How and Why Surge Protected Power Distribution Strips Fail Occassionally

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Picture 1. Open power strip

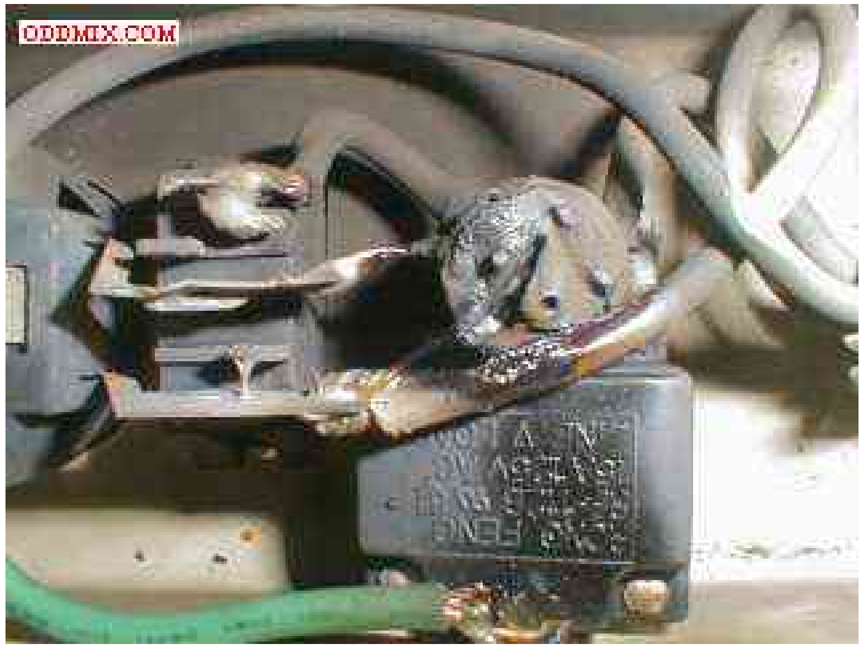
Picture 2. Healthy MOVs

Surge protection is all over the place. Many times it is there without anyone expects it. It is getting difficult to find power distribution strips without the built in surge protection device. Some strips are more effective than others with their protection. Expect to pay more for properly protected power strips, as they require more components and careful design. A well designed surge protection circuit never connects the protection device directly across the power line without additional components as it was done in this unit.

As can be seen in **Picture 1**, the power distribution strip had a primitive surge protection. Although at first thought surge protection appears to be a great idea, it can be a cause of a few problems as well. One important drawback could be that the protection device always conduct slightly and this small amount of current use a little power. It may not be a serious problem, when the power strip is AC line powered, but it will add unnecessary load to an Uninterruptible Power Supply [UPS] during a power failure when not much spare power is available. Many UPS systems have a warning against the use of surge protected power strips, or surge protection devices, for precisely the same reason.

Generic names for the most popular internal surge protection device is MOV. Other commonly used names vary from one manufacturer to another. MOVs or Metal Oxide Varistors are voltage dependent nonlinear devices, most often made of specially doped zinc oxide crystals. In-circuit operation of an MOV is similar to back-to-back connected Zener diodes, except that MOVs can't dissipate power continously.

MOVs are not static discharge or polarity sensitive devices and they made in several forms. The most common package is a disc with radial wire terminals. These copper wire terminals are connected to the metallization on both sides of the MOV disc. As shown in **Picture 2**, MOVs look much like coated ceramic disc capacitors. MOV surge protector devices are made by many companies large and small, and they are produced in different protection voltages and sizes. Their size is what determines the energy absorption rating, generally expressed in Joules. Naturally a larger MOV can absorb a lot more energy before it heats up to distruction, whereas smaller ones can absorb much less heat causing impulses. Heat sinks are also increase the MOV power absorption rating.



Picture 3. Surge protection device failed

Another major protection class of devices are the avalanche diodes also known as tranzorbs. These are the fastest and they are more expensive then MOVs. Specification values for MOVs are most impressive. Thousands of Amperes are not at all anusual. It is important to remember, that those values are for a nonrecursive extremely short duration pulse.

The benefits of surge protection include cleaner AC power input to the protected equipment. Protective action is provided by clamping the excessive voltage spikes which are exceeding the breakdown voltage threshold of the protection device. In most general purpose, line powered, surge protection units, the protection starts around 140±5 Volts. This voltage threshold is not very abrupt, and some conduction also occurs at lower voltages. Unfortunately this conductive current preheats the MOV. As a result, the surge protection device is unable to dissipate as much power as it is capable when completely cold.

If a potentially distructive high voltage spike is travelling along the power line, the MOV will attempt to clamp it to reduce its voltage below 140 Volts. It works well for short single pulses with limited energy content. The energy content of the pulse is the area under the pulse's curve, or the time integral of the pulse's amplitude. If a wide pulse comes along, or a train of less energetic pulses arrives in close proximity to one another, the protector will receive an integrated thermal load. If that thermal load exceeds the protectors maximum rating it may fail.

To sum it up - when the protection unit gets overwhelmed, it usually fails for thermal reasons. The MOV heats up by the first pulse, then if sufficient time is available, it cools off by dissipating its heat to the environment and gets ready for another protective action. If however, another pulse arrives before the protector is cooled off sufficiently, its temperature gets further elevated. If more impulses arrive during that time, and the current is not limited, the MOV may be completely destroyed.

For that reason, it pays to have a metal enclosed power distribution strip. See the destroyed MOV in **Picture 3**, it is just above the originally white color wire with a melted insulation. Notice the excessive vaporization on all surfaces inside the enclosure. The source of this film deposit was the MOV's metallization layer. Some remnants of this layer is still visible on the MOV - in the center of the picture.

Previous Page

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