Surge Protective Devices (SPDs) with an Advanced Thermal Disconnector (TD+) Provide Enhanced Electrical Safety

WHITE PAPER

Introduction

Surge Protective Devices (SPDs) play a critical role in safeguarding electrical systems from transient voltage spikes. These spikes, often caused by lightning strikes or switching operations, can damage equipment and pose safety hazards. Modern SPDs incorporate thermal disconnectors and arc extinguishing devices, representing a significant advancement in surge protection technology.

This paper explores the operation, benefits, and regulatory significance of these enhanced features, highlighting how each contributes to improving electrical safety:

- **Operation:** Explains how thermal disconnectors automatically interrupt current flow in case of excessive surge or internal component failure, preventing overheating and potential fire hazards. The operational capabilities of arc-extinguishing devices during surge events and why they are needed to enhance overall safety are also described.
- **Benefits:** Highlights the improved fire safety, increased equipment longevity, reduced downtime and high system reliability advantages that can be achieved by reducing surge exposure.
- **Regulatory Importance:** Learn about the relevant regulations and standards that mandate or recommend the use of SPDs with advanced features, underlining their growing importance in meeting electrical safety compliance.

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SPDs and the Risk of Thermal Runaway

SPDs, also known as transient voltage surge suppressors, safeguard electrical circuits from voltage spikes and surges caused by lightning strikes, power outages, and switching transients. They achieve this protection by diverting excess voltage away from the protected circuit (Figure 1), primarily through Metal Oxide Varistors (MOVs). However, MOVs are susceptible to degradation over time, especially after absorbing repeated or particularly powerful surges. This degradation can lead to a phenomenon known as thermal runaway, a condition where the SPD loses its protective function and instead conducts electricity continuously. This continuous conduction generates heat, posing a risk of overheating, damage to the SPD itself, and potentially a fire (Figure 2).

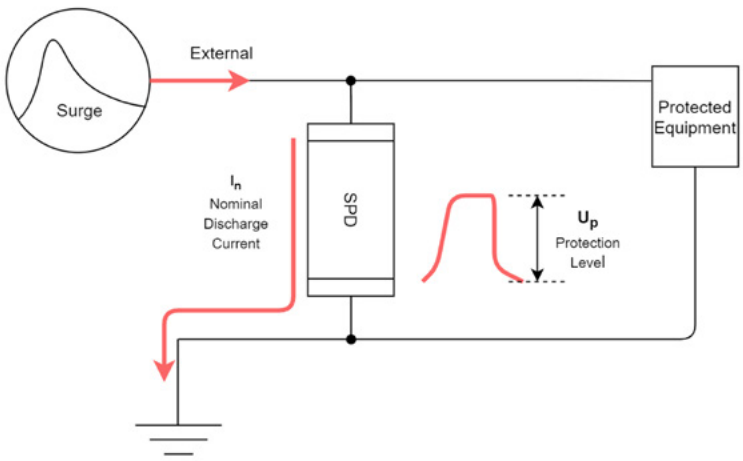

Figure 1. | *Excess voltage being diverted away from the protected circuit*

Figure 2. | *Examples of overheating and damage to electronics*

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Advanced Thermal Disconnector (TD+) Technology in SPDs

The Advanced Thermal Disconnector (TD+) represents a significant advancement in SPD technology, offering a comprehensive solution to mitigate thermal runaway risk. It integrates two critical safety features (Figure 3):

- **Thermal Disconnection:** Similar to traditional thermal disconnectors, a TD+ detects excessive heat buildup within the SPD. It then triggers a swift disconnection of the overheating component from the electrical circuit, preventing further damage and fire hazards.
- **Arc Extinguishing:** During disconnection or under fault conditions, electrical arcs can form, posing additional safety risks. With a TD+ that incorporates an arc extinguishing mechanism, these arcs can be suppressed and extinguished, thereby enhancing overall system safety. This is particularly valuable in high-energy circuits where arc formation is found more frequently.

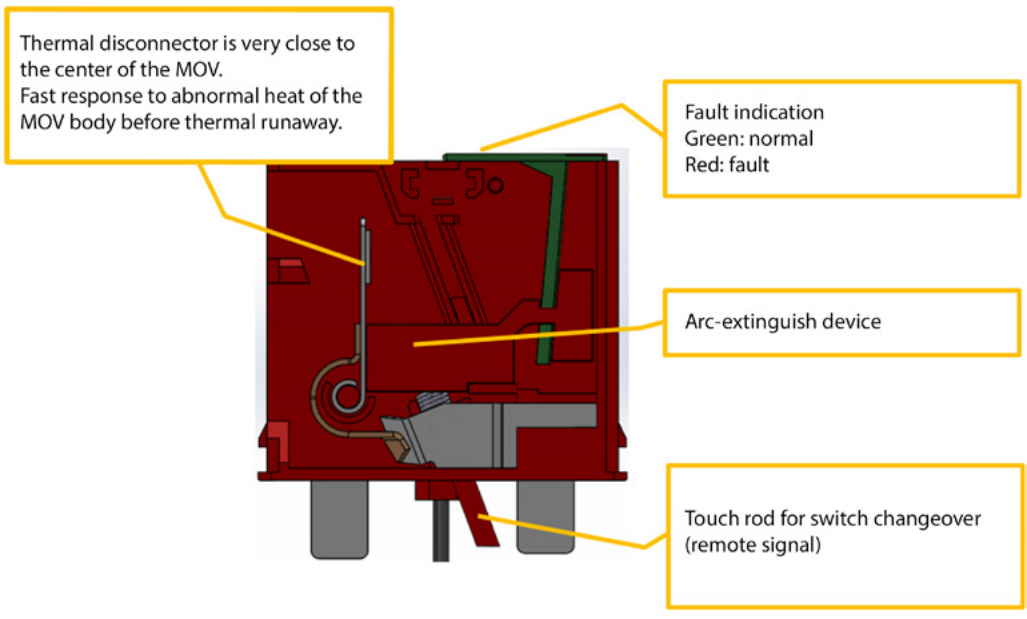

Figure 3. | *Diagram of the Advanced Thermal Disconnector (TD+)*

Benefits of TD+ Technology

- **Enhanced Fire Safety:** By promptly disconnecting and extinguishing arcs, an SPD with a TD+ significantly reduces the risk of fire hazards associated with thermal runaway.
- **Improved Equipment Protection:** Timely disconnection safeguards connected equipment from damage caused by overheating SPDs.
- **Increased System Reliability:** The comprehensive protection offered by an SPD with a TD+ minimizes downtime due to SPD failures, enhancing overall system reliability.

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Regulatory Requirements for Thermal Management in SPDs

The incorporation of thermal disconnectors and arc extinguishing devices within SPDs transcends mere best practice; it is a mandated requirement by various safety standards. As a good example, the UL 1449 standard (5th edition) for SPDs requires rigorous testing protocols to be performed, along with detailed documentation that verify the SPD's comprehensive safety measures, to effectively protect electrical systems from transient overvoltage threats and other surge-related hazards. This, and similar regulations, underscore the critical role that thermal management features play in helping to prevent system issues that lead to electrical fire hazards. By adhering to these standards, SPDs are demonstrably compliant with stringent safety and performance criteria.

Benefits of Regulatory Compliance

- **Manufacturer Credibility:** Compliance with safety standards signifies a manufacturer's commitment to electrical safety, fostering trust and brand reputation within the industry.
- **User Confidence:** Users gain heightened confidence in the protective capabilities of SPDs, ensuring peace of mind regarding the safety of their electrical systems.
- **Market Access:** Compliance with relevant safety standards is often a prerequisite for market entry into various regions.

Enhanced Operational Continuity and Maintenance Benefits

The advantages of thermal disconnectors and arc extinguishing devices extend beyond improved safety. These features contribute significantly to the operational continuity and the maintainability of electrical systems:

- **Reduced Downtime:** By preventing damage to the SPD and connected equipment during surge events, thermal disconnection and arc extinguishing minimize downtime and the need for emergency repairs. This translates to increased system availability and operational efficiency.
- **Proactive Maintenance:** The activation of a thermal disconnector serves as a clear indicator that the SPD has reached the end of its useful life after absorbing substantial surges. This timely notification facilitates proactive maintenance by prompting inspection or replacement of the SPD, ensuring continued surge protection for the system.
- **Simplified Maintenance Procedures:** The automatic disconnection feature in TD+ technology simplifies maintenance procedures. Disconnecting faulty components with a TD+ isolates the surge threat to ease a safe replacement of the SPD.

In essence, these advanced features promote a proactive approach to surge protection maintenance, minimizing system disruptions and ensuring the long-term effectiveness of the SPDs.

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Conclusion

The integration of advanced thermal disconnector (TD+) technology within SPDs not only represents a significant advancement in surge protection but also aligns with the evolving regulatory landscape. By prioritizing safety through features like thermal disconnection and arc extinguishing, TD+-equipped SPDs offer a superior solution for safeguarding electrical systems against damaging voltage surges, while simultaneously upholding the highest standards of electrical safety.

Bourns offers a growing portfolio of SPDs that feature TD+ technology. Offering superior surge protection, the features and capabilities of these advanced SPDs make them ideal protection solutions for a broad range of energy storage applications such as electric vehicle charging stations, Battery Energy Storage Systems (BESS), and green photovoltaic and wind energy systems.

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