APPLICATION NOTE

Designing Effective Surge Protection for Data Centers

Bourns® Model 1210 Series
Surge Protective Device (SPD)

Bourns® Model 1220 Series
Surge Protective Device (SPD)

Bourns® Model 1250A Series
Surge Protective Device (SPD)

Bourns® Model 1260 Series
Surge Protective Device (SPD)

Bourns® Model 1270 Series
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Bourns® Model 1280 Series
Surge Protective Device (SPD)

Introduction

Data centers are the backbone of today's modern digital infrastructure. This important equipment is used to house AI processing systems, servers, storage systems, and networking equipment that support various applications and services. Because reliability and uptime of data centers is paramount, surge protection needs to be an essential component in their design to help safeguard against electrical disturbances.

This application note explores why surge protection is a necessity for data centers, and outlines the recommended steps for selecting the right Surge Protective Device (SPD) for these applications. It also provides installation guidelines, discusses relevant certifications, and presents a data center system diagram example with suggested SPD solution options.

Why Do Data Centers Need Surge Protection?

Data centers are vulnerable to transient voltage surges caused by lightning strikes, power grid switching, and internal electrical noise. These surges can damage sensitive equipment, leading to costly downtime, data loss, and can significantly limit the anticipated lifespan of equipment. Following are the main reasons data center designers should include surge protection:

- **Equipment Protection:** Surges can damage critical components such as servers, storage devices, and network switches, leading to costly repairs and replacements.
- **Data Integrity:** Voltage spikes can corrupt data, causing data loss and impacting business operations.
- **Economic Impact:** Downtime due to surge-related equipment failure in data centers can severely disrupt continuous operation expectations, resulting in substantial financial losses and impacting service availability.
- **Regulatory Compliance:** Adhering to industry standards and regulations often requires the implementation of effective surge protection measures.

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Steps for Choosing the Right SPDs

Selecting the appropriate SPDs for data centers involves considering the types of surges, the criticality of equipment, and the overall electrical infrastructure. A three-stage protection strategy is recommended in order to implement a comprehensive surge protection solution.

Three-Stage Protection Strategy

1. Primary Protection (Service Entrance)

- **Purpose:** The primary protection is the first line of defense against large, externally originating surges, such as those caused by lightning strikes or disturbances in the power grid. These surges typically enter the electrical system through the service entrance, making it crucial to install robust protection at this point to prevent damage to downstream systems and equipment.
- **Recommended SPDs:** High-capacity surge protective devices with the ability to handle significant surge currents are recommended for installation at the service entrance. These SPDs are designed to protect the entire electrical system from the most severe surges and are typically classified as Type 1 SPDs according to UL 1449 standards. The Nominal Discharge Current (I_n) for Type 1 SPDs usually falls within the 10 kA to 20 kA range, allowing them to effectively manage and dissipate large surges before they can penetrate deeper into the electrical system.

2. Secondary Protection (Distribution Panels)

- **Purpose:** Provides additional protection by preventing residual surges that may have passed through the primary protection from propagating further into the electrical distribution system.
- **Recommended SPDs:** Medium-capacity SPDs are installed at distribution panels to safeguard branch circuits. These are typically classified as Type 2 in accordance with UL 1449. The Nominal Discharge Current (I_n) for Type 2 SPDs can vary, typically ranging from 3 kA, 5 kA, 10 kA to 20 kA, depending on the application and the level of protection required.

3. Tertiary Protection (Point of Use)

- **Purpose:** Protects sensitive and critical equipment like servers and networking devices directly at their power inputs, minimizing downtime and damage.
- **Recommended SPDs:** Low-capacity, high-performance SPDs are installed close to critical equipment. These devices are typically classified as Type 3 in accordance with UL 1449. The Nominal Discharge Current (I_n) for Type 3 SPDs is generally lower, with typical values of 3 kA to 5 kA, ensuring that sensitive equipment receives the appropriate level of surge protection without being exposed to unnecessary risks.

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Steps for Choosing the Right SPDs (Continued)

SPD Selection Considerations

1. **Assess the Risk:** Evaluate the data center's vulnerability to surges based on location, power quality, and historical data.

2. **Determine Protection Levels:** Identify the appropriate protection levels required for each stage (primary, secondary, tertiary).

3. **Select SPD Types:** Choose SPDs designed for AC and DC applications, ensuring compatibility with the data center's power systems.

4. **Consider Performance Ratings:** Look for key specifications such as Maximum Continuous Operating Voltage (MCOV), Voltage Protection Rating (VPR), and surge current capacity.

5. **Ensure Compliance:** Verify that selected SPDs meet relevant standards and certifications.

SPD Installation Steps for Data Centers

Proper installation of SPDs is crucial to ensuring effective surge protection. The following guidelines should be followed:

1. **Location**
   - Install SPDs as close as possible to the protected equipment to minimize lead lengths and impedance.

2. **Bonding and Grounding**
   - Ensure proper bonding and grounding to provide a low-impedance path for surge currents.

3. **Coordination**
   - Coordinate SPDs to ensure that primary, secondary, and tertiary protectors work together without interference.

4. **Regular Maintenance**
   - Periodically inspect and maintain SPDs to ensure continued effectiveness. Proactively replace any SPDs that have experienced significant surge events.

5. **Compliance with Standards**
   - Follow installation guidelines provided by manufacturers and ensure compliance with local electrical codes such as National Electrical Code (NEC) and National Fire Protection Association, where applicable, and safety standards.

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Common SPD Standards

SPDs for data centers must comply with various standards to ensure safety and performance. Key certifications include:

UL 1449 (5th Edition)
This U.S. standard focuses on the performance and safety of SPDs. It covers parameters such as voltage protection ratings (VPR) and nominal discharge current (I_n).

IEC 61643-11
This international standard specifies the requirements and tests for SPDs used in low voltage power distribution systems. It includes tests for nominal discharge current (I_n), maximum surge current (I_{max}), impulse current (I_{imp}), and voltage protection levels (U_p).

IEEE C62.41.2
This standard provides guidelines for surge testing in AC power systems, helping to determine the SPD's ability to withstand and protect against surges.

EN 61643-11
This European standard aligns with IEC 61643-11, ensuring SPDs meet stringent safety and performance criteria.

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Data Center System Diagram with SPD Protection

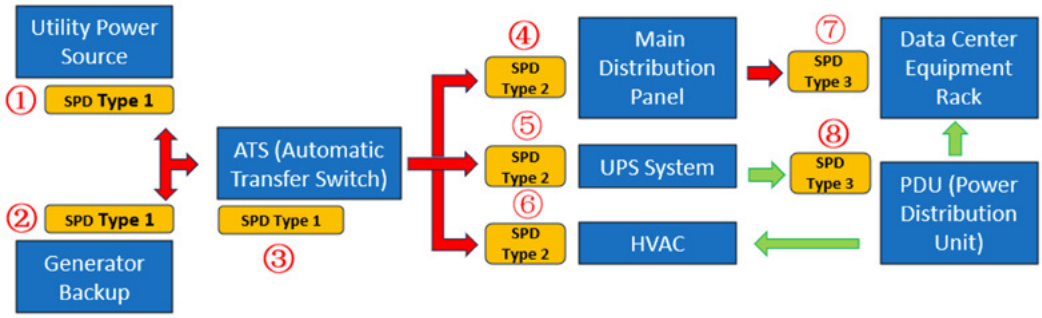

Table 1. | *The simplified data center power system diagram above includes recommended SPD type devices*

Key Components / Location	Function Description	Suggested Bourns® SPD Series	Standards
1. Utility Power Source	Provides primary power to the data center.	1210 Series	UL 1449 5th Ed. Type 1
2. Generator Backup	Provides backup power during outages.	1260 Series	IEC/EN 61643-11 Class I + II / T1 + T2
3. ATS (Automatic Transfer Switch)	Switches power source between utility and generator.	1270 Series	IEC/EN 61643-11 Class I / T1
4. Main Distribution Panel	Distributes the AC power to various loads.	1250A	UL 1449 5th Ed. Type 2CA
5. UPS System	Provides uninterrupted power supply.	1280 Series	IEC/EN 61643-11 Class II / T2
6. HVAC	Manages heating, ventilation, and air conditioning.	1220 Series	UL 1449 5th Ed. Type 2CA
7. Data Center Equipment Rack	Houses servers and network equipment.	1250A	UL 1449 5th Ed. Type 2CA
8. PDU (Power Distribution Unit)	Distributes power to equipment in the rack.	1280 Series 1220 Series	IEC/EN 61643-11 Class II / T2 UL 1449 5th Ed. Type 2CA

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Conclusion

By applying the three-stage protection approach suggested in this paper and strategically deploying the appropriate types of SPD devices, designers of data centers are able to significantly bolster their resilience against electrical disturbances and avoid the potential damage they can cause. Taking this proactive approach delivers multiple protection and equipment life advantages; namely, it helps safeguard critical infrastructure, prevents costly downtime, preserves data integrity, and aids in ensuring uninterrupted operations. Installing SPDs at the service entrance, within distribution panels, and at the point of use gives users the peace of mind that valuable data center assets are able to maintain vital business continuity.

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