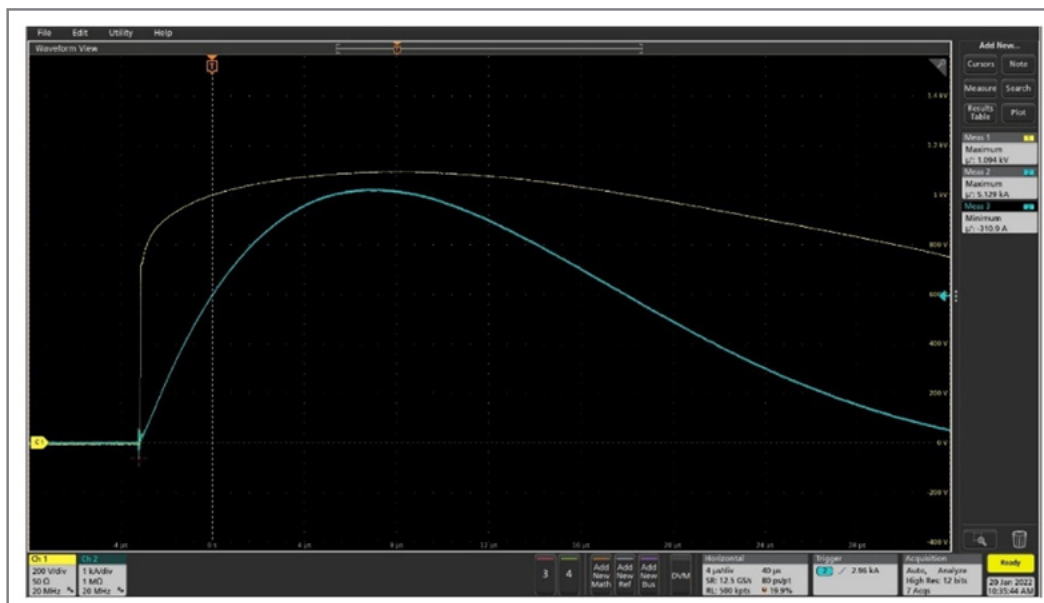


Figure 4 - Using the 14 mm EdgMOV™ protection component with the same voltage for comparison, the EdgMOV™ protector's clamping voltage is lower

Comparing the two, the MOV clamping voltage is very close to 1400 V while the EdgMOV™ protector's clamping voltage is less than 1100 V.

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LEVERAGING THE DESIGN BENEFITS (Continued)

Another benefit of a higher surge rating is a lower or equivalent clamping voltage. A typical 14 mm MOV has a maximum rating of 5 kA while the 14 mm EdgMOV™ disc varistor has a maximum rating of 8 kA. Testing a 14 mm MOV above 5 kA will generally result in an undesirable outcome, while the 14 mm EdgMOV™ device can sustain up to 8 kA.

A third advantage of the EdgMOV™ component is that the coating material is now rated for 105 °C, higher than the standard 85 °C. UL requires any components that are rated higher than 85 °C to undergo a 1000 hour aging test. By using a 105 °C rated component, the end users can have greater confidence of maximizing the lifetime of their equipment.



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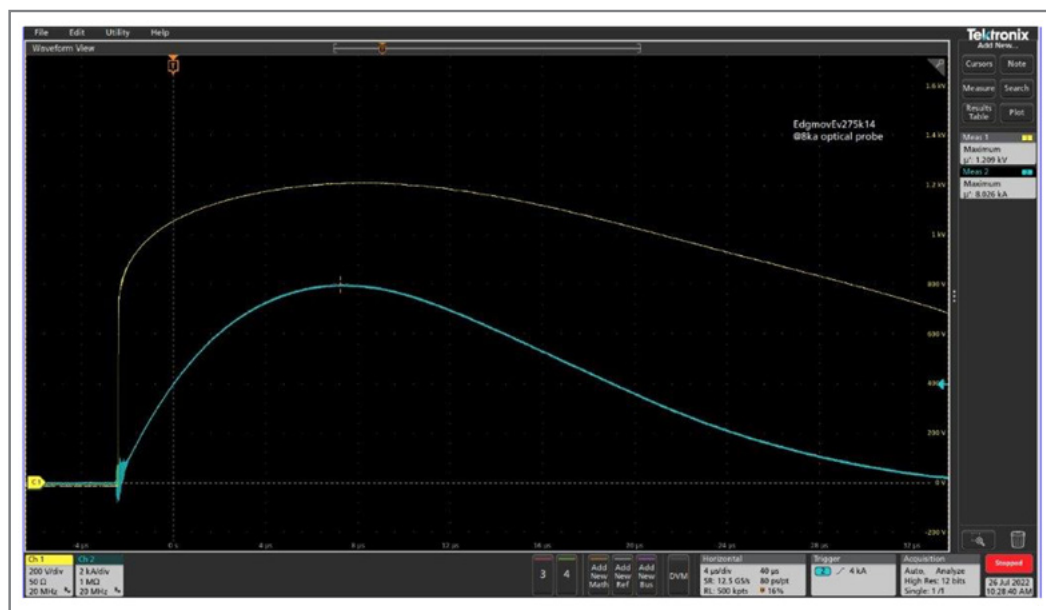


Figure 5 - The EdgMOV™ component coating material is rated for 105 °C; higher than the standard 85 °C

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PRIMARY PROTECTION UPGRADE

Bourns® EdgMOV™ high surge protectors can be used for effective primary protection across a wide variety of devices and equipment including power supplies, white goods, and LED lighting. If an application requires circuit protection, it typically has been designed with at least one MOV in the circuit. With the availability of Bourns® EdgMOV™ devices, designers are now able to upgrade their application's protection or save value board space. By addressing MOV degradation issues, Bourns® EdgMOV™ disc varistors also give designers additional peace-of-mind that applications are well-protected, increasing the value they deliver to their customers.

For additional voltage clamping comparison demonstrations between Bourns® EdgMOV™ High Surge Disc Varistors and traditional MOV devices, please see the Bourns YouTube channel at:

<https://www.youtube.com/user/bournsvideos/videos>

ADDITIONAL RESOURCES

[Bourns® Varistor Products Technical Library](#)

[Bourns® Varistor Components Brochure](#)

[Bourns® MOV, MLV and Hybrid Component Product Guide](#)

White Paper: [Specifying Bourns® Surge Protection Components for UL/IEC 62368-1 Compliance](#)

White Paper: [Designing Effective Circuit Protection for RS-485 and RS-422 Applications](#)

White Paper: [The Effect of Surge Testing Live Online for Surge Protective Devices](#)

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