Why surge protection is necessary

A White Paper presented by:
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INSPIRING INNOVATIONS

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Modern industrial, commercial, and residential life depend on the availability of electricity. The electricity supplied must be at a level of quality to facilitate efficient performance of today's sensitive electronic equipment.

Our dependence on electricity and the prevalence of more and more sensitive electronics make a reliable source of high quality power essential to modern life. Yet, disruptions can and do occur. In fact, one estimate by utility industry experts suggests that power-related problems cost U.S. companies more than $80 billion a year. When evaluated from a system level, effects on business include: high maintenance costs, high production costs, production delays, lost sales, late deliveries, an idle workforce, and increased spoilage and scrap. (Source: Lawrence Berkeley National Laboratory). Surge protective devices (SPDs) protect sensitive electrical equipment from harmful surges.

Surges defined

Surges are a natural result of any electrical activity. They have always occurred in electrical systems; however, the reliance on equipment containing sensitive electronics has increased the need to control the damaging effects of surges on electrical systems.

What is a surge? A rule-of-thumb definition of a surge is a voltage of at least two times the system's root mean squared (RMS) voltage with a duration measured from one to several hundred microseconds. For example, in a 120 V AC electrical system, a short impulse less than one millisecond greater than 240 V would be a surge. In a 480 V AC system, a short impulse greater than 960 V would be a surge. Surges must not be confused with swells and overvoltages. SPDs are designed to protect against surges and not other power quality issues such as swells and overvoltages.

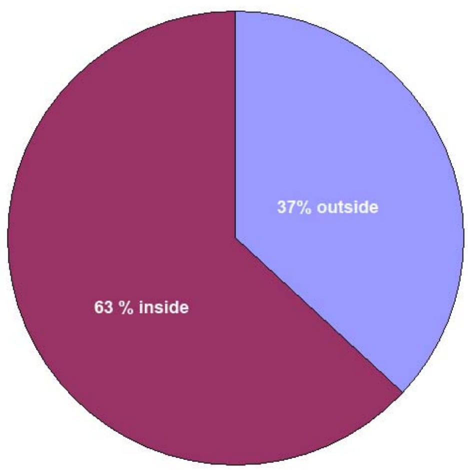

Figure 1: Source of surges to a facility

An estimated 63 percent of surges originate from within a facility. These surges are caused by internal events such as: motors starting and stopping, load dynamic changes on larger production machines, light load panels switching on and off, etc. The remaining 37 percent of surges originate outside of the affected facility. These surges are caused by external events such as lightning strikes, utility grid switching, switching of capacitor banks, electrical accidents, etc.

A **swell** is a temporary increase in the RMS value of voltage of more than 10 percent at the power frequency for durations of eight milliseconds to one minute. An **overvoltage** is a long duration RMS voltage variation at least 10 percent greater than the nominal voltage for a period of time greater than one minute. SPDs do not address swells or overvoltages.

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How surges cause damage

Some examples of business costs associated with surge damage include: high maintenance costs, high production costs, production delays, lost sales, late deliveries, an idle workforce, and increased spoilage and scrap. Uncontrolled, surges can and will cause damage to sensitive electronic equipment. The three main types of damage are:

- **Destructive** – Sudden incidents where equipment is destroyed. External surges are the primary cause.
- **Dissipative** – Long-term damage to systems and electronics created by poor power quality. Internally generated surges are the main cause.
- **Disruptive** – Interruptions to industrial process, including downtime and/or loss of data. It is often difficult to identify the cause of disruptive damage.

Destructive damage causes expenses in two areas: replacement/repair cost of the device and unplanned system downtime. The replacement/repair cost of a device can equal the cost of the surge protection. The cost of downtime can run from thousands of dollars per hour to per minute. The mean-time to repair (MTTR) includes time to diagnose, obtain replacement parts, install the parts and restart the equipment. Obtaining replacement parts can run from under an hour, if the parts are located on site, to days, if the parts need to be ordered. Equipment located in remote sites has additional travel time added to MTTR and downtime.

Dissipative damage is the shortened life of equipment. Many small, low level surges stress components on equipment, causing a failure and unplanned downtime. Sometimes this is more noticeable in larger facilities. One indication is certain equipment having a longer life in one area of the site than another.

Disruptive damage interrupts a process. A surge might cause a signal loss or an alarm, stopping a process until the fault is cleared.

Devices to address surges

The surge products available fall into four categories:

1. Power
2. Instrumentation and control
3. Data
4. Wireless antenna/coax

To properly protect a device, the input power needs to have protection. Additionally, if there are any communications/signal/data lines entering the device, protection should be installed. Surge protection placed at the electrical utility service entrance is unlikely to protect against internally generated surges. An antenna for a wireless radio system, placed outside the facility, should have protection placed on the coax cable. Providing solutions to specific applications is outside of the scope of this paper. Please see other Phoenix Contact white papers and application notes for detailed application protection.

The vast array of electronic equipment used in today's businesses and homes requires that power quality issues be addressed by the installation of state-of-the art SPDs.

Role of design in enhancing performance and safety

Surge protection design objectives appear to be very obvious and straightforward – clamp as tightly as possible and handle more current than expected at the installation location. Determining these seemingly simple design objectives has proven challenging to design engineers, users and the standards committees at IEEE, UL and NEC. An SPD can be subjected to extreme electrical events. End-of-life failure mode is an important design factor. SPD products must fail in a safe manner.

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SPD products that are appropriately protected for end-of-life and fault currents should be selected. Products meeting these high safety standards minimize the risk of surges, both internal and external, providing safe, reliable performance. These standards vary by surge protection categories and will be listed on the product specification data sheets.

Conclusion

A quality SPD minimizes the risk of surges, both internal and external, to provide safe, reliable performance. Properly designed and applied SPD products protect sensitive electrical equipment from harmful surges. Surge protection reduces business costs associated with poor power quality. Unplanned downtime is expensive and a major drain on budgets. Installing SPDs on power, signal, wireless/antenna, and data lines provides complete protection. Whether included as an integral component of the original system design or added as a retrofit product, consideration must be given to the safe, effective control of surges.

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