

TPMOV[®] CONSTRUCTION AND OPERATION

SURGE PROTECTION NOTE 3

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INTRODUCTION

Mersen's Thermal Protected Metal Oxide Varistor (TPMOV) technology helps improve safety of surge protection devices (SPDs). Before the TPMOV was released and several changes to industry standards (UL 1449), SPDs would often fail catastrophically. This tech topic will discuss the history, construction, and operation of the TPMOV.

1. HISTORY:

Historically, Metal Oxide Varistor (MOV) based SPDs provided superior protection against surges. However, MOVs were also known for catastrophic failure under certain conditions. In 2001, Mersen changed this notion with the introduction of the TPMOV product line. The TPMOV is a Thermally Protected MOV that disconnects the MOV from its circuit before catastrophic failure occurs.

Underwriters Laboratories (UL) had updated UL 1449 in February 2005 and September 2006 to Second Edition Revision and Third Edition respectively. These UL changes included more rigorous safety testing. Many SPD manufacturers struggled to pass the more stringent testing requirements. TPMOV passed these new requirements immediately including Third Edition's new 20kA Nominal Discharge Current (I_n) testing. Consequently, TPMOV offered a safe robust solution to a historical industry problem.

2. CONSTRUCTION:

MOVs are the most common overvoltage technology. Performance is directly dependent on its size. A larger diameter will result in a larger surge current rating. A thicker MOV will have a higher voltage rating. TPMOV uses 34mm square MOVs that provide a 50kA surge rating per TPMOV. Smaller diameter MOVs would need to have multiple in parallel to achieve the same rating. Such smaller MOVs generally have current sharing problems due to minor manufacturing deviations. The larger TPMOV eliminates these current sharing problems.

TERMS

- **TPMOV:** Thermally Protected Metal Oxide Varistor
- **SPD:** Surge Protective Device
- **MOV:** Metal Oxide Varistor
- **UL:** Underwriters Laboratories
- **Nominal Discharge Current:** The amount of current surges an SPD can withstand 15 times and remain functional

The TPMOV is an elegant yet simple design with a minimal amount of parts. The “pop-contact” in the TPMOV is soldered to the face of the MOV using a solder preform. The solder preform ensures that the correct amount of solder is always used. A template is used to position the preform correctly on the MOV face. The soldering process is automated, with many constantly monitored parameters and a rigorous set of quality controls. This proprietary soldering process is key to the TPMOV’s performance and repeatability.

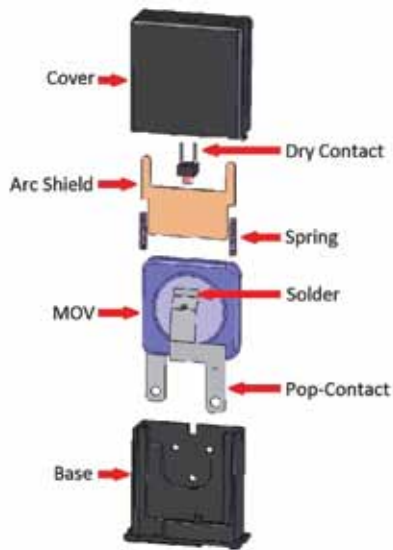


Figure 1: TPMOV construction

A spring-loaded arc shield is used to prevent any theoretical re-strikes from occurring. The arc shield is actuated by two springs and held in place by the “pop-contact” solder joint. The springs are selected, and tested, so that a single spring can operate the arc shield correctly. The two springs provide redundancy.

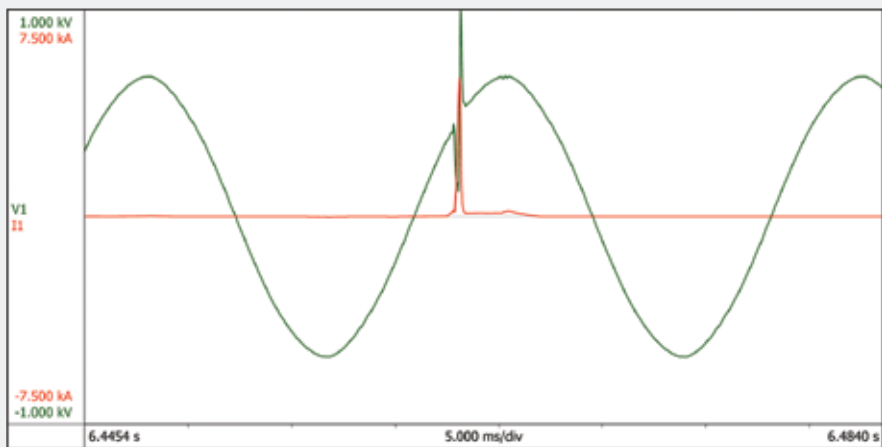
The arc shield provides two types of indication. The first is a visual indication and the second is remote indication. Visual indication occurs when the arc shield has actuated and the ends stick out of the top case. When this happens the arc shield also trips a dry set of contacts to provide remote indication.

All of these components are housed in a thermoplastic polyester resin base. This material is flame retardant and recognized as UL 94 V-0. The

base and cover design tolerances ensure correct operation of all components inside. The use of epoxy potting compound is not recommended as it may result in improper TPMOV operation. Epoxy is typically used to contain an MOV failure and protect other system components. The TPMOV is self protected and therefore has no need for epoxy.

3. TRADITIONAL MOV AND FUSE OPERATION

MOVs are very effective at limiting over-voltages. However when they reach end of life, they can approach a short circuit and overheat. In most simplistic terms, an instantaneously overheating MOV can explode. A ‘slowly’ overheating MOV could catch fire in a thermal runaway scenario. As a result, some MOVs are typically incased in epoxy to minimize damage to other components. Others employ a thermal link intended to disconnect low current MOV faults based on temperature. Also a current-limiting fuse is typically used to disconnect the MOV from the circuit. The published characteristics of current-limiting fuses apply to 60Hz or DC applications and therefore do not apply to surge applications. The fuse must be sized properly to pass rated surge current and only operate in the event of a MOV failure. If the fuse tries to operate on a surge, it may not be able to pass the surge’s energy and could explode.



320V 35mm MOV with VSP10 480 VAC 100 kA PF; 14.5%	
Vpk	998.25V
TVpk	3.6326 s
MT	0 s
Ipk	5.02366 kA
TIpk	3.6326 s
CT	3.6367 s
IIT	3.532 kA ² s
EIT	3.455 kWs
MIT	10.49µA ² s
PwrPk	3.758 MW

Figure 2: 34mm 320V MOV in series with a VSP10-2 tested at 480VAC 100kA

TPMOV® CONSTRUCTION AND OPERATION

In the above configuration, the fuse opens only after the MOV has drawn sufficient 50/60Hz fault current. Often, the MOV has ruptured which generates a current spike. A fuse operates by rapidly heating up and melting its element, producing an arc (internal to the fuse) which is then quenched by the sand filler. During the arcing time, the voltage drop across the fuse is typically around 1200V for a 600V rated fuse (wire element fuses can produce a higher arc voltage). Because the MOV has failed, the full arc voltage is imposed on the circuit it is meant to protect. Figure 2 shows a standard 34mm 320V MOV in series with a VSPI0 fuse, the MOV ruptured causing a spike in current (5kA) which the fuse opens on which causes a voltage spike of 1000V.

SPDs that use multiple, but separate, components as described above (MOV, thermal link and fuse) may inadvertently fall victim to ‘tolerance stacking.’ Each component has its own production tolerances. However, the combined ‘stacking’ of tolerances could result in improper surge current sharing and affect the SPD’s overall performance.

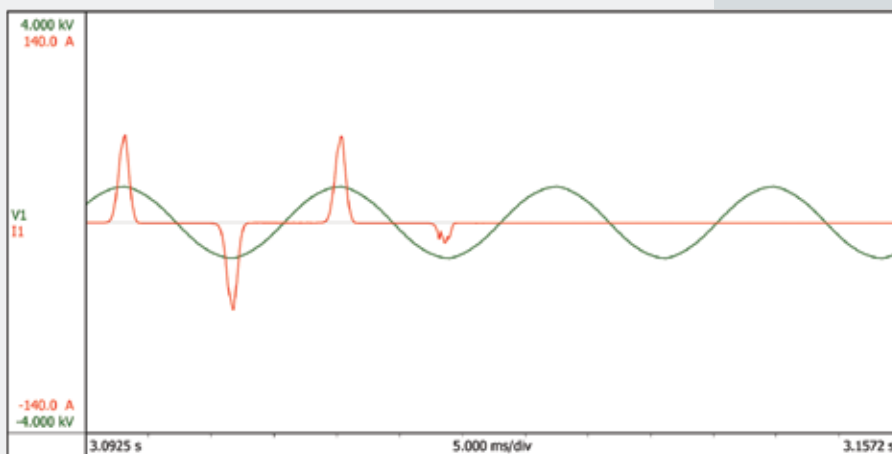
4. TPMOV OPERATION

Traditional MOVs are great devices for limiting the amount of overvoltage delivered to sensitive components. However as they reach end of life and approach a short circuit condition they overheat and present safety a concern.

As a TPMOV nears end of life, its MOV begins to heat the solder joint. The solder joint melts and the “pop-contact” pulls away. The arc shield is then driven upwards to prevent re-strikes. This works across the entire fault current spectrum. Visual and remote indication then signals that the TPMOV needs to be replaced and/or its host SPD requires attention. Figure 3 shows a 320TPMOV opening the maximum current flowing is 140A and there is no voltage spike above the MOV clamping voltage of 680V.

TPMOVs proven design and construction methods have been providing overvoltage protection since its launch in 2001. The innovative design allows the MOV to disconnect itself when it reaches end of life and has immediately passed all new safety standards. Contact Mersen Technical Services at technicalservices.nby@mersen.com for additional information on our TPMOV and SPD product offerings.

Figure 3: 320TPMOV test at 480VAC 100kA



320TPMOV	
480 VAC 100 kA PF; 14.5%	
Vpk	681.11V
TVpk	1.8357 s
MT	0 s
Ipk	138.316A
Ttpk	0.0079 s
CT	0.3015 s
IIT	126.4A ² s
EIT	1.618 kW
MIT	114.2 nA ² s
PwrPk	92.90 kW

SURGE PROTECTION PRODUCTS FROM MERSEN

TPMOV

Mersen's patented TPMOV (Thermally Protected Metal Oxide Varistor) eliminates common destructive failure modes associated with standard MOVs. Comprised of a voltage clamping device and a disconnecting apparatus that monitors the status of the metal oxide disk inside the TPMOV, the device is securely disconnected in the event of an overvoltage by an arc shield. Upon failure, the TPMOV is also equipped with a visual pin indicator as well as a normally open microswitch providing remote indication, if applicable.



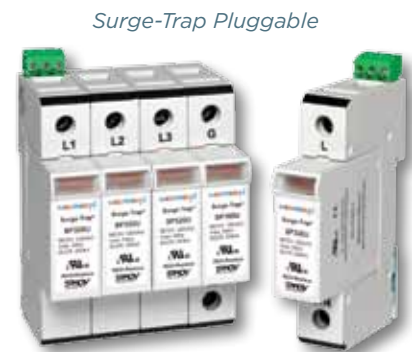
TPMOV



Surge-Trap Modular

Surge-Trap® Pluggable and Surge-Trap Modular

Surge-Trap Pluggable and Surge-Trap Modular Surge Protective Devices are no-fuse, fail-safe surge suppressors featuring Mersen's patented TMOV technology inside. The pluggable and modular SPDs are UL 1449 3rd Edition approved. They are DIN-rail mountable featuring a fail safe, self-protected design, visual indicator, and a small footprint. A remote indicator option provides status to critical control circuits. Surge-Trap Pluggable and Surge-Trap Modular SPDs have a high short circuit rating and a thermally protected MOV, which eliminates the need for additional overcurrent protection devices. For more information regarding Mersen's surge protection products, visit: ep-us.mersen.com/surge-trap.



Surge-Trap Pluggable

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ADDITIONAL RESOURCES

Surge Protection Note 1: Introduction to Specifying Surge Protection

Surge Protection Note 2: Surge-Trap® and the Different kA Ratings

These and other Tech Topics are available on ep.mersen.com.