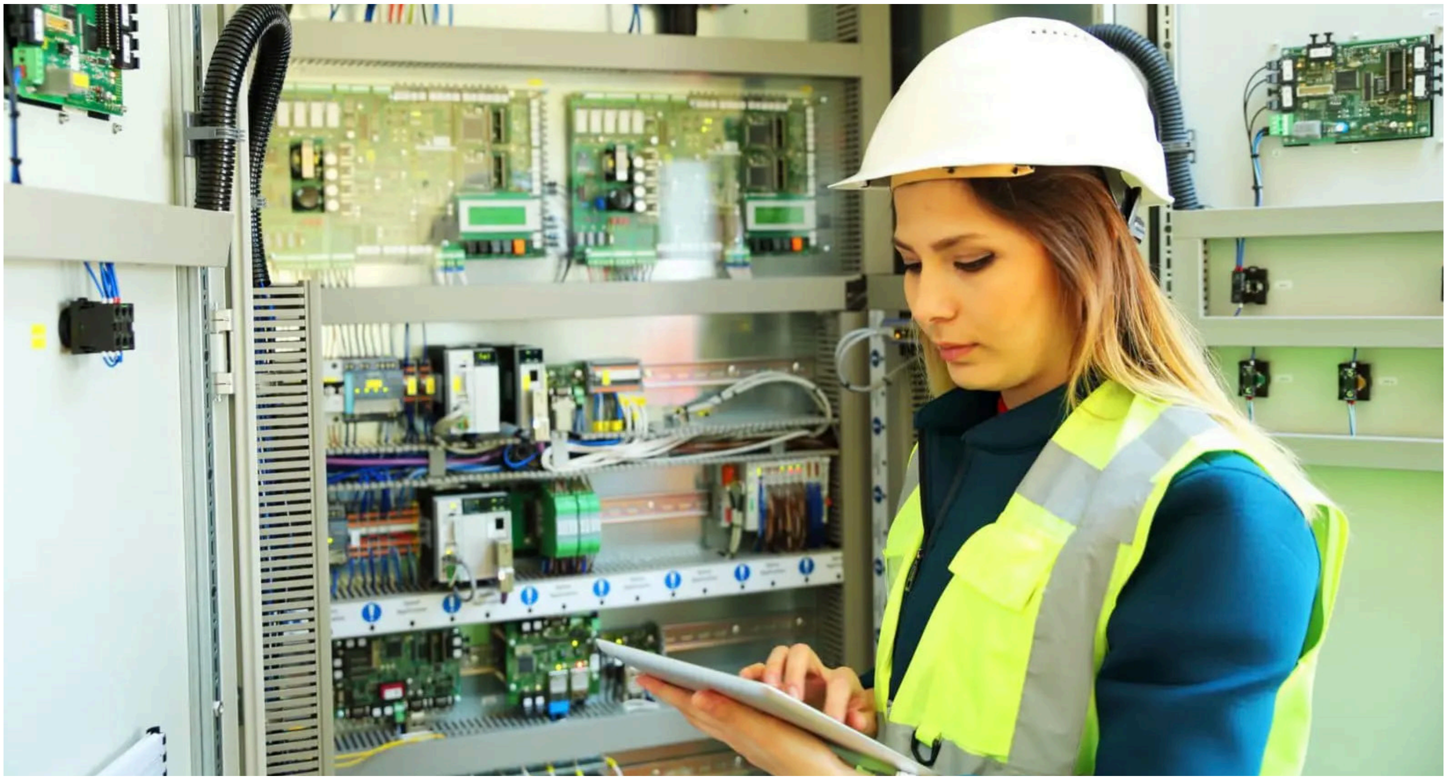

When an electrical surge occurs, voltage that greatly exceeds accepted peak voltage levels can pass through building circuits to electrical equipment. Without proper protection, this equipment is susceptible to damage or failure from a voltage surge. The type of protection required to negate these spikes can be provided by a surge protective device (SPD).

Specifying the correct SPD requires that you identify and understand the ratings associated with its application. There are many performance values and ratings associated with an SPD, such as maximum continuous operating voltage (MCOV), voltage protection rating (VPR), nominal discharge current (In), and short circuit current rating (SCCR). The most misunderstood rating is the surge current rating, typically quantified in kilo-Ampere (kA).

The UL1449 standard was developed to take the ambiguity out of the marketplace and ensure proper protection with a level playing field. However, it has undergone many changes over the years and any SPDs (or filters) installed in your facility or equipment prior to 2009 should be examined for compliance.

## How to Properly Size SPDs

There is very little published data or even recommendations on what level of surge current (kA) rating should be used in the different locations. The Institute of Electrical and Electronics Engineers (IEEE) has provided some input on what surge ratings are and how to interpret them but does not publish recommendations. Unfortunately, there is not a proven equation or calculator available to input system requirements and receive a solution. Any information a manufacturer provides, via calculators or other means, is merely their recommendation.

There is a tendency to assume that the larger the panel, the larger the kA device rating needed for protection. Another misconception is that if 200 kA is good, then 400 kA must be two times better. As you will see in this whitepaper, this is not always the case. As a result of its many years of knowledge, experience and expertise in the electrical industry, Emerson has generated some guidance on how to apply surge current ratings.
*(See figure 1, next page)*

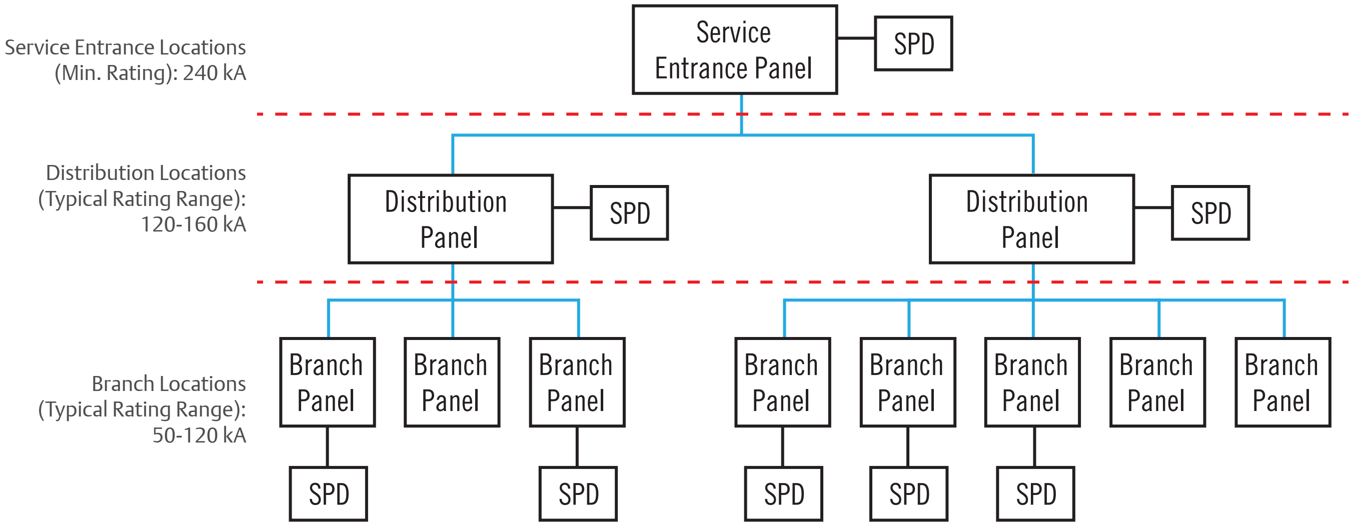


Figure 1: Cascaded Surge Suppression | IEEE Standard 1100

## Cascading Protection

To optimize the level of suppression throughout a system, SPDs should be installed at all levels of the electrical distribution system. This is known in the electrical industry as cascading (or layering), or as IEEE refers to it "Protection in Depth".

Cascaded surge protection provides additional suppression from large transients that step their way through from the service entrance by further reducing the let-through voltages. It also provides suppression from the more frequently generated internal transients.

Let-through voltage is the voltage appearing on the equipment side (load side) of an SPD when an impulse voltage/current of a defined wave-shape and amplitude is applied to the line side of an SPD. It can be used to compare different SPD's abilities to lower the surge voltage to the equipment requiring protection.

IEEE Standard 1100 recommends cascading levels of protection from the service entrance, to distribution and branch panels, and even protection for individual critical loads. The closer to the service entrance, the more robust the device should be rated. This protection in-depth strategy provides the best protection for your facility and critical loads. In recommending a kA per phase rating there is a general rule of thumb – the 3, 2, 1 Rule of Thumb. The service entrance should be 300 kA, distribution panels 200 kA, and finally branch panels can be 100 kA per phase.

*Once it has been determined where the SPD units are to be installed, help in determining the surge rating (level of protection) can be found by referencing the panels Ampere rating (see chart below).*

| | Surge Rating "Per Phase" (L-N + LG) Recommended Protection | |
|---|---|---|
| Panel Size | (Better) | (Best) |
| 0 - 225 Amp | 50 kA | 100 kA |
| 400 - 600 Amp | 100 kA | 200 kA |
| 800 - 1200 Amp | 100 kA | 200 kA |
| 1600 - 2500 Amp | 200 kA | 300 kA |
| 3000 Amp and Above | 300 kA | 300 kA |

| | |
|---|---|
| Type 1 | • Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of service equipment<br>• Installed without use of external overcurrent protective device |
| Type 2 | • Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device |
| Type 3 | • Point-of-utilization SPDs<br>• Installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel |
| Type 4 | • The component assembly consisting of one or more Type 5 components (typically MOV or SASD)<br>• Must comply with limited current tests and In<br>• Not tested as standalone devices to intermediate and high current faults |

*Note Type 5 – Discrete component SPD (MOV or SASD)*

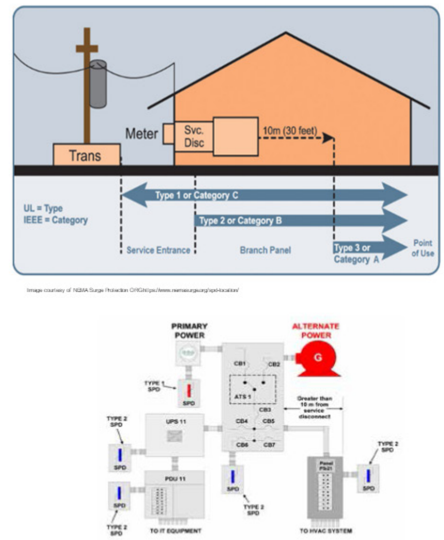


Figure 2: UL/ANSI 1449 | Types by Location

## Types of SPD Locations

Panel size does not play a major role in the selection of a kA rating. What is much more important is the location of the panel within the facility. UL1449 defines the location types within a facility as:

**Type 1** is intended for permanent application at the service entrance. It can even be before the main disconnect.
A UL1449 Type 1 device can be installed on the primary of buildings or the 1st disconnect.

**Type 2** is intended for installation on the load side of the main entrance panel.

**Type 3** is for specific devices, referred to as "point of utilization" in the standard.

**Type 4** would be a component device that is intended to be part of a larger assembly and is not approved for standalone use without additional safety evaluation. Be careful if you are offered a Type 4 device to be installed into a control panel. The panel builder would be responsible to submit for 3rd party safety approval, otherwise it wouldn't be covered in a catastrophic failure.

There is also a **Type 5**, which is the basic component, such as a metal oxide varistor, silicon avalanche diode or gas discharge tube. These clearly can't be directly installed into a facility.

## Recommendations

Choosing the appropriate surge rating for an SPD comes down to two things:

1) The location of the SPD within the electrical distribution, and;

2) The location of the facility (geographically)

*Emerson recommends the following surge current ratings based on SPD location within the electrical distribution using the general "3, 2, 1 Rule of Thumb" mentioned earlier.*

| Location | kA | Sola SPD |
|---|---|---|
| *Service Entrance* | *300 kA/phase* | *SPD300K* |
| *Distribution Panel* | *200 kA/phase*<br>*or 100 kA/phase* | *SPD200K*<br>*STV100K* |
| *Branch Panel(s)* | *100 kA/phase*<br>*or 50 kA/phase* | *STV100K*<br>*SPD50K* |

Larger more destructive surge currents are mostly found at the facility service entrance. On very rare occasions, for example if the exposure level is "extreme" (states like Florida), it might be wise to increase surge current ratings. In this example, the SPD will be exposed to larger surge events more frequently, but when choosing the correct surge current rating for your application, the SPD can then be exposed to a higher number of surge events before it needs to be replaced. In addition, SPD event counters come standard on some manufacturers models to help you accurately monitor events for these types of locations.

Our experience with SPD products shows that a device carrying a surge current rating between 240 and 250kA for a service panel or critical load will provide many years of service in the "high to medium" exposure locations over time, like the example above.

## Conclusion

The primary purpose of a surge protective device is to shunt and suppress the transient voltages that are being introduced into an electrical distribution system from either an external or internal source. Selecting the proper surge current (kA) rated SPDs throughout the electrical distribution system provides the best performance life for equipment. When selecting the appropriate SPDs for your facility, keep these key points in mind:

1. Providing proper surge suppression to a facility and the equipment within requires more than a single SPD located at the service entrance. We recommend cascaded SPDs with a proper surge current rating for each location. This will provide superior suppression for a service panel or critical load. A single SPD, no matter how big or expensive, will not provide the same level of system protection.
2. Over-sizing an SPD for its application cannot hurt a system, but under-sizing the SPD can result in premature failure of the SPD, leaving systems exposed to transients and their effects.
3. For direct lightning strikes, SPDs alone are not a replacement for a comprehensive lightning protection system (refer to UL96A Master Lightning Certification).

Following these guidelines for sizing and placing SPDs throughout an electrical distribution system (Table 1) takes the guess work out of selecting the appropriate SPDs for the intended locations and maximizes your surge suppression at every point. Remember, bigger isn't always better. Size appropriately for the load and protect your critical panels and loads to ensure a maximum return on investment.

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