

# Surge Protection for Residences

White Paper

# SURGE PROTECTION FOR RESIDENCES

## *Guidance For Contractors And Homeowners*

It is no secret that residences today contain more electronic equipment than ever before. Today, emerging technologies and the wide availability of internet connectivity have provided advanced communication and entertainment options to homes of every type. In addition, electronics are used to control even the most basic building systems and appliances. Because electronic equipment can be susceptible to damage from transient overvoltages, the proper application of surge protective devices (SPDs) is increasingly important. This paper describes the need for SPDs, the scope of protection needed to fully protect residential equipment and systems and the value of installing UL-Listed SPDs

### **The Importance of Protecting Electronic Equipment from Surges**

In the 1990's, a typical home may have been served by a single copper telephone line and an analog cable television service. Today, the list of communications and data services and the associated equipment now found in residences is extensive: Internet, television, communications, modems, routers, and wireless in-home networks; multiple personal computers, tablets and smartphones; sophisticated computer peripheral devices; advanced home theater systems; and internet-connected "smart" appliances.

Relatively simple appliances are no longer equipped with electro-mechanical controls, but are fitted with electronic control panels to optimize function, efficiency, and cost. Even modern LED lighting is controlled by electronic components. As the Internet of Things continues to expand, connected electronic devices will continued to be deployed to further optimize convenience and increase energy efficiency. Because of these changes, the value of electronic equipment in homes has increased and will increase to higher levels than ever before.

Because modern electronic components can be more sensitive to power "surges" than older equipment, electronic equipment can be more susceptible to damage than other types of devices. In larger or more sophisticated homes where the latest electronics are most likely to appear, the total value of electronic equipment can be significant. Surge protective devices are needed to mitigate damages from transient overvoltages to electronic equipment found in today's homes.

### **Surges Explained**

In order to protect residential electrical and electronic equipment, it is important to understand what a "surge" is. "Surge" is a common term for transient overvoltages that occur and decay very quickly, typically within microseconds. Most people associate transient overvoltages with lightning strikes. Lightning is, in fact, a source for overvoltage transients. For this reason, Underwriters Laboratories (UL) Standard 1449 prescribes testing that uses electrical impulses representative of potential lightning-induced transient overvoltages, where the majority of the energy decays within 20 milliseconds.

While lightning is a source of transient overvoltages, surges from utility switching operations are much more common. Nevertheless, lightning does not have to actually strike a home to damage the equipment it contains. Equipment in a home that is distant from a strike location can still be damaged when lightning-related transients are induced on utility wires that lead to a residence. For these reasons, it's important to apply surge protection at the service entrance of any building. However, overvoltage transients can also enter a home's electrical system along any conductor that penetrates its exterior, including telephone, cable television, and data communication lines.

Outside of a dwelling, lightning and utility switching are the most common sources of overvoltage transients. However, transients can also result from equipment operation within a building, such as motors or switched power supplies. Consequently, it can be important to apply SPDs to protect electrical and electronic devices from both external and internal sources of transient overvoltages. Recurring smaller surges can degrade equipment over time, causing them to fail pre-maturely.

## How SPDs Protect Against Overvoltage Transients

For residential applications, surge protective devices (SPDs) typically use metal oxide varistors (MOVs) to redirect excess voltage before it reaches appliances and electronic equipment. The properties of the solid state material in an MOV change according to the voltage that is present in a circuit. At nominal voltages, the material does not shunt voltage. When voltage exceeds the material's Maximum Continuous Operating Voltage, the material becomes conductive and redirects the excess voltage to a grounding system. In some applications, SPDs utilize different materials and technologies. Nevertheless, these units still redirect excess voltage to ground when transient overvoltages occur.

Residential wiring is typically comprised of conductors that carry 120 or 240-volt alternating current to equipment, a neutral conductor that returns to the power source, and a grounding conductor designed to safely carries fault currents to earth outside of the home. When SPDs are installed, they connect to the electrical conductors that supply AC power and to the grounding conductor. If a transient overvoltage reaches the SPD, the MOV redirects or shunts the excess voltage to the building's earthen ground. Licensed electricians and SPD manufacturers can provide guidance for selecting SPDs for specific nominal voltages and various grounding schemes.

## Safety Standard for SPDs

Underwriters Laboratories (UL) establishes testing requirements for verifying that electrical devices will operate safely when used for the purpose for which they were designed. UL 1449 - Standard for Surge Protective Devices is the primary standard for SPD safety, and sets forth minimum testing requirements for SPDs.

When selecting an SPD, it is important to verify that it is UL 1449 Listed, which indicates that it has passed UL 1449 safety tests for its designed use. Note that some SPDs are not UL-Listed, but are UL-Recognized. This designation indicates that an SPD has been tested for safety, and can be used within other equipment according to UL-specified restrictions. In addition, SPDs are available in the marketplace that have not been evaluated by UL.

In short, SPDs that have passed the most complete set of safety tests bear the UL-Listed designation shown in Figure 1. Any SPD used in residential applications should bear this mark.

<b>⚠ DANGER - HIGH VOLTAGE</b> <b>⚠ DANGER - HAUTE TENSION</b> <b>⚠ PELIGRO - ALTO VOLTAJE</b>	<p>Contains no user serviceable parts. This device features an internal protection that will disconnect the surge protective component at the end of its useful life but will maintain power to the load – now unprotected. If this situation is undesirable for the application, follow the manufacturer's instructions for replacing the device.</p>	<p><b>ASCO POWER TECHNOLOGIES</b></p> <p><b>MODEL: TE01XCS10AE2</b> <span style="border: 1px solid green; border-radius: 50%; padding: 2px;">UL 1449-4</span></p> <p><b>VOLTAGE: 240/120V</b></p> <p><b>MAX RATED AMBIENT AIR TEMP: 60°C (140°F)</b></p> <p><b>MCOV: 150/276V</b></p> <p><b>ENC TYPE: 1,12,4X</b> <b>SPD TYPE: 1</b></p> <p><b>MFG DATE: 1423</b> <b>In: 20kA</b></p>					
	<p><b>Connection Diagram—See Installation Manual</b></p> <table border="0"> <tr> <td>Black to Phase A</td> <td rowspan="5" style="border: 1px solid black; text-align: center; vertical-align: middle;"><b>SPD</b></td> </tr> <tr> <td>Black (or Orange), if equipped, to Phase B</td> </tr> <tr> <td>Black, if equipped, to Phase C</td> </tr> <tr> <td>White, if equipped, to Neutral</td> </tr> <tr> <td>Green, if equipped, to Ground</td> </tr> </table> <p>Remote Alarm wires to be connected to Class 1 circuits only.</p>	Black to Phase A	<b>SPD</b>	Black (or Orange), if equipped, to Phase B	Black, if equipped, to Phase C	White, if equipped, to Neutral	Green, if equipped, to Ground
Black to Phase A	<b>SPD</b>						
Black (or Orange), if equipped, to Phase B							
Black, if equipped, to Phase C							
White, if equipped, to Neutral							
Green, if equipped, to Ground							

Figure 1: SPDs should bear the UL mark and be listed to UL 1449



## Points-of-Entry

As previously stated, overvoltage transients can enter a home's electrical system along any conductor that penetrates its exterior. The IEEE Recommended Practice for Powering and Grounding Electronic Equipment (IEEE 1100) states that "a UL listed and properly rated surge protective device should be applied to each individual or set of electrical conductors penetrating any of the six sides forming a structure." For example, circuits that supply power to outdoor equipment can each serve to carry externally generated transient overvoltages into the dwelling. Outdoor equipment such as air conditioning units, water supply and swimming pool pumps, electric gates, irrigation systems, satellite antennas, vehicle-charging systems, and pole-mounted lighting can all feed transient overvoltages from the environment or from equipment into the dwelling. Figure 2 illustrates some of the systems that could require surge protection.

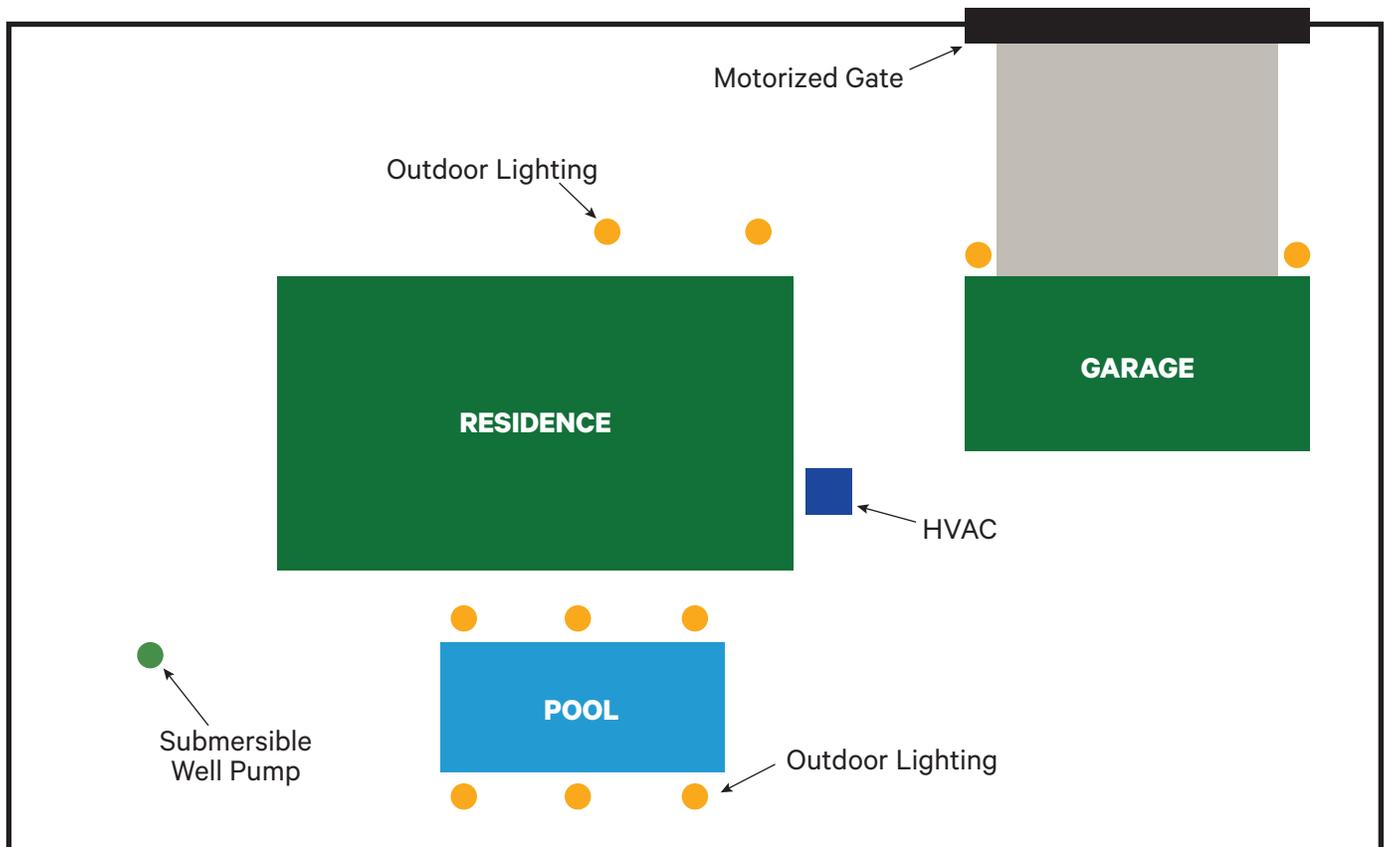


Figure 2: Residential systems that could require surge protection

When outdoor transient overvoltages travel toward a home, the transient can affect any equipment that it passes. To best mitigate transient overvoltages from exterior sources, IEEE 1100 recommends installing SPDs on each distribution panel in a residence, including any secondary branch distribution panels. For instance, if the electrical system uses a branch panel to supply power to a separate garage, then both the main and branch panels should be fitted with appropriate SPDs. In this way, a large surge entering the home from a garage circuit can be mitigated before it propagates to other circuits and the equipment they power. If a large home is served by two electrical mains, then a separate SPD is required for each of the service disconnects and distribution panels. In addition, outdoor equipment such as HVAC units and pole-mounted equipment may warrant protection using appropriate SPDs.

In some regions, utility companies offer monthly plans for providing SPDs to protect residential electrical systems. Typically, the utility company will install an SPD on a residence’s main distribution panel. While these devices can reduce transient overvoltages that enter a home through the utility main, they may not protect the electrical system from transients entering along other conductors, such as those used for cable and telephone services, or from circuits serving outdoor equipment. In addition, these devices will not provide full protection because this approach does not “cascade” protectors on circuits across the dwelling in accordance with IEEE 1100 recommendations. The need for further protection from transient overvoltages should be evaluated according to the type, amount, and value of the equipment located in a specific dwelling. A licensed electrician or an SPD manufacturer can help assess surge protections recommend appropriate SPDs as necessary.

## SPD Types

UL 1449 characterizes the potential surge environment according to locations within building electrical systems. The standard specifies different SPD types for each environment, as described in the following table. Locations for each type are shown on Figure 3.

Table 1: SPD Types		
SPD Type	SPD Features	Locations for Use
Type 1	<ul style="list-style-type: none"> <li>• Hardwired, permanently connected</li> <li>• Built-in overcurrent protection</li> <li>• Most rigorous UL-1449 testing requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Intended for installation between the utility transformer and a building’s main overcurrent protection device</li> <li>• Can be installed anywhere in a building’s electrical system</li> </ul>
Type 2	<ul style="list-style-type: none"> <li>• Hardwired, permanently connected</li> <li>• May or may not have built-in overcurrent protection</li> </ul>	Can be installed anywhere downstream of a building’s main overcurrent protection device
Type 3	<ul style="list-style-type: none"> <li>• Typically cord-connected</li> <li>• May or may not have built-in overcurrent protection</li> </ul>	<ul style="list-style-type: none"> <li>• Installed near equipment at the point-of-use, provided conductor length from a primary panelboard exceeds 10 meters (30 feet).</li> <li>• Type 3 SPDs are often corded power strips with built-in surge protection components</li> </ul>

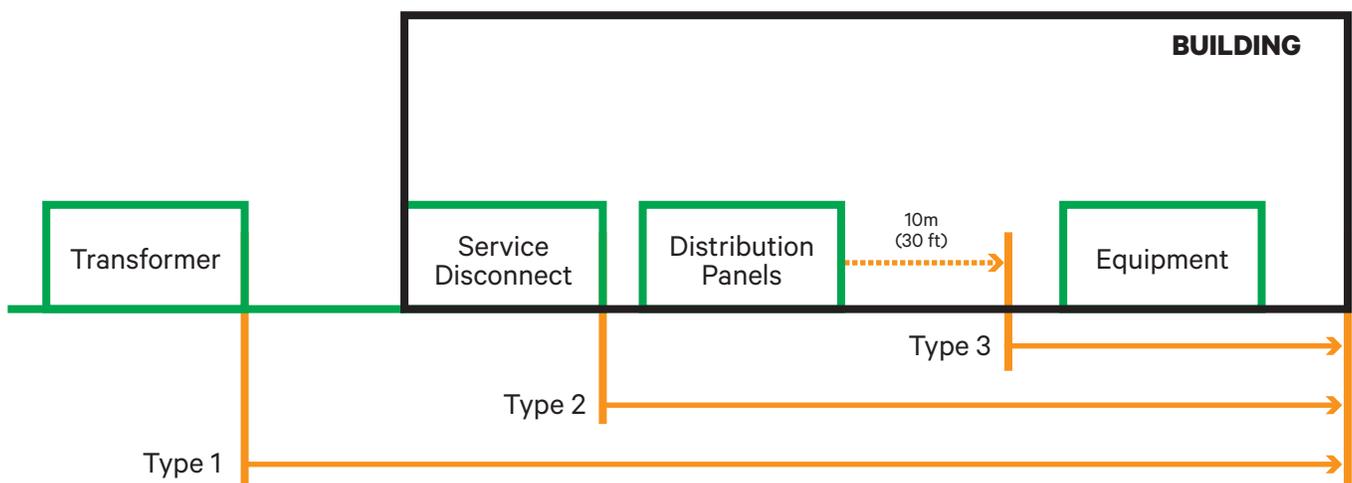


Figure 3: UL 1449 SPD Types by Location - For most residences, both the service disconnect and the distribution panel are located in a single box.

## SPD Designs

SPD designs vary according to the type of conductor to which they will be fitted, and according to the locations where they will be installed. For instance, panelboards are protected using hardwired SPDs, but cable television circuits require coaxial SPDs. Manufacturers offer SPDs in a variety of forms and specifications to protect a wide range of electrical equipment. The table below lists configurations and application notes for installing SPDs on equipment typically found in homes.

Table 2: SPD Applications			
Equipment	Type	Connection	Rating
Service Disconnect	UL 1449 Type 1	Hardwired	50kA per phase
Outdoor Generator	UL 1449 Type 1	Hardwired	50kA per phase
Primary Panel Boards	UL 1449 Type 2	Hardwired	60kA per phase
Copper Communication Lines (Phone, Modem, Fax, DSL, Security)	UL 497	RJ-45	250A
Cable TV (CATV, DSS, TV, VCR & Cable Modem)	UL 497C	Coax	5kA
Computer Equipment	UL 1449 Type 3	Cord-connected plug-in strip	39kA peak AC current 2-5kA for DC current
Modem			
Home Theater			
Electronically Controlled Appliances			
Outdoor HVAC	UL 1449 Type 1	Hardwired	50kA per phase

## Application Notes

It is important to note that Type 1 SPDs and certain Type 2 SPDs are manufactured with a built-in overcurrent protection device. This feature will disconnect the SPD from a circuit if a momentary overcurrent event occurs as a result of a transient overvoltage. When specifying SPDs, the rating of its internal overcurrent protection device must exceed the rating of the upstream overcurrent protection device on the electrical circuit. This ensures that the SPD will remain available to protect against overvoltage transients when the upstream circuit breaker is reset following an overcurrent event.

When installing hardwired SPDs, it is important to keep lead lengths as short as possible. As a general rule, each foot of conductor leading to an SPD increases its “let-through” or clamping voltage by 100 volts or more. For this reason, Article 285 of the National Electrical Code® specifies that SPD lead lengths shall not be longer than necessary. It also specifies that these leads shall be installed to avoid unnecessary bends.

In practice, it is not uncommon to find a 120V SPD that has been installed on a 240V circuit. Because the nominal voltage of the circuit is higher than the Maximum Continuous Operating Voltage (MCOV), this arrangement will result in continuous shunting of current to ground, leading to SPD failure. The nominal voltage of an SPD should always match the nominal voltage of electrical circuit that it will protect.

## Summary

Because electronic equipment has become prevalent throughout modern homes, unmitigated transient overvoltages could result in greater damage and cost than previously experienced. Potential damages from transient overvoltages can be mitigated by installing appropriate surge protection devices. While utility surge protection services may mitigate transients entering a home for utility power lines, full protection can only be provided by installing UL-Listed SPDs using the cascaded approach recommended in IEEE 1100. The type, amount, and value of the electronic equipment in the dwelling should be considered when evaluating the scope of surge protection that should be installed in a specific residence. A licensed electrician or an SPD manufacturer can help assess surge protection needs recommend appropriate SPDs.



**Schneider Electric**  
14550 58th Street North  
Clearwater, Florida 33760

[se.com/us/en/work/support](https://se.com/us/en/work/support)  
**1-888-778-2733**

WP-50016 RevA 02/2021