BOURNS®

Surge Protective Device Recommendations for Various AC Power Systems

APPLICATION NOTE

Introduction

In today's increasingly electrified and interconnected world, protecting electrical systems from surge events is no longer optional—it's essential. Electrical surges, often resulting from lightning strikes, switching events, or insulation failures, can severely damage sensitive equipment and disrupt power continuity.

Surge Protective Devices (SPDs) act as a critical safeguard in such situations to limit transient overvoltage. SPDs operate by diverting surge currents safely to earth, protecting both the equipment and the broader electrical infrastructure. Given the diversity of AC power distribution systems—such as TT, TN, and IT—SPD implementation strategies must be tailored to the specific grounding scheme and risk profile of these systems.

This application note outlines the significance of including SPD protection in various AC power systems and explains the main types of earthing systems. It also offers clear recommendations for selecting appropriate SPD types and configurations for specific grounding connections.

Why Do Power Systems Need Surge Protection?

Surges can lead to equipment failure, system downtime, safety risks, and costly repairs. Common causes include:

- **Direct or indirect lightning strikes**
- **Switching of large inductive loads**
- **Resonance effects in long cables**
- **Utility faults or switching operations**

SPDs serve as voltage limiters that prevent transient voltages from reaching dangerous levels. Installed at key points in a system (main panel, sub-distribution, terminal devices), they form a layered defense that protects power reliability and safety.

Types of Earthing Systems – What Does TT, IT and TN Earthing Mean?

Understanding the earthing (grounding) system is crucial when selecting an SPD. The method of earthing determines how surge currents are discharged and what type of coordination is necessary.

TN System

- The neutral is grounded at the source, and equipment Protective Earth (PE) is connected back via a PE or PEN conductor.
- SPDs must be chosen based on proper bonding and segregation of neutral and PE connections.
- Widely used in industrial and commercial systems.
- Variants:
  - TN-S: Separate PE and N conductors.
  - TN-C: Combined PE and N (PEN).
  - TN-C-S: Combination of both—PEN upstream, separated downstream.

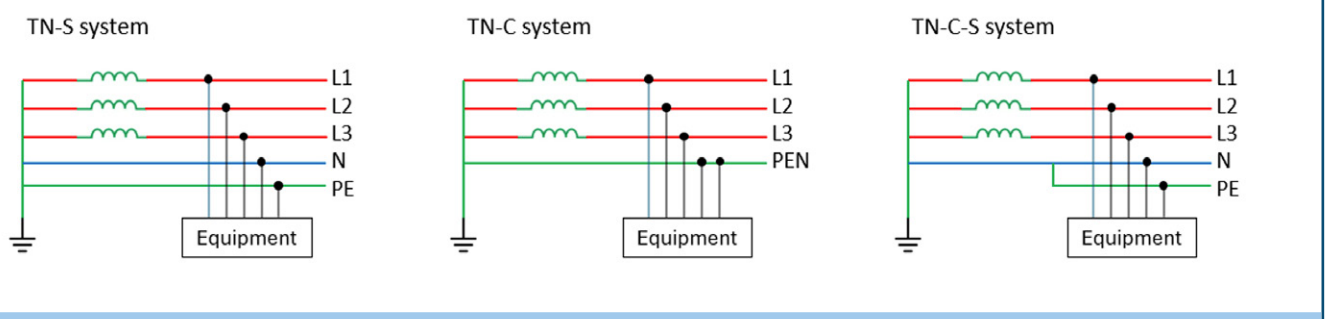

Figure 1. | *TN System Variations*

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TT System

- Neutral grounded at the supply, while the installation has its own local earth electrode.
- Common in rural and telecom installations.
- SPD must work in tandem with RCDs (Residual Current Devices) since fault current levels are low.
- Coordination with the RCD is crucial to avoid nuisance tripping.

IT (Isolated Terra) System

- No direct connection between the system and earth.
- Common in critical facilities (e.g., hospitals, data centers) due to operational continuity during the first fault.

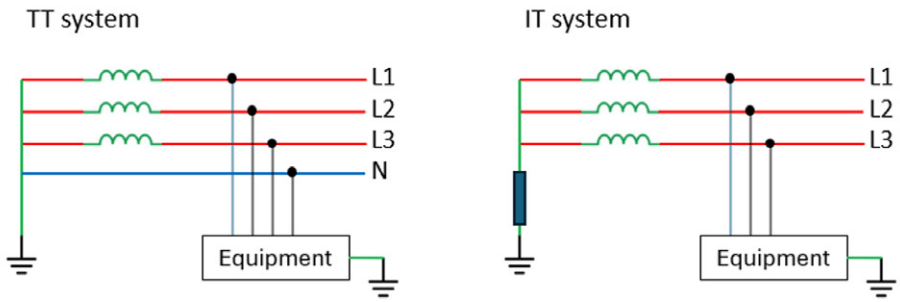

Figure 2. | *TT and IT Systems*

What is the Best Approach in Selecting an SPD?

1. System Voltage and Configuration
   - Confirm nominal voltage (e.g., 230/400 V, 1000 V DC).
   - Check if the voltage is single-phase or three-phase, and the earthing type (TT, TN, or IT).
2. Installation Location
   - Main distribution: Use a Type 1 SPD if exposed to lightning (10/350 µs).
   - Sub-distribution: Employ a Type 2 SPD (8/20 µs) for protection against switching surges.
   - Terminal device: Select a Type 3 SPD for sensitive electronics.
3. Surge Risk Level
   - Apply risk assessment methods (e.g., IEC 62305) to determine exposure.
4. Compatibility with Protective Devices
   - Ensure proper coordination with RCDs and fuses to prevent nuisance tripping.
5. Compliance with Standards
   - Make sure the following standards are met:
     - IEC 61643-11 for SPD performance
     - IEC 60364 for installation
     - UL 1449 for North American compliance

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SPD Configuration and Models Suitable for Different Power Systems

The following table outlines Bourns® SPD series recommendations based on the various power system and the installation location.

Power Systems	SPD Type Required by Location		System Description
	Main Distribution Board	Sub Distribution Board	
TN-C	Type 1 3P SPD 1210-3S-xxx Series	Type 2 3P SPD 1250A-3S-xxx Series	The system combines the neutral and protective earth conductors into a single conductor.
TN-S	Type 1 4P SPD 1210-4S-xxx Series	Type 2 4P SPD 1250A-4S-xxx Series	The system keeps the ground and neutral conductors separate throughout the distribution.
TN-C-S	Type 1 3P SPD 1210-3S-xxx Series	Type 2 4P SPD 1250A-4S-xxx Series	The supply is configured as per TNC, while the downstream installation is configured as per TNS.
TT	Type 1 4P (3+1) SPD 1270-4NS-xxx Series	Type 2 4P (3+1) SPD 1280-4NS-xxx Series	The TT method refers to a protective system that directly grounds the metal housing of an electrical device.
IT	Type 1 3P SPD 1210-3S-xxx Series	Type 2 3P SPD 1250A-3S-xxx Series	Power supply has no direct connection to earth, or it is connected through a high impedance.

Chosen SPDs must match the U_c (continuous operating voltage) of the system, and their U_p (protection level) must be below equipment withstand level.

Conclusion

Surge protection is a foundational element of modern electrical design. From factories to hospitals, the reliability of systems depends on the ability to withstand transient disturbances. SPD selection must be done with careful consideration of the earthing system, system voltage, surge exposure, and coordination with protection devices.

Whether it's a TT rural installation, a TN-C-S building, or an IT system in a critical environment, correctly applied SPDs drastically reduce downtime, enhance safety, and protect a company's capital investment. By integrating robust SPD solutions, such as those offered by Bourns, power system architectures are fortified against unpredictable electrical threats and align with global safety standards.