Another EMC resource
from EMC Standards

Suppressing Surge Transients

Helping you solve your EMC problems

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12. Suppressing transients

6

Protecting and maintaining Surge Protection Components (SPCs), and related safety issues

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Protecting and maintaining SPCs

- Some faults in mains networks can cause RMS voltages to nearly double, for a few seconds…
  - and 'power cross' tests apply 120/230V a.c. for several minutes onto telecommunications cables…
  - but SPCs are transient-rated (in Joules, not Watts) so can't handle much power for long

- To prevent damage or fire in such situations, fit SPCs with current-limiting or overcurrent-protection components…
  - and we must also fit them because SPCs wear-out and fail over time

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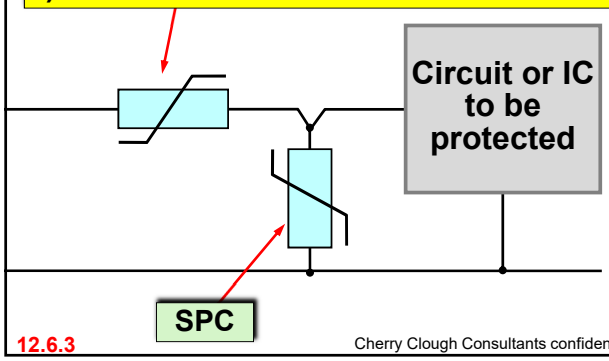
Combining SPCs with resistors, PTCs, or fuses to protect from long-term overvoltage or SPC failure

a) High voltage surge/pulse rated resistor (preferably a 'fusible resistor' that open-circuits if overloaded without catching fire), *or*…

b) PTC (Positive Temperature Coefficient Thermistor) sometimes called a resettable fuse, *or*…

c) Fuse or circuit-breaker



Thermally Protected Metal Oxide Varistor (TpMOV) "Fail-Safe Device"

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Overcurrent protection

- Fuses, circuit-breakers and PTCs...
  - all take some time to operate…
    - so cannot suppress fast current pulses
- Series inductors or chokes can be used to limit the rate of rise or fall of transient current...
  - their time-constant is L/R…
    - R is the circuit's resistance (in Ω), L is its inductance (in Henries)...
    - e.g. in a mains circuit with a resistance of 1Ω, a 1mH series inductor would force a transient current to have a rise-time no shorter than 1ms

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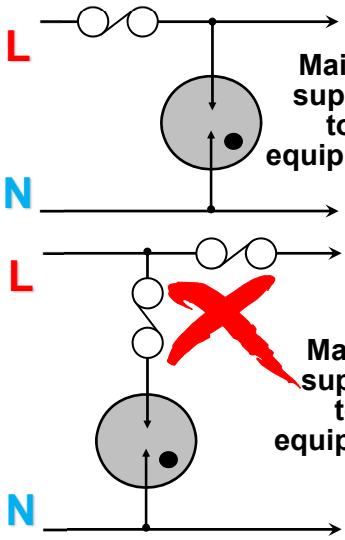
Fusing and maintaining SPCs

(GDTs shown, could be SCR or MOV types instead)
(Fuses shown, could be circuit-breakers or PTCs instead)



The normal method

Short-circuit failure of SPC opens fuse and equipment is unpowered

Repair discovers failed SPC

A *bad* method, sometimes wrongly used for critical equipment

If SPC fuse opens the equipment *might* keep operating, but *is not protected against next overvoltage*

It is best to use the 'normal method' (above) and add a UPS (or other method) to keep equipment operating

But see slide 12.6.11!

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Fusing and maintaining SPCs continued...

- **Careful co-ordination of fuse and SPC ratings…**
  - **allows SPCs to carry kA overcurrents without opening their fuses…**
    - **usually requires using 'time-delay' types of fuses (known as 'slow-blow' in the USA)**
- **Some types of equipment might need a planned maintenance routine to check their SPCs…**
  - **to be sure of replacing worn-out SPCs before their protection is completely lost**

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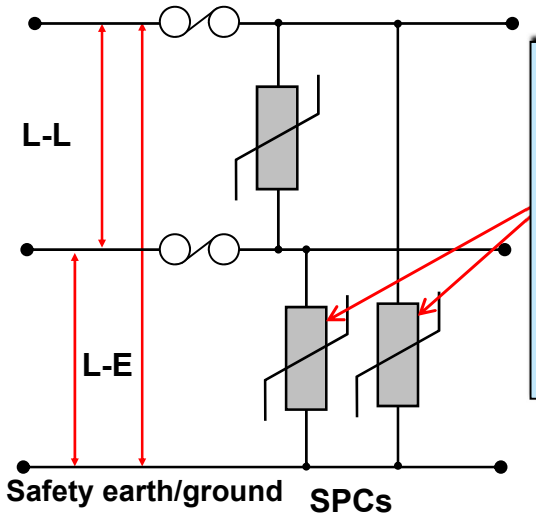
Safety of MOVs used on the AC mains (1)



Line-to-earth/ground MOVs can cause high levels of earth leakage currents when they fail, possibly causing shocks if the protective earth/ground is faulty

For safety reasons these are only permitted for permanently-wired 'fixed' equipment

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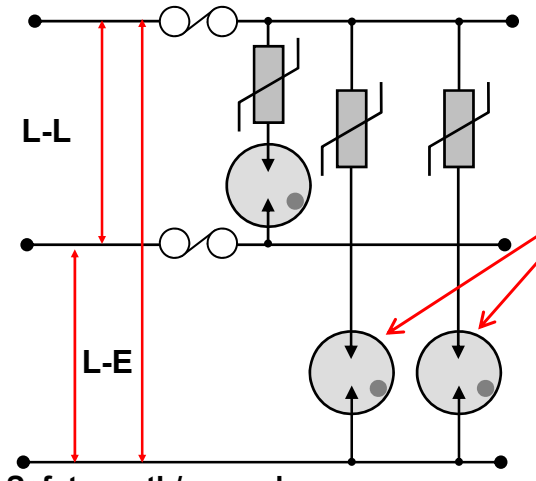
Combining a GDT with a MOV

isolates the MOV from the AC line (except for the larger surge transients that must be suppressed), helping the MOV to last longer



Some safety standards (e.g. IEC 60950-1:2013) permit *suitably-rated* Line-to-earth/ground MOVs in series with *suitably-rated* GDTs

But only under specified conditions!

See: "New Requirements for MOVs Used for Surge Suppression on AC Mains Ports", Joseph Randolph, InCompliance 2019 Annual Reference Guide:
www.incompliancemag.com/magazine/past-issues/

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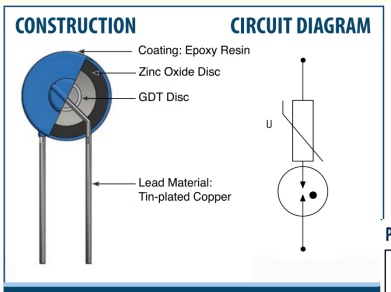
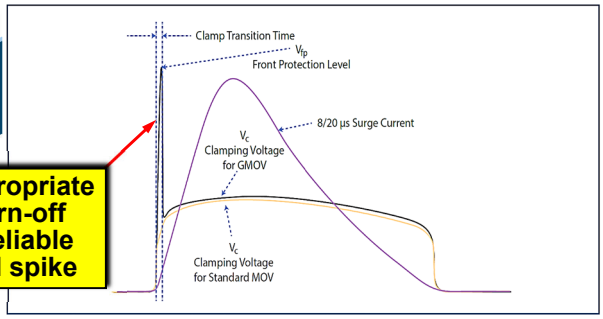
Example of GDT combined with MOV in one package



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.

PROTECTION CHARACTERISTICS



The series combination of appropriate GDT & MOV ensures GDT turn-off after the surge plus a more reliable MOV, for the price of an initial spike

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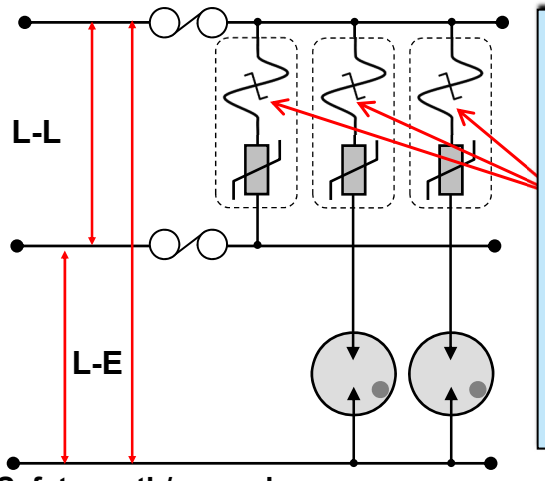
Safety of MOVs used on the AC mains (3)



IEC 60950-1 and some other safety standards will soon be replaced by IEC 62368-1:2018

– and they permit the use of Thermally-Protected MOVs (TP-MOVs)

But only under specified conditions different from before!

See "New Requirements for MOVs Used for Surge Suppression on AC Mains Ports"

And see the next two slides too!

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Safety of MOVs used on the AC mains (4)

- **Manufacturers have a variety of ways of creating the thermal fuses in their TP-MOVs…**
  - **which they call by a variety of commercial names, (e.g. Littelfuse call them TMOVs)…**
  - **e.g. meltable solder links, 'thermostat' switches, etc…**
  - **which are never resettable, once a TP-fuse is blown – its TP-MOV is scrap**
- **Some manufacturers provide a third terminal for monitoring the condition of the TP-fuse…**
  - **e.g. Littelfuse's iTMOV range**

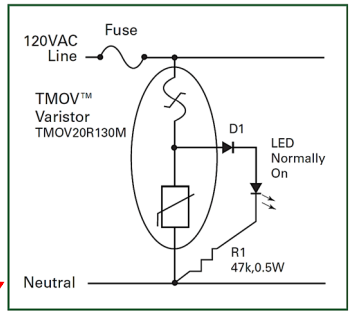

Figure 8. Indicator circuit using the iTMOV varistor (LED normally on)

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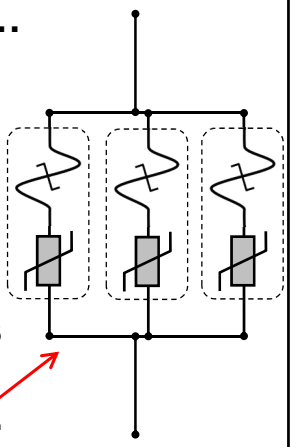
Safety of MOVs used on the AC mains (5)

- **IEC 62368-1:2018 apparently doesn't believe designers can select fuses correctly…**
  - **but perhaps it is concerned that users could replace them with the wrong type**
  - **but using TP-MOVs risks causing damage to the product when their fuses remove their surge protection,** ***see slide 12.6.5 for details***
- **One good solution when using MOVs is to replace each TP-MOV with a number of them in parallel, like this…**



  - **with failure monitoring to alert the user (or supplier via text or the IoT) when any TP-MOV becomes open-circuit**

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Safety of MOVs used on the AC mains (6)

- **Not using *any* Line-to-Earth/Ground SPCs should usually cost less, and use less board space…**
  - **by specifying the mains isolating transformer to have a higher-rated primary-secondary withstand voltage…**
    - **e.g. "New Requirements for MOVs Used for Surge Suppression on AC Mains Ports", in: www.incompliancemag.com/magazine/past-issues/ suggests 10kV peak surge withstand…**
    - **which probably only requires the usual 3kV AC RMS voltage withstand specification to be increased by a little**
- **And ordinary MOVs *can always be used*…**
  - ***as long as* their fire enclosure can handle burning / exploding SPCs *and* pass all of the safety tests**