Bourns® GMOV™
HYBRID OVERVOLTAGE PROTECTION COMPONENT
**INTRODUCTION**

Metal Oxide Varistors (MOVs) are popular bipolar ceramic components typically used for overvoltage protection on AC and DC power lines. MOVs operate as non-linear resistors exhibiting high resistance in their off-state. An MOV operates when the voltage applied to the MOV exceeds its maximum operating voltage (MCOV). As the voltage increases across the MOV, its resistance decreases quickly. In its fully on-state, the MOV clamps the voltage transient and then returns to its highly resistive off-state after the voltage triggering event has subsided. The term “varistor” is a generic term for a voltage-variable resistor and is often used to describe an MOV.

MOVs are manufactured using a variety of proprietary zinc oxide formulations due to their non-linear characteristics as well as their ability to support a wide array of voltages and currents. MOVs have been a widely accepted and popular overvoltage protector for many years. However, with the growth of electronic devices used in harsh and uncontrolled environments, MOVs are being exposed more often to transient events that can cause degradation and premature catastrophic failure of the component.

**DEGRADATION AND FAILURE of MOVs**

Degradation and catastrophic failure can occur if an MOV is subjected to transient surges or temporary overvoltage (TOV) conditions exceeding its rated maximum values. The life of an MOV is defined as the time required to reach a thermal runaway condition, which is a catastrophic failure mode resulting in either a short circuit, open circuit or some residual linear resistance. In some cases, the MOV can become a fire hazard requiring the need for additional fusing or thermal cutoff components.

Events such as lightning surges or switching transients exceeding an MOV’s current ratings can begin to decrease its varistor voltage, resulting in increased standby/off-state leakage and watt loss heating. Additionally, increased system voltage swells (TOVs) applied for durations longer than microseconds can lead to physical and chemical changes within the multiple grain boundaries of the MOV. With decreased varistor voltage, increased leakage and compromised ability to dissipate heat caused by these events, the MOV is more likely to enter into a thermal runaway condition, thus ending the MOV’s operational life.

**BOURNS® GMOV™ COMPONENT DESIGN**

Bourns designed its innovative GMOV™ hybrid overvoltage surge protection components as a way to provide enhanced performance and reliability compared to standard MOV components. Engineers combined Bourns® innovative and space-saving Gas Discharge Tube (GDT) with FLAT® technology with an MOV to create a compact and robust hybrid component that is size and footprint compatible with standard 14 mm and 20 mm MOVs.

A GMOV™ component functions when the GDT isolates the MOV from the circuit until such time as the voltage exceeds the turn-on voltage of the GDT. This isolation prevents the MOV from being damaged and prematurely failing from temporary overvoltage conditions below the turn-on voltage of the GDT.

**HOW IT WORKS**

In this series configuration, the MOV and GDT components are capacitively coupled. Under low frequency conditions, the voltage limiting of the GMOV™ component would be equal to the sum of the voltage limiting of the individual MOV and GDT components.

Under a high-rate voltage ramp condition, the situation is different. When exposed to a high-rate voltage ramp similar to what is experienced during a lightning or switching transient event, most of the voltage ramp appears across the GDT first, due to its relatively low capacitance compared to the MOV. When the GDT sparks over, it then charges the MOV capacitor and it begins to clamp and conduct. When in full conduction, the combined voltage limiting of the pair will be approximately the MOV clamping voltage. During full conduction, the MOV resistance is still sufficient enough to limit the follow-on current to the GDT allowing for turn-off and reset of the GMOV™ component.
Metal Oxide Varistors are widely used across many markets and applications. Currently, designers use discrete circuit protection devices in multiple configurations to address threats from unstable electrical service. Whereas discrete solutions have not necessarily been proven in real world situations, the GMOV™ hybrid overvoltage protector solution has been tested, evaluated and shown to be effective against many of the threats it will experience in the field.

Bourns® GMOV™ hybrid overvoltage protectors can be utilized in all the major market verticals such as industrial, consumer, medical (low/medium risk)* and communications. Examples of uses for GMOV™ components include Surge Protective Devices (SPDs), surge strips, white goods, chargers, solar power, medical electronics (low/medium risk)*, and data line over power applications. In general, almost any application that is powered by AC or DC can utilize a GMOV™ component for overvoltage protection.

The table above compares several different protection options available for a hypothetical 120 Vrms application. In summary, the standard 130 V MOV solution provides the least effective overall performance when comparing clamping voltage, leakage, aging characteristics and responses to temporary overvoltages (TOV). In some cases, a higher voltage 275 V MOV can be used to help mitigate leakage and aging issues. Leakage and aging performance is improved by selecting a varistor voltage that is far above the peak system voltage. However, a temporary overvoltage condition could still result in excess leakage and some damage to the MOV. The big disadvantage of this solution is the higher let-through voltage of the 275 V MOV as compared to the 130 V MOV solution.

The third example illustrates how a thermally protected 130 V MOV component provides similar performance as the standard 130 Vrms rated MOV but with an integrated thermally activated fuse that disconnects the MOV from the AC line during a catastrophic failure event. The thermally fused option assumes the MOV will fail but in a safer mode than the failure of a standard MOV. In contrast to the first three options is the Bourns® GMOV™ component. The GMOV™ solution provides similar clamping voltage as compared to the 130 V rated MOV and a superior level as the 275 V MOV. The GMOV™ design isolates the MOV from AC line voltage, resulting in excellent leakage and aging characteristics while at the same time achieving a higher level of tolerance against damage from temporary overvoltages.

MARKET OVERVIEW

Metal Oxide Varistors are widely used across many markets and applications. Currently, designers use discrete circuit protection devices in multiple configurations to address threats from unstable electrical service. Whereas discrete solutions have not necessarily been proven in real world situations, the GMOV™ hybrid overvoltage protector solution has been tested, evaluated and shown to be effective against many of the threats it will experience in the field.

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* Bourns® products have not been designed for and are not intended for use in "lifesaving," "life-critical" or "life-sustaining" applications nor any other applications where failure or malfunction of the Bourns® product may result in personal injury or death. See Legal Disclaimer Notice http://www.bourns.com/docs/legal/disclaimer.pdf.
WHY A GMOV™ COMPONENT SOLUTION IS SUPERIOR

By combining two technologies, the Bourns® GMOV™ component effectively eliminates leakage and most damage due to watt loss heating, resulting in a protection solution with zero standby energy consumption. The effect of no leakage significantly increases the MTBF (Mean Time Between Failures) for the MOV.

Damage due to temporary overvoltage is mitigated by selecting a GMOV™ component with a Maximum Continuous Operating Voltage rating (MCOV) higher than any expected voltage swells. In this case, the GDT isolates the MOV from the circuit until such time that the voltage exceeds the turn-on voltage of the GDT. This isolation reduces the likelihood that the MOV will be damaged and prematurely fail.

The GMOV™ component also protects against conditions that cause some designs to use a thermally protected MOV (TMOV). The function of the thermal protection is to provide a fail open condition that would remove the component from the circuit and allow for a safe failure of the component under a thermal runaway condition.

The GMOV™ component is a long life, reliable protection solution that provides a higher level of performance and safety compared to standard MOVs. The Bourns® GMOV™ components are ideal in AC applications where conditions are less than predictable or uncontrolled.

FEATURES

- Hybrid design using Bourns' patented FLAT® technology
- Standard 14 mm & 20 mm sizes
- Matched GDT-MOV pairings
- UL 1449 4th edition Type-5 component

BENEFITS

Performance
- Zero standby energy consumption
- Lower capacitance
- GDT isolates the MOV from AC/DC line voltages below GDT turn-on voltage
- Low leakage over life (<0.1 µA)

Optimal Design
- Compact form factor
- Drop-in replacement for standard 14 and 20 mm MOV

Safety & Testing
- Trips arc fault detectors in voltage swell situations
- Predictable EOL mode will consistently blow fuses and trip breakers
- Eliminates need for thermally protected MOV
- Meets UL ring wave requirements
The Bourns® GMOV™ component protection characteristics are defined by Front Level Protection (Vfp) and Clamping Voltage Level (Vc). Vfp is measured with 10% of peak current in accordance with IEC 61051-1. It should be noted that Vfp is a very short duration event, lasting less than 0.3 µs. Vc occurs after the GMOV™ component has transitioned into its fully on-state.

**KEY CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Size</th>
<th>MCOV Ratings</th>
<th>Leakage at MCOV</th>
<th>Max. Capacitance</th>
<th>Imax 8/20 µs</th>
<th>Ring Wave 200 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 mm version</td>
<td>45 - 320 Vrms</td>
<td>&lt;0.1 µA</td>
<td>4 pF</td>
<td>6 kA</td>
<td>±250 operations</td>
</tr>
<tr>
<td>20 mm version</td>
<td>45 - 320 Vrms</td>
<td>&lt;0.1 µA</td>
<td>4 pF</td>
<td>10 kA</td>
<td>±250 operations</td>
</tr>
</tbody>
</table>

**PROTECTION CHARACTERISTICS**

The Vfp represents the short time it takes for the GDT to turn on. Vc is defined as the clamping voltage level of the GMOV™ component which is the total of the MOV clamping voltage and the on-state arc voltage of the GDT.
**FEATURES**
- Hybrid design
- Low leakage
- Bidirectional protection
- UL 1449 Listed, Type 5
- Footprint compatible with standard 14 mm MOV
- RoHS compliant**

**APPLICATIONS**
- AC Line Protection:
  - White goods
  - Power line communications
  - Smoke alarm systems
  - High value consumer goods
  - UL1449 SPD
- DC Line Protection:
  - Solar inverters
  - Power supplies
  - Distribution systems

**ELECTRICAL CHARACTERISTICS @ 25 °C**

| Bourns Part No. | Operating Protection | | | | | | |
|----------------|----------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Vrms | Vdc | \(A_{rms}\) | 1 MHz | clamp | Current Class (1) | Protection Level | Clamp Transition Time | Energy (8/20 μs) |
| | | | | | | | | |
| GMOV-14D450K | 45 | 56 | < 1 | 4 | 3,000 | 6,000 | ± 250 | 900 | 150 | 0.3 | 24 |
| GMOV-14D500K | 50 | 65 | < 1 | 4 | 3,000 | 6,000 | ± 250 | 800 | 185 | 0.3 | 33 |
| GMOV-14D650K | 65 | 85 | < 1 | 4 | 3,000 | 6,000 | ± 250 | 800 | 320 | 0.3 | 53 |
| GMOV-14D950K | 95 | 125 | < 1 | 4 | 3,000 | 6,000 | ± 250 | 800 | 360 | 0.3 | 70 |
| GMOV-14D111K | 115 | 150 | < 1 | 4 | 3,000 | 6,000 | ± 250 | 950 | 380 | 0.3 | 78 |
| GMOV-14D131K | 130 | 170 | < 1 | 4 | 3,000 | 6,000 | ± 250 | 950 | 420 | 0.3 | 84 |
| GMOV-14D141K | 140 | 180 | < 1 | 4 | 3,000 | 6,000 | ± 250 | 950 | 470 | 0.3 | 99 |
| GMOV-14D151K | 150 | 200 | < 1 | 4 | 3,000 | 6,000 | ± 250 | 1,300 | 620 | 0.3 | 130 |
| GMOV-14D171K | 175 | 225 | < 1 | 4 | 3,000 | 6,000 | ± 250 | 1,300 | 675 | 0.3 | 140 |
| GMOV-14D231K | 230 | 300 | < 1 | 4 | 3,000 | 6,000 | ± 250 | 1,300 | 730 | 0.3 | 155 |
| GMOV-14D251K | 250 | 320 | < 1 | 4 | 3,000 | 6,000 | ± 250 | 1,300 | 800 | 0.3 | 175 |
| GMOV-14D271K | 275 | 350 | < 1 | 4 | 3,000 | 6,000 | ± 250 | 1,300 | 875 | 0.3 | 180 |

**HOW TO ORDER**

**Model Designator**
GMOV™ = GDT/MOV Hybrid Protection Component

**Disc Diameter**
14D = 14 mm
20D = 20 mm

**RMS Voltage**
S = See Electrical Characteristics Table

**Multiplier of Voltage Digits**
0 = No multiplier
1 = nn times 10

**MOV Disc Voltage Tolerance**
K = 10%

**Packaging**
Blank = Bulk
TR (upon request)

*excluding life-critical, life-saving and life-sustaining applications.*

20 mm GMOV™ Hybrid Overvoltage Protector Product Information

FEATURES
- Hybrid design
- Low leakage
- Bidirectional protection
- Low capacitance
- UL 1449 Listed, Type 5
- Footprint compatible with standard 20 mm MOV
- RoHS compliant**

APPLICATIONS
AC Line Protection:
- White goods
- Power line communications
- Smoke alarm systems
- High value consumer goods
- UL1449 SPD

DC Line Protection:
- Solar inverters
- Power supplies
- Distribution systems

ELECTRICAL CHARACTERISTICS @ 25 °C

<table>
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<tr>
<th>Bourns Part No.</th>
<th>Operating</th>
<th>Protection</th>
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<tbody>
<tr>
<td></td>
<td>Max. Continuous Operating Voltage (MOCV)</td>
<td>Max. Leakage @ MOCV</td>
</tr>
<tr>
<td>V_{rms}</td>
<td>V</td>
<td>μA</td>
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<td>GMOV-20D450K</td>
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<tr>
<td>GMOV-20D321K</td>
<td>320</td>
<td>415</td>
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GMOV - 14D nn (n) K - TR

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## Worldwide Sales Offices

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<tr>
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<th>Email</th>
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<tbody>
<tr>
<td>Americas:</td>
<td>+1-951-781-5500</td>
<td><a href="mailto:americus@bourns.com">americus@bourns.com</a></td>
</tr>
<tr>
<td>Brazil:</td>
<td>+55 11 5505 0601</td>
<td><a href="mailto:americus@bourns.com">americus@bourns.com</a></td>
</tr>
<tr>
<td>China:</td>
<td>+86 21 64821250</td>
<td><a href="mailto:asiacus@bourns.com">asiacus@bourns.com</a></td>
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<tr>
<td>Europe, Middle East, Africa:</td>
<td>+36 88 885 877</td>
<td><a href="mailto:eurocus@bourns.com">eurocus@bourns.com</a></td>
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<tr>
<td>Japan:</td>
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<td><a href="mailto:asiacus@bourns.com">asiacus@bourns.com</a></td>
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<tr>
<td>Korea:</td>
<td>+82 70 4036 7730</td>
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<tr>
<td>Singapore:</td>
<td>+65 6348 7227</td>
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<tr>
<td>Taiwan:</td>
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<td>Other Asia-Pacific Countries:</td>
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Bourns® products are available through an extensive network of manufacturer's representatives, agents and distributors. To obtain technical applications assistance, a quotation, or to place an order, contact a Bourns representative in your area.

Specifications subject to change without notice. Actual performance in specific customer applications may differ due to the influence of other variables. Customers should verify actual component performance in their specific applications.