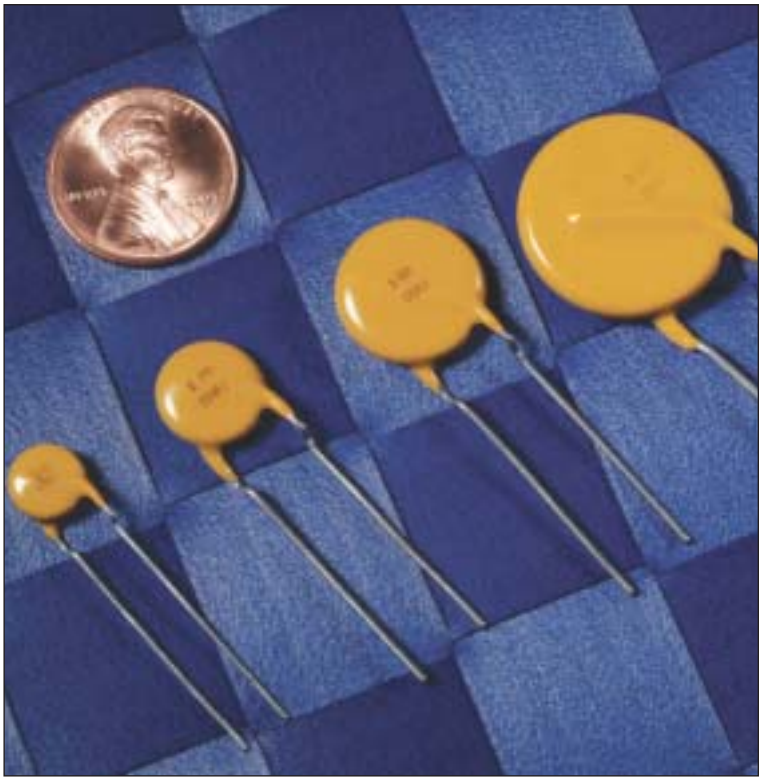
LVR and ROV Devices Help Designers Meet IEC 61000-4-5 Requirements for AC Mains Applications

Application Note

Design engineers are continuously challenged to increase the reliability of their products and ensure survivability under harsh environmental conditions. Electrical equipment can be put at risk from large voltage or power transients on the AC Mains inputs due to lightning strikes or power station load switching transients. IEC 61000-4-5 is the global standard for voltage and current test conditions for equipment connected to AC Mains.

Combining overcurrent and overvoltage protection at the AC Mains input can allow engineers to help meet their circuit protection requirements while minimizing component count and cost. Tyco Electronics now provides AC Line voltage rated PolySwitch devices and Metal Oxide Varistor (ROV) products to help meet these circuit protection needs.

This application note will provide information to help design engineers meet IEC Standard IEC 61000-4-5, "Electromagnetic Compatibility; Testing and Measurement Techniques – Surge Immunity Test" for AC Mains applications



The Problem

Overcurrent and overvoltage protection are often considered as two separate elements during the design process. As a result, protection strategies can result in multiple component solutions that can be costly. Additionally, synergies between protection devices can be overlooked as overvoltage and overcurrent protection are often viewed as completely unrelated conditions. With PolySwitch LVR devices and Raychem Metal Oxide Varistors (ROV), Raychem Circuit Protection offers designers a complete solution that helps enhance product protection and reliability.

IEC 61000-4-5 Test Conditions

The standard specifies voltage and current surge waveforms for five installation classes of equipment. An overview of the classes is as follows:

Class 1 – Partly Protected Electrical Environment, surge may not exceed 500V.

Class 2 – Electrical Environment, where the cables are well separated, even at short distances, surge may not exceed 1kV.

Class 3 – Electrical Environment, where power and signal cables run in parallel, surge may not exceed 2kV.

Class 4 – Electrical Environment, where the interconnections are running as outdoor cables along with power cables, and cables

Table 1. Selection of Test Levels (Depending Upon Installation Conditions)

Test Levels		
Installation class	Power Supply Coupling mode	
	Line to Line kV	LIne to Earth kV
0	NA	NA
1	NA	0.5
2	0.5	1.0
3	1.0	2.0
4	2.0	4.0
5	[1]	[1]

[1] Depends on the class of the local power supply system.
The surges (and test generators) related to the different classes are as in the following:
Class 1 to 5: 1.2/50µs open circuit (8/20µs short circuit)

are used for both electronic and electric circuits, surge may not exceed 4kV.

Class 5 – Electrical Environment, for electronic equipment connected to overhead power lines in a non-densely populated area, without a widespread earthing system, surge may not exceed 4kV.

Equipment for AC Mains applications is tested for surge immunity using a combination wave having a voltage waveform with 1.2usec rise and 50usec fall times and a current waveform having 8usec rise and 20usec fall times for all installation classes. Different rise and fall times exist for some telecom/datacom applications but all AC Mains applications are tested to the combination wave described above. Table 1 defines the test conditions for each class.

The Solution

Circuit Design

Raychem Circuit Protection's PolySwitch LVR overcurrent and ROV overvoltage devices offer a unique solution to help electronic equipment survive the harsh AC Mains environments and pass the tests specified in IEC 61000-4-5. Because the LVR devices are rated for operation up to 265V_{AC}, they can be combined directly with the ROV overvoltage protection devices in the AC Mains input lines. A typical installation is shown in Figure 1.

Layout Considerations

Placement of the LVR and ROV devices is not critical to their performance if there are significant layout constraints and the devices are chosen correctly. However, if the geometry allows, placing the LVR device adjacent to the ROV device can help protect the ROV device in extended overload conditions by transferring heat to the LVR device and causing it to trip faster.

Conditions which would cause any ROV device to remain clamped and conducting current can eventually result in overtemperature failure of the ROV. While not directly applicable to passing IEC 61000-4-5 tests, placing the LVR device in thermal proximity to the ROV device can cause the LVR device to trip faster, limit the current through the ROV and thus helping to protect it in continuous overload conditions. Taping the devices together may be required to achieve sufficient thermal transfer.

Device Selection

The LVR and ROV devices chosen for a particular application will 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 will be to match the hold current rating of the LVR device to the primary current drawn by the electrical equipment under normal operating conditions. The installation class will not affect the selection of an LVR device as all devices are rated to 265V_{AC}. LVR devices are not recommended in applications where they will be operated beyond their maximum ratings. Therefore, when using an LVR device in a Class 5 application, it should be protected by a series resistance or an ROV device in parallel.

Figure 1. Typical AC Mains Protection Circuit

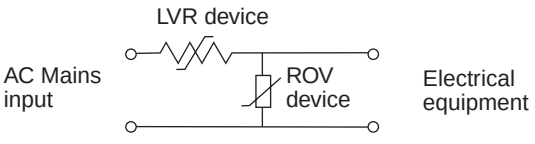


Table 2. LVR and ROV Device Selection Guidelines

IEC 61000-4-5 Installation Class	AC Mains Voltage	ROV Device* Line-to-Line	ROV Device* Line-to-Ground
1	120V	N/A	ROV05H201K
1	240V	N/A	ROV05-391K
2	120V	ROV07-201K	ROV07-201K
2	240V	ROV07-391K	ROV05-391K
3	120V	ROV07H201K	ROV07H201K
3	240V	ROV07H391K	ROV05H391K
4	120V	ROV10H201K	ROV10H201K
4	240V	ROV10H391K	ROV07H391K
5	120V	ROV10H201K	ROV10H201K
5	240V	ROV10H391K	ROV07H391K

* Table 2 presents a guideline. Any part should be thoroughly tested in the application to ensure proper operation before the design is finalized.

When selecting an ROV device, the nominal AC mains voltage rating for the equipment as well as the IEC 61000-4-5 installation class should be considered. The nominal AC Mains voltage will define the ROV device's voltage rating and the installation class will determine the ROV device's diameter.

Table 2 provides a guideline for ROV devices that can help equipment pass the IEC 61000-4-5 testing.