If you've ever wondered how surge protector strips are different from plug-in power conditioners, you're not alone. The enormous difference in price makes surge strips especially attractive to many people.

To make matters more confusing, manufacturers of these different devices often don't point out the performance differences, which are significant. If you buy any power protection device (including power strips) without knowing the facts, you may find you've purchased far less protection than you thought. The difference between a plug-in surge protector strip and plug-in power conditioner is more than just price. As you will see, surge strips are capable of providing only rudimentary protection.

Surge Strips

The event commonly called a surge is more accurately defined as a high-voltage transient or impulse. Surge strips are designed to divert the impulse away from the sensitive electronic system. That's why the term diverter is more appropriate for this type of protective device.

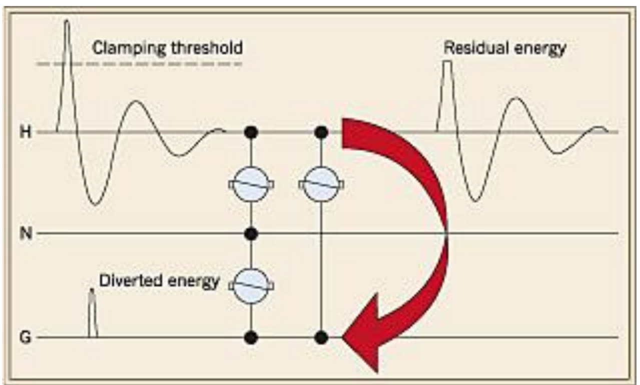

Fig. 1. The primary function of MOVs, SADs, and gas tubes is to divert a part of the harmful impulse energy away from the computer or system being protected by the surge strip.

Plug-in surge strips commonly use one or more of several electronic components, which may include metal oxide varistors (MOVs), silicon avalanche diodes (SADs), and gas tubes. There are differences in how each functions, but the intent is the same (Fig. 1) — to divert a part of the harmful impulse energy away from the computer or system being protected.

All surge strips have a voltage threshold, called a “clamping voltage,” at which they begin to conduct. Above that threshold, impulse energy is shunted across the diverter to another pathway — typically the safety ground. When the impulse voltage once again falls below the threshold, the surge strip stops conducting. Surge strips also have a “clamping response” time, which is the time required for the device to respond to an impulse. The amount of energy that a surge strip is capable of handling without being destroyed is also a consideration.

Due to these factors, each type of component typically used in surge strip has unique advantages and disadvantages.

MOV

This type of surge diverter component has a high clamping voltage (300V to 500V) but a slow response time. This means that, in best-case scenarios, voltage impulses of less than 500V usually enter the computer system unimpeded. In addition, higher voltage events with very fast rise times may pass by the MOV before it is able to respond. Although MOVs can handle a significant amount of energy, they are physically degraded each time they clamp. This characteristic alters their future performance and ultimately leads to physical failure.

SAD

The disadvantages of the MOV have led to the use of the SAD, either in conjunction with the MOV or in standalone applications. Compared to MOVs, SADs have a faster response time and are not subject to the physical degradation that characterizes an MOV design. The overall energy handling ability of the SAD, however, is not as high. An impulse that merely degrades an MOV may also cause outright destruction of the SAD. To overcome this disadvantage, many surge strip manufacturers whose designs use standalone SADs will parallel multiple SADs to increase the overall energy handling capability of the protector. Industry authorities often vigorously debate the effectiveness of this design method.

Gas Tubes

These devices have a high clamping voltage but are comparatively slow. However, they handle almost limitless amounts of energy. Some surge strip designs use gas tubes as the final line of "brute force" protection to spare the lives of the other surge diverter components in the presence of a catastrophic power line disturbance. In fact, many designs incorporate paralleled MOVs, SADs, and/or gas tubes in an effort to improve performance by combining the relative strengths of each particular component.
Inherent limitations of surge strips

All surge strips have certain inherent limitations. We've already discussed some of these (clamping voltage, response time, energy handling, etc.), but other factors are equally important.

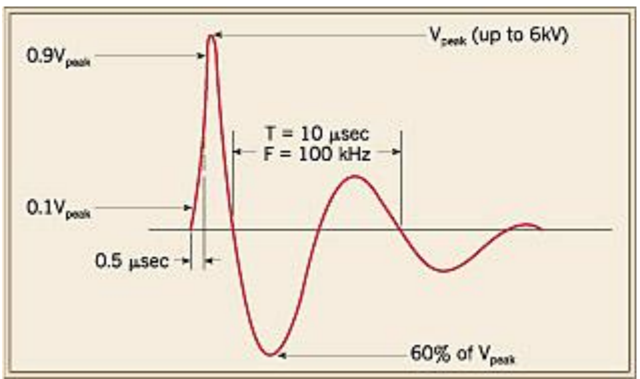

Fig. 2. Graph of a typical type of "ringing" transient often found at the end of a long branch circuit, where most computer equipment is installed.

The impulse shown in Fig. 2 is typical of the type of "ringing" transient often found at the end of a long-branch circuit, where most computer equipment is installed. This ringing is the result of the natural inductive and capacitive reactance found in building wiring. These reactance factors mean that the building wiring will oscillate at a unique frequency when energized by surge current — much the same as a radio transmitter oscillates when its output circuit is energized. While IEEE has found that 100 kHz is a typical ringing frequency for long branch transients, the actual frequency will vary depending on the specific reactance of the wiring. In fact, transient surges actually look more like a single (unipolar) impulse than a ringing one nearer to the electrical service entrance of the building (where little wiring reactance comes into play).

As part of the wiring system when installed, a surge strip interacts with its environment, and branch-circuit impedance becomes a factor in the frequency response and clamping performance of the device. This implication is important: Because branch-circuit impedance varies throughout the system, the performance of the surge strip will vary as well. Furthermore, because these same characteristics affect the frequency, wave shape, and rise time of an impulse at different places within the system, the performance of surge strips often becomes unpredictable. Because the "garden variety" surge strip is subject to all of these limitations, it is realistically best suited for limiting the worst part of a catastrophic electrical impulse.

Functional issues

There are two other functional factors of significant importance: longevity and what happens when a surge strip operates.

Because MOVs and SADs are both electronic components, both are subject to failure from a high-energy impulse. This is true whether they're used singly or in combination. The probability of ultimate failure is the reason why so many surge strip products incorporate an indicator light to signal when the protective elements are no longer functional. In most cases, surge strip components are operating “naked” on the power line, and eventual failure is a foregone conclusion.

What happens when a surge strip operates is a key issue. Where does the surge go, and what are the affects of sending it there? Answers to these questions, along with the inherent functional limitations of the surge strips, are the key differentiating factors between surge strips and plug-in power conditioners.

Plug-in power conditioners

A common question is: “What is a power conditioner?” Simply stated, a power conditioner is any device that provides all the power protection elements needed by the technology it's protecting. Although somewhat broad, this definition does focus our attention on the fact that today's modern systems require different protection than their predecessors.

The linear power supplies used in older generation computers required voltage regulation. Today's' modern systems are powered by switch mode power supplies (SMPS), which are technologically quite different. SMPS are immune to voltage regulation problems but require protection from impulses, power line noise, and, most importantly, neutral-to-ground (N-G) noise voltage.

N-G noise voltage can be disruptive to the operation of a computer because the computer's microprocessor makes logic decisions with reference to a clean, quiet ground. N-G noise voltages disturb this reference, possibly causing lockups, lost data, and unexplainable system failures.

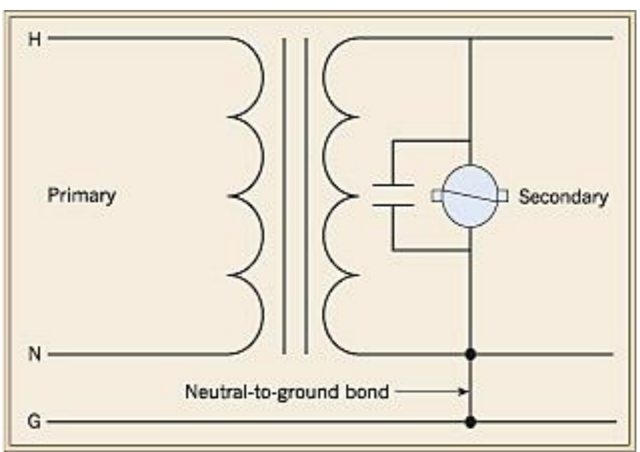

Fig. 3. An “ABC”-style plug-in power conditioner incorporates a surge diverter, isolation transformer, and power line noise filter.

Surge strips function by diverting disturbance energy to ground as we saw in Fig. 1. In the process, they convert a destructive disturbance into a disruptive one. Meanwhile, because the surge strip allows substantial energy to pass on to the computer, the computer itself may still be degraded by the residual surge energy. This explains why in so many instances a user experiencing catastrophic hardware failure will install a surge strip only to find that hardware failures (while fewer) still occur — and that the system now behaves unreliably at times.

A plug-in power conditioner will incorporate three elements: A) a surge diverter; B) an isolation transformer; and C) a power line noise filter (Fig. 3).

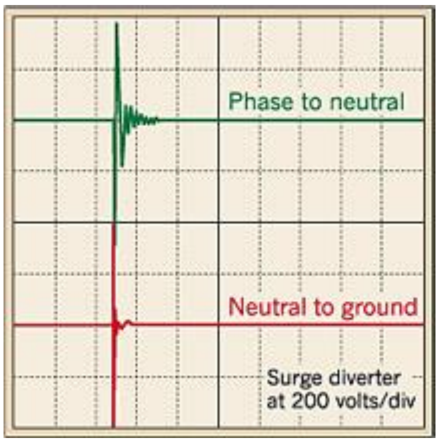

Fig. 4.The result of a surge strip responding to a 1,000V impulse injected between phase and neutral on its input. Note the amount of impulse energy passed by the surge diverter to its output as well as the amount diverted to ground.

This “ABC” approach provides several operational benefits. Isolation transformers permit the bonding of neutral to ground on the transformer secondary. (See The Elegance of Transformers on page 28.) Permitted by the NEC, per Sec. 250.20D, this “separately derived system” eliminates N-G voltages. This means that the surge diverter within the power conditioner can now divert surge energy to ground without creating an N-G disturbance in the process. Because noise filters also function by diverting electromagnetic interference and radio frequency interference to ground in the same manner, combining them with an isolation transformer also enhances their performance.

Due to the limitations already discussed, surge strips can only limit transient impulses to levels of hundreds of volts. Figure 4 illustrates the result of a surge strip responding to a 1,000V impulse injected between phase and neutral on its input. Note how much of the impulse is passed by the surge strip to its output and how much is diverted to ground.

A transformer-based (“ABC” style) plug-in power conditioner allows far less of the disturbance to reach the critical load. Figure 5 shows the same 1,000V impulse injected between phase and neutral at the input to an “ABC”-style plug-in power conditioner. Note that the phase-to-neutral impulse (normal mode) is attenuated to less than 10V while less than 0.5V appears between neutral and ground at the output.

The bottom-line

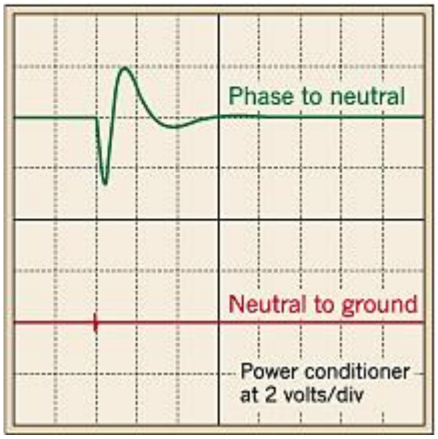

Fig. 5. A 1,000V impulse injected between phase and neutral at the input to an “ABC”-style plug-in power conditioner. Note that the phase-to-neutral impulse (normal mode) is attenuated to less than 10V while less than 0.5V appears between neutral and ground at the output.

Power line disturbances can destroy, degrade, and disrupt electronic systems. Plug-in surge strips are only capable of reducing surge energy — not eliminating it. Plug-in power conditioners that include a surge diverter, isolation transformer, and power line noise filter in their design can eliminate system destruction, component degradation, and operation disruption by exhibiting much better control over surge voltages.

Remember that the performance of naked surge strip components in an electrical system is unpredictable. The performance of plug-in power conditioners with an isolation transformer in the same electrical system is predictable and repeatable.

Surge strips create N-G voltage. Plug-in power conditioners eliminate it.