Bourns® GMOV™

HYBRID OVERVOLTAGE PROTECTION COMPONENT

BOURNS®

GMOV™ Hybrid Overvoltage Protection Component Introduction

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 a 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

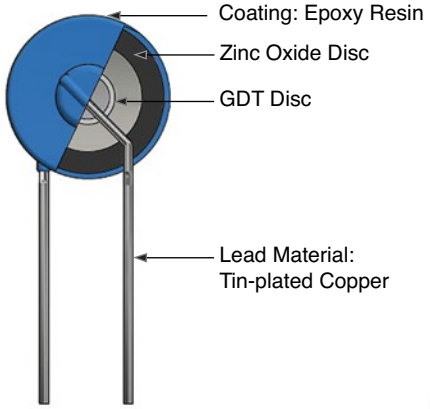
Degradation and catastrophic failure can occur if an MOV is subjected to transient surges or temporary overvoltage (TOV) conditions exceeding its rated maximum values. The life of an MOV is defined as the time required to reach a thermal runaway condition, which is a catastrophic failure mode resulting 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.

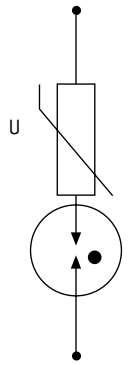
BOURNS® GMOV™ COMPONENT DESIGN

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.

CONSTRUCTION



CIRCUIT DIAGRAM



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.

BOURNS® GMOV™ COMPONENT vs. STANDARD MOV

Technology	Clamping Voltage	Leakage Current	Aging	30 % Voltage Swell Response
130 V MOV	340	Poor	Poor	Possible Fire
275 V MOV	710	Good	Good	Increased Leakage
130 V MOV + TF	340	Poor	Poor	Possible Fire
GDT + MOV	~360	Excellent	Excellent	Excellent

The table above compares several different protection options available for a hypothetical 120 V_{rms} 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 V_{rms} 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.

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.

* 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.

GMOV™ Hybrid Overvoltage Protector Overview

WHY A GMOV™ COMPONENT SOLUTION IS SUPERIOR

By combining two technologies, the Bourns® GMOV™ component effectively elminates 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

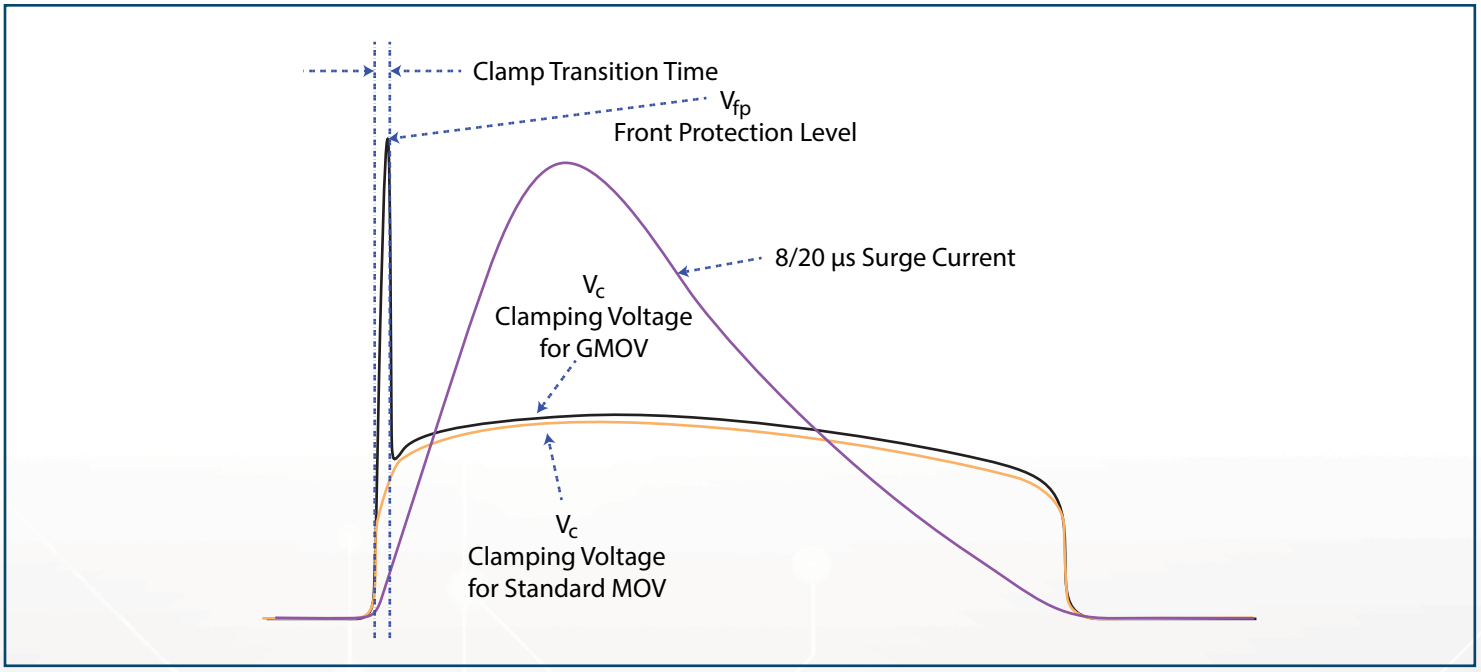
Safety & Testing

- 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

KEY CHARACTERISTICS

Size	MCOV Ratings	Leakage at MCOV	Max. Capacitance	Imax 8/20 µs	Ring Wave 200 A
14 mm version	45 - 320 Vrms	<0.1 µA	4 pF	6 kA	±250 operations
20 mm version	45 - 320 Vrms	<0.1 µA	4 pF	10 kA	±250 operations

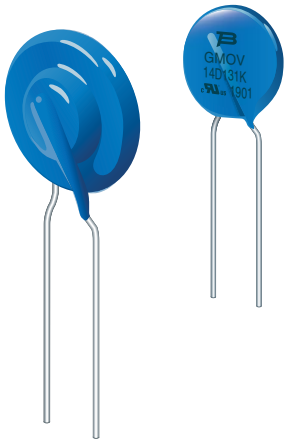
PROTECTION CHARACTERISTICS



The Bourns® GMOV™ component protection characteristics are defined by Front Level Protection (V_{fp}) and Clamping Voltage Level (V_c). V_{fp} is measured with 10 % of peak current in accordance with IEC 61051-1. It should be noted that V_{fp} is a very short duration event, lasting less than 0.3 µs.

The V_{fp} represents the short time it takes for the GDT to turn on. V_c 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. V_c occurs after the GMOV™ component has transitioned into is its fully on-state.

14 mm GMOV™ Hybrid Overvoltage Protector Product Information



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						
	Max. Continuous Operating Voltage (MCOV)		Max. Leakage @ MCOV	Max. Capacitance	I_{nom} UL 1449/4th.	I_{max}	Ring Wave Surge IEEE 62.41	Protection Level Current Class (1) IEC 61051-1		Clamp Transition Time	Energy
	V_{rms}	V_{dc}	A_{rms}	1 MHz	15 Ops.	1 Op.	200 A	Max.	Typ.		8/20 µs
	V	V	µA	pF	A	A	Ops.	V_{fp}	V_c	µs	J
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	150	0.3	27
GMOV-14D650K	65	85	< 1	4	3,000	6,000	± 250	800	185	0.3	33
GMOV-14D950K	95	125	< 1	4	3,000	6,000	± 250	800	270	0.3	53
GMOV-14D111K	115	150	< 1	4	3,000	6,000	± 250	800	320	0.3	60
GMOV-14D131K	130	170	< 1	4	3,000	6,000	± 250	800	360	0.3	70
GMOV-14D141K	140	180	< 1	4	3,000	6,000	± 250	950	380	0.3	78
GMOV-14D151K	150	200	< 1	4	3,000	6,000	± 250	950	420	0.3	84
GMOV-14D171K	175	225	< 1	4	3,000	6,000	± 250	950	470	0.3	99
GMOV-14D231K	230	300	< 1	4	3,000	6,000	± 250	1,300	620	0.3	130
GMOV-14D251K	250	320	< 1	4	3,000	6,000	± 250	1,300	675	0.3	140
GMOV-14D271K	275	350	< 1	4	3,000	6,000	± 250	1,300	730	0.3	155
GMOV-14D301K	300	385	< 1	4	3,000	6,000	± 250	1,300	800	0.3	175
GMOV-14D321K	320	415	< 1	4	3,000	6,000	± 250	1,300	875	0.3	180

HOW TO ORDER

GMOV - 14D nn (n) K - TR

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 applicationss.

**RoHS Directive 2015/863, Mar 31, 2015 and Annex.

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

Bourns Part No.	Operating				Protection						
	Max. Continuous Operating Voltage (MCOV)		Max. Leakage @ MCOV	Max. Capacitance	I_{nom} UL 1449/4th.	I_{max}	Ring Wave Surge IEEE 62.41	Protection Level Current Class (1) IEC 61051-1		Clamp Transition Time	Energy
	V_{rms}	V_{dc}	A_{rms}	1 MHz	15 Ops.	1 Op.	200 A	Max.	Typ.		8/20 µs
	V	V	µA	pF	A	A	Ops.	V_{fp}	V_c	µs	J
GMOV-20D450K	45	56	< 1	4	5,000	10,000	± 250	950	150	0.3	49
GMOV-20D500K	50	65	< 1	4	5,000	10,000	± 250	900	150	0.3	56
GMOV-20D650K	65	85	< 1	4	5,000	10,000	± 250	900	185	0.3	70
GMOV-20D950K	95	125	< 1	4	5,000	10,000	± 250	900	270	0.3	106
GMOV-20D111K	115	150	< 1	4	5,000	10,000	± 250	950	320	0.3	130
GMOV-20D131K	130	170	< 1	4	5,000	10,000	± 250	950	360	0.3	140
GMOV-20D141K	140	180	< 1	4	5,000	10,000	± 250	950	380	0.3	155
GMOV-20D151K	150	200	< 1	4	5,000	10,000	± 250	950	420	0.3	168
GMOV-20D171K	175	225	< 1	4	5,000	10,000	± 250	950	470	0.3	190
GMOV-20D231K	230	300	< 1	4	5,000	10,000	± 250	1,300	620	0.3	255
GMOV-20D251K	250	320	< 1	4	5,000	10,000	± 250	1,300	675	0.3	275
GMOV-20D271K	275	350	< 1	4	5,000	10,000	± 250	1,300	730	0.3	305
GMOV-20D301K	300	385	< 1	4	5,000	10,000	± 250	1,300	800	0.3	350
GMOV-20D321K	320	415	< 1	4	5,000	10,000	± 250	1,300	875	0.3	360

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Packaging
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TR (upon request)

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

**RoHS Directive 2015/863, Mar 31, 2015 and Annex.

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