SURGE SUPPRESSION TECHNOLOGY GUIDE

WHAT IS A SURGE?

A surge, also called a transient, is a sudden increase in energy which can cause damage to equipment connected to power, telephone, data or video cables. Energy is composed of voltage and current and it is the sudden "surge" in one or both of these components that causes damage to sensitive and valuable equipment.

Voltage is the difference in electrical charge between two objects. When a highly charged object comes into contact with or close proximity to an object of lesser charge, a discharge occurs from the higher charged object to the lower charged one. The size of the discharge in volts depends on the difference in charge (or "potential") between the two objects. A human being can become highly charged by walking across a carpet in insulating shoes. When he touches an object he can discharge this energy. Sometimes this results in the tingling electric shock most of us have experienced at some time.

Current is a measurement of the electricity that flows between objects of differing potential. A high voltage surge will not necessarily be accompanied by a high current, but, if it is, the result is likely to be far more damaging.

In considering how best to combat surges, it is important to understand the different kinds of surge, their causes and their characteristics - in particular, the speed with which the surge arises, its duration, the current and voltage levels. The next step is to match the surge suppression technologies to the type of transient.

MOST COMMON TYPES OF SURGE

Static Electricity

The most common source of this kind of surge is a human being, as in the example above. The surge occurs when a highly charged person touches a keypad, video controller or access control card reader. These surges have the following characteristics:

- Very fast
- High Voltage (up to 15,000 Volts)
- Very Little Current
- Very Short Duration

Lightning

Lightning is Mother Nature's static, but on a much larger scale. A direct hit from lightning produces a surge so severe that nothing is going to protect the affected equipment. However, such a strike is relatively rare in comparison to surges induced by lightning strikes nearby. These induced surges can be very large. Strikes up to a mile away can induce up to 70 Volts on one meter (3 feet) of cable. The surge travels along the cable and strikes the equipment at one or both ends of it. Lightning induced transients are generally slower than a human static strike, but generally last much longer and are accompanied by damaging high currents.

- Fast
- Very High Voltage
- Very High Current
- Long Duration (relative to static discharges)

AC Induction

This form of transient is generally caused by large AC motors, high voltage lines, noisy transformers, etc. close to the affected equipment or its connecting cables. The transient is generally rather slow in building up but can continue for a long time. It is often characterized by very large currents.

- Slow Build Up
- High Voltage
- Very High Current
- Very Long Duration

HOW DO WE COMBAT SURGES?

Several technologies are available to defend equipment against the damaging effects of power surges. These include devices which protect against excessive current, such as fuses and PTCs, and those which protect against excessive voltages, such as Sidactors, Tanzorbs, MOVs, glass discharge tubes, zener diodes, resistors, capacitors, inductors and spark gaps. Starting on page 4, you will find a description of these technologies and how they work. How does a manufacturer decide which of the available technologies to use?

MATCHING THE TECHNOLOGY TO THE APPLICATION

Video Signals

Video Signals are very prone to lightning-induced transients and require solid and effective protection against this kind of surge, which is characterized by *speed* and *high current*. On the other hand, they are very sensitive to line loss from connection to devices with high capacitance and resistance. Thus a video surge suppressor should have the following characteristics.

- Fast clamping speed (i.e. reaction time):
- Effective overcurrent protection

Stealth Laboratories use **Tranzorbs** or **Sidactors** for fast reaction without adding excessive capacitance or resistance on the video line. Additional protection is provided by inductive traces, spark gaps and ground plane. Overcurrent protection is provided by self-resetting ***SmartFuses*** (PTCs).

Phone Lines

Phone lines are very prone to lightning induced transients and require solid and effective protection against this kind of surge, which is characterized by *speed* and *high current*. Unlike video signals, they are not very sensitive to line loss from connection to devices with high capacitance and resistance. However, data signals are sensitive to induction. Thus a phone line surge suppressor should have the following characteristics.

- Fast clamping speed (i.e. reaction time)
- Effective overcurrent protection

Stealth Laboratories use **Sidactors** for the high speed reaction required to protect the transformers and very sensitive optocouplers which make up most interconnection circuits. Additional protection is provided by inductive traces, spark gaps and ground plane with some added resistors. Overcurrent protection is provided by self-resetting ***SmartFuses*** (PTCs).

Data Lines

Data lines are found in a variety of security-related applications. They are common in alarm systems, where they are prone to static discharges from users touching the keypad and in CCTV camera and dome control systems, where the main threat is from lightning. The data circuits are very susceptible to problems from parasitic capacitance and series induction, so the surge suppression technologies selected should be free of these phenomena. In addition, the operating voltage of the data bus is often low (e.g. 5 Volts) and damage could occur from surges of relatively low voltages (e.g. 9 or 10 Volts). The surge suppressor must react at a low enough voltage to protect these circuits. Thus a data line surge suppressor should have the following characteristics.

- Fast clamping speed (i.e. reaction time)
- Effective overcurrent protection
- Low capacitance and induction
- Able to clamp at relatively low voltages

Stealth Laboratories use **Tranzorbs** for their combination of high speed reaction, low clamping voltage, low capacitance and zero induction. Additional protection is provided by inductive traces, spark gaps and ground plane. Overcurrent protection is provided by self-resetting ***SmartFuses*** (PTCs).

Protection of data lines is complicated by variations in bus operating voltages. The most common are 5, 12 and 24V. Our data surge suppressors are available with varying clamping voltages (7, 15 and 24V) allowing you to match the suppressor to the data bus voltage (a 7V suppressor for a 5V bus, etc.)

AC Secondary Connections

AC secondary connections are prone to lightning induced transients. However voltages are generally stepped down from 120V to a lower voltage such as 16.5, 18 or 24V. Currents are limited by the transformer itself or the arcing over from the primary to the secondary. Large MOVs provide the best protection for the best price. Stealth Laboratories back this up with inductive traces, spark gaps and ground plane. Overcurrent protection is provided by self-resetting ***SmartFuses*** (PTCs).

AC Primary Connections

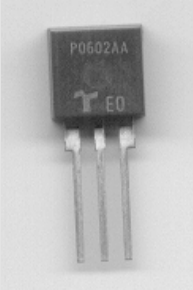
Where possible, protection should be placed on the secondary side of the transformer, in order to make best use of the transformer's step-down and isolation characteristics. This is not always possible, however, and sometimes primary protection is necessary. AC primary connections are prone to lightning induced transients with more destructive currents than those faced by secondary connections. Large MOVs and glass discharge tubes provide the best combination. Stealth Laboratories back this up with inductive traces, spark gaps, ground plane and resistors. Due to the high voltage, which exceeds the maximum ratings for PTCs, overcurrent protection is provided by glass fuses.

On the following pages, we offer a brief description of each surge suppression technology and how it works. For any further information or help in selecting the appropriate surge suppressor for your application, please call us at 800-360-4146.

Several different technologies are used to suppress transient voltage and current surges, each with its advantages and disadvantages. Our surge suppressors combine these technologies to offer the best possible protection for a wide variety of applications. This guide will explain how each technology works, how effective it is against different kinds of transients and how suitable it is for various applications.
Stealth Laboratories surge suppressors protect equipment from damage from both overcurrent and overvoltage. Since a surge consists of both these components, this adds an extra degree of protection.

OVERVOLTAGE PROTECTION DEVICES

SIDACTOR



Sidactor technology was developed for the telecommunications industry specifically to provide a super-fast clamping reaction, a flat clamping curve and the ability to handle large amounts of surge current. This kind of combination is typically induced by a lightning strike. Sidactors provide the best all-round protection against lightning and the most consistently effective performance as the power of the surge increases. Their main disadvantages are cost and a large capacitance compared to glass discharge tubes. This large capacitance has no discernible effect on most video and data transmissions and the high degree of protection makes Sidactors the recommended solution for high value CCTV equipment.

Sidactors are not suitable for every application. Their limitation derives from the voltage at which they are triggered into clamping the surge. No Sidactor is able to react to a surge with a voltage below 24V. Thus a Sidactor is not suitable for data lines with bus operating voltages of, for instance, 5 or 12 Volts, which could be damaged by high current surges of voltages below this level. For this kind of application, common in domes and pan/tilt/zoom cameras, the Tranzorb/SmartFuse combination offers the best protection.

TRANZORB

A Tranzorb is a silicon-based surge protector based on discrete avalanche diode and zener diode technology. Like a Sidactor, a Tranzorb provides a very fast clamping reaction. It has the advantage of being able to trigger at much lower voltages than a Sidactor, making it suitable for protection of circuits which could be damaged by high current surges of relatively low voltage (eg. Data buses).

The Tranzorb's main disadvantage, when compared to a Sidactor, is that it can only handle smaller amounts of current. Since a lightning induced surge typically includes a very high current, it is necessary to combine the Tranzorb with a second technology to handle this part of the surge. In Stealth Labs surge suppressors, a self-resetting fuse performs this function.

METAL OXIDE VARISTOR (MOV)

This is a typical "middle of the road" solution. It has moderate speed and can handle moderate currents compared to other devices. Like a Tranzorb, its voltage can be specified very low, but its major advantage is very low cost.
The major disadvantage of an MOV is that each surge degrades the device. Theoretically, the MOV is supposed to fail "short," causing the protected device to stop working and alerting you to the fact that it is no longer protected. In practice, on high voltage, high power mains lines, the MOV can be overwhelmed by the surge and "explode" in an open position, leaving the device unprotected, with no indication of this change. To overcome this potential problem in mains protection applications, the MOV should be combined with a fail-safe device. Stealth Labs use a glass fuse on the the ZP-120AC.

GLASS DISCHARGE TUBE (GDT)

The GDT is an old technology which was formerly widespread in the telecommunications industry. Its current handling capabilities are unrivaled by any other device, a characteristic that is well suited to lightning-prone circuits. They also have almost zero parasitic capacitance, meaning that line loss is nearly zero. However, they are very slow compared to other devices, are relatively expensive and are unsuitable for protection of circuits below about 50V. For 12 and 24V circuits other technologies must be used.

ZENER & AVALANCHE DIODES

Diodes are extremely cheap and fast. However, they are not able to handle heavy surge currents. They also have a tendency to "leak" once they fail, giving the impression that a surge suppressor is working, when it has in fact failed.

RESISTOR

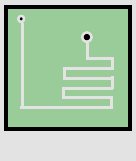
Resistors are inexpensive and very good at limiting currents and “steering” transients toward a protection-type component. The old adage “lightning seeks the simplest path to ground” is quite true, and resistors can be highly effective at blocking that path. Stealth surge suppressors use resistors to enhance the effectiveness of other technologies used in the surge protection design.

CAPACITOR

Capacitors act like a short circuit to AC voltages and some transient waveforms, with little effect on DC circuits. Careful designs with capacitors can be highly effective at a minimum cost.

INDUCTOR

Inductors act like a resistor to AC voltages and transient waveforms, with no effect on DC circuits. Like capacitors, inductors can add to the effectiveness of other surge suppression devices. Stealth Labs use inductive traces on the board as an enhancement to most surge suppressor designs. The drawing shows an inductive trace design.



SPARK GAPS and EARTH GROUND

Spark Gaps are specialized PCB designs that place the points of an earth-ground signal in close proximity to a protected circuit. The idea is that if a surge enters a sensitive circuit, it runs into protection or resistance. It then arcs over the air gap between earth ground and the circuit in question. The resulting “spark” dissipates the transient into earth ground and / or as light & heat from the arc.

OVERCURRENT PROTECTION DEVICES

PTC or SMART FUSE

The positive-temperature-coefficient resistor (PTC) is a device that limits current by increasing its resistance in the presence of heavy currents. They are somewhat more expensive than glass fuses. However, they can reset themselves once an over-current situation has passed and reduce the amount of service calls. Stealth surge suppressors include SmartFuses in keeping with our policy of providing overcurrent protection, as well as the overvoltage protection provided by industry standard products.

FUSE

The fuse is the most popular device for limiting damaging currents to a protected circuit. They come in dozens of shapes and sizes, are relatively inexpensive, and work very well. Their major drawback is that they work only once! For this reason, many currently available surge suppressors have no fuses and offer no overcurrent protection. Stealth Laboratories surge suppressors use self-resetting SmartFuses (PTCs) where possible. However in high voltage applications (greater than 48V), glass fuses are used in the absence of suitably rated PTCs .

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