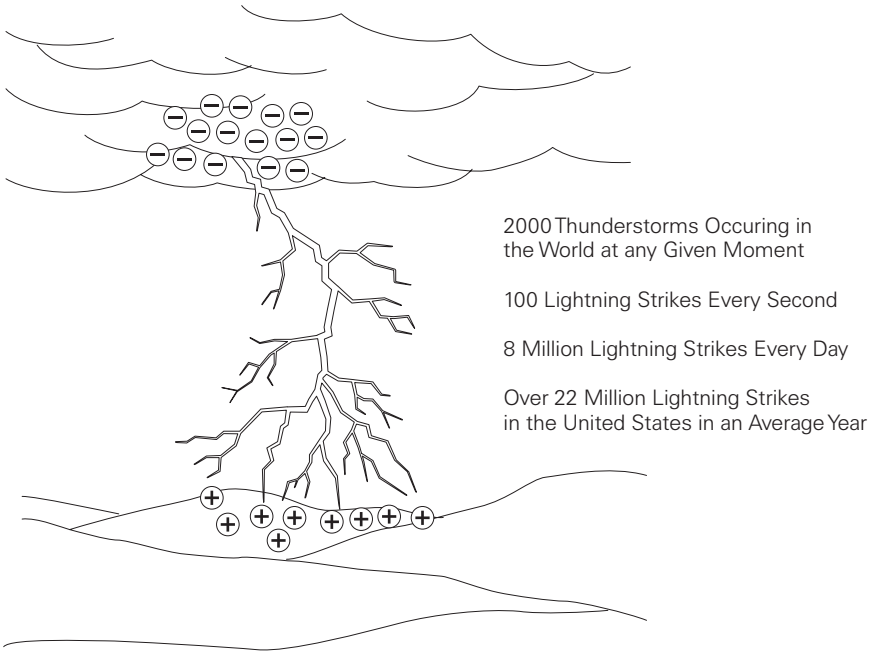
Sources of Voltage Surges

Surges from Outside the Home

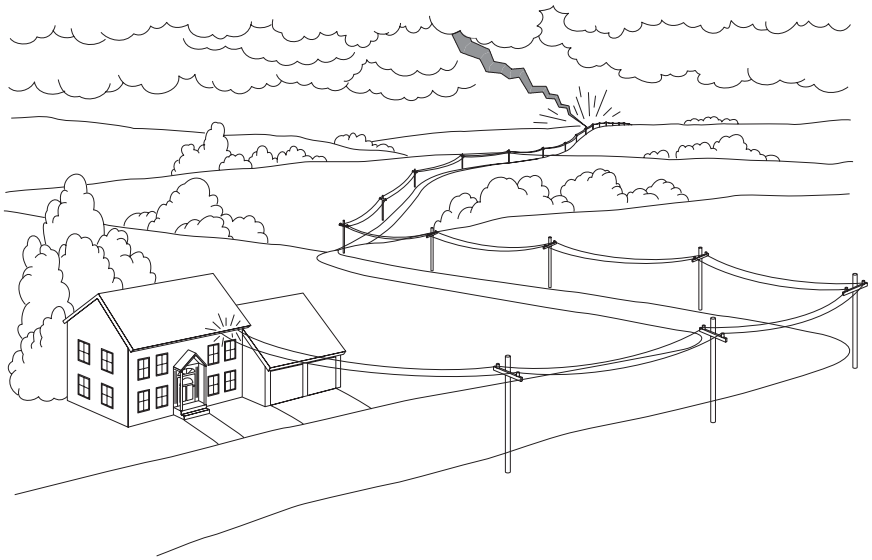
There are several causes of electrical surges that can originate outside the home. Surges can occur when large electrical loads are turned on and off, such as electrical machinery at a nearby factory or at the utility company itself.

Lightning is the most damaging source of surges. Lightning is caused by the attraction of positive and negative charges in the atmosphere. This results in a buildup and discharge of electrical energy. Lightning can occur within a cloud, from cloud to cloud, or from cloud to earth. According to the National Oceanic and Atmospheric Administration (NOAA) there is an estimated 2000 thunderstorms at any given moment in the world, resulting in 100 lightning strikes every second. There are over 22 million lightning strikes in the United States in an average year. A typical lightning strike consists of 20,000 to 100,000 amps at 30 million volts.



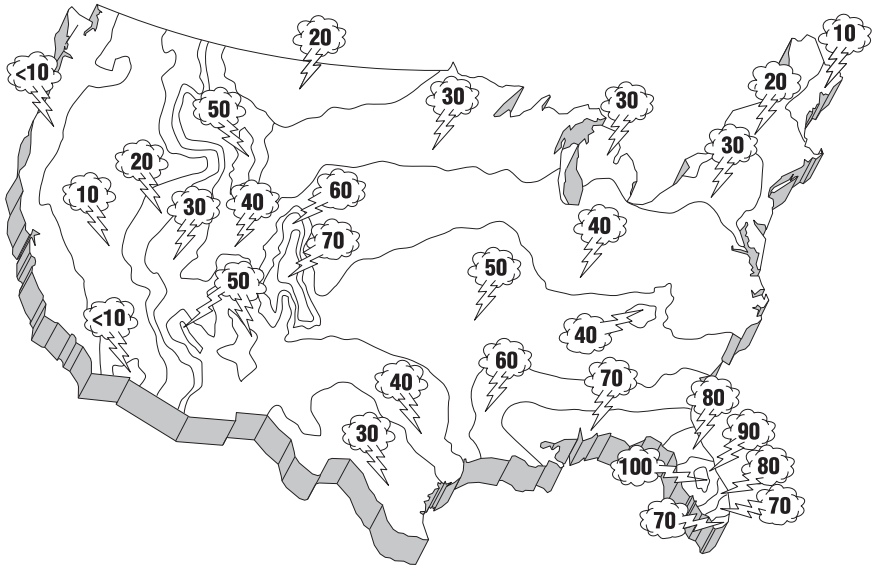
Electrical Equipment Damage

Lightning does not have to strike a home, or near a home to cause electrical damage. A lightning strike on a power line several miles away still has the potential to cause extensive electrical damage in a home. Lightning strikes on high voltage lines are generally dissipated by utility transmission lines.



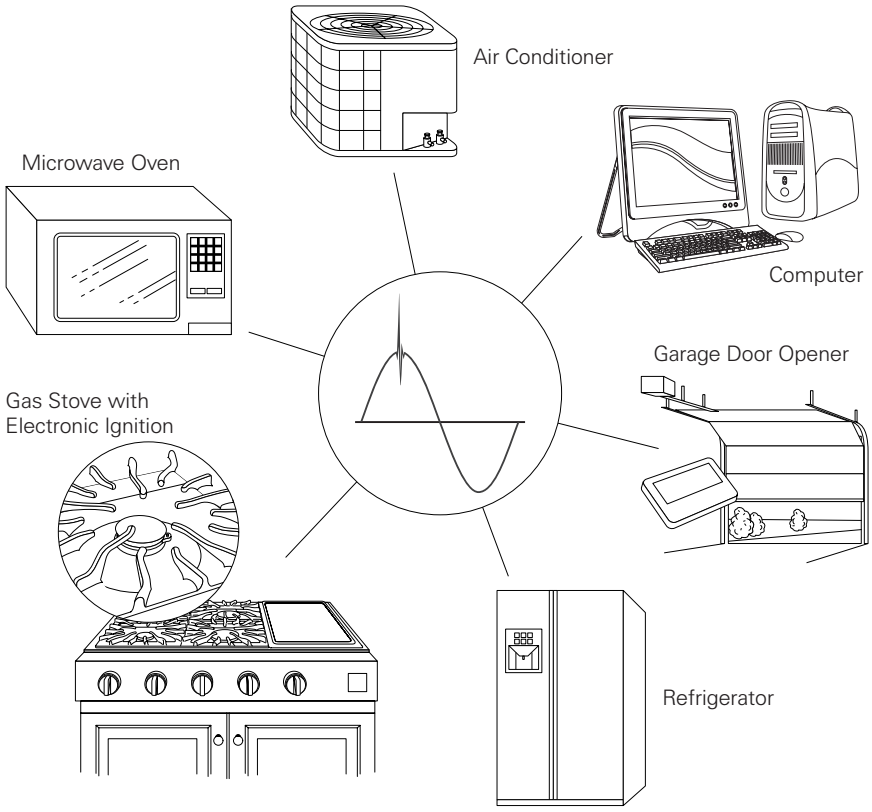
Thunderstorm Locations

Thunderstorms occur everywhere in the United States. The following map shows the approximate mean annual number of days with thunderstorms in the United States.



Surges from Within the Home

Lightning isn't the only source of electrical surges. Many devices that are sensitive to electrical surges also produce electrical surges. Motor driven equipment, such as garage door openers, refrigeration, and air conditioners are not the only sources of electrical surges within the home. Television, computers, microwave ovens, and modern gas ranges and furnaces that use electronic ignition can also cause line disturbances and surges.



Surge Protection

There are a number of devices available to protect sensitive electronic equipment from surges. An understanding of terms associated with surge protectors will help provide an understanding of how they work.

Units of Measurement

The International System of Units, known as SI (Système Internationale d'Unités), is used throughout the world. The SI system is more recently used in the United States.

Joule Rating

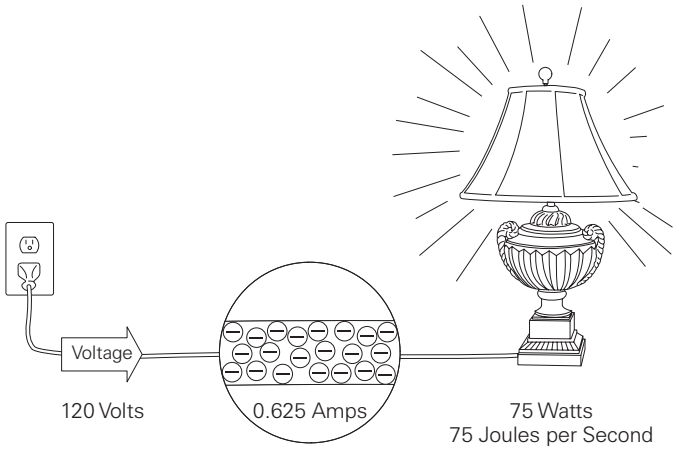
Surge protectors are commonly rated in joules (J), which is an SI unit of measurement for work done or energy expended. This rating provides an indication of how much energy a surge protector can absorb. The higher the joule rating, the more energy a surge protector can absorb.

Work is accomplished when a force causes motion. In an electrical circuit, voltage applied to a conductor will cause electrons to flow. Voltage is the force and electron flow is the motion. The result of this work is power which is used by an electrical light or appliance connected to the circuit. Power is the rate work is done or the rate of energy usage.

Power consumed is measured in watts (W). The watt is defined as *the rate work is done in a circuit when one amp flows with one volt applied*. If 120 volts were applied to a circuit that caused 0.625 amps of current to flow, the power consumed would be 75 watts.

P = ExI
P = 120 x 0.625
P = 75 watts

Another way to view this is to look at joules of energy used. One joule is equivalent to one watt of power for one second. In this example 75 joules of power is consumed every second. If a lamp were left on for an hour, 270,000 joules of energy would be used (3600 seconds x 75 watts).



Clamping Voltage

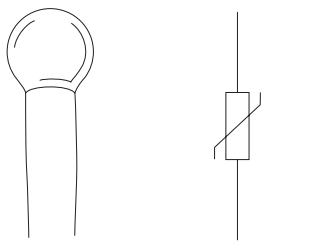
Clamping voltage is a measure of the voltage-limiting capability of a surge protector. Voltage at a lower level than the clamping voltage is passed on to the load. Voltage in excess of the clamping level is blocked.

Peak or Impulse Current Rating

Peak current rating specifies the maximum energy that can be dissipated from a single surge without causing the protecting device to be damaged. The higher the peak current rating the better the protection.

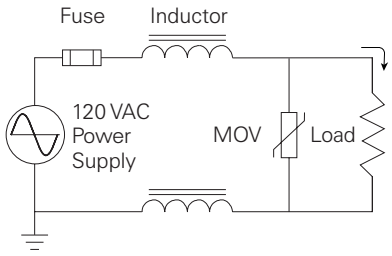
MOV

A metal oxide varistor (MOV) is a device commonly used in surge protectors. There are two characteristics of MOVs that make them desirable for surge protection. First, the resistance of an MOV decreases with an increase in voltage. In addition, MOVs are fast acting and can respond to a surge in just a few nanoseconds. This results in suppressing a surge before it has a chance to damage electronic equipment.



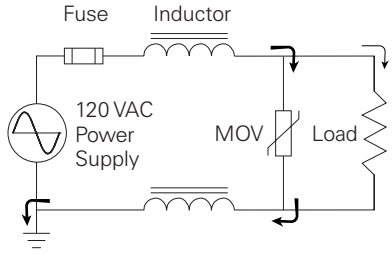
How Surge Protectors Work

Under normal conditions an MOV provides a very high resistance path. Resistance can be several hundred thousand ohms, limiting the current flowing through the MOV and allowing most of the current to flow through the load. In residential applications the load can be a computer, television, or other commonly used electronic device.



Normal Voltage

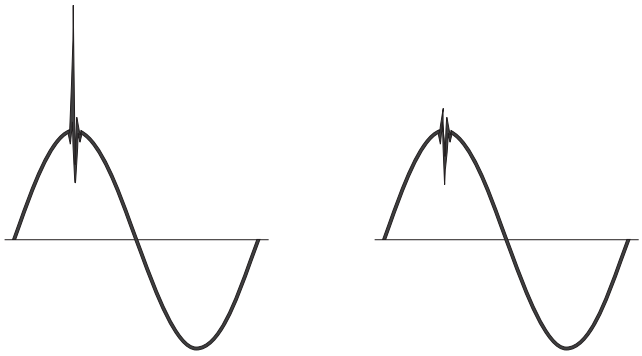
The voltage rating of an MOV is greater than the normal supply voltage. Therefore, when a surge occurs and the clamping voltage rating of the MOV is exceeded, the MOV switches from a high resistance path to a low resistance path. Surge voltage passes through the MOV to ground, bypassing the connected load. Better surge protectors have inductors in series with the load and MOV to the slow the rise in current. In addition, surge protectors may incorporate a fuse or miniature circuit breaker to protect circuits from longer overcurrent conditions.



Surge Voltage

Example

It is important to note that a surge protector's peak impulse rating applies to its ability to handle a surge. The lamp that used 270,000 joules in an hour would appear to far exceed the capability of a surge suppressor rated for 1500 joules. However, this is energy delivered to the load and not associated with current through the surge suppressor. Surges are typically short in duration, lasting only a few milliseconds. For example, a surge of 1000 volts at 100 amps would only provide 100 joules if the surge lasted one millisecond (1000 x 100 x 0.001).

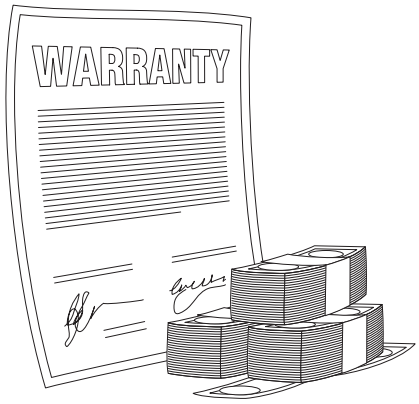


Unsuppressed Surge

Suppressed Surge

Warranty

Although warranty is not a technical term, it is very important when considering a surge protection device. Better warranties provide both product and connected equipment replacement. The amount of replacement available varies with the product and the manufacturer.



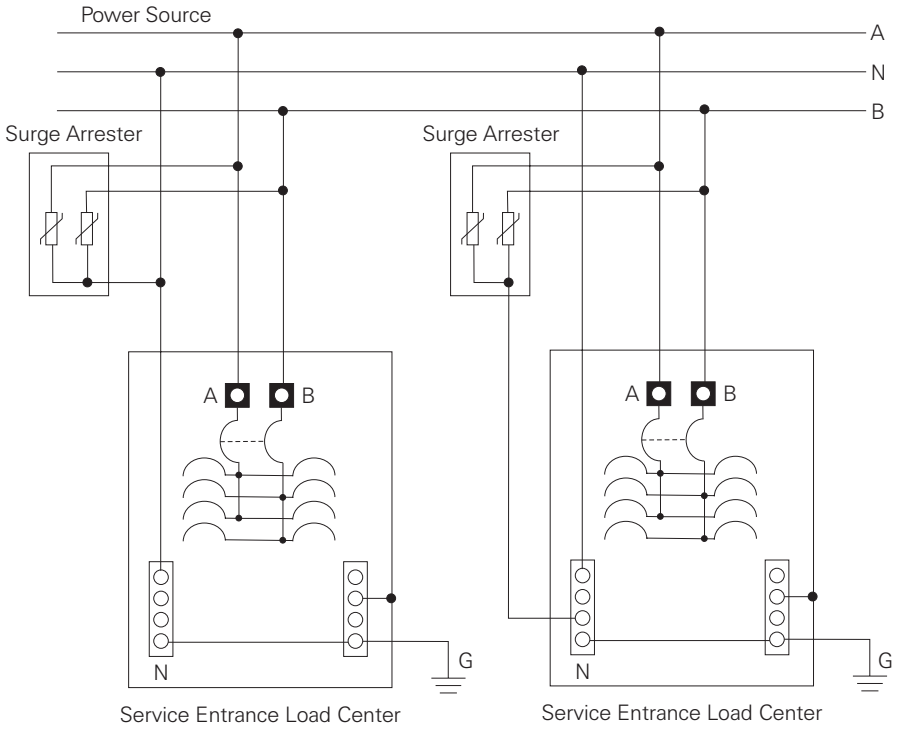
Surge Arrester and TVSS

Surge arrester and transient voltage surge suppressor (TVSS) are two terms associated with surge protection devices that are often interchanged. Both devices protect equipment by providing a preferred path of surge current to ground. Surge arresters are discussed in the *National Electrical Code®* Article 280. Transient voltage surge suppressors are discussed in Article 285.

Surge Arrester Definition

NEC® Article 280.2 defines a surge arrester as *a protective device for limiting surge voltages by discharging or bypassing surge current, and it also prevents continued flow of follow current while remaining capable of repeating these functions*.

The *National Electrical Code®* does not require the use of surge arresters, however; when surge arresters are used *NEC®* Article 280.21 permits them to be installed at the service entrance in front of the main disconnect. Article 280.3 requires a surge arrester to be connected to each ungrounded conductor. The following illustration shows two ways this requirement can be met.



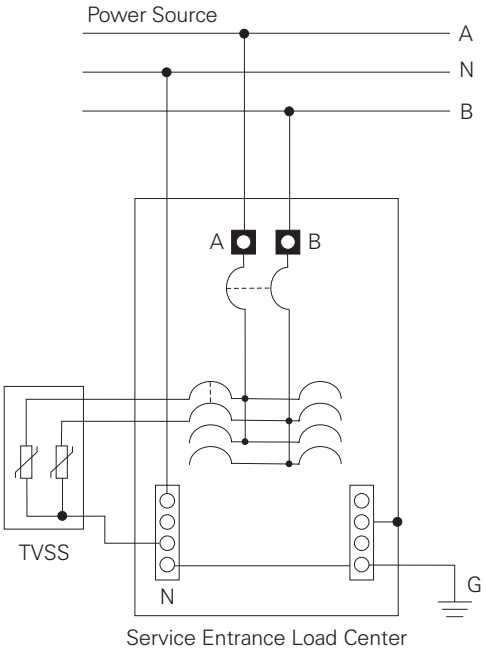
TVSS Definition

NEC® Article 285.2 defines transient voltage surge suppressors as *a protective device for limiting transient voltages by diverting or limiting surge current; it also prevents continued flow of follow current while remaining capable of repeating these functions*.

Transient voltage surge suppressors provides a similar protection function as a surge arrester. Transient voltage surge suppressors are generally installed to protect sensitive electronic equipment such as computers, telecommunications, and other electronic equipment. Two articles in the *National Electrical Code®* help provide distinction between a surge arrester and a transient voltage surge suppressor.

Article 285.5 requires that TVSS devices be listed. This simply means that equipment meets appropriate standards and has been tested and found suitable for a specific purpose. There are a number of companies that test and list electrical products. One such company is Underwriters Laboratories (UL), which is a private company that is nationally recognized as an independent testing laboratory. Transient voltage surge suppressors must meet criteria for UL 1449.

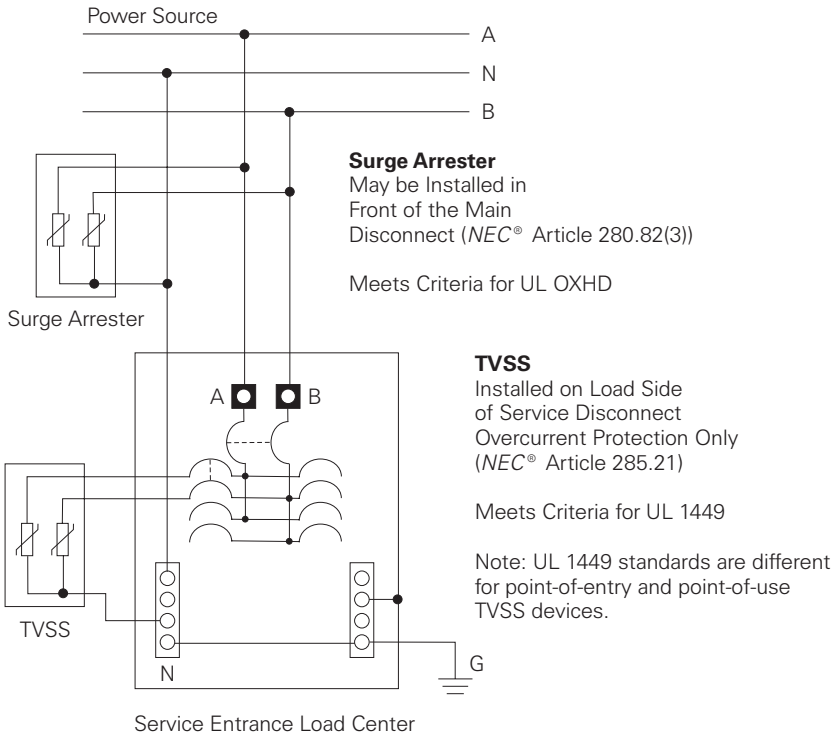
NEC® Article 285.21 specifies that when a TVSS device is used it must be installed on the load side of the service disconnect overcurrent protection.



Comparison

Although the *NEC®* definitions of a surge arrester and a transient voltage surge suppressor are similar, there are two things that distinguish the two. First, only surge arresters may be connected ahead of the disconnect (Article 230.82(3)). The *National Electrical Code®* requires that TVSS devices be located on the load side of the service disconnect overcurrent protection.

The second difference is in the standards they are expected to meet. Products that pass UL safety tests can carry a UL label. UL has several categories of labels based upon the product tested. We have already learned that TVSS devices must meet the criteria for UL 1449. Surge arresters are also tested and must meet criteria for UL OXHD.



Review 2

1. _____ is the most damaging source of surges.

2. A typical lightning strike consists of _____ to _____ amps.

3. Surge protectors are rated in _____ , which is an indication of how much energy a surge protector can absorb.

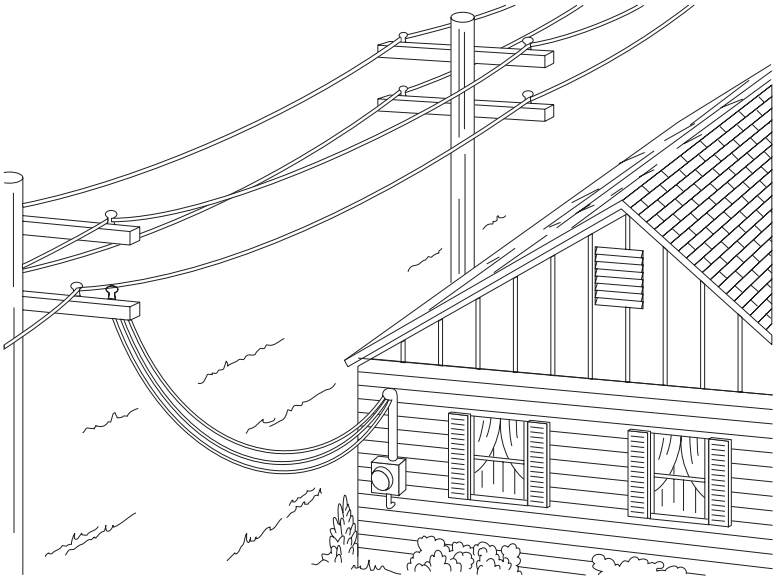
4. An _____ is a device commonly used in surge protectors that exhibit a change of resistance with a change in voltage.

5. Surge protectors typically provide a desired path to _____ when a surge occurs, bypassing the connected load.

6. A main difference between a surge arrester and transient voltage surge suppressor is that a transient voltage surge suppressor is connect to the _____ side of the service disconnect overcurrent protection.

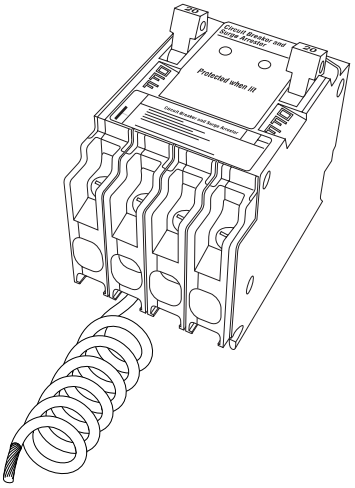
Point-of-Entry Surge Protection

Surge protection devices installed at the service entrance can divert surges to ground before they enter the premises. A properly installed and operating point-of-entry surge protector shields motor-driven appliances, such as refrigerators, dishwashers, electric washers and dryers, heaters, and air conditioners from damage.



Point-of-Entry Solutions

An electrical surge, whether it is caused by electrical equipment or lightning, always seeks ground. Any component between the source of the surge and ground can be damaged. Siemens circuit breaker surge arresters provide a preferred route to ground, bypassing expensive and sensitive equipment. Siemens offers product solutions for both Siemens load centers and load centers of other manufactures.

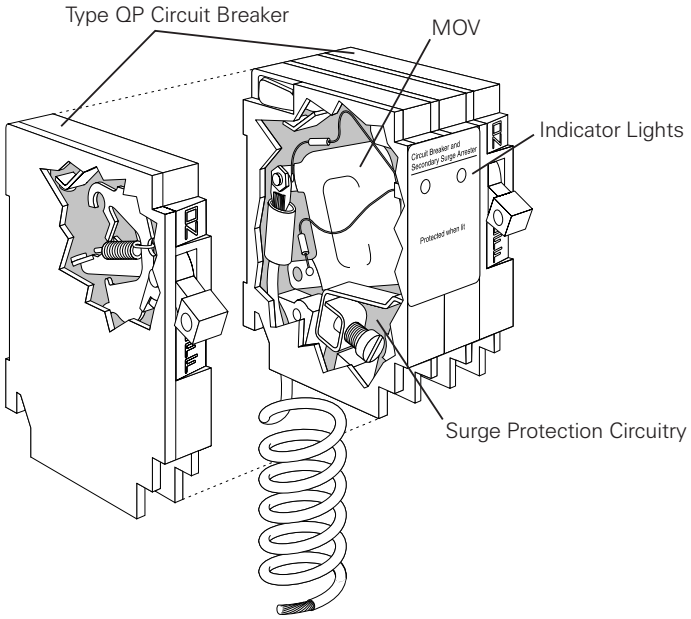


Type QP and TVSS Circuit Breaker
Siemens Load Centers

Primax Point-of-Entry Protector
Siemens and All Other Load Centers

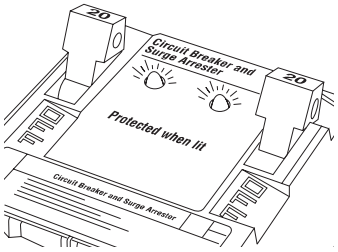
Siemens Circuit Breaker Surge Suppressor

The Siemens circuit breaker and transient voltage surge suppressor (TVSS) module is comprised of a highly effective surge suppressor integrated with two 1-pole circuit breakers.



Visual Indication

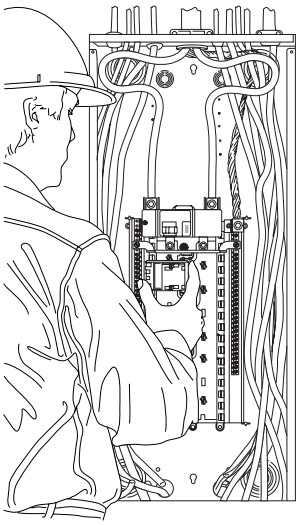
Even the best point-of-entry surge protectors are subject to failure in the event of a catastrophic surge. Good surge protectors will sacrifice themselves and not the connected equipment. Better surge protection devices provide visual indication that the surge protection circuitry is functional and protecting the connected equipment. If the indicator lights are not illuminated the home owner should replace the surge protector promptly.



Installation

Installation is as simple as mounting a conventional circuit breaker in a Siemens load center. After power is switched off and the trim removed, the circuit breaker/surge arrestor plugs into place. A wire is provided to connect the ground side of the module to the load center's neutral bus. It is best to position the circuit breaker/surge arrestor in the first position of the load center and connect the wire in the first neutral position. One device provides protection for the entire electrical system.

The device does not require a dedicated space as it replaces two existing circuit breakers. Although the circuit breaker portion can be connected to any 120 volt circuits, connecting it to a lighting circuit provides additional visual indication that the device is working. If the device trips due to a high voltage surge, it is reset like any other circuit breaker in the panel.

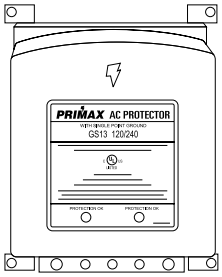


Ratings

Clamping Rating	500 V at 3000 A
Energy Rating	720 joules, line-to-line
Impulse Rating	40,000 A
Warranty	$20,000, includes kitchen and laundry room equipment connected to dedicated circuits

Primax® Point-of-Entry Protector

The Primax point-of-entry protector is another option to shield motor-driven appliances against electrical power surge damage. Primax is mounted external to the load center so it can be used with Siemens or non-Siemens load centers. Two versions are available, side mount and back mount.

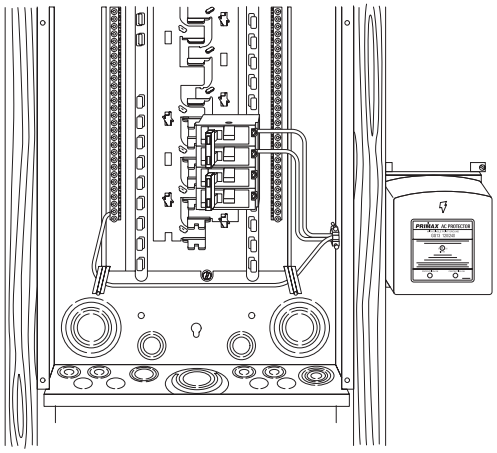


Back Mount

Side Mount

UL Listed

Primax is UL listed for installation before the main disconnect as a surge arrester (*NEC®* Article 280.21) or after the main disconnect as a transient voltage surge suppressor (*NEC®* Article 285.21). The following drawing illustrates a Primax point-of-entry surge protector connected as a TVSS. The Primax is connected to the load side of the main-service disconnect through a two-pole, 20 amp circuit breaker. Two LED lights indicate the protection status. In addition, if protection is disrupted there is an audible alarm.



NEC® and *National Electrical Code®* are registered trademarks of the National Fire Protection Association.

Ratings

Clamping Rating	400 V
Energy Rating	1920 joules, line-to-line
Impulse Rating	60,000 A
Warranty	Major household appliances are covered against surge damage for 3 years and up to $10,000 when a Primax is installed by a qualified electrician. Primax surge protectors will be replaced if damaged during the first 5 years of ownership.

Review 3

1. The Siemens circuit breaker and TVSS module is comprised of a point-of-entry surge suppression integrated with two 1-pole _____ _____.

2. The _____ point-of-entry surge protector can be used with Siemens or non-Siemens load centers.

3. The Siemens circuit breaker and TVSS module is rated for _____ joules.

4. The Primax is UL listed for installation before the main disconnect as a _____ _____ or after the main disconnect as a TVSS.

5. The Primax is rated for _____ joules.

Note: See complete warranty for full information on Siemens point-of-entry surge protectors