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Surge Protectors vs. Power Conditioners What's the Difference?

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Introduction

If you've ever wondered how a surge protector is different from a power conditioner, you're not alone. Low price makes surge protectors especially attractive to many people.

To make matters more confusing, manufacturers of these different devices often don't tell you about the performance differences. Surge protectors and power conditioners have significant differences, and those who buy a power protection device without knowing the facts may find they've purchased far less protection than they thought.

The differences between surge protectors (surge diverters is a more appropriate term) and power conditioners is more than just price. As you will see, surge protectors are capable of providing only rudimentary protection.

Surge Diverters

The event we commonly call a surge is more accurately defined as a high voltage transient or impulse. Surge diverters are designed to divert the impulse away from the sensitive electronic system. That's why the term diverter is more appropriate – it better describes the function of this device.

Surge diverter products commonly use one or more of several electronic components. These 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 (See Fig. 1), divert ***a part*** of the harmful impulse energy away from the computer or system being protected.

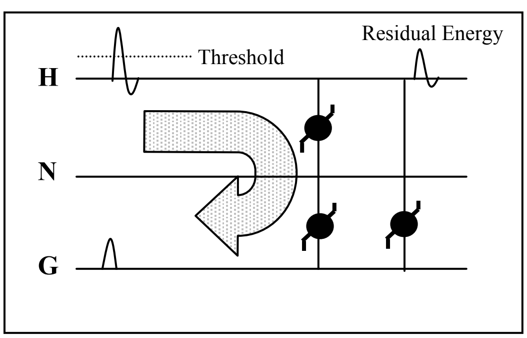

Figure 1 – Surge Diverter Operation

All surge diverters have a voltage threshold, called a "clamping voltage", at which they began to conduct. Above that threshold, impulses are shunted across the diverter to another pathway. When the impulse voltage once again falls below the threshold, the diverter stops conducting. Surge diverters also have a "clamping response" time or the time required for the device to respond to an impulse. The amount of energy each is capable of handling without being destroyed is also a consideration.

Due to these factors, each type of component used in surge diverters has unique advantages and disadvantages. MOVs have a high clamping voltage (300 to 500 volts) and a slow response time. This means that in best case scenarios, voltage impulses of less than 500 volts 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. And while MOVs can handle a significant amount of energy, they are physically degraded each time they operate. This characteristic alters their future performance and ultimately leads to physical failure.

These disadvantages have led to the use of the silicon avalanche diode (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 MOV design. The overall energy handling ability of the SAD, however, is not as high, and an impulse that merely degrades an MOV may cause outright destruction of the SAD. To overcome this disadvantage, many surge diverter manufacturers whose designs use standalone SADs will parallel multiple SADs to increase the overall energy handling capability of the protector. Some industry authorities debate the effectiveness of this design method.

Gas tubes are comparatively slow and have a high clamp voltage. However, they handle almost unlimited amounts of energy. Some surge diverter designs have employed 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 powerline disturbance. In fact, many surge diverter 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

All surge diverters have certain inherent limitations. Some have already been discussed;

clamping voltage, response time, energy handling, etc. Other factors are equally important. The impulse illustrated in Figure 1 is highly simplified. In the real world, powerline impulses come closest to resembling this perfect waveform only at the service entrance to a building.

At the end of a long branch circuit, where most electronic equipment is installed, powerline transients look more like the "ringing" transient shown in Figure 2. Building wiring contains significant inductive and capacitive reactance, which means that for each location in a building's wiring system, there is a unique frequency at which the system will oscillate. Much the same as a radio transmitter oscillates when its output circuit is energized, building wiring also oscillates when energized by surge current.

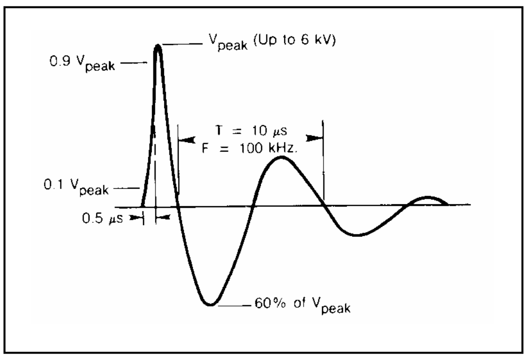

Figure 2 – Maximum Branch Circuit Impulse

While much work has been done by the IEEE to characterize the "typical" characteristics of a branch circuit impulse, the actual circumstances vary greatly. The surge diverter becomes part of the wiring system when it is installed on a branch circuit, and the circuit impedance that results from the wiring reactance becomes a factor in the performance of the surge diverter.

The implication is an important one. Since electrical characteristics vary throughout the system, the performance of the surge diverter will vary as well. And since these same characteristics affect the frequency, waveshape, and risetime of an impulse at different places within the system, the performance of surge diverters often becomes unpredictable.

Since the "garden variety" surge diverter is subject to all these limitations, it is realistically best suited for limiting the worst part of a catastrophic electrical impulse.

Functional Issues

In addition there are two other functional factors of significant importance. The first is longevity. The second is what happens when a surge diverter operates.

Since MOVs and SADs are both electronic components, it is important to remember that both are subject to failure from a high-energy impulse. This is true whether they are used singly or in combination with one another. The probability of ultimate failure is the reason so many surge diverter products incorporate an indicator light to signal when the protective elements are no longer functional. In most cases, surge diverter components are operating "naked" on the powerline and eventual failure is a foregone conclusion.

What happens when a surge diverter operates is a key issue. Where does the surge go and what are the affects of sending it there? The answer to this question along with the inherent functional limitations of the surge diverters are the key differentiating factors between surge diverters and power conditioners.

Power Conditioners Defined

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.* While 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 electronic systems 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, powerline noise, and, most importantly, common mode voltage.

Common mode voltage is disruptive to the operation of microprocessor based electronic systems. A microprocessor makes logic decisions by measuring small voltage transitions with reference to a clean, quiet ground. Common mode (neutral to ground) voltages disturb this reference and result in lockups, lost data, and unexplainable system failures.

Surge diverters function by diverting disturbance energy to ground (Figure 1). In the process, they convert a destructive disturbance into a disruptive one. Meanwhile, since the surge protector allows substantial energy to pass on to the electronic system, the system 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 diverter only to find that hardware failures, while fewer, still occur and that the system now behaves unreliably at times.

A power conditioner for a state-of-the-art electronic systems will meet state-of-the-art system requirements. It will incorporate three elements: A – a surge diverter, B – an isolation transformer, and C – a powerline noise filter (See Figure 3). This ABC approach provides several operational benefits.

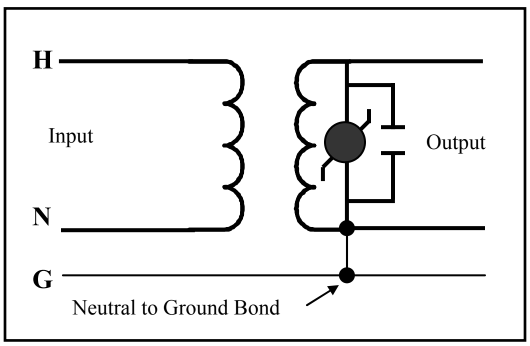

Figure 3 - Power Conditioner With Elements A, B, and C

Isolation transformers permit the bonding of neutral to ground on the transformer secondary. Permitted by National Electrical Code paragraph 250-5d, this “newly derived power source” eliminates common mode voltages. This means that the surge diverter can now divert surge energy to ground without creating a common mode disturbance in the process. Since noise filters also function by diverting EMI and RFI to ground in the same manner, their performance is also enhanced by combining them with an isolation transformer.

The Elegance of the Transformer

Transformers are an elegant power quality tool. Their secret is in their unchanging secondary impedance. As mentioned, surge diverters interact with the impedance of the building wiring in a way that makes their performance unpredictable. Noise filters suffer similar fates. However, when combined with the fixed secondary impedance of the isolation transformer, their performance is not only predictable but also controllable and repeatable by design.

Surge protectors limit transient impulses to hundreds of volts while allowing hundreds of volts to appear neutral to ground.. Power conditioners limit the same transients to tens of volts (typically ten volts or less) between hot and neutral (normal mode) and less than ½ volt neutral to ground (common mode). A transformer based power conditioner provides for much better control of transient energy and provides a much higher level of protection for a sensitive electronic system.

Conclusion

Electronic systems can be destroyed, degraded, and disrupted by powerline disturbances. Surge diverters are only capable of limiting damage from destructive events. Power conditioners utilizing elements A, B, and C eliminate system destruction, component degradation, and operational disruption. The performance of naked surge diverters in an electrical system is unpredictable. The performance of power conditioners with an isolation transformer in the same electrical system is predictable and repeatable. Surge diverters create common mode voltage. Power conditioners eliminate it. The differences between the two technologies is measured in system reliability, dependability, and performance.