APPLICATION NOTE

How Bourns® IsoMOV™ Protectors Compare to MOVs in Handling Extended Swell Voltage Events

Bourns® IsoMOV™ Hybrid Protectors

Introduction

Metal-oxide varistors (MOVs) are the workhorses of surge protection, acting as the core non-linear element in most commercial surge arrestors.. They shield sensitive equipment by diverting surge currents and limiting voltage spikes above normal operating levels. MOVs function like variable resistors, offering low impedance during surges to absorb current and high impedance during normal operation to avoid impacting the circuit. This surge absorption generates heat within the MOV. Larger MOVs have more material to dissipate this heat, allowing them to handle greater surge energy. Additionally, some MOVs are formulated with special additives to further enhance thermal management.

However, MOVs are not invincible. Their surge current rating, typically specified as an 8/20 microsecond (µs) pulse, defines their ability to handle short-duration surges. While the high energy deposited during a short surge can be dissipated quickly, repetitive surges or sustained overvoltage can overwhelm the MOV's thermal capacity, leading to a dangerous condition called thermal runaway and potential device failure.

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Swell Voltage and the Damage it Can Cause

Swell voltage, a sustained increase in voltage above the normal operating level, poses a significant threat to MOVs. Unlike short-duration surges, which MOVs can handle effectively, swell voltages last much longer (around 16.6 milliseconds per cycle at 60 Hz). These extended periods can have voltage twice as high as normal line voltage, forcing the MOV to continuously conduct and clamp the voltage (see Figure 1). This ongoing conduction generates heat within the MOV. Over several cycles, the heat buildup can exceed the MOV's thermal rating, leading to its degradation. The MOV's internal structure weakens as some of its grains short-circuit, ultimately culminating in a dangerous thermal runaway failure.

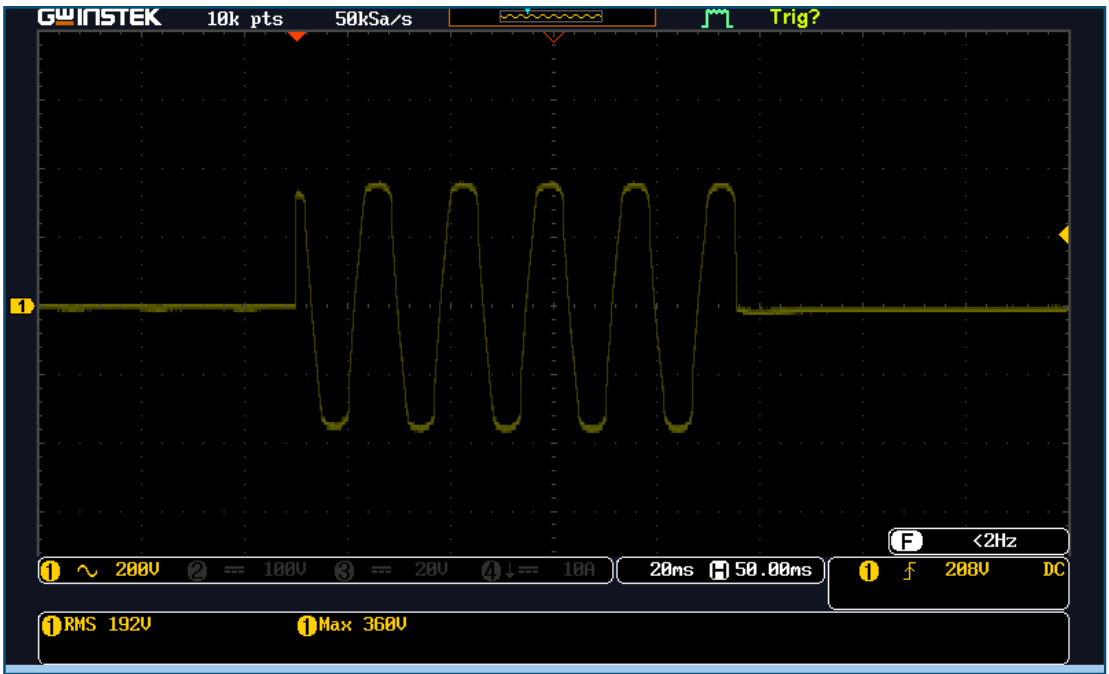

Figure 1. | *MOV Clamp Under Swell*

To mitigate the risk of thermal runaway caused by sustained overvoltage, designers often incorporate thermal disconnects (TDCs) into MOV circuits. These TDCs act as safety switches, automatically severing the MOV's connection from the circuit if its temperature exceeds a critical threshold just before thermal runaway. While this protects the MOV itself, it is important to note that the equipment becomes vulnerable to future transients until a replacement MOV is installed.

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Swell Voltage and the Damage it Can Cause (Continued)

While using a higher voltage MOV (rated for twice the line voltage) might seem tempting as a solution to swell voltage, it's a double-edged sword. On the one hand, this approach would prevent the MOV from conducting during swells, protecting it from damage. However, the downside is a potentially higher clamping voltage during transient surges. This higher clamping voltage could exceed the equipment's maximum input voltage rating, potentially damaging the very devices the MOV is meant to protect.

Figure 2. | *Five-Cycles of Swell Voltage Bypassing Without Affecting IsoMOV™ Hybrid Protector Operation*

To tackle the limitations of traditional MOVs, Bourns engineered its IsoMOV™ hybrid protector. By innovatively merging the strengths of MOVs and Gas Discharge Tubes (GDTs) into a single hybrid device, IsoMOV™ protectors are able to support high conduction voltage (Front Protection Voltage or V_{fp}), that is typically at least twice the line voltage to effectively shrug off swell voltage threats (see Figure 2).

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Swell Voltage and the Damage it Can Cause (Continued)

When a transient surge strikes, IsoMOV™ protectors maintain a clamping voltage comparable to a standard MOV (see Figures 3 and 4), ensuring continued protection for a wide range of equipment.

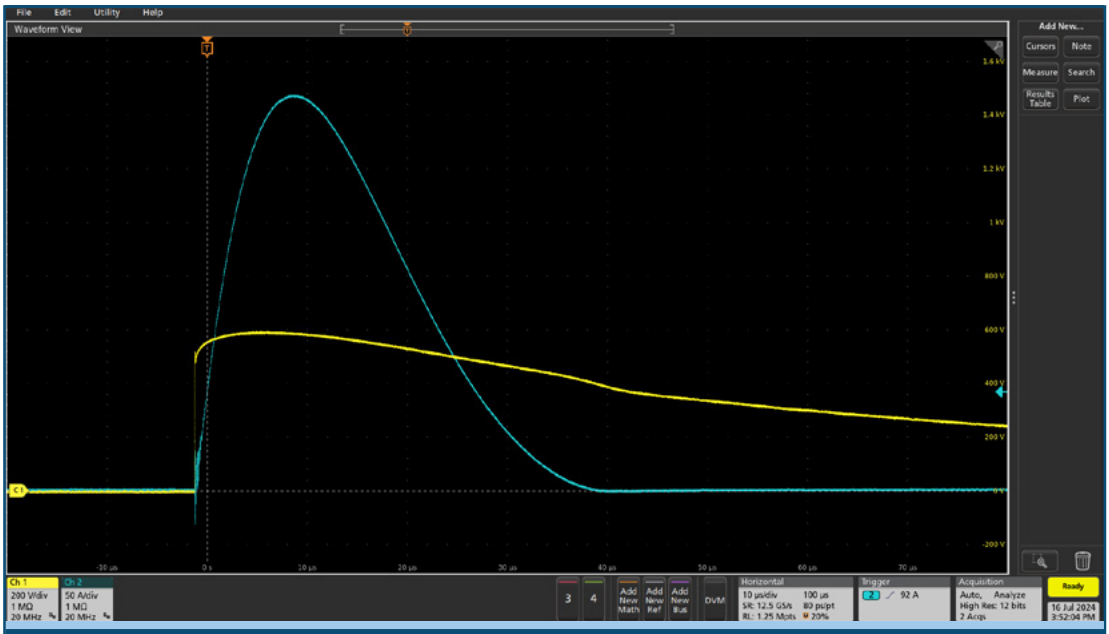

Figure 3. | *Scope View of Standard MOV Clamping*

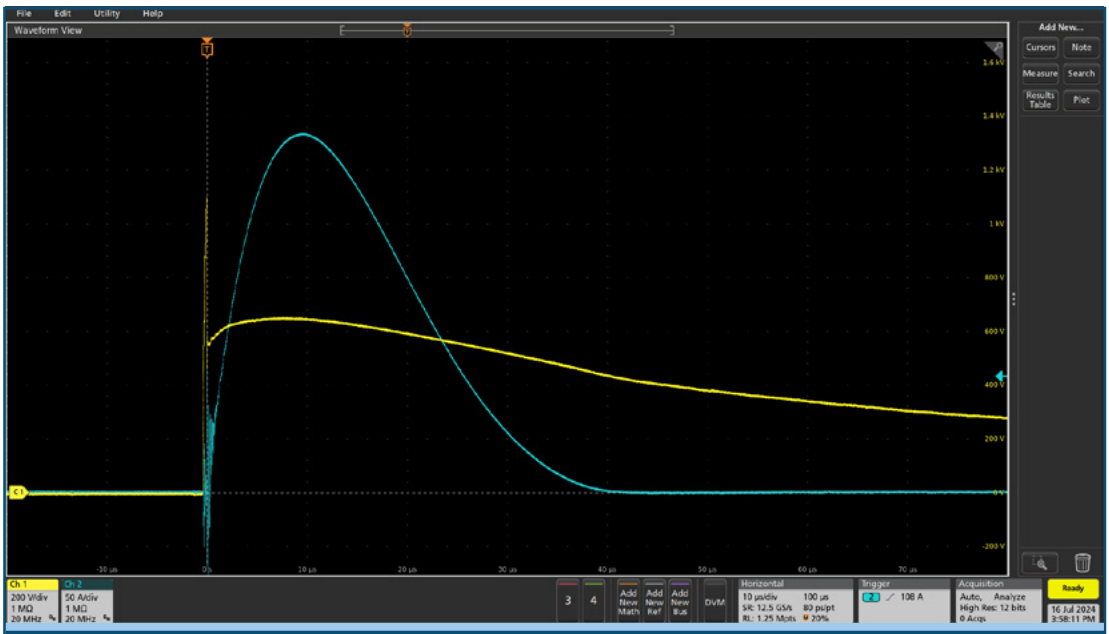

Figure 4. | *Scope View of IsoMOV™ Protector's Clamping Capability*

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Swell Voltage and the Damage it Can Cause (Continued)

The hybrid IsoMOV™ protector design allows it to be both immune to swell voltage and vigilant against transient surges. Additionally, IsoMOV™ hybrid protector technology incorporates special additives and an optimized form factor to enhance thermal management. This results in a higher energy rating compared to a traditional MOV of the same size, offering even greater protection potential.

Effective Voltage Swell Surge Protection

In conclusion, the IsoMOV™ hybrid protector emerges as a superior choice for surge protection. Its hybrid design provides a feature to effectively handle both swell voltage threats and transient surges, offering a comprehensive protection solution suitable for a broad variety of equipment. The high conduction voltage offered by IsoMOV™ protectors renders swell voltage a non-issue, while the clamping voltage remains comparable to a standalone MOV during transient surges. Additionally, its hybrid technology boasts superior thermal management, thanks to special additives and an optimized form factor. This translates to a higher energy rating compared to traditional MOVs, providing an extra layer of protection. By incorporating Bourns® IsoMOV™ protectors as part of a surge protection strategy, designers get the peace of mind from knowing their equipment is shielded from a wider range of threats while also minimizing thermal management concerns.

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