MOV and PPTC Devices Enable IEC 61000-4-5 Compliance

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Coordinating overcurrent and overvoltage protection at the ac mains input can help designers comply with safety agency requirements, minimize component count and cost, and improve equipment reliability. Overcurrent and overvoltage protection are frequently viewed as two unrelated elements of the circuit protection design process, often resulting in costly multicomponent solutions.

A cost-effective, coordinated circuit protection strategy—using a polymeric positive temperature coefficient (PPTC) overcurrent protection device and a metal oxide varistor (MOV) overvoltage protection device—can help designers meet IEC Standard IEC 61000-4-5 "Electromagnetic Compatibility; Testing and Measurement Techniques—Surge Immunity Test" for ac mains applications.

Large voltage or power transients on the ac mains inputs caused by lightning strikes or power station load-switching transients may damage electrical equipment and create safety hazards. IEC 61000-4-5, the global standard for voltage and current test conditions for equipment connected to ac mains, specifies voltage and current surge waveforms for five installation classes of equipment as follows:

- Class 1 Partly Protected Electrical Environment—surge may not exceed 500 V.
- Class 2 Electrical Environment—where the cables are well separated, even at short distances; surge may not exceed 1 kV.
- Class 3 Electrical Environment—where power and signal cables run in parallel; surge may not exceed 2 kV.
- Class 4 Electrical Environment—where the interconnections are running as outdoor cables along with power cables, and cables are used for both electronic and electric circuits; surge may not exceed 4 kV.
- Class 5 Electrical Environment—for electronic equipment connected to overhead power lines in a nondensely populated area without a widespread earthing system; surge may not exceed 4 kV.

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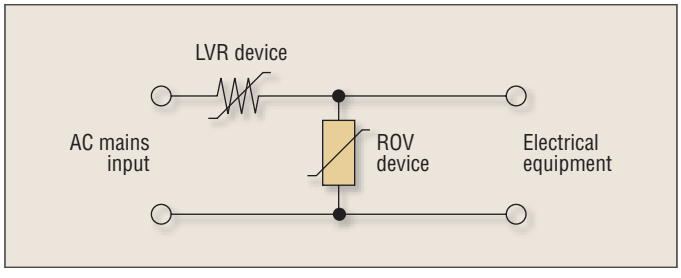
Equipment for ac mains applications is tested for surge immunity using a combination wave having a voltage waveform with 1.2-µs rise time and 50-µs fall time, and a current waveform with 8-µs rise time and 20-µs fall time for all installation classes. Different rise and fall times exist for some telecom and datacom applications, but all ac mains applications are tested to the combination wave described previously. The **table** defines the test conditions for each class.

The **figure** illustrates how Raychem Circuit Protection's radial-leaded metal oxide varistor (ROV) series MOV is used in combination with the LVR series of PolySwitch devices to improve equipment reliability in the harsh ac environment and help fulfill the IEC-61000 test requirements.

The ROV device's high current handling and energy-absorption capability, fast response and low cost make it



Coordinated overvoltage and overcurrent protection on an ac mains circuit is achieved with a circuit having one dedicated component for each event type.

Installation class	Power-suppply coupling mode	
	Line to line	Line to earth
0	N/A	N/A
1	N/A	0.5
2	0.5	1.0
3	1.0	2.0
4	2.0	4.0
5	*	*

*Depends on the class of the local power-supply system. The surges (and test generators) related to the different classes are: 1.2/50-µs open circuit (8/20-µs short circuit) for classes 1 to 5.

Installation conditions define IEC 61000-4-5 test levels.

suitable for overvoltage protection in power supplies, surge strips, control-board transformers and electric motors. The LVR overcurrent protection device is also rated at 240 Vac, permitting maximum voltages of up to 265 Vac, and can be installed with the ROV device in the ac mains input lines.

Unlike a single-shot current fuse, the resettable LVR device helps protect against conditions where faults may cause a rise in temperature with only a slight increase in current draw. When installed on the primary side of the circuit, in proximity to potential heat-generating components such as magnetics, FETs or power resistors, the LVR device helps provide both overcurrent and overtemperature protection with a single installed component.

Certain mains overload conditions may cause the ROV device to remain clamped and conducting current, eventually resulting in overtemperature failure of the ROV. While not directly applicable to passing IEC 61000-4-5 tests, placing the LVR device in close thermal proximity to the ROV device can help protect the ROV device in extended overload conditions by transferring heat to the LVR device. This causes the LVR device to trip faster, limiting the current through the ROV device.

This application of the LVR device allows designers to leverage the temperature response of the LVR and replace other thermal protection devices in the circuit. Not only does the LVR perform dual functions in this case, it also provides a fully resettable solution. Because the device resets after the fault is cleared and power to the circuit is removed, no maintenance or replacement are required. This helps reduce warranty and service costs and improves end-user satisfaction.

The LVR and ROV devices chosen for a particular application depend on the IEC 61000-4-5 class rating for the equipment as well as the operating conditions of the equipment itself. When selecting an LVR device, the primary consideration is to match the hold current rating of the LVR device to the primary current drawn by the electrical equipment under normal operating conditions. **PETech**