



THOR SYSTEMS, INC.

SURGE APPS SA-010: HYBRID DESIGN
(Guidelines and application tools to promote improved Power Quality)

HYBRID DESIGNS ENHANCE SURGE PROTECTION

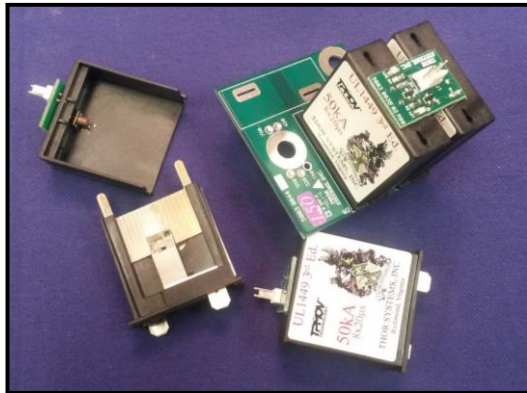
THOR SYSTEMS has always been a firm believer in the use of Hybrid Designs for the optimum in surge protection. By combining the three elements detailed below into an integrated Hybrid system, THOR SYSTEMS is able to offer surge suppression systems that provide effective performance on any transient event. From high energy lightning strikes to high frequency noise from capacitive switching, our Hybrid Suppression system addresses the anomaly and protects sensitive electrical and electronic equipment.

Ref. Standards:

UL 1449 4th Ed.
UL 1283 5th Ed.
C62.41.1: 2002 IEEE
C62.41.2: 2002 IEEE
C62.45: 2002 IEEE
C62.62: 2010 IEEE
C62.72: 2007 IEEE
NEMA
NEC 2014
NFPA 70
FIPS 94
MIL-STD 220A

METAL OXIDE VARISTOR

The foundation of THOR SYSTEMS' surge protection design is the Thermally Protected MOV (Metal Oxide Varistor).

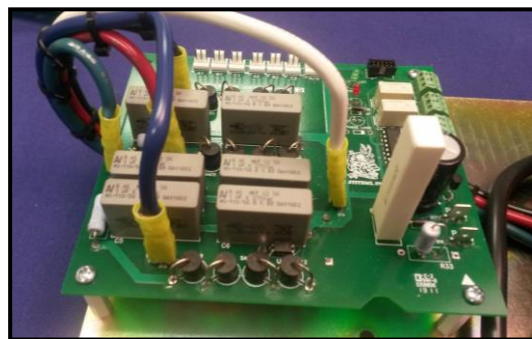


Thermally Protected MOV (TpMOV)

MOVs have long been the basis of surge suppression systems providing high current handling capability and fast response to transient events with little degradation over time. Adding the thermal protection to the MOVs (TpMOV) maximizes the safety of internal protection in the event of exposure to extended overvoltage conditions.

TVS DIODE

TVS Diodes (commonly called SADs – Silicon Avalanche Diodes) are often called the most ideal transient suppression device. It has the sharpest knee and the lowest (or closest to nominal) clamping voltage of any clamping or diverting technology. It also has the fastest response to transient events and virtually no degradation over time.



TVS Diode (SAD) & Filter Capacitor

FILTER CAPACITOR

The final element of THOR SYSTEMS' hybrid design is the filter capacitor. Specifically added to attenuate electromagnetic and radio frequency interference (EMI/RFI) or "electrical noise," filter capacitors act on high frequency events that fall below the voltage diversion levels of TpMOVs and TVS Diodes. These events are typically created by the starting or stopping of inductive or capacitive elements – motors, power factor correction capacitors, transformers, etc.

DESIGN PHILOSOPHY

THOR SYSTEMS decided early in the design phase that the fast rising edge of a transient event that exists *before* the conduction of the TpMOV needed to be addressed. Beginning the suppression within the first nanosecond of the event, limits the rise time of the leading edge of the transient. This fast rising edge is often when the most significant damages occur in a transient event.



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Designing the TVS diode and TpMOV to work in conjunction with each other, creates an effective suppression platform that addresses the fast rising edge of the transient. TVS diodes are limited in their current handling capabilities and, while described as the most ideal transient suppression device, they may not be the most economical transient suppression device. THOR SYSTEMS went through extensive design and testing routines to develop a hybrid package using the benefits of both the TVS diode and TpMOV technologies.

By tuning the suppression waveforms of the TVS diode and TpMOV to work together the combined platform is able to maximize the fast reaction of the TVS diodes along the high energy handling capability of the TpMOVs. This combination has been proven effective in extending the longevity of a standard TpMOV. This benefit, although difficult to capture and detail graphically, was verified through extensive testing using two standard 34mm MOVs in parallel with a TVS diode array. The 34mm MOV manufacturer estimated the life expectancy of the MOV to be approximately 6000, C3 10,000 amp 8/20 impulses. With the addition of the TVS diode array, the MOVs survived in excess of 21,000 (10,000 amp 8/20 μ s) impulses.

Finally, THOR SYSTEMS added the filter capacitors to provide protection for events that occur below the conduction point of the TpMOV/TVS diode array. This protection is referred to by many names from various suppression system manufacturers – sine wave tracking, noise attenuation, capacitive filtering, etc. – to effectively attenuate events initiated by energizing/de-energizing motors, transformers, capacitor banks and other reactive based equipment. Whatever name is used, the industry standard for filter attenuation is MIL STD 220A and THOR SYSTEMS offers filter capacitor networks with attenuation levels in excess of 50dB to address those occurrences.



Complete Hybrid System

We would like to become an information resource for your surge protection applications. THOR SYSTEMS offers products and services that provide protection from the more *obvious external* to the more *frequent internal* transient voltage sources.

Ref. Documents:

SA-001	Why THOR SYSTEMS SPDs
SA-002	Bottom Feed SPDs
SA-004	Site Risk Assessment/Sizing SPD
SA-005	Modular vs. Non-modular
AG-09	Features/Benefits
TSI 092	Case Study/Mfg.

Our consistent focus on improved product performance and increased value to the customer is conveyed by our products' transparent cover enclosures, showcasing the TILE Architecture, Innovative Design Configurations, and per Mode Status Indication.

Should you have any questions, please feel free to contact us (804.355.1100) or visit our Web site, www.ThorSystems.us.