

Agenda

- 1449 3rd Overview
- Differences from 2nd Edition to 3rd Edition
- Designing for 3rd Edition
- Littelfuse Surge Protection Devices

UL1449 Standard Overview

UL1449 is the primary safety standard for Surge Protective Devices*, or “SPDs”

Nearly all North American surge standards now reference the UL1449 3rd edition

UL1449 Design Considerations:

For SPDs used for the protection of AC electrical circuits and designed for repeated limiting of transient voltage surges

Refers to 50/60Hz power circuits not exceeding 1000V

* Referred in previous UL1449 editions as TVSS or Transient Voltage Surge Suppressors).

UL1449 Standard Overview

- UL 1449 3rd edition supersedes preceding editions.
 - From September 2009 on, all SPD equipment brought onto the market must satisfy these new requirements in order to qualify for the UL mark.
 - There is no specific UL standards for MOV's- UL1449 is often the most relevant, so most MOV's are qualified under this standard.
 - UL writes most standards with an annex for referenced surge standards ; UL1449 is typically the default standard for AC side surge requirements.

Differences from 2nd Edition to 3rd Edition

- **Terminology change** from TVSS (transient voltage surge suppressor) to SPD (surge protection device)
- **Added “Type” designations**
 - Type 1,2, and 3 for SPD’s based on installation location within the electrical system
 - Type 4 and 5 for component assemblies and discrete components such as MOVs
- **Testing Revised:**
 - Measured Limiting Voltage; Suppressed Voltage Rating (SVR) now called Voltage Protection Rating (VPR), and is tested at 6kV/3kA
 - Includes Nominal Discharge Current (In),

How does an SPD work?

SPD Design Goals:

- Divert as much of the transient away from the load as possible
- Redirect transient through a low impedance path (suppressor) to ground

Surge Suppression Components:

- **Metal Oxide Varistors (MOVs)**
 - Reliable components used in an SPD to reduce high energy transient voltages.
- **Silicon Avalanche Diodes (SADs) and GDT devices** –
 - Frequently used as data line or communication surge protectors

2nd Edition to 3rd Edition Changes: Application Type Designations

UL 1449 2 nd Edition	UL 1449 3 rd Edition
<p>Permanently Connected (PC)</p> <p>Direct Plug-In (DPI)</p> <p>Cord Connected (CC)</p>	<p>Type 1 – Permanently Connected (PC) between Service Transformer and Line Side</p>
	<p>Type 2 – Permanently Connected on load side of Service Disconnect</p>
	<p>Type 3 – Point of Use; Minimum 10 meters from Service Panel</p>
	<p>Type 4 – Component Assemblies for SPD or other non-SPD applications such as appliances</p>
	<p>Type 5 – Discrete Components for SPD or other non-SPD applications such as appliances</p>

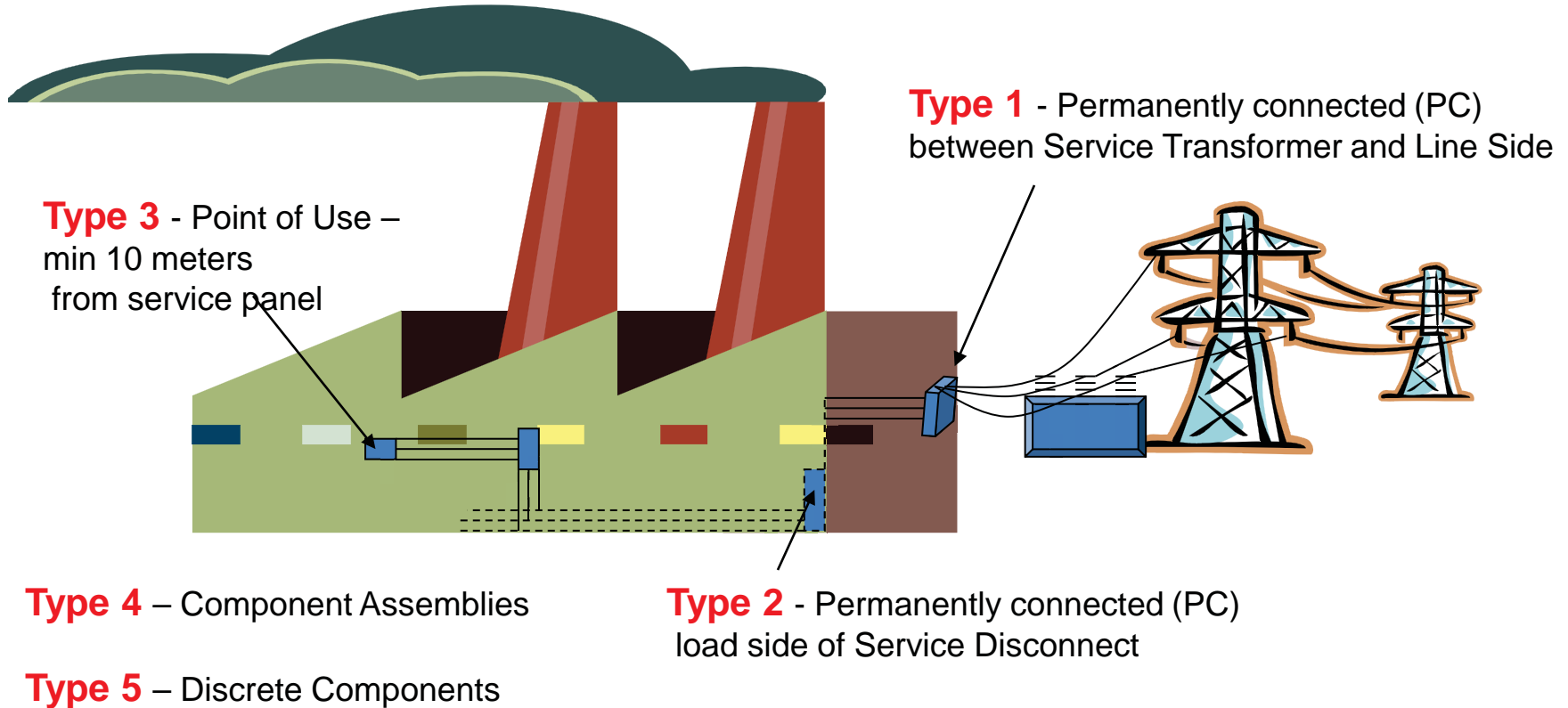
2nd Edition to 3rd Edition Changes: Testing Revisions

UL 1449 2 nd Edition	UL 1449 3 rd Edition																																												
<p>Section 34 – Measured Limit Voltage test Transient Voltage Surge</p> <table border="1"> <thead> <tr> <th></th> <th>kV</th> <th>kA</th> </tr> </thead> <tbody> <tr> <td>PC</td> <td>6</td> <td>0.5</td> </tr> <tr> <td>CC/DPI</td> <td>6</td> <td>0.5</td> </tr> </tbody> </table> <p>Duty Cycle 20 Pulses</p> <table border="1"> <thead> <tr> <th></th> <th>kV</th> <th>kA</th> </tr> </thead> <tbody> <tr> <td>PC</td> <td>6</td> <td>5</td> </tr> <tr> <td>CC/DPI</td> <td>6</td> <td>3</td> </tr> </tbody> </table>		kV	kA	PC	6	0.5	CC/DPI	6	0.5		kV	kA	PC	6	5	CC/DPI	6	3	<p>Section 37 – Surge Testing VPR – Voltage Protection Rating (3 Pulses)</p> <table border="1"> <thead> <tr> <th>Type 1, 2, 3</th> <th>kV</th> <th>kA</th> </tr> </thead> <tbody> <tr> <td></td> <td>6</td> <td>3</td> </tr> </tbody> </table> <p>Nominal Discharge Current (In) (15 Pulses)</p> <table border="1"> <thead> <tr> <th>In</th> <th>Type 1 (PC)</th> <th>kV</th> <th>kA</th> </tr> </thead> <tbody> <tr> <td>In</td> <td>Type 1 (PC)</td> <td>6</td> <td>10, 20</td> </tr> <tr> <td>In</td> <td>Type 2 (PC)</td> <td>6</td> <td>3, 5, 10, 20</td> </tr> <tr> <td>Duty Cycle</td> <td>Type 3 (CC/DPI)</td> <td>6</td> <td>3</td> </tr> <tr> <td></td> <td>Other</td> <td>?</td> <td>?</td> </tr> </tbody> </table>	Type 1, 2, 3	kV	kA		6	3	In	Type 1 (PC)	kV	kA	In	Type 1 (PC)	6	10, 20	In	Type 2 (PC)	6	3, 5, 10, 20	Duty Cycle	Type 3 (CC/DPI)	6	3		Other	?	?
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Explanation of UL1449 3rd Application Types



Explanation of Application Types: Type 1 Devices

Permanently Connected SPDs intended for installation **between secondary of the service transformer and the line side** of the service equipment overcurrent device, as well as the load side, including watt-hour meter socket enclosures and intended to be installed without an external overcurrent protective device.



Explanation of Application Types: Type 2 Devices

Permanently Connected SPDs intended for installation **on the load side of the service equipment** overcurrent device; including SPDs located at the branch panel.

Devices belonging to type 2 include automatic circuit breakers, hand dryers, motors as well as power supplies.



Explanation of Application Types: Type 3 Devices

Point of Use SPDs, installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel to the point of utilization, for example cord connected, direct plug-in, receptacle type and SPDs installed at the utilization equipment being protected. See marking in 64.2. The distance (10 meters) is exclusive of conductors provided with or used to attach SPDs.



Explanation of Application Types: Type 4 Devices

Component Assemblies consisting of one or more Type 5 components together with a disconnect (integral or external) or a means of complying with the limited current tests in 39.4.

These may include component assemblies such as an MOV with thermally integrated element (i.e. TMOV)



Explanation of Application Types: Type 5 Devices

Discrete Components, such as MOVs, that may be mounted on a PWB, connected by its leads or provided within an enclosure with mounting means and wiring terminations. Type 4 and 5 are subsystems comprising several components or discrete components that are tested in accordance with its end application environment (Types 1, 2, 3, or other non-SPD applications such as appliances).



UL1449 Design Considerations

Short-Circuit Conditions 39.2 -.3	Abnormal Over-voltage Limited Current 39.4	Surge Testing 37 Voltage Protection Rating – VPR – In
Prevent exploding components exiting enclosure	Prevent fire exiting enclosure	Low VPR means more protection of end application
Rugged enclosure	Higher rated MOV /Components	Select Low rated MOV/Components
Back fill enclosure with Sand / Epoxy	Add discrete Thermal Responsive device next to each MOV	Use SAD [Silicon Avalanche Diodes] TVS (Transient Voltage Suppressor) Diodes
Add fusing to MOVs	Build their own Thermal Disconnect arrangement	Combination of SAD or GDT with an MOV
	Rugged Enclosure	
	Back fill enclosure with Sand / Epoxy	

UL1449 Design Considerations

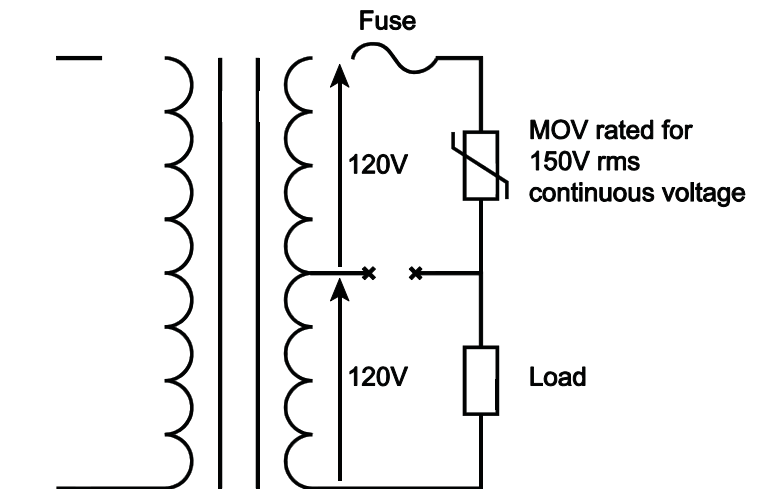
- Rugged enclosures are expensive as is back filling with sand or epoxy.
- Conflict between high voltage vs lower voltage MOVs:
 - High voltage MOV for abnormal over-voltage tests [eliminate the risk of MOV failure] but to obtain a Low VPR [module marketing requirements] a lower rated MOV is required. Customer choice as to which is more important.
- Fusing addresses the high short-circuit current situations, but does not address limited current, abnormal over-voltage conditions.
- A thermal responsive device, such as a TCO, in association with the MOV can be used, but increases component count, reduces available real-estate, and poses some assembly difficulties
- TMOV[®] thermally protected varistor focuses on abnormal over-voltage limited current tests - **These are not TCO (Thermal Cut-Off) replacements and therefore do not act as load OC protection**

UL1449 Design Considerations

Example:

Abnormal Over-voltage, Limited Current Condition and MOV's

- In AC line applications, the loss of a Neutral-Ground connection may occur in such a way that there exists a risk that a sustained over-voltage may be applied to a MOV that is rated for a much lower continuous voltage.
- In such a condition, the MOV will first fail to a low impedance and may often rupture.
- HOWEVER, if there are loads tied to the AC line that limit current flow, the MOV can overheat and potentially cause the SPD device to overheat, resulting in smoke, out-gassing, and eventually fire.



Possible fault condition for a limited current abnormal overvoltage event

UL1449 Design Considerations: Surge Suppression Components

Metal Oxide Varistors (MOVs)

- Reliable components used in an SPD to reduce high energy transient voltages.
- Under normal conditions the MOV is a high impedance component.
- When subjected to a voltage surge, the MOV will quickly become a low impedance path to divert surges away from loads.
- In AC power applications, over 85% of SPDs use Metal Oxide Varistors (MOVs) because of their high-energy capability and reliable clamping performance.

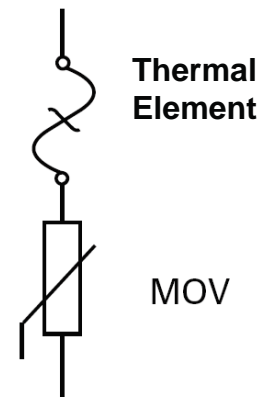
UL1449 Design Considerations: Surge Suppression Components

Silicon Avalanche Diodes (SAD) and GDTs

- Frequently used as data line or communication surge protectors
- Typically SAD devices are not recommended for use in high exposure AC applications due to their limited energy capabilities
- GDT devices are used less frequently due to the slow reaction time and are generally found in DC applications.

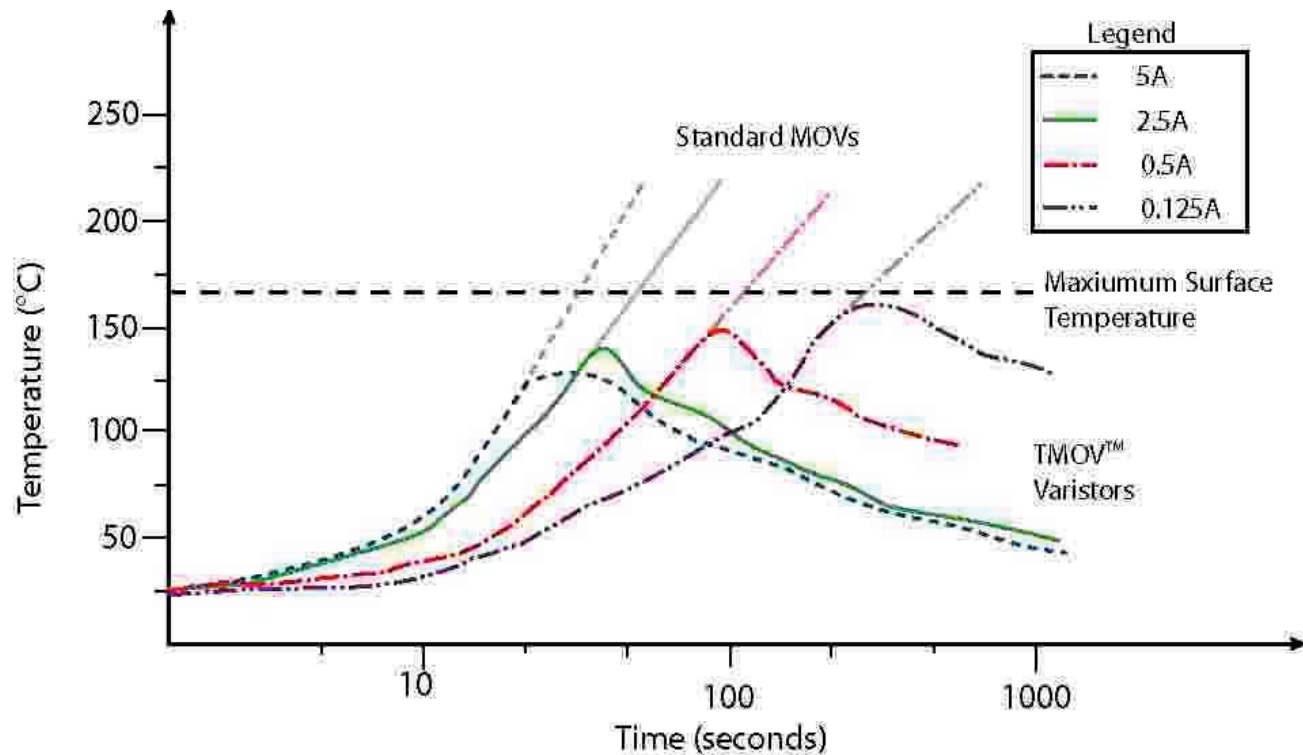
Littelfuse TMOV[®] and iTMOV[®] Thermally Protected Varistors

- TMOV[®] and iTMOV[®] devices are metal oxide varistors with an integrated thermally- activated element
- The device will automatically open-circuit, when overheating occurs due to abnormal sustained over-voltages
- The integrated thermal activation element means it will not flame, fragment or scorch when subjected to an abnormal over-voltage condition. Standard MOV's are susceptible to thermal events.
- **TMOV14 and TMOV20 device series are UL1449 3rd edition approved (UL file #E320116)**



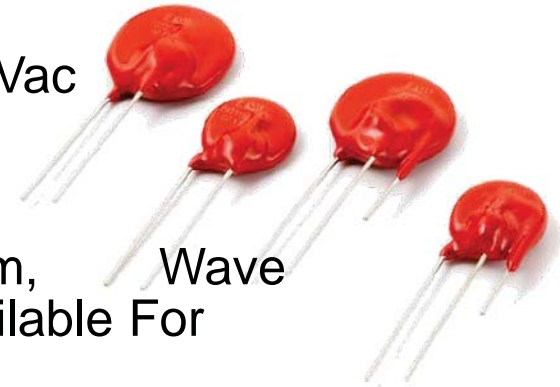
Littelfuse TMOV[®] and iTMOV[®] Thermally Protected Varistors

- Typical TMOV[®] and iTMOV[®] thermally protected varistors surface temperature of encapsulant during UL Limited Current Abnormal over-voltage test



Littelfuse TMOV[®] and iTMOV[®] Thermally Protected Varistors

- **Standard Operating Voltage Range:** 115V to 750Vac
- 6000A to 10000A at Peak Current $8 \times 20\mu\text{s}$
- **Energy Absorption Capacity** up to 480J
- Produced in radial lead package sizes of 14, 20 mm, solderable, Low Leakage, Three-Lead Version Available For Indication Purposes
- **Applications:**
 - SPD Products
 - AC Line Power Supplies
 - AC Power Meters
 - GFCI
 - White Goods
 - Inverters
 - AC Panel Protection Modules
 - Surge Protected Strip Connectors
 - Relocatable AC Power Tapes
 - UPS
 - Plug-in SPD
 - AC/DC Power Supplies
- **TMOV14 and TMOV20 device series are UL1449 3rd edition approved (UL file #E320116)**



Varistor Configurations For Higher Power Applications:

Littelfuse TMOV25S and TMOV34S are currently pending UL1449 3rd approval. For the interim, consider these alternatives

- TMOV25S Substitute:
 - Connect two TMOV20* in parallel
 - Connect an UltraMOV25 with a TCO** in series
- TMOV34S Substitute:
 - Connect a MOV34 with a TCO** in series

* TMOV14 and TMOV20 devices are UL1449 3rd edition approved

** Ensure that the TCO (thermal cutoff device) selected meets the surge requirement of the application, and be sure to test and verify the configuration before final manufacturing.

If you have questions about TMOV25S and TMOV34S UL1449 status, or if design help is needed with alternate options please contact your local Littelfuse product representative

<http://www.littelfuse.com/contact-us.html>

Thank you!

For more information including a complete list of Littelfuse UL1449 recognized devices please visit

<http://www.littelfuse.com/design/technical-resources/education-ul1449.html>

For information about our complete line of varistor products please visit

<http://www.littelfuse.com/varistors.html>

Visit <http://www.littelfuse.com/contact-us.html> to find technical support personnel in your area.