Life Is On | Schneider Electric

Active Surge Monitoring in Power Distribution Systems

White Paper

Active Surge Monitoring in Power Distribution Systems

A Proactive Approach for Characterizing and Mitigating Surge-Related Risks

Standard approaches to mitigating risks from transient overvoltages do not provide information to characterize the occurrence of transient overvoltages or confirm the adequacy of Surge Protective Device (SPD) performance. This document describes an approach to obtain this information using Active Surge Monitors and summarizes the benefits it brings to end-users.

THE BASIS FOR STANDARD SURGE PROTECTION STRATEGIES

Electrical power distribution systems are subject to temporal power conditions that are often termed "surges". In common use, this term inaccurately includes events such as voltage sags, voltage swells, and other abnormal electrical conditions. While each condition is undesirable, it is high-energy, short-duration transient overvoltages that often present specific risks to electrical equipment. These transients peak at thousands of volts within a few microseconds and decay nearly as quickly. For example, UL 1449, the safety standard for SPD safety testing, specifies a test voltage waveform that peaks in 8 microseconds and decays to half of peak voltage in 20 microseconds. A conceptual waveform is shown in Figure 1. For more information about the distinguishing features of transient overvoltages, refer to our paper entitled *Surges and SPDs Defined*.

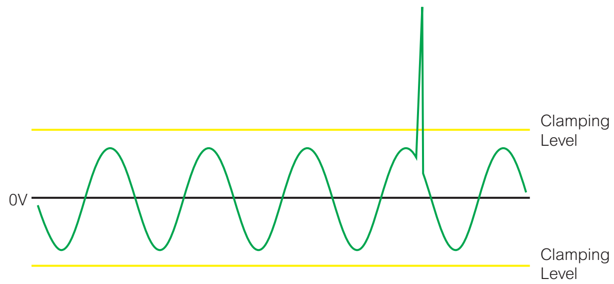


Figure 1: Sub-cycle transient overvoltages occur and decay quickly.

Figure 2: The ASCO Model 460 can be used to mitigate transient overvoltages to protect sensitive electronic equipment.

When they occur, transient voltages can impact the operations and reliability of electrical components and equipment. In the most dramatic examples, strong unmitigated transient overvoltages can damage electronic components, disrupting equipment operation or leaving equipment inoperable. More commonly, repetitive transient overvoltages can degrade solid-state components over time, leading to premature failures. For sensitive IT equipment and machines controlled by programmable logic controllers (PLCs), high-energy short-duration disturbances can disrupt digital processing, causing errors or failures. For these reasons, SPDs are installed in power distribution systems and at sensitive loads to protect load equipment from transient overvoltages (Figure 2).

Importantly, transient overvoltages originate from both outdoor and indoor sources, with transients from outdoor sources such as lightning and utility switching typically entering at the service entrance, and indoor sources originating from equipment switching and high-frequency devices. ANSI C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits, has characterized the surge environment in buildings so that SPDs can be placed in power systems to mitigate expected transients. IEEE 1100 - IEEE Recommended Practice for Powering and Grounding Electronic Equipment, recommends cascading SPDs at different levels throughout distribution systems to provide comprehensive protection. SPD manufacturers support cascaded solutions for addressing common surge risks by offering SPDs in various types, capacities, and form factors. By installing appropriate SPDs at the service entrance, distribution panels, and sensitive load equipment (Figure 3), surge activity can be mitigated throughout a power distribution system (Figure 4).

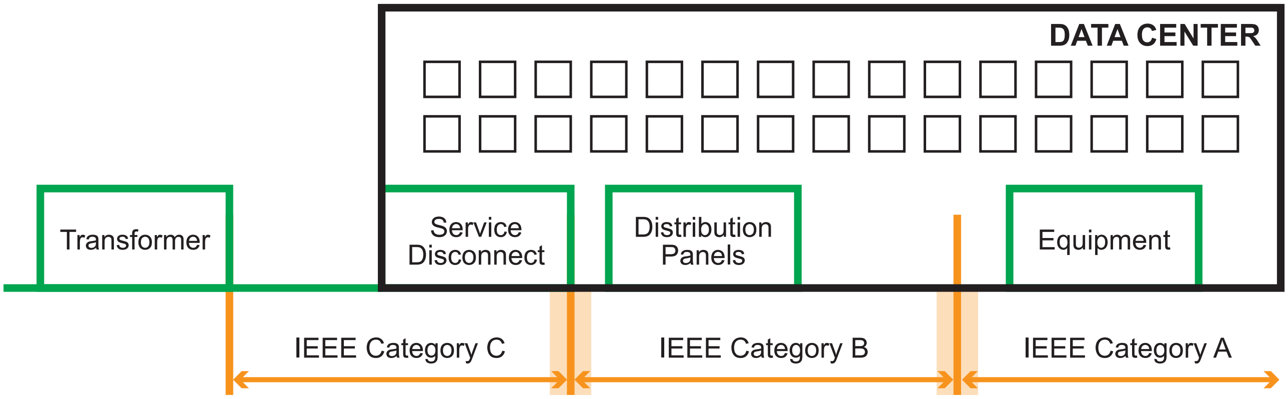


Figure 3: Industry Standards classify the surge environment into three types by distance from the service entrance.

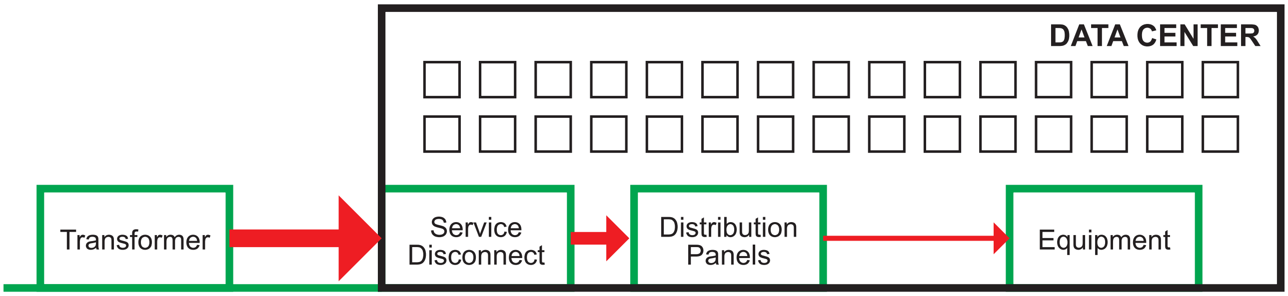


Figure 4: Installing SPDS at two or more appropriate locations provides "cascaded" protection for mitigating surges.

THE CASE FOR ACTIVE SURGE MONITORING

Industry standards provide a logical basis for implementing basic surge mitigation strategies. Installing SPDs at service entrances, panelboards, and sensitive and high-value equipment can provide adequate surge protection. Nevertheless, it is important to recognize that these protection strategies rely on generalized guidance about the occurrence of transient overvoltages, and not on facility-specific data.

Following installation, conventional SPDs may offer little information about their status and condition, or the electrical anomalies to which they are exposed. Some SPDs provide indicators that signify their level of function or dysfunction, and some offer surge counters that quantify transient overvoltages exceeding specific thresholds. (For more information, review our white paper entitled *Monitoring SPD Condition*.) Nonetheless, SPDs cannot provide detailed historical or real-time information about surges or other voltage anomalies in power distribution systems.

Without facility-specific information, facility managers cannot evaluate whether standard surge mitigation strategies are adequately protecting systems and equipment. Disruptions in electrical systems that power high-value revenue-generating equipment may cause more expensive losses than disruptions in electrical systems powering other types of loads. If the average revenue from a hospital's typical one-hour Magnetic Resonance Imaging (MRI) study is $2000, 30 hours of lost time on a single MRI machine could amount to $60,000 in lost revenue, plus the expense of services and goods required to restore this complex equipment. In data centers, transient overvoltages could cause downtime that violates Service Level Agreements, incurring the direct expense of significant contractual penalties and the tangential costs of a damaged business reputation. In high-tech manufacturing, electrical damages to robotic equipment can profoundly impact both revenue and expenses.

Monitoring the surge environment can enable proactive and protective measures commensurate with business and financial risks. This approach can be compelling for facilities that cannot tolerate operational disruptions and equipment failures.

THE KEY TO EFFECTIVE SURGE MONITORING

In order to detect fast transients, equipment must be able to sense and record overvoltages that develop in 8 microseconds. Relying on a single data point could result in inaccurate data. A more reliable approach is to rely on two successive measurements to trigger transient identification and recording. The necessary sampling interval thus becomes 4 microseconds, which corresponds to a rate of 250,000 voltage measurements per second. In a 60-Hertz system, this equates to 4,166 measurements per cycle. Only voltage monitoring equipment with fast sampling rates can obtain the data needed to assess the occurrence and characteristics of transient overvoltages at locations across a power distribution system.

A PROACTIVE APPROACH TO EFFECTIVE SURGE ENVIRONMENT CHARACTERIZATION

To track the occurrence of surges, a monitoring solution must record actionable data for subsequent review. If a facility realizes the need to monitor transient overvoltages only after its operations and equipment are impacted by surges, it will expend considerable funds and time before conditions reoccur that would enable forensic analysis of power data. Instead, proactively installing and operating a transient overvoltage monitoring system ensures that users can be notified of surge events in real-time and that associated data will be recorded for subsequent evaluation.

Using real-time data, facility managers can receive instant notification of surge events or other voltage anomalies so they can take responding action. By capturing and comparing surge data, facility managers can characterize the nature and potential source of recorded surge events; assess the adequacy of existing SPDs; and evaluate the effects of operational, spatial, and temporal changes in the facility on the occurrence and frequency of surges. The locations where SPDs are installed are well-suited for monitoring and characterizing surge activity in power distribution systems. Because SPDs are usually located at service entrances, panelboards, and key equipment locations, adding devices to measure and record voltage information at some or all of these locations would provide the detailed information needed to evaluate actual surge risks. The concept is shown in Figure 5.

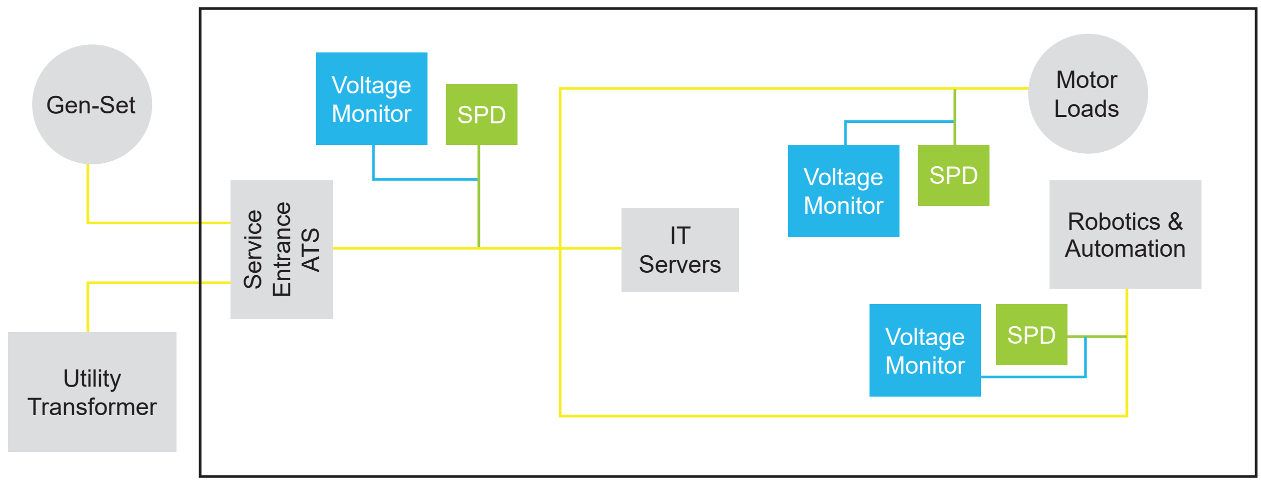


Figure 5: SPDs and Voltage Monitoring Devices Can Enable Comparisons Across a Power Distribution System

The work involved to engineer a custom system to monitor and record transient overvoltages, harmonics, and other power disturbances is beyond the resources of most end-users. To simplify this solution, an SPD and a voltage monitoring device can be integrated into a single unit, as shown in Figure 6. The resulting Active Surge Monitors provide both surge protection and visibility into the surge environment.

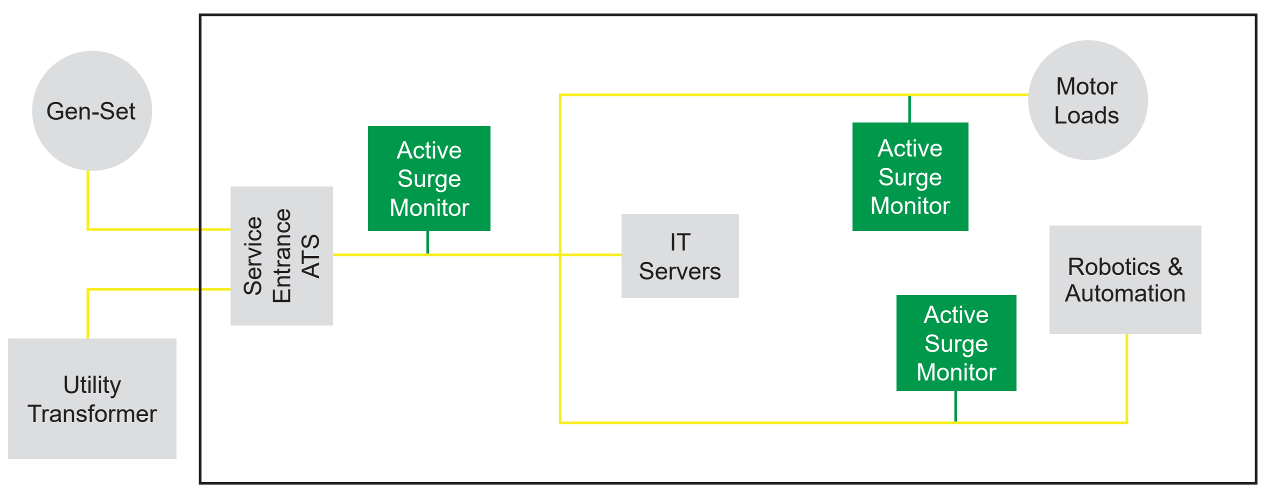


Figure 6: Active Surge Monitors contain SPDs and voltage monitoring components. They provide a unified solution for characterizing and mitigating transient overvoltage events.

FEATURES OF AN ACTIVE SURGE MONITOR

Integrating a voltage monitor, SPD, and other electronic devices into a single unit can provide advanced electronic data management and communication capabilities. The data logs provided by such devices can be used to proactively mitigate surge-related risks. Using this approach, the following data management and communication features can be made available at every monitored location. A sample voltage monitoring event log is shown in Figure 7.

Data Management

Real-time voltage measurements, including:

- RMS Voltage
- Frequency
- Voltage
- Total Harmonic Distortion
- Crest Factor
- Voltage Imbalance

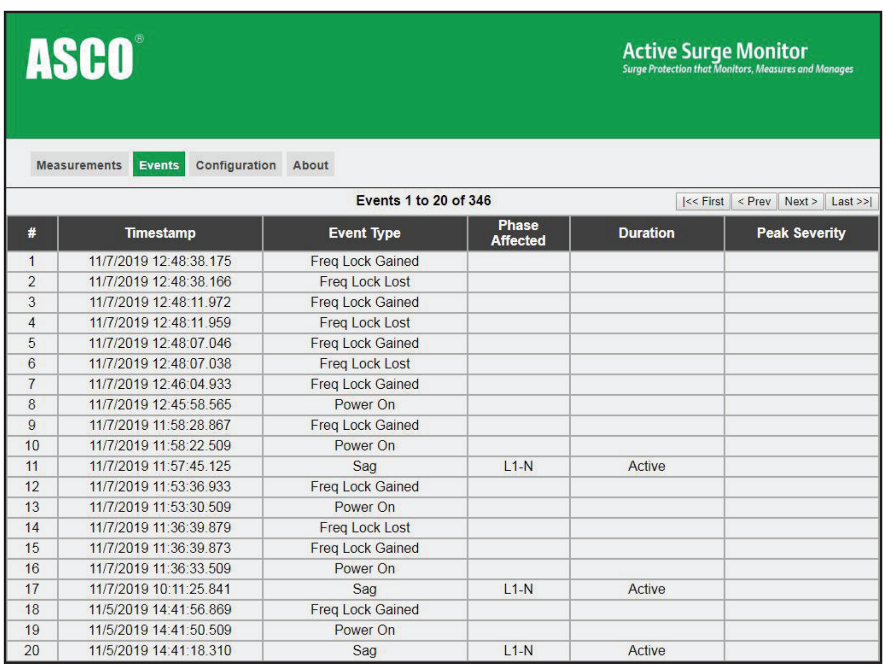
Timestamped logging of:

- Surges
- Sags
- Swells
- Other Voltage-Related Data

Data archiving for subsequent evaluation

Communications

- SPD Component Status Indication
- On-Device Display of Monitored Parameters
- Relays for Remote Alarming or Annunciation
- Webpage for Displaying Historical Data
- Data Feeds to a Building Management System via Modbus RTU or Modbus TCP/IP
- Real-Time Email Messaging to Mobile Devices
- Automatic Reporting of Surge Events



#	Timestamp	Event Type	Phase Affected	Duration	Peak Severity
1	11/7/2019 12:48:38.175	Freq Lock Gained			
2	11/7/2019 12:48:38.166	Freq Lock Lost			
3	11/7/2019 12:48:11.972	Freq Lock Gained			
4	11/7/2019 12:48:11.959	Freq Lock Lost			
5	11/7/2019 12:48:07.046	Freq Lock Gained			
6	11/7/2019 12:48:07.038	Freq Lock Lost			
7	11/7/2019 12:46:04.933	Freq Lock Gained			
8	11/7/2019 12:45:58.565	Power On			
9	11/7/2019 11:58:28.867	Freq Lock Gained			
10	11/7/2019 11:58:22.509	Power On			
11	11/7/2019 11:57:45.125	Sag	L1-N	Active	
12	11/7/2019 11:53:36.933	Freq Lock Gained			
13	11/7/2019 11:53:30.509	Power On			
14	11/7/2019 11:36:39.879	Freq Lock Lost			
15	11/7/2019 11:36:39.873	Freq Lock Gained			
16	11/7/2019 11:36:33.509	Power On			
17	11/7/2019 10:11:25.841	Sag	L1-N	Active	
18	11/5/2019 14:41:56.869	Freq Lock Gained			
19	11/5/2019 14:41:50.509	Power On			
20	11/5/2019 14:41:18.310	Sag	L1-N	Active	

Figure 7: Active Surge Monitor Data Log

With this feature set, users can gain visibility into real-time surge activity through local displays, remote annunciators, networked building monitoring systems, and mobile devices. They also collect timestamped voltage measurements for characterizing baseline surge environments, assessing changes in surge activity over time, and conducting forensic analysis of specific power quality events. These capabilities enable a proactive strategy for managing surge risks that is otherwise unavailable, and provide the detail and context required for fast and meaningful responses to surge events and issues. Using Active Surge Monitors, these capabilities become available through the installation of a single piece of equipment while foregoing design and installation of multiple electronic devices (Figure 8).

Figure 8: ASCO Power Technologies offers Active Surge Monitoring on select models in its premium 400 product line. To learn more, visit [*surge. ascopower.com*](surge.ascopower.com).

SUMMARY

Conventional surge mitigation strategies rely on industry standards and electrical codes to protect against foreseeable risks from transient overvoltages. However, SPDs do not provide comprehensive information about the surge environment in an electrical power distribution system, or about how the characteristics of that environment or the SPDs may change over time.

Using voltage monitoring devices with high sampling frequencies enables users to characterize the occurrence and nature of fast overvoltage transients. Installing these across a distribution system promotes comparison of surge environments, forensic analysis of surge events, and proactive planning regarding surge risks.

Combining voltage monitoring devices and SPDs into a single Active Surge Monitor streamlines deployment and operation, and provides for data storage and web-enabled communications for real-time visibility to local, remote, and mobile users. The foresight afforded by this approach allows users to evaluate historic data, react to events in real-time, and plan surge mitigation strategies commensurate with the importance and value of mission critical equipment.

Schneider Electric
6700 Tower Cir #700
Franklin, TN 37067

se.com/us/en/work/support
1-888-778-2733

WP-50034 RevB 11/2021