Normal and abnormal aberrations contribute to stress and failure of electronic components.

Surge protection ends system stress

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A computer facility on the East Coast was affected by lightning 3 times during its first summer of operation. The company experienced massive outages in its phone system, the building management programmable logic controllers and in office computer terminals. A maintenance contract covered repair costs of the phone system, but the company estimates business losses in the millions. It contacted the firm that had installed lightning rod protection on the building. As the hired consultant, I recommended that the company install several grounding changes and proper transient suppression equipment throughout the building. The cost of the protection—$30,000—amounted to only 2% of the loss. No downtime has been reported in the past 4 years, since protection was installed.

Poor power quality due to lightning storms and nature, as well as from normal and abnormal aberrations, from switching and operating power systems and electrical equipment, all contribute to stress on electronic components and integrated circuits, resulting in malfunction and failures.

Avoiding failure and downtime

Simple protective steps can be taken to eliminate power disturbance failures in all electronic systems such as security controls, computers, electronic key systems, building management HVAC systems and telephone equipment.

Engineering associations, such as the Institute of Electrical and Electronic Engineers, American National Standards Institute and the American Consumer Protection Agency have written guidelines for protecting computer and electronic equipment from electrical power surges. Some have defined magnitude and shape of these surges and voltage transients and have issued testing standards.

Lightning protection associations, such as the United Lightning Protection Agency and the Lightning Protection Institute, whose members install or engineer lightning rod fire protection systems for buildings, all recognize that "commercial grade AC power" must be properly conditioned to achieve "computer grade power," especially during lightning storms. Therefore, they specify that improved grounding techniques and transient suppression networks be installed in all buildings with high densities of electronic and computer equipment.

What is transient suppression?

Transients are fast-rising over-voltages with total time duration of less than 1 millisecond. Transients can rise to peak amplitudes of several thousand volts within a few nanoseconds and decay away within microseconds. Since these can force or find their way through DC power supplies and into electronic circuits, they have become the subject of great concern, research, and study.

Integrated circuit chips pack several thousand transistors onto a 0.1 inch square chip and have to perform several million operations per second by detecting fast voltage level changes between 0 and 5 volts. When a transient finds its way into the main 5 volt DC or onto logic lines, it injects havoc. Transients are interpreted as data pulses, which shouldn't be there. The system will perform functions not called for, or the system may temporarily forget what it is doing. CMOS microprocessors will lock up if transients take I/O lines lower than −0.6 volts.

We commonly hear the phrase "It just lost memory" or "the system just locked up." These are typical disruptive effects of transients—"disruptive" because once the system is rebooted, circuits are reset and proper memory data loaded back into the system, the system runs just fine, again.

The effect of lightning storm transients or "equipment switching spikes" is stressful on integrated circuits and damage accumulates inside the IC, until one day a small transient or surge is generated as the system is turned on and a circuit board fails.

The following methods to eliminate downtime, by eliminating transients, are most cost-effective, even for systems rated at $50 to $200 per hour downtime. How much more imperative are they then on critical security control systems.

Keep in mind the analogy that transformers and filters are like shock absorbers on a car. They average, or smooth the bumps, thereby attenuating or reducing road noise by so many decibels. But when your car hits a bad pothole the "shocks" do little toward smoothing the bump. The large shock of a pothole is like a voltage transient. The transient or surge saturates the energy-smoothing capability of filters and forces itself through the whole system, with disruptive or destructive results.

Filters are like a car's shock absorbers, and a voltage transient is like a bad pothole, which completely saturates the filter's energy-smoothing capability—with disruptive or destructive results.

How to apply suppression

A transient voltage surge suppressor device should be installed at each "change of voltage point" within the AC distribution system. If the proper type hybrid TVSS devices are used, inductance of system transformers will work with the TVSS devices to achieve tighter clamping, and will achieve better filtering as well.

Also, a "local TVSS" should be placed at the system being protected (computer) to stop transients induced onto lines along the same power branch circuit from getting into electronic circuits. These are smaller TVSS devices, needed because 65% of all transients are generated by equipment within the building. If this scheme of installation is not possible or not cost-justifiable, then a single series hybrid TVSS device with series inductance and filtering built in should be applied at the sensitive system's (computer) AC power input. Suppressors are now available with not only excellent design but which carry a warranty that will cover repair of the computer or electronic systems being protected, should power surge damage ever occur.

Simple parallel suppressors do not smooth distortions along the sine wave. Simple suppression components clamp or crowbar on a tran-

sient after the transient has exceeded the nominal peak voltage of the sine wave. A threshold is set that triggers the suppression circuit or device. Transients are stopped at that theshold, like hitting a cement wall. Some suppression devices crowbar or shunt the excess energy to ground, while a better technique is to clamp and force the voltage between AC "hot" and AC "neutral" to stay within thresholds by dissipating transient energy as heat within the TVSS and back along line side power wires.

Whereas individual suppression components each have limitations and strengths, this writer has been most successful by applying a line of hybrid suppressors that combine advantages of high-speed and high-energy suppression with highly capacitive EMI/RFI filtering, to most effectively eliminate transients. It is important to select a TVSS supplier with a complete product line of suppression devices including: AC power plug strips (temporary power taps), dual outlet devices to cover duplex wall outlets, circuit breaker main panel and sub panel protectors, RS-232 line protectors, tip and ring telephone line protectors, data line protectors, 48 VDC line protectors, CATV and CCTV cable protectors, PC control center protectors, etc.

Many articles have been published in computer trade magazines in recent years comparing performance capability of the product lines now available. Like insurance policies, the most expensive may not be the best—in fact may not meet your needs at all. However, in general you get what you pay for. Expert evaluation and independent test results should be considered before buying into a TVSS manufacturer's claims.

With proper surge suppression electronic systems can be protected from the power and data line surges that occur during lightning storms and during other natural and man-made transient surge occurrences. PS

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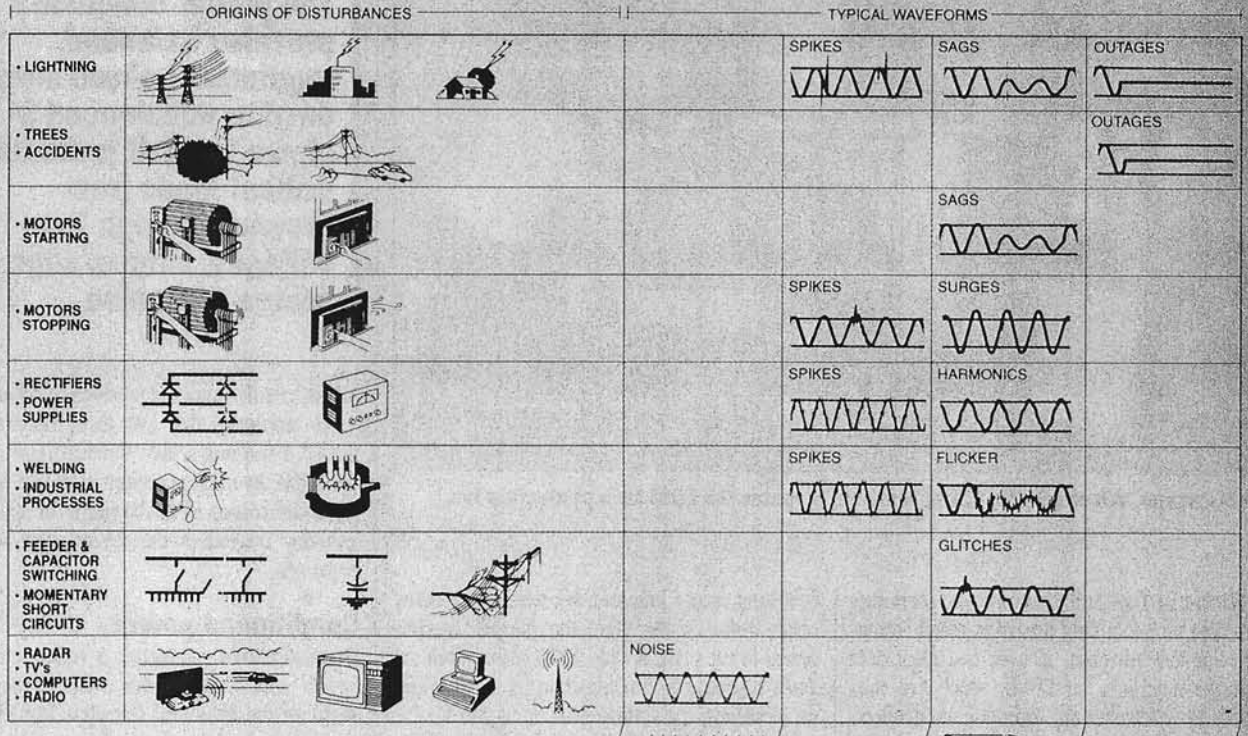
More information on power surge protection is available from Amemco, Kaysville, Utah.
To **learn** more, **Circle 404**

The Source of and Solution to Power Disturbances



SOLUTIONS TO POWER DISTURBANCES

GROUNDING—Proper grounding of equipment can eliminate most problems related to electrical noise.
TRANSIENT SURGE SUPPRESSORS—An inexpensive means of minimizing spikes. However, they usually have little effect on noise and do not provide voltage regulation.
POWER CONDITIONING SYSTEMS—A broad class of equipment that includes filters, isolation transformers, and voltage regulators. Each type of PCS provides a specific type of protection. Generally PCSs do not protect against power outages.
UNINTERRUPTIBLE POWER SUPPLIES—Systems that include a rectifier/battery charger, storage battery, and inverter components to provide power to meet site-specific criteria including waveform quality and expected outage duration.

Chart courtesy of Electric Power Research Institute