Tips on Selecting the Right Surge Protective Device

WHITE PAPER

Introduction

Surge Protective Devices (SPDs) have become increasingly important in all forms of electric systems to protect electronic devices, electrical circuits, and communication lines from voltage spikes and transient surges. Surges can result from lightning strikes, power outages, switching operations in power grids, or other disruptions that cause a sudden, temporary increase in voltage beyond normal levels. The primary function of an SPD is to limit transient voltages and divert surge currents away from the protected components, thereby helping to prevent damage, reduce downtime, and extend the lifespan of electronic systems.

To help designers select the SPD that is best suited to meet their application requirements, this white paper provides tips on which features and specifications designers need to evaluate to help them narrow down their search.

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SPD OPERATIONAL BASICS

The basic principle of an SPD is to limit the voltage that is applied to electrical equipment and systems to a safe level during transient overvoltage events. SPDs are typically installed at the point where electrical power enters a building or facility, which is commonly the main distribution panel or subpanels. They can also be installed at specific equipment locations to provide localized protection.

SPDs typically contain one or more surge protection components, such as Metal Oxide Varistors (MOVs) and Gas Discharge Tubes (GDTs). SPDs with MOVs are often designed with fail-open features. In the event of a catastrophic surge that exceeds the MOV's capacity, the SPD disconnects the MOV from the circuit, preventing the surge from propagating further or entering into a thermal runaway condition.

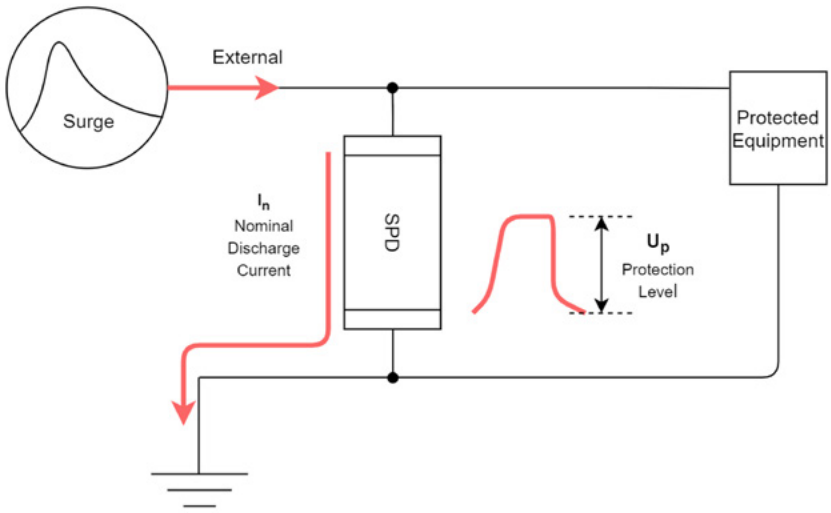

Figure 1. | *Excess voltage being diverted away from the protected circuit*

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WHAT IS THE BEST APPROACH WHEN SELECTING AN SPD?

The best approach when choosing the right SPD involves several steps to confirm that it meets the requirements of the electrical installation, while also providing an adequate level of protection without compromising the system's functionality. Below is a step-by-step guide that helps designers make an informed decision:

Step 1: Check for Safety and Compliance Standards

Determine if the SPD meets relevant standards like IEC 61643-11 (international) or UL 1449 (U.S.) for safety and performance. Make sure to evaluate the SPD's other safety features that could include thermal disconnectors to prevent overheating and arc extinguishing devices for added safety.

Step 2: Determine the Type of SPD Needed

Does the application require a Type 1 SPD that is designed to be installed at the service entrance in order to protect against external surges, such as lightning? Or, does the application require a Type 2 SPD to be used at the distribution board for protection against residual lightning surges and other internal surges within the building? Designers may also need to consider Type 3 SPDs that are installed within close proximity to sensitive equipment, providing protection against surges that might have bypassed Type 1 and Type 2 protection.

Step 3: Review Electrical Specifications

Designers also need to assess the application's electrical specifications to determine the appropriate SPD:

- Nominal Voltage (V_n): Is the SPD compatible with the system's operating voltage?
- Maximum Continuous Operating Voltage (MCOV): This calculation should be above the maximum expected line voltage to prevent the SPD from operating during normal conditions.
- Nominal Current (I_n): Selection should be based on the expected surge conditions and possibly one that exceeds the minimum installation requirements. Higher surge current ratings offer better protection but come at a higher cost.
- Voltage Protection Rating (V_{PR}) or Clamping Voltage (V_c): The lower the V_{PR}, the better the protection, but it should not be too low to avoid unnecessary tripping.

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WHAT IS THE BEST APPROACH WHEN SELECTING AN SPD? (Continued)

Step 4: Consider SPD Configuration and Power System

SPDs are configured in various ways to adapt to the unique characteristics and grounding arrangements of different power system types. The "3+1" and "4+0" configurations of SPDs are particularly suitable for TT and TN-S systems, respectively.

SPD 3+1 Configuration for TT Systems:

TT System Overview:

- In a TT system, the neutral is grounded at the power source only, and each building or facility has its own independent earth ground connection. This configuration is commonly used where the electrical environment is highly sensitive and where safety from electrical faults is a priority, such as in rural areas or individual homes.

- The "+1" signifies an additional protection mode between the neutral and earth. This is crucial in TT systems because the neutral and earth are only connected together at the source, and therefore, potential differences caused by transient voltages between the earth and neutral at the point of use can be significant. This mode protects against these differences, which are a common pathway for surges in TT systems.

SPD 4+0 Configuration for TN-S Systems:

TN-S System Overview:

- In TN-S systems, the neutral and protective earth conductors are separated throughout the entire system. This configuration is typically used in commercial and industrial installations where it's essential to prevent any interference that might be caused by earth faults in the neutral conductor.

- The "+0" indicates there is no specific neutral-to-earth protection, which is appropriate for TN-S systems since the neutral and earth are separated and do not typically encounter transient voltages between them within the installation.

Step 5: Analyze SPD Features and Ease of Maintenance

- Modularity: Some SPDs offer plug-in modules that can be easily replaced after a surge event without removing the entire device.
- Indicators: Visual or remote indicators for operational status can help with maintenance and timely replacement.
- Integration: Verify that the SPD can be easily integrated into your existing electrical setup without extensive modifications.

Step 6: Consult with Professionals

Before making a final decision, it might be beneficial to consult with electrical professionals or engineers, especially for complex installations or to check the right level of protection for highly sensitive equipment.

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WHAT IS THE BEST APPROACH WHEN SELECTING AN SPD? (Continued)

Example of SPD Usage Scenario

A 3-phase 277 VAC TN-S power supply system installed at a North American factory distribution board (requires I_n 20 kA, $V_{PR} \leq 1.5$ kV):

Step 1

Meets the standards UL 1449 5th Ed. for North American market.

Step 2

Type 2 SPDs are suitable for protection at the distribution board application.

Step 3

Voltage Rating – MCOV – higher than system voltage

- 15 % tolerance for the margin: 277 * 1.15 = 318.55 V -> MCOV >= 320 VAC
- Look for an AC SPD with $I_n \geq 20$ kA and $V_{PR} \leq 1.5$ kV

Step 4

SPD 4+0 Configuration for TN-S Systems

Step 5

- DIN rail mountable for easy installation
- Pluggable module for easy replacement
- Degradation failure indication.

Recommended SPD:

Bourns® Model 1250A-4S-277 (MCOV=320 V) SPD meets electrical specifications and power system TN-S 3-phase.

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WHAT IS THE BEST APPROACH WHEN SELECTING AN SPD? (Continued)

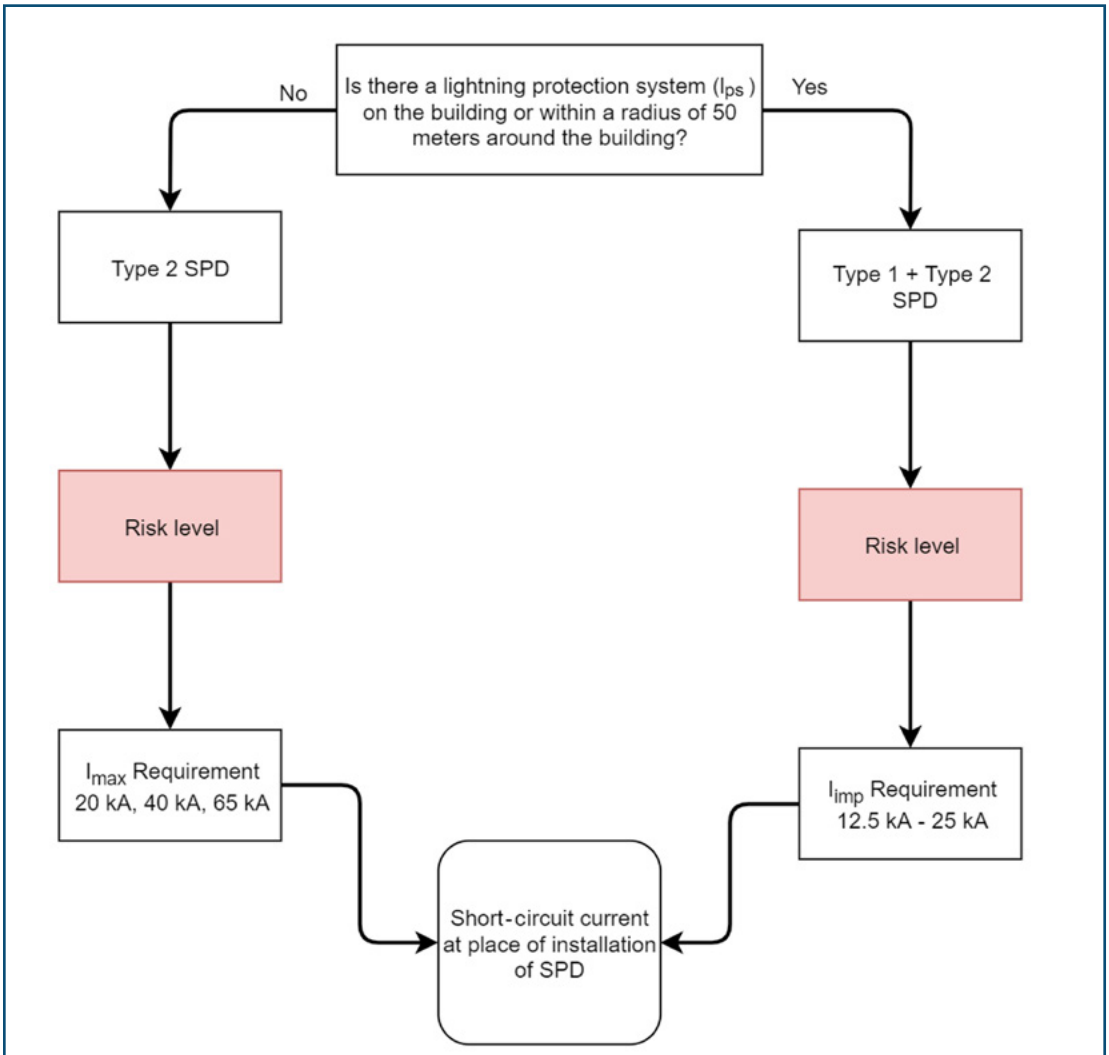

Figure 2. | *Simplified Selection Flowchart*

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Conclusion

By following the steps provided in this paper, designers have a roadmap that helps them select the SPD that provides the appropriate level of protection for their electrical system. Choosing the right SPD makes all the difference in helping to ensure the safety and longevity of valuable equipment.

Bourns leverages its extensive expertise in the development of discrete circuit protection devices in its advanced line of SPD products. Designers are able to select from a broad portfolio of SPD solutions designed to protect AC systems, DC power systems, signal and data line circuits, as well as coaxial networks and CATV.

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