Innovative Hybrid Protective Device Provides Rugged, Reliable Circuit Protection Solution

WHITE PAPER

Bourns® IsoMOV™ Hybrid Protector

INTRODUCTION

All electronic connections and wiring, whether for power or communications, are exposed to switching transients, lightning, voltage surges, and other overvoltage events that can damage or disrupt the operation of these applications. Therefore, a reliable circuit protection design is required for the connections and circuits in these applications.

However, circuit protection technologies have varying performance levels, which are not readily apparent by simply noting that subject devices meet stated minimum protection thresholds. In the case of evaluating the "ruggedness" of an overvoltage protection solution, a good point of reference is to compare devices taken well beyond stated data sheet and minimum performance standard limits up to the point of destruction.

This paper will explore two aspects of "ruggedness" with regard to the Bourns® IsoMOV™ hybrid overvoltage surge protector and compare its performance to that of a typical conventional Metal Oxide Varistor (MOV). The aspects of ruggedness to be considered are the surge life expectancy and the device's tolerance to temporary overvoltage (TOV) events.

To make useful comparisons, devices of each technology will be selected that are the same physical size and have the same voltage rating.

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LONGER SURGE LIFE

The typical transient overvoltage solution designers have used over the years has been an MOV. Unfortunately, there are documented instances of MOVs degrading over time from exposure to line voltage transients that can lead to a variety of problems. To solve these degradation issues, Bourns designed its new IsoMOV™ hybrid protector as a direct MOV replacement. The IsoMOV™ hybrid protector provides robust protection for operational circuits rated to 125 °C making it a good overvoltage protector for a wide variety of AC power, DC power, and other electronic circuits. Adding to its rugged performance, the IsoMOV™ surge protector has zero standby energy consumption and lower capacitance than MOVs.

Bourns tested several current and voltage ratings of the new IsoMOV™ protector against similarly rated MOVs. Each were compared for surge life at their rated maximum surge current for 15 surges and the UL current rating for surge life. The different IsoMOV™ devices were also tested for surge life at a lower current to demonstrate how many additional surges it could sustain when used at a reduced surge current. The results are shown in Figure 1.

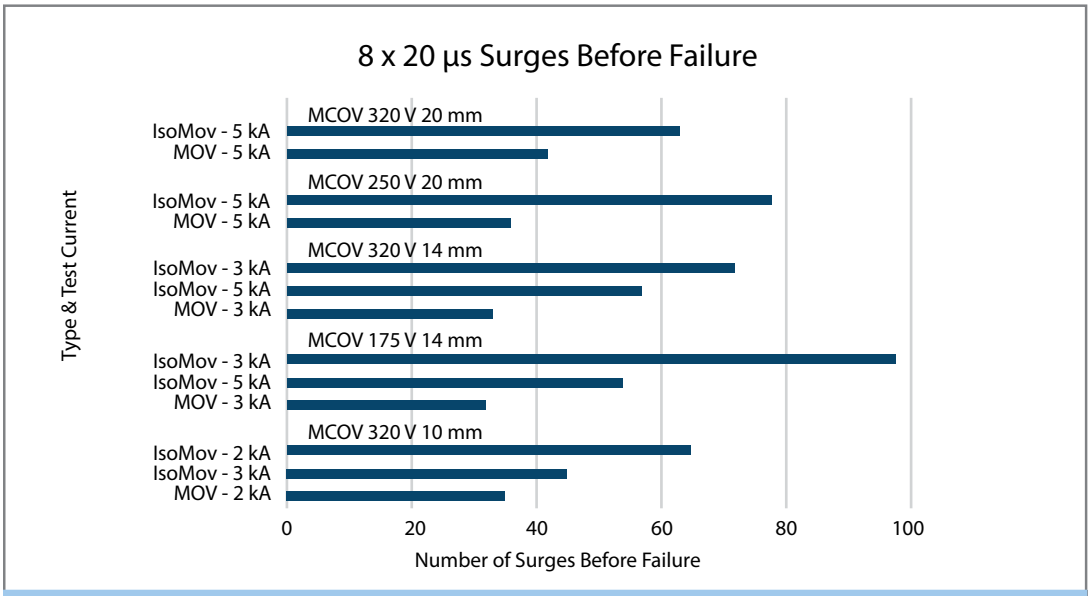

Figure 1- Number of surges 8 x 20 microseconds before failure compared for each size.

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IMMUNITY TO SWELLS AND TEMPORARY OVERVOLTAGES (TOV)

In addition, the Bourns® IsoMOV™ protector can withstand the swell voltages required for compliance to worldwide industry standards for extreme voltages in the electrical distribution network such as:

IEEE 1159-1995 - IEEE Recommended Practice for Monitoring Electric Power Quality

Table 1. Summary of TOV duration and amplitude from IEEE 1159-1995 electrical distribution standard.

IEEE 1159-1995	Duration	TOV % of V_{nom}	V_{rms} Max. 120 VAC Supply
Instantaneous	0.5 - 30 cycles	180	216
Momentary	30 cycles to 3 seconds	140	168
Temporary	3 seconds to 1 minute	120	144

For example, in Table 1, the TOV levels for nominal 120 VAC supply lines are shown. At 120 volts, applications can typically be protected by a primary protector with an MCOV rating of 175 volts. The 175 volt rating prevents the peak voltage of the AC waveform from exceeding 1 mA through the MOV at nominal operation.

The primary protector does not provide protection against TOV. It is up to the designer to harden the application against that threat. The primary protector, MOV or IsoMOV™ protector, is only present to protect the primary application from transient surges, in particular 8x20 microsecond lightning surges.

TOV CURRENT VS. CONSTANT ON-LINE CURRENT VS. FAST SURGE CURRENT

When an abnormal AC overvoltage is applied to the IsoMOV™ device, it will conduct a minuscule leakage current. Only when a fast surge voltage occurs will the IsoMOV™ protector conduct the rated surge current. Up to the maximum TOV referenced in the standards specifications at 216 volts, the IsoMOV™ device has less than 1/100 of the current of the MOV as measured and shown in Figure 5.

Since the MOV or IsoMOV™ device always has line voltage across it, the constant on-line current ages the MOV as compared to the IsoMOV™ surge protector, which does not experience significant leakage current or threat of thermal runaway. This is the reliability advantage of the IsoMOV™ hybrid protector over MOVs that contain indicator pins. Even with a connection to indicate a failure, a failed MOV will not provide surge protection. The indication simply reports the failure; however, the IsoMOV™ device prevents the leakage current failure from even beginning. Therefore, the IsoMOV™ device does not experience the aging effects of a conventional MOV exposed to the same events and conditions.

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FAILURE MODE TESTS

Below are photos taken during Bourns tests that illustrate the failure modes at each stage. The tests were conducted with the components connected to a variable voltage 60 Hz AC supply, 0 to 360 V_{rms}, where each was fused at 5 amps by a wire fuse connected in series with each device to protect the AC supply:

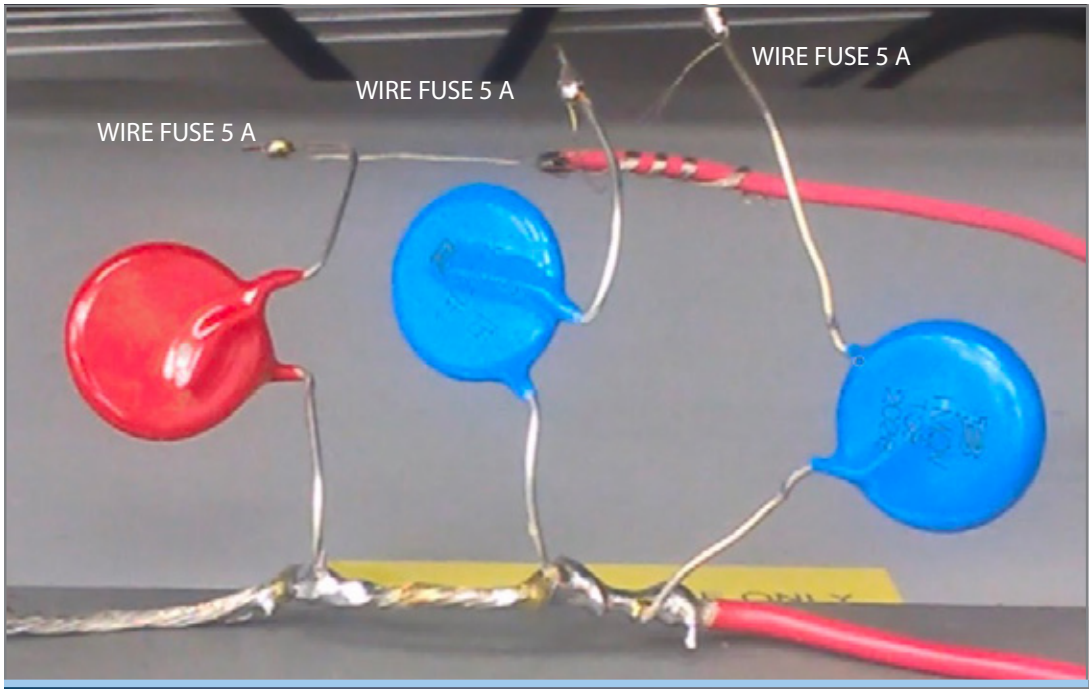

Figure 2 - The test setup at 216 volts.

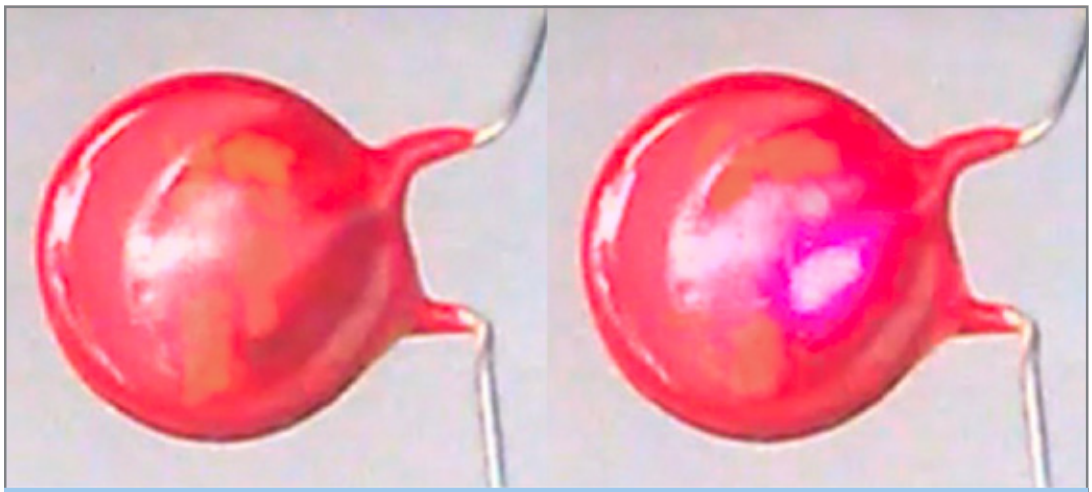

Figure 3 - At 240 volts, the thermally protected MOV heats up and swells (left picture). Just 33 milliseconds later the outside cover splits open with a bright flash inside its body.

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FAILURE MODE TESTS (Continued)

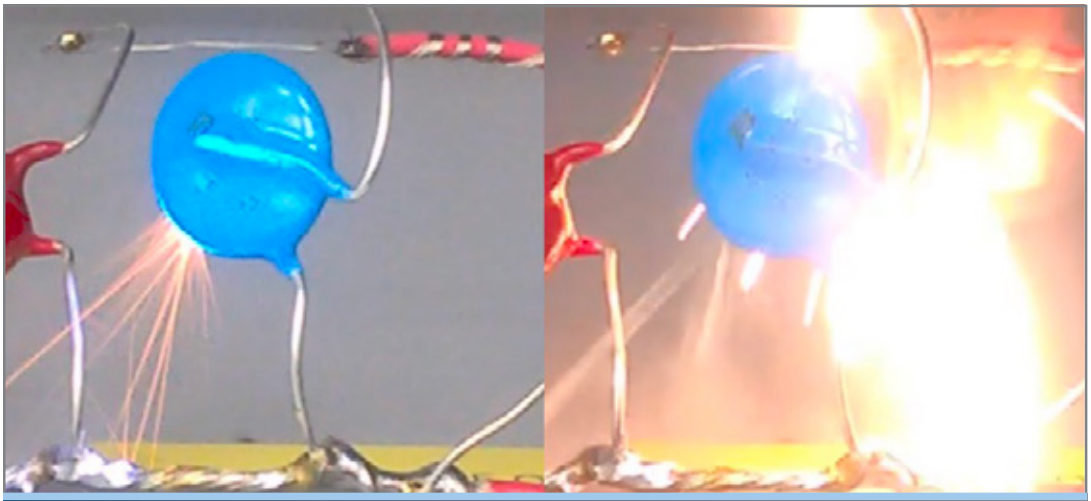

Figure 4 - The conventional MOV breaks down at 243 volts (left), and 100 milliseconds later, it erupts into flames and opens the fuse. Smoke continues for another two seconds.

The chart in Figure 5 shows each component's 60 Hz current, mostly due to the displacement current, and the voltages where damage is sustained. The IsoMOV™ device did not have physical damage or blow the fuse. Above 100 mA, the current increased quickly and blew the fuse within 33 milliseconds.

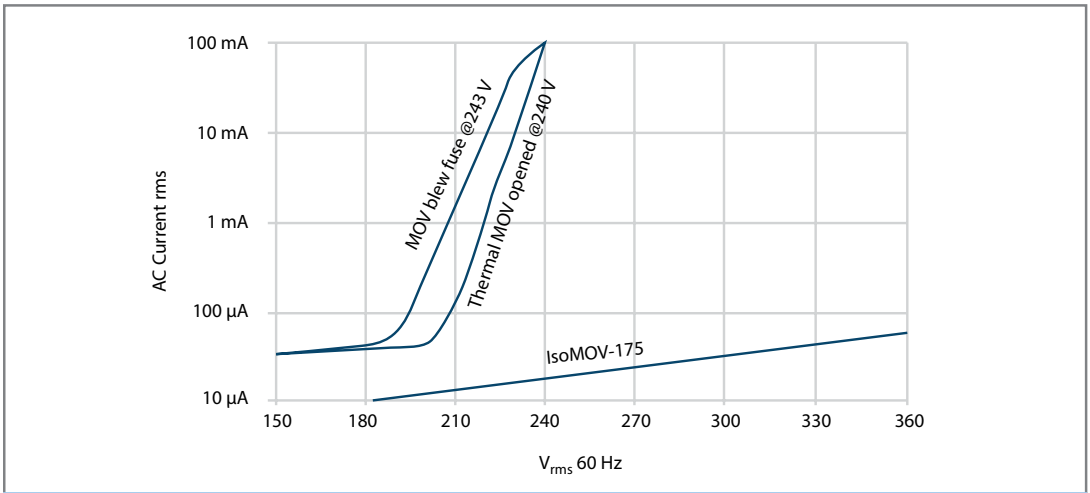

Figure 5 - AC Current for MOVs with MCOV = 175 volts as the applied voltage is increased from 150 to 360 VAC_{rms}.

All of these components provide 8x20 microsecond surge protection, but not TOV protection, to the protected circuit. However, the IsoMOV™ protective device did not fail in our laboratory tests.

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RUGGED SURGE PROTECTION

Bourns® IsoMOV™ protectors provide rugged circuit protection performance in the same or smaller printed wiring board area as similarly sized and rated MOVs. And, importantly, the IsoMOV™ device does not suffer degradation from leakage current since the MOV within it has no voltage across it during standby operation. This allows the IsoMOV™ protector to be always ready to clamp surge voltages when they occur.

Bourns® IsoMOV™ components offer exceptional protection against common system threats including transients due to environmental factors. With all the threats and performance considerations that designers must contend with, Bourns has developed a cost-effective way to reliably protect high voltage interfaces. The simplicity of its use provides inherent coordination with peripheral circuitry and fewer variables for the designer to consider.

Bourns is committed to continued technology advancements that address circuit protection needs in a range of applications. Serving diverse markets, Bourns has demonstrated its leadership in defining future circuit protection solutions with proven excellence in design backed by superior customer service.

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