

Integrated Circuit Protection Device Helps Protect Industrial Equipment from Overcurrent, Overtemperature, Overvoltage and ESD Damage

Integrated Circuit Protection Helps Protect Low-Power Systems

Lightning, inductive load switching, or capacitor bank switching may cause transient overvoltage conditions in AC line voltage applications such as white goods and appliances. Metal Oxide Varistors (MOVs) are typically used for transient overvoltage suppression in AC line voltage applications. However, in these applications there also exists the potential for a sustained abnormal overvoltage/limited current condition that may cause the MOV to go into thermal runaway, resulting in overheating or outgassing.

This paper describes new thermally enhanced MOVs that help protect a wide variety of low-power systems against damage caused by overcurrent, overtemperature and overvoltage faults, including lightning strikes, electrostatic discharge (ESD) surges, loss of neutral, incorrect input voltage and power induction.

Helping to Reduce Component Count

Under normal operating conditions the AC line voltage applied to an MOV is not expected to exceed the device's maximum AC root mean voltage (V_{ACRMS}) rating. Provided that the transient energy does not exceed the MOV's maximum rating, short-duration transient events are clamped to a suitable voltage level. However, a sustained abnormal overvoltage/limited current condition, such as a loss of neutral, may cause the MOV to go into thermal runaway.

Protecting the MOV from thermal over-dissipation is frequently accomplished with a Thermal Cut-Off (TCO) device, placed in series with the MOV. A typical line voltage transient protection scheme may also incorporate a thermal protection element, such as a fuse, to protect the system from damage caused by an overcurrent condition that exceeds a predetermined level.

Helping to Prevent Overcurrent Conditions and Thermal Runaway

Littelfuse integrated 2Pro device helps manufacturers meet industry test requirements, reduce component count, and improve equipment reliability. The device combines a Polymeric Positive Temperature Coefficient (PPTC) overcurrent component with an MOV component, resulting in one thermally protected device to help provide resettable current limiting for overcurrent conditions and voltage clamping during overvoltage events.

Standard unprotected MOVs are typically rated to $275V_{ACRMS}$ for a universal input voltage range. In a loss of neutral condition they may overheat with negative consequences, even if a fuse or power resistor is used upstream. In a worst case scenario, as shown in Figure 1, a voltage of $400V_{AC}$ instead of $230V_{AC}$, derived from a loss of neutral, is applied. In such a limited current condition, the unprotected MOV will first fall to low impedance of a few Ohms. However, due to the high amount of energy present, it is likely to rupture. If there are devices placed on the AC line return path to limit current flow these may also overheat due to the failure of the MOV.

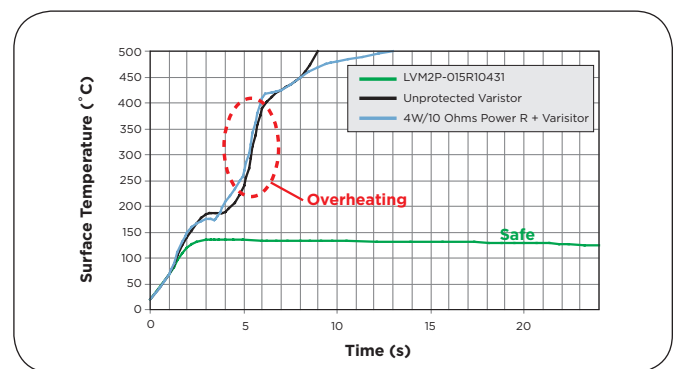


Figure 1. Effect of loss of neutral condition on various devices

Figure 1 illustrates the effects of these abnormal overvoltage conditions on three devices or a combination of devices:

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1. 2Pro LVM2P-015R10431
2. Single MOV (10mm, 275 V_{RMS})
3. MOV/4W Power Resistor (10 ohms)

The 2Pro device's PPTC element helps prevent thermal runaway, maintaining varistor surface temperature at less than 150°C. It also prevents the device from reaching unsafe temperatures caused by overvoltage transients.

This approach helps manufacturers comply with IEC 60950 and IEC 60335 and helps equipment remain operational after specified lightning tests according to IEC 61000-4-5 (Figure 2). Also, because the PPTC element is in series with the MOV, no additional overcurrent protection is required. This reduces component count and optimizes board space.

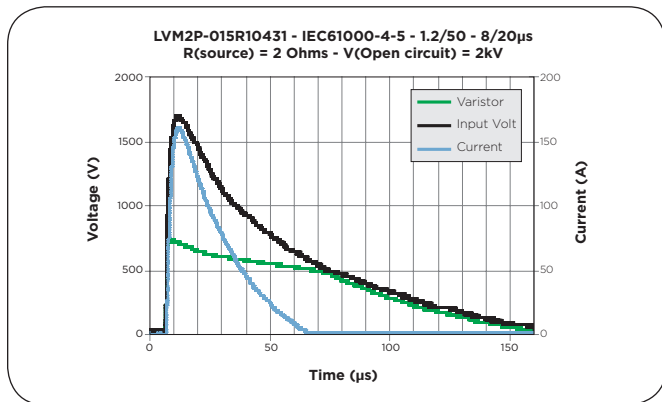


Figure 2. Typical 2Pro LVM2P-015R10431 device response under IEC61000-4-5 surge immunity test

How It Works

Although the AC line voltage applied to an MOV is not generally expected to exceed the device's maximum continuous operating voltage rating, overvoltage transients may occur that exceed these limits. By integrating PPTC technology with the MOV, the 2Pro device improves overcurrent and thermal protection under conditions where the MOV is exposed to prolonged continuous overvoltage events.

In the event of an overvoltage transient, such as a loss of neutral event shown in Figure 3, the PPTC element in the 2Pro device heats up, trips and goes into a high resistance state, helping to reduce the risk of MOV device failure.

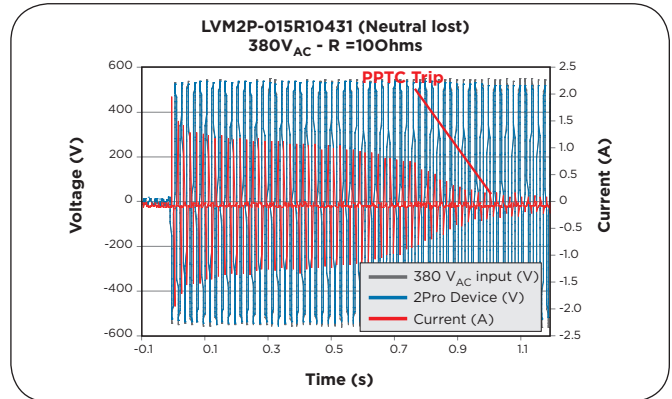


Figure 3. Typical 2Pro LVM2P-015R10431 device response to loss of neutral event.

The LVM2P-015R10431 parts used in the test scenarios described in this article are 10mm radial-leaded devices that utilize three leads. In the circuit diagram, shown in Figure 4, the first lead is connected to the PPTC element, the second lead is connected to the MOV/PPTC series connection (providing a path to ground), and the third lead is connected to the MOV.

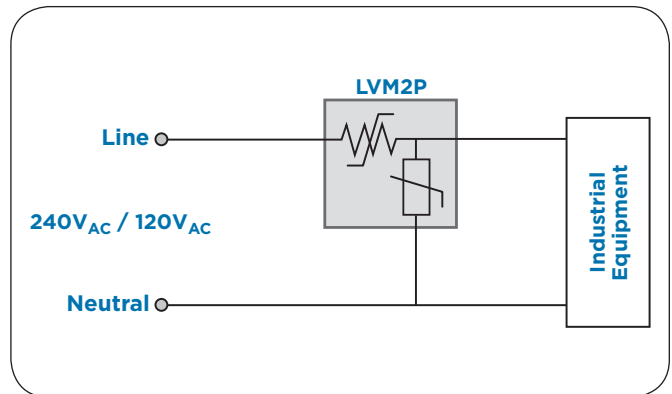


Figure 4. Typical circuit diagram utilizing the 2Pro circuit protection device

The single, small form factor circuit protection device helps reduce component count and footprint size, and helps provide a safe failure mode in case of varistor overstress. It also helps equipment comply with IEC 60950/IEC 60335 and IEC 61000-4-5 testing requirements.

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Bottom Line

Coordinated circuit protection helps reduce board space requirements and component count, and improves equipment reliability. The resettable functionality of the 2Pro device can also help manufacturers reduce warranty returns and customer complaints related to transient overcurrent and overvoltage incidents.

In addition to white goods and appliances, 2Pro devices help provide protection in a wide range of AC line applications, including AC LED lighting systems, PLC network adapters, cell phone chargers, AC/DC power supplies, (up to 30V as input power for 230VAC input voltage), modem power supplies, AC panel protection modules, and AC power meters.

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