APPLICATION NOTE

Surge Protective Devices for Photovoltaic Applications

Bourns® Model 1210 Series
Surge Protective Device (SPD)

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

Bourns® Model 1260 Series
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Bourns® Model 1430 Series
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Introduction

Helping to shield photovoltaic (PV) systems from harmful transient overvoltage events such as lightning and electrical switching, designers have found Surge Protective Devices (SPDs) to be excellent protection solutions. This application note dives deep into why SPDs are particularly ideal for these systems. It also provides details about their necessity, selection criteria, and the recommended installation location of SPDs in PV systems.

Why Surge Protection Matters in PV Systems

Photovoltaic systems are naturally exposed to all sorts of environmental conditions, making them particularly vulnerable to transient overvoltage threats. Voltage surges can damage sensitive components, reduce system efficiency, and lead to costly repairs. Here are key reasons why surge protection is crucial:

- **Lightning Strikes:** Both direct and indirect lightning strikes can induce extremely high transient voltages. Direct strikes cause immediate and catastrophic damage, while indirect strikes generate surges through electromagnetic induction.
- **Switching Operations:** Sudden switching actions in the grid or within the PV system itself can cause transient overvoltage conditions. These are less intense than lightning but occur more frequently.
- **Component Sensitivity:** Modern PV systems consist of sensitive electronics, including inverters and controllers, which can be easily damaged by surges.
- **System Downtime:** Surges can lead to system failures, resulting in downtime and loss of revenue. By installing effective surge protection, downtime risk can be minimized.

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How Many Solar Surge Protectors are Required for a Photovoltaic/PV System?

The number of SPDs installed depends on the system's complexity and configuration. Here are some general guidelines:

- **Solar Panels:** Used to generate DC electricity from sunlight. SPDs are typically not installed on panels.
- **Array Junction Box:** An SPD should be installed in each array junction box to protect individual strings of panels from surges.
- **DC Combiner Box:** Gathers DC power from multiple array junction boxes. Install SPDs in the DC combiner box to protect combined DC circuits.
- **Inverter Input:** SPDs should be installed at the input of the inverter to protect it from surges on the DC side.
- **Main Distribution Board:** Distributes the AC power to various loads, with additional protection devices like circuit breakers and SPDs.

An important note: A typical PV system requires multiple SPDs at each critical point to prevent surge damage. The exact number will vary based on the system size and design.

Steps for Choosing the Right SPD

Selecting the appropriate SPD for your PV system involves several key steps:

- **Step 1:** Determine System Voltage: Identify the Maximum Continuous Operating Voltage (MCOV) of the PV system. The voltage rating of the SPD should be equal to or higher than this value.
- **Step 2:** Assess the Surge Current Rating: Choose an SPD with a maximum surge current rating (Imax) that meets the location's lightning exposure. Higher Imax ratings provide better protection in high-risk areas to help reduce downtime and costly replacement.
- **Step 3:** Consider the Voltage Protection Rating (VPR) or Voltage Protection Level (U_p):The lower the VPR or U_p signifies better equipment protection. Choose an SPD with the lowest rating that meets the system's needs.
- **Step 4:** Evaluate the Environmental Conditions: Evaluate the features of the SPD(s), making sure they are suitable for the environmental conditions of the installation site, such as temperature range and humidity.
- **Step 5:** Verify Certification and Compliance: Confirm that the SPD complies with relevant standards for a given geographical market (e.g., UL 1449 for the U.S. or IEC 61643 for international markets) and has the appropriate certifications.

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Ensure Peak Performance: Installation Guidelines for SPDs in PV Systems

Proper installation is essential for maximizing the effectiveness of SPDs in PV systems. Below are the key installation guidelines:

Location and Positioning

- Install SPDs as close as possible to the point of potential surge entry. This includes junction boxes and inverter input.
- Ensure that the SPD is easily accessible for future maintenance and inspection.

Wiring Considerations

- Use short and straight wiring connections to minimize inductance and improve the SPD's performance.
- Follow manufacturer recommendations for wire sizes and lengths.

Solid Grounding is Critical

- For optimal SPD performance, ensure that all grounding connections are secure and meet local electrical codes.

Coordination with Other Protective Devices

- Coordinate SPDs with other protective devices, such as fuses and circuit breakers, to ensure they operate effectively together.

Periodic Maintenance

- Regularly inspect and maintain SPDs to ensure that they are functioning correctly. Replace any SPDs that show signs of damage or wear.

For optimum performance, consider placing a surge counter alongside SPDs, particularly at critical locations. This can help identify which areas experience the most surge activity, allowing operators to pinpoint maintenance needs and potentially reveal weaknesses in the system's surge protection strategy.

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What Kind of Standards do DC and PV SPDs Need to Follow?

Compliance with industry standards and certifications is required to help ensure the reliability and safety of SPDs. Here are the key standards:

UL 1449 (5th Edition)

- This standard is used in the U.S. and focuses on the performance and safety of SPDs. It covers parameters such as voltage protection ratings (V_{PR}), nominal discharge current (I_n), and maximum surge current (Imax).

IEC 61643

- This international standard is widely used in Europe and other regions. It defines requirements and testing methods for SPDs, including nominal discharge current (I_n), maximum surge current (Imax), impulse current (I_{imp}) and voltage protection levels (U_p).

Other Relevant Standards

- IEC 61643-31: Specific to SPDs for DC applications, particularly in PV systems.
- EN 50539-11: European standard for SPDs in PV applications.
- RoHS Compliance: Ensures the SPD does not contain hazardous substances.

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Suggested Bourns® SPD Model Series for PV Systems

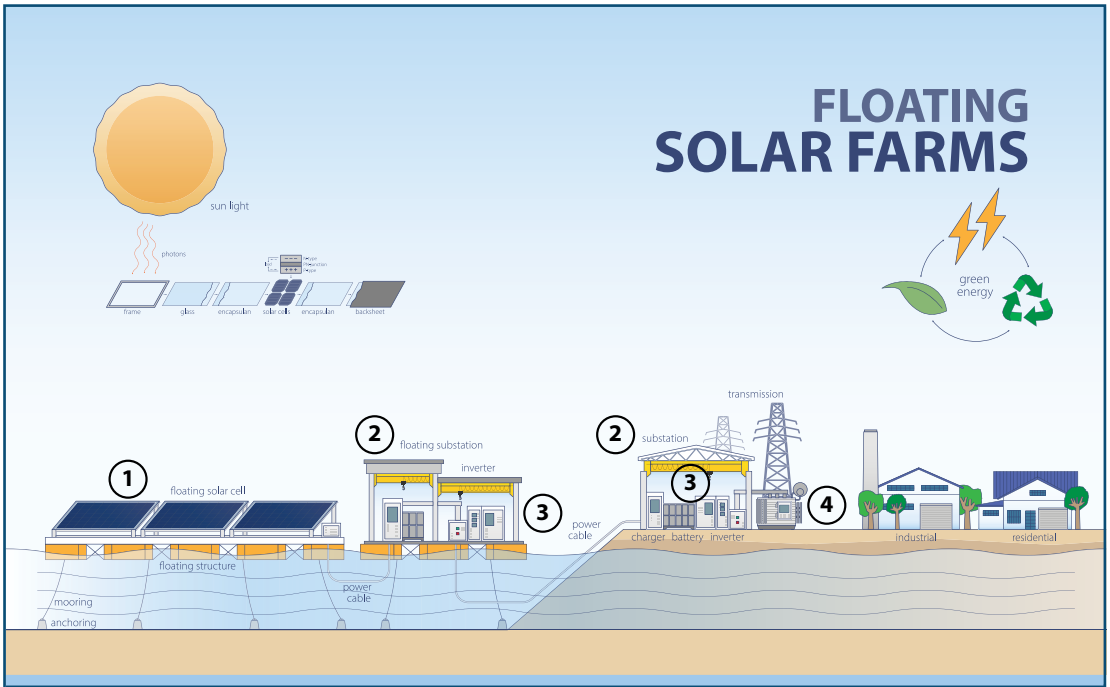

Table 1. | *Utility Grid Key Components and Locations*

Key Components / Location	Function Description	Suggested Bourns® SPD Series	Standards
1. Solar Panels	The primary sources of DC power.	1430	IEC/EN 61643-31 Class I / T1
2. Array Junction and DC Combiner Box	Each string of solar panels connects and combines the outputs from multiple array junction boxes.	1420A 1440	UL 1449 5th Ed. Type 2CA IEC/EN 61643-31 Class II / T2
3. Inverter	Converts the DC power from the solar panels to AC power.	1250A 1270 1280	UL 1449 5th Ed. Type 2CA IEC/EN 61643-11 Class I / T1 IEC/EN 61643-11 Class II / T2
4. Main Distribution Board	Distributes the AC power to various loads.	1210 1260	UL 1449 5th Ed. Type 1 IEC/EN 61643-11 Class I + II / T1 + T2

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Conclusion

Surge protection is an investment in the health and longevity of PV systems. By following the guidelines and suggestions provided in this paper, designers have a better understanding of how to select and specify the right SPD that can help to ensure solar panels operate reliably and efficiently for years to come, maximizing a customer's return on investment.

www.bourns.com

Americas: *Tel* +1-951 781-5500
Email americus@bourns.com

EMEA: *Tel* +36 88 520 390
Email eurocus@bourns.com

BOURNS®

Asia-Pacific: *Tel* +886-2 256 241 17
Email asiacus@bourns.com

Mexico: *Tel* +52 614 478 0400
Email mexicus@bourns.com