The Many Ways Your Systems Can be Compromised by Power Surges

Today, it is clear that organizations of every kind depend on electronic equipment for many aspects of essential daily operations. Office equipment, retail point of sale (POS) equipment, and access control and security systems – we depend on these systems, and in turn, all of these systems depend on electrical power and network connectivity to function. Protecting these systems from potential damage must be a high priority for business management to ensure organizational continuity and appropriate risk management.

While our dependency on these electronic systems has been increasing, there has been a parallel growth in the sources of electrical disturbances that can cause power surges and spikes. Power surges can be considered a “silent killer” of electronic equipment because most surges are small enough to remain undetected by organizational staff; and even though we don’t notice them, they slowly and steadily damage electronic equipment, reducing product life and reliability. Damaging surge events affecting your business is not a question of “if”, but “when”.

This paper addresses what causes power surges, why every organization should be concerned about them, and how to protect your essential electronic equipment from them.

DITEK®
Surge Protection

Electrical Power Surges: A Growing Threat

Our increasing dependence on electronic equipment

Businesses and organizations depend on electronic equipment today more than ever before. In any typical setting, the staff depends on computers, general office equipment, fire alarms, access control systems, security video systems, phone systems, antennas for wireless access, and many other common electronic devices. This is true for commercial offices, non-profits, educational facilities, medical facilities, houses of worship, airports, stadiums and every other type of facility. No matter what the objective of the organization, the team depends on these electronic systems as tools to help perform their essential daily operations.

Small businesses such as convenience stores and restaurants also depend on the general systems already mentioned, along with specific electronic systems, such as POS devices, fuel pump controls, lottery terminals, and ATMs, to name a few.

It is clear that our dependence on electronic equipment has only increased over time, and shows every indication of increasing even further into the future. Thus, protecting these systems from potential damage must be a high priority for business management to ensure organizational continuity and appropriate risk management.

A parallel increase in sources of electrical disturbances

While our dependency on electronic equipment and systems has been increasing, there has also been a growth of possible sources of electrical disturbances that can cause power surges and spikes.

As we will discuss in more detail below, damaging surge events can be the result of a range of human and naturally occurring triggers, and none of these factors is decreasing.

In particular, the number of sources of smaller, less noticeable surge events is increasing – and therefore subjecting electronic systems to an increasing number of undetected transient surges.

Whether your equipment is damaged quickly and dramatically, or slowly over time, the results are the same – unexpected failures and downtime. Since organizations depend on these electronic systems for daily operations, this can be costly, not only in terms of replacement of equipment and installation expenses, but also in terms of decreased staff productivity, work delays, and even lost customers.

Sources of Electrical Power Surges

There are many possible sources of power surges and spikes that can damage your electronic equipment and systems. This section details a brief overview of these sources to provide a basic awareness. Surge events are a result of either natural, human, or mechanical sources, as described below.

DITEK® Surge Protection

Natural (environmental) power surge sources
The most well-known of all the sources of power surges is, of course, **lightning**. On average, there are about 25 million cloud-to-ground lightning strikes per year – that's about 100 times per second – and at any given moment, there are about 1,800 thunderstorms in progress around the globe.

There are about 25 million cloud-to-ground lightning strikes per year.

Lightning can cause significant damage. One major university in the Southeast lost at least $100,000 due to improper surge protection after lightning hit and destroyed a dormitory's newly installed – but unprotected – eave-mounted surveillance cameras. The power surge then traveled to the unprotected network server, destroying both the server and the switch, and continued on through the wired computer network to destroy network cards in students' laptops at the very end of the cable runs. Surge protectors do not prevent lightning from striking a device, but they do help mitigate damage.

Direct lightning strikes to a facility's power lines, or to exposed wiring such as a communication antenna or surveillance camera connection cable, are fortunately fairly rare. When direct strikes do occur, they usually travel into the building wiring systems and deliver immediate, catastrophic damage.

While direct strikes to a facility wiring system are rare, **proximity lightning strikes** are extremely common, and they cause large voltage spikes for miles along transmission lines.

Electrostatic discharge, or ESD, can cause surprisingly high voltages over shorter distances, and can be caused by human contact, an electrical short, or dielectric breakdown. It actually takes very little energy to damage modern electronics. For example, consider an airport located in the Southeastern United States. A newly-installed access control system experienced card reader failures shortly after the system was installed. The problem was dry air that created electrostatic discharge (ESD), damaging the internal circuitry and causing controlled doors to malfunction. Eventually the access control system suffered major failures. Door solenoids failed, and the entry/egress doors in secured areas would not open. The overall physical security of the airport was compromised for a period of time. Once surge protection was added to the system, no further damage occurred.

Damage to electrical infrastructure can occur in several ways due to severe weather systems, causing an electrical power surge or spike event. Common events include wind causing tree limbs to fall on power lines, other wind damage due to tornados or hurricanes, and damage from power lines breaking due to snow and ice buildup. Depending on the nature of the damage, effects from these sources can be felt locally, or across an entire region.

Human power surge sources
Human error sometimes plays a role in damaging power surges. For example, in one well-known case, a banking data

DITEK® Surge Protection

center became aware of an overloaded power supply. Rather than reducing the load on the supply, a worker pulled the plug, instantly causing a set of servers to go down. Realizing his mistake, the worker plugged the supply back in – with all the servers turned on. The resulting inrush current caused an instant shock (over-voltage) to the entire system.

Other human errors that can cause power surges include any damage caused by carelessness and horseplay. For example, an employee operating a forklift with its forks raised can catch overhead power, data or communication lines and rip them down, causing short circuits.

Surge damage can be a result of **human intentional actions** as well, including vandalism or some other criminal intent. For example, disabling security systems by subjecting controls to a high voltage taser discharge could be the precursor to an attempted robbery.

Systemic power surge sources

In addition to natural causes such as lightning, and human errors, there are sources of electrical surges and spikes that are generated within the electrical power distribution system itself. According to the Insurance Institute for Business and Home Safety, lightning strikes account for just two percent of all surge-related damage. That means that 98 percent of the damage is done by the hundreds of smaller power surges that are mostly unnoticed every day. Here are some of the additional sources of electrical surge events:

- **Inductive loads** might well be the most common source of all electrical surges, and they are frequently generated right within your own facility. Typical, inductive loads include electric motors switching on and off inside or outside a facility such as HVAC systems, large refrigeration equipment, pumps, compressors, and heavy machinery. All of these items are commonly found in most facilities. These surges can deteriorate sensitive circuitry over an extended period, eventually destroying them.

98% of surge-related damage is done by smaller power surges that go unnoticed.

- The **failure of electrical transformers** can cause system disruptions that lead to surge and spike events. Transformers are used throughout distribution systems – at the beginning and end of long-distance transmission lines, at voltage step-down stations, and even on poles near residential neighborhoods. When transformers leak, or reach their end of life, their sometimes dramatic failures can have neighborhood-wide impacts.

- Another factor arises when utility companies switch transmission lines from one supply system to another. This action, called **grid switching**, can also cause significant electrical power disruptions that are able to travel long distances.

- Other significant system-level changes in supplied power or loading can cause **blackouts or brownouts**. These events of under-voltage or sag are usually followed by an unusually high voltage transient as the system recovers. If your lights flicker or dim, that is usually an indication that a brownout has occurred.

DITEK® Surge Protection

Other damaging power entry paths

It is important to know that power supply lines are not the only path for damaging power surges and spikes – signal lines, phone lines, data network wiring, and antenna cabling are also conductive pathways that lead directly to sensitive equipment. Under certain conditions, power surges can easily enter these types of cabling and travel to other connected devices, sometimes damaging entire subsystems.

For example, there are several scenarios of **accidental power contact**. Electrical wiring can accidentally make contact with phone or data network cabling, instantly creating an overvoltage situation. This can happen by accident, while an electrician is working on rewiring or troubleshooting in a junction box, or it can happen by human error as described in the forklift scenario above when cables are downed or damaged.

In addition, **insulation failures** and **water leaks** can cause short circuits, creating sudden and unexpected paths for electrical power surges.

Protecting Electronic Equipment from Power Surges

Clearly, surge protection is essential to shield and lengthen the life of a wide range of essential electronic systems by defending against all of these natural and accidental causes of damaging power surges and spikes. To be most effective, surge protection needs to be an integral element of the planning and design of any system connected to the electrical network, but if surge protection is currently lacking, management can take proactive action to install protection and reduce the risk of loss immediately. Current surge protector offerings can be easily and cost-effectively added to almost any electronic system or wired network.

It is also important to choose the right surge protection for each application, and to install it correctly in the right location, to gain the maximum protection possible.

Tips for Protecting Your Essential Electronic Equipment

General protection strategies

Strategy 1: Protect incoming utility lines at building entry

Recommendations for surge protection for electrical power follows the ANSI/IEEE C64.41.2-2002 industry standard, which divides a building into three categories – A, B and C. Category C is defined as the service entrance or main disconnect. Category B is at the distribution and sub-panel environment and Category A is at individual equipment or wall outlets. At a minimum, the standard requires protection at the service entry (C) and distribution point (B) that serves a sensitive load.

Start your protection at the service entry and main distribution panels, providing basic protection from all external sources of electrical spikes and surges.

Strategy 2: Protect incoming power close to every piece of sensitive equipment

The ANSI/IEEE C64.41.2-2002 standard goes on to recommend that maximum protection requires a surge suppressor at all three locations (A,B, *and* C).

Note that simply having a surge protector doesn't guarantee the safety of your equipment. The surge protector needs to be strong enough to handle the regular surges and spikes in your application.

DITEK® Surge Protection

Be sure that your surge protection is properly sized and grounded to prevent equipment damage.

Strategy 3: Ensure proper surge protection placement

For maximum protection, surge protection devices should be installed as close to each piece of sensitive equipment as possible. Ground conductors should be as short and straight as possible to minimize the resistive path of the circuit to ground. A solid connection to the system grounding conductor is essential for proper operation of surge protection devices. If possible, they should be equipped with indicators that show if the circuit is grounded and operating properly, and the units should be installed so these indicators can be easily inspected.

Strategy 4: Protect every wired connection to sensitive equipment

As described above, power connections are not the only entry point for damaging surges and spikes – data cabling, telephone wiring, antenna cabling, and similar connections can also carry damaging surges into sensitive equipment. Special surge protection devices are available to protect these kinds of connections, and care should be taken to protect all possible electrical paths.

Adding surge protection on all essential devices helps not only to protect them from power surges, but also to prevent them from disseminating surges along their network. To ensure proper protection, surge protectors should be installed between devices, as well as at each device, to prevent surges both from damaging equipment and from travelling between devices. As an example, each camera in a video surveillance system needs two devices: one camera-specific surge protector on the video cable near the camera, and one mounted at the camera's power source.

Typical protectors designed for this purpose include those for shielded Ethernet, PoE, and PoE extender circuits in both individual and multi-channel configurations. PoE devices warrant extra attention and protection – they are much more likely to send a surge along a network to damage other devices and systems because they are already carrying power using data cables.

Protectors are also available for antenna cabling, and for bidirectional amplifier (BDA) systems. Because BDA systems are used to ensure the effectiveness of first responder radio systems in building basements, parking lots, and other areas, surge protection for these systems is now required in an increasing number of areas of the country.

Strategy 5: Protect all wires that run underground or are attached to steel building frames

Because of their nature, these cables are particularly susceptible to possible water-induced short circuits and natural causes of electrical surges. Protecting these cables is similar to protecting the utility lines at building entry – it is intended to create a basic perimeter of protection and prevent external sources of surges.

Strategy 6: Institute a preventive maintenance inspection program to check surge protection devices monthly, and immediately following local lightning strikes

Surge protectors are designed to sacrifice themselves in order to save the more expensive, more essential

DITEK® Surge Protection

equipment they protect. A consistent program to identify damaged and destroyed surge protectors ensures that they are replaced when they are no longer functional.

Strategy 7: Make use of surge protection with audible alerts

This is really an extension of strategy 6 that will further reduce the risks of system damage.

The inherent weakness of even a regular maintenance inspection program is that the damage to SPDs is cumulative, and mostly unseen. Many SPDs have some kind of indicator, usually LEDs, that stop working when the SPD has reached the end of its life. Still, this may not solve the problem. How often can management send someone around to every closet and equipment room to check every single surge protector?

This means that during an inspection, the SPD can be operating but at any moment after the inspection is completed and the inspector turns away, a small unnoticed electrical surge could end the life of the device, leaving the “protected” system completely unprotected.

The best way to solve this problem is by using a **smart SPD with audible alarm.** When the unit stops functioning, it should alert the user – loudly – that it’s time for a replacement. This virtually eliminates the problem of an SPD becoming non-functional without the user realizing it. Ideally, the unit should also alert the user via flashing red LED light for visual confirmation and offer dry contacts for connectivity to alarm panels and direct notification to management.

Conclusion

Power surges and spikes have a range of possible sources, including natural, man-made, and systemic. None of these sources is decreasing – on the contrary, they are a direct and growing threat to the electronic systems we have come to rely on.

Organizations depend on electronic equipment and systems now more than ever, for safety and security, for communications, and for daily operations. Losing the use of these systems, even temporarily, can cause significant hardship, so it makes sense to take prudent steps to protect them from damage, including damage from power surges and spikes.

To protect sensitive electronic systems from damage and avoid costly downtime, surge protection is an intelligent investment. Incorporating surge protection into a facility is easy and affordable, because effective, low-cost devices are available to protect against the damaging effects of power surges, both for supplied power and for unwanted power on other conductive paths.

If you need help determining your protection needs, take the time to speak with a surge protection expert who can review your situation and make suitable recommendations. Reputable companies that specialize in surge protection may also offer free site surveys to help you achieve the most effective solution. Contact us for more information!

DITEK® Surge Protection